DURHAM

LOCAL PLAN

TRAFFIC IMPACT

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Durham Local Plan Traffic Impact

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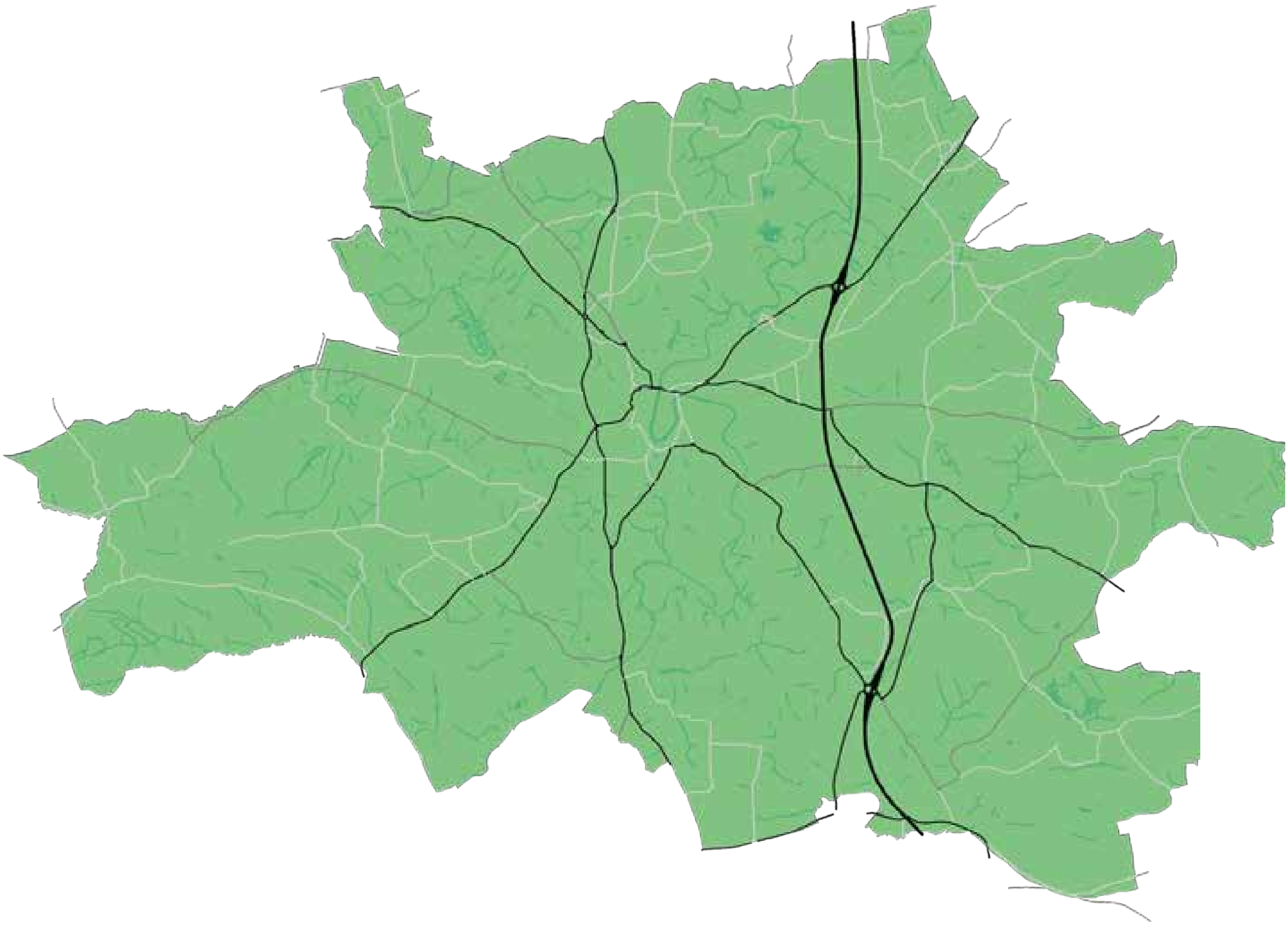
1. INTRODUCTION

The County Durham Plan will seek to meet the housing needs of residents and will aim to support economic growth through employment land allocations across the county. Transport infrastructure has a key role in this respect. It is widely accepted that there is a direct link between the productivity of a city or region and the performance of its internal and external transport infrastructure linkages. This study therefore considers the impacts of predicted housing and employment growth in County Durham on the operation of the local road network in the future.



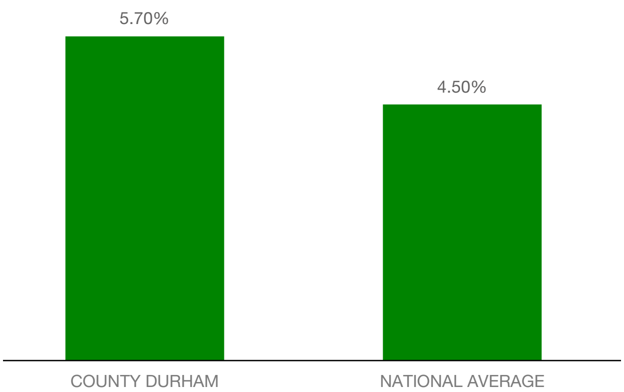
1.1 ECONOMIC CONTEXT

Current evidence suggests that County Durham is underperforming economically. The unemployment rate in County Durham is 5.7%, higher than the national rate of 4.5% (March 2017 figures). When considering Gross Value Added (GVA) per person in County Durham, this stood at £16,513 in 2016 and is significantly lower than the figures for the North East (£19,542) and UK (£26,320).

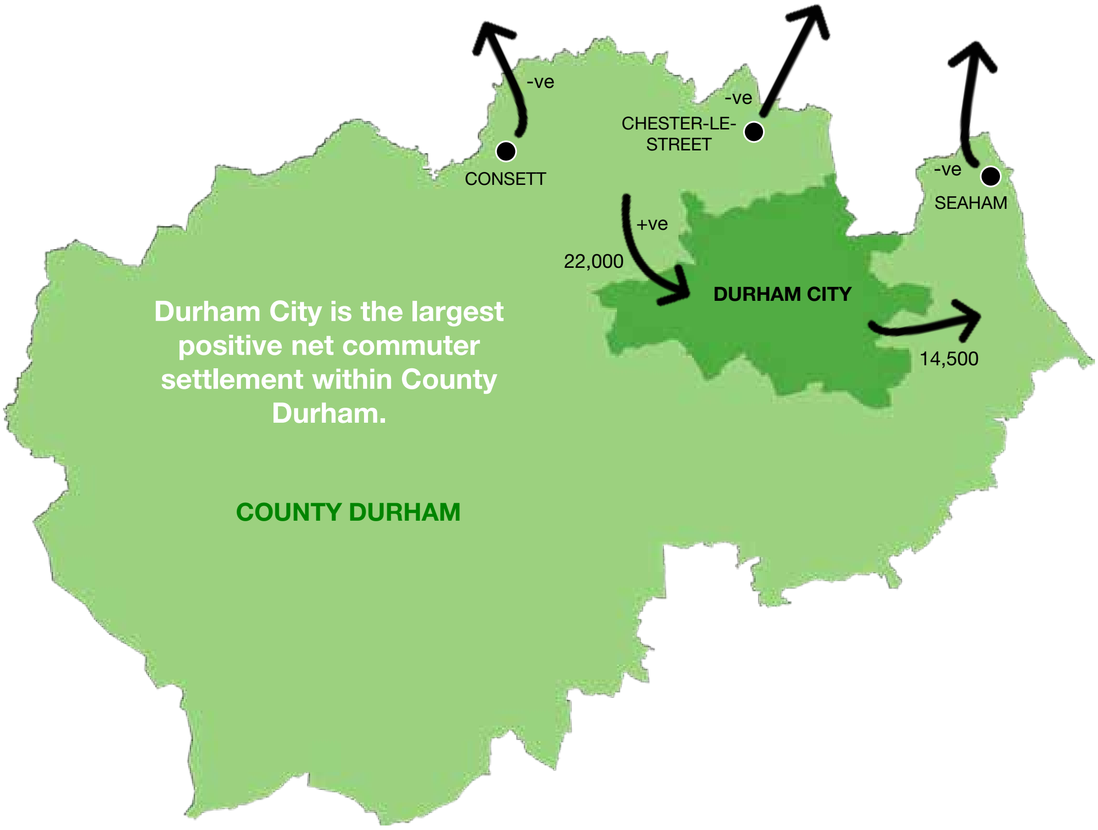
Durham City is the county's largest employment centre with 33,940 people working in the city. Newton Aycliffe and Peterlee are the next highest employment centres in County Durham, which are located near major transport corridors and they also have positive net in commuting statistics. Alongside Durham City, settlements such as Peterlee, Newton Aycliffe, Consett, Chester-le-Street and Bishop Auckland will all have a role to play in generating employment for the county.

Indeed, not only is Durham City the key employment centre within the county, it is also a major commuter destination for cross boundary journeys with 25% of all commuting journeys from neighbouring local authorities into the county destined for the city.

A clear relationship between the location of employment and commuting patterns exists within the county. Over 36,000 inward commuting journeys to Durham City are made every day, while the number of outward commuting journeys is under 14,500, representing a positive net commuting figure for the city of nearly 22,000. The only employment centre across the region with more inward commuting journeys is Newcastle with 88,000 journeys per day. This demonstrates that Durham City is a major attractor of economically active people within the county, and is also of importance in relation to the wider north.



UNEMPLOYMENT



Cross-boundary, work-related journeys from County Durham to neighbouring local authorities represent a leakage of productivity outside of the county. As evidenced by existing Census working patterns, provision of housing development in settlements located on the periphery of the county could result in a higher number of cross-boundary journeys as these areas have a strong links with neighbouring authorities. These commuting patterns highlight that the location of housing and employment development plays an important role in the economic performance of the city and wider county.

1.2 ACHIEVING HOUSING GROWTH

In recent years, ever increasing population within the UK has set the tone for central government to emphasise the importance of providing new homes in the right places within local authority areas. The Local Plan process aims to bring increased certainty to housing and employment growth in line with national needs and employment land allocations, appropriate for the county in accordance with their employment land review.

Not only is it imperative that County Durham strives to achieve its targets for housing growth, but it must do so in a way that maximises the ancillary benefits of this increased housing and population. It is generally accepted in housing market economics that the most optimum scenario for productivity gain is to balance labour force and jobs across an area. Locating housing in the largest settlements with the most employment opportunities would continue, and promote, trends of labour force productivity capture within the county, as well as encourage inward investment from employers.

1.3 IMPROVING AIR QUALITY

The Durham City Sustainable Transport Delivery Plan 2019-2035 (SYSTRA, 2017) cites the EU's European Environment Agency's statement that pollution is now the single largest environmental health risk in Europe, responsible for more than 430,000 premature deaths. Furthermore, the World Health Organisation has issued new warnings about deadly levels of pollution in many of the world's biggest cities, including the influence of traffic emissions.

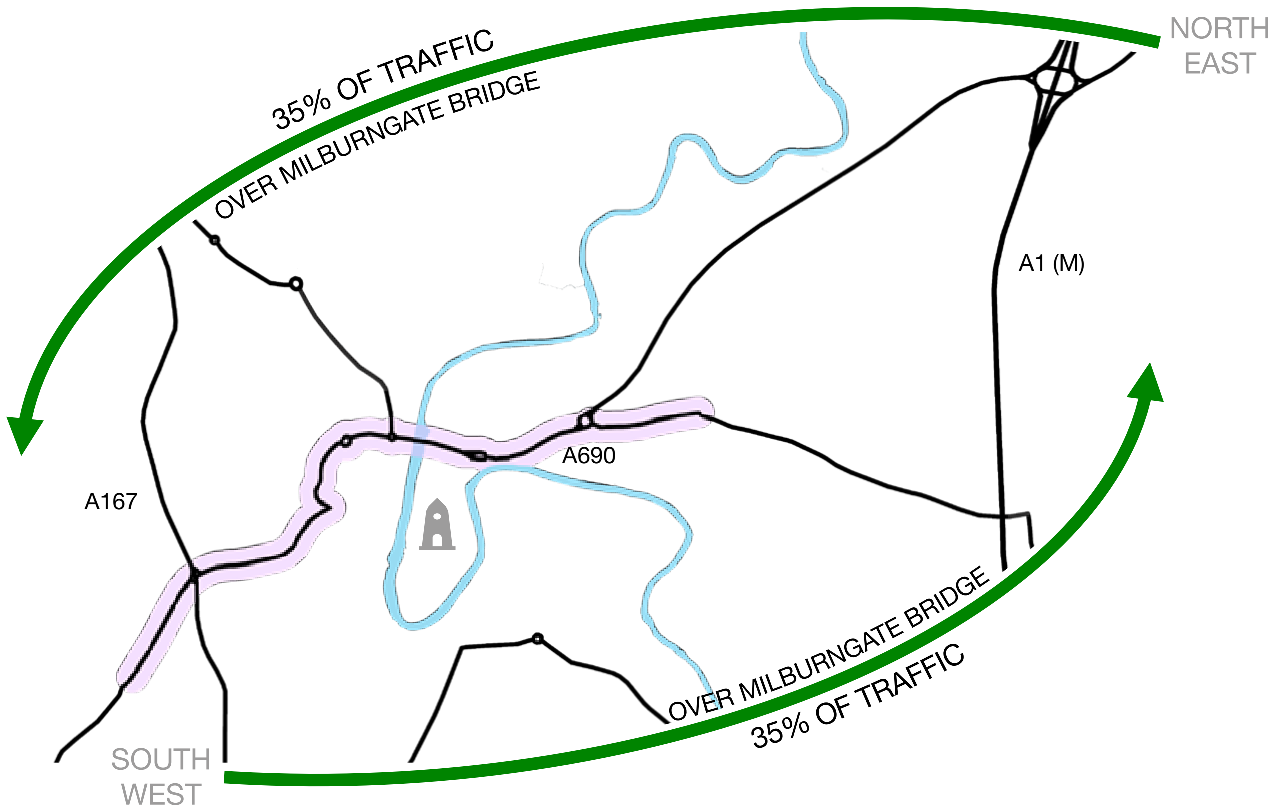
Air quality is also high on the national agenda at the time of writing, with the Department for Environment, Food and Rural Affairs (DEFRA) openly challenging local authorities to better problematic areas of air quality or face fines and interventions such as toll roads/ charge zones.

Given its designation as a World Heritage Site, it is surprising to note that air quality is a significant issue affecting Durham City, impacting on both public health and the natural environment. Durham Cathedral World Heritage Site was the most visited free attraction in the North East in 2015, attracting around 755,000 visitors. In 2016, 4.2 million people visited Durham City, making a total contribution to the Durham City economy of £806 million through expenditure and direct employment. Any worsening of air quality may negatively impact Durham City's appeal to visitors, in turn threatening a large contributor to the city's economy.

Poor air quality in the city is a direct result of decisions taken in the 1960's to channel all traffic into the city. Indeed, at the time the main city centre route was planned it was entitled the "New Through Road". This now feeds over 40,000 vehicles per day into the city centre over a single crossing point of the River Wear.

In 2011 Durham County Council declared an Air Quality Management Area within the centre of Durham City, covering the Highgate, Milburngate and the Gilesgate areas. The AQMA was extended in 2014 to cover the western area of the city, including Neville's Cross, in addition to areas of Claypath and New Elvet. These locations also experience high levels of traffic congestion and queuing vehicles highlighting further the competing interests of a historic centre and a key economic area.

The importance of improving air quality through Durham City is highlighted within the Durham City Sustainable Transport Delivery Plan. The principal objective of this action plan is to remove motorised journeys through the city, which will directly improve air quality standards. Approximately 35% of observed journeys through the centre of the city are designated as 'through journeys'. This highlights a stark lack of available strategic alternatives for longer distance travellers, ensuring that Durham City experiences the negative impacts of these journeys and no tangible benefit.


35% OF TRAFFIC
OVER MILBURNGATE BRIDGE
NORTH EAST
A1 (M)
A690
A167
OVER MILBURNGATE BRIDGE
35% OF TRAFFIC
SOUTH WEST

1.4 FUTURE-PROOFING DURHAM'S ROAD NETWORK

The population of County Durham, like the wider north and the rest of the UK, is set to rise in the future. Rising population is likely to be accompanied by rising car ownership levels and this will fundamentally encourage increased private car journeys. Regardless of the setting or geography, it is clear that the 'want' or demand for motorised travel is increasing.

A strategic transport model of the city has recently been produced to assess the impacts of this increasing demand for travel, making use of data from a series of roadside interviews and traffic surveys conducted in 2015. Analysis of the Durham Strategic Transport Model shows Durham is a city which suffers from congestion currently. The contributory factors to the condition of congestion are numerous, and include but are not limited to:

• Key junctions in the city approaching designed capacity

• Key roads through the city approaching design capacity

• A lack of viable strategic alternatives

• A high proportion of through traffic

• Existing parking constraints both on and off street

• Natural pinch points crossing the river when travelling east or west

And most tellingly:

• A road network which has not changed in strategic composition in many years other than to channel more traffic through the city centre.

Congestion on the road network also has a negative impact on sustainable travel modes by causing longer bus journeys and creating an uninviting environment for cyclists and pedestrians to navigate; factors which can discourage the uptake of sustainable travel. It is not just the road network which is under strain, there are also rising patronage levels on the East Coast Main Line.

To address the impacts of these constraints, effective planning is required to identify the forecast traffic impacts on the city's travel network. This includes sustainable modes of travel, alongside existing road network and performance. The County Durham Plan will meet the housing needs of residents, but without the ability to plan and future-proof for increasing housing and jobs growth, the accessibility of Durham City and the wider county will remain relatively static. The transport implications of growth in Durham City are explored later in this study.

2. A TRAVEL NETWORK UNDER PRESSURE

Durham City has grown in importance over many years as an employment, tourism and leisure destination as well as a desirable place in which to live. However, the network of key road routes in and around Durham City has remained largely unchanged for many years. The routes which have served the city for decades have not been supplemented with new road infrastructure to cope with modern day traffic levels and evolving travel patterns. There are a variety of reasons for this due to numerous local constraints, including:

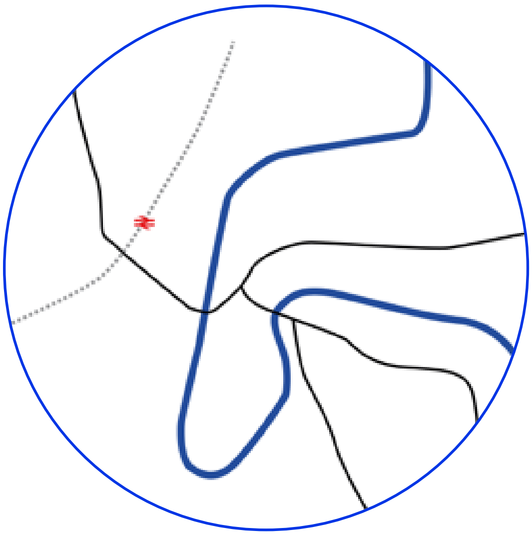
• Green belt - the green belt encircling Durham City is designed to protect the character and landscape of the area.

• Topography – the River Wear runs from south to north through the middle of city and presents a substantial natural barrier.

• Strategic national infrastructure – the A1(M) runs north to south along the eastern edge of the city while the East Coast railway intersects the city centre. Each pose physical barriers to the expansion of Durham's travel infrastructure.

According to the Durham City Major Centre 2016 Statistical Profile report, the population of Durham City increased by 1.6% between 2010 and 2015. The report also highlights an increase of 5.3% in the number of households with access to at least 1 car between 2001 and 2011. However, despite the trends of increasing population and car ownership, traffic levels within Durham City have remained fairly static throughout the last decade. While the rest of the UK has generally experienced traffic growth during this period, the contrasting evidence in Durham suggests the city's road network has essentially reached its capacity.

This suggestion is reinforced by the long-term growth in rail passenger numbers at Durham Railway Station which have more than doubled between 2000-01 and 2015-16. Clearly while the use of other strategic transport infrastructure in Durham such as the East Coast railway is growing, the city's constrained road network is unable to follow suit and support any growth in traffic.



1857

56 years from the first Census, Durham City had a population of between approximately 7,000 and 8,000. The main routes into the city very much reflect the current day road layout and designation.

1953

Almost 100 years later, and the population of County Durham saw an increase of 274%, establishing Durham City as a more prominent destination.

2018

A further 65 years on and the principal road network in Durham City remains incredibly similar to that of 1953, except it now has to cater for upwards of 65,000 residents in the City and many more in the wider region.

3. YOUR TRAVEL THROUGH DURHAM NOW

The Durham City road network currently experiences a number of problems which restrict its ability to operate efficiently and reliably. These problems have been identified through the recent traffic surveys and analysis, which show that several key city centre road links and junctions experience significant delays during peak periods. Strategic routes such as the A167, A691 and A690, which provide north-south and east-west connectivity across the city respectively, are particularly affected by lengthy journey times and low average speeds.

A690

The A690 provides access to Durham for strategic traffic from the east, extending into Sunderland, as well as access to traffic from the north and south through its connection with the A1(M). It carries in the region of 1,300 vehicles westbound into Durham City between 8am and 9am on a typical morning and represents a key arterial route for the area. This is the equivalent of one vehicle every three seconds.

Of this morning peak traffic using the A690, approximately 35% has a destination outside of the city extents. This shows that a significant proportion of traffic is passing through the city centre simply because of a lack of suitable alternative east-west routes across the city.

The Gilesgate and Leazes Bowl junctions along this route are both well know pinch-points which cause delay to journeys to and from the city during the peak morning and evening periods. Travel into Durham City along the A690 from its junction with the A1(M) can take from 7 up to 19 minutes during the morning peak. This equates to an average speed between 7 and 20 mph. This represents an underperformance of a strategically important A-road.

Furthermore, the lack of resilience of this route to cope with traffic incidents leads to queues forming onto the A1(M), impacting upon the operation of the trunk road network.

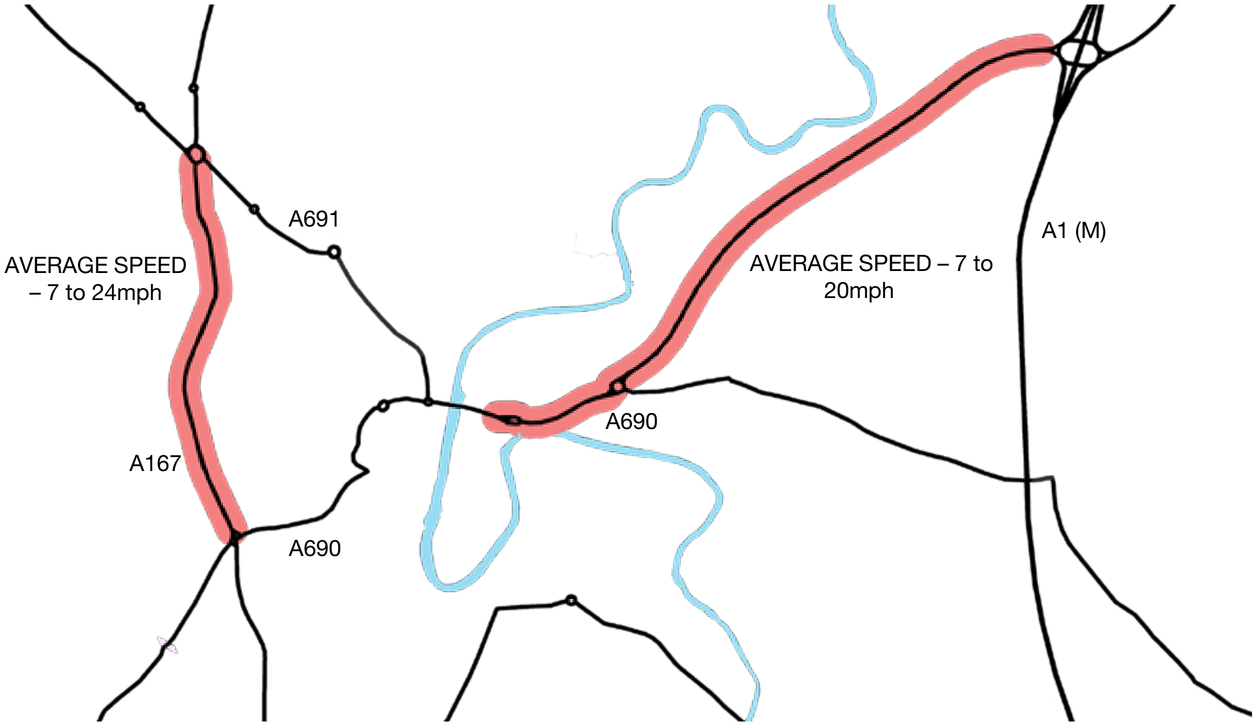
A167

The A167 corridor is a key north-south route connecting the city of Durham with Gateshead and Newcastle upon Tyne. Although it is an historically important route which links these key economic centres, the A167 corridor does not just serve as a through route to traffic. It also performs an important function locally within Durham enabling access to the University Hospital of North Durham, New College Durham, Durham Johnston school and the Sniperley Park and Ride site.

Both the A691 and A690 intersect with the A167 at the Sniperley roundabout and Neville's Cross junctions respectively. Situated between these two junctions is the Toll House Road junction. The interaction of the A167 with each of these busy side roads causes congestion and slow moving traffic which negatively impacts upon the performance of the corridor.

During peak hours at the A691 Sniperley roundabout junction, traffic on the A167 often queues through the junction, which not only causes delay to north-south A167 traffic but also impedes the movement of east-west traffic heading to and from Durham City.

The junction with Toll House Road, which serves the village of Bearpark to the west of the city, currently causes long queues and presents a major constraint for both northbound and southbound traffic on the A167. During the evening peak period in particular, a high demand for southbound A167 traffic turning right onto Toll House Road restricts the southbound flow of traffic along the A167. This junction is also used as a 'rat-run' into Durham City for east-west traffic which uses a combination of Toll House Road and the nearby Redhills Lane to traverse the A167, further highlighting the poor east-west connectivity across Durham.



* Results based on the morning peak period of 8am to 9am.

At the A690 Neville's Cross junction, a heavy flow of traffic during the morning peak period from the western arm of the junction onto the A167 northbound can cause queueing as the northbound traffic merges from two lanes into one. During the evening peak hour, the high volume of traffic turning right from the A167 onto the A690 westbound causes queueing which prevents the straight ahead southbound movement on the A167.

In the morning peak period between 8am and 9am, approximately 1,500 vehicles flow into the Sniperley roundabout from the A167 southbound and the A691 eastbound. Of these 1,500 vehicles, approximately 30% continue southbound along the A167 to the Neville's Cross junction. Similarly, at the Neville's Cross junction, approximately 1,500 vehicles enter the junction from the A167 northbound and the A690 eastbound. Approximately 55% of this traffic continues northbound along the A167 to Sniperley roundabout. This demonstrates that in both directions combined the A167 not only plays an integral role for access into the city but also for strategic north-south journeys.

During the morning peak period, a southbound journey along the A167 from the A691 Sniperley roundabout junction to the A690 Neville's Cross junction can take between 3 and 11 minutes. This equates to an average speed of between 7 and 24 mph. Again, this is substantially below the standard of a strategic A-road, and underlines the congestion issues drivers face on this route.

A691

The A691 corridor which provides a route into Durham City from Consett is also affected by congestion in and around the city centre during peak periods. In particular, Framwellgate Peth approaching Milburngate Bridge represents a key pinch point on the road network. As discussed previously, the interaction of this route with the A167 corridor at the Sniperley roundabout is also a constraint to the flow of traffic in and out of the city at busy times.

INTERNAL JOURNEYS

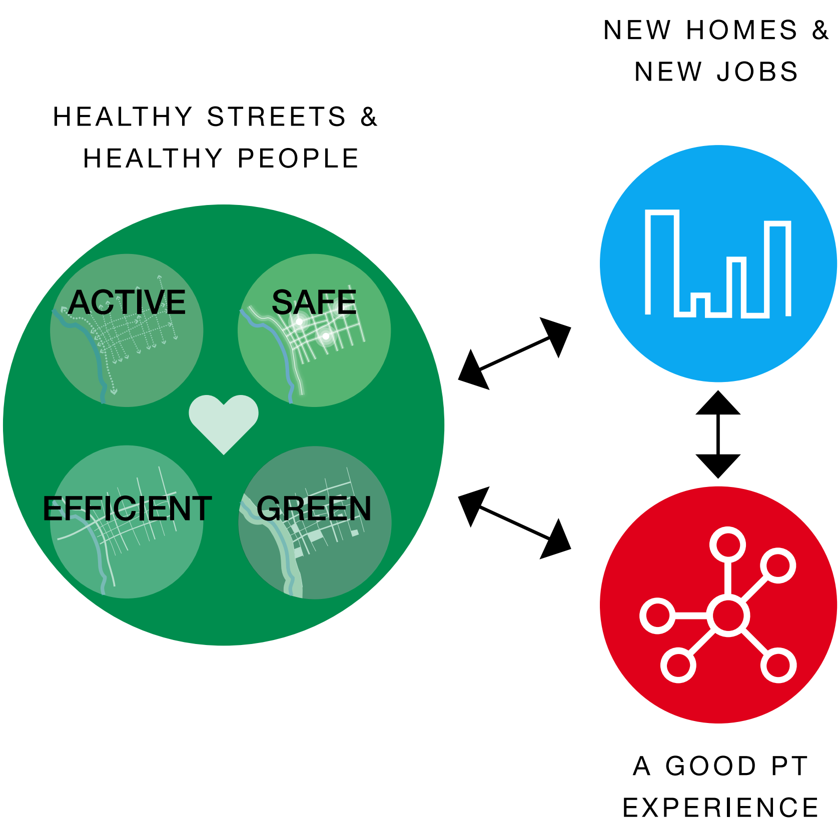
In terms of internal travel within the Durham City area, 30% of car commuting journeys which originate in the city, stay within the city. This level of journey retention is the highest of all the large settlements in the county and reflects Durham City's role as its economic centre.

With such a high dependency on the city centre road network for access to employment, it is vital that the key strategic routes for both private and public transport modes operates as efficiently as possible. The high proportion of through journeys which utilise the arterial city centre routes and occupy limited road space contribute to the problems of increased journey times, queueing traffic and poor air quality described previously. All of these issues have a detrimental effect on both the economy and environment of the city.

PUBLIC/SUSTAINABLE TRANSPORT

When it comes to sustainable travel, the nature of Durham City as a relatively compact city lends itself to the use of active travel modes such as walking and cycling. Indeed, according to the 2011 Census, over one third of the residents of Durham City walk to and from work. There is generally a good quality network of footways and footpaths across the city centre which provide for journeys on foot. This has been complemented by the introduction of shared pedestrian and cycle routes, such as those on Framwellgate Peth, to further support active travel.

Durham Railway Station is a major asset to the city and provides strategic connectivity via the East Coast Mainline. With 2.6m passengers using the station in 2015-16 and passenger numbers growing annually, Durham's rail connection is becoming increasingly important to both the business and visitor economies of the city. In addition to the existing rail facilities, County Durham has an extensive bus network. At the heart of the bus network is Durham City bus station, which is accessible to 70% of County Durham households within 60 minutes' door-to-door bus travel. There are three Park and Ride sites in Durham City situated on three of the main routes into the city, each providing frequent services to surrounding areas and a sustainable alternative to private car journeys into the city. This underlines the strength of Durham City's sustainable transport network and as a whole this network contributes to reducing congestion and pollution in the city centre.



4. YOUR TRAVEL IN THE NEXT 20 YEARS

The demand to travel both into and through Durham City over the next 20 years is only set to increase.

Using a combination of the Durham Strategic Transport Model and national planning tools to forecast growth and development, it is possible to assess what effect this increase in demand will have on the local road network.

Tests have been carried out into the effects of introducing housing and jobs growth in County Durham by the years 2022 and 2037 based on national forecasts. Results have shown that the operation of the road network in Durham City worsens in each of these future years with the anticipated levels of traffic growth based on these forecasts.

In each of these future scenarios, deterioration in the performance of Durham City's already congested road network is anticipated, which increases journey times and delays across the network. By the year 2022, the number of vehicles on the Durham City road network between 8am and 9am is expected to increase by approximately 4%, resulting in a two-way increase in journey times on the city's major routes of up to circa 6%. By 2037, the number of vehicles on the road network in Durham City road between 8am and 9am is expected to increase by approximately 20%, resulting in two-way journey time increases of up to circa 11%.

It is anticipated that the key junctions across the city, including the Sniperley roundabout, Neville's Cross and Leazes Bowl, will be required to handle in total in the region of an additional 700 vehicles in 2022 and 1800 vehicles in 2037 in the morning peak.

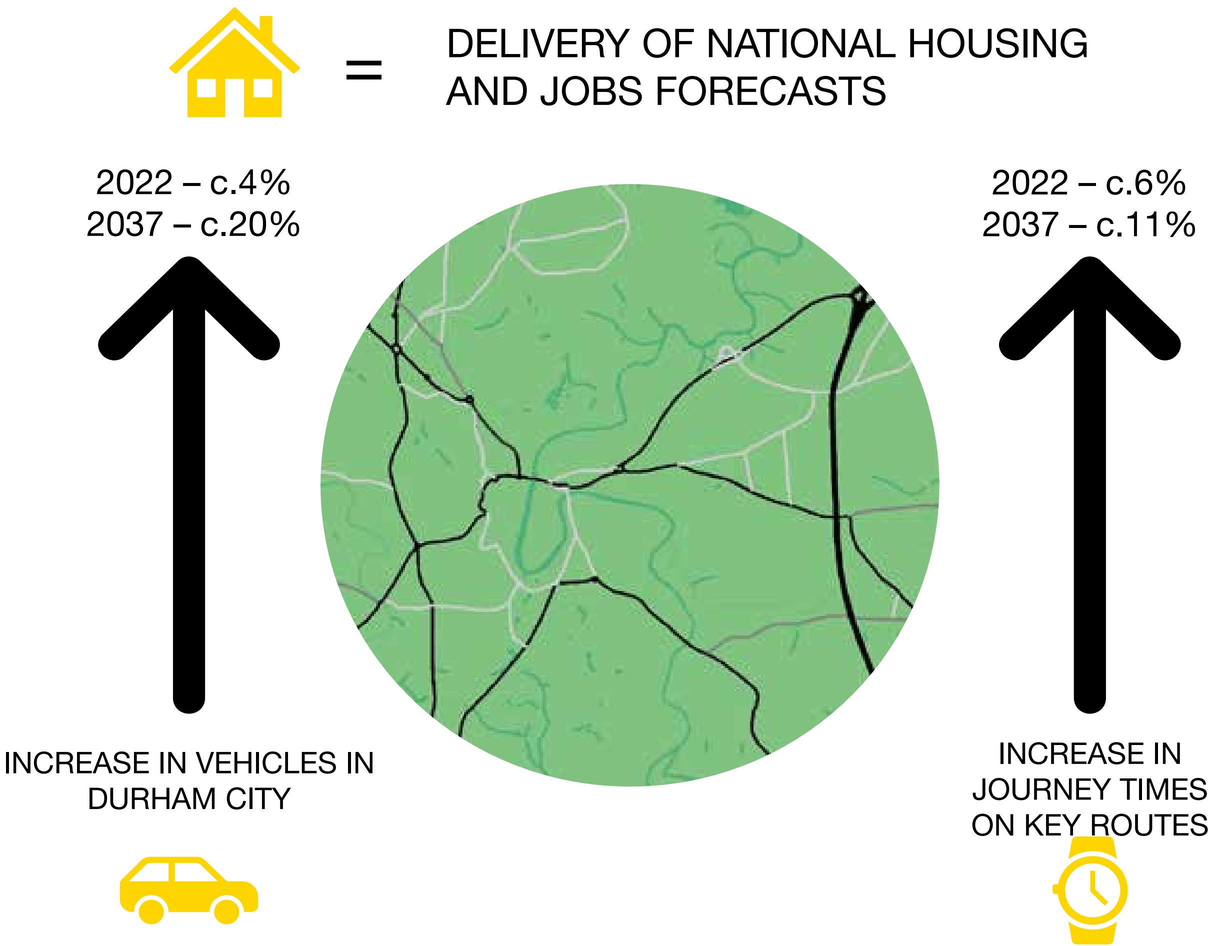
A number of the key junctions and strategic links described earlier in this document move further towards their total design capacity by 2037, as a result of forecast traffic. It should be noted that whilst overall design capacity of the key junctions has not been exceeded as a whole, this doesn't reflect the nuance of some of the arm-to-arm interactions. In current conditions, at key junctions such as Sniperley roundabout, Gilesgate roundabout and Leazes Bowl there are arm-to-arm movements that are at capacity and these would be further exacerbated with forecast traffic increases.

Without the introduction of transport improvements, the current configuration of the Durham City road network will not effectively support traffic increases brought about by housing and employment growth in line with national forecasts.

Increasing demand for journeys into the city centre also has the potential to force more non-centre journeys onto inadequate, non-strategic diversionary routes i.e. 'rat-runs', thus spreading congestion further out from the centre.

In summary, the Durham City road network is already constrained under current traffic conditions and is not equipped to adequately handle 'business as usual' i.e. growth without any transport mitigation measures, over the next 20 years.

An increasingly congested road network is more unstable and unreliable and makes journeys less predictable. An increase in congestion will also act as a deterrent to people selecting more sustainable modes and result in an increase in air pollution. These issues will also impact upon realisation of policy goals - promoting economic prosperity, achieving housing growth, improving air quality and future-proofing Durham's travel network. If housing and employment growth targets are unable to be met this will have a direct impact on the economic performance of the city. Having already established via Census data that Durham City represents a key county-wide and regional economic driver, the impacts of stifled economic growth in the city are likely to be far-reaching.

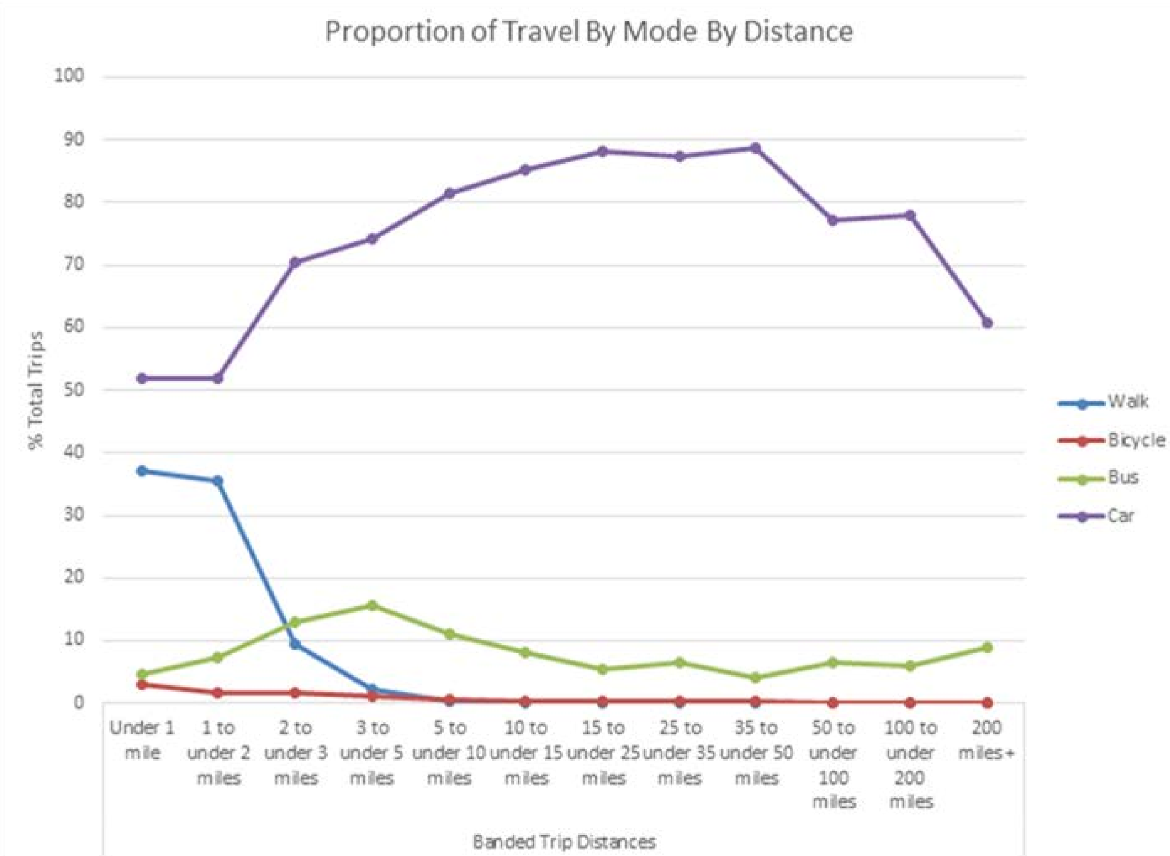


Results based on the morning peak period of 8am to 9am.

5. THE SOLUTION

As highlighted previously within this document, in order for County Durham to fulfil its economic and housing ambitions, focussed development within the city centre is a priority. However, with the potential benefits of locating housing and jobs growth within the city come a number of constraints that must be addressed to ensure successful delivery. The focus of this document is centred around the direct traffic related impacts of housing and jobs growth within Durham City on the existing road network and how this can enable or deter growth.

It has been shown that travel conditions in and through Durham City today are approaching exceedances in design, resulting in a slower, less resilient road network than that required of a key economic centre. Whilst traffic conditions have been forecast to worsen in the city, this is simply compounding existing issues – i.e. as the demand for travel into and through the city increases, there is no scope for it to do so within the current infrastructure. Therefore, to meet the growth objectives identified, infrastructure solutions in hand with other sustainable transport and air quality solutions must be sought.



5.1 THE OBJECTIVES: IMPROVING AIR QUALITY AND FUTUREPROOFING DURHAM'S ROAD NETWORK

To be able to meet both of these objectives, the solution is relatively straightforward; reduce private car travel in the centre of the city. However, how this is achieved requires a combination of approaches to best maximise the shift of traffic out of the centre of Durham City.

Sustainable travel initiatives, as highlighted previously in this document, can play a significant part in helping to reduce private car journeys through the centre of the city. There are aspirations aligned with the Local Plan to increase the use of sustainable travel modes through the centre of Durham City through various walking, cycling and public bus/park and ride enhancements. These initiatives have encouraged forward thinking about restraining capacity through the centre of the city in order to introduce space for sustainable modes.

This is a crucial, positive step towards reducing private car travel and improving air quality in the centre of Durham City. However, there is still an underlying issue that will not be addressed by the inclusion of the proposed sustainable travel measures; strategic through journeys.

It is known that generally, longer distance journeys are less likely to switch to local, sustainable modes of travel. Rail based travel is different, and caters for long and short distance movements but obviously a key requirement is the availability of stations in close proximity to the start and end points of a journey. Within Durham City, it has been shown that up to 35% of journeys going across Milburngate bridge are external to the city on both sides of the journey. As such, sustainable travel measures that are focussed on providing travel alternatives to and from the centre of Durham City are not going to cater for these strategic through journeys.

Whilst a shift to sustainable travel can be promoted within the city, the National Travel Survey suggests that walking and cycling activity travel drops off considerably after a distance of 3 miles. Public bus is also a well-considered mode of travel up until a journey distance of 5 miles. From that point on, private car travel dominates in terms of mode share.

The diameter of Durham City is roughly 5 miles. Therefore, it could reasonably be expected that the only trips that are able to be influenced greatly by sustainable travel initiatives are those which start and end within, or close to, the city boundary. Strategic through traffic is an issue for the city centre, and this is unlikely to be influenced by any sustainable travel initiatives.

As a benchmark for the possible switch to sustainable modes of travel, Darlington and their Local Sustainable Transport Fund work can be used. This scheme saw a switch of up to 15% of trips being made by sustainable modes. However, this was a sustained and targeted campaign which included educational, promotional and infrastructural measures. If Durham City achieved a 15% switch to sustainable modes from private car, it would result in a reduction of approximately 170 vehicles across the most highly trafficked roads such as the A167 and A690, which would not be enough to mitigate the issues described within this document.

It follows that a solution to removing cross-city strategic journeys must be found, correcting previous errors in planning major roads through the city centre. The solution to removing these journeys is to provide a strategic alternative for east-west (or north-east-south west) movement. This is in line with a deficiency of suitable east-west connectivity in the wider north.

Through testing in the Durham Strategic Transport Model, it becomes clear that a Northern Relief Road (NRR) facilitates the removal of journeys from the city centre. The NRR would be located towards the north east of the city centre between the A167 at Pity Me and the A690 at Carrville. Testing has been carried out for 2037. Between 8am and 9am, in excess of 1,800 vehicles use this alternative route in both directions. This results in a reduction of circa 13% of vehicles through the city centre in both directions. Similarly, a reduction of over 7% of vehicles is seen through key junctions in the city, illustrating that traffic levels within the centre are reduced as a result of the NRR.

A key facet of the Sustainable Transport Delivery Plan was that together with the creation of a Northern Relief Road, demand restraint measures would be introduced in the city centre. One such measure which has been tested in the Durham Strategic Transport Model is a reduction in the number of lanes on Milburngate Bridge, from two lanes per direction to one lane per direction, in order to reallocate road space to sustainable modes. The introduction of the NRR improves journey times in both directions on the A167 and A177 in the AM peak, as shown below, but has a lesser effect on delays on the A690 due to the lane reduction on Milburngate Bridge. This is advantageous as it encourages use of the NRR for through traffic.

- A167 – 5% journey time reduction southbound and 3% reduction northbound
- A691/A177 – 4% journey time reduction westbound and 6% reduction eastbound
- A690 – 4% journey time reduction westbound and 3% increase eastbound

It is clear from these figures that the NRR shifts strategic traffic from the city centre. The benefits of this re-routing are numerous. Direct impacts include:

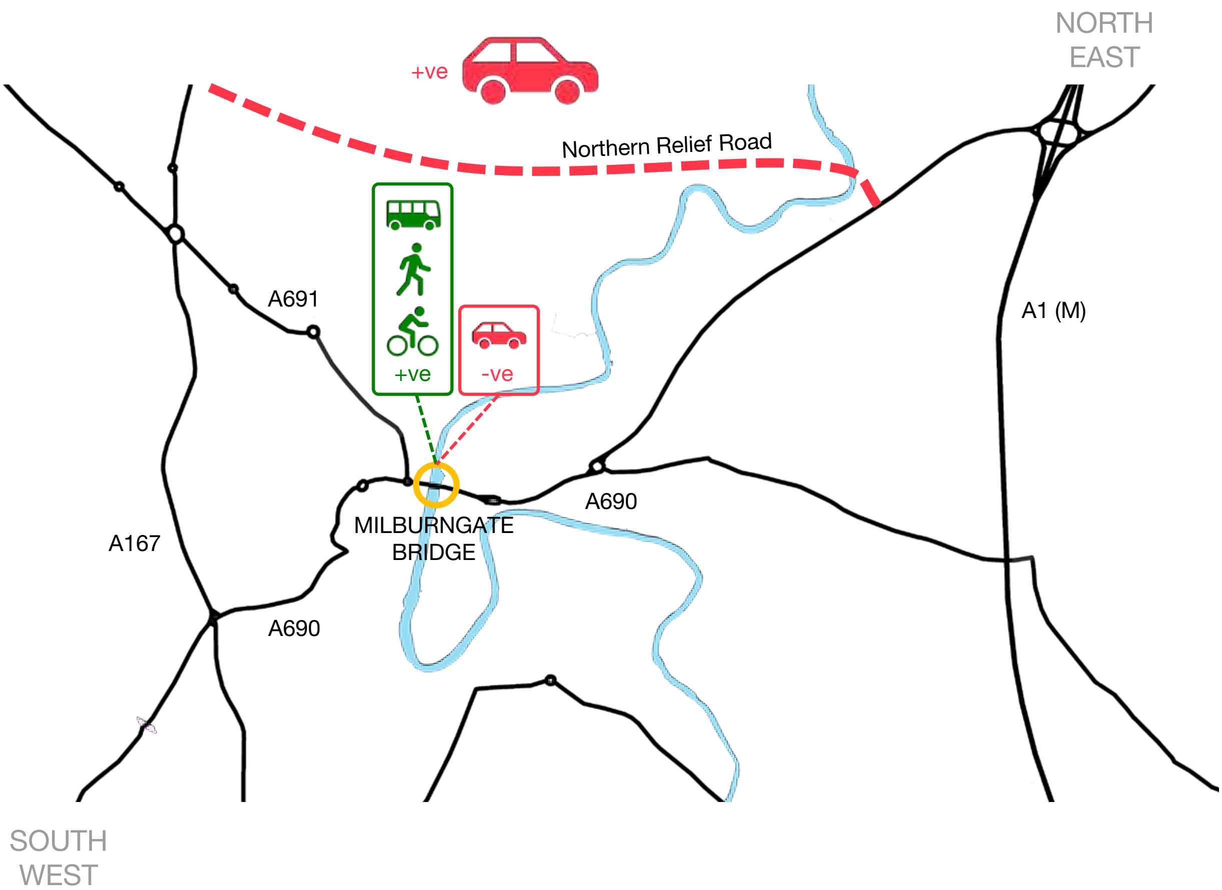
- Air quality improvements within the designated AQMA areas and known pinch points within the city centre. This in turn will have direct benefits on public health and contribute towards the promotion of a World Heritage Site. Further air quality modelling is ongoing and the potential exists to eradicate the current exceedances in the city.

• Sustainable travel is supported on key routes through the city promoting inward investment in initiatives to benefit walkers, cyclists and public transport users.

Additionally, there is a contributory benefit to the inclusion of the NRR:

• It improves travel conditions within the constrained urban core of Durham City, allowing for the enabling of development of housing to meet national forecasts and the introduction of jobs that are more likely to be served by the local labour force, increasing the productivity of the county.

However, it should be noted that with the introduction of the NRR, there are still wider constraints within the city that would need to be addressed in order to meet the objectives set out within this document. Such issues include the interaction with the western side of the city. The A167 is known to be another one of the busiest routes through the city along with the A690. Removing strategic traffic from the city centre via the NRR migrates issues with congestion and network constraints to the north west



of the city around the Sniperley area. As such, a more holistic approach is required to safeguard the performance of the entire network in the future and the delivery of housing and jobs growth.

5.2 THE OBJECTIVE: PROMOTING ECONOMIC PROSPERITY, ACHIEVING HOUSING GROWTH IN LINE WITH WIDER GOVERNMENT POLICY

Notwithstanding the objectives, constraints and solutions identified earlier in this document, further improvements are required to be made to Durham City's road network infrastructure to fully unlock housing and jobs growth in and around the city, facilitating the meeting of government targets and wider aspirations to increase the economic prosperity of the county.

The A167 has been shown, through the Durham Strategic Transport Model and associated Micro-Simulation Modelling, to be relatively one of the most congested and constrained key corridors through the city. Regular queuing into the city on busy morning peaks results in delay in accessing key employment or attraction centres such as County Hall, University Hospital of North Durham or Durham University. Furthermore, this congestion passes local schools presenting a direct conflict between walking and private car movements.

Unlocking this corridor through reducing congestion is seen as key to enabling further growth, both housing and jobs, within the city. As part of recent studies into the options available on the A167, work has been carried out by AECOM to identify whether remedial solutions within the footprint of the current infrastructure is possible. The conclusions from this piece of analysis suggested that there is not enough scope to make modifications to the junctions or connecting roads on the A167 in its current layout to fundamentally improve traffic through flow. As such, the conclusions were drawn that fundamentally, congestion along this route is not alleviated enough to solve the current issues or forecast issues associated with the demand for travel along the corridor increasing. That is to say that the network can't cope under current peak hour conditions, therefore it has little chance of coping with any increased traffic volumes as a result of new housing or jobs growth in the local vicinity.

Similarly, to the A690, the A167 caters for large numbers of strategic journeys. Along with the A1(M), it provides only one of two high standard north-south routes. To cater for these strategic journeys, and alleviate known congestion issues along the A167, a Western Relief Road (WRR) is proposed. The WRR would connect the A691 and A167 with the A690, to the west of Durham City centre.

Through testing in the Durham Strategic Transport Model, it becomes clear that the WRR in isolation facilitates the removal of journeys from the A167. Testing has again been carried out for 2037. Between 8am and 9am, up to approximately 1,400 vehicles use this alternative route in both directions. This results in a reduction of approximately 30% of vehicles (between Sniperley roundabout and Neville's Cross) along the A167 in both directions. Similarly, a reduction of approximately 4% of vehicles is seen through key junctions spanning the A690 and A167, illustrating that traffic levels within the city are reduced as a result of the WRR.

The reduction in traffic on key strategic corridors and junctions within the city inevitably during the AM peak creates a product of improved journey times through the centre, more specifically:

- A690 – a two-way reduction of up to 1%

• A167 – a two-way reduction of up to 9%

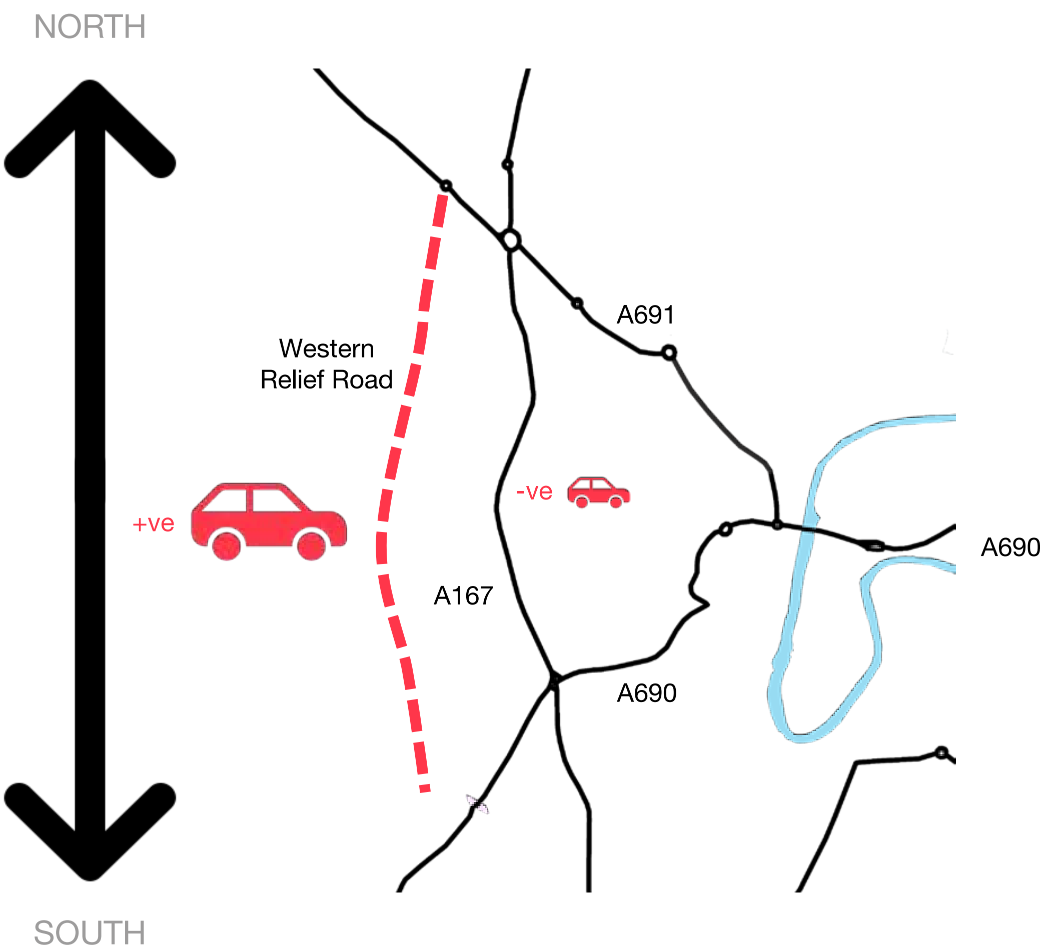
• A691/A177 – a two-way reduction of up to 1%

It is clear from these figures that the WRR shifts strategic traffic from the A167. Direct benefits include:

• Less congestion on the existing A167 which provides a more reliable and resilient route for north-south journeys to or through Durham City.

• Existing infrastructure on the A167 is more capable of coping not only with existing traffic conditions, but forecast traffic conditions associated with additional housing and jobs growth.

The direct impacts of the WRR on removal of car traffic through the centre of Durham City is less pronounced than the NRR. However, the WRR is viewed as a network



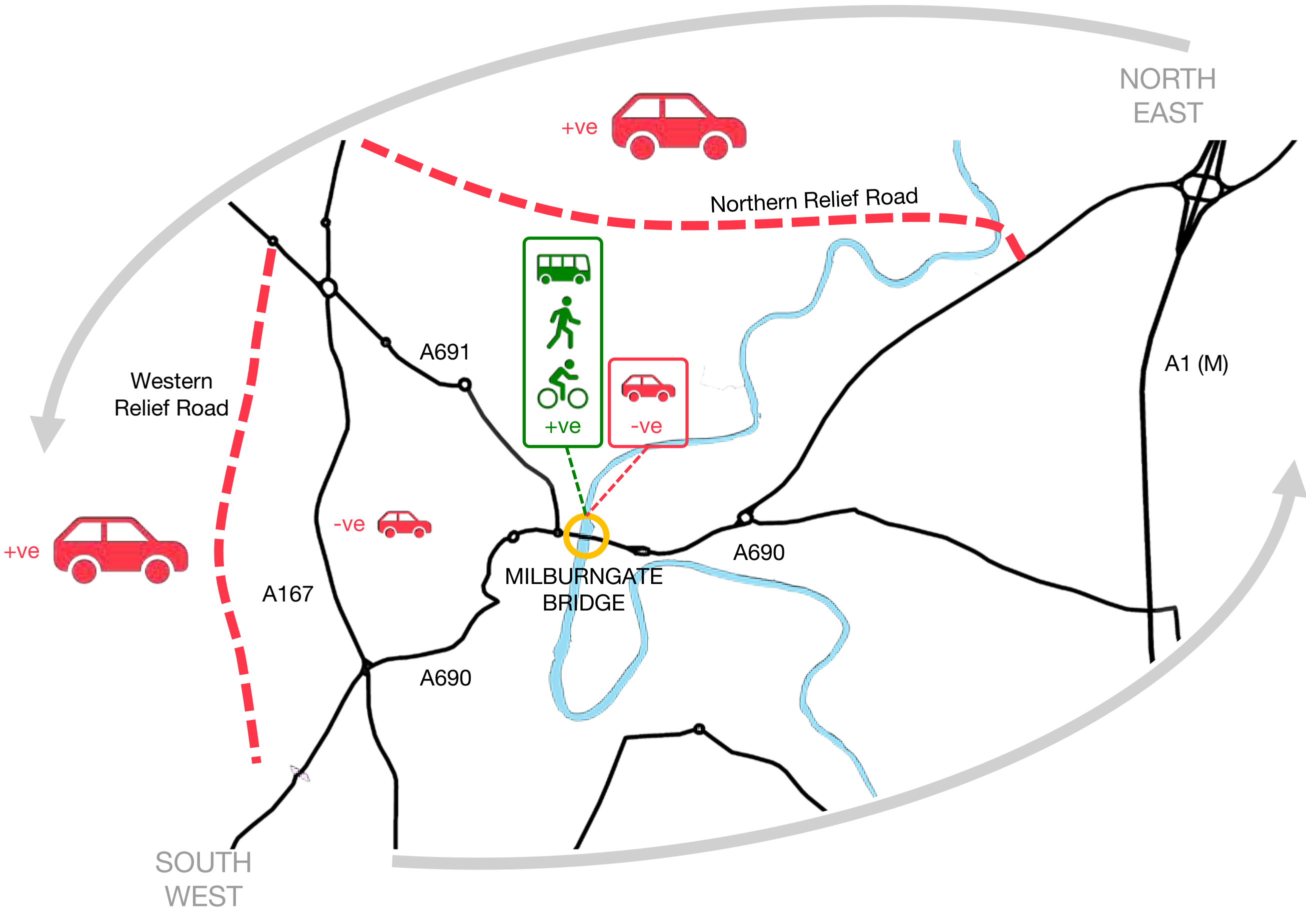
correction to better deal with current traffic conditions that have been shown to be unsuitable in terms of accommodating growth.

5.3 ACHIEVING ALL OBJECTIVES

Due to the forecast impacts on traffic of the two relief roads in isolation, owing to the strategic movements they serve, their location and tie-in points on the existing road network, there is greater benefit achieved by introducing the relief roads in combination than in isolation.

Between 8am and 9am in 2037 the two relief roads:

- reduce traffic at key junctions along the A690 and A167 by up to circa 11%
- reduce traffic along the A690 by circa 14% and the A167 by circa 30%
- reduce the two-way journey times along the A690 by up to circa 3% and the A167 by up to circa 13%;
- similar benefits can be seen in the evening peak from 5pm to 6pm; and
- allow the introduction of dedicated sustainable transport initiatives in the centre of Durham City.



This in turn allows for:

• Housing growth to be delivered in line with national forecasts promoting housing for economically active residents who will be more likely to work in the city, thus reducing the potential for productivity leakage across the county border

• Jobs growth to be delivered in line with national forecasts; stimulating economic productivity and aiming to help rebalance the labour force and employment market

• Traffic conditions to be improved to a state of betterment when compared with a future scenario with a low level of jobs and housing growth and no relief roads

• Air quality improvements will be made in the city centre befitting the city and its World Heritage Site status; and

• Future-proofing of the transport network to accommodate the above.

One potential consequence of providing the relief roads is induced traffic. Induced traffic is defined as new traffic that would not have occurred without the increase to network capacity, and can result from changes in:

• Mode of travel, e.g. switching from public transport to driving;

• Frequency of travel, specifically in terms of making additional trips that were not made previously;

• Distance travelled by changing route;

• Distance travelled by changing destination; and

• In the longer term, the distance travelled due to changes in residential or employment location or as a result of changes in land-use.

Induced traffic may be a perceived consequence of the Northern and Western relief roads. However, this may not necessarily be the case. The traffic analysis undertaken to date already accounts for induced traffic due to changes in route, and longer-term changes in land use (residential and employment). Surveys show that County Durham has lower levels of sustainable transport usage than the regional and national and so there is limited potential for mode switch. Of the remaining elements, it is not expected that these will result in significant levels of induced traffic.

This view is reinforced by a recent report for the Department for Transport*, which found that traffic generated by building new road capacity will rarely cancel out the benefits of building that capacity. Induced demand is generally higher for capacity improvements in large urban areas and there is little evidence that high levels of induced demand would occur in smaller urban and more rural areas.

*WSP and RAND, LATEST EVIDENCE ON INDUCED TRAVEL DEMAND: AN EVIDENCE REVIEW (2018)

Durham Local Plan Traffic Impacts

Durham County Council

Technical Appendix

| 1

May 2019

Durham Local Plan Traffic Impacts

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1	24/05/2019		CW	CH	CH

Contents

1. Introduction

This technical appendix summarises the work carried out in the development of the Durham Strategic Transport Model, specifically the 2015 base year model, which has been used to inform the traffic analysis presented in the Durham Local Plan Traffic Impact report.

This document will demonstrate that the model produces an accurate representation of existing peak traffic conditions in Durham City, making it suitable for the evaluation of the effects of housing and employment growth and the introduction of road network improvements, in the form of the proposed Northern Relief Road and Western Relief Road, in future year scenarios. In order to assess this suitability, the accuracy of the model will be specifically quantified against Transport Analysis Guidance (TAG).

The purpose of this technical appendix is therefore to:

- Describe the development of the model and related data sources used therein; and
- Present the calibration and validation outputs to highlight the level of model accuracy and its fitness for purpose

The remainder of this document is set out as follows:

- Section 2 - Overview of previous modelling
- Section 3 - Overview of previous testing and findings
- Section 4 - Specification of the current model
- Section 5 - Data included in the current model
- Section 6 - Model performance, including:
  - Screenline performance
  - Individual calibration and validation link performance
  - Journey time performance
  - Matrix validation performance
- Section 7 - Forecasting
- Section 8 - Areas for improvement moving through the plan

2. Overview of Previous Modelling

In order to understand why a new strategic model of Durham City has been developed, it is useful to outline the work which has preceded the new model to date. Jacobs has undertaken a number of transport modelling exercises for Durham County Council (DCC) over the last 12 years. This section provides a timeline and details of previous transport models and their purpose, up to the latest model used in the assessment of the impacts of the County Durham Plan.

2.1 Durham Transport Planning Model (2006 – 2014)

In 2006, Durham County Council commissioned Jacobs to build the Durham Transport Planning Model (DTPM). This multi-modal model had a base year of 2006 and was designed to make accurate transport forecasts some 10 to 20 years into the future. The model was developed in the CUBE TRIPS modelling software. The DTPM was developed to reflect the following time periods:

- AM (morning) average peak (07.00-10.00) hour
- Inter-peak (day time) average peak (10.00-16.00) hour
- PM (evening) average peak (16.00-19.00) hour

As these peaks are averaged they were representative of any one of the hours in each period. The averaging of the peaks meant that the model didn't predict the worst case scenario in terms of peak hour traffic. It also meant that traffic levels in shoulder periods of the peaks (when traffic levels would be expected to be falling) could be overestimated.

To ensure that the model was fit for purpose and accurately predicted forecast modelled traffic flows, it was developed in line with the DfT calibration and validation criteria available in TAG.

Since the model's inception in 2006, the majority of the work that was undertaken using the model can be categorised into four main areas, including:

- The Transport Innovation Fund (TIF) Major Scheme Business Case (MSBC) (2006 – 2008);
- Model development, validation and forecasting (September 2008 to October 2008);
- Local Development Framework (LDF) development scenario testing (2010 – 2012); and
- Option Appraisal Testing (2012 to 2014).

In 2010 the model was used by DCC during the development of its Local Development Framework (LDF). During Phase 3 of this process it was utilised to assess land use development impacts on the existing road network, and then in the progression towards public consultation on proposed highway schemes. This required it to be revised with the updated Value of Time, occupancy, purpose split, GDP growth rates and Vehicle Operation Costs data published in the 2011 release of DfT guidance.

The model was updated once more following the July 2011 release of the National Trip End Model (NTEM) 6.2 dataset, which superseded the previous version of the data used in the model matrix development. This update took into account the Office for National Statistics (ONS) 2008 population projection, dwelling updates, employment forecast consistent with more recent GDP projection and updated Car Purchasing Cost Index. These changes influence the car ownership patterns in future years, with less multiple car availability in single adult households.

These changes in demand resulted in the model displaying increases in vehicle flows on strategic routes leading to and from Durham City. These increases were largest on the west side of the city centre. The resultant changes in demand led to small changes in the journey times for the four key routes through Durham City; for most of the routes journey time increased under Phase 3 work. The revised results from the Phase 3 updates formed a more robust baseline for subsequent assessments as they utilised latest information and guidance from DfT, reflecting more recent economic and demographic trends.

During the course of use of the model for the above purposes, a number of strengths of the model were identified, including:

- Being able to reflect traffic volumes on all the key routes within and through the study area;
- Reflecting desired travel patterns across the study area;
- Using journey time surveys on cross-city centre routes to validate the base year model, and represent the travel times, delays and flow levels;
- Performing junction delay calculations to inform forecasting, leading to rerouting allowing the model results to remain robust.

However, a number of weaknesses of the model were also identified, the most pertinent of those being:

- It provided a less detailed representation of the local road network than some transportation tools;
- It did not provide fine detail on the variations in travel demand throughout the peak hours (in the way that a traffic simulation model can), nor on the interaction between junctions;
- The model may have under-represented capacity problems as a result of flow metering. The lack of flow metering in the model meant that modelled capacities may have overestimated actual flows;

It was therefore concluded that given the inherent weaknesses of the model, it would not be fit for purpose in terms of supporting a Major Scheme Business Case (MSBC), resulting in the requirement for an updated model.

2.2 DTPM Update (2015)

In 2015 Jacobs carried out an update of the Durham Transport Planning Model, using traffic count and roadside interview data obtained in 2015, to produce a fit for purpose modelling tool to examine the traffic and transport implications of the emerging County Durham Plan (CDP). In order to support the new CDP submission and Examination in Public (), the model was comprehensively updated in relation to the following:

- Inclusion of new observed traffic data including roadside interviews (RSIs), Automatic Traffic Counts (ATCs) and Manual Classified Counts (MCCs);
- Restructure of model zoning to capture updated 2011 Census data;
- Revisions to network coding;
- Updated TAG values of time and vehicle operating costs; and
- Speed-flow curves.

The DTPM also underwent further refinements to the network, demand and assignment matrices to ensure that the journey times and junction delays accurately reflected the existing patterns observed on the network.

The above updates and refinements were undertaken to ensure the model better represented the characteristics and performance of the road network in Durham to reflect a base year of 2015. As a result of this work, the model was considered to represent an up-to-date, fit for purpose tool for local planning in County Durham, and suitable for testing the impacts of the various scenarios associated with DCC's preferred future housing and employment allocation options. At this time it was also envisaged that the transport strategy for accommodating traffic growth resulting from the County Durham Plan would involve the delivery of either one, or both, of a Northern or Western Relief Road around Durham City. Therefore, the housing and employment allocations were also assessed in combination with a proposed Western Relief Road (WRR) and the sustainable transport measures detailed within the draft Durham Sustainable Transport Strategy 2016-2033 including a Northern Relief Road (NRR).

DfT guidance states that any scheme requiring funding over £5million in value requires a full supporting business case, which in turn requires a fully TAG compliant transport model to underpin it. Although the DTPM CUBE model represented an acceptable tool for the option testing associated with the County Durham Plan and emerging spatial development strategies, it did not represent a fully TAG compliant model. Therefore, it was not fit for purpose for supporting a business case for a future major scheme and the need for a new model was recognised.

2.3 Durham Strategic Transport Model (2017)

In 2017 Jacobs were commissioned to build a new, TAG compliant strategic transport model. This would replace the previous DTPM CUBE model and provide an up-to-date platform for testing the impacts of future developments and, more importantly, major scheme transport interventions in Durham City and the wider county.

A transport model plays a fundamental part in the development of a TAG compliant business case. This is because the model is used to develop the strategic case, the value for money case, and the financial case, along with a range of supporting analyses including environmental, social, safety and regeneration benefits.

The new Durham Strategic Transport Model makes use of current guidance and knowledge gained from use of the previous DTPM to ensure model outputs are suitable in scope.

In summary, the new Durham Strategic Transport Model and its outputs can possibly be used to:

- Underpin the business case for the proposed NRR and WRR, as well as other Plan transport schemes;
- Support alignment and benchmarking of progress and trends against the local policy objectives, supporting the strategic case;
- Assess the safety, environmental, social, distributional and integration benefits of proposed schemes;
- Provide direct inputs to air quality & noise modelling;
- Assist the local development planning context, and to help support and potentially refine future transport assessments;
- Provide forecasts to corridor based studies of public transport and urban realm improvements;
- Help secure private sector funding/additional developer buy-in, and provide supporting information in relation to the schemes in the Plan;
- Provide direct evidence for examination, or any potential inquiry/local opposition;
- Assist Highways England with Strategic Road Network (SRN) impacts and benefits of the proposed schemes;

- Support GVA and wider economic impacts analysis as a function of proposed schemes;

Full details of the specification and current state of the Durham Strategic Transport Model are provided in section 4 of this technical appendix.

3. Overview of Previous Testing and Findings

Following the update to the DTPM in 2015, the model was used to test several scenarios associated with DCC's preferred future housing and employment allocation options. The scenario tests quantified the key metrics pertaining to the road-based traffic associated with future development. Alongside these development scenarios, various mitigations were modelled to assess how successful each could be in providing Durham City a serviceable road network in the future. These mitigations included the proposed WRR and the sustainable transport measures detailed within the draft Durham Sustainable Transport Strategy (STS) 2016-2033 including the NRR.

During the above modelling exercise a base year model representing traffic conditions in 2015 was produced, along with future year models of the years 2026 and 2033.

The work carried out to develop the 2015 base year model discovered the following existing traffic problems on Durham City's road network:

- Approximately one third of traffic using the city centre is through traffic, for which alternative routes avoiding the centre are either not realistically available or are less direct;
- The majority of this through traffic comes from outside Durham City;
- Durham's traffic is dominated by discretionary journeys – shopping, leisure etc – which are more susceptible to competition from other destinations;
- The public transport mode share within Durham City is dominated by non-motorised modes, notably walking journeys by students;
- Traffic peaks are focused on the morning and evening peak periods, although traffic builds up through the afternoon;
- The main east-west route through the city is heavily congested throughout the day, particularly at Milburngate Bridge and along Gilesgate bank to the east;
- Key city centre junctions experience significant delays, as do junctions on the north-south A167; and
- Congestion occurs on most cross-city routes particularly in the morning and evening peak periods.

Analysis of the modelling of future traffic conditions found that the above problems would be set to worsen by 2026 and 2033 without significant interventions, specifically:

- Increasing demand for journeys to north of Durham City from the south and west will put increased pressure on the city centre and A167;
- Increasing demand for journeys into the city centre will force more non-centre journeys onto inadequate non-strategic routes, thus spreading congestion further out from the centre;
- Increasing junction delays and over-capacity links on the A167 and the south-eastern and eastern approaches to the city;
- Continued worsening of journey times, particularly on those routes which are currently least congested, demonstrating the congestion spreading effect; and
- Continuing decline of public transport as car ownership and usage increases.

Through further testing in the model it became apparent that the operation of the Durham City road network would worsen considerably with the anticipated levels of future traffic growth with or without the addition of the strategic housing and employment development sites. A number of junctions and strategic links across the network were highlighted as likely to fail by 2033 as a result of additional development traffic. In summary, this modelling exercise established the existing Durham City road network, without any transport interventions, would experience increasingly severe congestion and delay resulting from background traffic growth and the additional strategic development sites identified to deliver economic growth for Durham City in future years.

With the base year and future year traffic conditions established, three additional scenarios were modelled to test the effects of the WRR and NRR in isolation and combined.

In terms of the WRR in isolation, the modelling found that:

- A WRR would provide considerable benefit to strategic routes in the north and west of the city, principally the A167 and A691.
- Capacity constraints at key junctions on these routes would be reduced, most notably at Neville's Cross and Sniperley roundabout.
- Re-distribution of traffic across the constrained road network to the west of the city centre would generate considerable journey time savings on the wider network, for all three strategic routes and the majority of junctions, when compared to the future year 'do nothing'.

Modelling of only the NRR with sustainable travel initiatives set out in the STS found that:

- Considering modal shift to sustainable travel alone would have a relatively minor impact on key routes and junctions. The majority of car trip reductions were observed on short, local journeys.
- A NRR would have a clear positive effect in terms of reductions in traffic flows and journey times at strategic junctions as traffic re-distributes across the network.
- Although Milburngate Bridge would become more constrained as a result of the reallocation of road space to sustainable modes proposed in the STS, the key pinch point links of the A690 corridor and Framwellgate Peth and Leazes Road on approaches to the city centre improve as traffic diverts to alternative cross-city routes.

Testing of the WRR, NRR and STS measures in combination found that:

- The introduction of a WRR alongside modal shift measures would result in similar benefits to those observed in the scenario with the WRR in isolation in 2026.
- Introducing a NRR and reallocating road space on Milburngate Bridge encourages strategic journeys to circumvent the centre of Durham City onto the new road, benefiting local journeys as a result of a reduction in congestion on links and reduced traffic/journey times through junctions.
- Traffic volumes on Milburngate Bridge are shown to reduce with likely beneficial impacts on air quality.
- Traffic levels and therefore delay at junctions would be reduced considerably compared to the 'do nothing' scenario. As a result of the measures included in this scenario, journey time metrics across the network would be similar to current levels despite increases in traffic resulting from future development.
- Pinch points would inevitably still exist within the city centre, especially around Milburngate Bridge, albeit at a much reduced level when compared with other scenarios.

When considering the above findings of previous modelling work it can be seen that they are broadly consistent with the analysis presented in the current County Durham Plan Traffic Impacts report.

Essentially the narrative borne out of the analysis undertaken using the previous DTPM and the new Durham Strategic Transport Model has remained the same. In turn this means that the same conclusions have been drawn from past and present modelling and analysis of the Durham City road network, specifically:

- The Durham City road network is currently operating with high levels of constraint along several key corridors and at a number of key junctions;
- The current network configuration, without any transport interventions, can’t adequately handle ‘business as usual’ i.e. growth without any transport mitigation measures, in future years.

4. Specification of the Current Model

4.1 Current state of the model

The new Durham Strategic Transport Model will be used to support the development of strategic housing and employment growth sites, and provide an appraisal of the transport infrastructure improvements identified in the County Durham Plan. In particular, the model will be necessary to support any potential future business cases for the NRR and WRR which have been identified as the key improvement schemes required to deliver future growth and accommodate traffic demand forecasts.

Although the previous DTPM was sufficient for the purpose of option testing for Plan development, it is acknowledged that the model fell short of the requirements outlined in TAG for the purpose of the business case development of transport schemes associated with the Plan.

In line with the above appraisal needs, the new Durham Strategic Transport Model has been constructed in accordance with current best practice contained within the Department for Transport web-based Transport Appraisal Guidance known as TAG. **However, it should be noted that at the time of writing the model is undergoing further refinement and is not yet fully TAG compliant. However, it is at an appropriate state of completeness that strategic planning decision can be made and this is acceptable for Plan testing.**

Despite the ongoing refinement and improvement of the model to meet TAG criteria, the analysis of the integrity of the model as it currently stands, presented later in section 6, shows that the model capable of representing observed traffic patterns in Durham City.

4.2 Technical Specification

One of the key decision points in the development of a transport model is the choice of model software. As described in earlier in this document, the previous DTPM dated back to 2006 and used CUBE TRIPS software. A major drawback in continuing with the use of CUBE TRIPS for the development of the current model is the recent withdrawal of support and maintenance for the software by its developer. As CUBE TRIPS is no longer a live platform this would have left Jacobs and DCC vulnerable to any problems and system bugs that may have emerged through use of the software during the model build, potentially impacting upon delivery. Therefore, to minimise risks in terms of delivery and acceptability of model outputs for the purposes of business case development, SATURN software has been used to construct the new Durham Strategic Transport Model.

SATURN is readily adaptable to the development planning uses of the model and has further advantages in terms of familiarity and acceptability by DfT. In terms of technical capabilities, the key benefits of selecting SATURN as the modelling software package of choice can be summarised as follows:

- Detailed junction simulation;
- Blocking back & stacking capacities;
- Link-based capacity restraint;
- Motorway merge modelling;
- Different car/HGV speeds;
- Large gyratory movements; and
- Flare lane modelling.

- Calibration and validation facilities;
- Ease and speed of select link analysis;
- Integration with DfT's DIADEM variable demand modelling program.

Table 1 summarises the key aspects of the specification of the Durham Strategic Transport Model.

Table 1: Summary of Model Specification

Item	Specification
Software package	SATURN
Model base year	November 2015
Modelled time periods	Weekday AM peak (08:00-09:00) Weekday Inter peak (10:00-16:00) Weekday PM peak (17:00-18:00)
Model forecast years	2022 & 2037
Network coverage	Motorways, A-roads, B-roads, and minor roads are included in the network based on their importance in the county. Network coverage is likely to be broadly similar to the existing modelled network.
Zoning system	Zoning structure makes use of administrative boundaries concurrent with the latest NTEM release.
Journey purposes	Home-based work Home-based employer's business Home-based education Home-based other Non home-based other Non home-based work Non home-based employer's business
User classes	Car employer's business Car commute Car other LGV HGV Public Transport (concessionary and other)
Data sources	Predominantly existing 2015 RSI, MCC and ATC data.
Variable Demand Model (VDM)	VDM will be applied within the model according to the methodology within TAG Unit M2 - Variable Demand Modelling. Will be undertaken using DIADEM, the Department for Transport (DFT)'s 'Dynamic Integrated Assignment and Demand Modelling' software.

5. Data Included in the Current Model

5.1 Overview

Construction of the new Durham Strategic Transport Model has required several types of traffic data. Four main sources of data have been utilised in the construction of the Durham Countywide Transport Model, including:

- Roadside Interviews (RSI): an on-road interview consisting of asking the driver of a vehicle details of their journey, trip purpose, origin and destination of the trip;
- Manual Classified Counts (MCC): that capture the classification of vehicle types, usually undertaken by roadside manual surveys or by using video capture equipment;
- Automatic Traffic Counts (ATC): of which there are several technologies available (RADAR, temporary pneumatic tube or permanent/semi-permanent inductive loop) to capture counts, allow numbers and classifications of vehicles to be obtained;
- Trafficmaster journey time information: obtained for a locality which records the observed travel time of a vehicle over a stretch of carriageway at specific time of day.

Existing traffic data of the types described above was obtained during an extensive data collection exercise as part the Durham Model update in 2015, and has been used in the construction of the new Durham Strategic Transport Model. The data collection exercise took place in November 2015, which is considered a neutral month in TAG Unit M1-2 ‘Data Sources and Surveys’. The survey sites were located on the key strategic routes into Durham City and selected key roads in the surrounding area. These included major roads to capture the majority of traffic flows in and out of the study area as well as minor roads to capture the potential traffic movements.

The availability of up-to-date traffic survey data meant that relevant data was readily accessible to be integrated into the new model, reducing the need for further data collection. A review of the data collected for the previous model confirmed its suitability for use in the new Durham Strategic Transport Model and therefore no further data collection was necessary.

5.2 Details of Existing Data

5.2.1 Roadside interview data

20 roadside interviews (RSIs) were conducted as part of the previous data collection for the Durham Transport Model between the 4th and 19th of November 2015. RSIs were carried out by both face-to-face interviews and pre-paid post card where necessary depending upon the traffic conditions at each site. The RSI specification was as follows:

- Total number of survey stations: 20;
- Duration: 07:00 to 19:00 weekday (between Monday and Thursday);
- Number of days per site: 1 day;
- Inbound direction only;
- Information captured in the RSI survey includes:
    - Mode of travel;
    - Time of issue;

- Vehicle type;
- Vehicle occupancy (including driver);
- Origin address (full address, bare minimum is postcode);
- Origin purpose;
- Destination address (full address, bare minimum is postcode);
- Destination purpose
- Trip frequency;
- Number of cars in the household;
- Actual origin home address if delivery vehicles;
- Site diary according to DMRB (V5, S1, P4, TA11/09, clause 4.31)

The locations of the RSI sites are illustrated in Figure 1 and detailed in Table 2.

Figure 1: 2015 Durham Transport Model – RSI Site Locations

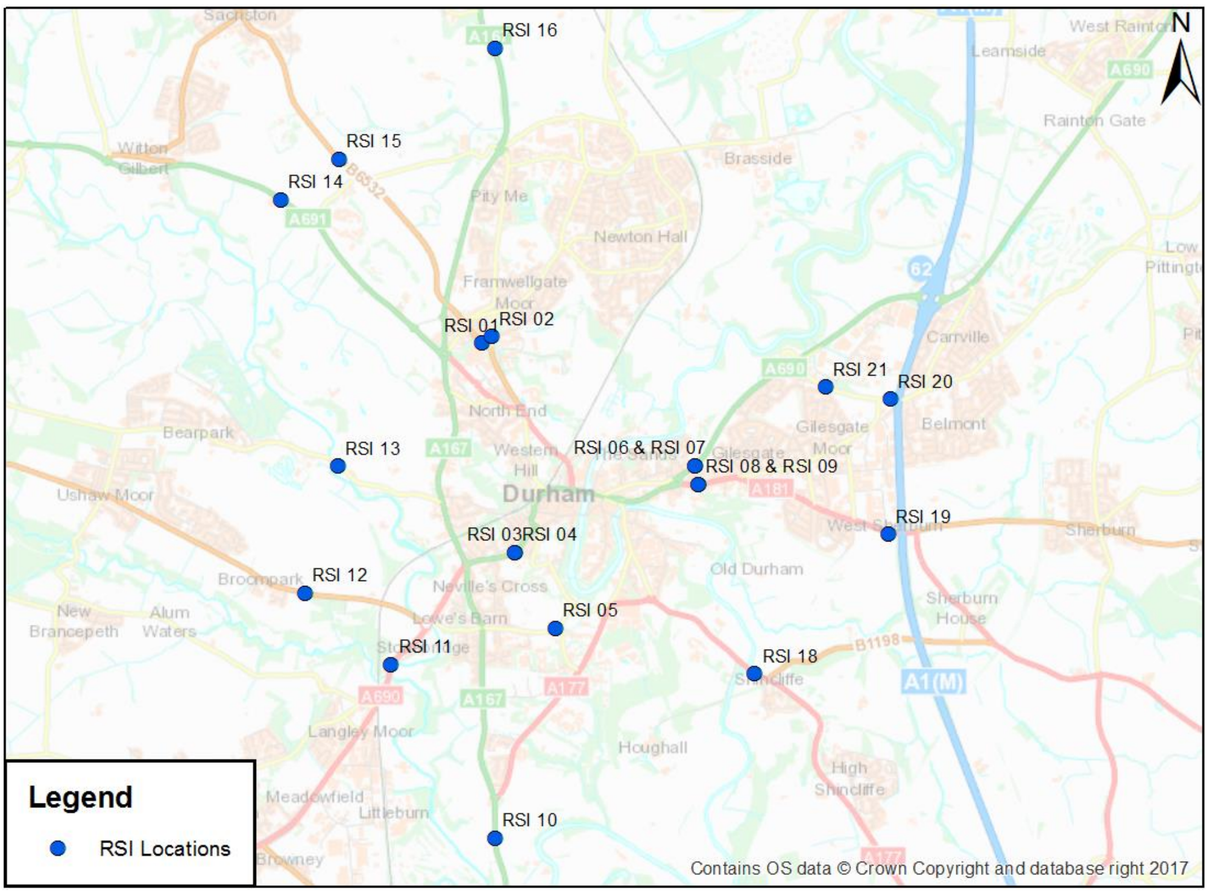


Table 2: RSI Site Location Details

Site ID	Location Description	Locality
RSI 01	B6532 Dryburn Road	Between Dryburn hill and Durham University Hospital roundabout
RSI 02	Durham road	Between Aykley Vale and Durham University hospital roundabout
RSI 03	A690 Crossgate Peth	Between the A167 and Margery Lane
RSI 04	A690 Crossgate Peth	Between the A167 and Margery Lane
RSI 05	Potters Bank	Between Elvet Hill Road and the A167
RSI 06	A690	Between the A181 roundabout and the Dragonville Belmont slip road
RSI 07	A690	Between the A181 roundabout and the Dragonville Belmont slip road
RSI 08	A181 Gilesgate	Between the A690 roundabout and Sunderland Road
RSI 09	A181 Gilesgate	Between the A690 roundabout and Sunderland Road
RSI 10	A167	Between Browney lane and the A177 roundabout
RSI 11	A690 High Street	Between entrance to Lidl Supermarket and Black Road
RSI 12	B6302 Broom Lane	Between entrance to Cooke's Wood and entrance to Broom Park Picnic Area
RSI 13	C17 Tollhouse Road	Between bridge over River Browney and Moorsley Banks Farm access
RSI 14	A691	Between Trout's Lane and entrance to Sleights House Farm
RSI 15	B6532	Between Trouts Lane and the B6312
RSI 16	A167	Between Potterhouse Lane roundabout and the B6312 roundabout
RSI 18	A177 Shincliff Bridge	Between Low Road and Shincliffe Bridge
RSI 19	A181	Between the B1283 junction and Damson Way
RSI 20	Broomside Lane	Between Buckinghamshire Road and Sunderland Road
RSI 21	Dragonville Belmont Slip Road off A690	A690 Southbound Off Slip and Premier Inn Junction

5.2.2 Manual classified count data

The previous Durham Model utilised manual classified count (MCC) data from 19 sites, collected between Wednesday 4th and Thursday 19th November 2015, which has been used in the Durham Strategic Transport Model. The existing MCCs have been used in the matrix development process in order to split out the different vehicle classifications modelled

The vehicle classifications captured by the MCCs are shown below:

- Car/Taxi;
- Light Goods Vehicle (LGV);
- Rigid Heavy Goods Vehicle (HGV);
- Articulated Heavy Goods Vehicle (HGV);
- Bus;
- Motorcycle;
- Cycle;

- Other Vehicles (i.e. farm tractors, cleaning vehicles).

The locations of the MCC sites are illustrated in Figure 2 and detailed in Table 3.

Figure 2: 2015 Durham Transport Model – MCC Site Locations

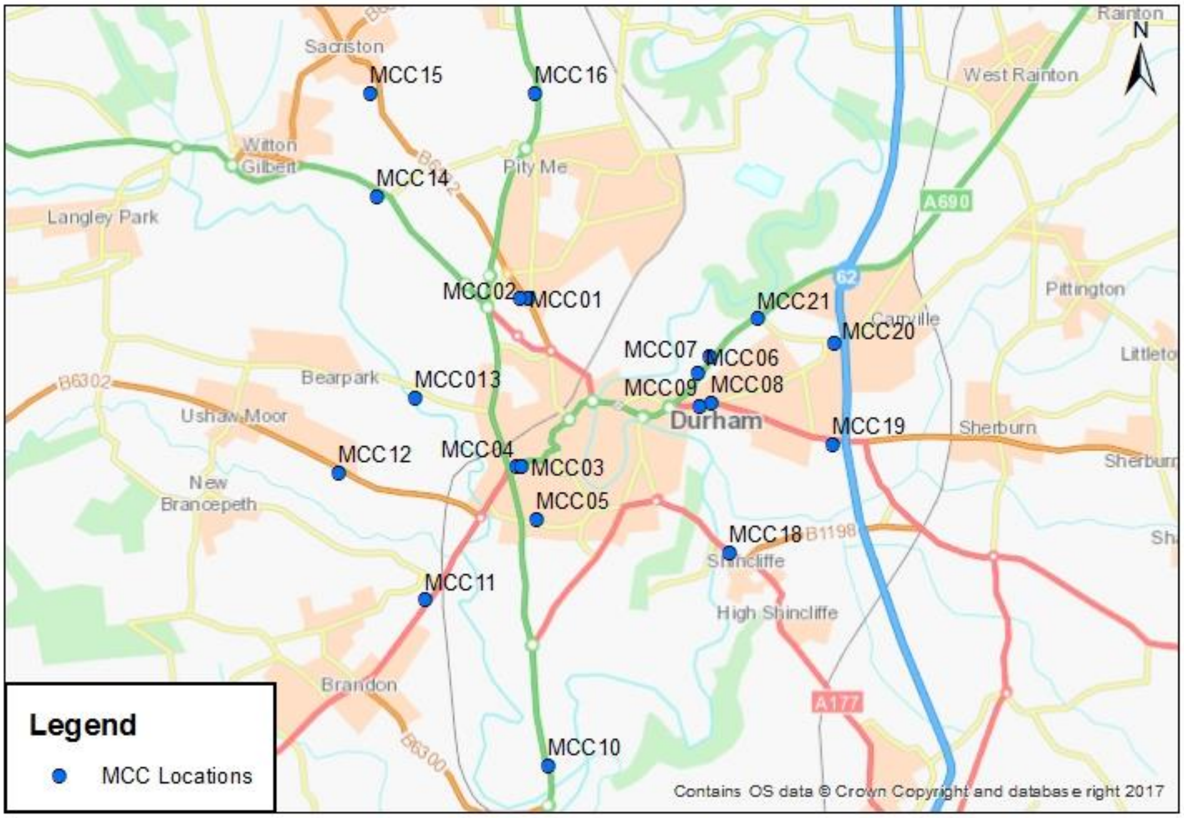


Table 3: MCC Site Location Details

Site ID	Location Description	Locality
MCC 01	B6532 Dryburn Road	Between Dryburn hill and Durham University Hospital roundabout
MCC 02	Durham road	Between Aykley Vale and Durham University hospital roundabout
MCC 03	A690 Crossgate Peth	Between the A167 and Margery Lane
MCC 04	A690 Crossgate Peth	Between the A167 and Margery Lane
MCC 05	Potters Bank	Between Elvet Hill Road and the A167
MCC 06	A690	Between the A181 roundabout and the Dragonville Belmont slip road
MCC 07	A690	Between the A181 roundabout and the Dragonville Belmont slip road
MCC 08	A181 Gilesgate	Between the A690 roundabout and Sunderland Road
MCC 09	A181 Gilesgate	Between the A690 roundabout and Sunderland Road
MCC 10	A167	Between Browney lane and the A177 roundabout
MCC 11	A690 High Street	Between entrance to Lidl Supermarket and Black Road
MCC 12	B6302 Broom Lane	Between entrance to Cooke's Wood and entrance to Broom Park Picnic Area

Site ID	Location Description	Locality
MCC 13	C17 Tollhouse Road	Between bridge over River Browney and Moorsley Banks Farm access
MCC 14	A691	Between Trout's Lane and entrance to Sleights House Farm
MCC 15	B6532	Between Trouts Lane and the B6312
MCC 16	A167	Between Potterhouse Lane roundabout and the B6312 roundabout
MCC 18	A177 Shincliff Bridge	Between Low Road and Shincliffe Bridge
MCC 19	A181	Between the B1283 junction and Damson Way
MCC 20	Broomside Lane	Between Buckinghamshire Road and Sunderland Road
MCC 21	Dragonville Belmont Slip Road off A690	A690 Southbound Off Slip and Premier Inn Junction

5.2.3 Automatic traffic count data

As part of the DTPM update in 2015, 28 automatic traffic counts (ATCs) were deployed to collect data between Wednesday 28th October and Thursday 26th November 2015. The data was collected in both inbound and outbound directions and included weekends. The existing ATC data has been used in the matrix development process, as well as the formation of screenlines for calibration and validation of the base year model. The locations of the ATC sites are illustrated in Figure 3 and detailed in Table 4.

Figure 3: 2015 Durham Transport Model – ATC Site Locations

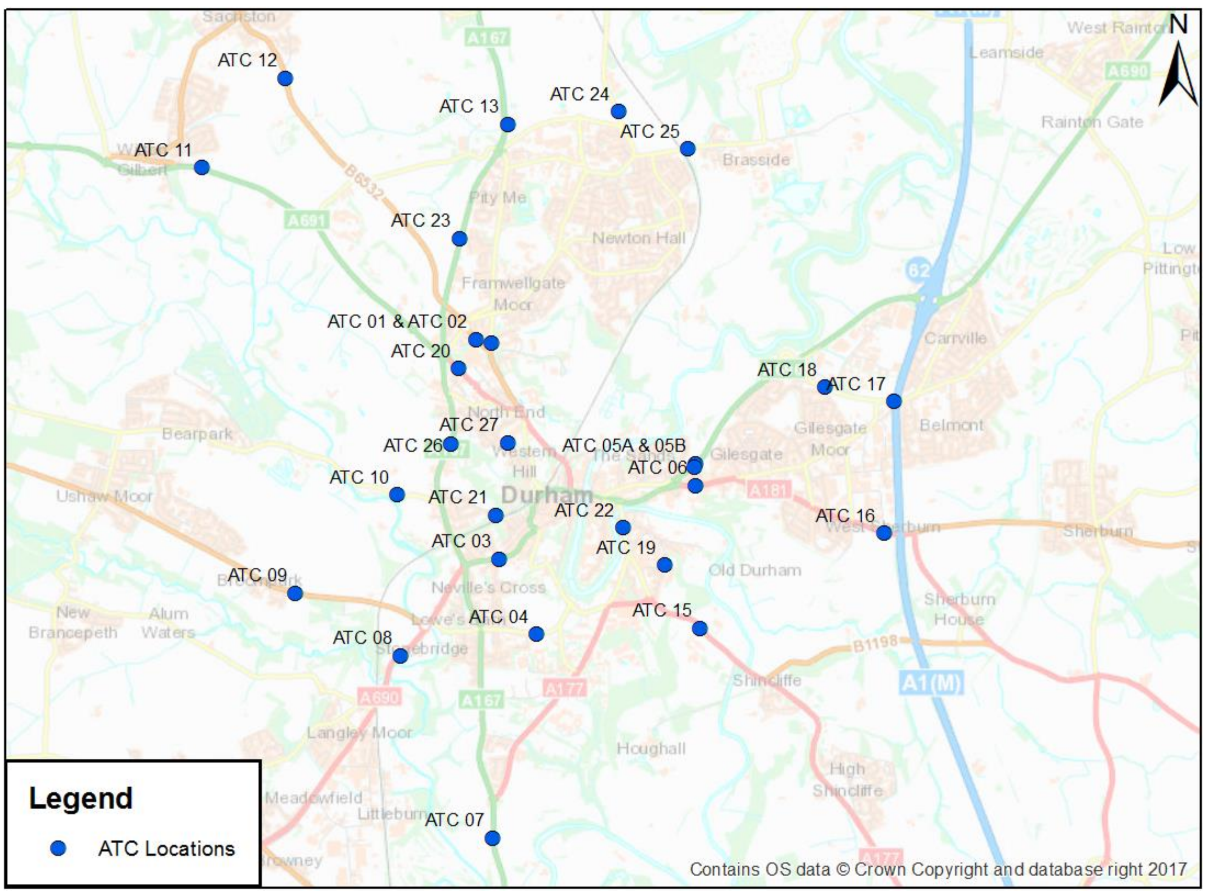


Table 4: ATC Site Location Details

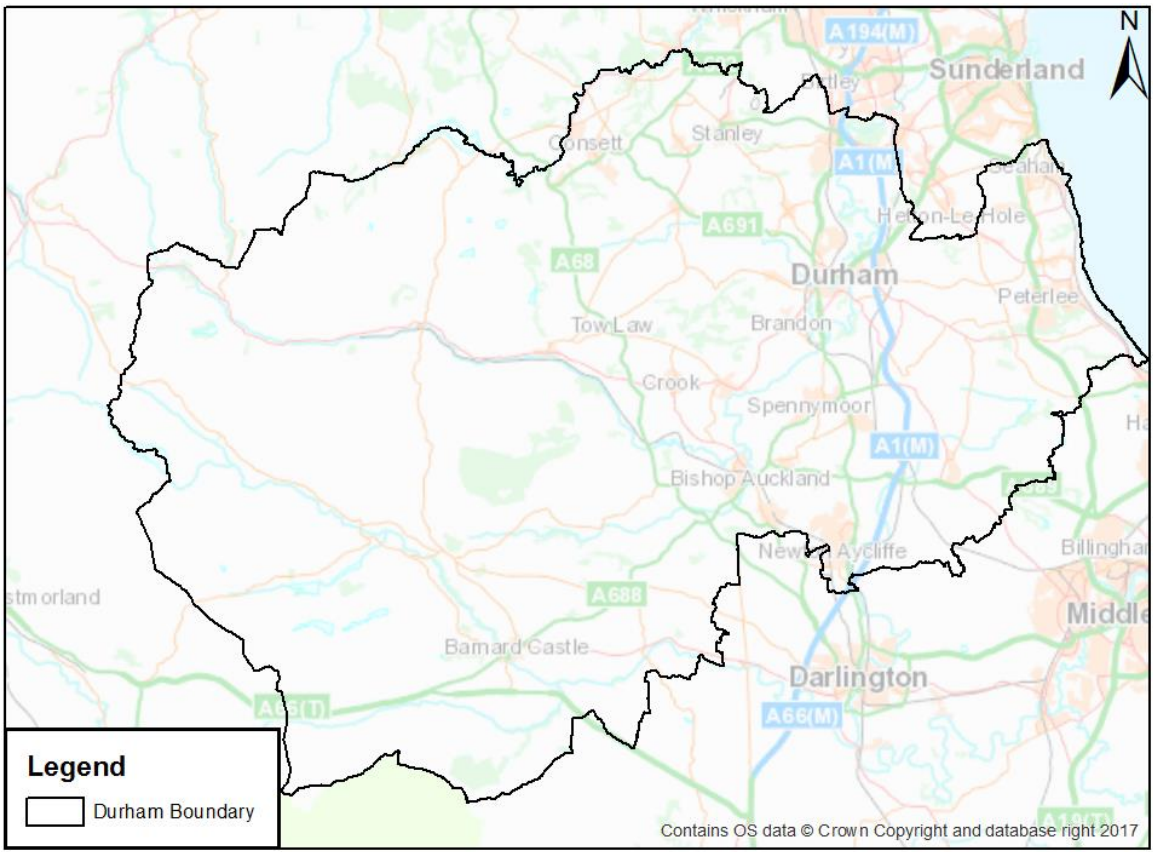
Site ID	Location Description	Locality
ATC 01	B6532 Dryburn Road	Between Dryburn hill and Durham University Hospital roundabout
ATC 02	Durham road	Between Aykley Vale and Durham University hospital roundabout
ATC 03	A690 Crossgate Peth	Between the A167 and Margery Lane
ATC 04	Potters Bank	Between Elvet Hill Road and the A167
ATC 05A	A690 Northbound	Between Ashwood and the A690
ATC 05B	A690 Southbound	Between Station Lane and the A690
ATC 06	A181 Gilesgate	Between the A690 roundabout and Sunderland Road
ATC 07	A167	Between Browney lane and the A177 roundabout
ATC 08	A690 High Street	Between entrance to Lidl Supermarket and Black Road
ATC 09	B6302 Broom Lane	Between entrance to Cooke's Wood and entrance to Broom Park Picnic Area
ATC 10	C17 Tollhouse Road	Between bridge over River Browney and Moorsley Banks Farm access
ATC 11	A691	Between Trout's Lane and entrance to Sleights House Farm
ATC 12	B6532	Between Trouts Lane and the B6312
ATC 13	A167	Between Potterhouse Lane roundabout and the B6312 roundabout
ATC 14	Chester Low Road	Between Cocken Road and entrance to Bishops Grange Farm
ATC 15	A177 Shincliff Bridge	Between Low Road and Shincliffe Bridge
ATC 16	A181	Between the B1283 junction and Damson Way
ATC 17	Broomside Lane	Between Buckinghamshire Road and Sunderland Road
ATC 18	Dragonville Belmont Slip Road off A690	A690 Southbound Off Slip and Premier Inn Junction
ATC 19	Whiney Hill	Between Hallgrarth Street and New Elvet
ATC 20	A691 Southfield Way	Between A167 roundabout and Durham University hospital roundabout
ATC 21	Redhills Lane	Between St Monica Grove and Flass Street
ATC 22	New Elvet	Between Church Street/Hallgarth Steet and Elvet Bridge
ATC 23	A167	LC, North of A691 Roundabout
ATC 24	Chester Low Road	Between entrance to Finchale Training College and entrance to Red House Farm
ATC 25	Finchale Avenue	Between Rowan Drive and Railway bridge over road
ATC 26	A167	Between Crossgate Moor Gardens and private entrance on opposite side of road
ATC 27	Fieldhouse Lane	Between Larches Road and entrance to St Leonard's School

5.2.4 Journey time data

Journey time data for calibration and validation of the model has been obtained from the Department for Transport (DfT) through its contract with Trafficmaster. All Trafficmaster vehicles are fitted with in-vehicle GPS systems which track the location of the vehicle from the moment the ignition is switched on until it is switched off. The GPS data is matched to Ordnance Survey Integrated Transport Network (ITN) links and aggregated for every ITN link by each 15-minute period of the day, resulting in an average journey time (in hundredths of a second) for each link. The data is split by vehicle type, including cars, light goods vehicles and heavy goods vehicles.

The Trafficmaster data utilised for the journey time analysis ranges from September 2015 to April 2016, excluding Saturdays and Sundays, school term holidays, bank holidays and the days of Lumiere festival. Data was obtained for the fully modelled area in Figure 4.

Figure 4: Extent of Trafficmaster Data Area



A total of eight journey time routes have been defined within the model to validate against. These are described in detail within section 6.3 (journey time performance) of this technical appendix.

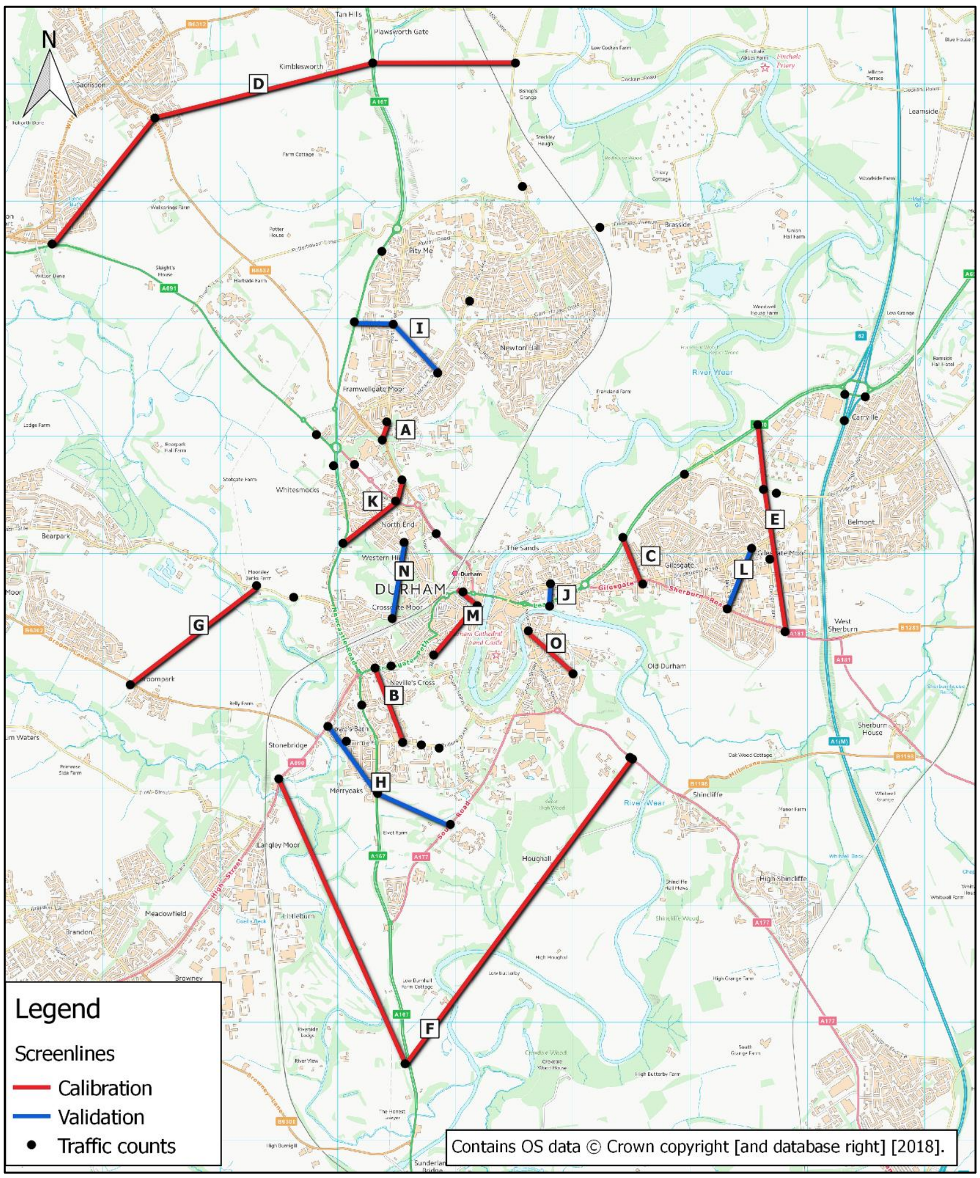
6. Model Performance

This section presents the key metrics used to determine the level of reliability of the model. As noted earlier in this document, the model is currently undergoing further refinement and is not yet fully TAG compliant, however, the results demonstrate that it is suitable for supporting strategic planning decisions in its current state.

6.1 Screenline Performance

To ensure that the levels of traffic assigned to links across the modelled area are representative of current observed flows, the model has been calibrated and validated to inbound and outbound screenlines, as shown in Figure 5. Screenlines are placed on the network where traffic has little option for route choice, e.g. a railway or river crossing, and therefore must cross that point.

Figure 5: Screenline Locations



The current TAG guidance is set as modelled screenlines being within 5% of the observed in order to be considered calibrated/validated. However, given the nature of much of the appraisal area, there is potential for relatively low flow on some of the roads and therefore also the overall screenlines. In these instances, the targeted 5% difference in flow across screenlines can be extremely difficult to achieve. The 5% criteria are designed for models representing a greater density of population, road network and thus trips. If there are issues meeting the 5% criteria due to low flow on the screenlines, then it is proposed that GEH may be a more appropriate measure of screenline performance within the model, as presented in DMRB Section 12. The GEH statistic has therefore been calculated for each screenline to provide a second measure of screenline performance. The GEH statistic is the form:

$$GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$$

Where M is the modelled flow and C is the observed count

GEH is the most appropriate measure of screenline performance within the model and a GEH of <4 is considered to indicate a good level of fit between observed and modelled flows. A GEH of >4 may indicate areas of the model which are less robust for various reasons.

Table 5 and Table 6 display the calibration and validation screenline results from the AM and PM model assignments for total vehicles. The following GEH scoring system has been used:

- <4 – cells highlighted green
- Between 4 and 10 – cells highlighted amber
- >10 – cells highlighted red

In the AM scenario, all calibration screenlines are all within the required guidelines. This indicates that movements into and out of Durham city centre have been captured and are well represented in the model.

In terms of validation screenlines, H and I meet the criteria in both directions, with L inbound and N outbound also meeting the criteria. Screenlines L outbound and N inbound are very close to being within guidelines. Screeenlines J shows a larger difference to criteria due to under-representing the levels of flow compared to observed data. This is a known issue within the model which will be rectified through further development and refinement of the model.

In the PM scenario, all calibration screenlines are within criteria except screenlines D inbound and K outbound. Screeenline D is an external screenline and covers two main A-roads, the A167 and A691. These routes are also captured by screenline A and K which are both internal screenline performing well within criteria for the inbound direction. This indicates that the flows on these routes are corrected closer towards the city centre.

In terms of validation screenlines, screenline H, J, and L meet criteria in both directions, with I inbound and L outbound also meeting the criteria. Screenlines I outbound and L inbound fall outside the guidelines.

Across both time periods, whilst some screenlines fall outside the criteria, all GEH values are less than 10.

Table 5: Screenline Comparison with Observed Flows AM All Vehicles

	AM Calibration Statistics: All Vehicles							
Cal/Val	Screenline ID	Direction	Counts Included	Observed Vehs	Modelled Vehs	Flow Vehs Dif	% Vehs Dif	GEH
Cal	A	IB	2	1084	1144	60	5.5%	1.8
Cal	A	OB	2	887	826	-60	-6.8%	2.1
Cal	B	IB	2	1141	1124	-17	-1.5%	0.5
Cal	B	OB	2	550	533	-17	-3.1%	0.7
Cal	C	IB	2	1573	1553	-20	-1.3%	0.5
Cal	C	OB	2	1250	1220	-30	-2.4%	0.9
Cal	D	IB	4	2607	2629	22	0.9%	0.4
Cal	D	OB	4	1402	1391	-11	-0.8%	0.3
Cal	E	IB	4	3109	3048	-61	-2.0%	1.1
Cal	E	OB	4	1830	1773	-57	-3.1%	1.4
Cal	F	IB	3	2987	2992	5	0.2%	0.1
Cal	F	OB	3	1862	1898	36	2.0%	0.8
Cal	G	IB	2	628	625	-4	-0.6%	0.2
Cal	G	OB	2	305	302	-3	-0.9%	0.2
Cal	K	IB	3	2714	2682	-32	-1.2%	0.6
Cal	K	OB	3	2408	2327	-82	-3.4%	1.7
Cal	M	IB	3	808	786	-22	-2.7%	0.8
Cal	M	OB	3	1126	1083	-43	-3.8%	1.3
Cal	O	IB	2	1000	1020	21	2.1%	0.6
Cal	O	OB	2	788	859	70	8.9%	2.5
Val	H	IB	3	2238	2073	-165	-7.4%	3.6
Val	H	OB	3	1461	1426	-35	-2.4%	0.9
Val	I	IB	3	2232	2133	-98	-4.4%	2.1
Val	I	OB	3	1364	1338	-26	-1.9%	0.7
Val	J	IB	2	1911	1619	-293	-15.3%	7.0
Val	J	OB	2	1606	1314	-292	-18.2%	7.6
Val	L	IB	2	650	646	-5	-0.7%	0.2
Val	L	OB	2	703	581	-121	-17.3%	4.8
Val	N	IB	2	266	384	118	44.4%	6.6
Val	N	OB	2	112	105	-7	-6.2%	0.7

Table 6: Screenline Comparison with Observed Flows PM All Vehicles

	Calibration Statistics: All Vehicles							
Cal/Val	Screenline ID	Direction	Counts Included	Observed Vehs	Modelled Vehs	Flow Vehs Dif	% Vehs Dif	GEH
Cal	A	IB	2	971	1010	39	4.1%	1.2
Cal	A	OB	2	1005	1096	91	9.1%	2.8
Cal	B	IB	2	716	746	30	4.1%	1.1
Cal	B	OB	2	905	800	-104	-11.5%	3.6
Cal	C	IB	2	1537	1532	-5	-0.3%	0.1
Cal	C	OB	2	1901	1979	77	4.1%	1.8
Cal	D	IB	4	1562	1937	375	24.0%	9.0
Cal	D	OB	4	2945	2859	-87	-2.9%	1.6
Cal	E	IB	4	2192	2258	66	3.0%	1.4
Cal	E	OB	4	2983	2846	-137	-4.6%	2.5
Cal	F	IB	3	2102	2239	137	6.5%	2.9
Cal	F	OB	3	2846	2856	10	0.3%	0.2
Cal	G	IB	2	458	404	-54	-11.9%	2.6
Cal	G	OB	2	800	708	-91	-11.4%	3.3
Cal	K	IB	3	2290	2386	96	4.2%	2.0
Cal	K	OB	3	2172	2405	233	10.7%	4.9
Cal	M	IB	3	1071	942	-128	-12.0%	4.0
Cal	M	OB	3	847	931	84	9.9%	2.8
Cal	O	IB	2	790	784	-6	-0.7%	0.2
Cal	O	OB	2	795	738	-56	-7.1%	2.0
Val	H	IB	3	1611	1492	-119	-7.4%	3.0
Val	H	OB	3	2092	2051	-41	-2.0%	0.9
Val	I	IB	3	1622	1543	-79	-4.9%	2.0
Val	I	OB	3	2056	1811	-244	-11.9%	5.6
Val	J	IB	2	1664	1649	-15	-0.9%	0.4
Val	J	OB	2	2150	2001	-149	-6.9%	3.3
Val	L	IB	2	832	686	-147	-17.6%	5.3
Val	L	OB	2	934	830	-104	-11.1%	3.5
Val	N	IB	2	71	56	-15	-21.6%	1.9
Val	N	OB	2	214	186	-29	-13.3%	2.0

6.2 Link Performance

Calibration of traffic flows on links occurs during the matrix modification process. The purpose is to ensure that modelled link flows match observed link flows on those counts selected for calibration purposes. Link flow validation uses pre-selected count sites that have not been used at any stage during model construction. It provides an additional ‘snapshot’, following successful link flow calibration, of how well traffic flows match recorded count data. Comparison of the flows and counts at the individual links represents the main method of model calibration. The TAG suitability guidance for individual links are detailed below in Table 7.

Table 7: Link Flow Validation Criteria

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/hr of counts for flows less than 700 veh/hr	> 85% of cases
	Individual flows within 15% of counts for flows from 700 veh/hr to 2,700 veh/hr	> 85% of cases
	Individual flows within 400 veh/hr of counts for flows more than 2,700 veh/hr	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

TAG guidance unit M3.1 §3.2.9 states that the above comparison of modelled and observed flows should be presented for total vehicle flows and for car flows, but not for LGV and HGV flows due to there being insufficient accuracy in the individual link counts for these vehicle types. In addition, the above information should be presented by time period. As with the screenlines, the link counts are split between those used for calibration and validation purposes. The comparison between observed and modelled link flows for total vehicles and cars only is given in Table 8 and Table 9.

Table 8: Calibration Link Flow Comparison with Observed Flows (Cars and Total Vehicles)

All Link Calibration Sites	AM		PM	
	Car Only	Total Vehicles	Car Only	Total Vehicles
Compliant links (TAG guideline is 85%)	87%	87%	85%	85%

Table 8 shows that the link flow calibration meets the full TAG criteria for cars only in the AM scenario. However, it doesn’t quite meet the criteria in all cases, although it is close for total vehicles in the AM scenario. Further refinement of the model will be undertaken to improve the level of fit in the PM scenario.

Table 9: Validation Link Flow Comparison with Observed Flows (Cars and Total Vehicles)

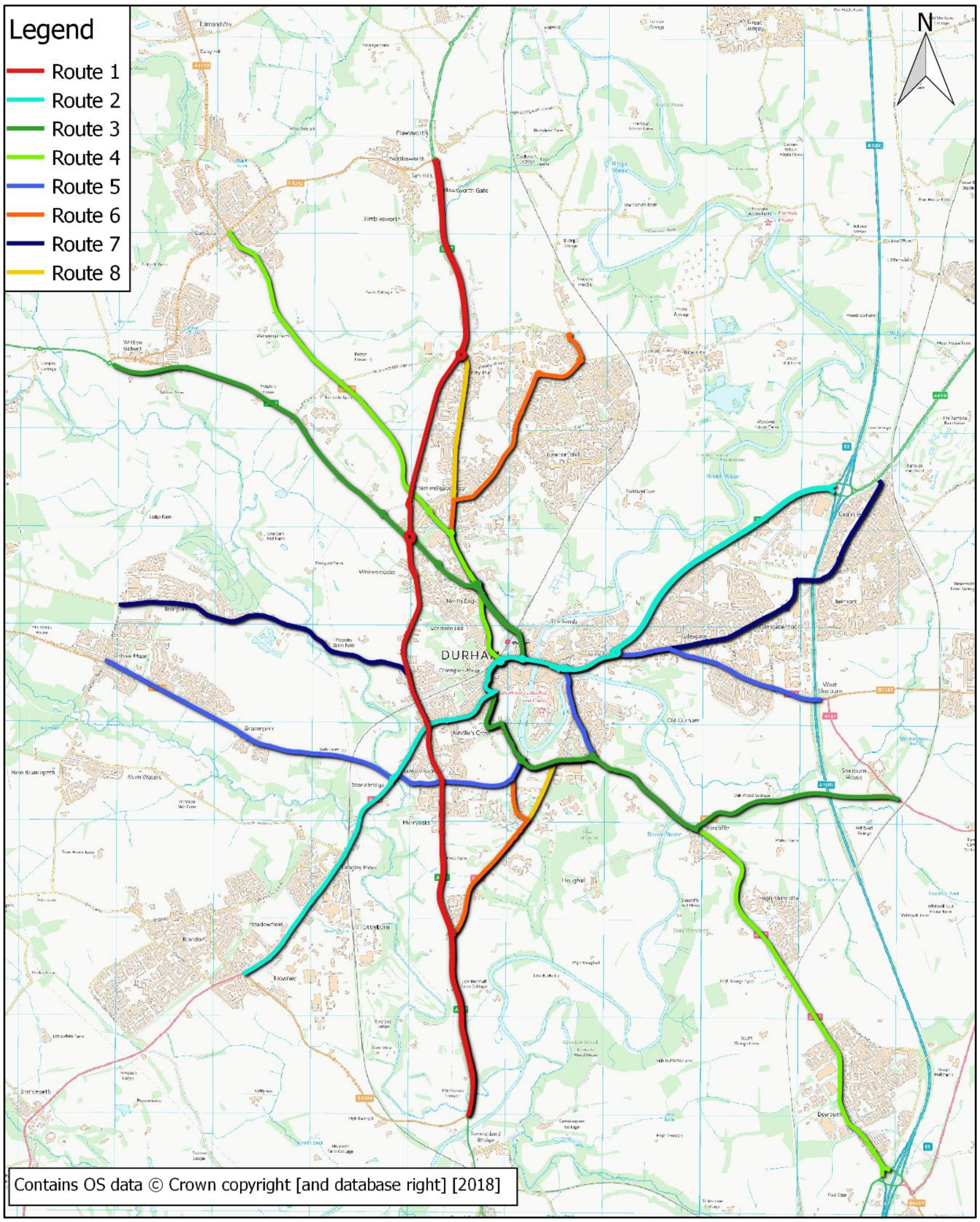
All Link Validation Sites	AM		PM	
	Car Only	Total Vehicles	Car Only	Total Vehicles
Compliant links (TAG guideline is 85%)	96%	92%	88%	88%

Table 9 shows a good level of validation at the individual link level within the model. The model validation exceeds the TAG criteria in both the AM and PM scenarios for both cars only and total vehicle results. Therefore, the model can be considered robust at the individual link flow validation level.

6.3 Journey Time Performance

As described earlier in this technical appendix, modelled journey time routes have been validated against the Trafficmaster dataset. A total of eight routes have been selected, all of which lie within the simulation area of the model and are shown in Figure 6. The routes have been specifically designed to cover as wide a range of route types as possible and cover the fully modelled area as evenly as possible. In line with TAG Unit M3.1 §4.4.4 and §4.4.5, the selected journey routes are between approximately 3 and 15km long (apart from the motorway route), and within 40-minutes as stated within guidance.

Figure 6: Journey Route Locations



TAG also contains acceptability guidelines for the validation of journey times. An assessment of the level of journey time validation has been undertaken against this criterion, which is given in Table 10.

Table 10: Journey Time Validation Criterion

Criterion	Acceptability Guideline
Modelled times along routes should be within 15% of surveyed times, or 1 minute if higher	> 85% of routes

TAG unit M3.1 §3.2.9 states that the speeds within the road network should be based upon separate relationships for light and other vehicle types. Network speeds were derived from the Trafficmaster dataset (averaged across similar link types) and verified against Google Maps journey time information.

A summary of which journey time routes meet guidance criteria is presented in Table 11 for the AM peak period and Table 12 for the PM peak period.

Table 11: All Journey Routes Summary – 8am to 9am

Route	Data Type	Direction	ID	Observed	Modelled	Difference	% Difference	DfT Compliant
Route 1	Trafficmaster	NB	1_N	929	949	20	2%	Yes
	Trafficmaster	SB	1_S	1100	899	-201	-18%	No
Route 2	Trafficmaster	EB	2_E	1166	1005	-161	-14%	Yes
	Trafficmaster	WB	2_W	1072	1041	-31	-3%	Yes
Route 3	Trafficmaster	EB	3_E	1245	1164	-81	-6%	Yes
	Trafficmaster	WB	3_W	1535	1307	-227	-15%	Yes
Route 4	Trafficmaster	NB	4_N	1556	1411	-145	-9%	Yes
	Trafficmaster	SB	4_S	1365	1272	-93	-7%	Yes
Route 5	Trafficmaster	EB	5_E	1158	1129	-29	-3%	Yes
	Trafficmaster	WB	5_W	1454	1186	-269	-18%	No
Route 6	Trafficmaster	NB	6_N	1121	1097	-24	-2%	Yes
	Trafficmaster	SB	6_S	1091	1033	-59	-5%	Yes
Route 7	Trafficmaster	EB	7_E	1354	1286	-69	-5%	Yes
	Trafficmaster	WB	7_W	1484	1379	-105	-7%	Yes
Route 8	Trafficmaster	NB	8_N	1236	1122	-114	-9%	Yes
	Trafficmaster	SB	8_S	1075	1076	1	0%	Yes
% of Routes within TAG Guidance (Guideline is 85%)								**88%**

Table 12: All Journey Routes Summary – 5pm to 6pm

Route	Data Type	Direction	ID	Observed	Modelled	Difference	% Difference	DfT Compliant
Route 1	Trafficmaster	NB	1_N	839	846	7	1%	Yes
	Trafficmaster	SB	1_S	888	911	23	3%	Yes
Route 2	Trafficmaster	EB	2_E	857	977	120	14%	Yes
	Trafficmaster	WB	2_W	873	1031	158	18%	No
Route 3	Trafficmaster	EB	3_E	1084	1161	77	7%	Yes
	Trafficmaster	WB	3_W	1429	1214	-216	-15%	Yes
Route 4	Trafficmaster	NB	4_N	1386	1283	-103	-7%	Yes
	Trafficmaster	SB	4_S	1212	1219	7	1%	Yes
Route 5	Trafficmaster	EB	5_E	1033	1165	133	13%	Yes
	Trafficmaster	WB	5_W	1149	1303	154	13%	Yes
Route 6	Trafficmaster	NB	6_N	1132	993	-139	-12%	Yes
	Trafficmaster	SB	6_S	981	966	-15	-2%	Yes
Route 7	Trafficmaster	EB	7_E	1147	1295	148	13%	Yes
	Trafficmaster	WB	7_W	1208	1303	95	8%	Yes
Route 8	Trafficmaster	NB	8_N	1277	1074	-203	-16%	No
	Trafficmaster	SB	8_S	1065	1031	-34	-3%	Yes
% of Routes within TAG Guidance (Guideline is 85%)								**88%**

It can be seen that the AM scenario falls within guidance with 88% of routes meeting criteria, with only route 1 southbound and route 5 westbound not meeting the criteria. Route 1 takes in the A167, including the Neville's Cross junction, and Route 5 takes in areas of Gilesgate and roads to the south and west of the city centre. The results show that the model is 'running quicker' than the observed journey times.

The journey time criteria are also met in the PM scenario with 88% of routes within guidance, with only route 2 westbound and route 8 southbound not meeting the criteria. Route 2 and Route 8 takes in several of the most constrained locations in the city including Milburngate Bridge, and Leazes Bowl. The results show that the model is 'running slower' than the observed along Route 2 and 'running quicker' than the observed journey times along Route 8.

These criteria are important to show, due to one of the key model purposes being for the testing of relief roads around the city centre. It is therefore crucial that the journey times are modelled correctly and so confidence can be had in any rerouting results produced in further work. Overall the model currently shows a good level of fit to the observed journey times and further development of the model is being carried out to bring the AM scenario within guidance.

6.4 Matrix Validation Performance

The robustness of the prior matrices has been tested through regression analysis in order to determine the interdependency of variables, confidence intervals and standard errors between observed and synthetic data. This outputs an R^2 value, representing the coefficient of correlation of the regression line, for which the closer to 1.00 the better the level of fit achieved. Figure 7, Figure 8 and Figure 9 present the results of this regression analysis, which has been performed at a sector level for modelled home based work (HBW) trips compared to Census Journey to Work (JTW) trips.

Figure 7: HBW vs JTW Outbound

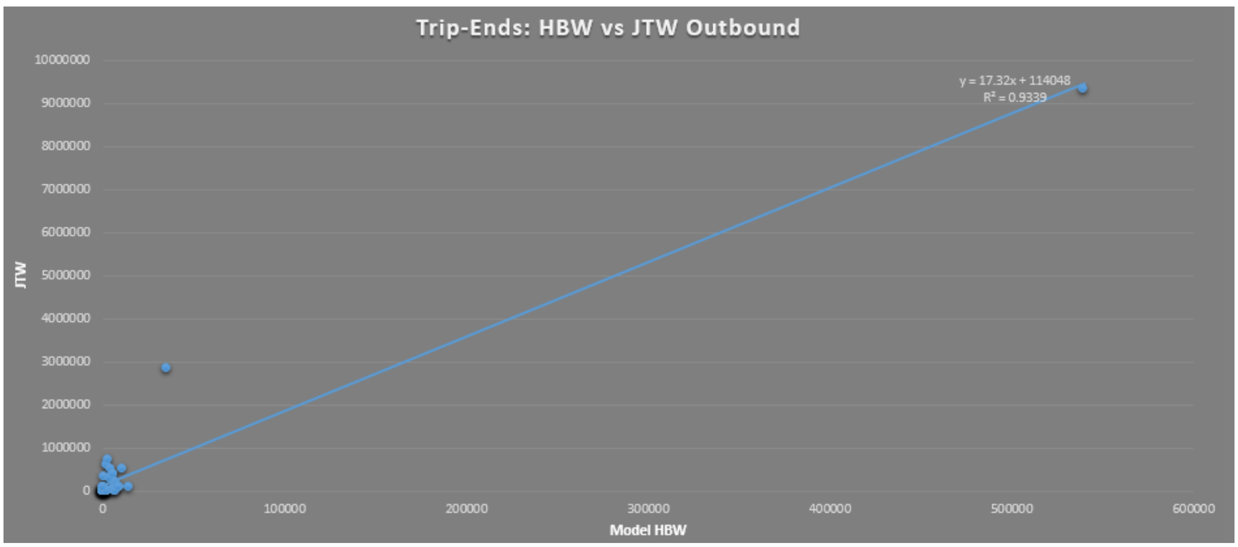


Figure 8: HBW vs JTW Inbound

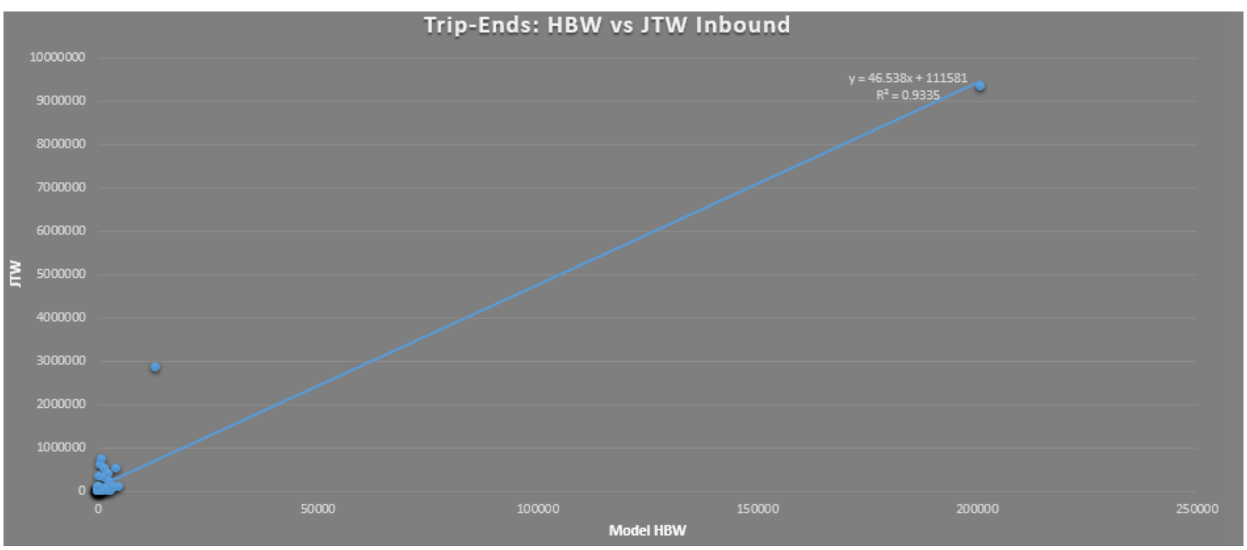


Figure 9: Model vs JTW

As shown in the figures above, the R^2 coefficient of variation value is consistently close to 1, indicating a high degree of interdependency between the model matrix and Census Journey to Work.

To ensure that the matrices are fit for purpose in terms of trip length distribution, analysis has been undertaken at a sector level to compare modelled trip lengths to National Travel Survey (NTS) observed values. This analysis has been carried out for both HBW trips only and all user classes, in order to demonstrate the level of fit against national and local travel patterns. Figure 10 and Figure 11 illustrate the results.

Figure 10: HBW vs NTS

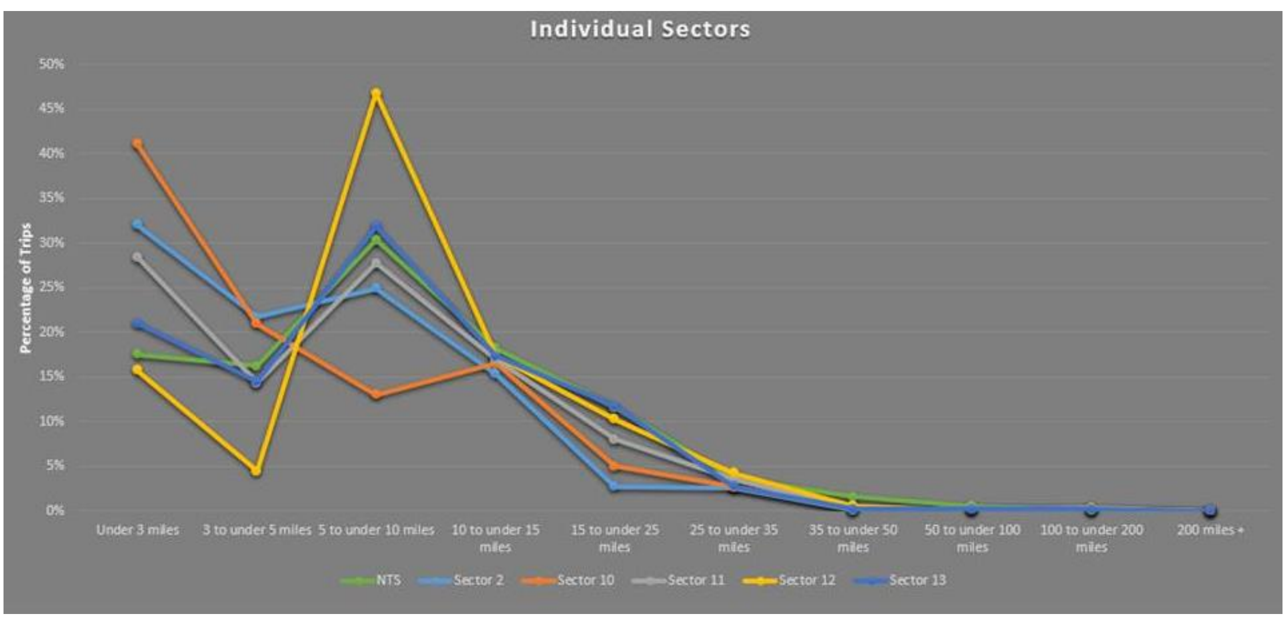
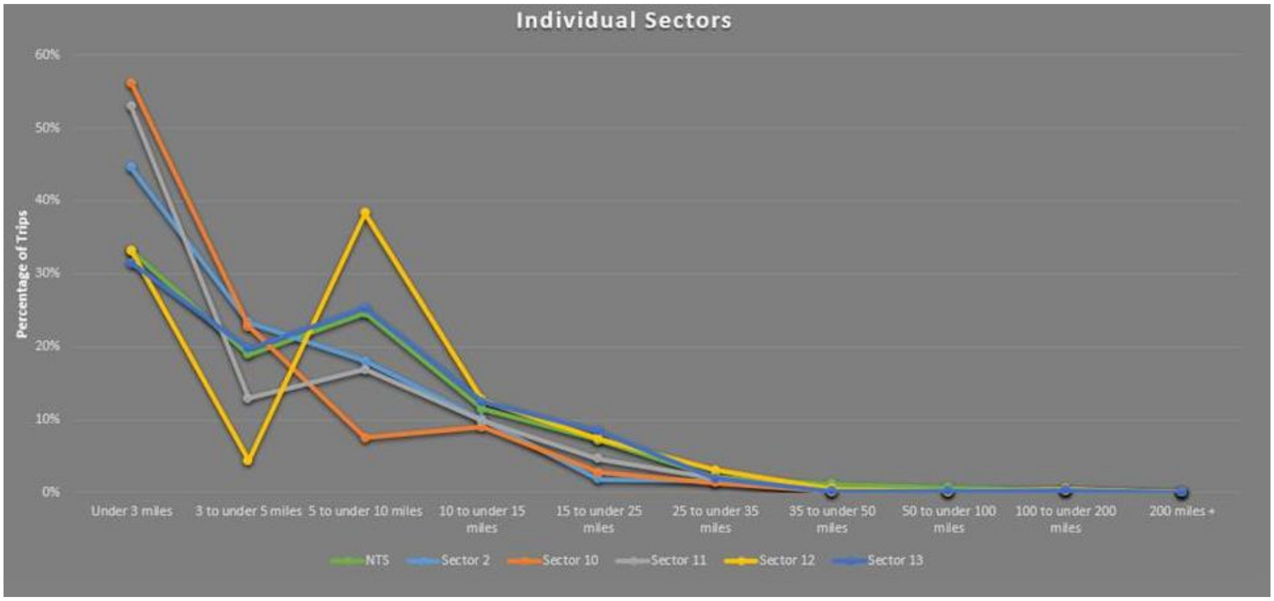


Figure 11: All vs NTS



As the above figures show, the model provides a good reflection of NTS travel distances.

6.5 Summary of Model Performance

The results show that the model is currently at an acceptable level of integrity to enable strategic planning decisions to be made. It is intended that the model is subject to further review and work to further satisfy the criteria presented within this document.

The majority of screenlines are shown to be operating within guidance, and those which aren't do not significantly affect the overall accurate representation of traffic flows within Durham City. Link flow calibration statistics currently do not quite meet guidance, but the link flow validation statistics exceed the criteria and indicate that the model is robust in this area. Model performance against observed journey times is generally good, particularly in the PM scenario which meets TAG criteria. However, it is acknowledged that the model is 'running quick' in comparison to observed journey times along certain routes and further refinement of the model will look to address this. Matrix validation checks have highlighted a good level of fit between the model matrix and independent datasets.

7. Forecasting

7.1 Forecast Years

At the most basic level, there needs to be two forecast years to demonstrate the long term benefits of the proposed transport interventions in the study area. The proposed years to be modelled are:

- 2022: To provide a suitable projected opening year for the new schemes;
- 2037: Long term design year, fifteen years after the schemes have opened.

An interim year and a final year may also be produced for use in the economic assessment of the proposed schemes, but the starting point for a proportionate assessment is two future years.

The following scenarios in Table 13 have been tested within the strategic transport model.

Table 13: Summary of Scenario Tests

Core Scenario		Network Scenario		
Development Scenario	Year	Western Relief Road	Northern Relief Road	Western and Northern Relief Road
With dependent developments	2015	X	X	X
	2022	✓	✓	✓
	2037	✓	✓	✓

7.2 Forecast Developments

The forecasting of trip demand within the study area needs to consider both the impacts of local and national trends in travel demand from the present year of the model to the forecast years. Local planning data on employment and housing developments has been obtained to calculate forecast traffic growth associated with the future developments in the simulation area.

The housing specifically detailed within the model is listed in Table 14. These have been split into committed sites and County Durham Plan sites. Committed sites with over 20 dwellings per site are listed individually, with the remaining 89 sites listed together at the bottom of the table.

Table 14: Housing Developments Included in the Model

Site	Status	Site Totals
Former Skid Pan	CDP	50
Sherburn Road	CDP	420
Cook Avenue North	CDP	50
Cook Avenue	CDP	200
Land at Hawthorn House	CDP	20
Sniperley Park	CDP	1700
Gilesgate School	CDP	60
South of Potterhouse Terrace	CDP	10
Milburngate House	Committed	441
Land to the South of Wallnook Lane and East of Recreation Ground	Committed	400
Former Cape Asbestos Works Durham Road (The Grange)	Committed	74
Land West of Browney Lane	Committed	161
Mount Oswald	Committed	173
Integra 61 Land South of Bowburn & West of the A688	Committed	270
Former Police Headquarters	Committed	149
Land on the North East Side of Cross Lane	Committed	200
North of Ladysmith Terrace	Committed	30
Land to the South West of Station Road	Committed	150
Land East of Mill Lane	Committed	120
Finchale Training College	Committed	100
Land to the North of Local Avenue and Front Street	Committed	31
Durham Johnston Comprehensive School Whinney Hill	Committed	75
Land to the West of Fulforth Way	Committed	73
Land to the North East of Hycroft Benridge Bank	Committed	65
Land at Kepier House	Committed	35
St Cuthberts Drive	Committed	24
Remaining committed dwellings over 89 sites	Committed	323

Additionally, the following employment sites listed in Table 15 have been included.

Table 15: Employment Developments Included in the Model

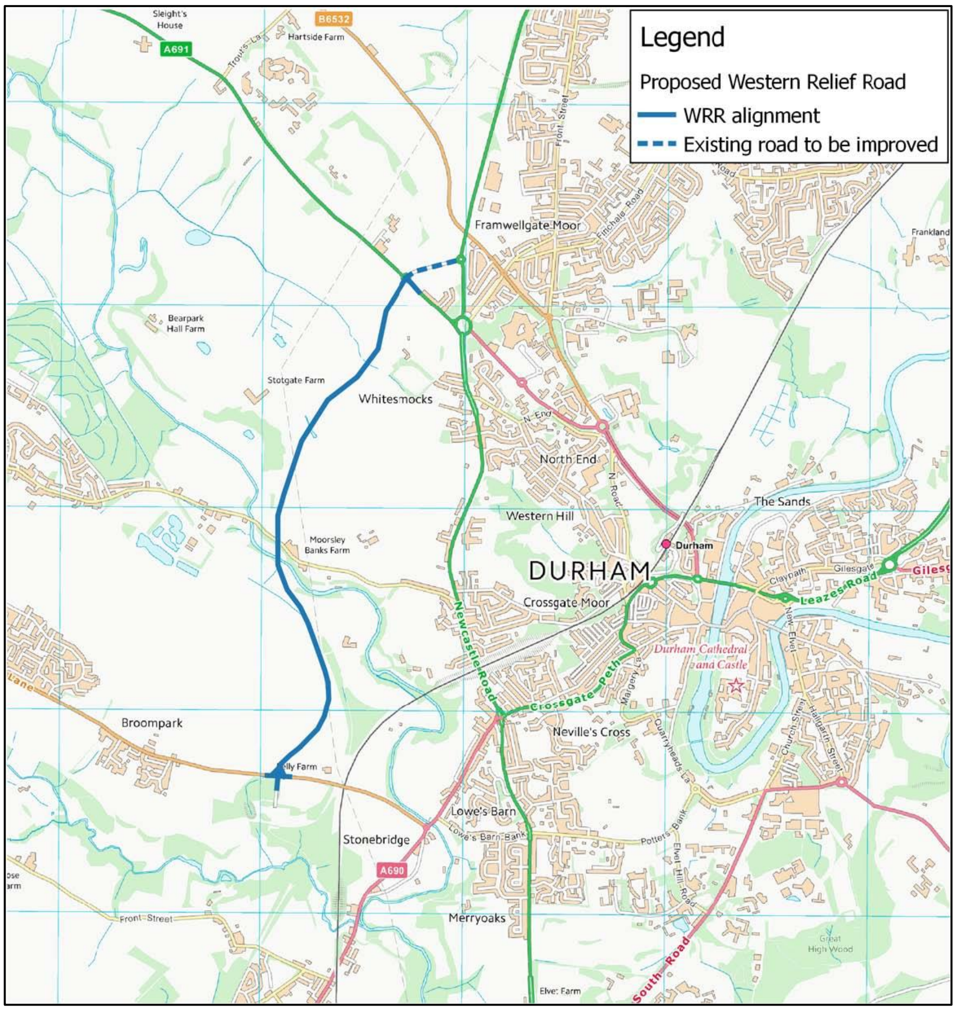
Site	Status	Site Total
Aykley Heads, Phase 1 – Northern Zone, Sites C, D, & E	Committed	979 Jobs
Aykley Heads, Phase 2 – Park Gateway Sites A South (1), A North, B	Committed	1137 Jobs
Milburngate House	Committed	14,262 sqm
New County Hall	Committed	1000 Jobs

It should be noted that the developments listed in Table 14 and Table 15 are specifically modelled, but have been constrained to NTEM growth, including the specifically modelled sites to the County Durham total.

7.3 Forecast Networks

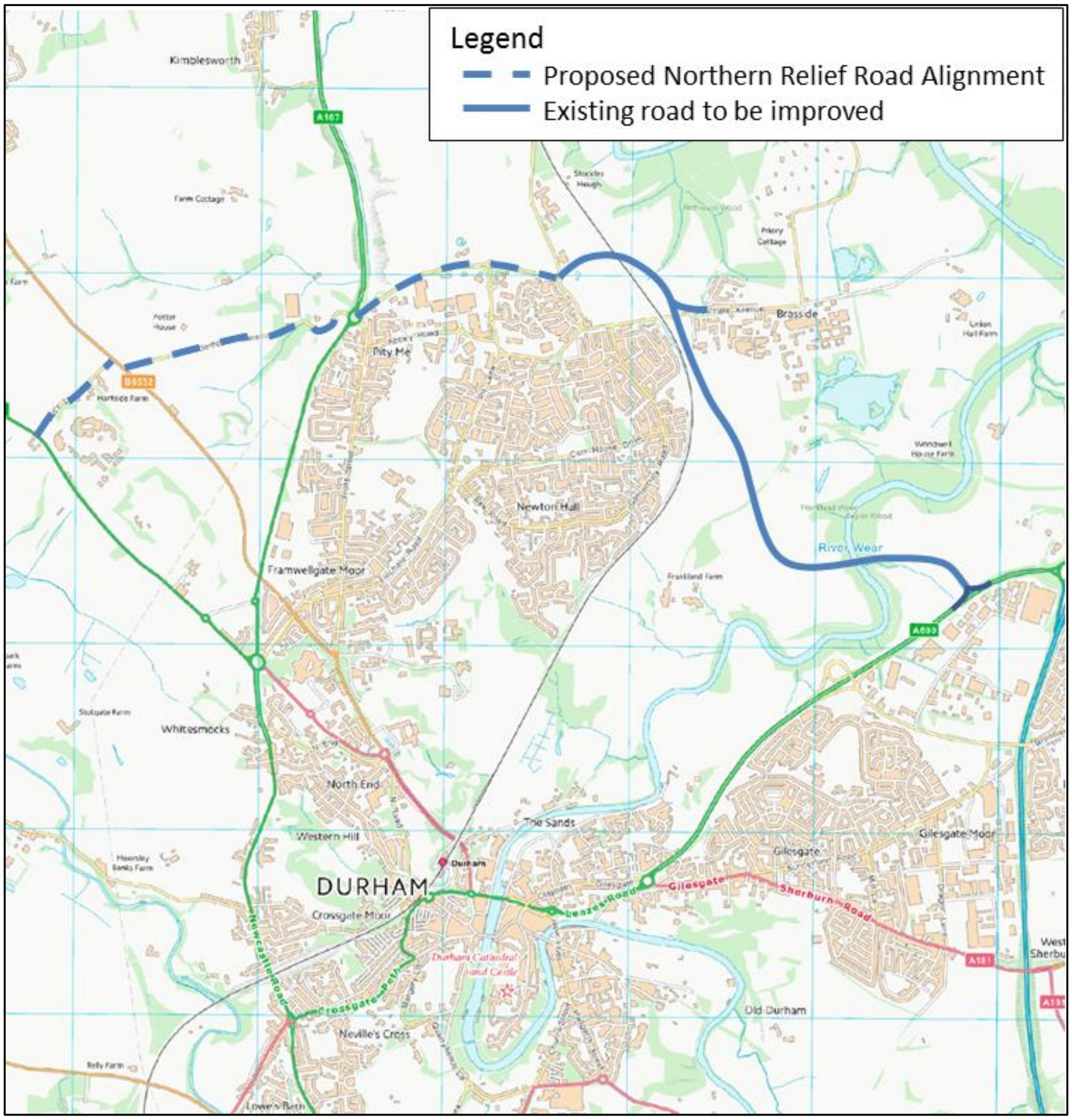
The WRR has been coded into the modelled highway network to the west of Durham City, connecting the A691 and A167 with the B6302 Broom Lane, which in turn connects to the A690. The proposed alignment of the WRR is illustrated in Figure 12.

Figure 12: Western Relief Road Proposed Alignment



The NRR has been coded into the modelled highway network towards the north east of the Durham City centre, between the A167 at Pity Me and the A690 at Carrville. It should be noted that any scenario which includes the NRR also features a lane reduction on Milburngate Bridge, with each direction reduced to one lane in order to test the reallocation of road space to sustainable modes. The proposed alignment of the NRR is illustrated in Figure 13.

Figure 13: Northern Relief Road Proposed Alignment



8. Areas for Improvement Moving Through the Plan Period

As the results presented within section 6 have shown, the model currently demonstrates a good level of fit with observed data and is capable of accurately representing current traffic patterns with Durham City. The model can therefore be considered a reliable tool to carry out Plan testing and inform strategic planning decisions as it currently stands.

However, to bring the model fully into line with DfT guidance and achieve full TAG compliance, work to further refine and improve the model is ongoing. The refinements currently being made fall into four broad areas, each described below:

- Work is being done to review the performance of the model with respect to journey times through key routes and junctions. Currently the model is 'running quick' against these journey times. The impact this will have is to potentially underestimate the positive impacts of the relief roads.
- Work is being done to ensure that junctions through the city represent the levels of delay that matches the observed conditions. SATURN does not handle junction delay well, underrepresenting it when capacity is less than the design capacity. It then extrapolates and spikes one capacity is hit, so getting the balance reflected correctly is difficult.
- The model is being reviewed as it currently under-predicts trip rates within the city in comparison to what is suggested within NTEM. This will, again, underestimate congestion in the city and thus potentially underplay the performance of the relief roads.
- The model is being updated to ensure that the long distance, through trips are in line with the observed matrices and independent datasets.