Daventry PRT Scoping Study

PHASE 2 REPORT

- FINAL
- 6th February 2008

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Executive Summary

1) Daventry's key objective is to develop a sustainable transport system for the town to facilitate its expansion from 23,000 population to 40,000 or more, reduce Green House Gas emissions and improve the quality of inward investment. SKM were appointed by Daventry District Council in December 2006 to undertake a two phase study. SKM led a team comprising the Benaim Group, SERCO, Interfleet Technology and the Tony Young consultancy.

2) The phase 1 work verified that Personal Rapid Transit (PRT) is an appropriate solution for Daventry and that the expected benefits to the area could be forthcoming. In doing so it drew on readily available information on PRT systems now under development or offered for service. A range of risks was identified which PRT development would need to overcome.

3) There were three main questions for Phase 2:

   - what public transport option might deliver comparable benefits to PRT?
   - what is the best pilot route?
   - is PRT or an alternative to be preferred?

   These questions need to be answered by the appraisal process which also needs to be driven by planning policy objectives and the requirements set by government. The planning policy context for Daventry is complex with five tiers of international, national, regional and local policy, including an Integrated Regional Strategy agreed by key planning bodies. The project will therefore need to be consistent with a wide range of regional/economic policy objectives.

4) Economic development and transport project appraisal criteria are relevant for grant application and for seeking powers to construct. The appraisal framework developed in Phase 2 covers both aspects, including the five key objectives in NATA appraisal.

5) PRT was defined in the Phase 1 report and further developed in Phase 2 for planning and costing through an outline functional specification. Our industry research showed that about five PRT systems could be candidates for a Daventry installation. However, other systems are being developed and may also be candidates.

6) PRT capacity is often quoted on the basis of very short headways. Much depends on the control and safety systems but collision avoidance under crash stop conditions (a rail-type safety case, assuming no 'virtual trains') from 40 kph implies a minimum headway of about 3.5 seconds. This determines maximum passenger capacity which, at 1.2 persons per car, would be about 1,200 persons /hr /direction, Practicable capacity may be less than this for several reasons but this capacity is likely to be sufficient for Daventry.

7) Nine public transport modes were considered, including PRT, building on work started in the Daventry SDOS. Three were discounted and the remaining six of these modes were scored in a multiple criteria appraisal framework with qualitative, unweighted scores against a base defined by existing bus services. PRT performed best in the assessment followed by upgraded

bus. Therefore, an upgraded bus scheme (High Quality Bus) was selected as the best alternative to PRT. Both options were, therefore, developed in detail for full appraisal.

8) Pilot schemes for PRT and High Quality Bus were identified through a process of area screening and network specification. The area screening covered five considerations, including the need to serve developed areas and to avoid demolitions, it also reviewed the level of demand from DTS/DDTS. The flows by car in the am peak forecast for 2021 were used to show the strongest demand corridors. Also several minimum scale criteria were imposed to help define the PRT pilot so that it will demonstrate key PRT features while performing a proper transport role, with comparable considerations for the High Quality Bus alternative. These considerations supported a pilot scheme in the area already identified in the DDTS.

9) Capital costs of £17m-£18m for the DDTS proposed pilot network was judged to be too high. Therefore, a shorter pilot PRT scheme (4.9 km guideway) was identified costed at £14m serving: town centre - former rail alignment - Drayton Way - Northern Way – town centre. There would be five stations. The depot site proposed in DDTS would be used and connected to the pilot along the old rail alignment. The costs were built up in some detail but exclude land, major earth works, planning costs and detailed design. Operations and Maintenance costs are forecast to be £1.7m year.

10) A safety review of PRT was undertaken covering operation and construction of a generic system. No insurmountable construction issues were identified. Initial discussions with the Railway Inspectorate confirmed that PRT has already been considered and no fundamental difficulties identified. Under present arrangements, the Inspectorate will need to approve the PRT scheme, working with the operator, and a full safety case will be needed. Their main areas of interest are: safety of passengers, system failure and recovery, separation of PRT from other traffic and pedestrians, the integrity of the vehicle routeing and control systems. In general, safety issues have mostly been addressed by APM/AGT systems. The HAZOP (Hazard Operability) 1 assessment identified the safety issues specific to PRT which need special consideration.

11) The High Quality Bus option, serving the area of the PRT pilot scheme, was developed and costed. It would provide low waiting times and highly reliable journey times needed to mimic features of PRT as far as practical. Bus priority, a new depot and ten buses would be needed costing £5.5m. Annual operating costs are forecast at £1.4m.

12) The transport economic evaluation was based on capital costs above, plus optimism bias, and operating costs. Benefits were assessed using DDTS high and low demand giving benefit/cost ratios (BCRs) for PRT of 1.9 to 2.9 depending on the level of demand and revenue. High Quality Bus has a BCR of 1.7. Therefore, on DDTS forecasts, the PRT pilot performs better than High Quality Bus. High Quality Bus is more affordable but costs much more than a conventional bus scheme to achieve a service quality to rival PRT. (PRT costs are high for a pilot system because of certain unavoidable system costs.)

13) The full range of broader appraisal considerations is presented in a summary table describing the likely impact of PRT pilot system. Many potential benefits are confirmed although hard to quantify at this stage. These include increased competitiveness for Daventry, attracting investment and visitors, direct and indirect employment effects, access benefits and the possible creation of a “Transport Technologies Park”. The realisation of the benefits partly depends on who drives/implements the project.

14) Procurement policy will need to address: cost and revenue risk, the allocation of these risks, grant agency requirements, whether to procure infrastructure separately from operations and what form of model (contract) to use. There is some merit in partnering, in DBF(O) and in concession/franchise for infrastructure procurement, while joint venture or franchise use models for D & M procurement are worth considering. The pilot PRT installation will need to be procured under EU open competition rules. Procuring the system partner, construction and operation separately, with opportunity for private sector investment factored in, seems likely to be the most appropriate approach.

15) It will be hard to control some risks particularly construction and technology (cost) risk, and bus competition. Demand/ revenue risk cannot be assessed without further forecasts. It will also be important to ensure that procurement of the pilot is linked to procurement of extensions since there will be a technology ‘tie-in’. Therefore, a single contract for the supply of technology (the Intellectual Property) is recommended with provision for the pilot and extensions, while separate contracts for infrastructure are desirable, also operations should be let under concession. However, a carefully co-ordinated public sector approach to procurement is needed. Also, since private rights are affected, Transport and Works Act powers are likely to be necessary.

1. Introduction

1.1 Findings of Phase 1

Although the DTS showed that Daventry's planned growth could take place without significant improvement in public transport, the implications of road traffic growth were poor for sustainability, emissions, noise, safety and congestion delays. A sustainable public transport alternative was needed, attractive to motorists. The DDTS found that PRT should deliver this, and that there appeared to be no conventional public transport option promising comparable public transport quality for a town the future size of Daventry. In Phase 1 of this study we drew six main conclusions:

- PRT appeared to offer greater benefits than other public transport options on the basis of information available today.
- The proposed PRT network developed in DDTS needed optimizing before the economic case was presented. Our view was that the cost of the 55km, 500 car network was likely to be higher by about 25%. However, there were probable savings if weaker parts of the network were rationalised, and reducing the number of cars to 300 would have minimal impact on total journey times and should be seriously considered.
- PRT capacity was probably less than often claimed and, specifically, headway was likely to be more than commonly experienced on busy roads because a railway style safety regime would apply. This could limit the minimum separation of cars to between about 3.5 and 7.5 seconds at 40 kph depending on safety and control assumptions. However, PRT theoretical capacity would probably be sufficient for Daventry.
- The viability of a 55km, 500 car network proposed in DDTS was likely to be marginal which is usual for a public transport project; hardly any fixed track systems in the world repay capital charges. At a fare of £1.60 and annual operating cost of £96.9m there could be losses. However, forecast operating costs should be less than this while network optimization would probably save capital and other costs; the combined effects of which could restore viability. However, there would have to be a strong initial capital grant finance element.
- The environmental, user and safety benefits of PRT are potentially high and the indications are that the overall (socio-economic) business case remains positive.
- There was a range of risks associated with PRT system development and with being early in the field. However, one of the chief risks - achieving safe automatic operation - has now largely been demonstrated by Automated Guideway Transit systems round the world. PRT faces these same risks, albeit in a more complex network environment.

1.2 Purpose of Phase 2

Phase 2 of the study involves a review of innovative public transport schemes, the identification of a pilot scheme for PRT and the best alternative (BA) scheme and recommend a way forward. Although the Daventry Development Transport Study (DDTS) recommended PRT as the best way to serve the expanded town and achieve a raft of economic development benefits, this was in the context of a whole town network. This study specifically looks at the case for a pilot system, as well as making an independent assessment of the technical and practical issues involved in the PRT and the BA (necessary as part of the consideration of a pilot is the likely ultimate viability of the system in question). Phase 2 also involves preparation of a grant application for the preferred public transport option.

In Phase 2 it is necessary to undertake two principal assessments. Firstly, what is the best alternative to PRT? Secondly, is PRT to be preferred to the alternative? While taking into account the broader technical, economic and other issues, these questions need to be answered in the specific context of Daventry. In other words, there is a third question, which is of a different nature: where should a pilot scheme be introduced?

SKM

2. Economic Development and Transport Policy

2.1 Introduction

This section reviews the policy environment within Daventry and the wider region, and outlines where the PRT or BA proposals must fit policy objectives in order to be acceptable or to achieve public sector financial support.

2.2 The Tiers of Economic Development and Transport Policy

Economic development projects and programmes in the Daventry area should be appraised to demonstrate their fit with the various economic development strategies and polices which affect the area. In the case of Daventry, this is extremely complex and detailed with five levels of policy and an unusually large number of relevant policies.

It could probably be argued that there are too many strategies for one area but, for this project, we attempt to indicate that PRT or best alternative will meet the important and relevant aspects of the majority of the strategies. Clearly, a well designed strategy environment will see documents and policies supporting each other such that if the proposal fits one strategy, there will be a good chance that it fits all. However, in practise this is not always the case. In addition, because PRT is a form of public transport, requiring public transport permissions, it must also meet transport policies and strategies, even if it is being presented as an “economic development project” or a project to be supported because its economic benefits make it worthwhile.

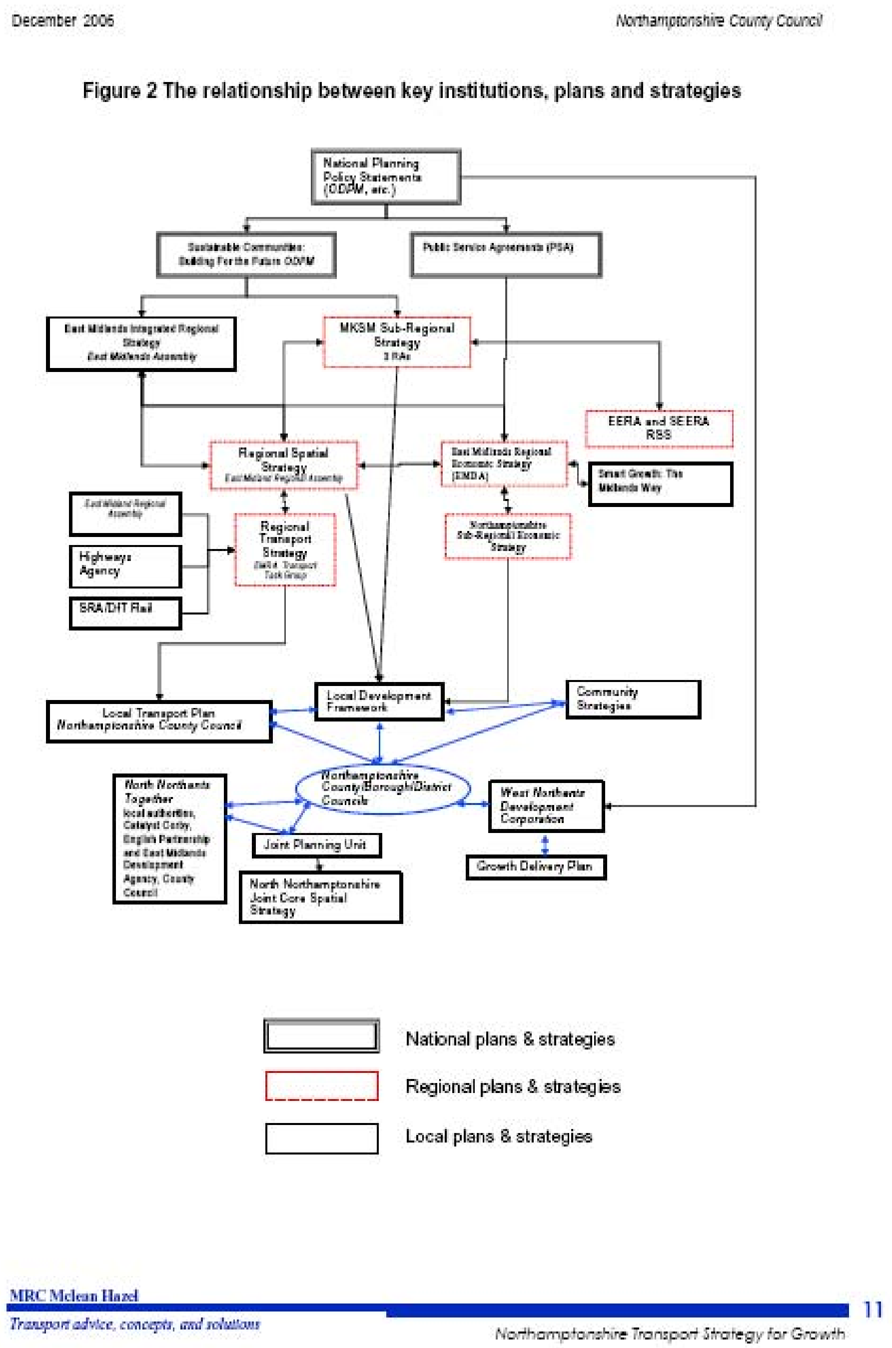
The complex interaction of regional policy is shown by Figure 1 which is taken from NCC’s draft Transport Strategy for Growth –Transport Prioritisation Framework. (It should be noted that even this is a significant simplification of the total picture of strategies which includes local documents, the Oxford 2 Cambridge Arc and the inter-regional Midlands Way).

2.3 Screening of Policy Objectives

There is a wide range of objectives in relevant policy. Not all of them need come into the appraisal. There are general policy statements that set the context for any economic development intervention, and others which provide context for public transport improvement schemes. Some of these objectives set necessary requirements that any scheme will need to meet, others are less relevant because they deal with other topics. A few policies will be directly relevant and will help differentiate one scheme from another. Therefore, it is necessary to screen policies to identify those with which the scheme must be consistent.

In transport policy terms, the key policies in the Transport White Paper (see section 2.3 below) set necessary requirements which are echoed at regional and local level. They do not need to be brought explicitly into this appraisal framework.

- **Figure 1 The relationship between key institutions, plans and strategies**



2.4 European Level

Starting at the European scale, Daventry falls within the East Midlands Competitiveness Programme 2007-13. Applications for ERDF will be assessed in line with the Operational Programme which was formally approved by the European Commission in December 2007, with the required organisational procedures being put in place in February 2008.

The Operational Programme (GMOP) does not intend to support transport projects as such, but does identify Programme Priority 1 as "Increasing productivity through innovation".

Section 3.5.1 of the GMOP states that "there is a need to increase the number of businesses investing in R&D activity and to improve the effective commercialisation of this activity to create spin out companies and to improve products, process and services, in both the manufacturing and service sectors in order to achieve productivity gains…. One of the key challenges is to create and support an innovation culture or environment by promoting networks of individuals, organisations and facilities".

It does, however, appear to emphasise the importance of private sector businesses becoming more innovative rather than, say, a local authority driven innovation scheme. It states: "Businesses need help to deploy new technologies and processes ….. and/or bring to market the latest technologies".

In order to achieve greatest impact from ERDF, it will target resources at the region's key sectors, high growth businesses and in support of resource efficiency needs.

This will conform to the regional Innovation Strategy and Action Plan.

2.5 National

National policy is set by the UK government. In transport terms, the strategic agenda was set out by the Labour government in 1998 in "A New Deal for Transport, Better for Everyone" as subsequently developed in "Transport 2010, the 10 year Plan". These were supplemented by The Future of Transport White Paper (CM6234) of January 2005. This sets the context for transport investment and emphasises three central themes: sustained investment with increased spending up to 2015, improvements in transport management to improve the performance of transport systems and planning to address growing congestion through demand management and other measures. It also announced the setting up of the Transport Innovation Fund (TIF) for innovative action on demand management, principally linked to road pricing measures.

The White Paper lists a range of measures and aims which include the enhancement of local travel, making services more accessible to give people real choice about travel and respecting the environment through delivering carbon savings, reducing the impact of all forms of transport and by investing in public transport to provide alternatives to the car.

In Economic Development terms the most relevant guidance is offered by DCLG in "Assessing the Impacts of Spatial Interventions – Regeneration, Renewal and Regional Development". Some of the key issues covered are:

- Supply Chain Effects – how best to ensure that economic benefits accrue to the local area/region/UK rather than being bought in from overseas.
- Inward investment effects - how will the proposal impact on assisting increased investment into the local and regional areas?
- Development effects and Regeneration effects – how will the proposal assist in increasing development of derelict and vacant land and in assisting people to find work or access training opportunities?
- Spatial effects - will be linked partially to how well the system links to other regional transport networks, including the West Coast Main Line and M1, but must also tie closely into the ability for Daventry to absorb the proposed new growth.
- Educational effects – can an innovative idea lead to wider educational opportunity and impact?
- Institutional effects will similarly be felt only after a positive pilot, but the potential can be evaluated early on in the project lifecycle.
- Sustainability effects and Health effects – will include impact on greenhouse gas (carbon dioxide) emissions but also educational and behavioural issues which impact on improved health.

In addition to transport and economic development policies, there is an increasing emphasis on environmental policies and the need to assist the UK's climate change strategy. For this reason it will be helpful if public transport proposals can demonstrate that they can help reduce carbon emissions and provide positive environmental benefits. This is an area which may require further work as measuring of carbon footprints grows in sophistication.

In broad *economic development* terms, the idea of a low carbon form of public transport which assists mobility to and around areas of employment, leisure and housing is undoubtedly good. For this reason, PRT would appear to fit most, and possibly all, local, regional and national economic development and climate change policies and strategies. At this stage, however, it is important to focus on those which can effectively influence the implementation and funding of PRT in Daventry. This requires a focus on appraisal and funding guidance documents.

2.6 Inter Regional level

This section considers policy at the "Inter Regional" level, effectively the West Midlands and East Midlands considered together. Although this covers two Regional Assembly areas, it is necessary to consider as one joint region because the areas are developing new forms of collaboration, partnership working and cross funding.

"Smart Growth - The Midlands Way Action Plan" is a collaborative project developed by Advantage West Midlands (AWM) and East Midlands Development Agency (*emda*), which prepares an economic development plan for the whole Midlands region. It focuses on the need to increase productivity and close the GVA[1] gap with the UK average. The Midlands Way Action Plan sees the Midlands as the UK's centre for high value manufacturing and engineering, as a central hub for transport, logistics and distribution and one of the UK's principal growth locations. It encourages collaborative action across the Midlands region based on three key principles:

- Will the project or activity make a contribution to closing the Midlands' GVA gap in a sustainable way?
- Will there be any added value in a Midlands Wide collaborative approach?
- How practical is the partnership arrangement within the Midlands?

Four action areas have been identified which should form the basis for designing and developing future collaborative action. These are:

- tackling shared productivity challenges;
- enhancing connectivity;
- promotion and positioning;
- encouraging Sustainable Growth.

While not all development activity will be undertaken in a collaborative manner across the Midlands region, major projects should acknowledge the importance of the Midlands Way Action Plan and should attempt to demonstrate the Inter-regional benefits and the ability to meet the challenges and priorities outlined above.

Midlands Way is intended to support other strategies and plans and to focus on those issues where there is a strong case for collaborative working across the East and West Midlands. Both regions wish to drive up productivity and achieve a longer term shift to inherently higher value sectors. The

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[1] GVA – Gross Value Added is a measure of economic prosperity and wealth generated. The Midlands generates some 3148bn GVA, approximately £1 in every £6 of England's GVA, although the region has 1 in 5 of England's population. GVA measures the element of a company's turnover which is distributed in salaries and profits. It is used today in place of GDP which is a similar measure but takes taxes and subsidiaries into account.

regions are seen as the premier area of the UK for high value manufacturing and engineering, particularly in transport.

2.7 Integrated Regional Strategy (IRS)

This section considers the East Midlands region and Northamptonshire's integration with Derbyshire, Leicestershire and Nottinghamshire. Partly because of the presence of an East Midlands Regional Assembly covering this area, it could be argued that this is the most important geographical level of policy. The East Midlands Development Agency (*emda*) will certainly play a significant role in distributing public sector financial support to major projects in this area.

The links between policy areas are formally recognised in the IRS Framework, first published in January 2005, which coordinates policy at regional level. EMRA, *emda*, GOEM and EMRLGA work together in partnership to prepare the IRS. The IRS contains agreed priorities for the region which may be paraphrased as:

- Reduce inequalities;
- Conserve and enhance the environment;
- Create sustainable and healthy communities;
- Improve economic performance;
- Reduce climate change impacts.

The IRS is described by EMRA as the "Sustainable Development Framework for the East Midlands" and its objectives cover four key areas: social, environmental, economic and spatial.

The spatial objectives are particularly relevant to the PRT / BA proposals, as follows:

- To ensure that the location of development makes efficient use of existing physical infrastructure and helps to reduce the need to travel;
- To promote and ensure high standards of sustainable design and construction, optimising the use of previously developed land and buildings;
- To improve accessibility to jobs and services by increasing the use of public transport, cycling and walking, and reducing traffic growth and congestion.

2.8 National Planning Policy at Regional and Local Level

There are further relevant policy and strategy guidance documents at the East Midlands Regional level.

Since the Planning and Compensation act 2004, Planning policy has operated at a two tier level, consisting of Regional Spatial Strategies and Local Development Frameworks.

Regional Planning Policy [RSS] is prepared by the Regional Assemblies at English Region level and adopted by the Secretary of State at DCLG. The relevant economic policy for East Midlands is contained in the Regional Economic Strategy "A Flourishing Region" produced by *emda* [2]. Planning and transport policy are contained in the RRS for the East Midlands and its component Regional Transport Strategy.

A review of Planning policy confuses the situation further, as the important polices for the sub-region are contained in the Milton Keynes and South Midlands Sub-regional strategy, which sets the population growth target for Daventry. Although Milton Keynes does not fall within Northamptonshire or the East Midlands Regional Assembly area, it is nonetheless the centre of the relevant planning policy documents.

Local Development Frameworks are prepared by District Councils and, in the case of Daventry, this was prepared in 2007. There are also three documents which provide informal planning guidance for the development of the town: The Strategic Development Options Study (SDOS), the Interim Draft Daventry Masterplan and the Town Centre vision 2021.

2.9 Regional Economic Strategy

In "A Flourishing Region", the economic vision has three main themes: raising productivity, ensuring sustainability, achieving equality. For each of these themes strategic priorities for the region are identified. The most relevant of these priorities for this study under raising productivity are:

- to raise skill levels;
- to support enterprise; and
- to support innovation.

Under ensuring sustainability:

- increase transport and logistics investment; and
- reducing the impact on climate change.

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[2] Although this should be considered jointly with "Smart Growth: Midlands Way Action Plan" prepared by Regeneris for *emda* and Advantage West Midlands to deal with integrated policy topics affecting the whole of the Midlands, as described in section 2.5.

These require actions which are listed in the document. These include three of direct relevance: improve transport connectivity, and accessibility, stimulating new markets and enterprise opportunities, and to develop a Regional Procurement Opportunities Plan to open up more opportunities for local business. This last point is important in helping the region to maximise the total economic development potential of PRT/High Quality Public Transport investment.

The key aim within "A Flourishing Region" is to make the East Midlands a European Top 20 Region by 2020. Sub headings aspire to making communities safe and thriving while economic wellbeing is now seen as an overriding aim. *emda* have developed a complex means of measuring this, based on the costs of pollution, the quality of the natural environment, voluntary work, the costs of crime and other factors. Not all of these will link to PRT, but a high quality and appropriate form of public transport system can have a major impact on the regional aims, both directly at Daventry and as a means of opening up such an option for implementation in other locations.

2.10 Regional Core Objectives

The Regional Core Objectives are based on the combination of economic development, transport, planning and environmental policy documents. This section considers the transport policy and its integration with the other regional policies and strategies noted above.

It is stated that the Regional Spatial Strategy was developed within the overall vision of the IRS and that the RSS is guided by 10 regional core objectives which are reflected in Development Plans, Local Development Frameworks, Local Transport Plans and Economic Development Strategies all as set out below.

1) To address social exclusion, through the regeneration of disadvantaged areas and reducing regional inequalities in the distribution of employment, housing, health and other community facilities;
2) to protect and where possible enhance the quality of the environment in urban and rural areas so as to make them safe and attractive places to live and work;
3) to improve the health of the region's residents, for example, through improved air quality, the availability of good quality well designed housing and access to leisure and recreation facilities;
4) to promote and improve economic prosperity, employment opportunities and regional competitiveness;
5) to improve accessibility to jobs, homes and services across the region by developing integrated transport, ensuring the improvement of opportunities for walking, cycling and the use of high quality public transport;

6) to achieve effective protection of the environment by avoiding significant harm and securing adequate mitigation where appropriate, and to promote the conservation, enhancement, sensitive use and management of the region's natural and cultural assets;
7) to bring about a step change increase in the level of the region's biodiversity, by managing and developing habitats to secure gains wherever possible, and ensuring no net loss of priority habitats and species;
8) to promote the prudent use of resources, in particular through patterns of development and transport that make efficient and effective use of existing infrastructure, optimise waste minimisation, reduce overall energy use and maximise the role of renewable energy generation;
9) to take action to reduce the scale and impact of future climate change, in particular the risk of damage to life and property from flooding, especially through the location and design of new development; and
10) to promote good design in development so as to achieve high environmental standards and optimum social benefits.

Objectives 5, 6 and 8 are perhaps most relevant to the transport objectives of PRT in particular, while others are also relevant to the provision of high quality public transport in general.

2.11 Regional Transport Strategy (RTS)

Focusing on the clear transport strategy for the East Midlands area, the relevant document is the "Core strategy for EMRTS". It is based on four key objectives:

- reducing the need to travel, especially by car;
- promoting a step change in the level of public transport;
- making better use of existing networks;
- developing new highway capacity as a last resort.

The regional transport objectives that local authorities are to consider in their Local Transport Plans and Local Development Plans are summarised in six statements.

- Support sustainable development in the region's Principal Urban Areas and Sub-Regional Centres described in Policy 5 and consistent with MKSM.
- Promote accessibility and overcome peripherality in the region's rural areas in support of Policy 6.
- Support the region's regeneration priorities outlined in Policy 21.
- Promote improvements to inter-regional and international linkages that will support sustainable development within the region.

- Improve safety across the region and reduce congestion, particularly within the region's Principal urban areas and on major inter-urban corridors.
- Promote opportunities for modal shift away from the private car and road based freight transport across the region.

These broad objectives are further refined into sub-area objectives. For the southern Sub-area (Northamptonshire) the most relevant is the need to develop transport infrastructure to support MKSM Growth.

2.12 Sub regional and Local Level

Moving down the geographical hierarchy, the next step is to consider policies below the Regional level, and to review County and District based polices.

Sub regional and local strategies such as the Northamptonshire Enterprise's Sub Regional Economic Strategy and Daventry District Council's Economic Development Strategy 2003-2006 detail various actions that will help the area contribute to these regional strategic aims. Although the strategy dated 2003 – 06 would appear to be out of date, it includes an economic and employment action plan which is still relevant.

The aim is to achieve "A sustainable economy with employment opportunities for all" while the three objectives are to:

- ensure a stable, balanced and sustainable business environment;
- ensure employment and training opportunities for all; and
- value voluntary and unpaid work.

The Civic Trust and District Council produced Daventry Town Centre Vision 2021 which encapsulates these and other actions into a single vision of the town centre over coming years. The Council has subsequently built on this by having the Interim Draft Daventry Masterplan prepared by Marchini Curran Associates. While this latter document is still 'work in progress' the Council has adopted it as a statement of its vision of a desirable future for the town – this vision includes highly accessible and environmentally sustainable public transport in the form of PRT.

2.12.1 Northamptonshire Local Transport Plan and Transport Strategy for Growth

In addition to economic development and planning policy at the County and District level, it is important to consider the sub regional transport polices. These are driven by Northamptonshire County Council. The second Northamptonshire LTP was published in 2006 and contains seven objectives, six of which are directly relevant:

- to reduce road accidents;
- to reduce congestion;
- to improve access to all activities for all;
- to support growth;
- to minimise the effect of transport on the environment;
- to encourage healthier travel choices.

The LTP contains the schemes and revenue support measures adopted by the County Council for the period 2006/7-2010/11. These are set out under the main policy headings and include schemes to support growth which include funding by the Community Infrastructure Fund and from developers. There are proposals for public transport infrastructure schemes and a range of revenue support allocations, mainly to support bus services.

The LTP highlights the need to develop a transport strategy for growth to examine in more detail the longer term transport impacts of the growth proposals in MKSM. Car traffic in Northamptonshire has grown faster that the national average and there is limited capacity to absorb more on the highway network while growth proposals for the region are likely to lead to traffic increase of up to 50% to 2021 unless action is taken. In 2007 a report on Transport Strategy for Growth (TSfG) was submitted for consultation. The draft TSfG included a Transport Strategy Framework, guidance on creating lasting mode shift and Town Strategies for several towns including Daventry, which are being developed.

The mode shift guidance acknowledges that, to accommodate growth on the scale proposed in MKSM, it will be necessary to reduce the proportion of trips made by private car. This guidance recommends a range of measures, including better public transport and a “SMART” strategy. It includes mode shift targets:

- 20% for new developments, to be measured as reductions in single occupant car trips;
- 5% for existing developments.

The TSfG committee report lists the schemes proposed by the Transport Prioritisation Framework which includes a range of interurban public transport measures and confirms that Town Strategies, including one for Daventry, will have to include public transport improvements.

The version of the TSfG adopted by the County Council deals largely with inter-urban travel and leaves the detail of town proposals for later development in conjunction with LDDs for the areas in question. It does, however, contain the same general aspirations, including those for modal shift.

2.12.2 West Northamptonshire Development Corporation

It is worth singling out one body for their important remit – WNDC have been set up to achieve the Government-driven growth in the area (although it should be noted that their sole statutory function is to secure the regeneration of their area of operation, and their role in delivery of growth has to be seen in that context). They are the only Urban Development Corporation outside London which indicates the importance and determination that this area will grow significantly. Targets are set for increasing population, building houses and attracting new jobs to the area. In other words, Daventry and West Northamptonshire are one of the key growth areas of the UK.

All the above strategies and requirements are, therefore, placed in a context of a growing town – and this could be significantly different from attempting to achieve the same goals in a town of static population and limited growth. Transport will be critical to help the town to grow and achieve the above policy aspirations.

Growth on this scale will create new demands on the transport infrastructure, but also create opportunities for developing a more sustainable public transport network. It also offers Daventry the chance greatly to increase both its sustainability and the value of its economic base: these are seen as the twin purposes of the PRT Pilot project.

2.12.3 *emda* Criteria

These are summarised in the table below. Only some of them are directly relevant to the provision of PRT or an innovative alternative (the Best Alternative or BA) and only then if it can be introduced by 2009. Therefore, these may not apply if implementation is later, although it may be assumed that similar objectives will continue to be in place.

- **Table 1 *emda* Criteria**

emda Aim	How Fit Can be Demonstrated
To increase the proportion of workforce travelling to work by public transport, walking or cycling by 23% by 2009	Clearly identify routes between residential and employment areas and indicate adequate capacity at peak hours. Although the time target is unrealistic, we can still demonstrate the fit with the subject.
To move towards the national average in both solid waste and total CO2 emissions per £million GVA produced by 2009	Provide factual evidence on reduced CO2 (compared to other forms of transport) Think about how it may reduce waste?
To maintain average annual growth in employment floor space of 1.5% by 2009	Show how PRT or BA pilot should be expected to help local businesses to grow, diversify, add greater value and (in some cases) be created. To show how developers are encouraged to build at stations and PRT/BA drop off points.
Increase proportion of residents involved in volunteering	Not applicable
Increase rural and urban activity rates	Demonstrate how PRT can help disadvantaged into work – i.e. fares must be affordable, must be routes to

emda Aim	How Fit Can be Demonstrated
	training opportunities, and possibly easy links to hospitals/clinics to assist those on incapacity benefit get back into workforce. Given the great improvement PRT offers to accessibility compared to bus, as shown in the DDTS, this should be straightforward to address.
To reduce proportion of working age claiming key benefits	Demonstrate how PRT/BA can help get people to work.
Increase economic activity rates in most disadvantaged areas (these are clearly identified and delineated areas)	Demonstrate that PRT will assist those in geographically disadvantaged locations – in Daventry's case this particularly means the Southbrook estate.
To increase GVA per hour	Have to demonstrate that PRT/BA can help attract higher value jobs (e.g. R&D) and that workers can use PRT to access them.
To address sub regional disparities in employment rates	Difficult as Daventry appears to have higher employment rates than parts of Notts & Derbys. But we can focus on improving Daventry's role in Northants, and in Daventry as part of the MKSM growth area helping 'migrate' activity from the South East into the East Midlands.
To take skills and learning levels up to national averages by 2009	We will have to demonstrate that PRT/BA can help people get better education and training. The example – and opportunity to be involved in – a pilot should inspire learners at school, further and higher educational levels. Also, many students and trainees require low cost public transport between home and place of learning.
Increase and maintain small businesses, especially growing VAT registered businesses	Need to show that the pilot will encourage the development of related business, or unrelated ones trading off the image and profile the pilot creates. Should also demonstrate that PRT/BA will run to areas where new business start ups are likely to locate.
To increase R&D expenditure	Ideally the pilot would secure R&D work on PRT (or BA) in the area. PRT would have to work with Enterprise and Development Agencies to ensure that potential R&D sites (the proposed innovation / science park) will be well served There is already a strong hint the pilot is working in this area, though the University of Northampton led bid to *emda* for the Environment iNET, to be based in Daventry (and involving the Universities of Loughborough, Leicester, Nottingham and Lincoln and the BRE)

Overall, for the purposes of a bid to *emda*, meeting the requirements of the Regional Economic Strategy will be essential. It will be necessary to demonstrate the PRT benefits are useful for the whole region and will not just attract businesses to Daventry instead of Northampton or elsewhere in the region.

3. The Appraisal Framework

3.1 The Appraisal Task

This section outlines the Appraisal Framework adopted for assessing the realistic potential of innovative public transport in Daventry, together with the ability to secure the required levels of funding.

Proposals for significant innovation in transport and major transport investment generally require careful appraisal. Major transport projects are subject to appraisal processes that are well documented by DfT on WebTAG and in Local Transport Plan Guidance. These processes apply to schemes that need government grant through DfT. In the case of innovative transport for Daventry, which may be PRT, DfT grant is one potential source of finance but others are also relevant, particularly support from the economic development, regeneration and growth agencies. The Daventry PRT pilot proposals were developed with wider economic benefits in mind while there are also transport and sustainability objectives for the scheme.

Any PRT implementation would greatly benefit from the support of the highway and local transport planning authority for Daventry, which is Northamptonshire CC, for two reasons: construction of PRT will require Transport and Works Act powers which will be very much easier to obtain with the support, or at least acquiescence, of the highway authority because highway land is vested in the highway authority, and NCC's support would also make obtaining a TWA order more straightforward (although the support of the local highway authority is not absolutely essential to obtaining a TWA order, as the Luton Translink TWA Order[3] shows). PRT would also need NCC support if it requires transport grant funding through the Local Transport Plan. Therefore, innovative public transport schemes will greatly benefit from the support of NCC which implies compatibility with County and regional transport policies.

The appraisal framework has to meet three clear objectives

- Indicate that the project is economically viable. DfT will not consider any project for funding if it requires an operating subsidy. While other funding sources may be more flexible in connection with a pilot, it seems highly likely they would wish at least to be confident that a full scheme would not require operating subsidy from the public purse.

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[3] The TWA order grants powers exclusively to Luton BC, even though parts of the route run in Bedfordshire CC's area, and for part of the application period Bedfordshire CC was opposing the Order.

- Indicate that the project can receive funds through the currently available sources of European, National, Regional or Local budgets – be they transport specific or broader economic development, research or other funds.
- Show that the project meets the area's economic development, environmental and/or transport objectives. It must accord with local policies and regional strategies as far as is practical.

There is a need to consider criteria in economic development, environmental and transport terms. Therefore, if the appraisal indicates that PRT meets economic development objectives rather than transport objectives and can receive funding through research, environmental and/or economic development budgets rather than transport budgets, then it may be possible for the project to proceed, even if it is weaker under transport policy tests or transport objectives. However, the support of transport authorities would be valuable and, therefore, the appraisal should satisfy transport criteria. This also seems sensible given the nature of the project, albeit economic development and environmental criteria will need to be given particular emphasis.

A further consideration is that appraisal may be problem based or objectives led. As far as DfT is concerned, these two approaches are considered to be equally valid. In this case, therefore, our approach is objectives led and it will be expected that local and regional policy contains the objectives which will "nest" within government policies as expressed in the five main objectives for transport schemes – which also contain at least in embryo the economic and environmental aspects of appraisal relevant to this project.

In developing an appraisal framework, there has been a need to think slightly laterally. The reason for this is that this project may not neatly fit the more "normal" transport appraisal frameworks referred to above. PRT is not adequately supported in the current Northamptonshire County Council LTP and, therefore, funding through transport sources initially appears to be unlikely unless TIF funding can be attracted or DfT's approach to funding changes. But this does not mean that the project should be dropped. It is our opinion that this project has been taken this far forward because it is far more than a simple transport project; it requires an appropriate appraisal framework adequately to determine whether it is a project worth supporting to pilot or implementation stage. The appraisal framework selected here is, therefore, adapted from the government's NATA-based major project appraisal guidelines[4]. It also covers elements of feasibility assessment more normally associated with an economic development project than a

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[4] We have made particular note of the Scottish Transport Appraisal Guidance (STAG) which places a high emphasis on Economic Activity and Location Impacts (EALIs) in addition to Transport and other overarching objectives

transport project, particularly utilising DCLG's "Assessing the Impacts of Spatial Interventions – Regeneration, Renewal and Regional Development" (known as the "3Rs" guidance). This framework is most relevant because the project includes unusual economic development potential.

3.2 The Questions for Appraisal

The appraisal of transport options for Daventry, therefore, has two main strands: economic impact and transport, and both may be important in financing the proposals. Other sources of funding, including research, may also have some bearing but these would tend to relate to the two major headings and therefore are not treated separately. It is necessary to set out the full policy context for both strands and to build objectives-led criteria for assessing a range of possible public transport options to produce a best alternative to PRT and to underpin the selection of the particular PRT pilot scheme.

Essentially, there are three questions to be answered:

1) What public transport option might deliver comparable benefits to PRT?[5]
2) What is the best pilot route for PRT or the best alternative?
3) Is PRT or the best alternative to be preferred?

These three questions can be answered by a process of appraisal but, although the appraisals must be consistent, it is not appropriate to use the same level of detail or criteria for each. As far as transport service is concerned, question 1 is essentially about delivering PRT-like service and can be assessed using criteria driven mainly by public transport mode characteristics. Question 2 is a purely local question which has few implications for wider planning objectives. However, it is most important to address question 3 using a comprehensive set of criteria that address the relative performance of PRT and the best alternative in terms of the most relevant policy objectives, including key elements of an outline business plan. This requires that objectives-led appraisal be undertaken and that all relevant policy objectives are considered.

3.3 Appraisal Guidance

There is appraisal guidance for transport and also for economic development projects. The former is contained on WebTAG, the DfT project appraisal guidance web site, and generally follows and

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[5] Note: We have not asked "what alternative development projects might deliver economic development benefits comparable to PRT" as this is almost an open ended question, and not particularly meaningful as other (non-transport) economic development projects may be complementary rather than competitive to PRT implementation. We have accepted that Daventry through officer and political enthusiasm have favoured PRT as an appropriate and innovative development project which will bring substantial benefits to their area.

builds on the new approach to appraisal (NATA) developed in the late 1990s and promoted in "A New Deal for Transport" 1998. NATA introduced balanced consideration of performance of transport investment under five overarching objectives: safety, economy, environmental impact, integration and accessibility. Specific topics and measures are defined for each objective and transport investment proposals are assessed under these with the results summarised in an Appraisal Summary Table (AST). These assessments are quantified where possible, although some are qualitative. The department's guidance states:

"An audit trail from assumptions, mode choice model outputs, and costs to the Public Accounts (PA) and Transport Economic Efficiency (TEE) tables and full cost benefit analysis is required for all public transport schemes………The assessment of alternatives should start from an initial wide base of possible options. The Department requires a clear understanding of why some particular options are preferred to others. Each option must be assessed against both local and central Government objectives, and in terms of the contribution to LTP objectives. The assessment of alternatives must be sufficiently robust to allow a detailed comparison between the preferred scheme and its alternatives. The Department may wish to see ASTs and worksheets (including TEE tables) for the rejected alternatives, though the level of detail provided in these ASTs and worksheets should be proportionate to the stage at which the rejected alternative was scoped out. For smaller schemes (<£20m) non-quantified ASTs are sufficient for all rejected alternatives except the preferred and low-cost option. For larger schemes the level of detail required for discounted options should be discussed with the Department on a case by case basis."

For major schemes, generally those costing more than £5 million, an appraisal is needed to obtain DfT approval which needs to be submitted as Annexe E to the Annual Programme Report of the Local Transport Plan. This appraisal must accord with NATA, needs to address value for money, needs to test the scheme against options likely to deliver comparable benefits, must include risk assessment and optimism bias and to meet other specific requirements.

"Economic Development" Appraisal should comply with the HM Treasury 'Green Book' (Appraisal and Evaluation in Central Government, which lies behind all central government appraisal standards, including TAG) and should meet the requirements of DCLG's "Assessing the Impacts of Spatial Interventions – Regeneration, Renewal and Regional Development" – known as the 3Rs appraisal. Green Book appraisal includes requirements the assessment of options, including the "Do Minimum" while DCLG guidance provides specific focus for the business, environmental and social implications of the development project being appraised.

DCLG "3Rs" refers to the Regeneration, Renewal and Regional development interventions. These terms typically do not have simple definitions but the distinguishing characteristic of these interventions is that they have a strong spatial focus and often, as a result, distributional impacts.

They tend to affect the process of sustainable development for target areas and groups, and have the specific objective of improving outcomes in social, economic and environmental terms.

The ultimate aim of the "3R" interventions is to achieve thriving, inclusive and sustainable communities in all regions by raising levels of social inclusion, neighbourhood renewal and fostering regional prosperity.

Therefore, the study needs to consider both the immediate effect of the Pilot scheme and the effect of the Pilot scheme leading to the network serving much of the town and the potential for links to other fairly close destinations within the region – whether directly by PRT or, perhaps more likely, through PRT facilitating access to other forms of public transport for longer journeys.

3.4 The Objectives of PRT

According to Daventry District Council, PRT "offers Daventry the chance to greatly increase both its sustainability and the value of its economic base: these are the twin purposes of the PRT Pilot project." But how will these dual aims be achieved? The following are the more precise objectives and aspirations of PRT in Daventry.

- To help deliver sustainable travel patterns within Daventry – including travel to work, education and for leisure
- To increase modal share of public transport
- To reduce overall carbon emissions from transport
- To integrate new development areas of Daventry into the town centre and areas of employment
- To make the town centre (and other service and employment centres) more accessible to all
- To provide a cost effective, comfortable and fast form of transport for social, leisure and business benefits
- To help ensure that Daventry doesn't grow as a dormitory town for car borne residents to drive to work elsewhere. (This could be described as contributing towards the creation of a sustainable community)
- To increase Daventry's sustainable development credentials (both in real terms and in perceived or image terms)
- To increase Daventry's profile as an area of innovation
- To encourage a roll out of PRT throughout the MKSM or even East Midlands area
- To encourage local businesses and people to become "experts" in PRT so that they can benefit from future deployments of PRT across the country and worldwide
- To support business diversification into new and growing economic sectors
- To assist in improving the skills base

- To assist educational development and encourage University research and tuition.
- To encourage inward investment to the Daventry area
- To promote civic pride
- To prevent leakage of investment, retail leakage and increase expenditure locally
- To form part of the overall progressive new Daventry which will include biomass based power generation, leisure based canal developments and town centre retail improvements

If the above objectives are met, then Daventry should meet the two overall objectives noted in the brief, and stated above.

3.5 The Appraisal Criteria

From the above it is clear that developing a framework is not a simple or standard task. Should both a transport appraisal, in line with WebTAG etc, and a separate economic development appraisal, in line with HM Treasury Green Book and DCLG guidance, be carried out simultaneously? Or would this produce unnecessary paperwork, repetition and potentially conflicting outcomes?

Having reviewed the relevant issues, we cannot support the idea of carrying out two separate appraisals. The repetition and inefficiencies would be time consuming, inefficient and potentially counter productive. Carrying out an economic development appraisal only would not be appropriate as the PRT system, if supported, would require Transport & Works Act Powers. These would be unlikely to be granted except following a transport appraisal (in addition to Environmental Impact Assessment and extensive consultation). Carrying out a transport appraisal only could fail to capture the potential economic development benefits associated with PRT.

Therefore, we believe that the most appropriate appraisal framework for this particular project is a hybrid which captures all the important elements of transport appraisal necessary for Transport & Works Act powers, but also a wider investigation into economic and locational benefits.

Our framework, therefore, focuses on the following five headline objectives in line with transport appraisal of major projects:

Safety	Integration	Accessibility	Economic	Environmental

These five overarching objectives have a range of sub-objectives which are described below. It is not possible to conduct a full appraisal under all of these but we need to concentrate on key criteria.

The **economic objective** is extended to include a greater level of detail than normally required by transport appraisal. The economic sub-headings are given in Table 2 together with their policy provenance.

- **Table 2 Appraisal Criteria for Economic Impact/Development**

Criteria	Justification
Travel To Work Patterns	Daventry District Council Economic development Strategy (DDC); Northamptonshire County Council Transport Strategy for Growth (NCC), Regional Economic Strategy (*emda*)
CO2 emissions	NCC, Regional Spatial Strategy (EMRA), *emda*, NATA
Direct Employment	*emda*, DDC, Northamptonshire Enterprise Ltd (NEL)
Indirect Employment	*emda*, DDC, NEL
Training and Work for Marginalised & Disadvantaged	*emda*, NEL
Gross Value Added and High Value Added Business Base	*emda*, DDC, NEL
Productivity	*emda*
lifelong learning, skills and education	NEL, NCC
SME benefits	NEL
R&D benefits	*emda*
Urban Vibrancy	NCC
Business collaborations	*emda*
Social activities	DDC
company start ups and spin offs	NEL, *emda*
Links with other Daventry flagship projects	DDC
Design Criteria	DDC
Land recycling	DDC
Supply Chain	DCLG
Inward Investment	DCLG, DDC, *emda*, WNDC
Private sector leverage	*emda*
Health Effects	DCLG, NATA

There will be some (acceptable) overlap between economic, environmental and accessibility criteria.

From *emda*'s point of view, the overall economic aspiration is to develop the East Midlands as a Top 20 Region in Europe. The appraisal will keep this aspiration in mind throughout, although it is accepted that the role of any one project in developing a region will be subjective and it is unrealistic to attempt to quantify PRT's contribution to developing the East Midlands into a Top 20 Region in Europe.

In developing outputs and outcomes in line with these sub-headings, it will be possible to investigate the appropriate benefits and potential opportunity that will be required when completing an application form for funding, particularly if that application is to be made to *emda*.

Other aspects of the economy objective under NATA are three sub-objectives: the present value of costs to the public accounts which involves identifying the money streams associated with costs, revenues and tax effects; the Transport Economic Efficiency effects which is mainly about transport user benefits; reliability impacts which has measures applicable to private and public transport users.

The **safety objective** has two sub-objectives: reduction of accidents, which are usually valued in money terms and a qualitative assessment of safety and security for transport users.

The **accessibility objective** is concerned with peoples' ability to reach different locations by different modes and has three sub-objectives: option values, severance and access to transport systems. These may be scored qualitatively but if there are data available there is a measure of transport system access that can be quantified.

The **integration objective** is concerned with the transport and other policy context. The scheme should be compatible with relevant policy, particularly that set by central government. There are three sub-objectives: policy for integrating transport modes; compatibility with environmental policy, integration with land use planning; compatibility with other policy including economic development.

The **environment objective** is concerned with the reduction of the direct and indirect impact of transport on the environment. There are ten sub-objectives concerned with the particular impact on: noise, local air quality, greenhouse gases, landscape, townscape, biodiversity, heritage, water environment, physical fitness and journey ambiance. Emissions (including greenhouses gases) and noise should be quantified where possible. Other effects are normally assessed qualitatively.

4. PRT and the Alternatives

4.1 PRT

4.1.1 The PRT Concept

In a paper given to the Institution of Mechanical Engineers at the end of 1966 L.R Blake described ‘an automatic-taxi, public transport service for towns and cities aimed to be competitive with the private car’. The proposal, using mini-sized cars for 4/5 people, was to provide non-stop personal on-demand service for passengers. A passenger informs the station computer where he wishes to go. The passenger is allotted a vehicle. If one is not available in the station an empty vehicle is directed to that station by computer control. The passenger, having made his destination known to the computerised controller is carried alone or with his chosen companions to that destination without stopping or changing at intermediate stations. The concept represents the Utopia of public transport services – minimum waiting time, a non-stop journey, and a personal vehicle. Only in the need for a walk to the station does the service fail to approach that provided by private cars – and this may be ‘recouped’ if PRT eliminates parking problems at trip end.

4.1.2 The History of PRT

The ‘autotaxi’, or ‘cabtrack’ as it later becomes known, was the subject of considerable research and development in the UK during the late 1960s but in 1971 it was shelved. The cost was likely to be high (equivalent to at least 5p per passenger kilometre) the overhead track structure which was proposed was unacceptable in most areas and the technical problems of short headway operation were thought to be insoluble, in the short term, without massive financial assistance. Development therefore concentrated on the cheaper and technically simpler Minitram. Elsewhere in the world, development of autotaxi systems continued. In France, Matra Engins developed the Aramis system and, in Germany, Messerschmidt Bolkow Blohm and Demag cooperated in the development of ‘Cabinentaxi’. In Japan, a system called CVS was seriously examined. Prototype vehicles and short stretches of test track were constructed. Various projects were developed in the USA including Alden Starrcar – some included freight modules.

A Minitram system was proposed for Sheffield in the early 1970s. Minitram, (alias Autotram) was later examined in Coventry in considerable detail and sensitivity tests were conducted by considering the effect of varying some of the vital parameters such as population density and cost of track.

In recent years there has been a revival of interest in PRT. ULTra is being promoted in the UK with a test track in Cardiff and studies for the implementation of the system in Bristol and Cardiff. It is understood that ULTra is being built to link Heathrow Terminal 5 with car parks which should be the first ULTra system in public service, due to open in 2009.

4.1.3 PRT Outline Functional Specification

General

This outline specification is intended to set out the high level requirements of PRT for Daventry. The general requirement is for the design of all elements of the PRT system to conform to relevant standards and the safety and operating features to conform to those required for commissioning and acceptance by the ORR/HMRI and other safety authorities. These requirements are set out independently of any particular design.

Access Requirements

1) Roofed stations with platform screen automatic doors acting together with car doors, with visual and audible warning of operation.
2) Stations to conform to DDA requirements.
3) Suitable station lighting, PA, public information displays and means of communicating with control.
4) Means of requesting service with appropriate display and audio messages of time to arrival of PRT car.
5) A means of fare collection, preferably cashless.

Quality of Service

1) The maximum waiting time for normal operation, to be confirmed after analysis, is set initially as 1 minute at off peak times and 3 minutes at peak periods. Associated average waiting times for service planning to be 1 and 2 minutes respectively.
2) Station capacity, including the number of docking positions to be commensurate with peak period demand and the need to avoid delays to PRT cars.
3) Cars to have a capacity of four seated passengers including one in a wheelchair, and a reasonable space for luggage or one bicycle.
4) Minimum possible headways (time between rear of successive cars passing a fixed point at different speeds) consistent with collision protection are to be achievable.
5) Cars to operate singly and to run directly to the selected destination/s without other intermediate stops when in “Demand Mode”.
6) The capacity of the PRT network to be determined by the peak period demand requirement and the maximum waiting time.
7) Car/platform gaps to be step free permitting unassisted wheelchair access.
8) Ride quality to be acceptable to seated passengers over the speed range envisaged.

9) Journey times to be generally comparable with that of taxi between the stations concerned.

10) PRT is to be available for operation round the clock, all year, except when possession for maintenance is needed. This possession will be limited as agreed with the service provider under contract.

11) Three operating modes are envisaged:

- Demand Mode – cars respond to passenger demand for service and run directly to destination;
- Fixed Route – as a standby mode in which cars operate to fixed routes with stops programmed by control;
- Manual Operation - under direct control of maintenance staff in the control centre or on the cars.

12) Station dwell times to be set automatically, probably maximum 25 seconds including door cycle time, but adjustable over a range to be agreed, and capable of responding to passenger giving close door/depart signal.

Safety

1) The normal approach to incidents would be for the vehicles to continue to a station and, if this is not possible, for passengers to remain in the vehicle while assistance arrived. Beyond this, and in the case of fire, a means of escape is required from vehicles at all points on the guideway for ambulatory and disabled passengers. It shall be possible for ambulatory passengers to escape without assistance (with further discussion with HMRI it may be possible to relax this requirement to some degree).

2) Walkways and amenity areas to be lit for night use.

3) All elements of the system to have adequate fire protection.

4) The collision protection system is to provide for the safe stopping of cars at emergency braking rate on degraded guideway without collision.

5) Secure two way voice communication shall be possible between Control and all cars.

6) The guideway shall be designed to minimise the risk of damage from road vehicle collisions.

7) CCTV shall be provided for supervision of all station platforms and cars.

8) The system will comply with all relevant provisions of HMRI guidance (RSPG Part 2 Section G) see below.

Guideway

1) To be designed to support and guide cars operating in one direction only.

2) Must be designed to contain cars and to prevent them leaving the guideway under all reasonably foreseeable circumstances.

3) Must enable passengers to escape safely from cars stopped at any point and walk unaided to exits at suitable locations.

4) To provide a means of safe access for maintenance and inspection of all equipment.

5) Must be designed with appropriate drainage and to prevent the build up of snow and ice.

6) Must enable access to assist passengers in cars stranded at any point.

7) Must incorporate suitably insulated and protected traction power and other supplies.

8) The network shall be designed to provide alternative routeing in the event of a failure or blockage at any point.

4.1.4 What PRT Systems are Available?

Based on our initial evaluation, we identified 10 systems with PRT aspirations of which five systems appear to have the potential to be used for a pilot system in Daventry:

- ATS (ULTra)
- 2getthere (CyberCab)
- Vectus PRT
- Taxi 2000 (SKYCab)
- MicroRail

ULTra and 2gethere both have demonstration systems in operation, and Vectus is currently constructing a test track in Sweden. ULTra uses a laser- based guidance system and 2getthere uses the FROG navigation control system, which has already been proven in public service in the Netherlands. The Vectus concept is well developed and the test track will enable further progress towards commercial application.

SkyCab and MicroRail have been selected as two strong contenders among the larger number of systems currently at the concept or early prototype stage.

Two of the other systems considered in more detail have operational or test-track experience, but neither is well suited for application in Daventry. The Serpentine system is primarily designed for low speed operation in pedestrianised areas, and has had problems with approval of automatic operation. The Railcab system is primarily intended for longer-distance AGT implementation, mainly using existing rail lines.

All evaluation was based on published information and there was direct contact with the suppliers of ULTra, 2getthere and Vectus. The standard of published information is variable, and it is possible that contact with the other suppliers will provide further details which may result in re-evaluation of potential systems for Daventry. There is no guarantee that any of the PRT systems will bid for a Daventry pilot. We understand the ATS, Taxi2000 and also MISTER (a nascent Polish system) have express strong interest, and 2getthere Vectus has also been in contact with the Council.

4.1.5 Network Planning Issues

Capacity

The capacity of PRT is an important issue which requires careful consideration. Capacity is important for two fundamental reasons: PRT must be able to meet the demand for travel at peak times and places or it will not deliver its promise of quality; it must also be able to generate the revenue needed to justify the investment. Minimum headways of a few seconds are claimed by PRT promoters and these are needed to deliver capacities comparable with other urban transport systems. The analogy with roads is seen to be very strong. Road capacity is determined by driver behaviour, perceptions of safe braking distances and by the volume of traffic. However, more specific rules need to apply to automatic tracked systems.

On automated systems collision protection is necessary and will be a requirement of the safety authorities. Even at low speed, collisions can cause serious injury or damage. A considerable body of knowledge has been built up with railway signalling and control and the same principles need to apply. At any point on the network, the minimum headway is a function of speed, equipment reaction time and safe braking distance under all track conditions. However, it must also take account of worst case event of a sudden stopping of the leading car or train. In this crash stop case the minimum separation is given by:

M = c + v*tr + v*v/2b

Where: M = minimum separation metres

v = car speed (m/sec)

tr = equipment reaction time (secs)

b = average deceleration rate (m/sec/sec)

c = car length and safety zone (m)

This necessarily limits the safe minimum headway which, unless collision protect standards are violated, must apply. Table 3 shows the minimum headways associated with different speeds setting b at 1 m/sec/sec/or at 3m/sec/sec, tr at 0.5 secs and c at 12m (4m car + 8m).

Table 3 Speed and Capacity at Minimum Headways

b= 1m/sec/sec

Speed kph	Speed (m/s)	Min Headway Secs	Capacity/Hour	
			@4 Car	@1.2 Car
10	2.78	6.2	2319	696
20	5.56	5.5	2648	794
30	8.33	6.1	2358	707
40	11.11	7.2	2018	605

b= 3m/sec/sec

Speed kph	Speed (m/s)	Min Headway Secs	Capacity/Hour	
			@ 4 car	@ 1.2 car
10	2.78	5.3	2726	818
20	5.56	3.6	4016	1205
30	8.33	3.3	4326	1298
40	11.11	3.4	4196	1259

If passengers are strapped in, higher braking rates may be tolerated with consequent reductions in headway. However, such a requirement introduces further complications and a system promoter would need to demonstrate how they would ensure compliance with such a requirement. If this can be achieved then deceleration rates similar to highway traffic might apply[6].

In practice, these headway minima will not be achieved consistently since, for many reasons, cars are unlikely to be positioned so as always to operate as closely as possible. In addition, it may be necessary to allow for degraded track which occurs when ice forms[7] or in wet conditions. In any case, the PRT car occupancy will also be a critical factor in link capacity.

These headways and capacities are only possible with “off-line” stations at which stopping cars can be overtaken by other cars. Separate tracks serving the station need to be long enough to allow for deceleration/acceleration. (Without this through cars would be delayed by cars loading/unloading which adds the station dwell time and the acceleration and deceleration time to the headway. This is what fundamentally limits headways on metro systems).

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[6] We understand that the Vectus Safety Case to the Swedish Rail Administration is based on an initial headway of 3s suggesting that this can be achieved.

[7] Accordingly, preventing the formation of ice is likely to be important in system design (unless operators are prepared to accept lower capacity during cold periods.

The minimum headways of 3.7-7.2 seconds at 40kph contrasts with the assumed minimum of 2 seconds quoted in DDTS at the same speed. For phase two of this work we assumed 4 second minimum headways, which should be achievable by a range of systems in the near term. The minimum headway is a key factor in the fleet size/waiting time/delay simulation. However, a 4 second minimum headway is likely to deliver sufficient capacity for Daventry.

Stations

The need for off-line stations on all busy sections is clear. On quieter sections they may not be necessary. The key issue with stations arises at locations of greater demand. The issue here is how large the stations need to be. The number of docking positions (for car access) will influence passenger waiting times. It is necessary to provide enough capacity to meet normal demand and more to meet peak demand but it will be difficult to decide how much station capacity to provide to avoid all delays. This is an issue the Pilot would be expected to explore.

The implication of this is that it is likely that longer passenger waiting times and delays to arriving cars will occur in the peaks unless large station capacity is provided. Therefore, some longer waiting times can be expected in the peaks. The other problem is that the capacity of more popular stations need to be larger and their cost will be higher but this is hard to forecast. Conversely, the quieter stations may cost less.

Fleet Size

The size of the PRT fleet will depend on the extent of the network, the projected density of traffic and the target waiting times. The fleet is likely to constitute a major cost item in a full system and a significant one even for a pilot system, and will also determine the cost of stabling and maintenance facilities. Initial calculations for fleet size were undertaken in the DDTS where a fleet of 500 cars was indicated for the high demand scenario for a network of 55.3km covering the whole of Daventry; however, as was noted in the Phase 1 study, above around 300 vehicles savings in wait times were negligible, so it would probably be sensible to use 300 vehicles as the basis for a whole-town system and explore the minimum wait time/headway/fleet size relationship further.

4.2 The Range of Public Transport Modes

An alternative to PRT will necessarily be defined from established public transport modes or their logical development. A list of modes is given in Table 4.

Table 4 Public Transport Options in DPSS Phase 2 Proposal (2006)

▪ PRT
▪ Light Rail
▪ Guided bus (kerb or rail)
▪ Demand – responsive bus services in partnership with an operator

- Trolleybus/hybrid buses using FTR-style vehicles

These modes would need to be supported with comprehensive ITS and marketing in ways not yet achieved in towns the size of Daventry. Driverless operation should also be explored.

The Strategic Development Options Study, commissioned to recommend the location and nature of the development needed for the growth of the town, also reviewed a range of transport alternatives with the objective of achieving a sustainable future. These were summarised and assessed in a table which is reproduced below.

- **Table 5 Public Transport Options from Daventry SDOS (2005)**

Form of Public Transport	Flexibility of Timetables	Flexibility of Route Planning	Potential Network Area	Travel Information	Journey time reliability	New Infrastructure Requirements	Operational Costs	Cost of network Expansion
Quality Bus Partnership	Pre-defined timetable	Pre-defined Routes, along public highway	The extent of the Public Highway [1]	Real Time Information at designated bus stops and timetable information available via the internet and also paper timetables	Medium, with bus priority at key junctions, bus services will still operate with general traffic	Bus stops on existing highway and buses	Driver, Vehicle and overheads	Bus Stop Facilities, new vehicles, new drivers, additional highway if required
Hail-and-Ride Bus Services	Pre-defined timetable	Pre-defined routes along public highway	The extent of the Public Highway [1]	Real Time Information at designated bus stops and timetable information available via the internet and also paper timetables	Medium, with bus priority at key junctions, bus services will still operate with general traffic	Existing Public Highway and buses	Driver, vehicle and overheads	Bus Stop Facilities, new vehicles, new drivers, additional highway if required
Demand Responsive Bus Services	Fixed hours of operation. Services respond to passenger requests	Varies according to passenger requests	The extent of the Public Highway [1]	Real Time Information via internet. Fixed timetable info via the web and paper timetables	Low bus priority is more problematic to implement as routes are not fixed	Bus Stops on existing public highway, telematics and staff training	Drivers, vehicle and overheads (including telematics and / or staff for service co-ordination)	Bus Stop Facilities, new vehicles, new drivers, co-ordinating staff, additional highway if required
Guided Bus	Pre-defined timetable	Pre-defined Routes, along public highway and busways	The extent of the Public Highway [1]	Real Time Information at bus stops and timetable information available via the web and also paper timetables	Medium/High busways are traffic free, however some sections of route will be with general traffic	Bus stops on existing highway and buses. Guided busways.	Driver, Vehicle and overheads	Bus Stop Facilities, new vehicles, new drivers, additional highway if required

Form of Public Transport	Flexibility of Timetables	Flexibility of Route Planning	Potential Network Area	Travel Information	Journey time reliability	New Infrastructure Requirements	Operational Costs	Cost of network Expansion
PRT	Demand responsive, very flexible timetable (24 / 7 operation)	Telematics calculates optimum route in real-time	Origins and Destinations Restricted to PRT network	Estimated journey times could be available in cab, and at stations	High, operates on segregated network	PRT track, telemetrics, specialist vehicles, PRT stations at all origins and destinations	Vehicles, track, stop and telemetrics maintenance, control room operation and staff	Additional PRT, vehicles, stations, track and associated telematics
Taxi/ Private Hire Car	15 minute delay, timetable very flexible, pre-booked or demand responsive	Driver uses experience to optimise route choice	Origins and destinations limited to public highway	Driver's opinion	Low/Medium Majority of journey is shared with general traffic; taxi priority could be introduced to improve this.	Taxis	Licensing and highway maintenance, drivers	Additional Taxis and drivers to maintain service levels

Notes: [1] Public Highway refers to that which is suitable for use by bus

[2] Light Rapid Transit LRT has been excluded from this assessment as it fits in the scale somewhere in between guided busways and a heavy rail extension

4.2.1 Automated Guideway transit (AGT)

If PRT proved unattainable for any reason, the best option would be one that retained as many of its features as possible, including on demand automatic driverless operation. The only other option in this category is AGT which involves driverless cars on a purpose-designed guideway which must be fully segregated[8]. They are mostly used as shuttle systems in controlled environments such as airports. Generally, AGT vehicles have an individual higher capacity than PRT although often less than a bus. They require more substantial structures and the environmental impacts would be greater than for PRT.

4.2.2 Light Rail and Tram

Light rail, or modern tramway, is now well known in the UK. It involves steel wheel on steel rail with cars that are capable of street running and of using segregated alignments. Almost always electrically powered, mostly with overhead line but other options are available. Light rail has great alignment flexibility and a potential line capacity much higher than any likely level of demand in Daventry.

4.2.3 Guided bus

Bus operation can be upgraded by sections of guideway which guarantee a segregated alignment as they can be virtually self enforcing compared to a bus lane. They also guarantee level access for boarding and alighting but only at stops on the guideway. A number of forms of guidance can be

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[8] The 2getthere group transit automated vehicles operate at the Rivum business park in the Netherlands in mixed mode with cyclists, although this is not intended, and operated a Schipol Airport in semi-segregated mode in a car park.

used: kerb guidance, central rail (GLT), optical and electronic. Kerb guidance is most familiar in UK and is in service in Ipswich, Crawley, Bradford, Edinburgh and in Leeds. It is being introduced between Cambridge and St Ives, and is proposed for the Luton Translink. It cannot so easily be used in pedestrian areas as the kerbs involve steps for pedestrians. However, the kerb and the guideway can have short gaps.

4.2.4 Busway

A conventional busway uses conventional but dedicated road, does not require any modification to the vehicles and can be used by any type of bus, or for emergency vehicles. Taxis or minibuses could also be permitted. The primary objective of a busway is to provide a congestion free track for buses, or to provide direct access to traffic objectives (e.g. in a residential area or town centre) which is not available using the all purpose highway network. The most famous example is the Runcorn busway system.

4.2.5 Ultra light rail

The Ultra light rail concept (ULR) has been developed over a number of years by Parry People Movers, Bristol Electric Railbus and HILTech Developments and experimental operation has been undertaken in several locations, notably Bristol and Stourbridge. To date no permanent system has been installed, but a service on the Stourbridge branch line, using Parry vehicles, forms part of the new West Midlands rail franchise. It comprises small railcars using conventional railway or tram tracks which may operate on street or segregated alignment. The system uses flywheel energy storage to avoid the use of continuous overhead line or conductor rail. Its advantages over PRT are that it does not require full segregation and could be easily integrated into pedestrian routes such as the former rail alignment. Stops can be simple low platform layout integrated into surrounding footways. The principal disadvantage is that it has to be manually driven[9] and would operate on a scheduled service, not on demand, to a limited range of destinations.

While very different to PRT, it would be innovative because no town has yet implemented a ULR system for regular passenger use.

4.2.6 Minitram/Mobilicity

The characteristics of Minitram are similar to ULR but with different technology. It is a rubber tyred minibus, battery powered with manual and automatic (optical) guidance options. No Minitram system has been yet been implemented but it has been used in demonstration projects and is still being developed.

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[9] Although HILTech Developments claim to be able to deliver an automated ULR vehicle, this has yet to be produced.

A similar concept is being developed by the bus designers Capoco, known as Mobilicity. The Mobility concept vehicle is promoted as having potential in the long term for fully automated on-street operation.

4.2.7 Demand responsive bus

The 'on demand' characteristics of PRT can be partially replicated using buses on all purpose roads. However, they cannot match the theoretical waiting times of PRT and require pre-booking by telephone or e-mail. Most examples have not been successful but this could be due to their role when used as a supplementary service and to the operating context.

4.2.8 Taxi

Conventional taxis could be developed into an organised network to replicate the characteristics of PRT. However, waiting times would be significantly longer, unless pre-booked, and taxis would not be perceived as an innovative solution or offer environmental benefits. A local taxi service will continue to operate in any event.

4.2.9 Sub-options for Buses

A further consideration for bus systems is the method of traction and the vehicle design. The overall quality of service is also of great importance so service delivery is a key issue. Therefore, there are sub-options for buses, the most important of which are: trolleybuses, hybrids and FTR-type approaches. Any of these and conventional buses on busways and conventional roads may be operated commercially or with revenue support. A recent concept is the Quality Bus Partnership which has already been applied to a Geoff Amos bus service in the Daventry area.

Trolleybus

These are electric buses powered via overhead lines using twin trolleybooms. There are many modern systems worldwide but none in UK since the closure of the Bradford system in 1972. The main benefits of trolleybuses are their superior performance, obvious "presence", low noise, non-dependence on oil and zero emissions at the point of use due to electric traction. However, the overhead line is costly and visually intrusive.

Hybrid bus

Various forms of hybrid bus have been developed which combine the advantages of diesel and electric traction. They are a sub-option of a standard bus and could be used on guideways or with a quality bus partnership. Apart from low emissions they are unlikely to offer any other advantage over conventional buses.

'FTR' type bus

The FTR bus or 'Streetcar' has been developed as bus based alternative to light rail and recently introduced on high frequency services in York. It is a standard articulated bus but with stylish design to capture some of the allure of recent light rail schemes. The appeal of FTR is simply the attractiveness of the vehicle.

Quality Bus Partnership (QBP) or Contract

A QBP, is a partnership between an operator and the local transport authority. The operator provides a high level of service in return for infrastructure improvements (including traffic management, bus priority and stop infrastructure) provided by the local authority. A quality bus contract (QBC) goes further and replaces the competitive system with applies in most of England with a franchised arrangement as found in Greater London. No QBC has yet been applied, in part because of the onerous statutory tests applied which have to be fulfilled to enable their establishment. Proposed changes in legislation may affect regulatory control of bus services.

4.3 Selecting the Best Alternative

4.3.1 Objectives

It may be assumed that a key objective for any 'best alternative' should be to provide a level of public transport service as close as possible to that which a PRT system should be able to deliver. An important feature is access and waiting time which PRT aims to minimise.

In our proposal we stated that the long list of (mode) options would need to:

1) meet the broad objectives identified in Phase 1;
2) stimulate economic development;
3) provide a 'step change' in the quality of public transport;
4) support a strategy of sustainability.

The broad objectives at Phase 1 were concerned with the need to match the aspirations for transport in Daventry, the requirements of commissioning and the need to meet safety requirements. The sustainability objective reflects the aims clearly stated in the RTS, the IRS and TSfG. This is becoming even more important under the latter as policy becomes more strongly focussed on achieving lasting mode shift.

Objective 3 may best be assessed by comparing the alternative public transport options with the level of service expected to be offered by PRT. The key features of PRT are very short waiting times (average wait of 1-2 minutes are predicted in DDTS) and direct journeys without intermediate stops at about 40 kph. Walk access times to PRT depend on station location and spacing and are expected to be similar to bus stop location/spacing.

Further desirable objectives are:

- to meet DDC's aspirations for an innovative solution that may have wider economic benefits;
- to provide a level of capacity appropriate to a medium sized town;
- to be capable of integration within the existing and planned areas of the town;
- to have capital and operating costs broadly consistent with likely corridor demand levels.

The first of these additional objectives represents a more specific aim of stimulating economic development and relates principally to innovation and the associated potential spin offs. This is distinct from other economic development impacts such as direct employment and other regional objectives.

Therefore, we propose to assess alternative public transport modes against nine objectives as follows using qualitative scores to give broad rankings:

- Access time
- Waiting time
- Journey time
- Potential for wider economic benefit
- Support sustainability including mode shift.
- Innovation
- Integration in the town
- Capacity
- Capital and operating costs

4.3.2 PRT System Options

Unlike more conventional public transport technology, PRT concepts and systems in development are all proprietary. Similar to AGT systems, each supplier has its particular designs and system concepts. There can be differences in car dimensions, layout and weight, traction power, propulsion, vehicle guidance, control and collision protection philosophy. Therefore, the assessment of PRT is problematic. Dimensions, performance and cost for one system will not necessarily match another. Yet we need to assess what PRT might deliver and to compare it to the best alternative.

Our approach is to assess PRT systems as best we can drawing on readily available information supplemented by questions to the suppliers/developers. This revealed a range of information but also showed that it is very difficult to assemble a standard set of information for all of the more developed PRT systems. Consequently we have tried to define a generic PRT system for outline design and costing purposes. It is not intended to describe any single proprietary system and the costings are not, therefore, specific to any one system.

The Phase 1 Report contained a cross-section of an elevated PRT guideway which we have retained as the basis for further work. Clearly this shows a supported system with the car running on the guideway. Most proposed PRT systems have this basic configuration but there are other systems that involve suspended cars which are very different. However, even in these cases the broad impacts are likely to be similar except that suspended systems have higher track structures.

4.3.3 AGT

Most AGT systems are installed in locations where there are concentrated flows of passengers with no alternative transport option, often at airports where the use of AGT can be justified because it relaxes constraints on airport terminal layout and can maximise apron area for large aircraft without excessive walking for air passengers. AGT also exists in mini-metro form. The French VAL system is the most well known and operates as mini-metros in Lille, Toulouse, Taipei and Turin.

In all cases AGT operates without variable routeing generally to fixed schedule but can work on demand at off peak times. However, fixed route, all stations operation is the rule. To emulate PRT as closely as possible implies high investment in AGT cars to provide short headways. It would, however, be more difficult to emulate PRT alignments since AGT has a larger track cross section and larger cars. There are several well developed proprietary systems based on both electric propulsion and cable haulage. Some offer large capacity cars which may form trains. A well known AGT supplier is Bombardier which offers a range of designs from shuttles to mini-metros. Costs vary enormously but can be expected to be of the order of US $15m-$30m per km. This is equivalent to £8m-£17m per km plus guideway and station costs, which brings costs to £12m-£25m per km.

These costs mean that it is unlikely to be affordable except in the largest towns. Even in a small town like Daventry it would be very expensive to offer an AGT network. Therefore, it would be very hard to achieve the low access (walk) times possible with bus and, theoretically, with PRT.

4.3.4 LRT and Tram

New LRT systems have been installed in many cities round the world. LRT generally caters for higher passenger flows than bus and costs more. One advantage of LRT is its alignment flexibility permitting use of street running and reserved track. Light Rail Vehicles (LRV) are available to many different designs, mostly articulated and low floor, which have capacities of between 150 and 300 passengers. It is possible to operate at close headways of 1-2 minutes. The access time to LRT would depend on the network configuration but would be longer than for bus because of stop spacing and the network density which will be determined by affordability. Typically there would be a lower network density than for bus. The cost of LRT would be between £10m and £20m per route kilometre including LRVs.

The economic development opportunities with LRT in Daventry are likely to be limited. This is principally because there are several LRV builders established in the European market and limited scope for new entrants, although a lower cost LRV has been developed by Tram Power and tested at Birkenhead and Blackpool. An LRT route in Daventry would create construction and operating jobs but the latter would not be numerous.

These comments on LRT broadly apply also to trams. The main difference is that trams are more likely to use street running and to have lighter infrastructure generally than LRT. This could bring costs down to about £8m per route kilometre based on recent installations such as Portland "Streetcar" in the USA. Comments on the economic development potential of LRT apply similarly to tramways.

LRT and trams would be somewhat complex to introduce in Daventry due to the large number of roundabouts on the road network.

4.3.5 Ultra Light Rail

This mode has been under development for several years. A ULR car is providing off peak service on the Stourbridge Town – Stourbridge Junction rail branch is the West Midlands.

Although ULR offers minimum cost light rail service by dispensing with overhead line, it requires track similar to LRT and is manually driven also similar to LRT. It is not clear if it can operate safely on the street at reasonable speeds as this requires appropriate emergency braking. Assuming that this can be provided, the capital costs of ULR are likely to be somewhat less than those of LRT/Tram but the operating economics are likely to be quite similar. Recently quoted capital costs for ULR are £1m per route kilometre but it is hard to see how this could be achieved given the minimum cost of stops and of track, particularly if street running is involved.

There might be economic development spin-offs from a ULR system in Daventry because it would be a first and does involve flywheel technology which has several applications.

4.3.6 Minitram

From the little information already available it appears that Minitram would operate as a guided minibus that could use a dedicated right of way or be driven on the street. Therefore, it could operate as limited capacity AGT but with greater alignment flexibility. The lightweight vehicle would render elevated guideways more affordable and it could serve a wider network rather like PRT. However, Minitram has not been operated automatically and requires a driver. Therefore, the operating economics are likely to be very similar to buses and there seems little point in using Minitram instead of modern buses, although there may be some environmental gains.

We understand from DDC that a similar concept, under the name of Mobilicity, is being promoted by Capoco Design. Capoco have expressed interest in trialling their product in Daventry.

If Minitram or Mobilicity were to be developed, it would probably have economic development spin offs and would involve innovation that could benefit the Daventry economy. However, costs are likely to be significant for automatic operation and this would add nothing to the AGT/PRT offer. Costs are quoted, very broadly, as about £1m per route kilometre for an optically guided vehicle on its own right of way but this does not include automatic operation or network control capability. Given these issues, Minitram/Mobilicity were not considered further in the assessment.

4.3.7 Buses and Busways

The pre-2007 bus network was studied in DDTS. The Stage 1b&2 Final Report contains an assessment of an enhanced bus network, a new network with no new infrastructure and a new network with sections of guided busway.

The enhanced bus network comprised route amendments and increased frequencies. The new network expanded this concept to serve the areas of new development and envisaged headways of 15 minutes on all routes. The third network variant involved a further enhancement with sections of guideway mostly for access to new development areas.

It is clear from the DDTS results using the DTS model that the enhanced network and the new network both attract additional patronage and have an impact on mode shares. However, the use of guideways has no effect in the forecasts which means either that this use has little impact on journey times or that the reliability and image benefits of busways are not reproduced in the DTS model. Discussions with Arup confirm that the DTS model is not sensitive to these aspects.

It is widely believed that buses are failing in Daventry although the low patronage is entirely consistent with what is found in other smaller towns with little or no road traffic restrictions. Buses are generally perceived to be poor quality public transport but they can be improved radically with the right vision and finance. There is no reason why the Daventry network should not set new, higher standards of journey ambience and reliability.

The bus network changed in 2007 and would be easy to modify further. There is a section of busway being built in Middlemore and other measures could be taken to isolate buses as much as possible from traffic delays. Use of guided busways has been successful in Leeds, Ipswich and elsewhere with strong patronage growth recorded.

Investment in a better bus network to rival PRT level of service would imply significant revenue support payments, at least while patronage built up, and might depend partly on road traffic restrictions. The economic development impact of such investment is likely to be limited, apart from the extra jobs in bus operation. There is little new technology that Daventry would apply that is not in use elsewhere. Nor are there major opportunities in the bus manufacturing industry that is not already well covered by mature players in the industry. The exception to this would be selection of a more sustainable traction option such as hybrid buses or trolleybuses. In both cases, there is no strong UK industry base for these systems, although there are well established manufacturers of trolley vehicles and overhead line equipment in Continental Europe.

Other innovation opportunities might be to adopt centre rail or optical guidance, or combine busways with their use by Minitram/Mobilicity type vehicles. Of the alternative forms of guidance, the former is offered by Translohr and at least one other French supplier. The latter has been tried in UK but there are concerns over safety, particularly in slippery conditions. The combination of Minitram/Mobilicity with busways might be an interesting option, albeit without the level of passenger service offered by PRT.

Without economic development benefits, it is difficult to see how the higher costs of guided bus or trolleybuses could be justified in Daventry. However, Daventry could be a test-bed for sustainable technology.

These 'bus' options could provide access times comparable to the theoretical PRT times. It would be extremely difficult, however, for them to achieve similar waiting times although higher frequency buses could reduce the difference substantially, and journey times will generally be longer due to the need for intermediate stops, and – in many cases – the requirement for interchange.

The key issue with any bus option is bus deregulation. Under the legislation only non-commercial services can be tendered (and, therefore, specified by local authorities). Commercial services are not subject to any regulation although QBCs are a mechanism suggested for specifying enhanced bus services which can also be commercial. If any special infrastructure or special technology is to be used it can be built into non-commercial bus service tendering or specified as part of a QBC, or if not forming part of the highway, could presumably be restricted to the Council's choice of operator.

4.3.8 Demand Responsive Buses (DRT)

These may be fixed route or variable route, fully scheduled or purely on-demand. The reason that they are worth considering as an alternative to PRT is that, in theory, they can emulate the variable routeing and the low access times that PRT aims for. It may also be possible to offer quite low waiting times if the bus fleet is large enough.

In general all the comments that apply to fixed route buses apply to DRT. Busways can be part of the package as can innovative traction although the use of trolley buses might limit variable routeing. However, trolley buses with auxiliary engines can operate off the wires.

There is potential scope for innovation with DRT since there have been problems in delivering a control/dispatch system that can combine low waiting times with a fully inclusive, easy-to-use booking system. Daventry could be a test location for innovation in this area.

Costs of DRT are likely to be similar to fixed route buses but with the added cost of a control centre.

4.4 Assessment of Mode Options

The assessment of public transport is intended to identify the preferred alternative to PRT so that a full appraisal of both can be undertaken. This assessment is undertaken using a qualitative ranking based on criteria described above. The main considerations in the process are summarized below.

- Assessment criteria were developed specifically for this task and discussed as part of the appraisal framework.
- Only the public transport systems described in this report were assessed. There are many variants, particularly among guideway-based systems, but these are largely detailed variations which would be unlikely to affect the overall findings of this assessment.
- It was not possible to develop detailed networks and forecasts for all the mode options nor is this necessary for this broad, comparative assessment. General mode characteristics and costs were used.
- The assessment involves simple qualitative scoring against a base. The base represents the "existing" bus network. All scores are intended to show whether the alternative public transport mode is likely to be better or worse than conventional bus.
- A simple scoring system was used. Setting conventional bus to zero under all assessment criteria, the scoring indicates whether the alternative is likely to be better (+) or worse (-) than conventional bus against each criterion.
- Equal weighting was applied to each assessment criterion. This is a simplifying assumption which does not reflect, for example, the importance of economic development issues in mode selection compared to other criteria.

The results of the assessment are shown in table 4.4. Thus, for example, PRT scores better than conventional bus on most criteria except cost, access time and risk. Access time will reflect the network density achievable and the number of stations provided; as the number of stations increases so cost increases. None of the alternative modes are judged to have greater potential for wider economic benefits than PRT.

■ **Table 6 Assessment of Public Transport Mode Options**

	AGT	LRT	Busway	ULR	DRT	PRT
Access Time	--	-	0	-	+	-
Wait Time	+	+	+	+	+	+++
Journey Time	++	+	+	+	-	++
WEB Potential	+	+	0	+	+	+++
Supports Sustainability	+	++	+	++	+	+++
Innovation	+	0	+	++	+	+++
Integration in town	--	+	+	+	+	++
Capacity	+++	+++	+	0	0	++
Cost	---	--	-	-	-	---
Impl risk	-	-	0	--	0	---
TOTALS	**1**	**5**	**5**	**4**	**4**	**11**
Ranking	**6**	**2**	**2**	**4**	**4**	**1**

Notes: 0 = Performance of the do min

+/++/+++ = Better performance that the do-min

-/--/--- = Worse performance than the do-min

A simple ranking of the net scores is given at the bottom line in the table. This shows that LRT and buses/busways rank second after PRT mainly because they score well on waiting and access time and, if sufficiently attractive, could support sustainability well. In addition, bus capital cost is likely to be lower although more expensive than existing conventional bus. The next best scoring options is Demand Responsive Buses (DRT). Therefore, there is a case for considering DRT as a variant of improved buses, particularly if the PRT-like service characteristics can be maximised.

Based on this analysis the best alternative to PRT that can address most of the same objectives while being affordable, is upgraded bus. Buses could be conventional fixed schedule, or DRT, or a combination. The main requirement is to upgrade bus service and image as attempted elsewhere. The main objective will be to provide frequent service all week and for long hours each day, achieve very high reliability and minimise need for interchange.

5. Selecting the Pilot Schemes

5.1 Pilot System Requirements

We considered the detailed requirements for the pilot PRT under three main criteria as shown in Table 7

- **Table 7 Pilot Network Selection Criteria Table**

	Requirements
Costs and benefits	1) The total cost should be limited to a level which it is credible to believe funding could be secured; 2) There should be demonstrable benefits under economic development criteria, 3) There should be a good chance that revenue exceeds operating cost.
Areas served	1) The pilot installation must perform a useful transport role; 2) It should serve existing developments, or those where development is currently under way. 3) It should avoid areas and sections of route where there are specifically identified problems or constraints. 4) It should avoid major issues that could affect the granting of TWA powers 5) It should serve areas where there is a good fit between PRT service characteristics and the anticipated pattern of demand. 6) The pilot must be capable of extension to form part of a wider network.
Technical characteristics	1) All key features which would be required for an eventual full system of PRT should be demonstrated; 2) It should include at least three stations to demonstrate direct operation; 3) There should be a small fleet of cars sufficient to offer attractive total journey times 4) It should include both elevated and at grade sections of guideway

Using this grouping, the sifting process for route selection was in two parts:

- A high level sift of potential areas to be served and detailed route selection within short-listed areas

Using a small number of high level factors we considered each of the industrial and residential areas in Daventry which would be served by the proposed full PRT system, to identify those where we might proceed to detailed route selection for the pilot.

We initially identified possible pilot route sections and station locations to serve the areas identified by the high level sift. We then applied the technical objectives to the proposed route sections, and modified them as necessary so that they would be suitable for inclusion in a pilot system.

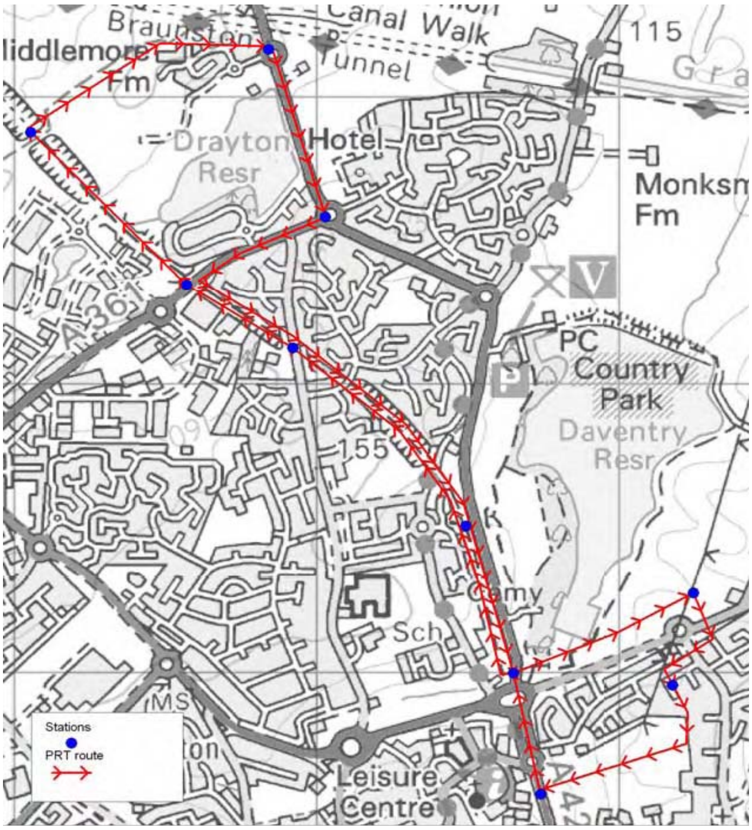
The basis for the pilot route selection process was the “PRT Preferred Routeing Option with addition of the Southbrook Link” as set out by Buchanans in the DDTS.

We did not consider any additions to the Buchanan network; however, we considered modifications as follows:

- sections shown by Buchanans as single track may be double track and vice versa.
- detailed layouts at junctions may be modified.
- the suggested direction of operation on single track sections may be reversed.
- station location may be varied both to achieve a better fit with local conditions and to serve areas which would otherwise have been served by different stations on the full system.

The final version of the DDTS also includes Buchanans’ proposal for a pilot network, as below shown in Figure 2

- **Figure 2 Proposed Pilot in DDTS**



This is similar to that which was suggested by Daventry DC when we met them to discuss possible constraints – they were concerned to keep the route, if possible, to land owned by public authorities or highway.

5.2 Selecting the Location of the Pilot Scheme

5.2.1 Assessment factors

Based on the area requirements as noted above, and our discussions with Daventry District Council, we identified the following high-level factors which have been used to assess possible areas to be served by the PRT pilot.

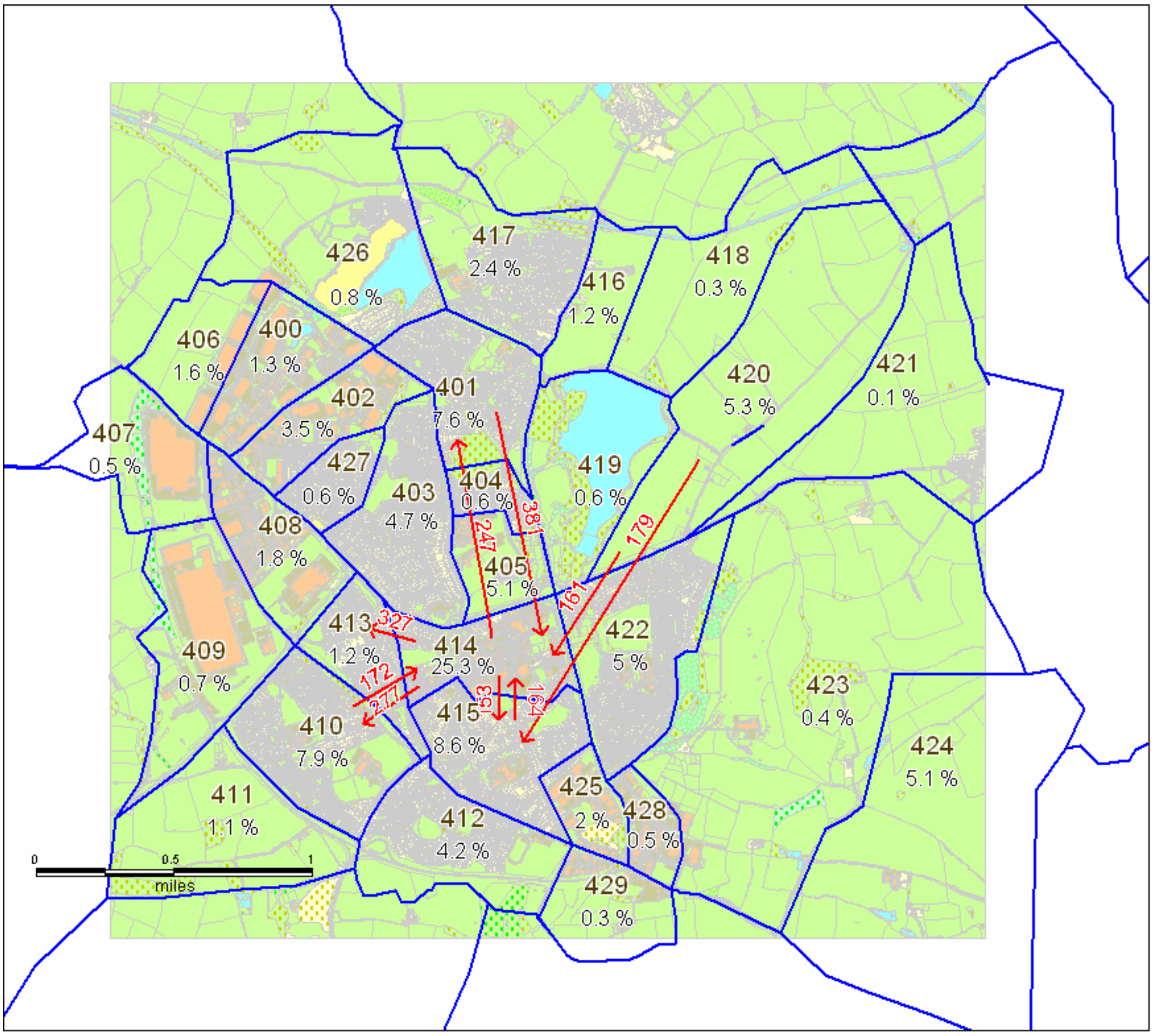
- **Table 8 PRT Pilot – Criteria for Area Screening**

Factor	Comments
Transport role	The pilot route should serve corridors where there is an identified demand. PRT is less likely to be attractive for areas close to the town centre where walking is already an option.
Stage of development	The intention is to serve areas which have already been developed, where development is currently under way or commencement of construction is imminent and would be substantially complete when the pilot as built.
Routes subject to constraints or disruption by major redevelopment	Daventry DC have indicated that construction of development planned for the western side of the town centre will potentially disrupt a possible PRT alignment via Eastern Way and Braunston Road, and therefore that any pilot route should avoid this section
Requirement for land acquisition	Wherever possible the pilot route should use existing highway and local authority owned land, and avoid any requirement for property demolition.
Traffic demand patterns	Areas should if possible offer a demand pattern which extends through the day and into the evenings and weekends, with a mix of journey purposes.

5.2.2 Demand

Because the pattern of demand to and from industrial areas is mainly work related, and is concentrated within a small number of peaks, it would not be representative of the demand pattern for a full PRT network and we have, therefore, excluded these areas as a main focus. Analysis of DDTS 2021 am peak travel demand matrices indicates the main forecast flows by car and public transport between model zones within the Daventry area. We selected the strongest peak flows by car in Daventry. These are all flows with more than 100 trips from the full matrix. They are shown on a simple ‘desire-line’ plot shown at figure 5.2. This shows that the significant flows are to the town centre from the north, south and west. There are also stronger flows between the northeast and south of the town centre. There is also a strong flow from the town centre to the north. This shows that the north-south corridor probably has most potential for mode shift and offers most prospects for a PRT pilot.

- **Figure 3 Daventry Trip Proportions and Main Movements**



5.2.3 Other Issues

We are aware of a number of specific constraints which could affect PRT alignments, and, in particular:

- underground services, including high-voltage cables and pipelines.
- electricity substations and pylon lines.
- ancient monuments, sites of special scientific interest and county wildlife sites.
- conservation areas and listed buildings.

We understand that these constraints were taken into account by Buchanans when setting out their proposed network.

We are also aware of possible constraints which may apply if use is to be made of the old railway alignment due to its status as, in part, a County Wildlife Site.

5.2.4 Area analysis

The effect of application of these factors on an area basis is as shown in Table 9

- **Table 9 Area Screening**

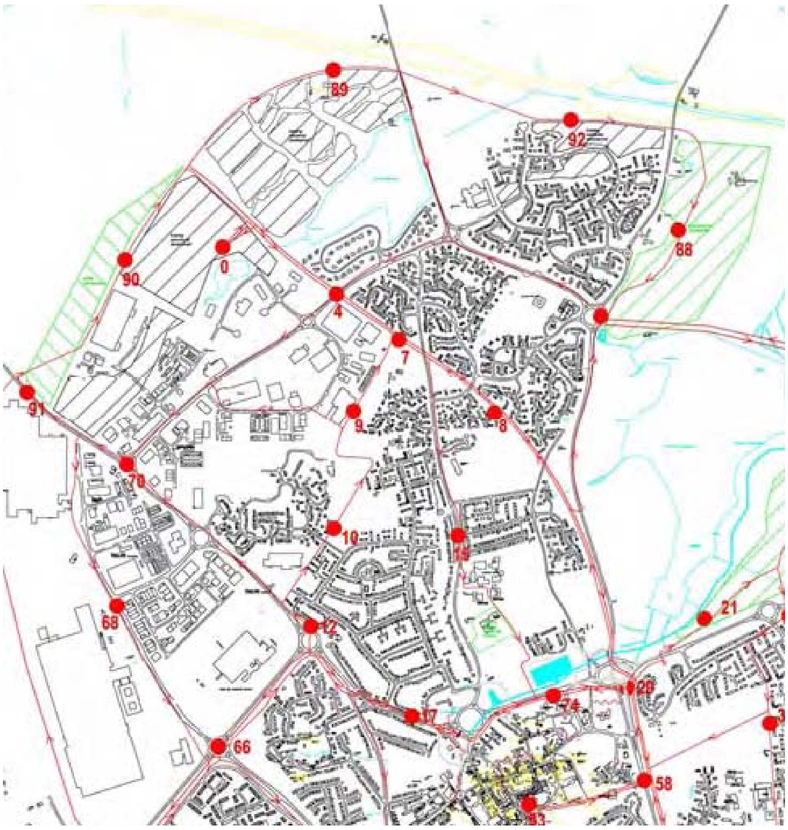
Area	DDTS Indicative Stations	Commentary	Conclusion
Town Centre	20, 74, 93	▪ Problems accessing station 93, however good possibility for station between 20 and 74 in new car park	Take forward new station as possible for pilot
B4036 development site	21, 25, 30, 86, 87	▪ Site not yet developed	Not suitable for pilot
Southbrook	24, 31, 33	▪ Relatively close to town centre ▪ Difficult access - may require land acquisition	Not suitable for pilot
Marches Industrial area	35, 37, 72, 75, 79	▪ Industrial area	Not suitable for pilot
Development site east of Burnt Walls	76. 77, 78, 80	▪ Site not yet developed	Not suitable for pilot
Hospital	56	▪ Difficult access - may require land acquisition	Not suitable for pilot
Stefen Hill	46, 47, 50, 51, 52, 54	▪ Relatively long access routes, especially if Eastern Way and Hospital sections not available	Not suitable for pilot
The Grange	62, 63, 65, 66	▪ Would require access via Eastern Way	Not suitable for pilot
Drayton	17	▪ Would require access via Eastern Way ▪ Relatively close to town centre	Not suitable for pilot
Royal Oak Way	66, 68, 70, 91	▪ Industrial area	Not suitable for pilot
Headlands	15	▪ Would require access via Eastern Way ▪ Relatively close to	Not suitable for pilot

Area	DDTS Indicative Stations	Commentary	Conclusion
		town centre	
Catesby Grange	10	▪ Would require access via Eastern Way	Not suitable for pilot
Drayton Fields industrial area	90	▪ Industrial area	Not suitable for pilot (However, may be suitable as depot location)
Middlemore	89	▪ Part complete, remainder currently being developed ▪ Remote from town centre	Possible location for inclusion in pilot
Ashby Fields	4, 6, 7 ,8	▪ Established development ▪ Further from town centre	Possible location for inclusion in pilot
Lang Farm	92	▪ Established development ▪ Remote from town centre	Possible location for inclusion in pilot
Monksmoor	88	▪ New development, construction imminent ▪ Remote from town centre	Possible location for inclusion in pilot

The relevant section of the Buchanan network including the possible areas identified for the PRT pilot is shown below.

SKM

▪ **Figure 4 Section of the DDTS PRT Network**



In comparison with the pilot network proposed by Buchanan in the DDTS, we specifically exclude serving Southbrook, as there are likely to be significant problems with achieving the suggested alignments.

5.3 The PRT Pilot

5.3.1 Cost

Our appraisal criteria include a cost limit. It would not be appropriate to define a pilot PRT system that was clearly unaffordable. On the other hand it will be necessary to include some less "divisible" items, particularly the depot and the control system, in the pilot. We set the initial cost limit at £20m.

5.3.2 Assessment factors

Based on the technical characteristics as noted above, we identified the following comments which were relevant in assessing possible alignments to be included in the pilot PRT network.

- **Table 10 PRT Pilot – Technical Selection Criteria**

Factor	Comments
All key features required for eventual full system to be demonstrated	▪ Key features such as a depot and control room will be required irrespective of the size of the system, although the size and complexity of these could be reduced. ▪ The full system will incorporate a mixture of single and double track sections and a variety of junction and station configurations.
Include at least three stations	▪ Users should be offered a genuine choice of destinations, and the control system should be capable of expansion to the level of complexity envisaged for the full system. ▪ The full system will included elevated stations and stations at ground level, therefore, both should be included.
Small fleet of cars, but enough to offer attractive journey times	▪ The size of the car fleet will also determine the requirements for depot space and, possibly, capacity at stations
Include both elevated and at grade sections of guideway	▪ The requirement for total segregation of the guideway will necessitate at least some elevated sections.

As far as possible, the pilot system should seek to incorporate the features to be demonstrated within the context of the transport requirements for the areas to be served, however it may be necessary to introduce some additional complexity on the pilot route to enable all required features to be tested.

Station sizes and configuration may, therefore, need to take into account;

- higher levels of anticipated usage when incorporated in the full system
- requirements to test larger station layouts and peak loading characteristics which may be required for the full system.

Thus a few stations may be built to a larger size than initially required for the pilot, or with provision for subsequent enlargement.

The control system must be capable of determining an appropriate route through the system between any selected pair of stations. Ideally there should be multiple options for at least some station pairs so that the control system can be used to demonstrate selection, taking account of other traffic already on the network.

Our working assumption is that all guideways (except possibly for short sections within stations and depots) will be designed for single direction operation. Although bi-directional working on single track sections may be technically feasible, it is considered that this may place unnecessary constraints on eventual system and supplier choice, would substantially reduce available capacity and increase potential for delay on the sections concerned. Certain sections of route may therefore be built with double track.

5.3.3 Core route

The high level sift identified four areas for PRT pilot route selection, plus a possible town centre station location. All of these are to the north of the town centre. An old railway alignment runs north west from the town centre, which is used by pedestrians and cyclists. This includes stations 8, 7 and 4 on the Buchanan network. This has already been identified by Daventry DC as a potential route for a PRT pilot, and the final version of the DDTS also shows a possible pilot using this alignment.

This alignment itself could serve parts of Ashby Fields and extends to Middlemore. It also passes a possible depot location on the Heartlands Industrial Estate. Other parts of Ashby Fields, also Lang Farm and developer proposals for Monksmoor, could be served by extensions to the core route.

Key advantages of using this alignment are:

- ability to serve several areas of the town identified as having potential for a PRT pilot, either on the route itself or with short extensions.
- alignment continues towards the new development at Middlemore.
- alignment runs adjacent to possible depot location on Heartlands Industrial Estate.
- land within the corridor is potentially available without serious planning and consent issues.
- there are relatively few crossing points which would require grade separation.
- clearances required for pedestrian and cycle crossing are less than for roads.

However, this route also has a number of problems which would need to be overcome at the detailed design stage:

- addition of PRT and retention of pedestrian and cycle access will require encroachment on vegetation on verges of current combined footpath/cycle track.
- the replacement bridge over Ashby Road is only suitable for pedestrians and cyclists and would need separate provision for PRT.
- the crossing with Shackleton Drive is at grade and a PRT route would need to be grade separated.
- available width for stations is limited, especially if there are to be double-track sections of PRT guideway.

5.3.4 Station locations on core route

The Buchanan network shows three potential stations on the core alignment north of the town centre as follows:

- Station 8: Scott Close/Peartree Close
- Station 7: Wold Close
- Station 4: Drayton Park

Each of these is located where there is pedestrian access to the old railway alignment.

It would appear that the Daneholm Avenue/Welton Road area would be served on the full system by station 15 on Ashby Road near the schools. It is, therefore, proposed that this area is served by a station on the pilot route near Osprey Drive where there is pedestrian access and a pedestrian underpass beneath Northern Way.

5.3.5 Extension of the core route

If the core route is confined to the rail alignment, it will provided limited opportunities to test route choice and the management of merging and diverging routes, except in the detailed context of station operation. Operation would essentially be linear, with individual cars running non-stop through or past intermediate stations. The Buchanan proposal includes a loop round the Drayton Reservoir via Middlemore. However, this alone would not significantly add to the complexity of route choice.

The pilot system should, therefore, include at least one extension off the core route to add some of the complexity which will be a feature of the full system. These extensions should, as far as possible, meet traffic objectives, which are summarised in Table 11.

- **Table 11 More Issues for the Pilot**

Area	Potential to Serve	Recommendation
Middlemore	Good traffic objective. Station 89 is close to potential traffic focus at pub Potential PRT route is probably constrained by agreed plans for completion of development.	Consider serving station 89 plus additional station at north-west of development.
Ashby Fields	Already on core route and served by stations 7 and 8. North eastern corner could be served by potential station at 6, which could also serve the Country Park.	Consider serving station 6.
Lang Farm	Good traffic objective but station 92 not ideally sited. Although similarly poor for access, could be served by stations at A361/A425 roundabout and station 6 without	Consider serving with new station at A361/A425 roundabout and station 6.

Area	Potential to Serve	Recommendation
	need to build loop through station 92.	
Monksmoor	Not yet built, though may be before pilot is constructed. Station 88 gives some improvement to access to Lang Farm but not worth inclusion in pilot. Could serve south of new development with station at 6.	Only consider station 6 for pilot

5.3.6 Town Centre Station Location

The old railway alignment runs on an embankment to the north west of the adjacent roundabout, and it is proposed that the pilot route should be elevated across Eastern Way and Welton Road, with a station located as near to the shopping centre as possible without taking property.

We also understand that a proposal for a pedestrian and cycle bridge, with potential for PRT capacity, is being considered for this area. If proceeded with, this would help reduce the alignment cost.

A key advantage of co-location would be that there could be shared use of lifts and stairs and the station could be totally enclosed. We considered combining maintenance and stabling facilities for the PRT cars into this location. However, our view is that these are better located in a purpose-designed facility.

5.3.7 Depot Location

The Buchanan network envisages a depot at DDTS station 0 on the Drayton Park Industrial Estate. This would appear to be located to the west of Newnham Drive. There is open land adjacent to the old rail alignment on the east side of Newnham Drive which, if available for depot construction, would avoid the need for a road crossing. Therefore, it is proposed that the depot is located in this area.

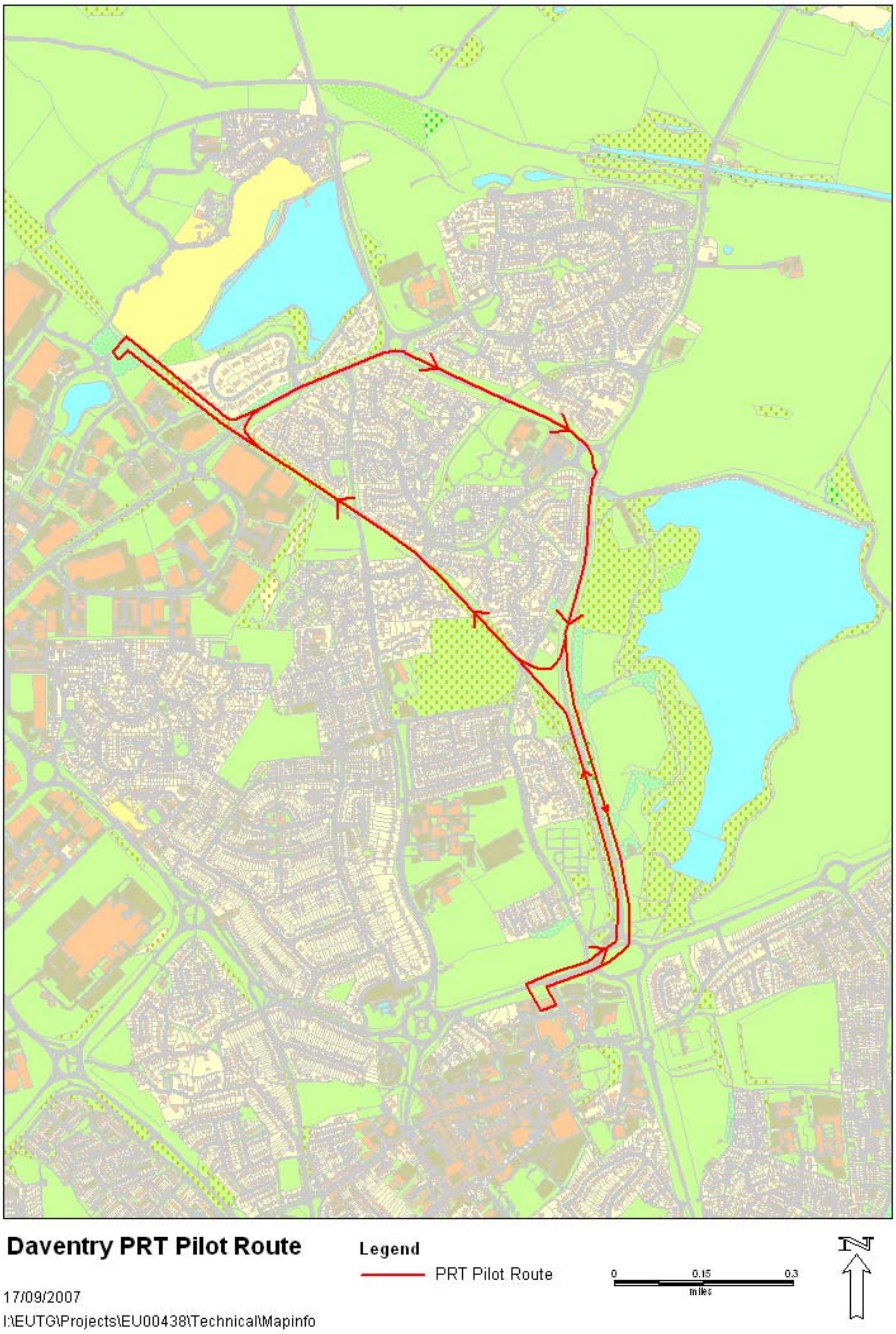
It transpires that Daventry District Council owns the land in this area, and while using it for the depot would still incur an opportunity cost, there should be no difficulty in actually securing the site.

5.3.8 Pilot PRT Network

Figure 5 shows the proposed Pilot PRT scheme. The scheme would comprise double track starting at a station in the town centre, probably built into a new car park, running north along the former railway alignment. It would divide and the northbound guideway would follow the DDTS suggested routeing serving stations approximately at locations 7 and 8. The single guideway would continue beside Drayton Way to the Sedgemoor Way roundabout where there would be a station. It would then turn east along Northern Way to reach DDTS station 6 whence it would run south beside Northern Way to the town centre. The route would operate as a one-way clockwise loop with a connection allowing cars to run directly from station 6 to 8. The depot site would be on the northern edge of Drayton Fields Industrial Estate beside the former railway alignment reached by a guideway connection from Drayton Way. Stations are assumed at Shackleton Drive at the junction of Drayton Way and Northern way and the junction of Northern Way and Welton Lane.

This pilot route was costed at about £14m for 4,881m of guideway and is assumed to be served by a fleet of 25 cars. It would serve five stations.

- **Figure 5 Pilot PRT Network**



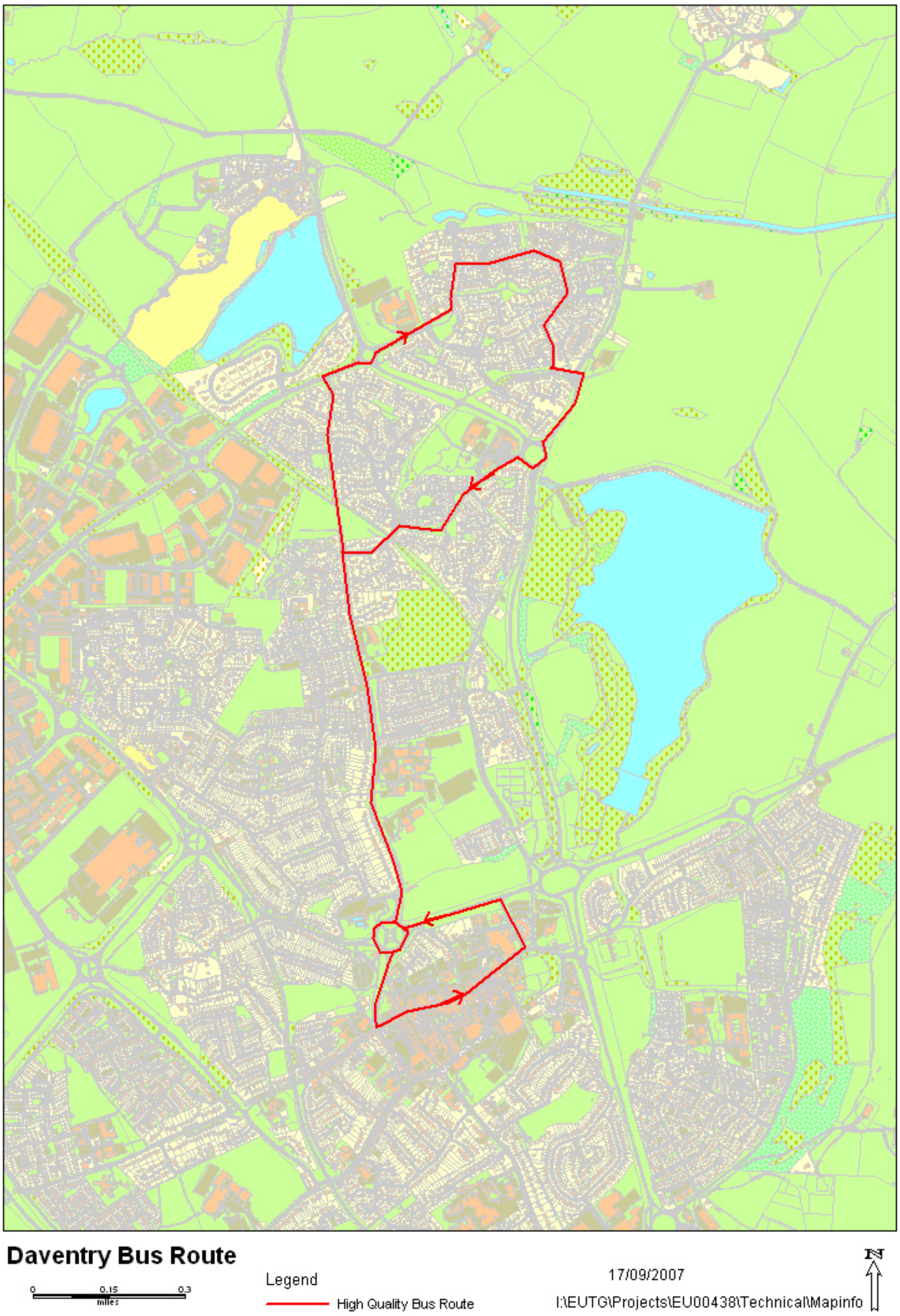
5.4 The High Quality Bus Alternative

For comparative appraisal an alternative way of providing high quality public transport was developed. The mode assessment showed that upgraded bus offered the best way of delivering sustainable transport benefits after PRT. This option would only offer comparable benefits if it offered a radical step change in bus provision. We envisage an intensive service all day to achieve waiting times comparable with PRT which will require a headway of no more than four minutes (2 minute average wait time), high quality waiting facilities and information systems, and freedom from delays in all traffic conditions to give very high reliability.

Figure 6 shows the proposed High Quality Bus Route to serve the pilot area. running: town centre, bus station – Eastern way – Ashby Road and then a one way loop via Drayton Way-Sedgemoor Way-Newbury Drive-Edgehill Drive-Nantwich Drive-Marston Way- Welton Lane- Speke Drive-Shackleton Drive-Ashby Road-High Street- bus station. The route would have 25 stops together with a dedicated depot and a system of bus priority measures with short stretches of busway where appropriate. The target headway implies the need for 8 buses in service plus 2 spares for reliable operation.

It would not be a commercially attractive proposition for bus operators and there would be competition between the HQB and existing operation for local patronage. Therefore, the procurement of the operation would need careful planning with a form of QBC but present bus competition and subsidy rules present a number of obstacles.

■ **Figure 6 High Quality Bus Route**



6. PRT Technical Requirements and Cost

6.1 Technical Requirements

6.1.1 Introduction

A major element in determining the feasibility of implementing a PRT system in Daventry will be the ability of PRT vehicle and systems technology to meet the primary system objectives as follows:

- To ensure the safe functioning of the PRT system during normal and abnormal operation and maintain an acceptably safe environment for passengers, staff and members of the public.
- To deliver the functionality, performance and reliability to meet the operational demands to provide an efficient point to point PRT system for Daventry.

To assess if it is feasible to achieve these primary objectives it is first necessary to identify the key functional requirements of the vehicle and systems against which to assess the potential systems. The key functional requirements have been developed based on the PRT outline functional specification in the phase 1 Daventry PRT Scoping Study Report, applicable or related industry standards, relevant experience of automated transport systems and the results of a top level system hazard and risk review.

6.1.2 Scope

This section covers the PRT vehicles, command and control system and power supply system. Details are also given on where the functionality of these elements has an influence on the requirements of other parts of the system (e.g. the guideway). In addition to the technical requirements, consideration is given to the requirements associated with system assurance and regulatory approval of a PRT system.

The requirements identified in this section are top level and mainly relate to the unique or particularly important requirements for a PRT or automated transport system. Requirements that are typical to other forms of transport systems have not been included at this stage.

The section assesses three potential PRT system designs against the key requirements. The three potential designs have been chosen from this list of potential suppliers identified in the phase 1 report because they each employ different aspects of PRT technology. This selection does not imply any pre-judging of the actual system Daventry might deploy.

In addition to the requirements for development and assessment this section covers the following PRT vehicles and systems issues;

- Freight transportation requirements.

- PRT maintenance requirements.
- Identification of construction and commissioning issues.
- Broad cost estimates for vehicles and systems.

6.1.3 Assessment of Vehicles and Systems

Key Functional Requirements

Although the concept of PRT was invented in the 1960s the technology required to implement a practical system is only now emerging, there are no proven systems on which to base future system requirements. However in terms of technology and equipment, PRT system requirements are similar to automated people mover system requirements which are now relatively mature systems. In developing the PRT key requirements we have followed the requirements of the Automated People Mover (APM) Standards committee where we consider them to be applicable to PRT. The principal standards used were as follows;

- APM standard part 1 ASCE 21-05 – Operating environment, safety requirements, system dependability, automatic train control, audio and visual communications.
- APM standard part 2 ASCE 21-98 – Vehicles, propulsion and braking.
- APM standard part 3 ASCE 21-00 – Electrical equipment, stations, guideways.

In developing the requirements we have also considered current ORR Railway Safety Principle and Guidance requirements where we consider them helpful in defining PRT requirements.

The key functional requirements have also been developed based on relevant experience of automated transport systems and input from a top level system hazard and risk review undertaken in conjunction with Serco Assurance.

The key functional requirements are divided into the technical requirements and the system assurance requirements associated with meeting the necessary regulatory requirements.

Assessed Systems

In the phase 1 report a number of potential PRT systems where identified as being suitable for implementation in Daventry. Due to time limitation and the availability of design information we have chosen to review three system designs from the phase 1 list as follows;

- The ULTra system from Advanced Transport Systems (ATSL).
- The CyberCab II system from Frog Navigations Systems.
- The Vectus system from Posco.

We have chosen to review theses systems because they are being implemented either as a first application or at a full scale test facility. They are also systems that employ different aspects of PRT technology. Other systems may be worth considering, and are not ruled out by this review, including those which use other approaches (e.g. suspended) at tender stage. Indeed, Daventry DC should keep as many options as possible open to benefit from a competitive bidding.

ATSL ULTra system

ATSL is a UK company that have been working on PRT development for 10 years. Their Ultra system uses a 4 seat battery powered vehicle that operates on a simple concrete guideway. The vehicle is designed using components mainly from the automotive industry. ULTra vehicles navigate themselves to the require destination based on an electronic map of the guideway network. The required routeing, synchronized in space (location), and time across the network is assigned to the vehicle by the central control system. Safe vehicle separation is ensured by a fixed block automatic vehicle protection system.

ATSL have a test facility in Cardiff. They are currently installing their first commercial system which is a 3.2km system with 18 vehicles that links Heathrow terminal 5 with three car parks.

The ATSL ULTra system has been chosen for evaluation because it is a relatively well developed concept that uses components and systems that are proven in other industries.

Frog Navigation CyberCab II system

Frog Navigation Systems is a Dutch company who have a long history in the development of automated systems for industrial and transport applications. Their CyberCab II PRT system has not to date, been implemented in a practical application. However, the system is based on a mini bus size Frog automatic vehicle called Parkshuttle which was in operation at Schiphol Airport and is in operation at Rivum Business Park.

The CyberCab II vehicle is a 6 seat battery powered vehicle operating on a simple concrete guideway. Routeing and navigation is based on an electronic guideway map and magnetic markers fixed to the guideway surface. Safe vehicle separation is ensured by a fixed block vehicle protection system and a vehicle obstacle detection system that can bring the vehicle to a safe stop if obstacles are detected up to 40m in front of the vehicle.

The CyberCab II system has been chosen for this evaluation because it uses technology that has been developed for larger automated vehicles and it is a system that employs an obstacle detection system as part of the vehicle protection system.

Posco Vectus system

Posco is a Korean Steel company who have set up Vectus Ltd to develop a PRT system. They have no previous experience in automated transport systems but are partnered with British and Swedish companies who have experience in monorail systems, rail vehicle design and control systems.

The Vectus system uses a linear motor propulsion system with motors being located along the guideway to propel 4 seat vehicles. The Vectus guideway design is a steel structure with the linear motors to being fixed every few metres and electrical control equipment for the motors is also located along the guideway. Vectus vehicles are not self navigating, routeing through junctions is controlled by the central control system similar to a normal railway. Safe separation of the vehicles is ensured by a moving block vehicle protection system with a dedicated short range communications system being used by the central control system to manage vehicle speed to ensure the vehicle remains a safe distance from the vehicle in front.

Vectus have constructed a 400m loop test track at Uppsala in Sweden. The first tests on the test track in Uppsala occurred in spring 2007. Vectus is planning to operate the test track until 2010.

Vectus has been chosen for evaluation because using linear motor propulsion, central control guidance and moving block vehicle protection make it a radically different concept to ULTra and CyberCab II (the two other battery powered systems).

6.1.4 Assessment Results

Each system has been assessed against the key technical functional requirements for a PRT system. The ULTra and CyberCab II systems have also been assessed against the key system assurance and regulatory requirements for a PRT system. It has not been possible to assess the Vectus system against the key system assurance requirements due to the limited information available from the Korean supplier.

Our assessment is based on a review of published technical information on the systems, information and correspondence with each of the suppliers and a visit to the ATSL ULTra test facility in Cardiff.

Full details of the assessment results are included in Appendix C.

6.1.5 Freight Transportation Requirements

To date no proposed PRT systems have considered the transportation of freight. However from a vehicles and systems view point there are no fundamentally different requirements in transporting freight from those for transporting passengers. Assuming freight PRT vehicle would be designed as variants of the standard design and the freight would be transported on standard passenger PRT vehicles the following issues should be noted:

- the freight would need to fit through the door aperture of the PRT vehicle which is typically 1400mm x 850mm;
- the weight of the freight being carried should not exceed the payload of the vehicle which is typically 500kg.

On this basis any of the three PRT systems assessed would be capable of transporting freight. The following design requirements may assist in transporting freight using the passenger PRT vehicles:

- tip up seat to allow the full floor space to be used for stacking freight. Typically 4 seat vehicle have 2 tip up seat so that a wheel chair can be accommodated. However having 4 tip up seats in a vehicle would increase the floor space for freight (but may not deliver the level of passenger comfort required and could encourage standing);
- anchor strong points on the vehicle floor to allow freight to be secured.

Specialised goods vehicles may be justified if there are facilities making use of the capacity on a regular basis. One possibility which we understand has previously been discussed is carriage of waste, for example from town centre shops to a central disposal/recycling site.

6.1.6 PRT Maintenance Requirements and Depot Design

The following maintenance requirements will be necessary for PRT vehicles in order to ensure their consistently safe and reliable operation in service, with a high standard of vehicle presentation.

The requirements have been considered for a small 25 vehicle pilot scheme through to a large 500-car fleet, and the workshop area has been designed with easy expansion as a major consideration.

6.1.7 Lighting

There are currently no standards for the application of street lighting for use in PRT systems; however, it is reasonable to assume that the British/European Standard for Road Lighting (BS 5489) should provide good industry guidance. This standard covers many scenarios, such as high speed and residential roads, amenity areas etc. It has therefore been assumed for PRT that lighting would be required for the guideway to serve a number of functions, such as, but not limited to:

- assist night-time operation and maintenance;
- provide a welcoming environment and a feeling of safety for patrons;
- support emergency situations that may arise;
- provided a well lit environment to deter vandalism and anti-social behaviour;
- improve colour rendering and visual capability of security systems.

If at all possible lighting of PRT should be avoided to reduce:

- visual impact on the environment;
- carbon footprint through energy use and infrastructure;
- minimise capital and revenue expenditure.

Two scenarios were considered, i.e. full lighting provision along the whole of the guideway and secondly as reduced provision of the 50m approaches to all stations. The estimated capex and opex costs are based on the lower provision of 50m approaches to the stations; however, it may transpire following further HMRI discussions that full provision is necessary and may need to be considered at the detailed design and procurement stage of this pilot project. The Pilot scheme could be used to test the requirement for lighting in this regard.

Careful consideration will need to be given to the lighting level to be adopted together with mounting heights and luminaire profile. With certain locations of the PRT guideway, for example on elevated superstructures, the heights of lighting units should be limited to minimise visual intrusion. 'Full cut off' luminaries should be considered to minimise light spill on the surrounding area in accordance with the recommendations given in the Institution of Lighting Engineers (ILE) guidance notes for the reduction of obtrusive lights.

If CCTV is deployed along the PRT guideway consideration should also be given to the use of a light source with a colour rendering index (RA) of >65 (perhaps an RA of 80) to improve the night time performance and colour rendering of the CCTV system.

6.1.8 Surveillance, Communication and Monitoring System

The exact nature of the surveillance, communications and monitoring system will depend on; the geometric design of the guideway, the ability of the PRT vehicles to detect obstructions, the level of general surveillance required and the quality of images that may be required for evidential purposes. The estimated capital costs for the surveillance, communication and monitoring fall into these sections:

- CCTV equipment (procurement and installation) for the Security Control Centre;
- CCTV equipment (procurement and installation) at each site (station or depot);
- communications provision between the Security Control Centre and each site;
- provision of other equipment in the Security Control Centre (for example, operator workstations, other system terminals, telephones);
- changes to the site (for example, improved lighting, removal of vegetation, modifications to entrances and boundary fences);
- provision of improved CCTV signage that is compliant with legal requirements regarding the use and storage of CCTV footage;
- procedures/ guidelines for the procurement, deployment and use of the CCTV System.

It is anticipated that cameras will be required in the depot, stations, and at spacing of between 110m and 160m intervals on the track to have complete or near complete coverage respectively.

For the Pilot system, this would result in approximately 77 cameras and for the Final system, this would result in approximately 660 cameras.

Further work will be required to determine the number of CCTV cameras on site when a Final track system and layout is decided. A suggested standard for each station could be two fixed cameras and a pan, tilt and zoom (PTZ) camera, with an allocation of an additional camera to view the track in each direction from every station. This would require four fixed cameras for each station and one PTZ camera.

A key component of the capital cost of the security system will be whether storage media will be provided to meet ACPO and Home Office guidelines. Cost estimates are provided for the Core CCTV System (for location at the Security Control Centre, stations and depots), together with the costs of the additional display equipment to be installed in the Security Control Centre. It is anticipated that the initial capital investment required without achieving evidential quality recording of all stations and depots, together with a fully equipped Security Control Centre (from a CCTV perspective) will be of the order of £4.2m for the full system.

At this stage it is assumed that storage for evidential records will not be required. However, the cost of providing the storage media is significant (it adds £1m to the total cost for the full system).

6.1.9 Route selection and reservation from each station

In order to reserve a vehicle, a passenger will be required to select a destination from a main display screen or passenger information terminal. These selection points will then interface with the fleet management system and allocate a vehicle to the passenger(s). At the entrance to the station it has been assumed that a passenger information terminal will also be provided. It has therefore been assumed that stations will require:

- passenger information terminals, Plasma Screen – one per vehicle bay;
- smart card readers such that a vehicle can be reserved and collected by the passenger – one per vehicle bay;
- ticketing machines with smart card payment and access facilities – one per station of the Pilot and one per five stations, for the Final system, to reduce to a reasonable cost.

6.1.10 Operations and Maintenance Activities

The cost of operating the Daventry PRT system will comprise:

- staffing for management, operations and maintenance;
- energy usage for vehicles, stations, depot and facilities;
- replacement parts and spares.

Staffing and Service Level

No drivers are required for PRT but, in the event of vehicle failure or unruly behaviour of the occupants, certain additional measures will need to be provided and these are likely to introduce additional cost. There is a requirement for some form of CCTV system to ensure safe operation of the vehicles on the guideway and notification of abnormal behaviour.

Estimated costs were broken down into the likely work required and the time taken to carry out the tasks. Certain assumptions have been made to derive the staff required to deliver an acceptable level of service.

It should be noted that the staff estimated are full-time equivalent posts, but with the operation being conducted on a 24 hour, 7 day a week basis the number of staff required to provide cover and call-out duties for repairs will be higher as indicated below.

Costs are based on a minimum wage and then multiplied by an uplift factor for the different skill types and services provided. Further work on these uplift factors may be required to tailor them to the local employment market.

Managerial and Supervisory Staff

The managerial and support tasks were estimated based on the typical duties to operate the service and ensure its success and includes activities such as planning and preparation for initial operation, public outreach, advertising, community engagement and of course operational and staff management. The managerial staff required is as follows:

- **Table 12 Managerial Staffing Assumptions Pilot PRT**

Staff Categories	Numbers
General Manager	1
Operations Manager	-
Operations Supervisor	1
Maintenance Manager	-
Maintenance Supervisor	1
Office Clerk	1
Accountant	1
HR Personnel	-
Total	**5**

The senior managerial staff numbers will change between the Pilot and full systems as a result of some roles being combined, for example, in the Pilot system, it is likely that HR matters and the General Manager will be combined, similarly it is possible that the Operations Supervisor and

Maintenance Manager will be combined. For supervisory management and administration staffing the magnitude of the tasks will be smaller for the Pilot and so would require less staff.

General Operations and Maintenance Staff

The estimated operations and maintenance staff are provided below. The detailed breakdown and estimation of the operation and maintenance staff can be found in Appendix H.

- **Table 13 Operations and Maintenance Staff Levels Pilot PRT**

Staffing Areas	Numbers
Stations require three 30min cleans per week	1
Vehicles require two 10min cleans/safety checks per day	3
Vehicles require a 30min service per fortnight	1
Additional Staff at the depot	-
Staff required to monitor the system from the control room while operational	5
Staff required to walk around the track to conduct a safety inspection *	-
Building services are required to maintain the depot/station/track infrastructure	1
Electrical staff to maintain the CCTV/ communications/ control/ displays	2
Security staff/Incident Response/Revenue Collection	2
Staff required for vehicle maintenance/repairs	5
Total	20

* may not be required depending on CCTV coverage

The two highest resource activities are:

- monitoring system from the control centre;
- PRT vehicle maintenance and repairs.

Clearly the level of staffing can be reduced to control costs. However, any reduction will affect the level of service and potentially the quality and potential attractiveness of the PRT system. In the case of the cleaning activity this is probably the most visible aspect supporting the attractiveness of the system. A 10 minute clean is not unrealistic; this activity would also include manual handling of the vehicles to/from the cleaning area and receiving the next vehicle.

There is a potential that the level of resource for the PRT vehicle maintenance and repair activity could change. There are very few fully operational PRT systems to compare with and any trial/emerging systems have yet to prove their reliability and required maintenance regimes. However, for a potential fleet size of 300-500 vehicles for Daventry just a few extra minutes of maintenance can have a significant effect on the resource required; conversely just a small reduction could reduce the staffing required.

We understand Daventry DC would explore integrating the control room operation with town centre CCTV for economies of scale. However, this potential saving has not been incorporated into the analysis.

Energy Usage

Energy usage is one of the key operating items. Energy prices have been extremely volatile due to their dependency on gas and oil prices and their uncertainty of supply. In the UK over the last 12 months the unit price per kWh has been in the range of 4.9 to 9 pence. The calculations in this document are based on a rate of £0.10 per kWh. Should there be a significant reduction in energy prices then a reduction in this facet of the PRT operation could be realised.

The major items of plant and operations that utilise energy within either the Pilot or Final PRT system were identified as:

- internal lighting and equipment at stations;
- internal lighting, equipment and offices at the depot;
- surveillance, communications and monitoring system;
- lighting of 50m approaches to stations and amenity areas;
- operating or charging the PRT vehicles.

Internal Lighting and Equipment at Stations (excl CCTV)

The stations are likely to consist of relatively simple facilities, but ‘fit for purpose’. It is assumed that they will be designed for minimum wait times and hence require minimum provision for shelter. Within the stations there will be equipment and technology deployed to provide: information to passengers, provision for vehicle booking, security for patrons and a means of safe and validated entry into the PRT vehicles. In estimating the energy use at each station the following features were considered:

- lighting;
- passenger Information Terminals;
- ticketing Facilities;
- power outlets for cleaning and maintenance;
- elevator when not at grade;
- screen doors.

For each of these features the duty cycle will vary significantly, by time of day, season of year and patronage. An average use for these features has been assumed, i.e. a 50% utilisation, with the anticipated load of these features at each station to be 15kWh per day, giving a cost of £525 per annum. Table 14 provides the annual energy usage and charge for the Pilot and PRT system.

- **Table 14 Annual PRT Energy Usage at Stations (Pilot System)**

Item	Pilot	Comment
Average Load at Stations	1.5 KVA	
Energy Used per annum per station	5,250kwh	Assume 50% utilisation
No of Stations	4	
Energy Cost per annum (£)	£2,100	Assume 10p per kwh

Note: the energy used to 'charge' the vehicle batteries in the case of self contained electric vehicles is considered in the 'Vehicle Energy Requirements' below and, therefore, excluded from the station assessment.

Internal Lighting, Equipment and Offices at the Depot

For the purposes of energy estimate it was assumed that the administration and management functions will be conducted from within the depot. It is also assumed that the control centre and associated equipment room will be housed in the depot. The equipment room will require a temperature controlled environment. The electricity usage by the depot is based on a system allocation of 100kVA.

- If the Pilot system has a utilisation of 10%, the electricity charge would be £8,800 per annum
- If the Final system has a utilisation of 50%, the electricity charge would be £44,000 per annum.
- Surveillance, Communications and Monitoring System. This covers both electricity used in the stations and on the track to supply the cameras and the video compression equipment (nodes). The electricity charges are expected to be approximately £50/camera per annum.
- If the Pilot system has 40 cameras, the total electricity charge would be in the order of £2,650/yr to run the cameras.
- If the Final system has 320 cameras, the total electricity charge would be in the order of £21,100/yr to run the cameras.

Lighting of the Station Approaches and Amenity areas

The provision of lighting and its use has a variable duty cycle that is mainly affected by the seasonal change in daylight hours. A summary of the estimated energy costs for guideway and amenity lighting is provided in the table below:

- **Table 15 Summary of Estimated Cost for Lighting of Guideways for 50m Approaches**

Item	Quantity	Unit Cost (£)	Energy Cost Per Annum
Pilot PRT Scheme	4 Stations	130	£520
Final PRT Scheme	48 Stations	130	£6,240

Vehicle Energy Requirements – Operating or Charging the PRT vehicles

The basis for this calculation is the vehicle energy usage figures identified from the ULTra system and trips from the Daventry Transport Study (DTS) model. ULTra claims 0.55Mj per passenger kilometre. In order to work out a projected energy use, an average trip length and occupancy of each vehicle is required.

- **Table 16 Annual PRT Energy Usage**

Item	Pilot	Comment
Energy per Passenger kilometre	0.55MJ	Data from ATS (ULTra)
No. vehicle movements per annum	1,000,000	
Average Trip Length	3km	
Average Passengers per Trip	1	
Passenger km per annum	3,000,000	
Energy Used per annum	458,333kwh	1 kwh = 3.6Mj
Energy Cost per annum	£45,833	Assume 10p per kwh

The Pilot system was not tested in the DTS model. However, if the assumption is made that the trips in the Pilot system are one tenth the trips in the Final system, the annual cost will be £0.045 Million. Although this is possibly an over simplification without additional demand forecasting it is considered to be a reasonable assumption.

Other transit schemes such as tram systems or AGT systems such as the CityVal[10] use significantly more electricity than is suggested by this PRT analysis. One possible explanation is that the energy

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[10] CityVal is described as the new generation Automated Mass Transit System from Siemens Transportation Systems. A modular, driverless vehicle with potential capacity ranging from 1,000 to 30,000 ppdph @ 4 passengers per square metre. Although not suitable for PRT it has been used as a reference for discussing the energy duty cycle of PRT vehicles.

used in these systems is independent of passenger demand, as it relates to the timetables and trips of the vehicles which occur regardless of the occupancy of the vehicle. In a PRT system, the vehicles will only use energy when moving to a location to pick up a passenger or transporting a passenger to their destination.

6.1.11 Maintenance Regime

The suggested routine maintenance programme for PRT vehicles is as follows:

- cleaning (interior and exterior);
- planned preventative servicing (e.g. checking brake component wear);
- planned overhaul or heavy maintenance (e.g. wheel bearing renewal);
- corrective work arising from inspection (e.g. damper/shock absorber renewal following leakage);
- corrective work resulting from damage (e.g. collision or vandal damage including graffiti).

The programme of preventative maintenance must be thorough as the vehicles are operating without any staff on board. A suitable regime is summarised in table 17.

Table 17 Programme of Preventative Maintenance

Inspection Frequency	Core Content	Staff Grade
Bi-Daily	Internal clean; interior inspect; exterior inspect; under-body inspect (basic); doors operation check; basic diagnostic using PDA	“Servicer” (Cleaner)
Monthly	Underside exam (ramp or drive-by using pit); interior & exterior heavy clean	Servicer
3-Monthly	On-ramp inspection; geometry check (wheels alignment); brake pad/shoe wear; gearbox oil level; battery discharge test & fluid levels; suspension/steering linkages check; traction motor temp. check (adhesive temp. strips); brake force check; door system check; air conditioning check.	Servicer
6-Monthly	Battery pack exchange; body paint touch up as necessary; tyres renew *	Servicer
4-Yearly/100,000 kms	Renew wheel bearings; renew brake fluid; renew brake system hoses; renew driveshaft & steering gaiters; renew gearbox oil; renew brake disks/drums; traction motor exchange; renew dampers; renew power steering fluid	Technician & Servicer
8-Yearly/200,000 kms	Car withdrawn for condition assessment or disassembly; renew rubber components if necessary;	Technician

	suspension parts crack detection.	

* Tyre wear is difficult to predict accurately, so the 6-monthly life is a shot estimate

6.1.12 Depot Design

The proposed depot design assumes that the vehicles are battery powered. The main considerations for this design have been as follows:

- the ability to build a small self-contained initial structure at low cost;
- the assumption that the site should be as self-sufficient as possible even at an early stage;
- the easy extension to the base structure in stages as the fleet grows;
- the incorporation of an automatic exterior wash plant for the time when the fleet size demands this.

The workshop will also need the following support areas:-

- Battery Room (36 m^2 with spark-proof air extraction system);
- Stores (108 m^2 with high roof & racking);
- Staff Mess room (18 m^2);
- Staff locker room & toilets (18 m^2);
- Clean Room/Technical Room (storage and repair of sensitive items like electronic & hydraulic components) (36 m^2);
- Offices – Manager/Clerical/Stores (3 off each 36 m^2) – placed on the first floor above the stores & workshops.

The layout should obviously allow for future expansion as the fleet grows. To this end the tyre and paint areas have been placed at the far end of the initial building, so that when the depot is extended, the specialist equipment these activities need (extraction fans/filters and access to tyre changing equipment) does not need to be duplicated. It is suggested that the Battery & Clean rooms are initially set up as partitioned areas within the stores, and they can be moved into their own areas when the depot building is extended later on.

The following items would ideally be needed as part of the depot structure and fit out:

- CCTV;
- fire alarm;
- fire hydrants;
- telephone system;
- spark-proof extraction system for battery room;
- Maintenance Management System (software);

- workshop heating & ventilation;
- support road vehicles (1x estate car or van initially);
- PCs/Faxes/Printers;
- office furniture (3x offices);
- kitchenette for mess room;
- waste removal contract;
- Stand-by generator (40 kVA) which might be needed later - hire in initially if needed

6.1.13 Exterior Cleaning

Routine exterior cleaning will be carried out using an automatic washing plant in the bigger scheme, but such plant cannot be expected to keep the cars looking presentable over a long period of time. Therefore it will be necessary to hand clean each car monthly, as part of a deep clean process carried out inside of the car.

It would be reasonable to wash the cars externally at least every three days, given that their presentation to users needs to be of a high standard. With an automatic plant and the cars entering and leaving in driverless mode, a very high throughput will be achievable, and would allow daily washing even on the 500-car fleet. The estimated cost (£85,000) is for a 35 car-per-hour conveyor-type plant (it engages with a front wheel and draws the car through the process), which is a budget quotation for the smallest of this type of machine. For a 70 car-per-hour machine, the cost roughly doubles to £140,000. The smaller plant can be upgraded later on to the higher throughput if needed. These prices exclude the enclosure building needed.

The washing plant shall provide a selectable plain water underside spray to clean off road salt and other debris (less critical if a non-corrosive ice- treatment chemical is used on the guideway instead). This must not be a high pressure application otherwise consequential damage to the running gear may result.

The washer plant also has an optional drier stage. This is mainly of value in the winter, to prevent the cars freezing up after washing and being stabled outside.

In the early stages (fleet size up to around 40 cars) it would be more cost effective to hand clean the cars, and only invest in the washer plant once the project is seen to flourish. One additional Servicer rostered on middle turn (between the peaks or 10:00 to 16:00 6-days a week) could hand wash around 12 cars per day, so they would be washed every third day with a fleet of up to 36 cars.

6.1.14 Depot Equipment

The capacity of the workshop will obviously have to change as the fleet grows. Taking the fleet size steps, the number of workshop bays that will be required are estimated in Table 18.

▪ **Table 18 Estimated Number of Workshop Bays**

Fleet Size	25	100	250	500	Remarks
Maintenance bay	1	2	4	7	Plain bay (some with centre pit). Cars will not usually need to use this bay for long each day.
Lifting Ramp	1	2	2	3	4x post high-lift 2.8 tonne capacity
Glazed Under-floor pit	n/a	n/a	1	1	4m long x 2m wide with thick laminated glass cover
Tyre bay with 2-post ramp	1	1	2	3	With 2-post ramp 2.8 tonne
Damage/repair bay *	1	2	4	7	Plain bay (some with overhead 1 tonne electric hoist and some with centre pit)
Rolling Road (brake testing)	1	1	1	1	Std. MOT equipment
Paint booth	n/a	1	2	2	Screened bay with extraction
Exterior wash plant	n/a	1	1	1	Std full function conveyor-type washer

* The time a car spends in this bay will be variable depending on the work involved

6.2 Costs

6.2.1 Infrastructure Costs

Cost summary

Civil/structural costs for the various infrastructure items are summarised as follows:

▪ **Table 19 Civil/Structural Costs**

Item	Cost	Comments
One-way at-grade guideway	500 £/m	incl. walkway at £40/m
Two-way at-grade guideway	795 £/m	incl. 2 walkways at £80/m
One-way elevated guideway	1,970 £/m	incl. walkway at £235/m
Two-way elevated guideway	3,885 £/m	incl. 2 walkways at £470/m
One-way at-grade station	£121,500	incl. one pedestrian x-over
Two-way at-grade station	£189,000	incl. one pedestrian x-over
One-way elevated station	£207,000	-
Two-way elevated station	£414,000	-
Pedestrian cross-over	£54,000	-
Total Pilot depot	£510,000	-

For details on how the above costs were calculated, refer to Appendix E of this document. It should be noted that for this phase the saw-tooth parking station arrangement was used for costing purposes. If through line stations were to be adopted some savings can be expected, particularly for two-way which utilise a shared central access platform.

A number of assumptions and approximations have had to be made in calculating the above costs. The sketch plans used to calculate the costs are also very preliminary and will require considerable development. For these reasons the above costs should only be considered accurate to within +/- 30%.

Inclusions/Exclusions

The above costs relate to civil and structural costs only and include the following:

- supply and installation of civil/structural items for the guideways, stations, depot etc. including structural steelwork, concrete foundations, slabs on ground &suspended floors, walkway grating, handrails, fencing, stairs & cladding;
- allowances for the fit-out of stations and the depot (i.e. partition walls, depot mezzanine flooring) have been included except where noted in the exclusions;
- allowances for minor earthworks and drainage;
- a 30% allowance for preliminaries has been included. This allowance includes site mobilisation & demobilisation, site staff & supervisors, temporary works, general tools & power, head office staff, insurances, profit etc.

All other project works will need to be costed at the detailed design and procurement stage and will depend on the PRT system chosen, which include but are not necessarily limited to:

- land purchase - some land will need to be purchased including land for the pilot depot and for a section of the guideway along the former railway line approaching Ashby Road. As DDC owns the land, the cost is actually an opportunity cost rather than cash cost;
- major earthworks and/or retaining walls, if required;
- mechanical & electrical costs, which will include lighting, lifts for elevated stations, automated sliding doors within stations, lifting equipment for the depot maintenance building etc.;
- the PRT vehicle fleet & required tracks, if applicable (note the use of tracks may actually simplify sections on elevated & reduce guideway costs);
- communications & control systems;
- detailed design or project management;
- relocation of existing services adjacent roadways etc.;

- land clearance. Costs will generally be minor, except along the old railway where significant clearance will be required to allow installation of guideways and stations;
- landscaping, where applicable;
- architectural finishes, if required;
- contingency.

Estimates omitting these items are set out in the following sections.

6.2.2 Estimated Vehicle and Systems Costs

The following vehicle and systems estimated costs are for a battery type system.

- **Table 20 Vehicle and Systems Cost Estimation**

PRT system element	Estimated cost.	Comments
PRT vehicle.	£50,000 / vehicle	These are not mass produced and therefore the high cost assumed. There may be an opportunity to negotiate/partner with a supplier to reduce cost. This can only be determined at the next stage of the project.
Vehicle protection and routeing systems.	£2,500,000	The costs associated with this element which is principally a software system are indicative
Power supply system.	£2,000 / charging point.	Assumes a battery system with automatic in station charging. Cost includes distribution system.
Platform screen doors	£18,000 / bay	One bay equates to one vehicle.
Depot equipment.	£329,000	Assuming a depot for 25 vehicles.
Management of the procurement, construction, commissioning and system assurance costs for vehicle and systems.	£2,000,000	A 6 man engineering team to manage the turnkey contractor for 2 years.

Lighting Costs

- **Table 21 Typical Costs for 50m Station Approach Lighting Arrangement**

Arrangement	Possible Spacing (m)	Installation Cost (£) *	Annual Maintenance Cost (£)	Annual Energy Consumption (£)
50m Station Approach Only	25	5,150	100	130

It is suggested that lamp change and clean would be on a 3 yearly cycle. An estimated maintenance cost per annum for this activity is detailed in the table above. Energy costs are based on the use of the 60W Cosmopolis at 4,200 burning hours per annum using a unit rate of 10p/kwh.

A summary of the estimated capital cost for the guideway lighting provision in the Pilot is provided in the table below:

- **Table 22 Summary of Estimated Cost for Guideway Lighting for Pilot and Final PRT Systems**

Item	Quantity	Capital Cost (£)	Maintenance Cost (£) Resource & Energy
Pilot PRT Scheme	4 Stations	20,600	920
Final PRT Scheme	48 Stations	247,200	11,040

Surveillance, Communications and Maintenance Costs

The tables below provide a summary of the estimated capital costs for the PRT Pilot and Final CCTV systems.

- **Table 23 Estimated CCTV Cost for Pilot PRT System**

Item	Quantity	Capital Cost (£)	Comment
Station Cameras (incl. adjacent guideway)	20	40,000	
Depot Cameras	10	20,000	
Node Channel Equipment	10	280,000	
Fibre Transmission Network	10km	25,000	Dual ring circuit
Control Centre Equipment	1	133,000	Evidential record storage not allowed for
Total		**498,000**	

6.2.3 Operations and Maintenance Costs

Route Selection and Reservation Costs

- **Table 24 Estimated PRT Costs of Route Selection, Ticketing & Passenger Information per Station**

Equipment	Quantity	Unit Cost (£)	Capital Cost (£)	Comment
Passenger Info Terminals at Vehicle Bays	3	500*	1,500	One for each vehicle bay
Concourse Passenger Information Terminal	1	1,000*	1,000	
Smart Card Reader	3	1,000	3,000	One for each vehicle bay
Total			**5,500**	

*Equipment for PRT systems will almost certainly be bespoke although based on industry standards and hence estimated costs may change

- **Table 25 Summary of Estimated Costs of Route Selection, Ticketing & Passenger Information for Pilot and Final Systems**

Item	No Stations	Capital Cost (£)
Pilot PRT Scheme	4	46,000

The Capital cost of the Smart Cards or similar devices have been excluded from the above estimates.

Summary of Staff Requirements and Cost

The types of staff have been categorised into grades to allow a summary of staff costs to be estimated. This summary is provided below.

- **Table 26 Summary of Staff Costs per Annum Pilot PRT**

Grade	Salary (£)	Quantity
General Manager	50,000	1
Operations & Maintenance Manager	40,000	0
Operations & Maintenance Supervisor	30,000	2
Clerical Support	14,000	1
Accountant	35,000	1
HR personnel/Public Relations	35,000	0
Sub total		**5**

Grade	Salary (£)	Quantity
Technicians	21,888	9
Control Room & Response Staff	16,416	7
Operators/attendants	10,944	4
Sub total		**20**
Salary Uplift for training, allowances etc.	15%	
Total Staff		**25**

6.2.4 Replacement parts and spares

Lighting

An allowance should be made for total replacement of the lamps/lanterns and replacement of the columns and cable network every thirty years.

Surveillance, Communication and Monitoring System

It is normal to make a 10% spares allowance for CCTV systems, but in the case of the Daventry PRT, the type of system is such that there are many of the same types of equipment. For the Pilot

System spares should remain at 10% of operational quantities, whereas for the Final System savings can be made, such that the allowance of 3% of operational quantities is recommended.

- **Table 27 Spares Allowance for CCTV System on Pilot PRT per Annum**

Item	Allowance	Cost (£)
CCTV Cameras	10%	17,260
Node Equipment	10%	28,000
In-station Equipment	10%	13,333
Total		**58,593**

Route Selection, Ticketing and Passenger Information

It is normal to make a 10% spares allowance for such systems, but in the case of Daventry PRT, the type of system is such that there are many of the same type of equipment. For the Pilot System spares should remain at 10% of operational quantities, whereas for the Final System savings can be made, such that the allowance of 3% of operational quantities is recommended.

- **Table 28 Spares Allowance for Route Selection, Ticketing and Passenger Information – Pilot PRT**

Item	Allowance	Cost (£)/yr
Information Terminals at Vehicle Bays	3	1,500
Concourse Information terminals	2	2,000
Smart Card Readers	3	3,000
Total		**6,500**

Allowance for life expired equipment is appropriate at 15 year intervals for all electronic equipment and thirty year intervals for communications cabling and infrastructure.

6.2.5 Depot and Equipment Costs

The following items would ideally be included as part of the depot structure and fit out.

- **Table 29 Depot Fit-out Costs**

Item	Budget Price
CCTV	£60K
Fire Alarm	£20k
Fire Hydrants	£8k
Telephone system	£6k
Spark-proof extraction system for battery room	£5k
Maintenance Management System (software)	£50k
Workshop Heating & Ventilation	£100k
Support road vehicles (1x estate car or van initially)	£10k
PCs/Faxes/Printers	£5k
Office Furniture (3x offices)	£3k

Item	Budget Price
Kitchenette for mess room	£1k
Waste removal contract	£6k p.a.
Stand-by Generator (40 kVA) *	£10k

* Later on – hire in initially if needed

- **Table 30 Estimated Equipment Costs**

Item	Cost Estimate	Quantity for 25 cars
Main 4-Post Lift (Ramp)	£ 5,000	1
Tyre Change 2-Post Lift (Ramp)	£ 3,000	1
Brake Test Rolling Road	£ 6,000	1
Tyre Fitting Equip. *	£ 600	0
Tyre/Wheel Balancing *	£ 4,000	0
Wheel alignment	£ 700	1
Overhead hoist (1 tonne 12v)	£250 ea	1
Paint booth *	£ 20,000	0
Compressed Air supply	£ 12,000	1
Exterior wash plant (not enclosure)	£ 85,000	0
Tool Storage Cabinets	£ 1,500	1
Stores Racking	£ 5,000	1
Hand Power Tools	£ 2,000	1
Mobile Battery Chargers x2	£ 400	1
Air Hand Tools	£ 1,000	1
Technician's Hand Tools (1 set)	£ 2,000	1
Pillar Drill	£ 800	1
MIG Welder & Screens	£ 400	1
Pressure Washer	£ 700	1
Parts Washer	£ 400	1
Bench grinder	£ 250	1
Artisan lockers (2 per person) x13	£ 1,300	1
Soil extraction machine	£ 500	1
Vacuum Cleaners x2	£ 400	1
Tripod Lights x4	£ 200	1
Oil Drainer	£ 200	1
Car Creeper x2	£ 60	1
Total		**£44,060**

* Sub-contract this work initially

If the cars are to be fitted with air conditioning, then maintenance equipment to a value of £6,000, for leak detection and refrigerant reclamation will be needed. Perhaps a spot cooling system using semi-conductors would be more appropriate.

6.2.6 Cost Summary

Table 31 PRT Pilot Capital Cost Summary

Item	Quantity	Unit Cost	Total Cost
Guideway, single track:			
Elevated	2,671m	£1,970/m	£5,261,870
At Grade	1,530m	£500/m	£765,000
Guideway, double track:			
Elevated	308m	£3,885/m	£1,196,580
At Grade	372m	£795/m	£295,740
Stations, single track:			
Elevated	4	£207,000	£828,000
At Grade	0	£121,500	£0
Stations, double track:			
Elevated	0	£414,000	£0
At Grade	0	£189,000	£0
Platform screen doors	4	£18,000	£72,000
Cars	25	£50,000	£1,250,000
Control System	1	£2,500,000	£2,500,000
Depot	1	£839,000	£839,000
Lighting	1	£20,600	£20,600
CCTV	1	£314,318	£314,318
Route Selection etc	4	£11,500	£46,000
Power Supply System			£1,000,000
Total			**£14,389,108**

7. Safety Review

7.1 Introduction

The Safety Review process focussed mainly on the PRT option. Although many of the safety and security issues relating to PRT are similar to those which apply to other transport systems, an important differentiator of PRT is the ability to provide high levels of passenger service with a relatively small number of staff through the widespread use of automatic operation. It is also intended that vehicles should be small and lightweight. In addition, with the limited exception of the ULTra demonstration system, there is no practical experience in the construction, approval or operation of PRT in the UK, and only very limited experience worldwide.

We have accordingly structured our safety review process in three sections as follows:

- Safety in Construction – Completion of a Project Design Safety Checklist, covering environmental issues, temporary works (including construction methods), permanent work and materials.
- Discussions with HMRI to gauge their views on the acceptability of a PRT based transport solution and what they consider are the most significant safety issues that need to be addressed.
- A HAZOP Study to identify safety issues associated with the operation of a generic PRT system in an urban environment.

7.2 Safety in guideway construction

The construction of the PRT Guideway Infrastructure should not present any major construction issues. The construction of the guideways will not be dissimilar to the installation of a new roadway through an existing city, although the guideways are smaller and lighter. However, the design of the guideway and the methods of construction are expected to incorporate some technological advancements and developments. While there is unlikely that there will be anything particularly innovative or unusual, there are areas that need special consideration in terms of guideway construction.

As the PRT guideway extends over several kilometres, the construction site is not self-contained. It is covers a wide area, will change as construction progresses, and will be adjacent to many areas accessible to the general public. All these aspects will need to be addressed carefully prior to commencement of construction.

The construction of the guideway will have an impact on the general public in terms of noise and vibration and dirt and disruption. A range of construction techniques can be used to minimise this impact. Careful control of site access and construction traffic will be required and the use of construction techniques such as “hush-piling” for the installation of sheet piles where applicable. Adequate site fencing systems and signage will be required combined with the education of the general public into the hazards presented by construction sites. All of these will be important factors in reducing the risk of injury.

The CDM [Construction Design & Management] Regulations seek to address the issue of construction safety (including maintenance and subsequent demolition) and will be fully applicable to this project. A new version, CDM07, came into effect from 2007 which further increases the Client’s obligations in this regard. A CDM Co-ordinator will need to be appointed as soon as any design decisions are being made and the client will be obliged to allow sufficient time and resources in the development of the design to address construction safety. It is also to be noted that the CDM07 now includes site welfare.

As well as potential hazards, the development of the pilot scheme also gives rise to opportunities for developing safe systems of construction and allowing Daventry to demonstrate its commitment to all aspects of Health & Safety. It is essential that the method of construction and erection be considered at the earliest opportunity. The pilot stage could address the issues of craneage, sequence of construction and method of erection of the elevated sections. It could also explore methods of construction for the at-grade sections, which will make up the majority of the scheme. Purpose made steel shutters could be considered for in situ concrete construction and compared with the economies and the safety issues of supplying and erecting the on-grade concrete troughs as discrete pre-cast elements. The latter approach would reduce the impact on the general public and reduce the amount of noise and vibration and the amount of excavation and hence the amount of soil removal required. The extent and nature of any tunnelling works is unknown at this stage but below-ground construction can give rise to very specific construction risks which will need to be addressed individually for each section of tunnel construction (whether in open cut or bored). Tunnel sections have stringent safety implications which would affect car design and other matters.

The elevated guideway is very likely to be of pre-cast concrete construction: possibly of reinforced concrete but more likely as pre-stressed concrete. This latter option will reduce costs and improve durability, as well as reducing the weight of units to be erected. Alternatively, they could be steel, aluminium or perhaps advanced composite construction. The columns or piers could be of steel or pre-cast concrete construction, or potentially aluminium or advanced composite, the latter options avoiding the need for repainting and hence offering benefits in terms of maintenance and whole life costing. The foundations would be either pad or, where ground conditions dictate, piled foundations; the key issue being overturning forces from wind and nosing forces, as well as centrifugal forces on curved sections of viaduct.

A kit of parts will need to be developed to allow various span arrangements and horizontal and vertical alignments to be accommodated, as well as junctions and transitions. The erection of elevated sections of viaduct over road junctions and / or within the town centre will all need to be considered on an individual basis.

It is anticipated that a range of ground conditions will be encountered. Issues that could arise include the removal of ground water, the possibility of contaminated ground and its disposal to licensed tip sites and the diversion of services. All of these issues have safety issues that will need to be the subject of a detailed Safety Management system.

A full Project Design Safety Checklist has been compiled, and potential construction issues for the pilot route that should be considered include, but are not necessarily limited to, the following;

- The construction will involve potentially hazardous operations, such as the installation of elevated guideways over or adjacent to existing roads. Roads will need to be temporarily closed (or part closed) to ensure safe construction methods are possible.
- Monolithic pre-cast deck segments will require large cranage if they are to be adopted. It is envisaged that these segments would not be able to be feasibly installed along the old railway
- The available space for site works along the old railway and alongside existing roadways is very limited. Construction in these areas will require careful planning including allowances for safe access and egress.
- The remove of existing trees (e.g. in some cases along the old railway) to allow construction of the guideway will be a potentially hazardous task to be completed by suitably qualified persons only.

7.3 HMRI requirements

The Office of Rail Regulation (ORR) is responsible for the regulation of health and safety on the railways, and this responsibility is exercised by HMRI. This responsibility extends to light rail systems and tramways, and includes PRT. Thus any proposed PRT system for Daventry will need to comply with the requirements of ROGS and gain Safety Authority and Certification from the HMRI before commencement of the public operation, although at the Heathrow PRT system it appears HMRI have adopted an approach which essentially leaves safety case matters in the hands of the future operator – we understand this relaxation is only being applied to PRT systems operating at 40kph or less.

Initial discussions have been held with HMRI to gauge their views on the acceptability of a PRT based transport solution and what they consider are the most significant safety issues that need to be addressed. The key points were that:

- HMRI are concerned with safety of operation and any catastrophic events that could endanger passengers, staff or the general public.

- HMRI have already considered the safety of PRT systems in a number of UK locations. They have allowed the ULTra test track in Cardiff to test with passengers and are currently involved in considering the use of PRT at Heathrow Airport.
- Based on this consideration no fundamental difficulties have yet been encountered which would prevent the approval of a PRT scheme operating in the UK. However, this is dependent on the design and operational solution put forward.

In assessing the safety of PRT, HMRI use Railway Safety Principles and Guidance (RSPG) Part 1, and RSPG Part 2G – Guidance on Tramways. These documents are not specific to PRT but they provide generally applicable guidance.

The key issues HMRI will expect to be addressed are as follows:

- Suitability and integrity of the vehicle routeing and positional control system.
- Separation of vehicles from pedestrians and other traffic.
- Introduction of new hazards.
- Personal safety.
- System failure and recovery.
- System maintenance.

7.3.1 Suitability and Integrity of the Vehicle Routing and Positional Control System

The integrity of the control system that controls the movement of the vehicles, their routeing around the network, and the maintenance of a safe separation distance, is of primary importance to HMRI. Any system presented to HMRI for approval will have to demonstrate that an appropriate Safety Integrity Level (SIL) has been established for the control system and that the supplier can demonstrate that this SIL is delivered and can be maintained into the future. The robustness of the control system and its supporting infrastructure will also need to be demonstrated for its ability to withstand failures and external hazards such as electromagnetic compatibility (EMC) commensurate with its SIL level.

This requirement is independent of the technology used to deliver the control system.

Some PRT systems propose the use of different separation distances between loaded and empty vehicles, in order to facilitate distribution of empty vehicles. At this stage we have not discussed such operation with HMRI. However, it is likely that it could only be implemented if it were demonstrated that the control system could verify that a car was genuinely empty to an appropriate SIL.

7.3.2 Separation of Vehicles from Pedestrians and other Traffic

Hazards which are created by conflicts between the movement of PRT vehicles and any other operation need to be either removed or controlled. The types of conflicts typically covered are with pedestrians, other forms of guided transport, and road traffic. Given that PRT vehicles are designed to be small, lightweight and rapid, situations in which conflicts could arise should be removed. This requires a solution that guarantees the full separation of the PRT operation from other activities. Separation could be achieved in a number of ways through the use of fenced embankments, fenced and protected guideways, or elevated guideways.

The integrity of the guideway structure needs to be maintained and a key element of this is the protection of the structure from impact. The principle source of impact is likely to be from road vehicles but there could be locations where other forms of impact or damage could occur.

We consider that there are essentially 3 forms of protection:

1) Design of columns and piers to resist collision impact forces such that the overall structural integrity of the structure is maintained following impact;
2) Provision of separate barriers to resist collision impact forces and prevent impact on columns or piers;
3) Design of guideway such that a collision (or other event) that leads to the “removal” of a column or pier does not give rise to progressive or catastrophic failure.

In practice, all three of the above approaches will be utilised. The form of protection will depend on the location of the guideway and the level of protection needs to be proportionate to the risk of impact and the consequence of failure. For example, the risk of impact on piers that are more than 4.5m from a road carriageway can be considered to be small and the consequences of failure may not be as severe as guideways in an inner city area adjacent to a busy traffic intersection.

We would recommend that the following approach should be considered. These are all subject to any discussions with HMRI and NCC as highway authority either of whom may have other considerations.

4) All columns and piers, independent of location shall been designed to withstand a nominal impact force, the loads shall be taken as 150kN at 0.75m above ground level plus 100kN at the most severe point between 1m and 3m above carriageway level. These loads are based on BD37/01;
5) For columns and piers within 4.5m of a carriageway, which are not fully protected by protective barriers, shall be designed (as per BD60/04) for the following loads:

- A main load of 1000kN at the most severe load between 0.75m and 1.5m above carriageway level;
- and for a residual load of 500kN at the most severe point between 1m and 3m above carriageway level;

6) The guideway deck is assumed to be more than 5.7m above carriageway level and is therefore not subject to impact;
7) The overall design of the guideway shall be such that the removal of any one column does not lead to a catastrophic, disproportionate or progressive collapse. In particular, the removal of one column shall not cause the deck to impact on adjacent columns and cause failure of them. Consideration should be given in particular town centre locations to providing structural continuity at piers such that the deck can span through catenary action from adjacent columns.

Where protection is provided, this could be in the form of standard highway barriers, independent concrete walls, kerbs etc or other forms of bespoke barrier.

On the guideway itself, consideration needs to be given to impact loads from the PRT vehicles and the risk of the vehicles toppling over the guideway needs to be examined in detail. However these are dependent on the exact details of the PRT vehicles and will need to be considered during examination of actual system proposals (probably as part of tender evaluation or scheme development with the selected partner).

The handrailing on the outside edge will be designed to horizontal loads of 3kN/m at 1.1m above walkway level as per BS6399. Permitting evacuation via the guideway deck requires a fail safe system for ensuring use cannot restart until the guideway is proved clear; if this cannot be provided to an appropriate SIL level then other options such as a pedestrian walkway may be required. We have investigated the impact a walkway would have on the costing and appraisal by undertaking a non-walkway appraisal.

7.3.3 Introduction of New Hazards

Where a system will be introducing new hazards into the environment then it will have to be shown that these hazards are adequately controlled. For PRT the system used to power the vehicles may introduce new electrocution or EMC hazards. This is dependent on the type of system chosen. Thus, if continuous high voltage power pickup is provided to power the PRT vehicles, then the safety of this system will have to be proved. EMC will also have to be demonstrated.

7.3.4 Personal Safety

The safety case for PRT will have to deal with the personal safety of the general public and passengers. While much of this is not novel, the use of small, low occupancy, unstaffed PRT cars is novel and would require careful consideration of the measures for personal safety in the car. Similar considerations apply at stations, as it is likely that most or all of these will be unstaffed. In all cases there must be a safe means of escape at all locations on the system. How this is resolved will depend on the details of the system finally selected, but as a minimum it is expected that pedestrian escape routes from the guideway before each merge point would be provided, combined with fail safe protection against restarted vehicles operation as described above. The requirement for fire precautions at stations will be dependant on the extent to which they are enclosed and means of access and egress. Vehicle design must take into account the need to limit fire load, ignition sources and fire spread.

Provision will be required for passengers to contact the control centre in the event of an emergency, and it will be important that communication is still possible even if other parts of the PRT system are not operational.

In parallel with discussion with HMRI we have considered the provision which may need to be made for emergency evacuation of passengers. Key points are as follows:

- Where the system is elevated, it will be necessary to provide emergency facilities for passenger evacuation. If fail safe measures to an appropriate SIL level cannot be provided this may require the provision of walkways.
- Because the system will need to be segregated, it will be more difficult for passengers to escape from the system in the event of an emergency. This is likely to require the provision of emergency exit facilities.
- Because the system will be automated, there is a possibility that passengers who alight from cars in an emergency will be at risk from other moving vehicles, although this risk should be minimal due to the anticipated one-way operation. This may require the provision of emergency stop facilities.

7.3.5 System Failure and Recovery

It would have to be demonstrated that there were robust and safe arrangements in place to cope with localised or widespread failure of the system. The arrangements would have to take account of:

- system failure, for example, traction power or control system failure;
- supply of instructions to vehicle occupants;
- method for safe, timely recovery of vehicles and, if appropriate, occupants;
- consideration of passenger adherence to recovery mechanisms;
- reliability of the system so reducing need for recovery.

On heavy rail passengers have been known to break out of stranded trains, sometimes with fatal consequences. Depending on the type of PRT solution chosen additional requirements for maintaining the safety of vehicle occupants may need to be specified.

7.3.6 System Maintenance

The system design would have to consider how it was to be safely maintained. Thus, adequate means of reducing the risk to staff would need to be provided, when working on guideways.

Particular provision will be required to ensure that maintenance staff working on or near the track are not at risk from automatic operation of vehicles, and the control system should take into account the possibility that the track may be blocked by maintenance vehicles and equipment.

7.4 The Safety Review Panel

7.4.1 HAZOP Study Objectives and Methodology

The purpose of the HAZOP Study was to identify safety issues associated with the operation of a generic PRT system in an urban environment. This ensures that significant hazards associated with PRT are identified at an early stage and that the impacts of these hazards are adequately addressed when considering the suitability of PRT for Daventry.

7.4.2 Scope

A generic design of PRT was subject to a high level HAZOP Study as outlined below. The objective was to determine any hazards and operability issues associated with the operation of a PRT system in an urban area. Assumptions have been made about the general form and delivery of the PRT system to allow the hazard identification to take place.

The HAZOP 1 study methodology was utilised as the basis for this HAZOP Study. The hazard workshop addressed hazards exhibited during operation. The PRT system was broken down into five nodes as follows:

1) Vehicle
2) Station
3) Guideway
4) Maintenance Facility
5) Control Centre

For each node the workshop considered a range of guidewords to prompt the identification of hazards. The Hazard Identification and Risk Assessment checklists provided in the Yellow Book (Issue 3) were used as the basis for a list of appropriate guidewords.

The study did not attempt to risk ranking hazards or investigate operability issues during the study. The study output is intended for use during detailed system selection by comparing any candidate system with the hazards identified during this study.

7.4.3 Generic PRT

For the purposes of the HAZOP a "generic" PRT system was studied. This system has characteristics drawn from a number of PRT offerings. This was necessary as no decision has been taken as to which PRT system would be best for Daventry.

It was assumed that the PRT system will have the following characteristics:

- Small light passenger cars capable of holding around 4 people.
- Cars are driverless with no in car attendant.
- Control room provides monitoring of the system during operation.
- Some form of guide track is used with the ability to switch routeing of passenger cars during a journey. This switching mechanism can be track or vehicle mounted.
- Multiple possible destinations with small stations off the main track way. The station could be an enclosed space or little more that an extended bus shelter type of design.
- Merging of traffic emerging from station into main traffic on track way.
- Cars travelling at speed to reduce journey times (40 km/h).
- Short headway between cars travelling on track way to ensure high capacity achieved.

7.4.4 Study Results

The review identified a set of hazards that a generic PRT system could display. These were identified using a traditional HAZOP 1 process. The hazards identified are system level hazards that are consistent with a study held during the early stages of a project. As such they are not informed by any significant design detail as this does not exist for a generic system.

In some cases hazards are dependent on the PRT design solution chosen. This is to be expected as, for example, different hazards will arise depending upon whether the passenger cars are supported or suspended, and whether a system uses rail guided vehicles or steered vehicles. There would also be different hazards if the power supply was provided by on board batteries as compared to third rail or other forms of power pickup. Thus while a generic version of PRT was considered, the study was mindful of the variation in the design solutions being put forward by suppliers and the hazards that these would create.

The study results have been captured on a series of HAZOP sheets .These record:

- The **Node** being considered.
- The **Guideword** that is being applied.
- The **Hazardous Situation** that has been identified.
- The **Cause** of this hazardous situation.
- The **Consequences** that could result from the hazardous situation.
- The **Safeguards** that could be put in place to either eliminate the hazardous situation or mitigate it. This mitigation could be either to make the hazardous situation less likely or reduce its consequences.
- A statement as to whether the safeguards can be provided with an **Existing Technology Solution**. If there is existing technology then project risk is reduced as less development work is required.
- Finally a **Comments** column is provided to record information not captured elsewhere.

7.4.5 Summary of Results

A large number of PRT transportation system hazards have been identified. In general these hazards are typical of a guided transport system and the hazards are ones which have been identified for other more established non-PRT systems. Where differences arise they are mainly due to an inherent feature of PRT (automatic control, no attendant, small light vehicles and guideway) or a specific implementation of PRT (suspended vehicle, guide rails or steered vehicle).

The HAZOP sheets provide a listing of all the issues raised. The specific points that are noteworthy as the project moves forward are discussed here in more detail.

7.4.6 PRT Vehicle

Crashworthiness - A maximum design impact needs to be developed to take into account the vehicle/system to be used and the level of protection afforded by other measures. This would allow the level of crashworthiness required from the vehicle to be defined. Given the current uncertainty in the design solution only generic requirements may be possible at this stage.

Crowding - The hazards to passengers are partly dependent on the number of passengers within a vehicle and whether standing is allowed or actively prevented. Supplier designs would have to address this issue to argue that their solution was adequately safe under all use cases.

Emergency Escape - Little is known about the emergency escape arrangements for all the PRT systems in development. Emergency escape is a situation that can give rise to additional hazards and risk apart from the ones linked to the cause of the emergency. The nature of these and the means necessary to reduce risk are PRT implementation dependent. However any implementation must develop a robust and safe means to allow occupants of a vehicle to call for help, receive instructions, exit the vehicle and make their way to safety. How this is implemented will be design specific but is likely to require staff to gain access to a vehicle quickly or, failing this, a means for passengers to walk away from a vehicle.

Construction Standard – The construction standard that the PRT vehicle is designed to should take account of the hazards to which the vehicle is exposed in an urban environment. This may have impact on the requirements for robustness and associated weight and power requirements.

Braking Rates – The maximum acceptable braking rates for a PRT vehicle need to be defined for both emergency and service braking in relation to passenger comfort and safety. It is recognised that there is a direct relationship between the braking rate and minimum separation distances.

7.4.7 Station

Trespass Prevention – The HAZOP has highlighted the need to prevent trespass on the guide way by passengers and the general public. If the vehicle and guide way fails to detect a trespasser then they could be hit and injured by a moving vehicle. In this case trespass has to be prevented at stations and along the guide way (e.g. fences). An alternative would be for a supplier to engineer his system to detect trespass and react to ensure the safety of all parties. It is considered unlikely that such a system can be engineered. Thus physical trespass prevention will be required (barriers, fences, etc.).

Platform Edge Doors – At stations a means is required to prevent trespass onto the guideway. Platform edge doors can provide this. They can also help to prevent people being dragged by a departing vehicle. This can occur where an item smaller than the design limit of the door edge protection is caught in a door. The use of platform edge doors together with vehicle doors and appropriate controls is likely to prevent this occurring.

7.4.8 Guideway

Guideway Protection – All elements of the guideway, (at grade or elevated) will have to be designed to withstand impact from road vehicles where it is located near traffic. For sections at grade a physical barrier preventing vehicle ingress is likely to be required.

Guideway Surface – The interface between the PRT vehicle and the guideway should be designed to operate reliably and predictably in all conditions (snow, ice, surface contamination). If this is not possible then another means is required to ensure the safety of the system users. This could be through speed limits, cleaning regime, reduced capacity etc.

Guideway Containment – In the event of a PRT vehicle guidance system failure the guideway should contain the vehicle within the guideway in an upright condition. This will prevent vehicles falling from elevated sections and assist in emergency rescue.

7.4.9 Control System

System Integrity – Complete reliance is placed on the automatic control and routing system for vehicles. The control system will have to have an appropriate Safety Integrity Level (SIL) defined and a demonstration provided that it has been achieved. It is likely that to achieve its required SIL it will need to implement key safety related functions such as maintaining safe separation distance separately to other functions.

7.4.10 Maintenance Depot

Automatic versus Manual Control – It is recognised that there is likely to be part of the vehicle depot which operates under automatic control (receipt and dispatch of vehicles), while the remainder operates under some form of manual control. The safety of this interface and the depot operational arrangements will need to be better defined when a candidate system is put forward.

7.4.11 System Implementation

General - While a large number of hazards have been identified the majority have proven design or operational solutions which a new PRT system could employ. Some of these solutions will add to the cost and complexity of the system and so would have to be considered within the system design process as there may be alternative means to control the risk. An example is the control of overcrowding with standing passengers. One design solution is to weigh the vehicle. This prevents overloading but does not prevent standing. Another could be to make the roof lower. This would deter standing but make access/egress more difficult. Another could be using CCTV and image recognition to prevent a crowded vehicle departing. The exact solution has to be decided by the supplier when considering their entire design philosophy and should not be defined at this stage in the project as it could favour one solution above another without good reason.

Control System – The ability of the PRT system to meet its required capability requirements is largely dependent on the capability of its control system. As part of any bidding process, and prior to a trial system being built, prospective suppliers should demonstrate that their concept control system has the capability to run a PRT system of a size to serve the whole of the town of Daventry. This is not strictly a safety issue but has safety implications if the system is unreliable leading to stranded passengers.

7.4.12 Conclusions

A system level hazard identification exercise was carried out. This considered a generic implementation of PRT in an urban environment to identify hazards that occur during operation, maintenance and emergency running. The study used a standard methodology (HAZOP 1) with guidewords based on rail industry lists (Yellow Book 3). Present at the study were a group of informed technical experts with experience of driverless passenger rail systems.

The study has identified a large number of PRT transportation system hazards. In general these hazard are typical of a guided transport system and the hazards are ones which have been identified for other more established non-PRT systems. Where differences arise they are mainly due to an inherent feature of PRT (automatic control, no attendant, small light vehicles and guideway) or a specific implementation of PRT (suspended vehicle, guide rails or steered vehicle).

The issues which are either specific to PRT or which require special consideration are:

- The PRT vehicle structural integrity requirements need to be defined. This will influence the robustness of the vehicles, their weight, loadings on structures and energy requirements.
- The Safety Integrity Level (SIL) of the control system, including any safety supervisory system, must be defined.
- The arrangements for the safe dispatch of PRT vehicles from a station should be explored with system developers as this can influence the complexity of stations and the land area required.
- Operation of the system in degraded and emergency conditions will need to be developed with prospective system suppliers. In particular the methods of ensuring the safe escape of passengers from vehicles on elevated guideways.
- The means provided to protect the PRT operation from trespass needs to be explored with suppliers. It is likely that sections at grade will require fencing and barriers to protect the operation from people and vehicles. Stations will require trespass prevention to protect the guide way including platform edge doors. Elevated sections will need protection to supports near roads.

7.5 Best Alternative – High Quality Bus

A bus-based option will use vehicles and patterns of operation which are already in widespread use. In this context, no additional safety review is considered necessary.

8. System Operations and Business Plan

8.1 Introduction

This section of the report includes the ‘Operational Services Review’ required by the brief. Much of this section covers both PRT and HQB as stated in our proposal.

8.2 Implementation Programme and Procurement

The procurement requirements are summarised in section 10. There are many considerations for PRT which could determine procurement policy. However, procurement of upgraded bus service for the Pilot area is relatively straight forward and follows well established practice. The only new feature would be the possible use of a Quality Bus Contract approach.

Implementation of PRT will involve a sequence of actions which will include the following (not necessarily in this order, and some actions will overlap):

1) Determine procurement model
2) Procurement (to EU requirements)
3) Prepare full business case
4) Full *emda* grant application, negotiate for transport grant with NCC and DfT
5) Prepare TWA order application
   - Detailed revenue forecasts
   - Environmental assessment
   - Land ownership and valuation
   - Detailed costings
   - Risk register/assessment

Some of these actions would be conducted in parallel. A guideline elapsed time is two years for TWA order application plus procurement time which may be several months.

Provision should also be made within the procurement process to encourage potential private sector investment (in addition to that from the system providers) by companies interested in development opportunities and/or intellectual property.

8.3 Staffing

The major element of any transport system, whether in the UK or elsewhere, is the cost of the labour necessary to provide the required level of service. Over the years there have been various attempts to reduce labour costs on public transport services, for example, the introduction of driverless trains (DLR, Stansted airport shuttle etc.) or the removal of bus conductors. These labour saving initiatives can be significant and justified. However, the impact on the level of service provided through the introduction of such initiatives can also be adverse and must be fully understood.

In the case of PRT, the use of vehicle drivers would be uneconomical and is against the principle of operation of PRT; but given the possibility of vehicle failure or unruly behaviour of the occupants certain measures will need to be provided and these will, of course, cost. Probably the most notable measure would be the requirement for some form of CCTV system to ensure safe operation and monitoring of behaviour.

A certain level of labour resource is required to maintain an acceptable level of service. This level of service is an essential part of the provision of a high quality PRT system that enhances the reputation of Daventry, but also offer an affordable solution. Costs were built up from the likely work required and the time taken to carry out the tasks. Certain assumptions were made to derive the staff required to deliver an acceptable level of service.

It should be noted that the staff estimated are full-time equivalent posts, but with the operation being conducted on a 24 hour, 7 day a week basis the number of staff required to provide cover and call-out duties for repairs will be higher as indicated below. However, not all staff would be shift workers.

Costs are based on a minimum wage and then multiplied by an uplift factor for the different skill types and services provided. Further work on these uplift factors may be required to tailor them to the local employment market.

8.3.1 Managerial and Supervisory Staff

The managerial and support tasks are estimated based on the typical duties to operate the service and ensure its success and includes activities such as planning and preparation for initial operation, public outreach, advertising, community engagement and of course operational and staff management. The managerial staff required are provided in Table 32.

- **Table 32 Managerial Staffing Assumptions**

Staff Categories	Pilot	Final
General Manager	1	1
Operations Manager	-	2
Operations Supervisor	1	3
Maintenance Manager	-	1
Maintenance Supervisor	1	3

SKM

Staff Categories	Pilot	Final
Office Clerk	1	1
Accountant	1	1
HR Personnel	-	1
Total	**5**	**13**

The senior managerial staff will not change significantly between the pilot and final systems as a result of some roles being combined. For example, in the Pilot system, it is likely that HR matters and the General Manager will be combined; similarly it is possible that the Operations Supervisor and Maintenance Manager will be combined. For supervisory management and administration staffing the magnitude of the tasks will undoubtedly be smaller for the Pilot and so would require less staff.

8.3.2 General Operations and Maintenance Staff

The estimated operations and maintenance staff are provided in Table 33. The detailed basis of the numbers of the operation and maintenance staff can be found in Appendix H.

- **Table 33 Operations and Maintenance Staff Levels**

Staffing Areas	Pilot	Final
Stations require three 30min cleans per week	1	2
Vehicles require two 10min cleans/safety checks per day	3	39
Vehicles require a 30min service per fortnight	1	3
Additional Staff at the depot	-	2
Staff required to monitor the system from the control room while operational	5	5
Staff required to walk around the track to conduct a safety inspection *	-	2
Building services are required to maintain the depot/station/track infrastructure	1	2
Electrical staff to maintain the CCTV/ communications/ control/ displays	2	5
Security staff/Incident Response/Revenue Collection	2	3
Staff required for vehicle maintenance/repairs	5	20
Total	20	85

The two highest resource activities are:

- Cleaning the PRT vehicles twice a day at 10 minutes each
- PRT vehicle maintenance and repairs

Clearly the level of staffing can be reduced to minimise expenditure. However, any reduction will affect the level of service and potentially the quality and potential attractiveness of the PRT system.

In the case of the cleaning activity this is probably the most visible aspect supporting the attractiveness of the system. A 10 minute clean is not unrealistic; this activity would also include manual handling of the vehicles to/from the cleaning area and receiving the vehicle.

There is a potential that the level of resource for the PRT vehicle maintenance and repair activity could change. There are no operational PRT systems to compare with and any trial/emerging systems have yet to prove their reliability and required maintenance regimes. However, for a potential fleet size of 300 vehicles for Daventry, just a few extra minutes of maintenance can have a significant effect on the resource required; conversely just a small reduction could reduce the staffing required.

8.4 Operational Services Review

8.4.1 Meeting peak demands

Operation at PRT stations is likely to be similar to that at taxi ranks. If large numbers of intending passengers arrive at the station around the same time, the speed at which the resulting queue can be cleared will depend on factors including

- the availability of vacated cars at the station
- the rate at which empty cars can be repositioned from elsewhere in the system
- the average boarding time for each car
- the number of cars available for simultaneous boarding
- any pathing delays while loaded cars wait to take up slots on the main running line.

Depending in the nature of the peak demand, it is possible that the departure station will not, at that time, be a popular destination. Therefore, it will be necessary to reposition empty cars from elsewhere in the system. As experience of operation is gained, it may be possible to program the control system to anticipate peaks and begin to redeploy cars to stations in advance of the peak. Even if this can be achieved, however, there will be limits on the number of empty cars which can be held at or close to stations.

Until a specific system for boarding control and route selection is determined, it is difficult to predict average boarding times. Much will depend on how much of the passenger ticketing and destination choice takes place on the platform and how much within the car itself. At minimum, it is likely that departure from the station will require passenger confirmation that they are ready to depart, as there will not be routine supervision.

Station layouts will in some cases be constrained by space and there may, therefore, be limited scope for provision of multiple boarding positions in some places.

High Quality Bus will have sufficient capacity to meet most peak demands depending on the size of the vehicles and the headway. There will, however, be some instances, such as school traffic, where buses of midi capacity in normal service might need supplementing by contract buses.

8.4.2 Car parking at stations/stops

There is currently no charge for parking in Daventry town centre, and no significant problems with congestion. The location of the Pilot town centre station will be no more attractive than existing and projected car parks. Therefore it is unlikely that the PRT pilot will be used for informal park and ride, and most intending passengers will access stations on foot. No specific provision is proposed for car parking in the vicinity of PRT stations for the pilot.

However, the significant growth in population planned for the town, and development of the town centre, will introduce much higher demands for trips to the town centre; this is analysed in the DTS and DDTS studies. Current plans for additional parking provision are fairly minimal, and for success are likely to require significant modal shift to walking, cycling and/or public transport. Therefore, in the longer term, either through simple lack of capacity or if town centre car parking charges are introduced some car-based trips will divert to PRT[11]. In this event it may be necessary to consider either the provision of parking places at remote PRT stations or a residents' parking scheme in the town centre area to discourage non-local drivers. However, these effects are likely to be only very modest in connection with the pilot, only becoming significant in connection with a wider system and some time in the future.

Car parking at bus stops is normally not provided unless a formal park and ride scheme is implemented. Informal/on street parking may take place. However, car users are very unlikely to switch to bus for part of their journey if there are no parking restrictions at the destinations. Upgraded bus services of 10 minute headways are, however, likely to be attractive for park and ride if town centre or other parking restrictions are introduced.

8.4.3 Integration with other services

The current focus of bus operation in Daventry is the bus station in New Street, which will not be served by the PRT pilot, although it would be the whole-town network set out in the DDTS. PRT pilot services would potentially replace the through journey opportunities currently available by bus between Ashby Fields, Lang Farm and Northampton.

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[11] We understand that the Council is now considering the possibility of park and ride, potentially using PRT, as a means of reducing the impact of town centre parking.

Stagecoach have already indicated that they would be open to the possibility of providing interchange between PRT and bus services, and this could be achieved through the provision of enhanced bus stops in the vicinity of the Civic Centre. Depending on the fares and ticketing system eventually adopted for PRT, Stagecoach would also be interested in the possibility of through fares. The total journey time may well be reduced through the PRT/bus combination, although this would be offset to some extent by the need to interchange.

The upgraded HQB pilot would terminate at the bus station where its controller would also be located. Although the service would not run through Northampton, timed interchange could be arranged and through ticketing could also be provided. These features would become easier to provide if the pilot HQB service operator also operates the Northampton and other town services.

8.4.4 Impact on existing streetcape

The majority of the pilot route runs either along the old railway alignment or alongside roads which have no footways. All existing pedestrian routes alongside or crossing the PRT guideway will be maintained. In most cases the guideway has been elevated at locations where it crosses existing pedestrian route, though in some cases a ramped footbridge is proposed. No new pedestrian underpasses are proposed. Alongside sections of Northern Way the guideway runs at grade along the existing grass verges. However, some minor visual impact and severance would result from the fencing/safety barriers for at-grade alignment.

The principal impact on the streetscape will, therefore, be at elevated station locations. A key element for these will be the position of the base of the staircase to the platform and the base of the associated lift shaft. As far as possible these will be sited for easy pedestrian access.

An upgraded bus service would have minimum impact on the urban landscape of the roads served. There would be some extra bus stop furniture and the marginal intrusion of additional buses but no other structures to affect visual amenity. The buses would, however, be likely to be noiser than PRT, and would emit polluting gases.

8.4.5 Recovery and fallback

In common with all tracked systems, the PRT network will be vulnerable to the effects of vehicle failure, as this will potentially block the running line. Because the system is automated, provision will be necessary for evacuation and/or recovery to take place with limited staff input, and an important function of the pilot will be to test these procedures in advance of any expansion to a wider network. Plans will be needed to cope with partial or total system outage.

Provision must also be made for proving the integrity of the system when restarting after a planned or unplanned shutdown.

Bus services using the highway are not subject to stoppage due to the failure of one vehicle. Breakdowns will not stop the service but will cause disruption. Diesel buses are increasingly dependent on oil imports and will be vulnerable to interruption of supplies. Recovery from vehicle breakdown can be quick if standby buses are available nearby; this is not the case currently but could be provided at additional cost.

8.4.6 Malicious disruption

Because the PRT system is both automated and demand responsive, in addition to normal provision to minimise vandalism and criminal damage, it may also be necessary to detect and if possible prevent malicious disruption. Depending upon the ticketing and control system used this may include:

- attempts to dispatch of empty cars on "ghost" journeys to deplete stock at stations and tie up capacity;
- delaying car departure from stations, eventually resulting in cars blocking back awaiting access.

Where possible, the control system should be designed to detect such activity and alert the control room staff who can then take appropriate action to resolve the situation.

This sort of disruption is harder with buses because they are staffed by drivers in communication with control. However, even buses are not immune from malicious acts and are frequently the target of vandalism by less desirable elements. The response is to conduct a rapid response maintenance regime combined with deterrence through good surveillance and determined legal action.

8.4.7 Maintenance

Within the context of the pilot system it is likely that a relatively simple maintenance system will be applied. However, because operation of PRT in regular public service is relatively untried, it will not necessarily be possible to determine optimum levels of stockholding from the start of operations, especially if certain components are very specific to the system adopted.

Probably the biggest unknown will be the overall performance of the control system, and in particular, how it copes with fluctuations in demand

The HQB system with clear reliability targets will require a higher level of maintenance than is normally provided for bus services.

Maintenance costs for PRT and HQB pilots were assessed for the appraisal and are presented in the relevant chapter.

9. Appraisal of PRT and High Quality Bus

9.1 Overview

Transport Economic Appraisal was undertaken for the following three options:

- PRT pilot, with demand based on a modelling assumption that PRT mode constant is equal to that of car;
- PRT pilot, with demand based on a modelling assumption that PRT mode constant is equal to that of bus;
- High Quality Bus

The options were appraised relative to a base case, using 2021 outputs from the Arup Northampton Multi-Modal Study (NMMS) model as previously adapted for use in Daventry for the Daventry Transportation Study (DTS).

9.1.1 PRT Pilot

The PRT pilot route would run from Daventry town centre to the northern residential suburbs of the town, such as Lang Farm. A single-track loop is proposed with four stations: in the town centre; near to the cross over of the ex-heavy rail alignment and Shackleton Drive; at the junction of Drayton Way and Northern Way; and at the junction of Northern Way and Welton Lane.

Demand forecasts for the PRT options were extracted from the DTS model as follows:

- High Demand: option 6702 PRT Option 1 (mode constant set to equal that of car); and
- Low Demand: option 6802 PRT Option 1 (mode constant set to equal that of bus);

9.1.2 High Quality Bus

The bus option would serve approximately the same areas as covered by the PRT pilot scheme. It represents a significant enhancement to the current bus routes serving these suburbs, in terms of quality including frequency, which is proposed to be maintained throughout the extended operating hours.

Demand forecasts for this option were extracted from the DTS model Option 7302 Bus Option 2, 2021

9.1.3 Base Case

The base case from the DTS model was used to represent the transport demand scenario, which represents public transport supply.

9.2 Appraisal Methodology

The transport appraisal was undertaken using DfT Transport Analysis Guideline (WebTAG) guidance.

9.2.1 Key Assumptions

Following WebTAG advice for appraisal of an infrastructure scheme with no fixed life, an evaluation period extending 60 years post-opening was adopted. The PRT scheme is forecast to open in 2012, with the evaluation period, therefore, extending to 2071. For comparison it was assumed that implementation of the best alternative option also occurs in 2012.

All unit values are in 2002 values and prices, and 2002 is the discount year, using currently recommended discount rates taken from the HMT Green Book as follows:

- Discount rate of 3.5% pa for 30 years from current; and
- Discount rate of 3.0% pa for 31-75 years from current.

Capital and operating and maintenance cost information was taken in the given cost year, with no adjustment for inflation.

Residual values of assets were not included in the appraisal as WebTAG advises that for projects with indefinite lives the appraisal period should end 60 years after the opening year.

Demand for years 2012 – 2021 was extrapolated from model outputs based on sole driver of Daventry-wide population, assuming linear population growth across the period. Population forecasts from the Colin Buchanan DDTS report, sourced from DDC were used, as shown in Table 34. Beyond the forecast for 2021, benefit input values (such as number of vehicle kilometres saved) were assumed to remain at 2021 levels, based on WebTAG advice, which recommends not using continually rising benefits in indefinite project life schemes. However, unit values, such as value of time, were allowed to change over this period.

- **Table 34 Daventry Population Forecasts**

Year	Population
2005	23,000
2021	40,000

Source: DDTS

It was assumed that the benefits generated by PRT and HQB will grow to full levels over the first four years of operation. The following build-up profile was, therefore, applied to benefits based on recent LRT schemes:

- Year 1 : 30% of benefits;
- Year 2 : 60% of benefits;
- Year 3 : 95% of benefits;

9.2.2 Value of Time

Value of time is generated through surveys of transport users' 'willingness to pay' for time savings and is used to give monetary valuation to the time savings realised by all users in the appraisal. The recommended non-working value of time was adopted. Therefore, a 2002 value of £5.04 was used for all modes and journey purposes. Increases in the value of time were also included in the appraisal, to account for real increases in income levels, which affect both personal and business travel values. Real growth factors from WebTAG, as shown in Table 35, were used in the appraisal.

- **Table 35 Value of time growth**

Time Period	Real Value of Time Growth (pa)
(2002-2003)	1.58%
(2003-2004)	1.78%
(2004-2005)	2.57%
(2005-2006)	2.37%
(2006-2007)	1.97%
(2007-2011)	1.76%
(2011-2021)	1.55%
(2021-2031)	1.24%
(2031-2051)	1.59%
(2051-2061)	1.45%
(2061 onwards)	1.60%

Source: WebTAG Unit 3.5.6 Table 3

9.2.3 User Time Savings

User time savings were calculated using variable matrix appraisal technique. PRT was treated as a public transport enhancement. Consequently, total time on public transport in both options exceeds that in the base because of mode switching. This is counteracted by assessing the 'worth' of journeys made by mode switchers on a zone to zone basis, which is valued as the average of journey times with and without the scheme. Time saving benefits that arise from trip generation / mode switching were valued using the 'rule of half'.

9.2.4 Non-user Time Savings

Enhanced bus and PRT lead to an overall reduction in travel by private car. This results in increases in average travel speed for users who remain on the highway network as congestion is relieved. Aggregate vehicle hours travelled (VHT) by non-switching users therefore reduce in both options yielding a benefit. The benefits were valued using the average value of time as outlined above.

9.2.5 Annualisation

User time savings were converted from the modelled period (a single am peak hour 0800 – 0900) to annual values using an annualisation factor of 2,500. Non-user time savings were assumed to occur in peak periods, including peak shoulders, only, and were, therefore, multiplied by an annualisation factor of 300 [12].

9.2.6 Vehicle Operating Cost Savings

Users switching from car to public transport (PRT or enhanced bus) realise a benefit from the private Vehicle Operating Costs (VOCs) they save. These costs include fuel and non-fuel elements.

The WebTAG formula for calculating fuel related VOCs based on average travel speed was applied. The formula is:

$$VOCf = a + b.v + c.v^2 + d.v^3$$

Where:

- VOCf = fuel operating costs, expressed in pence per km (2002);
- v = average speed in kilometres per hour; and
- a, b, c, d are parameters defined for each vehicle category.

The parameters for an average car were applied, as shown in Table 36.

- **Table 36 Fuel VOC Parameters**

Parameter	Value for average car
a	3.253842
b	-0.07402
c	0.000839
d	-0.00000269

Source: WebTAG Unit 3.5.6

Real increases in fuel resource prices were applied from WebTAG advice for an average car type as shown in Table 37. Increases in vehicle efficiency of between 1.1% and 1.7% per annum were

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[12] The annualisation factors of 2,500 and 300 are consistent with the Colin Buchanan DDTS appraisal, which used the same modelling outputs.

also accounted for up to 2020, based on WebTAG values. No forecasts are available beyond 2020, so no further vehicle efficiency improvements were assumed.

Table 37 Real Fuel Cost Increases

Year	Real growth % pa
2002 – 2003	13.2%
2003 – 2004	-11.2%
2004 – 2005	31.7%
2005 – 2006	7.9%
2006 – 2007	-6.3%
2007 – 2008	-7.2%
2008 – 2009	-7.9%
2009 – 2010	-6.7%
2010 – 2015	0.9%
2015 – 2020	1.0%
2020 – 2025	0.03%
2025 +	0%

Source: WebTAG Unit 3.5.6

Non-fuel costs include such expenses as oil, tyres, maintenance, and depreciation. The flat rate for an average car of 3.31 pence per kilometre was applied (WebTAG). Non-fuel VOCs were assumed to remain constant in real terms over the forecast period. This assumption is based on WebTAG advice and was made because the main elements which make up non-fuel VOCs are subject to less volatility than fuel VOCs.

9.2.7 Accident Savings

Highways

Enhancing the public transport provision in the area results in reduced private car vehicle kilometres travelled. As a result, a reduction in road accidents was forecast under both main options.

Accident rates for links and junctions combined were obtained from the COBA 11 Manual, for the predominant local urban area single-carriageway road-type in the study area. Year 2000 base rates of 0.844 personal injury accidents per million vehicle kilometres were used, with a ratio of 17.7 property damage only accidents per personal injury accident.

Trends in accident rates show declining accident rates per vehicle kilometre travelled. COBA rate reduction factors were applied, resulting in reducing accident rates over time. The accident rate reduction factors shown in Table 38 were used.

■ **Table 38 Future reduction rates for accidents**

Years	Reduction factor (pa)
2001 - 2010	0.984
2011 – 2020	0.992
2021 – 2030	0.996
2031+	1

Source: COBA 11 Manual

COBA also provides advice on typical accident severity for a given personal injury accident (PIA), which were applied to a proportion of forecast accidents in the categories of fatal, serious injury, and slight injury. The proportions used are as shown in Table 39.

■ **Table 39 Proportions of PIAs by Severity**

Accident Severity	Proportion
Fatal	0.007
Serious Injury	0.126
Slight Injury	0.867
Total	1

Source: COBA 11 Manual

Economic costs incurred as a result of accidents are provided in the COBA advice and these were applied to accident numbers. 2002 values are as shown in Table 40. Growth in real accident costs were linked to forecast real GDP per head, as recommended in the COBA manual.

■ **Table 40 Costs per accident by Severity**

Accident Severity	Cost per accident £ (2002 prices)
Fatal	1,257,560
Serious Injury	143,918
Slight Injury	12,851
Property Damage Only	1,397

Source: COBA 11 Manual

PRT

PRT will operate as a segregated system, except for passenger access at stations, with inbuilt vehicle safety features. Therefore, no accidents are anticipated to be associated with the system.

Bus

Bus kilometres were added to private highway kilometres in the base case and option, to input into accident calculations, and reflect the impact of reduced (PRT option) or increased (High Quality Bus) bus kilometres.

9.2.8 Greenhouse Gas Impacts

Recent changes to WebTAG include social cost values for emissions of carbon. Reduced private vehicle kilometres result in reduced carbon emissions in the study area. These are, however, offset to a degree, by increased carbon emissions resulting from PRT energy generation, or increased bus movements.

Social values given to carbon emissions are from WebTAG Unit 3.3.5 Table 2 Central Estimates, as shown in Table 41. Linear growth between the given years was assumed.

- **Table 41 Social Costs of Carbon Emissions for Selected Years**

Year	(£) per tonne of carbon in 2002 prices – Central Estimate
2000	72.45
2002	74.52
2006	78.66
2010	82.80
2020	93.15
2040	113.85
2060	134.55

Source: WebTAG Unit 3.3.5

Highways

Carbon emissions per litre of fuel burnt are from WebTAG 3.3.5 Table 1. These are calculated for typical UK fleet splits by petrol and diesel cars. An assumption is built into these values that carbon emissions per litre of fuel burnt will reduce due to increased use of biofuels. No reduction is forecast by beyond 2020.

Litres of fuel consumed per vehicle kilometre at a given speed were calculated using WebTAG advice from unit 3.5.6 Table 10. These were calculated for petrol and diesel cars separately, based on the typical UK fleet split. Fuel efficiency improvements, in terms of litres per kilometre, were also applied. This process allows reductions in vehicle kilometres travelled to be turned into corresponding reductions in carbon emissions. These were valued using the unit costs shown above.

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PRT

Although PRT uses electric traction, and hence does not produce local air emissions, it does require remote energy generation, which in turn results in carbon emissions, assuming fossil fuel power generation.

Energy consumption for typical PRT vehicle operation of 0.55MJ per passenger kilometre was assumed. This is based on the ULTra system, and is the only available estimate of operational energy usage for this type of transport. Passenger kilometres travelled per annum were sourced from a 25-vehicle PRTSim run conducted by Colin Buchanan's for the PRT pilot. To account for energy use incurred by empty vehicle positioning movements, an uplift factor of 25% was applied to the above values.

Carbon emissions resulting from typical electricity generation in the UK, in kilo-tonnes per terawatt hour, were sourced from the Strategic Rail Authority Rail Emissions Model (2001), as recommended by WebTAG. Forecast average carbon emission rates for UK electricity generation are reported for two scenarios, based on assumptions of alternative generation methods. The mean of these two scenarios was applied to the energy consumption of PRT, as shown in Table 42. Linear growth between the given years was assumed. No change was assumed beyond 2020. It is possible that PRT power could be drawn from a Combined Heat and Power Project planned for Daventry. This could have lower carbon emission rates.

- **Table 42 Carbon Emission Rates for UK Electricity Generation**

Year	k tonnes/twh average of scenarios
2000	523.3
2005	392.7
2010	376.6
2015	390.5
2020	379.0

Source: SRA

High Quality Bus

Carbon emission changes resulting from bus kilometres were calculated in comparable fashion to car emissions. Factors and parameters for buses were obtained from WebTAG for this purpose.

9.2.9 Revenues

Incremental public transport revenue was calculated (option minus base). To ensure consistency with the assumptions used in the modelling, a flat fare of 80p per trip was assumed for all public transport modes, with no real increase in fares over time.

SKM

9.2.10 Costs

No real increases in any costs were assumed. Optimism Bias uplift was added to upfront capital investment costs, including vehicle purchase. Optimism Bias is defined by the Green Book (2003, p.29) as 'a demonstrated systematic, tendency for project appraisers to be overly optimistic'. A 66% optimism bias uplift factor was applied to PRT capital costs, representing 'rail' style system construction, appraised at pre-feasibility stage, from WebTAG unit 3.5.9.

Optimism bias factors of 66% were also applied to all capital expenditure associated with the HQB options. Although well proved bus technology is assumed, there would be uncertainties in delivering extensive bus priority and upgrading to Minitram may also be anticipated.

PRT

It was assumed that PRT construction occurs during 2008 – 2011, with costs incurred evenly across these four years. Vehicle costs were assumed to be incurred in 2010 – 2011, in preparation for the start of operation in 2012. Table 43 displays the pilot PRT capital costs used in the appraisal.

Infrastructure replacement costs were included at 30 years of operation for all electrical infrastructure and equipment, as shown in the final column of Table 43. Replacement costs were spread over two years, and totalled £5.9 million including 66% optimism bias.

It was also assumed that the PRT fleet will be subject to a refurbishment and replacement programme. Replacement after 30 years was assumed, with half-life major refurbishments of the fleet. Replacement costs were assumed to be equal to initial capital outlay (£50k per unit) and to be incurred over two years. Refurbishment costs were assumed to equal one third of purchase costs (£16.6k per unit), and were also spread over a two-year period. No residual values were assumed at the end of the vehicles' 30 year life.

Operating and Maintenance costs were calculated for the PRT pilot. These covered the following:

- infrastructure maintenance;
- staffing;
- energy;
- spares and Replacements; and
- ancillaries.

▪ **Table 43 PRT Pilot Capital Costs**

Item	Level	Length m	Unit cost (£/m)	Quantity	Unit cost (£/ number)	Total Cost	Replacement at 30 years
Double Track guideway	at grade	372	795			295,740	N
	elevated	308	3,885			1,196,580	N
Single Track guideway	at grade	1,530	500			765,000	N
	elevated	2,671	1,970			5,261,870	N
Double track station	at grade			0	189,000	0	N
	elevated			0	414,000	0	N
Single Track Station	at grade			0	121,500	0	N
	elevated			4	207,000	828,000	N
Platform screen doors				4	18,000	72,000	Y
Cars				25	50,000	1,250,000	Y
Control System				1	2,500,000	2,500,000	Y
Depot				1	839,000	839,000	Partial
Lighting				1	20,600	20,600	Y
CCTV				1	314,318	314,318	Y
Route Selection				4	11,500	46,000	Y
Power Supply System						1,000,000	Y
					Total	**14,389,108**	
					Optimism Bias Uplift	**66%**	
					Revised Total	**23,785,919**	

A summary of the operating and maintenance costs used is as shown in Table 44. Simplifying assumptions were adapted for spares and replacements; the cost level and profile do not reflect the full detail of costs given earlier. Ancillaries refer to PR, recruitment and other costs.

- **Table 44 PRT Operation and Maintenance Costs**

Component	Cost (pa)
Infrastructure upkeep	104,295
Staffing	785,029
Energy	81,475
Spares and Replacements	51,701
Ancillaries	30,000
Total	**1,052,500**

High Quality Bus (HQB) Option

To represent incremental public transport operating and maintenance costs with respect to the base case, an equivalent costing of the existing bus service in Daventry's northern area was prepared, based on an augmented cost model used by Colin Buchanan in the DDTS report. The CB model models all-inclusive annual service provision costs. These were disaggregated into capital costs and annual running costs, based on a purchase price of £150,000 per bus, with linear depreciation over 10 years and no residual value. This facilitated separate treatment of capital and O&M costs.

The CB model all-inclusive annual calculations were compared with recent tender awards in London, which are also reported in all-inclusive annual service costs. All-inclusive costing for the HQB service shows £160,000 per peak vehicle (PV) per year. In comparison, the average tender cost per PV bus for a sample of 31 London bus routes tendered during 2006 was £191,000. This is somewhat higher than we have assuming for Daventry. However, this may be a reflection of London cost levels. A summary of this equivalent costing is as shown in Table 45.

- **Table 45 Existing Bus Service Equivalent Operating Costs**

Cost Component	Cost per annum
Bus ownership related costs	12,600
Staffing	70,200
Mileage related costs	19,165
Operator Profit Margin	10,196
Total	**112,161**

Incremental public transport operating and maintenance costs for the PRT pilot options are, therefore, £0.94million per annum.

It was assumed that to provide a good alternative to PRT, modern buses would need to be offered. A purchase cost of £150,000 per bus was assumed, with 10 buses required for provision of a stand-alone fleet for the service, including spare allowance.

Bus economic life was assumed to be 10 years, requiring full replacement on this timeframe. Major refurbishment at the half-life stage (5 years) was assumed and set to one-third of purchase price per vehicle. No residual values were assumed at the end of the 10 years.

A small depot / stabling facility would be required for a stand-alone service. This was assumed to cost £1m, to include small shed, stabling area, maintenance, fuelling facilities and offices.

The service would be complemented with enhanced passenger waiting and information facilities at all stops. In addition, systematic bus priority is envisaged, including stretches of busway, for which £2m is allowed.

It was assumed that half of the costs of providing the bus infrastructure (depot and passenger facilities) are incurred for replacement after 30 years of operation.

O&M costs were calculated in the same manner as those for the existing operation, and are as shown in Table 46. To provide service comparable to PRT the level service was assumed to be 15bph all day (06:00 to midnight) and 2bph all night.

- **Table 46 HQB Operating and Maintenance Costs**

Cost Component	Cost per annum
Bus ownership related costs	67,200
Staffing	1,046,000
Mileage related costs	221,130
Infrastructure upkeep	66,400
Operator Profit Margin	140,073
Total	**1,540,803**

Incremental operating costs were calculated by comparing the above to the equivalent existing service costs and are therefore £1.43m/yr.

9.3 Transport Economic Appraisal

Results of the Transport Economic Appraisal are given in Table 47. The measure of economic worth presented for each option is the Benefit Cost Ratio (BCR). This divides the total benefits created by a project by the total costs incurred, incremental to the base case, and gives a measure of project worth that is relative to the magnitude of expenditure required. In line with DfT guidance, revenue was treated as a benefit component and was, therefore, included in the numerator of the benefit cost ratio calculation. As a starting point, it is typically expected that a scheme will generate a BCR of at least 1 to 1, and the higher the BCR, the more attractive a project is, in transport economic terms.

- **Table 47 Results of the Transport Economic Appraisal (PV)**

Category	Option		
	PRT High Demand (£pv)	PRT Low Demand (£pv)	HQB (£pv)
Costs			
Infrastructure Capital (including replacement)	18,833,302	18,833,302	5,822,383
Vehicle Capital (including refurbishment and replacement)	2,555,494	2,555,494	7,190,858
O&M costs	17,619,306	17,121,840	27,016,238
Total Costs	**39,008,102**	**38,510,636**	**40,084,480**
Benefits			
User Time Savings	92,034,462	68,323,282	60,650,723
Vehicle Operating Cost savings	1,131,065	497,055	444,695
Non-PT user time savings	1,229,616	643,697	729,121
Accident Savings	3,434,827	1,564,288	997,754
Greenhouse Gas Savings – Highway	138,600	75,638	54,200
Greenhouse Gas Savings – Public Transport	-106,272	-64,115	-82,393
Incremental Revenue	9,072,677	0	6,550,543
Total Benefits	**106,934,975**	**71,039,844**	**69,344,642**
BCR	**2.74 to 1**	**1.84 to 1**	**1.73 to 1**

PRT High Demand Option

Significant capital outlay on infrastructure and vehicles is required for the project. Significant proportions of this investment also require replacement during the appraisal period. In present value terms capital expenditure, including replacement costs, is £18.8 million for infrastructure and vehicles. In addition, a substantial cost undertaking is incurred in terms of incremental annual O&M costs. These total £17.6 million in present value terms.

Substantial transport benefits are generated by the pilot scheme. These benefit results are based on the demand outputs from the DTS model run which assume that PRT has the same mode constant as, or is equally preferable to, car. The main benefits realised are in terms of public transport user time benefits. These benefits total £92.0 million across the 60 year appraisal period in present value terms. A series of other benefits result, including vehicle operating costs, non-public transport user benefits, accident cost savings and greenhouse gas emission savings. These categories are much smaller in magnitude. Mode switching from private car to PRT generates additional revenue of £9.1 million. Total benefits are £106.9million in present value terms, giving a BCR of 2.74 to 1.

PRT Low Demand Option

This option has the same capital costs as the PRT High Demand option. The only cost difference is in terms of operating costs. Reduced demand results in less energy consumption, hence reducing incremental operation and maintenance costs are approximately £17.1 million in this option.

Public transport user time benefits also dominate the results of this option, with £68.3million of benefits generated in present value terms. VOC, non-user time, accident and greenhouse gas emission benefits for this option result from a redistribution of trips between the modes of bus, car and PRT in the NMMS modelling results. This redistribution leads to forecast reductions in total private car vehicle kilometres travelled (VKT), which in turn generate benefits, even though aggregate public transport demand does not change.

Results for this option are based on the demand outputs from the NMMS model scenario which assume that PRT has the same mode constant as, or is equally preferable to, conventional bus. As a result aggregate public transport demand does not increase in this option, with respect to the base. Therefore, no incremental revenue is generated.

Total benefits of this option are £71.0 million in present terms, giving a BCR of 1.84.

High Quality Bus

The capital costs incurred for this option are substantially lower than for PRT. Infrastructure and vehicle costs, including replacements, total £13.0 million in present value terms. Incremental operations and maintenance costs are higher, totalling £27.0 million in present value. Total costs are therefore £40.1 million in present value terms

Results for this option are based on the demand outputs extracted from the Arup DTS model run which reflect significantly enhanced bus operation. The main benefits realised under this option are public transport user time benefits, which total £60.7million across the 60 year appraisal period in present value terms. Benefits are also realised in terms of reduced vehicle operating costs, non-public transport user benefits, accident cost savings. These categories are again much smaller in magnitude across the evaluation. Incremental revenue of £6.6million, in present value terms, is generated. Greenhouse gas emissions rise overall in comparison with the base case, generating a small disbenefit. Total benefits are £69.3million in present value terms, giving a BCR of 1.73 to 1.

SKM

9.4 Sensitivity Testing

Sensitivity tests were undertaken on the high demand option above. These included:

- exclusion of the costs of providing a continuous walkway along the PRT guideway;
- use of a higher investment cost optimism bias uplift factor of 86%.

Results of the sensitivity tests can be seen in Table 48. The results are largely self-explanatory. Costs were increased or decreased, and these change in costs resulted in reduced or increased BCRs respectively.

- **Table 48 Results of Sensitivity Tests**

Category	Option	
	PRT High Demand No Walkway	PRT High Demand Optimism Bias 86%
Total PV Costs	37,766,412	41,833,531
Total PV Benefits	106,934,925	106,934,925
BCR	**2.83 to 1**	**2.56 to 1**

9.5 Summary of Transport Economic Appraisal

In transport economic terms, each of the options tested in the appraisal generate economic returns, with benefit cost ratios at least 1.9. The PRT High Demand generates the highest BCR of 2.78. The PRT low demand generates higher benefits than the comparable (in terms of cost and quantum of service) HQB resulting in a higher BCR of 1.87 compared with 1.73 respectively.

The sensitivity tests undertaken show that the economic cases are robust enough for reasonable variations in scheme costs, whilst still generating positive BCRs. In all cases, however, the benefits are principally from people switching to PRT or HQB, while costs are bound to be uncertain. Therefore, a review of the demand forecasts is likely to form a part of business case verification, which takes account of the characteristics of the preferred PRT system.

9.6 Economic Development Appraisal

9.6.1 Introduction

This section of the appraisal focuses on the economic impact aspects of potential PRT and High Quality Bus schemes. It was prepared in line with the appraisal framework, prepared by SKM and submitted to Daventry District Council in March 2007, and conforms to the DCLG "3Rs" guidance.

"3Rs" refers to the Regeneration, Renewal and Regional development interventions. These terms typically do not have simple definitions but the distinguishing characteristic of these interventions is that they have a strong spatial focus and often, as a result, distributional impacts. They tend to affect the process of sustainable development for target areas and groups, and have the specific objective of improving outcomes in social, economic and environmental terms.

The ultimate aim of the "3R" interventions is to achieve thriving, inclusive and sustainable communities in all regions by raising levels of social inclusion, neighbourhood renewal and fostering regional prosperity.

The study therefore needs to consider both the immediate effect of the Pilot and the effect of the Pilot leading to the network serving much of the town of Daventry and the potential for links to other fairly close destinations within the region. It also considers spin off effects throughout the region. These will be related to the technology and business activity associated with PRT rather than being directly linked to the specific PRT route itself.

The 3Rs guidance is in essence the Green Book re-cast specifically for interventions where the impacts will be spatially focussed OR where the objectives of the organisations promoting or assessing the interventions may be spatially based. The guidance is therefore very useful for bodies, such as Regional Development Agencies, whose remit is to address economic development and employment in a particular area.

Being derived from the Green Book, the appraisal framework of the 3Rs is cost benefit analysis. However, 3Rs does recognise the value of multi-criteria based approaches to appraisal as a way of providing additional information to decision makers. Given its spatial focus, 3Rs also deals with how to address issues of additionality and displacement where a gain to one area may represent a loss elsewhere.

This section presents the main components of a 3Rs appraisal targeted towards the economic criteria agreed in the appraisal framework and, where possible, it estimates values for these components. This provides a reasonably clear picture of the order of magnitude costs and benefits of PRT, as the impacts that are not quantifiable at this stage are also relatively minor. The appraisal also explores where there are major risks and uncertainties regarding the appraisal numbers, and proposes adjustments to some of the source data in order to present a more realistic assessment of costs and benefits. This is especially important given that this is relatively new technology.

This appraisal is undertaken at a "national level". Although this project is envisaged as much as an "economic development project" as a transport scheme, the 'first wave' benefits are initially transport benefits which are appraised using standard transport methodology. While this considers (principally) time savings where they occur, the value of these savings is also the final impact on the national economy, and it is quite likely that through economic processes these impacts will largely leak out of the area in which the initial time savings are generated and result in general regional and national benefits.

9.6.2 Appraisal Framework

The Appraisal Framework agreed with DDC provides the critical economic indicators to be included in this appraisal. Because this project is based on new technology – or, more accurately, new uses of technology – there will inevitably be a large number of assumptions, estimates and comments with "high risk potential" (that is, while they may appear realistic at this stage, they are based on above average levels of unknowns and therefore represent a higher than average level of risk of deviating from expectation).

In helping to understand the project as a whole, and complex series of issues and potential opportunities, we developed this economic appraisal through first understanding the more directly transport related benefits of the scheme and, second, looking at the project as a stimulator of economic development within the region. This second aspect of appraisal is based on the assumption that the public sector locally and regionally will provide a suitable level of commitment to the project. Should this commitment not be forthcoming, then some initial estimates should be treated as having potentially large margins of error.

9.6.3 Appraisal and Decisions

Appraisal is fundamentally about providing the information that decision makers require if they are to make sound and rational investment decisions. In developing this particular appraisal, it has been important to consider the information that decision makers with a regional development remit (such as *emda*) might require. A potential funding agency needs to be clear about:

- the market failure(s) its funding contribution will address;
- the incremental benefit – cost ratio of the assisted intervention compared with the base case;
- the benefits of interest to the funder

9.6.4 Defining the intervention

The central proposed intervention is the development of a PRT pilot – with two options considered. The best alternative intervention is a significant enhancement to the existing bus to the area covered by the PRT pilot. The upgraded bus service would operate at a significantly increased frequency.

9.6.5 Market failure

This section considers market failure initially from the transport perspective. Left entirely to market forces, the private sector bus and other "public" transport providers tend to select the high demand routes first, while lower demand routes or routes where there is significant competition from cars tend to be under-served. This leads to a situation where there is a mix of overuse of cars by those who have chosen to own or have regular access to a car or other vehicle, and varying levels of exclusion from a whole range of opportunities, including employment, for those unwilling or unable to own and run a vehicle. Critically the market also fails to include ‘external’ costs such as environmental impacts (including emissions of global warming gasses), harming the environment for others (such as residents or people on foot) and the impact of journeys on other people’s travel times.

The market, therefore, fails to deliver a solution that is environmentally or socially optimal. Overuse of cars at a level beyond that which would prevail if users paid marginal social and environmental costs leads to severe negative external effects especially at peak times, while under-provision of public transport leads to social exclusion and labour markets which perform inefficiently.

For these reasons the public sector generally intervenes in public transport through subsidy and other arrangements to ensure that people who would otherwise be underserved by bus operators receive some level of service. However, there generally remains an absence or severe lack of push and pull mechanisms that would reduce car use and car dependency:

- Push factors would include high(er) parking charges and road user charging especially at peak times, in order to get some drivers to change travel behaviour;
- Pull factors include much better public transport in order to provide car users with alternatives that are closer to the car experience than the “normal” bus services.

Clearly the market will not provide either push or pull factors of a type or at a level that will lead to a more optimal use of road space and other transport related resources. In the absence of strong push factors the market has little incentive to develop public transport services to attract a high level of car users, as this would involve high revenue risks (lack of market response) and competitive risks from other operators who would have an incentive to “dump” conventional bus services at high frequencies and low fares to undermine a provider trying to introduce a high quality or innovative public transport service.

The PRT proposal is therefore a measure that is unlikely to be taken forward by the private sector, even though it offers a step change in public transport quality that is likely to attract people out of cars for some trips. Specifically:

- PRT involves significantly higher technological risks and potentially higher capital risks than a bus or light rail based scheme: the technology is not fully proven and market response is uncertain;

- PRT involves fixed infrastructure and is, therefore, less flexible than bus services to respond to economic, land use and population changes, which adds to the risks.

Accordingly the private sector is very unlikely to develop and implement this technology by itself. It is however, likely to be interested in a risk sharing arrangement that gives the prospect of future returns once a full scale version of PRT has been shown to work. There are risks for the public sector as well, so that it needs to look at how it can share in the rewards if its initial investment in PRT is successful.

Therefore, there is a market failure which PRT and the HQB option could address beyond that which is capable of being addressed through the provision of "normal" subsidised bus services. In both cases, the revenue stream will under or overstate the true benefits. However, in the case of PRT there may be wider benefits associated with the early adoption of new technology, just as there are also risks in being among the first with a new transport mode.

9.6.6 Wider economic benefits

Recent appraisal guidance from DfT identifies that there may be welfare benefits that are not captured by conventional transport appraisal because of market imperfections. In addition it is important to consider DCLG appraisal guidance in order to identify and measure the non-transport outputs and outcomes. These include:

- agglomeration benefits, due to positive external effects between businesses where their relative density is increased;
- changes in competitive conditions and reduction in the effects of imperfect competition;
- exchequer benefits from additional tax revenues from additional people in employment
- local and regional supply chain effects;
- local and regional inward investment effects arising from the enhanced profile and image of the town and surrounding areas;
- local and regional development effects arising from the willingness of housing and related developers to develop the area;
- spatial effects arising from improved transport connectivity and its economic and social role in the area;
- regeneration effects especially in the town centre and associated residential areas;
- educational effects if the pilot serves schools and specialist colleges, and the contributions to graduate and postgraduate study; and
- institutional effects on the perspective of the UK government, European Union institutions and learned societies.

In looking at national level impacts, there is a need to consider whether there may be

- inward investment impacts or
- visitor impacts.

At the national level, Daventry might attract new investment that would not otherwise come to the UK due to the increased place competitiveness of Daventry. It is likely that such investment would be in a high technology sector, attracted by the halo effect associated with being in a town with a leading edge technology. Clearly the most probable investment would be associated with the development and production of PRT systems[13].

Similarly, Daventry could attract additional visitor expenditure arising from increased numbers of people visiting to view or study the PRT system. Even if these visitors would visit the UK in any event, it is possible many would spend extra time and money in order to visit Daventry. It is likely that the direct value of such visits would be very small when considered against the transport and other impacts; however, their role in attracting inward investment may be significant. It may also be important during the early, pioneer years of the system.

Overall, however, the key economic development potential is associated with the possibility that a PRT cluster or Centre of Excellence could locate in or near Daventry. This is of course an indirect benefit and one which, at this stage, cannot be guaranteed. But the initial indications are that, if PRT is successful and rolls out in other parts of the UK, Europe and worldwide, then there will be a large demand for supplies, services, skills and manufacture which is currently not established. Businesses will develop to serve the pilot and these will then be a strong position to serve the full Daventry network and, consequently, any future UK and international roll outs.

The companies that will help develop the pilot will have to establish themselves somewhere. Daventry would appear to be as good an option as any because the company would be located in proximity to the trial. The other most likely location for a PRT cluster would be close to the University / science centre where related technology has been established, especially if the University in question has a purpose made “spin out” technology park.

If we consider the leading PRT companies, there may be no obvious better location for spin out companies than Daventry.[14] The main companies under consideration have their main bases in

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[13] The term PRT systems covers a range of hardware and software features relating to the construction of infrastructure and vehicles, the operating and maintenance systems, and new technology not currently used for other transport systems.

[14] Note: this is clearly not a simple issue and there are many actors and complexities governing a company’s location decision. This paper cannot guarantee that companies would locate in

Bristol, Netherlands, Korea, the USA and Poland respectively. While there may be reasons for these companies to develop their businesses in their home location, they will see some benefits to locating in the proximity of the trial system. The maximum economic benefits will clearly be delivered if a cluster of companies providing facilities and services can be encouraged to locate in or near Daventry.

In addition to the potential economic benefits, there may be a related environmental benefit which can legitimately be included in a 3Rs appraisal; the value of the improved visual or civic amenity due to an enhanced public realm. The rationale for this is that people are willing to pay for this type of enhancement just as they are willing to pay for time savings when travelling or to have the option to, for example, see rare species in a zoo (option values).

At this stage there is no basis for making an estimate of these amenity benefits. This may merit further research, which a pilot scheme will assist. Similarly further research might be useful in quantifying other amenity and environmental benefits.

9.6.7 Social inclusion Benefits

There is no agreed basis for valuing social inclusion benefits. The best that might be done here would be to quantify the numbers of people benefiting from better accessibility to different facilities and end uses (health care, training and so on) and using values imputed from a range of other measures intended to achieve improvements in access to these facilities or end uses. This is beyond the scope of this appraisal at this time. However, the DDTS does illustrate that a whole-town PRT network would render access to employment and services by public transport much more viable; this would be of particular advantage to those unable to use cars because of age, disability or income.

9.6.8 Encouraging and Increasing Economic Benefits

One of the most exciting aspects of the PRT project, is that it is pioneering – if Daventry is to be the first town in the UK to roll out a PRT system, it puts itself in prime position to attract the many and varied supplier industries, services and research organisations that will be linked to PRT and, in the fullness of time, will contribute to PRT systems throughout the UK.

At this stage, introduction of a PRT pilot in Daventry will do no more than stake the town and region's strong claims to accommodate the new, expanding and diversifying businesses that will eventually become "the PRT sector". If the businesses do locate here, then the economic benefits

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Daventry, but merely suggest reasons as to why they may do, and how Daventry might encourage this further.

will be strong – because there will be a range of high and low skilled jobs; because the sector is modern; and because the jobs will be new and not displacement. There will, however, be competing claims for these jobs. For example, the technology associated with one PRT supplier has been developed at Bristol University. There must surely be a good chance that the development and enterprise agencies in that area would like to see spin outs from their University remain in their area. Therefore, we cannot expect the advantages simply to come to Daventry, just because the pilot is located here. Other initiatives may also be needed. One suggestion, which is made here to help strengthen the economic case presented, is that Daventry could open a "PRT park[15]". There are several reasons for developing a park or facility and possible benefits.

- It will demonstrate a commitment to the sector which may encourage businesses to locate here rather than say, close to Bristol University.
- There will be adequate employment land designated as part of the growth of Daventry.
- The locational advantages of Daventry are good and WNDC would expect a good quality business site to be popular.
- The park could offer management, marketing and incubating services to help businesses in the transport technologies sector.
- In theory, horizontal and vertical business linkages could develop between companies located within the park.
- It should make companies feel welcome in the area (this can be more important than it sounds – businesses will be gambling on this new sector developing from almost nothing and will need all the confidence they can get).
- There may be potential to offer financial inducements or grants to companies locating here.
- Training and business development assistance could be easily targeted to the park's occupants.
- It will make it easier to advertise Daventry as the modern PRT town.
- It will enable the Centre of Excellence concept to appear realistic.
- It will make it easier to develop links with the Universities and the educational sector in general.
- Other towns in the UK considering PRT will find an easy one stop shop in which to discover more about PRT.

This does not imply that companies in the region who may be able to benefit from PRT would have to relocate. For example, AVE, based in Derby is already working on prototype PRT systems and

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[15] This could equally be called the Transport Technologies Park to reflect regional strategy priorities

may expect to win work without having to relocate from Derby. Another issue may be that certain area initiatives have been discredited in recent years and the concept of a strictly sectoral park may not be universally welcome. There may need to be some means of developing permeable boundaries or overcoming concerns related to a single sector focus. The fine details of a PRT or Transport Technologies Park would have to be resolved, but it is assumed that ways of overcoming these small issues will be found.

The concept of a Technology Park is presented here as part of the appraisal in order to acknowledge that the economic benefits described in this paper may need additional public sector intervention in order to be realised, and that such intervention appears to be both achievable and desirable.

Another issue which should be addressed, and which can help make the potential economic benefits happen, is related to who drives the project. There is a range of delivery options;

- Option 1 is that Daventry goes alone, utilising the wealth of knowledge already available within the District Council and ensuring the bulk of the economic benefits accrue to the town and District of Daventry. However, Daventry's expenditure budgets are limited, the town has a series of other economic development priorities, a Transport and Works Act Order would probably be required while grant funding would be sought through *emda*. This option would not demonstrate the commitment to regional partnership working that is discussed in the various economic development strategy documents relevant to this area.
- Option 2 would see a joint Daventry/Northamptonshire partnership. This may be more practical as there will be larger sources from which to pay capital and revenue costs, the project could be developed as one which helps the county, and its current growth ambitions, and there would be the obvious benefit of having the main local transport authority in the team.
- Option 3 would see this develop as an East Midlands regional project, where *emda* are part of the team which drives the project. This may dilute the economic benefits to Daventry as, for example, *emda* would see equal benefits for a company located in Derby or Daventry. However, the scale and potential impact of this project is huge, and it almost certainly needs finance which is only available at the regional scale and with regional support.
- Option 4 envisages a partnership with the West Midlands in line with the Midlands Way Action Plan. This seeks added value through East and West Midlands working together. The disadvantage is that the potential influx of companies to Daventry may not happen as the jobs are dispersed across a wider region. The advantage is that West Midlands could probably benefit extensively, not least because the recent decline in the regional car industry suggest that there will be an available workforce who would need only simple reskilling in order to take certain manufacturing jobs, while the West Midlands probably has sites which could accommodate a PRT Technology Park or part of it.

It is not important to choose a delivery option at this stage. But ideas are presented here to indicate that the economic benefits will be concentrated or dispersed in relation to a number of factors, some of which can be controlled or influenced by the local public sector.

9.6.9 Economic Development Appraisal High Quality Bus Option

The best alternative to PRT an enhanced bus option. While the benefits in terms of transport economics or the ability of people to move more freely around Daventry can be assessed and directly compared to the benefits offered by PRT, the ability to compare the non-transport or wider economic benefits is significantly more difficult.

PRT offers the distinct benefit of having a unique or individual status. Because it is different it will be noticed; because it is new and without established suppliers, an industry will have to spring up to service the system. While the nature, scale and potential of that industry will be influenced by a number of factors, the situation with buses is not the same. Bus systems are already established throughout the UK. If Daventry's enhanced bus alternative means that more buses will be purchased, they will be procured from existing sources. For example, Travel West Midlands recently placed an order for 100 new buses which will be manufactured at the long established TransBus facility in Falkirk, Scotland. Servicing, spare parts, post manufacture accessories and so on will already be available as the bus market is well established. Some of these will be local and some regional, but others will be sourced from elsewhere in the UK and overseas.

Overall, because a bus service – even an enhanced one – does not offer PRT's distinct advantage of uniqueness and the need to set up and establish a whole background infrastructure, it will not have the ability to compete in economic development terms. The provision of enhanced bus services will inevitably create some local jobs in cleaning, servicing, maintaining, but it is neither practical nor sensible to attempt to compare these to the potentially substantial economic development benefits that PRT could possibly bring to the region.

9.6.10 Summary Economic Impact Appraisal Table

The economic impact assessment is summarised into the table presented below. At this stage, margins of error will inevitably be high and the table is based on a large number of assumptions. Because the project under appraisal is initially being developed as a pilot project, it is inevitable that there will be several unknowns or uncertainties – factors which the pilot will be designed to sort out.

- **Table 49 Economic Impact/Development Indicators – PRT Proposal**

Criteria	Impact
Travel To Work Patterns	Significant positive benefit in that the layout of the full network will link

	areas of residential properties to areas of employment. However, the maximum impact on travel to work patterns will be dependent on Daventry establishing more "work local" residents, which will require initiatives separate to this project. These initiatives are partially underway with the new housing developments and proposed new industrial developments in Daventry. The PRT system will enable these new developments to be serviced by sustainable modes of travel to work transport. The improvement will be relatively significant because the starting position is poor – with too few people both living and working locally, and most travel to work patterns involving the use of the private car. PRT appears capable of meeting Daventry level demand and generating an improvement to travel to work patterns. During the pilot, the travel to work patterns will be constrained by the short length of track and the inability to reach key areas of employment. The pilot therefore should not be expected to establish more sustainable travel to work patterns itself – these will develop with the deployment of a full network. On a larger scale, if the Pilot is successful it should enable the roll-out of PRT in other locations, in time supporting widespread and nationally significant change in travel behaviour.
Direct Employment	The direct employment from the pilot is expected to be 30 jobs, all of which are expected to occur in Daventry. This, however, excludes the jobs associated with construction of the guideway, construction of the vehicles (which may not be in Daventry) and design consultants. The estimate of 30 jobs will include the operation and monitoring of the technology, cleaning and maintenance staff, operational and management staff, clerical and administration staff, marketing and promotional staff. During the full deployment of the network, this employment will increase significantly. The construction jobs will depend on the length of guideway to be built, while the manufacturing jobs will depend on the number of carriages proposed. If the initial desired figure of 300 vehicles is built, then there is currently no manufacturing base for this in the UK. The potential for these manufacturing jobs locating close to the pilot should be good. This could possibly bring over 100 jobs to the region. While further investigation is required, initial research indicates that the workforce recently employed by Peugeot at Ryton or Rover at Longbridge may have suitable skills and require only relatively straightforward retraining. This could see the jobs locate in the West Midlands if the former car factory premises are used or in the East Midlands if a suitable site can be found. Operational staff for a full deployment will also be significantly greater than the pilot and are expected to number just fewer than 100 jobs, with further opportunities in construction of guideway and associated facilities.
Indirect Employment	Indirect employment could be achieved in two ways, although as with direct employment, the gains from a full network roll out will be significantly greater than that of a pilot. Indirect employment will relate firstly to increase labour force participation. Second additional inward investment jobs which are linked to the area's increased reputation and enhanced "saleability" to mobile investors. Putting a figure on this is fraught with difficulty as inward investment decisions are made following an assessment of a wide range of factors such that one feature (PRT in this instance) is rarely responsible for attracting new investment alone. Equally, the number of jobs that could be attracted is an unknown as each investment will have its own characteristics and create various numbers of jobs. Third tourism

	sector jobs could also be created, but again it is difficult to estimate numbers because tourists visit a place due to a number of reasons. There could however, be a reasonable amount of PRT study tourism, which would help contribute to the number of tourism related jobs locally. We would suggest using a figure of 100 FTE as a proxy for the inward investment and tourism jobs created indirectly, due to the inability to estimate a figure with so many information gaps. Third the establishment of a PRT park could focus PRT related jobs into the region. If a cluster of PRT related manufacture, ICT, service, design and supply jobs could agglomerate locally at this park, a significant number of jobs could be created. The scale of investment and the number of jobs is as yet unknown – it will become clearer during the trial.
Training and Work for Marginalised & Disadvantaged	As mentioned above, the DDTS indicates that a whole-town PRT network will make it much more straightforward (faster) for people to travel from all residential areas to all employment areas and service locations. This will be of particular advantage to those unable to drive or access a car by reason of age, disability or income. The removal of need for interchange should also make PRT-based travel more viable for those with learning disabilities or simply nervous about travelling. Because PRT is effectively starting from a near blank canvas, there will be opportunities to create a wide range of jobs locally, should the suppliers wish to locate at the site of the pilot. This opens good opportunities for training locally marginalised and disadvantaged residents. This will require additional actions by the public sector locally to help prepare the workforce for the potential PRT jobs.
Productivity	PRT can help increase productivity levels through modernising the local supplier base, through helping staff make easier and quicker journeys to work and through establishing new modern, dynamic companies in the area. However, it is likely that productivity increases will mostly occur indirectly, through impacts which help modernise the regional economy rather than having a direct impact on local business performance. Nationally, the transport BCR figures imply in the DDTS imply that widespread use of PRT would offer significantly higher rates of return than many conventional transport investments, thereby increasing productivity in transport, which is a significant sector of the economy. The Pilot's role in catalysing this should be a significant contribution to national productivity in the medium to long term.
lifelong learning, skills and education	As a new technology which introduces a new range of work opportunities, there will be a need for increased education and training. This may or may not involve retraining former car plant workers, depending on whether the West Midlands are absorbed into the programme. In Northamptonshire, Danetre School and the University of Northampton are both well equipped to provide learning, education and training directly related to PRT.
SME benefits	Similarly, local SMEs will have the opportunity to tender for contracts, to train staff and to investigate the potential associated with PRT ahead of competitors located elsewhere. There will be contracts relating to manufacture, supplies, services and a wide range of skills. Initial discussions with suppliers of PRT technology indicate that there could be some 20-30 contracts let at the pilot stage and 50 – 100 for the various aspects of the full network roll out. Not all will go to local SMEs but a figure of 50 beneficiary SMEs for the full scheme would not appear

	unreasonable.
R&D benefits	There could be very significant R&D benefits locally, simply because this project is for a pilot or trial. There is still a good deal of research to be carried out, and there are clear reasons why local companies and the regional economy could benefit if this work is undertaken locally. The danger is that R&D initially locates close to the developers of the prototype systems, such that it is carried out in Bristol, Netherlands, Korea or Poland. This is where the idea of a PRT park may be positive, it may help ensure that R&D is carried out close to the pilot. A separate initiative may be required to help ensure that local research organisations and the University of Northampton can maximise the potential associated with R&D.
Urban Vibrancy	Daventry has previously been described as "a tired looking town". While this description may or may not be fair, and may not be welcome locally, PRT will offer a highly visible "wake up call" which will undoubtedly contribute to urban vibrancy. It will not only boost the town's image, aura and modern feel, it will help transport people into the leisure and recreation opportunities in the town centre helping to sustain the buzz and vibrancy where it has greatest potential. While measurement under this heading is not recommended, it is clear that PRT can play a major role in increasing urban vibrancy.
Business collaborations	If a PRT park is developed, then there may be strong potential for business collaborations. PRT will offer chances for both local and international business collaborations, although the scale and intensity of such collaborations is likely to become clear only as the pilot progresses.
Social activities	PRT will enhance the potential for residents of Daventry to undertake social activities because it will provide new, affordable transport to access the town centre and all other parts of the town. Because the destination is chosen by the passenger, it will be particularly useful for stimulating social links between residents of separate housing areas – journeys which would normally be taken by car.
company start ups and spin offs	PRT is new and untried technology. While there are already a number of companies active in different aspects of PRT, there are, for example, no large scale manufacturers of the vehicles, any specific maintenance companies and any tailored marketing or advertising specialism. But these companies will be needed and there is a clear opportunity for them to be generated in the region.
Links with other Daventry flagship projects	Daventry's other flagship projects are the town centre redevelopment and the proposed canal link. PRT will greatly enhance the ability for residents to access the town centre such that the link will be extremely positive. It has already been indicated that a PRT station can be accommodated in the town centre and will not have adverse effects. In addition, Daventry is a potential site for a sustainable housing exemplar (the Council is in early discussions with the BRE), is pursuing the potential of biomass and combined heat and power and a bid for the Environment iNET lead by the University of Northampton have received initial *emda* approval. This would include a base ("iHUB") in Daventry. These projects, together with each other and the PRT pilot will help position Daventry as a town known for excellence in environmental industries. As such, the town could well become a focus for inward investment in these sectors, benefiting both itself and the wider Region.

Design Criteria	One of the issues to be tested within the pilot will be design. This covers the external and internal design of the vehicles – which at prototype stage look futuristic[16], the design of the stations (which must accommodate disabled access and other practical design features as well as aesthetics), and the design of the track itself. The safety review suggests that many parts of the track may have to be fenced or otherwise segregated, ensuring this does not run counter to other general urban design principles will form an important part of the pilot trial.
Land recycling	The volume of brownfield land in and around Daventry is limited, such that opportunities for land recycling are limited. However, sections of PRT are planned to operate on wide roadside verges, effectively re-utilising land. It is these wide verges that help make a retrofit of PRT achievable in Daventry, and which means that the system will effectively use a good deal of underutilised land rather than being based solely on greenfield sites.
Supply Chain	Developing an effective local or regional supply chain is the key to generating regional scale economic benefits. It is imperative that the public sector grasp the opportunity presented by the trial to encourage local suppliers to provide skills, services and materials to both the pilot and the full network. Initial research by NEL suggest that locally there may be as many as 400 companies which could potentially provide some service or supply to PRT. This indicates that the public sector does appear to understand the importance of developing strong supply chain links, and also, that the potential for increasing the contracts awarded to local companies could be strong.
Inward Investment	Inward investment benefits could accrue in three different ways; First, directly, if the suppliers of PRT are appointed to run the pilot, then they could make direct investments – possibly small scale at the pilot stage, but larger scale at the full network stage. The scale and reality of such an investment will not be known until the procurement or tender process is under way. Second, indirectly, if PRT can help modernise the Daventry image and reputation, then it may help attract more inward investment. Although this may sound vague at this stage, it is a realistic proposition given WNDC's remit to attract new business and jobs to the area. As previously noted, inward investment decisions are based on many different characteristics, but PRT can be used as a demonstration of the area's forward thinking dynamic potential. Third, also indirectly, PRT can be used as a symbol for the region, with photos of PRT vehicles used in promotional literature used to help attract investment. At one stage further, potential investors could possible have their own PRT station (there appears to be no obvious reason why a station couldn't be located within a building, providing a unique sales point not found in any competitor locations within the country.)
Private sector leverage	The amount of private sector finance levered by this project will be known at the tender stage. It is expected that the system will be procured through a combination of public and private sector funds, while the suppliers of the PRT technology will accept that they have to make an investment and contribute to costs themselves in order to promote their

[16] Of the systems considered, most are supported on guideways while two are suspended from beams. All have a design that most observers would consider to be modern.

	technology. The competition between PRT system suppliers which already appears to be developing should be helpful in this respect.
Health Effects	Health effects could be positive especially if it helps remove people from private cars to public transport. Health benefits in general will be the same as other forms of public transport, although the backers of PRT will argue that the lack of exhaust fumes associated with older buses will provide a general health benefit for residents.

10. Procurement Review and Recommendations

10.1 Introduction

The procurement process for Daventry PRT is critical to the successful outcome of the project, the project is certainly unique in the UK environment and almost unparalleled worldwide. Whilst other PRT projects, such as Heathrow, are being developed, the scale of the Daventry application and the objectives are significantly different. For example, the Heathrow system will not charge fares and is provided to transport passengers from a few origins to one main destination although, in the longer term, BAA intends to operate many-to-many PRT operation across Heathrow. In the case of Daventry the objectives are markedly different and can be summarised as:

- providing an alternative and acceptable means of transport to the private car;
- providing a transport system that is fully inclusive socially;
- engender a culture of lasting modal shift to reduce the impact on the environment;
- raising the awareness of Daventry as a stimulus to attracting investment, business and people;
- stimulating the market for transport solutions that offers significant environmental advantages and productivity gains.

Daventry is pioneering in its approach to deliver personalised transport in a sustainable manner, to meet environmental objectives and to achieve wider economic benefits. However, the downside of Daventry's commendable commitment to innovation, is that the project will inevitably carry higher than normal levels of risk. Because PRT has not yet developed a track record, key aspects of risk have not yet been established. A risk assessment should be carried out and a "Risk Register" prepared, starting with the work reported here. This will assess the sources of financial and technical risks, the probability of occurrences, the potential impact or leverage on the costs and outcomes of the project, and potential solutions or minimisation actions.

In view of these risks, alternative procurement strategies must be carefully assessed. It is important that risks are shared between the promoters of the system and the public sector. It is also important to determine who is best placed to manage the risks. This is crucial to the form of procurement because it is most likely that those who will bear most risk will only do so if the potential rewards for a successful project are high. Also local authorities and public funded bodies may not be allowed to accept undue risk which, if the worst case scenario happens, could leave these bodies in financial difficulties which might jeopardise the system.

10.1.1 Construction Risk

The first risk is associated with the capital cost and timescale of construction. While some of the construction technology appears relatively straightforward, there will be unknowns which will affect total construction cost if they are not adequately assessed at the outset. No other town in the UK has built a PRT system or even a pilot, so this is several orders of magnitude different from a light rail system where, even where the technology is well known, costs have nonetheless usually escalated (see for example the National Audit Office report on UK light rail schemes, 2004).

There is not at present a range of experienced suppliers of infrastructure or vehicles to choose from, as would be the case with light rail. The absence of experienced builders and of market competition is likely to put upward pressure on capital costs. Also, unlike light rail, the contracting industry does not have the experience of bolting all the technology together and making it work. This may also add to costs and probably rules out procurement methods in which a contractor will take on design and build responsibility, at least without a large reward and some risk sharing with the promoters. The upside of this, however, is that it offers an opportunity for Daventry/ Northamptonshire/East Midlands to develop as the Centre of Expertise if local companies can take the risk and get the pilot or demonstration model to work. Companies within the region could then be well placed to help develop future PRT schemes elsewhere. If this were to happen there could be local economic benefits as well as financial gains for the companies with the vision or commitment to invest in the new technology now.

The company promoting the technology has to find a way of bearing some, and possibly most, of the capital cost risks. This may require some form of mainly equity vehicle to do so. This may work best for a pilot scheme if the equity holders take most of the (more limited) capital risks and are guaranteed returns if certain pre-set performance criteria are met. For example, availability payments for the PRT infrastructure.

10.1.2 Operating Cost and Revenue Risk

The second risk is associated with the costs of operating and maintaining the system, which are partly related to passenger use and also those of maintenance. Because the technology is new, there is no experience to provide confidence on operating costs. Maintenance patterns will have been established only in testing, and not in a “real world” situation. However, before the Daventry pilot is finally committed, the BAA system at Heathrow is planned to be carrying passengers by late 2008 and this should give additional confidence, albeit in connection with one particular system (ULTra) only. Similarly, the Vectus test track in Sweden began operating in 2007; this should provide further comparative data.

The third risk is revenue. Revenue forecasts provided in DDTS and updated here are subject to wider than normal ranges of uncertainty. Revenue risks depend on: a) whether Daventry will develop in accordance with development plans – DDC and WNDC can influence this, but the promoters of the technology cannot; b) whether people will transfer from cars – NCC/DDC can affect this if they have powers to set parking charges and introduce traffic management measures but DDC and NCC have a range of interests to consider; c) whether people will transfer from buses. If bus operators decide to compete with PRT, the PRT patronage and revenues could be severely affected. This is unlikely at present because few Daventry local bus services are commercial, but could become an issue as the town grows. It is unlikely that this risk can be mitigated without a QBC for the area served by PRT. However, the likelihood of additional bus operations being established during the timescale of the pilot is judged to be low.

Buses are not a commercial proposition in Daventry and are unlikely to compete with PRT, this could change as the town expands and Bus/PRT competition is conceivable, but it seems highly unlikely that bus services would abstract many passengers from PRT. Currently DDC pays £83,000 pa to subsidise bus services in the town, most of which is Section 106 funding for bus services linking Middlemore and the town centre. This could, in theory, be diverted to support the PRT Pilot.

Investment in toll roads provides a good illustration of the revenue risks associated with transport infrastructure investment. Standard & Poor's (Ref.1) suggests that the greatest risk in investment for tolled roads is predicted traffic volumes over the concession period and hence the estimated revenue streams. Many toll road concessions are successful, but it can be argued that they are based mainly on good forecasts of traffic flow, which in turn allows accurate forecasting of revenue, thereby reducing the risk of failure. At this stage, patronage risk on PRT is high which suggests that the scheme would be regarded as high risk overall.

There are other factors to consider here, in particular how the market might respond to any safety incident or poor publicity. There could be incidents to do with innovative technology, which may lead to poor public perception or market nervousness.

For all these reasons, the procurement process needs to establish at the outset who is best positioned to absorb the different types of risk, and who is most likely to benefit from a successful project.

10.2 The Balance of Private and Public Service Interests

It is reasonable to assume that DDC and its public sector partners need to divide up the risks and find others to bear some of these. It is very likely, however, that the public sector will have to carry risk, probably the major proportion.

There is a recent history of private sector investment in transport schemes in the UK. However, in most cases, the technology has had some track record and the private sector has still looked for various forms of underwriting of risk depending on the scheme. The principles are well known: the private sector will finance the capital costs and operate a scheme in exchange for a risk-adjusted return for this investment. Forecast revenue will be a key factor. An interesting example in the

Channel Tunnel Rail Link (now High Speed 1) in which, after early difficulties, a series of risks – both capital and revenue – were placed under commercial insurance arrangements.

Private sector companies evaluate the returns on that investment and the period over which it will be earned, but they also look carefully at their exposure to risks at all stages of the process, and they negotiate deals which seek to get the public sector to take on as much risk as possible. Frequently there are very few private sector takers for transport projects which leaves the public sector is in a weak position to transfer risk.

Returns on investment do not have to mean exclusively 'money or profit'; benefit could also accrue from access to and future sharing of Intellectual Property Rights (IPR); this can be important where a project is innovative, and where the private sector partner believes there will be future opportunities to exploit. There may also be kudos or market advantages from an innovative project or through being a market leader. However, caution is advised – both the Channel Tunnel and the Dome were market leaders and innovative; but both had spiralling capital costs that make it difficult to achieve the anticipated returns.

Private sector partners may well be cautious, as the risks are inevitably greater and less easy to predict or control than for established technology.

It is also the case that, for PRT, there is no experience of competition for the supply of the technology and a lack of contractor experience of putting it all together (especially within time constraints) and making it all work. Capital costs have far exceeded initial expectations in almost every recent public transport project in England. The pilot scheme is, however, intended as an opportunity to assess risk and provide solutions and this should increase confidence for subsequent stages.

10.3 Risk Minimisation

The public sector can, in theory, influence the patronage of PRT. The two clear ways that it can do this are to ensure that the predicted growth in Daventry does go ahead (i.e., the population actually does increase to over 40,000 and the associated job opportunities are brought to Daventry and especially to locations served by PRT, rather than remaining outside the town). Given the intense developer interest in Daventry – planning applications for over 9,000 houses have already been submitted, more than required to achieve the 40,000 population target for 2021 – the population growth does not appear problematic. They can also introduce carrot and stick measures to discourage private car use and influence the wish to travel by PRT. The political and practical difficulties of doing this are likely to be significant in a relatively uncongested small town, although clearly there are also practical and financial difficulties in sustaining a policy of providing sufficient and free parking, which seem to be affecting the Council's planning so that, for example, park and ride (potentially using PRT) is a possibility the Council may explore.

Before entering any form of risk share, any potential private (or public) sector partner will expect the relevant public authorities to provide appropriate support. DDC could impose town centre parking charges and, therefore, help modal shift from car to PRT. These risks may require a risk sharing arrangement in the contract.

10.4 Grant Agency Requirements

Each public sector agency will also have its own requirements. It is likely that *emda*/NEL would be asked to fund this project and would only do so if they could see economic benefits accruing to the region. For example, they may wish to see evidence that local companies could support the pilot and be in a position to supply and service other PRT roll outs. This issue is addressed in the economic aspects of the appraisal. The potential for any support from the West Midlands would be dependent on a joint West Midlands – East Midlands initiative, in line with the requirements of the Midlands Way Action Plan. NCC, conversely, may be encouraged to become involved only if it sees transport and direct user benefits for Daventry or more widely for Northamptonshire.

There may be some potential for European Regional Development Fund (ERDF) grant. The East Midlands has a new programme which started in 2007 and the guidance is provided by the East Midlands 2007 – 13 ERDF Competitiveness Operational Programme (Consultative Draft issued December 2006 with Brussels approval expected shortly). In comparison with previous European structural fund programmes, the 2007-13 programme has less significant funds available - £268.5m at 2006 prices – which work out at £36m - £40m per year for the whole East Midlands Region. Unlike previous programmes, which have made ERDF available only in certain eligible wards, this programme will consider applications from any location. However, Daventry will not be a priority location in terms of unemployment and social deprivation. Summary measures of the Index of Multiple Deprivation 2004 rank Daventry District the 8th least deprived district in the Region with neighbouring South Northamptonshire the least deprived. Therefore, Daventry will have to present a stronger case when applying for ERDF than more deprived districts.

The Operational Programme will encourage support for innovation, and the development of an innovative new technology in the region would initially appear to offer opportunities for successful ERDF applications. However, the programme appears to offer less support for transport proposals; in line with many other Operational programmes across the UK, the ability or encouragement to part fund transport projects has declined. Therefore, an argument which persuades the programme that this is an economic development project, based on innovative technology, would have to be made if there is any prospect of securing ERDF grant for the pilot.

This means that the procurement process will require an extensive planning stage. It may be that, in effect, the public sector support is gained through demonstrating a wide range of benefits to suit each partner's specific demands, while the private sector involvement is related to the success of WNDC in attracting new industry and business to Daventry. If the jobs attracted fall below the target figure, then any private investor may expect some form of compensation for reduced revenue potential. This indicates an added complication, but one where there are some precedents, such as the pioneering stages of the Docklands Light Railway.

10.5 Basic Procurement models

The number of potential suppliers of PRT is limited. There will have to be a fair and transparent competition between possible suppliers, one which meets grant funding requirements if appropriate and does not contravene State Aids restrictions.

It is uncertain whether any of these suppliers would also wish to be responsible for the construction and operation of the system; if not, a contractor will be required and that contractor might also be a potential operator of the system.

The Design, Build, Finance and Operate (DBFO) model attempts to transfer much of the risk away from the Sponsor (Public Sector). However, private sector players generally seek some form of guarantees or underwriting of revenue risks, which they are not well placed to manage. In contrast, separate Design, Construct and Operate models, either in partnership or managed by the public sector, retain public sector risk. Clearly there are variations to these approaches, but the key is balancing and managing the risk and reward.

Daventry PRT could be procured under one design , build and operate contract or in two stages: firstly, provision of infrastructure and cars, secondly: provision of service (operations and maintenance). Both approaches have been used on light and heavy rail schemes.

10.6 Separating Infrastructure and Operations

For infrastructure procurement useful guidance was published in 2004 by the Public Private Partnership Programme (4ps), in collaboration with the Institution of Highways & Transportation and a selection of local authorities: ‘A Guide to Procuring Local Authority Transport Schemes and Services’ (Ref.2). This document mainly applied to projects and the provision of associated infrastructure and identified a number of procurement models as summarised in Table 50.

- **Table 50 Infrastructure Procurement Model Summary**

Procurement Model	Comment
In-house provision	It is very unlikely that Daventry would possess sufficient in-house resource, or be willing to risk a huge commitment to one project.
Service Outsourcing	Contract provision of infrastructure maintenance is not appropriate for infrastructure procurement.
Traditional Procurement	Requires significant in-house resource and retains risk. Again it is unlikely that Daventry could absorb this risk alone.

Procurement Model	Comment
Partnering Contracts	Some merit and sharing of risk
PFI or DBFO	Some merit and sharing of risk, but the uncertainty about patronage and new technology may not be attractive to the private sector
Concession or Franchise	Some merit and sharing of risk, although Daventry would retain risk associated with construction but allows private sector to utilise expertise to enhance the service

Operations and maintenance procurement options are summarised in 'Achieving Efficient Delivery of Local Highways Services' (Ref.3) that identifies a number of procurement options. The options listed in Table 51 are specific to the procurement of highway services, but they do highlight the different approaches that could be considered.

- **Table 51 Operation and Maintenance Procurement Model Summary**

Procurement Model	Comment
In-house provision	Daventry does not possess sufficient in-house resource
In-house plus ad-hoc support	Daventry does not possess sufficient in-house resource
Public Sector Consortium	Other public sector bodies would only wish to support this if they were confident that they would receive additional non-transport benefits. This would require the development of a strong regional development / inward investment case.
Joint Venture with Public Sector	Some merit and sharing of risk: This may require the development of a special purpose vehicle for the pilot
Total service with Single Provider	Some merit and sharing of risk, but may suffer from a weak element of the project: may also require guarantees from the public sector
Total service with Construct, Operate and Maintenance Providers	Some merit and sharing of risk and allows 'best in class' to be selected for each service

These two tables illustrate that the procurement options for transport projects and service delivery are slightly different. This difference relates to the level of investment at the different stages of the project and also the changing level and type of risk during the project stages.

As long as the structure of the guideway can be specified clearly it can be separated from the mechanical and electrical components. The latter are highly likely to be proprietary. The former may be procured from a range of possible designers/contractors. Splitting in this way is likely to maximise the competition in procurement. Operations and maintenance can be separately procured and could be made attractive to specialist operations providers. This has the merit that performance clauses can more readily be included in the contract and, if performance is unsatisfactory, the contract can be re-let.

10.7 Recent Practice in the Procurement of Public Transport Schemes

There is no precedent for PRT procurement in UK but there are useful precedents for procurement in some recent rail projects. The Docklands Light Railway (DLR) has constructed four extensions and is constructing two more and planning at least one other. This is the most extensive planning effort of UK rail networks and offers some useful lessons. DLR Ltd is one of several trading company subsidiaries of Transport Trading Ltd (TTL) which is itself a subsidiary of Transport for London (TfL). Other trading companies include London Underground Ltd and London Buses Ltd. These companies handle service provision and revenue collection. TTL is a private limited company and has an important role in tax handling and tax liability minimisation for TfL. Tax and insurance (and safety) liabilities remain with the trading companies rather than with TfL.

For most, and all the larger, capital schemes undertaken by TfL, the Greater London Authority provides the capital grant. TfL then approves all major schemes and allocates the grants. DLR extensions have been implemented under two main models: Lewisham for which the concessionaire, CGL took some revenue risk under a Design, Build, Finance and Maintain (DBFM) contract which involves a payment by DLR Ltd to CGL for passengers on the extension above a threshold and general availability payments to provide the main revenue stream. The extensions to Beckton, City Airport, Woolwich and the Stratford International extension now being planned are Design, Build Maintain and Transfer (DBMT) schemes in which the contractors provide the infrastructure in exchange mainly for availability payments over the contract period at the end of which the schemes are transferred to DLR.

So far the only English Shire County that has procured a rapid transit scheme is Nottinghamshire which procured Nottingham Express Transit (NET), the new tram/LRT system serving Nottingham, which opened in March 2004. Phase one is running successfully and two further lines are to be procured as phase two. The joint promoters are Nottinghamshire CC and Nottingham City Council. They are developing the preliminary design to a level suitable for consultation, TWA application and for a procurement competition. A market testing exercise will be carried out to seek views of potential bidders. Phase two could involve the combined line one operation/phase two implementation package. This approach is possible because of the widely understood design standards for LRT and the established supply industry.

10.8 Procuring PRT

The procurement of the pilot is likely to be without commitment to proceed to a full network. This would logically follow when operations are proved and benefits apparent. Potential contractors may take the view that winning the pilot conveys advantages, principally:

- knowledge of the risks of PRT roll-out;
- development of a supply chain capable of delivery;
- fundamental knowledge to enable a robust price to be tendered;
- a part funded 'learning experience' of PRT.

The public sector may need to take a larger share of risk at the pilot stage because of the indivisible costs it involves (control system, depot etc) and the limited benefits associated with the small network. This share may be reduced in subsequent stages.

A decision is needed about whether procurement of the full system should be in stages under one contract or procured in separate contracts. The former has the advantage that the successful pilot stage bidder deploys its knowledge in subsequent stages but it has the disadvantage that there would be no competition for later stages. However, procuring PRT inevitably involves a commitment to one system design and one supplier - this may preclude the use of separate contracts for each stage. It is also likely to reduce the risks to the supplier and ties the public sector client to the technology. This seems impossible to avoid with the present state of PRT development.

EU procurement rules require open competition for projects of this size. It would be appropriate to hold a competition for a supplier of the Pilot with possible extensions. It would not be realistic to hold a second competition for extensions because of the technology problem. Although some or all of the infrastructure and, possibly, the cars could be subject to competitive tender. (Under the EU rules, such a situation would constitute a public works/services concession contract, under which there is expectation that the concession holder will tender major items of work e.g. construction.)

There is a complication related to the fact that there are several different organisations represented under the heading "public sector". At the local level, DDC may be seen as the main beneficiary but, for budgetary reasons, may expect *emda*, as Regional Development Agency, to contribute financially to capital costs. NCC is the main transport authority for the area and their support is also important.

emda support projects locally through NEL, and are aware of the limited budgets available to NEL, but *emda* funds projects of regional significance directly. *emda* may, of course, wish to see additional public sector involvement, through UK Central Government or perhaps the EU. This could supplement the *emda*/NEL contribution, but also a UK Government contribution may provide *emda* with the confidence required to support untried technology. Therefore, it would be helpful to obtain Central Government commitment (for example through providing grant funding through the Transport Innovation Fund or other source). In this way, the "public sector" contribution (financial and political support) would come from the District, County, Regional and National levels.

The private sector also splits in terms of potential beneficiary. The private contribution could be split between the PRT provider, who would benefit substantially if the success of the pilot led to roll outs of PRT in other UK towns, and private sector developers/investors who sees PRT as an opportunity. At Heathrow Airport, BAA has acquired an equity stake in ATS, who will deliver ULTra's PRT system at T5. ATS benefit through public exposure to their system (Daventry may consider ULTra as one of the few systems clearly available). BAA benefit as it helps meet their airport operational requirements and they would share in returns from other ULTra installations. The appetite of potential system providers for taking some of the risks of the pilot in exchange for the experience and, therefore, potential returns from systems in other towns needs to be explored.

Any grant assistance will probably come from competitive sources and there is no guarantee of success in obtaining grant. It is also likely that grant will defray capital cost. Revenue grants are much more difficult to obtain because most funds will not support "open ended" commitments.

The pilot and subsequent full network will have to be procured through an approach which fits the limited in-house resource, and the need to avoid exposure to excessive risks for the Councils. It must also be accepted that there are very few private companies with the operating knowledge, ability and experience to operate a PRT system. This makes it difficult to follow a "normal DBFO" procedure. A stand alone company, supported by the public sector locally could be set up and, in theory, reduce the risk exposure to any one public body. Given the right legal basis and powers to trade, the body should also be able to apply for grant assistance towards capital costs.

The procurement strategy needs to be based on a thorough understanding of the risks of the project. For PRT these may be considered in three categories.

- Technology – how unknown / leading edge is it in reality; is there any useful evidence from successful or even unsuccessful trials elsewhere?
- Interfaces - the various players in a consortium need to be incentivised to solve problems under a contract that also places some fundamental risks with the council or special purpose company.
- Demand: this is critical. A clear and robust forecast of revenue is needed which will stand scrutiny. The key problem here is lack of precedent and the need to anticipate behavioural reactions to a new transport mode. Without this, it will be very hard to get the private sector to take on much of the revenue risk. Existing travel data give little indication of the scale of revenue and existing forecasts carry much uncertainty.

Depending on the answer to these questions, there may be some potential players willing to pull a consortium together under some sort of risk sharing framework. Some bidders for trams combine engineering and project management capability with operational expertise and these could be interested, at least in a low risk (to them) pilot venture that could become a full scheme later on. Others like to take on cutting edge technology but again they will not be willing to take on substantive risk. Transport and Works Act powers should be sought. Until these are obtained all parties face a major planning risk that implementation may be blocked. Therefore, until TWA powers are obtained, private section interest is likely to be limited and procurement cannot be completed.

The costs of obtaining powers can be significant in terms of staff time and fees and are usually borne by the public sector promoting schemes unless a particularly attractive revenue stream is expected. Typical minimum elapsed time for obtaining powers is 2 years. The key requirement is to specify the alignment correctly, taking account of system characteristics. For LRT schemes, powers can be pursued without a preferred bidder, providing that the system design is understood but, even with LRT, this has not always worked. For PRT it makes sense to lock in the technology in time to make sure that TWA powers are properly based but to avoid a full commitment to build until the powers are obtained.

The scope and programme for TWA powers varies widely. The Commission for Integrated Transport reports that the time from TWA application to Secretary of State Decision can be anything between 12 and 53 months depending on how contentious the scheme is and the need for public inquiry. If an inquiry is held there can then be a significant delay while the inspector's report is prepared. An average of about 2 years from application to decision is apparent. The key steps in the process are as follows:

1) Forecasts and appraisal (present position)
2) Prepare Environmental statement
3) Order Application (week 0)
4) Public notice period for objections (week1-6)
5) Notice of inquiry/hearing/written representations(week10-32)
6) Statement of Case (week 16)
7) Inquiry (if necessary) (week32+)
8) Prepare inspector's report.

This does not show all the actions. There will need to be a final business case which would require a careful refinement of revenue forecast and of costs, although this need not be on the critical path.

Traffic regulation orders might also be needed where highways are affected and these involve due procedure. Further information on TWA powers is contained in Appendix A.

Although there has been no previous procurement of PRT in the UK, there is still a benefit in reviewing some previous transport investments and attempting to learn lessons form their procurement processes. Docklands Light Railway (implemented), Edinburgh Tram (procurement process under way) and Merseytram (stalled), raised the following points and may be of relevance.

- It is important to identify the critical stages within the process and to strengthen staff resources at that critical time both within the SPV/operational Company and the Council.
- Previous projects required full Council approval to proceed with the procurement on the basis of estimated costs as presented at the early design stage. The process should allow for a negotiation stage should initial estimates and later estimates differ greatly.
- In Edinburgh, the Council approved the tram project on the basis of a Draft Final Business Case. This was seen as sufficient to instruct and finance the diversion of utilities. Approval of the Final Business Case is expected approximately one year later following negotiation with Tramco and Infraco. Operations are expected to commence some four years after the Final Business Case. The Council approved the utility diversions subject to the tender evaluations for Tramco and Infraco confirming the affordability of an appropriately phased tram network.
- The SPV should maintain a register of all identified risks and produce an active management and mitigation plan for each risk. In addition to the uncertainty associated with the new technology and demand forecasts, key areas of risk may include: utility diversions – management is needed between utility diversions and follow on works by the Infrastructure provider to minimise delay, changes to scope or specification – this requires effective management of the consideration of changes through strong Governance processes, obtaining Consents and approvals. It is expected that the Council and SPV would work jointly to speed the consents process, although allowances should be built in for public inquiries.

10.9 Conclusions

The detailed procurement strategy will depend on the understanding of risks. Although these are known in general terms at this stage, they need to be understood in depth for the candidate systems. Revenue risk is likely to be an important consideration.

For procurement of the PRT system a single contract covering the Pilot and the subsequent possible extensions seems likely to be the only workable approach. This should cover guideway and systems but probably not operations. An attractive approach is to contract for the provision of a PRT system against a technical performance specification and allow the PRT provider to procure the guideway from civil/structural engineering contractors as appropriate. Technical risk in achieving reliable, safe operation would remain with the contractor not the public sector.

Cost and risk sharing for other aspects of PRT should be realistic. The private sector are unlikely to bear a high proportion of the risk related to Daventry growth, land acquisition, transport policy or bus competition, particularly for the pilot PRT installation.

A separate O&M contract is recommended with performance clauses, renewable on the basis of good performance but open to competition periodically. This could be let by DDC, the SPV or the PRT prime contractor.

Daventry DC needs to coordinate the public sector approach to procurement involving NCC, NEL and other agencies as appropriate. A range of public sector funds could be relevant and needs coordinating.

A procurement company is probably needed (SPV) to be the contracting agency to appoint contractor/s. This will be a trading company probably formed under the Local Government Acts 2000 and 2003 for which there is a number of precedents.

As Daventry grows, there will be a need to coordinate bus service support with NCC either to support PRT or to achieve radically upgraded bus provision. This will need to include careful consideration of possible competition if commercial operation becomes more likely. Even though buses are unlikely to compete with PRT a properly prepared policy for this aspect will be needed and will be scrutinised by DfT.

EU Procurement rules require open competition and cannot, therefore, be used to procure an extension to the pilot without accepting a change in PRT technology or being open to challenge by disappointed bidders. Consequently the single contract approach appears best.

Procurement cannot be concluded before construction powers have been secured. A TWA order could take a minimum of two years. Until powers are obtained project risks remain high and negotiations are likely to be limited in scope. However, the SPV and contractor, if appointed early, can assist in the process.

Procurement will need to follow the securing of powers and will also take time. This would be reduced if a preferred bidder/partner can be identified beforehand. However, it is difficult to envisage the start of works before powers are secured. The elapsed time for construction and procurement of operations contracts will depend on the detailed nature of the works e.g. diversion of utilities and on refinement of the design which may be driven by the business case. A general approach similar to that followed by BAA for the T5 system offers advantages. The preferred PRT Intellectual Property (IP) holder would be brought in as the preferred bidder at an early stage. (BAA has not sought TWA Powers as they own most of the land for PRT construction, there are no nearby residences and have negotiated use of a small piece of land they do not own).

EU procurement for public authorities takes place under the Utilities contracts Regulations, 2006 or the Public Contracts Regulations, 2006. These differ in the minimum contract value to which they apply and in other respects related to the procurement task each performs. They can be used for direct and indirect procurement. An example of the former would be DDC procuring PRT Infrastructure directly by inviting bids to undertake works with DDC as the direct client. Indirect procurement involves the letting of a competition for a concession to provide the scheme, which would permit further procurement by the concession winner. Indirect procurement might also involve an agency set up by DDC to undertake procurement.

An example of DBFM procurement is the DLR Woolwich Extension. This is being built by a concessionaire on a 30 year contract. Four consortia bid for a concession following an OJEU notice using the standard procedure: call for expressions of interest>assess the qualifications of those expressing interest>ITT process. The concession proposals were assessed on the basis *inter alia* of the NPV of construction cost and concession payments stream. No payments to the concessionaire are made until the extension is available, which is an incentive to complete rapidly, and payments are then made only when a Service Performance Demonstration (i.e. an operations test) is successfully made. Appropriate performance mechanisms and break clauses apply.

DLR extensions to not involve untested technology but the principles are relevant to PRT procurement on the basis of a functional specification with reliable and safe operations demonstrated before payments are made.

There is now provision for a competitive dialogue procedure where open or other procedures are considered inappropriate. This allows a dialogue before final tendering.

The general sequence of PRT procurement could be as follows; however, there are many detailed possibilities:

- EU competition to select system provider/IP holder;
- System provider enters into contract with Council/SPV. May also have ownership relationship with SPV (i.e. system provider buys £X million of SPV shares, with public authority grant funders, Council, etc. holding the rest);
- Council or SPV obtains TWA order for system but with inputs from the system IP holder;
- Council/SPV seeks:
  - contractor for infrastructure provision;
  - system O&M franchise.
- If the pilot is successful, future stages are subject to the same arrangements, except that the IP holder is already in the relationship and retains its position throughout.

11. DRAFT *emda* Grant Application

Appendix G provides an outline of how an application for grant funding to *emda*/NEL may look. It is, however, too early in the process to actually submit an application. At this stage, the purpose of the draft application included here is to indicate whether the criteria that *emda* require in an application can be met or not, what information is still outstanding, and whether a positive, encouraging case can actually be prepared to support a grant application.

In our opinion, the application at this stage appears relatively strong. There are still some gaps that can only be filled once some of the tentative issues are clarified in stage 3, but the main thrust of the application is relatively clear. It shows that the PRT pilot presents a project that can be justified and supported in economic development terms, and will provide sufficient outputs and outcomes to justify the level of funding applied for. The application appears to be strong in principle, although is perhaps supported by evidence which is overly dependent on conjecture and short on hard data. However, this is only to be expected for an application which relates to such new technology.

12. Conclusions and Recommendations

12.1 Introduction

Three questions were addressed in this study:

1) What is the best alternative to PRT?
2) Where should a pilot scheme be introduced?
3) Is PRT to be preferred to the best alternative?

These questions, taking into account the broader technical, economic and other issues, form the framework for our conclusions.

PRT Systems

The work required the definition of PRT and other preparatory work on which the feasibility of PRT operations and costings in the appraisal were based. We concluded that:

- PRT is a concept that has been around for nearly 40 years and development of practicable systems for public service has been slow and difficult but recent progress is encouraging and public service is imminent;
- Some five PRT systems are at a sufficiently advanced stage of development to be candidates for Daventry (Vectus PRT, Taxi2000-Skycab, Minirail, ATS ULTra, 2getthere-Cybercab); ULTra is being installed at Heathrow Airport Terminal 5 and is due to open in 2008/9;
- a railway-based safety regime is likely to apply and, under present arrangements, the HM Railway Inspectorate are likely to be responsible for safety and operating approvals;
- there is a range of safety issues identified under a HAZOP 1 assessment but most of these have been successfully addressed on Automated People Mover systems, however, there is no substitute for demonstrating solutions in public service;
- the capacity of PRT systems is likely to be less than often claimed but capacity is likely to be sufficient for Daventry;
- PRT would need to be fully segregated with partial or continuous walkway provision.

What is the best alternative to PRT?

Nine different public transport systems were considered as options for Daventry including PRT. Six of these were assessed using a multi-criteria appraisal framework against a base defined by the existing bus network. These criteria were objectives-led. This showed that PRT would best meet the criteria and that a radically upgraded bus system would be the best alternative. This High Quality Bus Scheme (HQB) would only be comparable if it provided low waiting times and highly reliable journey times – a step change in bus provision rarely achieved.

Where should a pilot scheme be introduced?

The pilot PRT scheme should serve an existing developed area, it should avoid property demolitions, it should be of minimum scale needed to demonstrate all key service features, cost should be limited and it should have reasonable potential demand. We concluded that the pilot scheme should be in the area of North Daventry already identified in the DDTS. For the purposes of feasibility and costing a generic PRT system with rubber tyred cars running on top of guideways was assumed.

The scheme would comprise double track starting at a station in the town centre running north along the former railway alignment. The northbound guideway would follow the DDTS suggested routeing serving stations approximately at DDTS locations 8 (Shackleton Drive) and 7 (Highlands Road). It would continue beside Drayton Way to the Sedgemoor Way roundabout where there would be a station and it would turn east along Northern Way to reach DDTS station 6 (Welton Lane) whence it would run south beside Northern Way to the town centre. It would operate as a one-way clockwise loop with a connection allowing cars to run directly from station 6 to 8. The depot site would be on the northern edge of Heartlands Industrial Estate beside the former railway alignment reached by a connection from Drayton Way. This pilot route was costed at about £14m for 4,881m of guideway and is assumed to be served by a fleet of 25 cars (it should be noted that this is higher per m than for a larger system; see below). It would serve four stations. O&M costs are forecast to be £1.7m/yr

An HQB pilot scheme was defined to serve the same area which provides the basis of comparison with PRT against a common base. HQB would provide four minute headways all day and a night service. It would use dedicated vehicles housed in a new depot. Bus priority and other reliability safeguards would be provided. The capital cost were assessed at £5.5m; O&M costs are forecast to be £1.4m/yr.

Is PRT to be preferred to the alternative?

The transport economic evaluation, including optimism bias and using DDTS high and low demand, indicate benefit/cost ratios (BCRs) for PRT of 1.9 to 2.9 depending on the level of demand and therefore revenue. High Quality Bus has a BCR of 1.7. Therefore, on DDTS forecasts, the PRT pilot performs better than High Quality Bus.

High Quality Bus is more affordable but costs much more than a conventional bus scheme to achieve a service quality to rival PRT. PRT costs will be disproportionately high for a pilot system because of indivisible depot and system costs.

PRT offers better user journey time savings largely due to the very low forecast waiting times for passengers and in-vehicle journey times comparable with car. The present value of PRT user benefits are estimated at £92m compared with the £61m estimated for HQB. Other significant benefits offered by PRT are accident savings as a result of mode switch from the private car. For PRT, greenhouse gas savings from reduced highway traffic are estimated at twice that of HQB. The present value of incremental revenue for PRT compared with HQB is estimated at £2.5m over the appraisal period.

The economic development appraisal confirmed many potential economic benefits for PRT, although hard to quantify at this stage. These include:

- increased competitiveness for Daventry;
- attracting investment and visitors;
- direct and indirect employment effects;
- access benefits;
- the possible creation of a "Transport Technologies Park".

The realisation of these benefits partly depends on who drives/implements the project. Social inclusion benefits from better access to employment and activities are likely for a larger PRT network but probably not for the pilot. It is hard to argue that these benefits would arise for HQB. We can, therefore, conclude that PRT offers major potential benefit and can, in principal, offer a more attractive alternative to car use than HQB.

12.2 Risks

- Main construction risks appear manageable although there is a lack of experienced suppliers.
- HAZOP/operations safety risks were assessed using rail industry approach and appear manageable.
- Preliminary discussions with HMRI confirm that RSPG parts 1 and 2G will apply but that no fundamental concerns exist.
- The main technical risk is whether the system can be made to operate reliably in the timescale planned. This could have important impacts for public relations, the timing of revenue streams and the scale of O&M costs. A key risk is whether the control system can cope with demand fluctuations. It will be an advantage not to be the first system implemented – the ULTra installation at Heathrow Terminal 5 is due to open in 2009 and this will provide much valuable experience.
- There are significant revenue risks associated with the demand forecasts, bus competition and transport policy. These can be minimised by ensuring planned growth of Daventry occurs as programmed, by adopting policies to discourage car use and by review and improvement of the forecasts.
- Key operating risks concern emergency evacuation and malicious action which will need to be carefully considered in system specification and assessed in operating trials.

- Planning and environmental risks (visual intrusion concerns) can be significant and imply the need for legal powers.

12.3 Procurement

Procurement strategy must be based on a thorough understanding of risks. The possible contractual options are complex. We conclude that:

- Transport and Works Act powers should be obtained;
- a single contract for the pilot with an optional extension for the full system is probably the only workable approach, particularly under EU procurement rules;
- a separate O&M contract/concession has advantages;
- DBFM models with a suitable concession period also offer advantages.

The implementation of PRT will involve several major tasks, principally these are:

- determine procurement model;
- procurement (to EU requirements);
- prepare full business case including detailed revenue forecasts;
- full *emda* grant application, negotiate for transport grant with NCC and DfT and European sources;
- prepare TWA order application;
- Environmental Assessment;
- land ownership registration and valuation;
- prepare detailed costings;
- compile a Risk Register/assessment.

The procurement strategy should encourage private sector investment, on intellectual property and/or development grounds.

12.4 Funding

Capital grant will be needed. PRT plans are broadly consistent with *emda* /NEL grant criteria and a draft *emda* application is included in an Appendix. PRT development is in line with a wide range of national, regional and sub-regional economic and planning policies.

There may be ERDF or other EU grant potential.

Grant from DfT sources is likely to require a full business case under WebTAG guidelines and a clear implementation plan. This full business case will require revenue forecasts following best practice which in turn requires forecasting model refinements. The scheme appraisal needs to be robust to enable it to stand up to scrutiny at public inquiry

We expect some contribution from system suppliers who stand to gain marketing and intellectual property advantage from a successful installation. Their contribution is likely to be subject to a due diligence process which will also focus on the business case.

Funding for elements such as the vehicles and guideway could be sourced from a procurement partner.

12.5 Recommendation

The PRT pilot scheme performs well at this stage, confirms the range of potential benefits indicated in phase 1 and is preferred to a high quality bus option. Daventry DC should develop the implementation strategy. The next main steps in implementation should be to assess private sector interest and to prepare a full business case in consultation with funding agencies and to determine the detail of the procurement approach. At an appropriate point this will require a review and upgrade of the demand forecasts and costs to provide the detail and confidence needed for a full business case. This will probably need the preferred system to have been selected, as each system has somewhat different parameters.