The Leeds Trolley Vehicle System Order

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Leeds Transport Model
APP-5-2: Main Proof of Evidence on behalf of the Applicants

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1. **Introduction**

**Qualifications and Experience**

1.1. My name is Paul Hanson. I am a technical director of AECOM, an international engineering company, where I am responsible for the technical excellence of our transport modelling services. I have worked for AECOM for 11 years and before that for 16 years for MVA, a company specialising in transport modelling.

1.2. My educational qualifications include an honours degree in mathematics at Oxford University and a Masters degree in Business Administration (MBA) from Open University Business School. I am a member of the Transport Planning Society (TPS) and hold the Transport Planning Professional qualification.

1.3. I have 27 years experience as a transport planner. I have specialised in forecasting demand for travel across all modes of transport. My experience includes a balance of research and for specific projects. I have contributed to the development of modelling and appraisal guidance and to the software tools as well as forecasting impacts of a range of transport schemes.

1.4. For the past five years I have overseen the use and development of the Leeds Transport Model in forecasting demand for the proposed NGT service.

**Scope of evidence**

1.5. The purpose of my evidence is to describe the Leeds Transport Model (LTM), how it was applied to produce forecasts and to explain why those forecasts can be relied on.

1.6. My evidence sets out the number of passengers forecast to use NGT and other public transport services, together with the forecast of traffic using the road network. In particular, it is to explain the forecast effects of introducing NGT on travel in Leeds. These forecasts were used:
• in undertaking air quality and noise environmental appraisal, which is the subject of the evidence of, respectively, Mr Leather [App-15-2] and Mr Forni [App-13-2];

• informing the engineering design requirements explained in the evidence of Mr Smith [App-3-2], and of the assessment of traffic capacity and operation of junctions, presented in the evidence of Mr Robertson [App-6-2]; and

• to develop the business case, set out in Mr Chadwick’s evidence [App-7-2].

Declaration of truth

1.7. This proof of evidence includes the facts which I regard as being relevant to the opinions that I have expressed and that the inquiry’s attention has been drawn to any matter that would affect the validity of that opinion. I believe that the facts stated in this proof are true and that the opinions stated are correct. As a designated member my evidence has been prepared and is given in accordance with the guidance of the TPS.
2. **Outline of Evidence**

2.1. My proof of evidence is structured as follows.

- In Section 3 I explain why the Leeds Transport Model (LTM) is required, how it was developed and the overall scope of the model used for the LTVS TWA submission.

- In Section 4 I explain why I judge that the LTM is suitable for testing the impacts of NGT.

- In Section 5 I describe why forecasting assumptions are required to assess transport interventions. I then set out the assumptions used and how travel demand in Leeds is forecast to evolve without NGT.

- In Section 6 I then explain the forecast effects of NGT on travel demands and travel conditions.

- In Section 7 I explain the forecast effects of alternative schemes to NGT on travel demands and travel conditions.

- In Section 8 I explain how uncertainties in modelling transport schemes are considered and present the outputs of sensitivity tests designed to understand the implications of these uncertainties for the forecasts.

- In Section 9 I then summarise the implications of my evidence for the relevant matters identified in the Statement of Matters.

- In Section 10 I then respond to particular issues raised by objectors.

- A summary and my conclusions are set out in Section 11.
3. Development of the Leeds Transport Model

3.1. The purpose of this Section is to explain the role of the Leeds Transport Model (LTM) to inform the design and appraisal of the NGT scheme.

3.2. I first explain the need for transport models and explain how the outputs are used to appraise and to inform the design of transport schemes. I then describe what capabilities transport models are expected to have. Finally I describe how the Leeds Transport Model was developed to support the design and appraisal of the NGT scheme.

3.3. All transport models apply functions representing behaviour, to observations of travel derived from surveys. In this section I consider the suitability of the functions used in LTM and the adequacy of the surveys undertaken to provide a model representing travel in Leeds. In Section 4 of my proof I then consider whether the model is sufficiently detailed, accurate and responsive to judge its suitability specifically for preparing forecasts for the NGT TWAO.

The Need for Transport Models

3.4. Transport schemes are designed to serve transport needs. A scheme such as NGT takes time to plan and construct, and is intended to serve users needs for many decades. This requires an understanding of how transport needs may evolve.

3.5. As explained by Mr Chadwick in his evidence [App-7-2], developing the business case for a transport scheme draws together evidence of its performance and its likely impacts. The process involves a careful, structured process [E-3-1, Figure 1] to: understand the problems, define objectives, formulate, test and appraise economic, environmental and social implications of solution options. At the heart of this process is a requirement to test and appraise options.

3.6. This testing and appraisal of options requires a forecast of the effects they will have. For major transport schemes, such as NGT, these forecasts are produced by a model.
The Model Outputs

3.7. A transport model, such as the LTM, is used to provide a range of outputs to inform design and appraisal. The outputs help understand travel demand and are used to inform a range of impacts, for example:

- traffic flow; the numbers of vehicles travelling along roads; these outputs are used to interpret operational performance of the highway network and to assess emission of pollutants and of noise generated by traffic;
- traffic congestion; delay incurred by road users;
- public transport passenger flows;
- travel patterns; that is the origin, destination, purpose and time of day of journeys;
- door to door travel times and costs, by mode and time of day of journeys.

Modelling Functionality

3.8. The Department for Transport sets out guidance on modelling and appraisal of transport schemes in WebTAG\(^1\). The Department updated this guidance\(^2\) in January 2014. I was responsible for peer reviews assisting the Department in their work to undertake this refresh of WebTAG. My role was to help ensure that the update achieved its aim of simplifying and consolidating the wording of guidance without, inadvertently, making substantive unplanned

\(^1\) http://www.dft.gov.uk/webtag/
\(^2\) https://www.gov.uk/transport-analysis-guidance-webtag
changes to the technical requirements. In the following paragraphs I refer to the guidance that was in force and was followed throughout the development of the LTM and its use in preparing the forecasts that are the subject of my evidence. The January 2014 revisions to WebTAG do not include any changes that would have affected the modelling approach. There were however changes in economic forecasting assumptions which I discuss in Section 8.14 of my proof.

3.9. WebTAG Unit 3.11.1 explains the range of considerations that affect the choice of model for public transport schemes such as NGT and states that for a light rail scheme ‘a multi-modal transport model will be required, which includes all the main traveller responses and detailed network models’ and adds that the ‘same kind of model may be required for an urban guided bus scheme’. [E-3-15, Section 2.2]. This involves the development and integration of three main components or sub-models: a demand model, a highway assignment model, and a public transport assignment model.

3.10. The role of the demand model is to provide forecasts of travel demand, distinguishing the mode (in particular car and public transport) and time of travel, together with the origin and destination for the journeys. Two particular types of processes are employed in demand models. The first is to reflect changes in land use; if residential development results in more people living an area then the demand for travel from that area would be expected to increase. The second is to reflect changes in travel conditions, that is the time and the monetary cost required to make journeys. Travellers prefer to make quicker, easier, more comfortable, or cheaper journeys. The integration of a multimodal transport model involves representing a balance between the demand choices and the level of service (that is the journey time and cost) provided by the transport networks.

3.11. The role of the highway assignment model is to represent the performance of the highway network. The models include a representation of the roads and junctions. Congestion is caused by the volume of traffic traversing the network and the models include functions to represent the level of delay caused as traffic increases. Car drivers however choose their route taking
account of the time and cost of different routes. Thus drivers can use ‘rat runs’ or indirect routes to avoid congestion. The highway models represent this routeing behaviour and the balance between this and the level and location of congestion.

3.12. The public transport assignment network model provides a similar role in representing how many passengers use different public services. The models include a representation of the service timetable and stop locations, together with the scope to access or transfer between services. Bus services operate over fixed routes, and, where services are not segregated from other traffic the travel time is affected by traffic congestion. In addition to the in vehicle time, wait time, and fare, passenger’s choice of route is influenced by the location of stops or stations that they can access and by where it is reasonable to transfer between services.

3.13. Models are intended to provide outputs to assist in reaching informed decisions. Investment in transport models should be proportionate to the intended use [E-3-1, Section 1.4.2]. This involves careful consideration of the detail required [E-3-2, Section 1.2]. In updating guidance2 the DfT have further clarified the requirement to ‘consider the trade-off between developing the model (in terms of its accuracy and functionality) and carrying out additional forecasting work to test for sensitivity and uncertainty’ [unit M1-1, Section 2.3.6] and that it ‘may not be necessary to use the most sophisticated or detailed models’ [unit M1-1, Section 2.4.3].

3.14. It is, therefore, good practice for models to be developed as schemes progress from initial concepts or strategies to detailed design to reflect the changes in the appraisal requirements at different stages of this process. Large models of major cities are typically designed to represent the overall patterns of demand and performance of the transport networks and in most cases do not represent with a high degree of accuracy the detailed performance of individual roads and public transport services. This provides outputs of sufficient quality to inform decisions on strategy and feasibility of major transport schemes. WebTAG 3.19 acknowledges that ‘It may be less
achievable to meet the benchmark criteria in larger-scale strategic models’ [E-3-25, Section 8.3.17].

3.15. As schemes progress additional investment in models is justified to reflect the precision with which the scheme can be specified and the tolerance of decisions to output errors in appraising and designing the scheme.

3.16. The LTM has been maintained and developed to enhance its capabilities to respond to new requirements in this way, as I next describe.

Initial Development of the LTM (2009-2011)

3.17. AECOM was commissioned in August 2008 by Metro (West Yorkshire Passenger Transport Executive) and Leeds City Council to develop a multi modal model for the city of Leeds. At the time the model development was part of the City’s Transport Innovation Fund project. The objectives of the model were to test the feasibility of transport interventions ranging from infrastructure investment to road user charging. The model was also intended to have wider uses in supporting the appraisal of major developments and transport scheme investment across Leeds. This included the New Generation Transport proposals.

3.18. The data used are described in Leeds Transport Model, Report of Surveys, January 2010, [C-2-3]. A substantial sample of 78,000 highway [C-2-3, Section 2.4] and 26,000 public transport [C-2-3, Section 6.4] interviews were undertaken. These data were collated to provide information on the nature of travel, that is to understand how, where, why and when travel in Leeds is made.

3.19. To complement these surveys a comprehensive set of traffic counts, journey time data, and public transport ticketing and count data were assembled. These data provide information on the use and performance (speed, congestion) of the transport network.

3.20. In my view these data have sufficient detail and quality to understand travel patterns and network performance in Leeds. Accordingly the data were used
to develop a demand model, a highway assignment model and a public transport model.

3.21. The Leeds Transport Model, Demand Model Report, July 2011 [C-2-6] describes how the demand model was developed and tested in accordance with WebTAG unit 3.10 [E-3-10, E-3-11, E-3-12]. The model represents travel by purpose, and distinguishes travel into periods reflecting the differences in travel conditions at different times of day, delivering the requirements I introduced in Section 3.10 of my proof.

3.22. The highway assignment model development, in particular, benefited from the independent peer reviewer, Dr Denvil Coombe. At the time Dr Coombe was drafting WebTAG 3.19 [E-3-25] guidance and was able therefore to ensure that our approach to the model development was compliant with emerging guidance. The model development and performance is described in Leeds Transport Model, Highway Assignment Model Development and Validation Report, September 2011, [C-2-7], providing the capabilities I introduced in Section 3.11 of my proof.

3.23. The public transport network model of Leeds was developed in accordance with WebTAG unit 3.11.2 [E-3-16]. The Leeds Public Transport Model, LMVR, August 2011 [C-2-8] describes the model development and reports the model performance, providing the capabilities I introduced in Section 3.12 of my proof.

3.24. These reports demonstrate the rigour with which the initial model was developed and show that the model reproduced the existing patterns of travel and network performance and that the model responds in an appropriate way to changes in transport supply and cost.

3.25. The model reports describing the initial model [C-2-6 and C-2-7] note some limitations of LTM. These related to assessment of schemes where the detail contained in the initial LTM was not sufficient. However the intended purpose of the initial model was limited to testing strategies, such as the feasibility of NGT and in my view the model was demonstrated to be suitable for feasibility or strategy assessment, subject to specific analysis of the model outputs to
verify its performance for specific applications. As part of their review of the NGT programme entry, the DfT considered the capability of the LTM and also reached this conclusion in advising that the model should be used in developing the business case for NGT [C-6-8].

NGT Best and Final Funding Bid (2011)

3.26. The main purpose of this submission to DfT was related to funding. A review of the model performance in the NGT corridor was undertaken. The Leeds Transport Model, Highway Assignment Model Development and Validation Report, August 2011, [C-2-9, Section 6] explains the performance of the highway network model in the NGT corridor. Sensitivity analyses were reported (C-2-9, Section 7) illustrating that the modelled highway responses were appropriate. The public transport model was shown to comply with acceptability guidelines for the NGT and adjacent corridors (C-2-9, Section 8). In my view this demonstrated suitability of the initial model for testing the outline business case of NGT.

Business Case Re-Approval (2011-2012)

3.27. Following initial uses of the model two particular applications justified additional investment in the model. The first was to support the business case development of a significant maintenance scheme for part of Leeds Inner Ring Road and the second was for NGT business case re-entry.

- For the former the additional detail was required to represent parts of the central Leeds network together with the Inner Ring Road.

- For the latter these related to the representation of NGT in the public transport network.

3.28. Updates were documented in the Leeds Transport Model, Validation Addendum Report, August 2011, [C-2-2]. The adequacy of the model for NGT business case re-approval was subject to detailed scrutiny by the DfT. Working papers [C-2-32] and [C-2-33] describe exploratory analysis undertaken to provide complementary information as part of this review. Based on this detailed review, the DfT concluded that there was sufficient
confidence in the model performance and reliability of its outputs for the purpose of the re-approval.

**TWAQ (2013-2014)**

3.29. Developments were subsequently made to the LTM in preparing forecasts for the NGT TWAQ application. These reflected the need to develop junction designs, to appraise impacts along the corridor, to improve confidence in Park and Ride forecasts, and further to refine the public transport model.

3.30. Enhancements made to the highway network model relate to increased accuracy of representation of the central Leeds road network, and benefit from traffic counts and journey time data that supplement the data originally available. The Leeds Transport Model Update [C-1-3, Section 2] explains the changes made.

3.31. Improvements to the public transport network related primarily to the methods used to represent new high quality services, such as NGT. Sensitivity testing was undertaken in preparing the NGT programme re-entry business case submission [C-2, Section 7.15-20] to identify the uncertainties in the representation of the choice between NGT and bus. These related to questions about how well the network model was able to represent the choice travellers make between bus and NGT.

3.32. In many circumstances passengers waiting at a bus stop simply board the first service to arrive that takes them to the destination. Where services compete by offering distinct service quality or charge different fares, the choice involves also the consideration of these differences. The initial model included a process to represent the choice of stop, that is for example to walk further to board a faster service. However the use of this mechanism also to represent the choice between NGT and Bus was a modelling simplification that, in my view, contributed to the need for the sensitivity testing I mention in section 3.28 of my proof.

3.33. I considered more sophisticated modelling methods which are discussed in WebTAG unit [E-3-16, Section 7.5-7.8] to represent this behaviour.
Additional functionality was consequently added to the LTM to better distinguish the choice between NGT and other bus services, as explained in the Leeds Transport Model Update [C-1-3, Section 3]. At the same time refinements were also made to the accuracy with which public transport accessibility is represented in the city centre.

3.34. Part of the NGT scheme includes two park and ride sites. In order to inform the NGT business case, surveys were undertaken at existing park and ride sites and used to calibrate forecasting parameters [C-1-3, Section 4].

3.35. These enhancements have established current version of the LTM, the version designed to be used in support of the TWAO application. I consider the suitability of the model for this purpose in Section 4 of my proof.

Summary

3.36. In this section I have described the development of the LTM aligned with the stages of NGT scheme development. I have explained that the model development was undertaken in accordance with best practice set out in WebTAG. I have also described how due care has been taken to refine the capabilities of the model as the output requirements have changed at different stages of the scheme’s development. This care has ensured that the LTM has remained a suitable tool as the requirements of the model have evolved.

3.37. While I have demonstrated in this Section that the model has been developed from a satisfactory observed evidence base and that it has appropriate functions, I have not demonstrated its suitability for use in preparing forecasts for the NGT TWAO, which I consider in the following Section.
4. **Suitability of the Leeds Transport Model**

4.1. The purpose of this section is to explain why I judge that the LTM is suitable to assess NGT for the purpose of the TWAO.

4.2. I have explained in Section 3 that the model was developed using sufficient data and with suitable functional capability to forecast the effects of the NGT scheme on the public transport and highway networks and to forecast how travel demand would change as a result of the scheme. I also explained that the model can provide the range of outputs required.

4.3. My specific assessment of model’s suitability rests, therefore, on:

   - model detail, that is whether the model is sufficiently detailed to represent the scheme;

   - model accuracy, that is whether the model outputs adequately reproduce observed conditions and demand; and

   - model sensitivity, that is whether the model responds appropriately to input changes.

4.4. In this section I explain how I have assessed the model performance in regard to these questions in turn. I then conclude this section by explaining how I satisfied myself that the outputs are being used appropriately.

**Model Detail**

4.5. Models aggregate space into zones, or areas, from which trips start or finish. WebTAG Unit 3.11.1 sets out principles for defining zones and explains that they ‘should generally be sufficiently small for it to be realistic to expect people to walk from anywhere in the zone to the nearest public transport stop or station’ [E-3-15, Section 4.3]. This guidance was followed in the development of the LTM to define a representation of access to the public transport network with zones at a sufficiently detailed level [C-2-8, Section 4.2].
4.6. WebTAG Guidance adds that ‘the road traffic assignment model should be sufficiently detailed to model both the road capacity changes required by the public transport scheme and the effects of those changes on road traffic congestion’ [E-3-16, Section 2.2.3]. The LTM was designed with this functional capability [C-2-7, Section 4].

4.7. The guidance also explains that the public transport assignment model should distribute ‘trips between the modes in a realistic manner’ E-3-16, Section 4.1.8]. The design of the public transport model provided this capability [C-2-8, Section 4], and specific consideration is given to represent the choice between NGT and bus travel [C-1-3, Section 3].

Model Accuracy

4.8. In section 3 of my proof I explained how the LTM was developed in accordance with guidance carefully verifying the integrity of the data. Having confirmed that the model has suitable detail for the requirements of the TWAO, I now consider whether the model is sufficiently accurate for this purpose. I refer to and use the DfT acceptability guidelines to consider the performance of LTM along the NGT corridor.

4.9. Highway model accuracy is tested by comparing modelled traffic flows and journey times against observed data. These are used to test how well the highway model represents traffic queues and delays, together with the effects on traffic routeing.

- WebTAG Unit 3.19 sets out criteria to test model flows [E-3-25, Table 2]. The comparison undertaken demonstrates that for 80% of count sites on roads crossing the screenlines and 84% sites specifically on the NGT route the differences in modelled flow and the count are within the WebTAG criterion [C-1-3, Table 1, and Figures 1-7]. This is aligned with the acceptability guideline of 85%, and indicates a good reproduction of flows along and adjacent to the corridor.

- WebTAG Unit 3.19 also sets out criteria to test modelled journey times [E-3-25, Table 3]. The comparison of modelled and observed journey times
along the NGT route [C-1-3, Table 2] shows that across all time periods 96% of modelled journey times are within the criterion. This exceeds the acceptability guideline of 85%.

4.10. DfT accuracy standards for public transport assignment models are defined in WebTAG 2.11.2 [E-3-16, section 10.1.6]. This tests how well passenger’s choice of route or service is represented. The model performance on and adjacent to the NGT corridor [C-1-3, Section 3.4] complies with the acceptability criterion that public transport flows should be reproduced to an accuracy of less than +/-25%.

4.11. Analysis undertaken [C-1-3, Section 4] demonstrated that the model replicates the characteristics of use at park & ride sites, indicating sufficient confidence in the forecasts for use in the development of the business case. The model outputs have not been used for detailed design of the car parks and I would advise the need for supplementary information if they were used for that purpose.

**Model Sensitivity**

4.12. Given the model demonstrates a good reproduction of demand and travel times, the final consideration of its suitability rests with its responsiveness. This tests how well the outputs of the model change as a result of changes to the model inputs. Guidance on reasonable sensitivity ranges are set out in WebTAG 3.10.4 [E-3-12, Section 1.6]. This guidance is defined in terms of how sensitive it is reasonable for a model to be. Thus for example, if fuel costs were to increase by 10%, traffic forecast by the model should reduce by about 3%. The model responses comply with this guidance [C-1-3, Section 5].

4.13. As I explain in Sections 3.26, and 3.28, sensitivity analyses have been undertaken to explore the reasonableness of the model responses to introducing NGT. Tests have also been undertaken which demonstrate that the model reproduces the highway impact of network changes, in particular the East Leeds Link and Inner Ring Road [C-2-7, Section 13.3].
4.14. I am therefore satisfied that the LTM has been developed with appropriate
rigour, in accordance with the methods set out in WebTAG, has suitable
functional scope and detail, the outputs comply with the WebTAG criteria
tolerances and that it responds appropriately. I conclude that the LTM is
suitable to produce forecasts for the NGT TWAO.

4.15. I will now consider how the outputs were used in the environmental
statement, business case and junction design.

Air Quality and Noise

4.16. Traffic flows, composition and speeds are used to forecast traffic noise and
traffic emissions.

4.17. The transport model outputs were aggregated to provide forecasts of 12, 18,
24 hour and night time periods that are required for noise and air quality
appraisal. Traffic count data from the NGT corridor were used to extrapolate
from the 12 hour period explicitly modelled.

Business Case

4.18. The transport model outputs are used directly to assess the economic and
revenue implications of NGT. The first stage in this process is to extrapolate
from the October term time weekday that is represented in the transport
model to establish annual impacts. Annual count data were used to establish
total annual demand and factors derived to extrapolate from the modelled
periods as set out in the Annualisation Factors report [C-1-2].

4.19. Economic benefits were calculated using the DfT program TUBA based on
travel demand and journey time forecast by the LTM. The model forecasts of
travel demand, journey times and costs were accordingly assessed using
TUBA [C-1-17]. Public transport revenues by mode were calculated from
fares and demand forecasts, which distinguish concession and non-
concession passengers.
**Detailed Junction Design**

4.20. The highway design involves prioritisation and allocation of capacity between general traffic and public transport services. The traffic forecasts are thus considered in this process.

4.21. WebTAG 3.11.1 [E-3-15, Section 4.2] explains that ‘striking the right balance between issues of this kind - model accuracy, model run times, and survey budgets - is a difficult process for the design of any transport model’. A particular consideration reflects the detail in which local impacts on the road network are represented. WebTAG 3.19 [E-3-25, Section 9.3.2] explains that ‘turning movements may not validate to the standards achieved for link flows’. The Traffic Appraisal Manual [E-4-2 Section 13.5.10-11] states ‘traffic models cannot, in general, directly provide reliable estimates of the forecast year peak period turning movements which may be required in design’ and recommends ‘that the turning movements used for junction design are not those output directly’.

4.22. WebTAG unit 3.1.1 [E-3-2, section 1.2.28pp] explains the option to define a hierarchical system to address this application and unit 3.10.2 [E-3-10, Section 1.5.5] explains alternative methods that are used to establish interface between less and more spatially detailed models.

4.23. This hierarchical approach has been taken in developing detailed traffic forecasts for NGT. Mr Robertson [App-6-2] in his evidence explains the interface and interpretation of traffic forecasts both for his appraisal of signalised junction performance and for detailed junction design described in the evidence of Mr Smith [App-3-2].

4.24. I have reviewed the way in which data from LTM are being used in other processes and am satisfied that they are being used in an appropriate way.

**Summary**

4.25. In this section I have explained how I have reviewed the performance of the LTM and concluded that it is suitable for the purpose of providing forecasts for the NGT TWAO.
4.26. I have explained why the LTM outputs are suitable for preparing the business case and appraising environmental impacts of NGT. I have explained that the outputs are not directly suitable for use in junction design and that I am satisfied that appropriate care has been taken in interpreting them for this purpose.
5. **The Forecasts, Without NGT**

**Introduction**

5.1. The LTM is used to forecast travel demand and associated network conditions. As explained in Section 3, the LTM includes a representation of travel in its base year, 2008. In forecasting the approach taken is to apply changes. Thus, for example if population increases, demand for travel will correspondingly increase, or if the cost of travel increases there will be a reduction in travel demand. The model was applied to forecast change from its base year, 2008, to produce forecasts for 2016 and 2031.

5.2. The purpose of this section is to describe forecasts of future demand for travel in Leeds, without NGT.

**Forecasting Assumptions**

5.3. Travel demand and travel conditions are affected by a range of factors including: economic change and prices; and land use changes and socio-demographic developments; in addition to changes in transport provision.

5.4. The forecasting report [C-1-8, Section 2] describes how best practice, as set out in WebTAG 3.15.3 [E-3-22], was applied to review evidence and develop assumptions about these factors which will influence future travel demand.

5.5. These forecasting assumptions have been assembled from relevant sources and represent, in accordance with guidance, a coherent perspective of the future. I consider these assumptions to suitable for forecasting how demand for travel may be expected to develop in Leeds. I comment on forecasting uncertainties in Chapter 7 of my proof.

**Future without NGT – Overall Demand In Leeds**

5.6. The LTM forecasting report [C-1-8, Chapter 3] presents information on how travel demand in Leeds is forecast to change over the forthcoming decades. In line with the assumed change in population, overall demand for travel is forecast to increase by about 6% to 2016 and 26% to 2031.
5.7. The monetary cost of travel by car is assumed to reduce over time which will increase car travel demand. Traffic congestion, however, will moderate forecast highway growth. Overall car trips in Leeds are forecast to increase by 9% to 2016 and 30% to 2031 [C-1-8, Table 21]. This is consistent with DfT projections.

5.8. Public transport fares are forecast to increase over time, and act in conjunction with increased travel time due to traffic congestion to moderate demand for travel by public transport that might be expected from the population growth. The forecasts are for a 3% reduction in travel by public transport between 2008 and 2016, and then for an increase such that by 2031 there will be 20% more public trips than occurred in 2008. These forecasts are consistent with DfT projections.

Future without NGT – The NGT Corridor (A660 - North)

5.9. Traffic growth in Leeds is forecast to impose additional pressure on the road network. Travel time along the A660 is forecast to increase, relative to 2008, by about 20%, or more than 4 minutes, for a journey from the outer ring road to the centre in the morning peak by 2031 [C-1-8, Table 40]. Outbound from the city centre in the evening peak the additional delay from congestion is forecast to be over 7 minutes. During the inter-peak period and northbound in the morning and southbound in the evening peak the forecasts are for travel times to increase by about 2 minutes, or 15%.

5.10. The effect of this congestion is to moderate forecast traffic growth along the A660. Overall between 2008 and 2031, traffic between the outer and inner ring roads is forecast to increase by 5% southbound in the morning peak and 2% northbound in the evening peak. That said, the network changes that are represented are forecast locally to affect traffic flows.

5.11. Increased traffic congestion would delay buses along the A660. The increase in bus travel time is forecast to suppress passenger demand along the

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3 Excluding the effects of congestion and travel cost, TEMPRO [E-3-21] trip productions in Leeds are for a 35% increase in car traffic and 22% increase in public transport between 2008 and 2031.
corridor. The daily demand using services\textsuperscript{4} along the A660 (north of the city) is forecast to decline by about 15\% to 2016 with a return to 2008 levels by 2031. During the day, bus patronage is forecast to decline by about 10\% in the peak periods and increase in the inter-peak period by 18\% [C-1-8, Table 49] between 2008 and 2031.

Future without NGT – The NGT Corridor (A61 - South)

5.12. To the south of the city centre the provision of the final stage of the Inner Ring Road and the East Leeds Link have provided relief along the corridor with the result that traffic flows are forecast to reduce on the A639, Low Road between 2008 and 2016 [C-1-8, Table 34]. Travel times are, correspondingly, forecast to be shorter in 2016 than they were in 2008 [C-1-8, Table 39].

5.13. Between 2016 and 2031 traffic volumes are forecast to grow on the southern route as a result of the expected population and employment changes [C-1-8, Table 34]. The consequences of traffic congestion would correspondingly increase delays, such that travel times are forecast to be about 5\% longer in the peak times and directions in 2031 than those observed in 2008 and about 5\% quicker at other times and directions [C-1-8, Table 40].

5.14. The southern NGT route passes through areas assumed to benefit from a relatively high rate of development and the bus services times are expected to reduce relative to 2008. Daily demand on the bus services\textsuperscript{5} along the corridor (A61 Hunslet Road) is forecast to increase by 35\% between 2008 and 2031 [C-1-8, Table 49].

Summary

5.15. In this section I have explained how the expected growth in population, together with the changes in congestion and the cost of travel, are forecast to result in an increase in travel demand in Leeds.

\textsuperscript{4} (96,1,28,97,X84,95) in 2008 and (93,6,1,28,X96,97,X84) in 2016/2031  
\textsuperscript{5} (110,12,13,169,61,189,44,168,MC1_1,74,85,87,410,13A,X41) in 2008 and (48, 110, 12, 13, 169, 61, 189, 443, 168, 74, 85, 87, 410, 13A, X41 in 2016/2031
5.16. I have also explained that traffic congestion along the A660 is forecast to constrain both car and public transport demand using the corridor.
6. The Forecast Effect of NGT

Introduction

6.1. Having explained, in Section 5, how demand for travel is likely to develop in Leeds and in particular along the NGT corridor, the purpose of this section is to explain the forecast impacts of NGT. I first explain how NGT has been represented in the LTM and then describe the forecasts.

6.2. Transport models are applied to compare the effects of a scheme. Given the effort involved in preparing forecasts it is not efficient to undertake forecasts for many different future years. Instead interpolation is applied to establish how outcomes would vary over time. In preparing forecasts for NGT I have undertaken tests show what the effects of NGT would be in 2016 and in 2031 and the outputs have been interpolated in particular to provide forecasts of traffic flows in 2020 for junction design and environmental assessments. In my evidence, however I explain the effects NGT is forecast to have on travel in Leeds if it operated in 2016 and 2031.

NGT Service Assumptions

6.3. Mr Smith describes in his evidence [App-3-2] the proposed highway design, alignment of the NGT route and location of the stops. The characteristics of the service that would be operated are described by Mr Chadwick in his evidence [App-7-2], together with the expected response of operators and effects on bus services. The design and service were represented in the LTM [C-1-8, Section 4].

6.4. There were two aspects of the specification that required particular consideration in their representation in the LTM. In both these cases I have considered and tested uncertainties in the interpretation, which I set out in Section 8.19 of my proof.

6.5. The LTM represents how congestion delays bus services. Mr Robertson’s evidence [App-6-2] describes his operational assessment of junction performance. In his evidence Mr Chadwick [App-7-2] explains how the runtime model [C-1-13] was developed to assess the journey time that the
scheme would deliver for travel by bus and by NGT. In representing NGT there was a choice of whether to use the run time model outputs directly within the LTM. This has the advantage of using the considered assessment undertaken. The disadvantage was that assessments were for 2020, and there would therefore be some mis-statement of future bus speeds in 2016 and 2031. However, the interpolation of LTM outputs offsets this apparent discrepancy. I judge therefore that the advantage outweighs the disadvantage and used the runtime model outputs.

6.6. Part of the benefits of NGT are in the step change in service quality it would provide. Mr Chadwick explains in his evidence [App-7-2] the stated preference research undertaken to assess the value Leeds residents would attach to these service improvements [C-2-4]. The quality improvements are represented in LTM in accordance with guidance [E-3-22, section 2.4.4-5] and I have reviewed the valuation to satisfy myself that it is within the range identified in independent research [E-3-17, para 6.5.3] and consistent with a high quality service.

Forecasting Effects of NGT on Public Transport Demand

6.7. The provision of NGT would substantially improve the public transport service along the corridor. The service would deliver reductions in in-vehicle travel time of between 5 and 10 minutes for most journeys, and improved service quality which would be perceived to be of similar magnitude. For some users access time would increase relative to bus and wait time would be longer. Overall the effect of these improvements is forecast to increase public transport demand along the corridor by about 50% [C-1-8, Figures 15-17], a change which is commensurate with the overall scale of improvement in public transport provision.

6.8. The bus services operating along the corridor would provide a competitive alternative for short point to point services and for journeys where the origin or destination is outside the NGT corridor but along the bus route. The forecasts indicate that NGT would capture about 60% of public transport demand in the corridor. Allowing for the increase in public transport demand
this implies a reduction in passengers using bus services operating in the corridor by about one third [C-1-8, Figures 15-17].

6.9. The forecasts are for NGT use to be greatest in the evening peak hour. 3400 passengers are forecast to use the service in the evening peak hour in 2016 and 4000 in 2031 [C-1-8, Table 50]. Hourly flows at other times of day are forecast, in 2031, to be 3200 in the morning peak hour and 3600 during the inter peak period.

6.10. Over three quarters of NGT demand is forecast to be direct travel along the corridor, without interchange [C-1-8, Table 56]. The service would traverse a new direct route through the city centre which would provide improved access to those parts of the city centre, such as for rail passengers accessing the university.

6.11. Some 15\% of the NGT demand is forecast to derive from the new Bodington and Stourton Park and Ride sites [C-1-8, Table 51].

6.12. The dominant use of NGT is forecast to be for travel to and from the city centre. In addition substantial demand is forecast to and from the university. Accordingly the service loading is forecast to be highest as the service traverses the university and city centre stops (demand profiles are shown in the forecasting report [C-1-8, Figures 4 and 5]). Peak hourly flows on the service are forecast in the evening peak at 1250 in 2016 and 1450 in 2031. [C-1-8, Tables 52, 54].

6.13. Outside the immediate NGT corridor, provision of the NGT service is not forecast materially to affect public transport demand. Overall the forecasts indicate a reduction of less than 3\% of forecast public transport demand using bus services in other corridors as a result of passengers changing route or destination to use NGT.

**Forecasting Effects of NGT on the Highway Network**

6.14. Provision of NGT includes investment in the highway network to manage the capacity available and provide increased priority to public transport services.
6.15. Mr Smith [App-3-2] explains the overall design of the corridor and Mr Robertson [App-6-2] explains how traffic signals would be configured. The measures proposed have a range of effects. Traffic signals are used to align capacity to reduce the formation of queues, but impose a delay during the red phase. Closure of some side turns will cause traffic to take an alternative route.

6.16. Overall the NGT scheme is forecast to have little impact on daily highway travel conditions within the corridor with a 1% increase in travel distance and a 2% increase in travel time [C-1-9, Table 7]. Along the corridor, however, there are larger forecast changes in flow. An example of this is on the section of Otley Road just south of the Outer Ring Road where traffic flow is forecast to increase by almost 50% [C-1-8, Table 63] over a short section. This is a result of the alterations to Lawnswood Roundabout that provide additional capacity for general traffic. Some of the trips which, without the NGT scheme, are forecast to use Spen Lane and Spen Road are forecast with the NGT scheme to use the Outer Ring Road and Otley Road instead. Another example is on Low Road where the forecast flow reduces in the northbound direction [C-1-8, Table 63] where the priority given to NGT reduces capacity for general traffic.

Summary

6.17. In this section I have explained that the traffic management measures proposed are not expected substantively to affect overall traffic flows or journey times along the corridor within the ring road, although there are local effects reflecting the proposed traffic management measures.

6.18. I have explained that the NGT service would substantially improve public transport along the corridor. The forecasts reflect these improvements. NGT is forecast to capture over half the demand in the corridor and the total use of public transport in the corridor is forecast to increase by about 50%, with bus patronage in the corridor thereby reducing by about a third.
7. Alternative Options

7.1. The ‘Leeds NGT sensitivity testing’ [C-2-9, Table 2] describes two main alternative options:

- the ‘next best’ alternative (NBA), which provides vehicles based on an alternate technology which are assumed to be perceived as lower quality; and

- the ‘low cost’ alternative (LCA), which provides some priority to improve bus service times but operates conventional bus services.

7.2. Following the publication of the January 2014 Sensitivity Report [C-1-9] further review of the forecasts identified that while the Low Cost Alternative reflected the improved bus journey time provided by the scheme, it incorrectly applied the reduced frequency for services 1 and 6 that was assumed in the NGT Central Case scenario rather than their existing frequencies. Replacement model outputs for those reported in the Sensitivity Report in relation to the LCA option have been provided in the Appendix accompanying my proof [App-5-3-1].

7.3. In addition to these alternative options a further five alternative options have been tested since the publication of the January 2014 Sensitivity Report [C-1-9]. As explained by Mr Chadwick in his evidence [App-5-2] these are all variations of the two main alternative schemes presented in that report.

- A NBA option with a quality parameter half way between that of the Preferred Option and the Business Case Review assumption.

- The south route only of the Business Case Review LCA (Stourton Park & Ride with dedicated express bus to the University).

- The north route only of the Business Case Review LCA (Bodington Park & Ride, on-street bus priorities, enhanced stops, existing services).

- The north route only of the Business Case Review LCA without Bodington Park & Ride (on-street bus priorities, enhanced stops, existing services).
The full LCA option with provision of a P&R express service that links Bodington and Stourton – the purpose of this test is to assess the potential benefits of providing faster bus services between the Bodington P&R site and the City Centre, as well as providing a link to destinations south of the Aire.

7.4. The required information for the business case assessment of these alternatives has been provided to Mr Chadwick. In addition some key indicators from the model tests of these scenarios are presented in Appendix 1 [App-5-3-1].

7.5. In respect of public transport demand, the next best alternative is forecast to attract some 27% [C-1-9, Table 9] less demand to the new service compared with NGT. The NBA option with better perceived quality is forecast to carry 14% less demand than NGT.

7.6. The Low Cost alternative is forecast to result in modest changes in demand along the corridor. The NBA provides the same design and priority as NGT and was forecast to have the same impact on average traffic speeds: a reduction of 0.3 Kph [C-1-9, Table 7]. The Low Cost option does not provide as much priority for buses and included some highway improvements that aim to improve conditions for all road users. The effect was forecast to increase average 12 hour traffic speeds in the corridor by 0.1 Kph from the central case forecast speed of 25.7 Kph in 2031.

7.7. The Low Cost variants all have a similar level of impact on the highway network as the main Low Cost option for the part of the route that is implemented. The Low Cost variants all result in slightly lower levels of bus passengers compared with the main Low Cost Alternative.

Summary

7.8. A Next Best Alternative and a Low Cost Alternative scheme have been assessed using LTM. Variations of these schemes have also been assessed. In all cases the forecast use of the new bus services in these schemes is less than the use of NGT with the LCA being considerably lower.
7.9. The highway impact of the NBA scheme and its variant is similar to that of the central case. The LCA options have a smaller highway impact as the scheme does not provide as much priority for buses and include some highway improvements that aim to improve conditions for all road users.
8. Implications of Forecasting Uncertainties

8.1. The forecasts I described in Sections 5 and 6 of my proof depend on assumptions. Best practice is to consider the implications of forecasting uncertainties [E-3-24].

8.2. The purpose of this section is to explain how these forecasting uncertainties have been investigated and to set out the consequences for the forecasts. In this section I first describe the implications of general uncertainties in the demand forecasting and then discuss specific uncertainties affecting the NGT service, first considering Next Best and Low Cost alternatives and then considering other uncertainties in specifying and representing NGT.

Uncertainties Affecting Future Travel Demand in Leeds (Irrespective of NGT)

8.3. Travel demand arises from the desire of individuals to undertake activities. Travel demand is thus dependent on land uses and the associated population and employment patterns. The willingness or ability to travel also depends on the monetary costs and the time required.

8.4. WebTAG 3.15.3 [E-3-22, para 3.3.2] identifies the level of uncertainty in growth that it is reasonable to consider in forecasting travel demand. This guidance was applied to develop ‘high’ and ‘low’ growth scenarios to provide an indication of the range of uncertainty in the demand forecasts, as reported in ‘Leeds NGT sensitivity testing’ [C-1-9, Section 3.2]. Across Leeds the tests demonstrate a range in forecast traffic growth of +/- 11 percentage points around the central forecast of 30% [C-1-9, Table 3].
8.5. As I explained in Section 5.9, congestion on the A660 acts to constrain forecast changes in traffic growth. The total traffic volume using the A660, A61 and immediately adjacent roads is forecast to vary by +/- 5% around the central forecast [C-1-9, Table 7]. The variation in total traffic flows forecast along the A660 between the city centre and Lawnswood roundabout on the ring road is less than 3%.

8.6. For traffic along and adjacent to the NGT corridor average weekday 12 hour traffic speeds are forecast to reduce from 28.3 Kph in 2008 to 26.0 Kph in 2031 [C-1-9 Table 7]. The average speed in 2031, without NGT, is forecast to range between 24.8 (high growth) and 27.2 Kph (low growth).

8.7. The forecast effect of NGT is similar in the central, low and high scenarios. In all three cases 12 hour traffic volumes using the A660, A61 and adjacent roads are forecast to increase by around 1%, and average 12 hour traffic speeds reduce by around 1% [C-1-9 Table 7].

8.8. The central case forecast was that public transport trips in Leeds would grow by 20% between 2008 and 2031. The high and low growth forecasts demonstrate a range of +/- 9 percentage points [C-1-9, Table 4].

8.9. The tests show demand forecast to use NGT similarly varying by +/- 7% [C-1-9, Table 4] and a similar profile of usage [C-1-9, Appendix].

8.10. I conclude that while variations in growth would impact on travel conditions and the level of demand, the forecast impacts of NGT do not vary materially across the range of uncertainty tested.

Elland Road Park and Ride Site

8.11. Since the definition and preparation of the central case forecasts, funding for plans to develop a Park and Ride site at Elland road was agreed. The site is some 4Km to the west of Stourton, and is also adjacent to the M621. Tests were therefore undertaken to ascertain whether the two park and ride sites were sufficiently close for there to be a material impact.
8.12. The forecasts indicate that there would be very little overlap between the catchment areas for the two park and ride sites with forecast demand at Stourton reducing by 4% with Elland Road. I conclude that the opening of Elland road park and ride site would have no material implications for the NGT forecasts.

Forecasting Fares and Costs

8.13. In reviewing the forecasts in preparing my evidence, I observed a misrepresentation of the way fares are represented in the LTM which overstated the effects of fare changes on public transport travel demand. I have tested the implications. These show that this misrepresentation would understate the demand forecast to use NGT by less than 4% and the change in traffic forecast to use the NGT corridor by less than 1%. These differences are both small and substantially less than the range of forecasting uncertainty I have presented and would have a similar effect for all options. I would conclude that there are no material implications for the forecasts of demand I have presented.

8.14. The DfT updated guidance on values of time and car operating costs in January 2014. There were two changes of potential relevance to the LTM forecasts. The first was that current values of time have been reassessed, implying that non business values (for 2008) are now considered to be 8% higher and business values 18% lower than they were at the time the LTM was developed. The second is that updated economic and fuel costs information has been incorporated in advice on future values.

8.15. A test has been undertaken assigning the base year highway network using revised 2008 values of time. There were no changes in excess of 5% or of 50 cars on or near the NGT corridor. Unless there are tolls, congestion delays dominate the choice of route for urban car travel and this outcome is, therefore, to be expected. The change in value of time would reduce the sensitivity of the demand model to price changes by about 5% and would not

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therefore change the sensitivity of the demand model to costs by the same amount. This implies that these changes in values of time would not noticeably affect traffic flows and that the demand forecast would change by about 1%. I conclude, therefore, that the change in base year values of time would not materially affect the LTM forecasts.

8.16. Reflecting updated economic evidence, the updated forecasts are that values of time will remain about 5% lower in the future and that car fuel costs will be about 2% less than the previous DfT advice that was used in preparing the forecasts I have described. Reflecting the sensitivity of the LTM to these inputs, the effect of these changes would be to reduce the traffic forecast by about 1%, public transport demand by less than 2%. In terms of user benefits the increase in the current non business value of time would dominate, but with user benefits increasing by less than 5%. These are considerably less than the change presented in the ‘low’ and ‘high’ growth scenario I have already described. I consider that these changes would not materially affect the forecasts I have presented for NGT.

Uncertainties in Representing NGT

8.17. The Leeds NGT sensitivity testing report [C-1-9, Table 2] describes a range of sensitivity tests exploring uncertainties in the frequency, fare and run time assumptions and in the way in which operators may respond.

8.18. These forecasts demonstrate no appreciable difference in traffic volumes or performance along the corridor.

8.19. The scale of changes forecast for NGT use [C-1-9, Table 9] are, in summary that:

- a service operating with a frequency of 8 rather than 10 vehicles an hour is forecast to carry 12% less demand;

- charging a 25% premium fare is forecast to reduce NGT demand by 21%;

- operating the same fare as other bus services, rather than a higher charge for short journeys is forecast to increase NGT demand by 2%;
with the effect evident mainly in terms of short trips within the city centre increasing total NGT trips by 10% [C-1-9, Appendix A];

- increasing in travel time on NGT by 10% is forecast to reduce NGT demand by 9%;

- operating a NGT service where the quality of the vehicles was perceived to be about half that assessed for NGT is forecast to reduce NGT demand by 14%; and

- should operators continue to provide the existing bus service frequency, despite the reduced demand, the increased attractiveness of the bus services would be forecast to reduce NGT demand by 4%.

8.20. While most of these tests are not forecast materially to affect bus use along the corridor:

- operating the same fare on NGT as on bus services is forecast to reduce bus use in the corridor by about 4% and to result in a small increase in bus use elsewhere through transfer to NGT; and

- where operators are assumed not to reduce bus frequencies in response to NGT, bus passenger flows in the corridor were forecast to increase by about 20%.

Summary

8.21. In this section I have demonstrated that the forecast impacts of NGT on the public transport and highway networks are not significantly affected by general forecasting uncertainties.

8.22. I have explained how uncertainties in NGT and bus service operations and fares are forecast to affect demand.
9. **Statement of Matters**

9.1. The Secretary of State has issued a Statement of Matters that he has asked the inquiry to consider. My evidence describes information that supports consideration, of Matters 2 and 3.

- **Matter 2**: The justification for the particular proposals in the draft TWA Order, including the anticipated transportation, regeneration, environmental and socio-economic benefits of the scheme.

9.2. The forecasts of the LTM are used, as I explained in Section 1.6 to inform the appraisal of NGT.

9.3. Mr Chadwick’s evidence [App-7-2] considers the business case for NGT, drawing on these outputs. Dave Haskins’s evidence [App-2-2] also addresses this matter and in particular, NGT’s transportation benefits.

- **Matter 3**: The main alternative options considered by the Promoters (including alternative modes to bus, and alternative means of propulsion) and the reasons for choosing the proposals comprised in the scheme.

9.4. I explain in Section 7 tests of the Next Best Alternative and the Low Cost Alternative options

9.5. Mr Chadwick’s evidence [App-7-2] considers the business cases of these two options.
10. **Response to Objections**

10.1. A number of objections have been made to the draft Transport and Works Act Order submitted in respect of the NGT scheme.

10.2. This section addresses the concerns and comments made in relation to the Leeds Transport Model that are the subject of my evidence. These include, but are not limited to the objections made by:

- Professor Todd (Obj/171);
- Mr Broadbent (Obj/573);
- Professor Griffiths (Obj/728);
- First West Yorkshire Ltd (Obj/923);
- Mr McKinnon on behalf of A660 Joint Council (Obj/1644);
- Mr Kemp and Mr Thomas on behalf of North West Leeds Transport Forum (Obj/1719);
- Ms Cavill (Obj/980);
- Mr Thomas on behalf of the Weetwood Residents' Association (Obj/1354);
- Dr Griffiths (Obj/1483); and
- Mr Kemp on behalf of the West Park Residents' Association (Obj/1720).

10.3. Rather than address each objection individually, I have identified a number of themes that relate to my evidence:

- Issue 1 – That demand for NGT is overstated (Objectors 728, 923, 1483, 1644, 1720);
- Issue 2 – Poor integration between NGT and bus resulting in additional access time and waiting time (Objectors 171, 573, 923, 980, 1354, 1483, 1644, 1719, 1720);
• Issue 3 – Annualisation Factors are Seriously Flawed (Objector 923);

• Issue 4 – Development and performance of LTM (Objectors 573, 728, 923, 1354, 1483, 1644, 1719);

• Issue 5 – Preference for NGT (Objectors 728, 923, 980, 1483, 1644, 1719);

• Issue 6 – Demand by Students living in Headingley will reduce (Objectors 171, 1719, 1720);

• Issue 7 – Attractiveness of Park and Ride (Objectors 171, 573, 728, 923, 1354, 1483, 1644, 1644, 1719, 1720); and

• Issue 8 – Detrimental Impact on Bus Users (Objectors 171, 728, 573, 1354, 1719)

• Issue 9 - The traffic impacts of NGT are understated (Objectors 573, 728, 1354, 1483, 1644, 1719, 1720).

10.4. I have sought to address many of these grounds for objection through the evidence I have presented in Sections 3-7 of this proof.

Issue 1 - That demand for NGT is overstated

10.5. The objectors consider potential demand reflecting the population that lives within 400m or 500m of the NGT corridor, together with the current passengers using bus services operated by First Bus.

10.6. I would observe that access distances to public transport do vary depending on the nature and availability of services.

10.7. Nevertheless, I have explained in Section 5 of my proof that population growth in Leeds would increase demand. I have also explained in Section 6 that the forecast public transport demand in the corridor would increase as a result of overall service improvements. Finally, I have also explained that some demand would transfer to use NGT for improved access within the
centre. I consider therefore that the forecasts I have provided for NGT demand are reasonable and can be relied upon.

**Issue 2 - Poor integration between NGT and bus**

10.8. I have explained in Sections 3 and 4 of my proof that the LTM was developed to provide an appropriately detailed representation of the public transport network and, in Section 6.3, that the location of stops and service frequency of services is represented. The LTM thus represents where passengers are disadvantaged by additional walk or wait times for their particular journeys.

10.9. The economic appraisal draws upon the changes in travel times and weights these by the individuals affected. Thus in-vehicle time savings will, where applicable be offset by additional wait time. In his evidence Mr Chadwick [App-7-2] explains overall the user benefits.

10.10. The specification of the NGT system including its proximity to other public transport modes and interchange possibilities is covered in the evidence of Mr Smith. The specification has been developed to facilitate interchange while at the same time maximising the benefits to public transport users.

10.11. I consider therefore that the forecasts and the conclusions drawn from them fully reflect the integration between NGT, bus and rail.

**Issue 3 – Annualisation Factors are Seriously Flawed**

10.12. I have explained in Section 4.18 of my proof how the model forecasts for an October weekday are extrapolated, based on annual count and ticketing data. In the case of public transport annualisation factors only data from within the NGT corridor have been used in order to ensure that the effects of University term time are represented. I would observe that the analysis presented by the objector concludes that if the calculation of annualisation factors was incorrect in the way they allege then it would result in a negligible 1% difference in annualised demand.
10.13. Objectors have expressed concern over the development of LTM, reliance on data from 2008 and changes that have subsequently occurred, such as the reduction in traffic using the A61 and on the forecasting assumptions.

10.14. The development of transport models requires investment. I have explained in Sections 3 and 4 of my proof that it is best practice to balance that investment against the requirements. It is therefore normal for transport models to be refined in line with the nature detail as schemes progress through design stages.

10.15. DfT guidance is that highway models should be tested if the base data are more than six years old. This is not the case. I have furthermore explained in Section 3, 4 and 5 of my proof that the model forecasts reflect major changes, such as the reduction in traffic using the southern corridor following the opening of the East Leeds Link and Inner Relief Road section. I have also explained in Chapters 5 and 6 of my proof the careful consideration given to preparing suitable forecasting assumptions.

10.16. I consider therefore that the data used and performance of the LTM are reliable.

Issue 5 – Preference for NGT

10.17. Objectors have questioned both whether there is a preference and the extent of this preference for NGT over bus services. Comments are also made reflecting the configuration and capacity of vehicles and the consequences of standing.

10.18. Mr Chadwick explains in his evidence [App-7-2] the stated preference research that was undertaken with bus passengers in Leeds to understand their attitudes and preferences to public transport quality. He also explains how the of NGT service attributes have been assessed using this evidence.
10.19. I have explained in Section 6 that I have reviewed these findings and judge them to be consistent with guidance related to a high quality public transport service.

**Issue 6 – Demand by Students living in Headingley will reduce**

10.20. I have explained in Section 5.6 of my proof how changes in population input to the transport model to drive demand changes. The specific inputs to LTM include a reduction in the population resident in the zone.

**Issue 7 – Attractiveness of Park and Ride**

10.21. Concerns over the forecasts expressed by the objectors relate to the proportion of traffic that passes the Bodington site and then continue along the A660 into the centre of Leeds, the difficulty of attracting users from their cars without parking restraint in the centre and issues of perception relating to shared use of the service and the potential to have to stand for the return journey to the car park.

10.22. I have explained in Sections 3 and 4 of my proof how the transport model represents the pattern of travel in Leeds and explicitly represents the time and cost of using park and ride relative to direct car and public transport journeys and thus represents the effective catchment for park and ride sites. I have also explained how surveys were undertaken in 2012 better to understand park and ride behaviour in Leeds and to calibrate the LTM to reflect this. I would observe that the park and ride users surveyed used shared rather than dedicated services and, that they may need to stand on returning to their vehicle in the evening.

10.23. I consider that the basis of and assumptions used in forecasting park and ride demand is reliable.

**Issue 8 – Detrimental Impact on Bus Users**

10.24. Mr Chadwick explains in his evidence [App-7-2] how careful consideration was given to potential bus operator responses to NGT.
10.25. I have explained in Section 6 of my proof that a reduction in the frequency of bus services 1 and 6 is represented in the central case. The effects of this on passenger waiting times are reflected in the demand forecasts and are incorporated in the appraisal of economic benefits. I have explained the impacts of some further potential operator responses in Section 7 of my proof.

**Issue 9 - The traffic impacts of NGT are understated**

10.26. Objectors express concern that NGT will lead to rat-running, buses bunching, that there will be enforcement issues and there will be additional delays to traffic at signal controlled junctions.

10.27. I have explained in Sections 3 and 4 of my proof that the highway network provides sufficient detail and accuracy to represent the overall impacts of NGT along the corridor. I have explained in Section 6 of my proof that the NGT highway design has been represented in the model and, furthermore, illustrated that the model is sensitive and responds to these inputs.

10.28. Mr Robertson explains in his evidence [App-6-2] how he has undertaken a detailed local review of these forecasts and how he has assessed the adequacy of the performance of traffic signals along the corridor.

**Other Objections**

10.29. I believe that all other material objections to the NGT Scheme relevant to this proof of evidence on the basis of Leeds Transport Model have been addressed in earlier sections.
11. Summary & Conclusions

Scope of Evidence

11.1. The purpose of my evidence is to describe the Leeds Transport Model (LTM), how it was applied to produce forecasts and to explain why those forecasts can be relied on. I explain that the forecasts have been used to inform the business case, environmental and highway operational assessment of the NGT scheme.

The need for a Transport Model

11.2. Developing the business case for a transport scheme draws together evidence of its performance and its likely impacts. At the heart of this process is a requirement to test and appraise options. This requires forecasts which are produced by a model. The design of the model is crucial to ensuring that outputs can be produced at an appropriate level of detail. I have shown how the Leeds Transport Model (LTM) has been developed to achieve this.

Model Functionality

11.3. The Department for Transport relevant guidance on modelling (WebTAG Unit 3.11.1) [E-3-15, Section 2.2] explains the requirement for the development and integration of three main components or sub-models: a demand model, a highway assignment model, and a public transport assignment model.

Model Suitability for Assessing NGT

11.4. An initial model known as the Leeds Transport Model (LTM) with this structure and functionality was developed. The data used to develop the model have sufficient detail and quality to understand travel patterns and network performance in Leeds. I have explained that the model development was undertaken in accordance with best practice set out in WebTAG.

11.5. I have also described how due care has been taken to refine the capabilities of the model as the output requirements have changed at different stages of the scheme’s development. This care has ensured that the LTM has
contained the necessary functionality to remain a suitable tool at each stage of the scheme’s development.

11.6. In addition to having suitable functionality, in explaining my view that LTM is suitable for assessing NGT I have also shown that the model:

- is sufficiently detailed to represent the scheme;
- outputs adequately reproduce observed conditions and demand; and
- responds appropriately to input changes.

11.7. I am satisfied that the LTM has been developed with appropriate rigour, in accordance with the methods set out in WebTAG, has suitable functional scope and detail, the outputs comply with the WebTAG criteria tolerances and that it responds appropriately. I conclude that the LTM is suitable to produce forecasts for the NGT TWAO.

11.8. I consider that the LTM outputs are suitable for preparing the business case and appraising environmental impacts of NGT. However, I do not consider that the outputs are directly suitable for use in junction design but I am satisfied that appropriate care has been taken in interpreting them for this purpose.

Future Year Forecasts without NGT

11.9. I have described how the future year scenario without NGT has been prepared. I have explained that the expected growth in population, together with the changes in congestion and the cost of travel, are forecast to result in an increase travel demand in Leeds. I have also explained that traffic congestion along the A660 is forecast to constrain both car and public transport demand using the corridor.

Future Year Forecasts with NGT

11.10. I have explained how the NGT service has been represented in LTM with respect to its route, journey time, stopping locations, quality and fares.
11.11. The forecasts are for NGT use to be greatest in the evening peak hour. 3400 passengers are forecast to use the service in the evening peak hour in 2016. 4000 in 2031 [C-1-8, Table 50]. Hourly flows at other times of day are forecast, in 2031, to be 3200 in the morning peak hour and 3600 during the inter peak period.

11.12. The NGT service would substantially improve public transport along the corridor. The forecasts reflect these improvements. NGT is forecast to capture over half the demand in the corridor and the total use of public transport in the corridor is forecast to increase by about 50%, with bus patronage in the corridor thereby reducing by about a third.

11.13. The traffic management measures proposed are not expected substantively to affect overall traffic flows or journey times along the corridor within the ring road, although there are local effects reflecting the proposed traffic management measures.

Alternative Schemes

11.14. A Next Best Alternative and a Low Cost Alternative scheme have been assessed using LTM. Variations of these schemes have also been assessed. In all cases the usage of the new bus services in these schemes is forecast to be less than the usage of NGT.

11.15. The highway impact of the NBA scheme and its variant is similar to that of the central case. The LCA options have a smaller highway impact as the scheme does not provide as much priority for buses and include some highway improvements that aim to improve conditions for all road users.

Uncertainty in Forecasts

11.16. All forecasts have an element of uncertainty. There are uncertainties in the level of future growth without NGT and uncertainties in the values of the parameters used to describe NGT within LTM. I have used LTM to explore these uncertainties and to understand what impact they may have on the demand forecasts.
11.17. In all these sensitivity test forecasts the impact of NGT is not appreciably different in terms of traffic volumes or performance along the corridor.

11.18. The scale of changes forecast for NGT use [C-1-9, Table 9] are, in summary that:

- a service operating with a frequency of 8 rather than 10 vehicles an hour is forecast to carry 12% less demand;

- charging a 25% premium fare is forecast to reduce NGT demand by 21%;

- operating the same fare as other bus services, rather than a higher charge for short journeys is forecast to increase NGT demand by 2%;
  with the effect evident mainly in terms of short trips within the city centre increasing total NGT trips by 10% [C-1-9, Appendix A];

- increasing in travel time on NGT by 10% is forecast to reduce NGT demand by 9%;

- operating a NGT service where the quality of the vehicles was perceived to be about half that assessed for NGT is forecast to reduce NGT demand by 14%; and

- should operators continue to provide the existing bus service frequency, despite the reduced demand, the increased attractiveness of the bus services would be forecast to reduce NGT demand by 4%.

**Conclusions**

11.19. I am satisfied that the LTM has been developed in accordance with DfT WebTAG to be used to inform the design and to undertake operational, economic, environmental appraisal to inform the business case of NGT. I consider the LTM is suitable for the assessment of NGT as part of the TWAO and that its outputs can be relied on for these purposes.