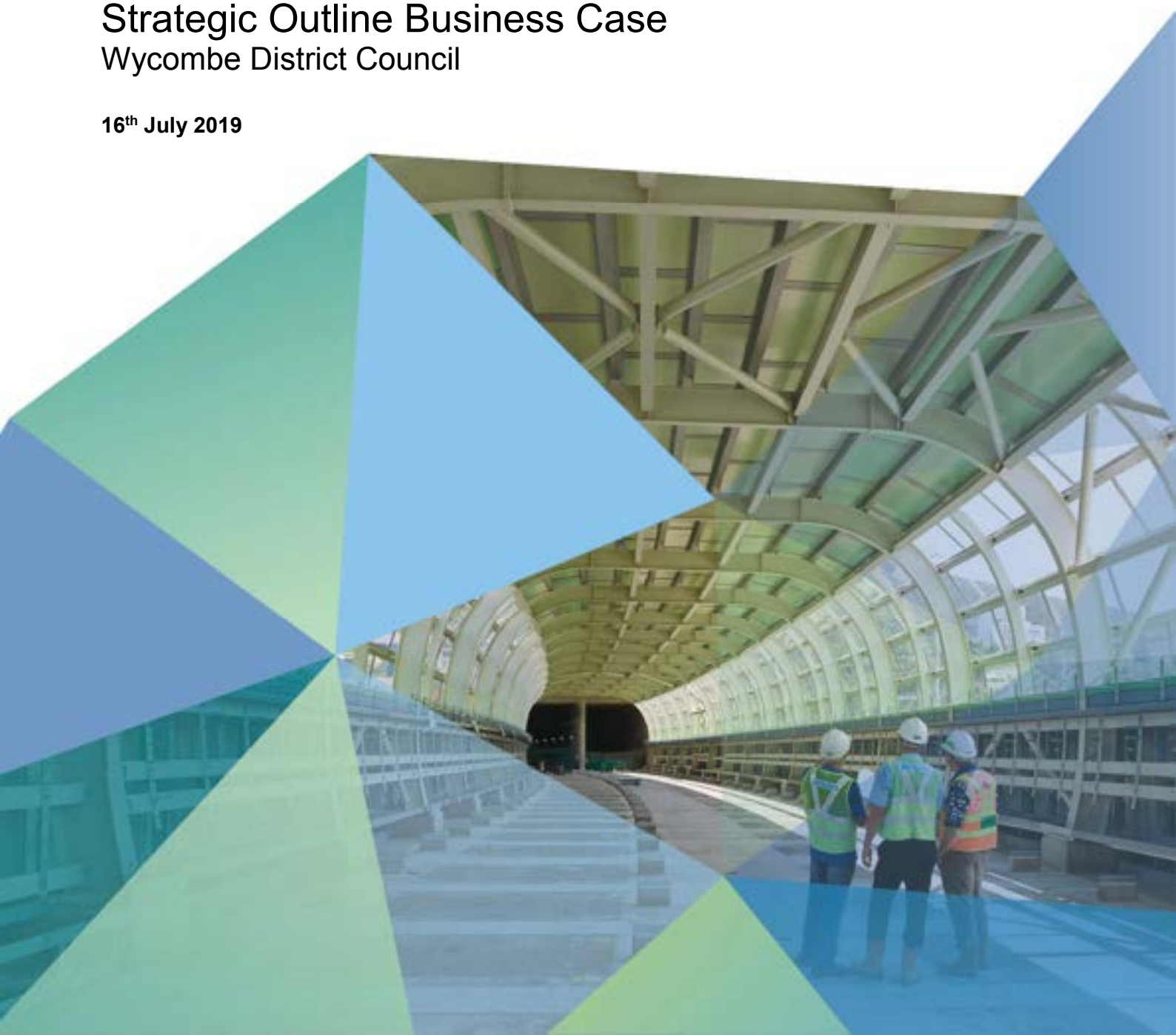
ATKINS

Reinstatement of Heavy Rail between High Wycombe and Bourne End

Strategic Outline Business Case

Wycombe District Council

16th July 2019



Notice

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This document has 79 pages including the cover.

Document history

Job number: 5161498			Document ref:			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 2.0	Final	CF/CN/JU/JB	CF/CN/JU/JB	AJB	AT	14/06/19
Rev 3.0	Comments Addressed	CF/CN/JU/JB	CF/CN/JU/JB	AJB	AT	16/07/19

Client signoff

Client	Wycombe District Council
Project	Reinstatement of Heavy Rail between High Wycombe and Bourne End
Document title	Strategic Outline Business Case
Job no.	5161498
Copy no.	
Document reference	

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1. Purpose of Document

1.1. Strategic Outline Business Case

Atkins has been commissioned by Wycombe District Council to produce the Strategic and Economic Case elements of a Strategic Outline Business Case (SOBC) for the reinstatement of a heavy rail line between High Wycombe and Bourne End, which would provide a connection between the Chiltern Main Line (and the proposed East West Rail) and the Great Western Main Line (and Crossrail).

Department for Transport (DfT) guidance states that the primary purpose of the Strategic Case is to clearly articulate the case for change and the need for a project[1]. The Strategic Case will therefore set out:

- The national, regional and local policy drivers of relevance, and the associated ambitions for the economy, transport and the environment in the study area;
- The need for the scheme by setting out:
    - the current demand and performance of the transport networks in the study area;
    - the importance of the study area to the economy, and the need for strong connectivity to support its future prosperity;
    - potential gaps in service provision in the study area transport networks; and
- An assessment of the impact of scheme options in addressing transport and wider policy issues.

Given that there are many calls on public investment, it is essential that a transport scheme is able to provide convincing evidence of its need, as well as how transport and wider policy objectives are addressed as a direct result of the intervention.

The Strategic Case feeds directly in to the Economic Case, where the anticipated benefits of the scheme are compared with a “Reference Case” or Do-Minimum situation in which the scheme is not built, but where other planned infrastructure and development (such as already approved transport schemes, housing and mixed-use) does take place.

As part of the interface between the Strategic and Economic Cases, this study has made use of a previously developed long-list of service options as presented in the ITT documents. An initial high-level option sift has been carried out to give a short-list of 5 options that have been modelled as part of the Economic Case. The approach to the high-level option sift is reported within this Strategic Case.

This study only considers reinstatement of heavy rail – alternative transport schemes such as light rail, bus, highway or active mode schemes are out of the scope of this study.

1.2. Structure of the Strategic Outline Business Case

The SOBC covers the Strategic Case and the Economic Case. The structure of the Strategic Case is as follows:

2. Context and Problems to be Addressed by the Scheme;
3. Scheme Objectives;
4. Constraints;
5. Dependencies;
6. Key Stakeholders;
7. Options and Outline Selection Criteria.

[1] DfT. (2013). The Transport Business Cases.

The structure of the Economic Case is as follows:

8. Outline Assessment Approach;
9. Shortlisted Options for Testing;
10. Do Minimum Assumptions;
11. Scheme Costs;
12. Scheme Appraisal Results;
13. Conclusions; and
14. Next Steps.

2. Context and Problems to be Addressed by the Scheme

2.1. Background to the Study

The scheme proposes to reinstate heavy rail between High Wycombe and Bourne End. This comprises both the link itself between High Wycombe and Bourne End and the services that will operate on the link and the surrounding rail network.

The now disused line from Bourne End to High Wycombe was closed by British Railways to freight traffic on 18th July 1966 and to passenger traffic on 4th May 1970 as part of cuts recommended in the Beeching reports. The scheme will seek to reinstate the link using either the original route or an alternative alignment. Much of the local geography has changed over the last 50 years and so reinstating the original route may have considerable issues and obstacles.

Currently Buckinghamshire and the Wycombe district have strong east-west rail connections, particularly towards London, but very limited north-south rail connections. Many trips to key employment centres and other important locations, such as High Wycombe to Heathrow Airport, Princes Risborough to Slough, or Milton Keynes to Maidenhead, can realistically only be made on congested roads (by car or bus) or circuitously by rail via London or Oxford.

However, there is less than 4km, as the crow flies, between the Chiltern Main Line and Bourne End on the Marlow-Maidenhead branch of the Great Western Main Line. This is now a ‘missing link’ in the rail network and is a potential opportunity to provide new direct or easy-interchange rail journey opportunities.

Although previous studies have been cautious about the viability of reinstating this link, there are now several background and policy reasons why this should be re-examined, including:

- The growth and devolution agendas, focusing on the ability of locally-led transport investments to support economic growth;
- Continuing congestion, and limits on the ability of the road network to accommodate significant housing and employment growth;
- The M25 South West Quadrant study identifying the need to provide public transport alternatives to journeys currently using the M25;
- An opportunity to influence the forthcoming M25 alternatives study which will look at these alternatives in more detail;
- The continuing lack of high quality public transport more generally across the region;
- Opportunities to create synergies from linking-up committed and proposed rail investments, particularly East West Rail, Crossrail and the Western Rail Link to Heathrow (WRLtH); and
- Continuing train-capacity and passenger-capacity constraints on the south-east’s rail network, making a ‘London bypass’ alternative potentially attractive.

2.2. Study Area

There are two key railway routes in the study area - the Chiltern Main Line and the Great Western Main Line. The latter branches off to a single line via Bourne End to Marlow and since the closure off the Bourne End – High Wycombe line, these two routes have existed as two completely independent rail systems.

The Chiltern Main Line is the railway line running between London Marylebone and Birmingham Snow Hill. There are 2 major stations along the Chiltern Main Line that service the Wycombe District: High Wycombe and Princess Risborough. There are 4tph in each direction from High Wycombe and 2tph from Princes Risborough, offering frequent connections to Central London and other locations along the Chiltern Main Line.

The Chiltern Main Line allows access to a number of important strategic locations. To the north of High Wycombe, there are connections to Oxford (via Bicester) and Aylesbury, which in the future will offer an interchange with the Western Section of the proposed East West Rail service.

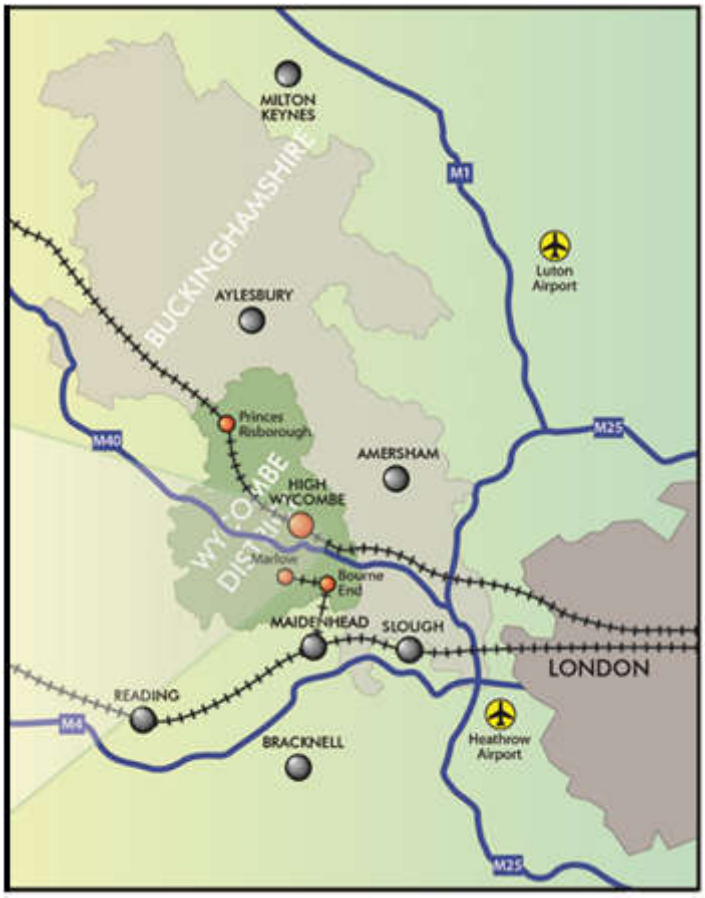
The Bourne End/Marlow single line is a small branch line which connects the towns of Marlow and Bourne End to the Great Western Main Line via Maidenhead. The line has 4 stations and is served by a single hourly shuttle train travelling between Marlow and Maidenhead, with a reversal at Bourne End.

The Great Western Main Line allows access to a number of important strategic locations including Oxford, Reading, Maidenhead, Slough, Ealing Broadway and London Paddington. From 2019, Maidenhead will become part of the Elizabeth Line, allowing access to Crossrail services. In the future, there will also be a connection with HS2 at Old Oak Common and access to Heathrow Airport via WRLtH. Reading station allows access to the South Western Railway and Cross Country services.

For those living and working in the study area, the Chiltern Main Line and the Great Western Main Line provide viable alternatives to the key highway corridors used to get in and out of Central London. The Chiltern Main Line runs alongside the M40 and A4010, whereas the Great Western Main Line partly runs parallel to the M4. However, for other key routes, there is often no alternative to travelling by car due to the nature of the rail network in the study area.

The study area is shown below in Figure 2-1 and includes the broad area over which the new rail link could provide improved rail connectivity and facilitate new journey opportunities, either directly for locations served by trains using the link or indirectly for locations within an interchange of those services.

Figure 2-1 Study Area



2.3. Drivers for Intervention

2.3.1. Introduction

This section presents the case for intervention by assessing current demand for transport and usage of existing transport networks, as well as local and regional growth ambitions and future expectations of demand. In addition, this section also reviews previous studies that have examined the case for re-opening this rail link.

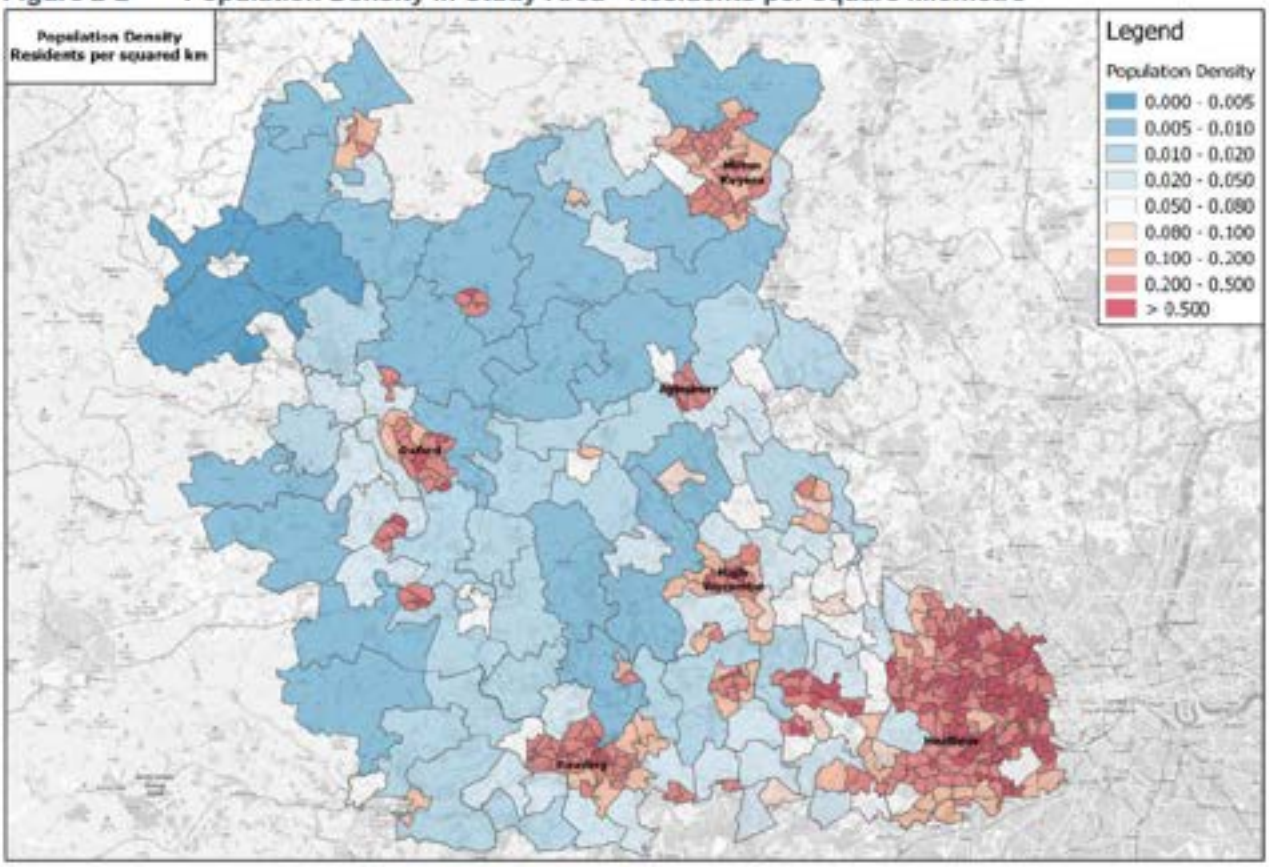
The evidence-based analysis covering the study area will highlight key locations, movements and the importance of connectivity in the context of areas forecast to grow and constraints in terms of transport network capacity and the increased consideration and importance given in multiple policies and identified strategic objectives to delivering more sustainable forms of development, including sustainable transport requirements.

2.3.2. Spatial Context

2.3.2.1. Current Demand Drivers – Population

Figure 2-2 shows the population density, based on 2011 Census population data, in the study area. As would be expected, the highest number of usual residents per square kilometre is found within London and the Heathrow Airport area, together with key town centres, such as High Wycombe, Milton Keynes, Oxford and Reading. The south and east of the study area are more densely populated than the north and west of the study area.

Figure 2-2 Population Density in Study Area - Residents per square kilometre

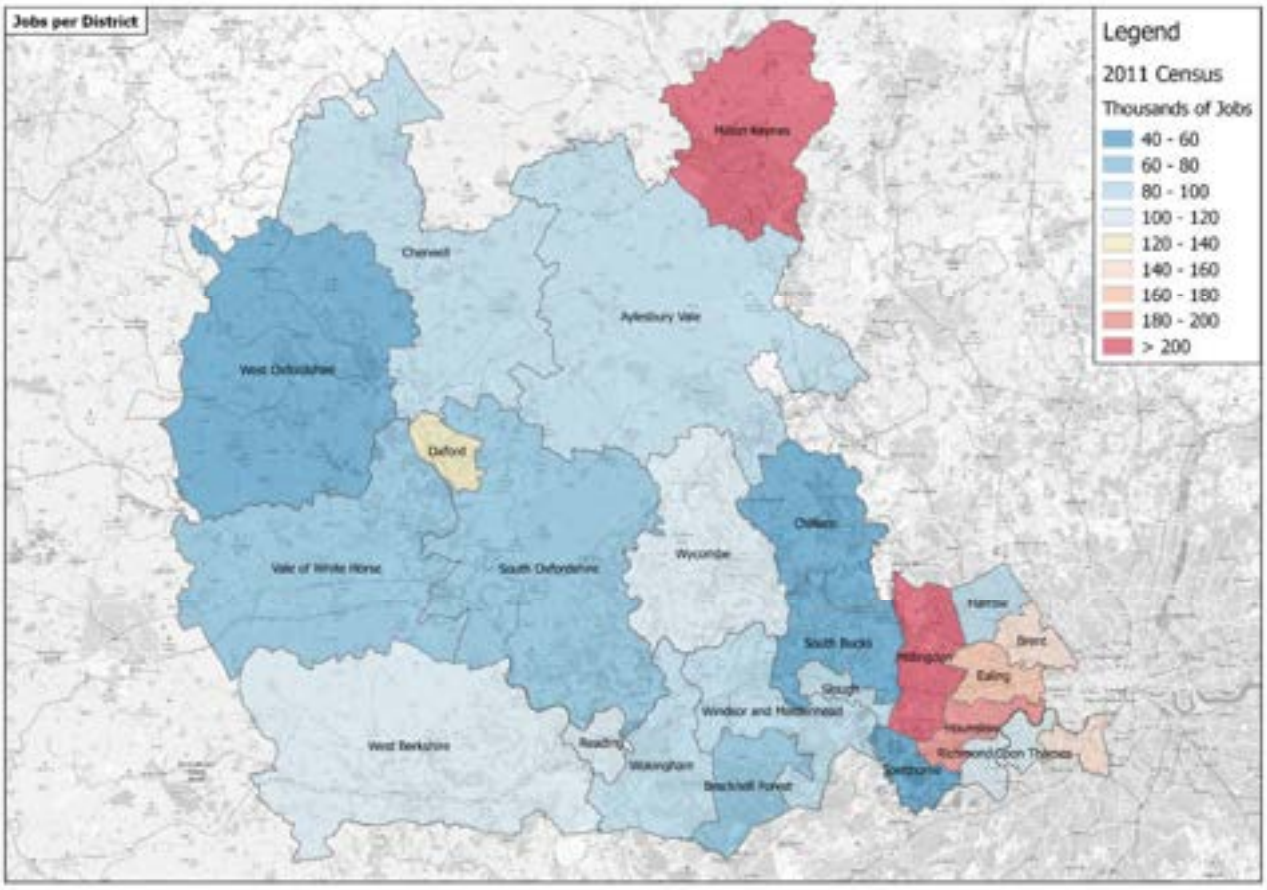


2.3.2.2. Current Demand Drivers – Employment

Figure 2-3 below shows the number of jobs in each of the districts within the study area. It can be observed that there is a particularly high number of jobs in Milton Keynes and in Hillingdon, as would be expected due to Heathrow Airport. However, when comparing the job density within these districts, Milton Keynes has a higher job density (1.19), that is the number of jobs per residents in age to work, than Hillingdon (1.04), due to the higher population density in the Hillingdon area as shown in **Error! Reference source not found.**. This would imply that due to the higher job offer compared to population in Milton Keynes, a high number of people would be expected to commute to work into Milton Keynes.

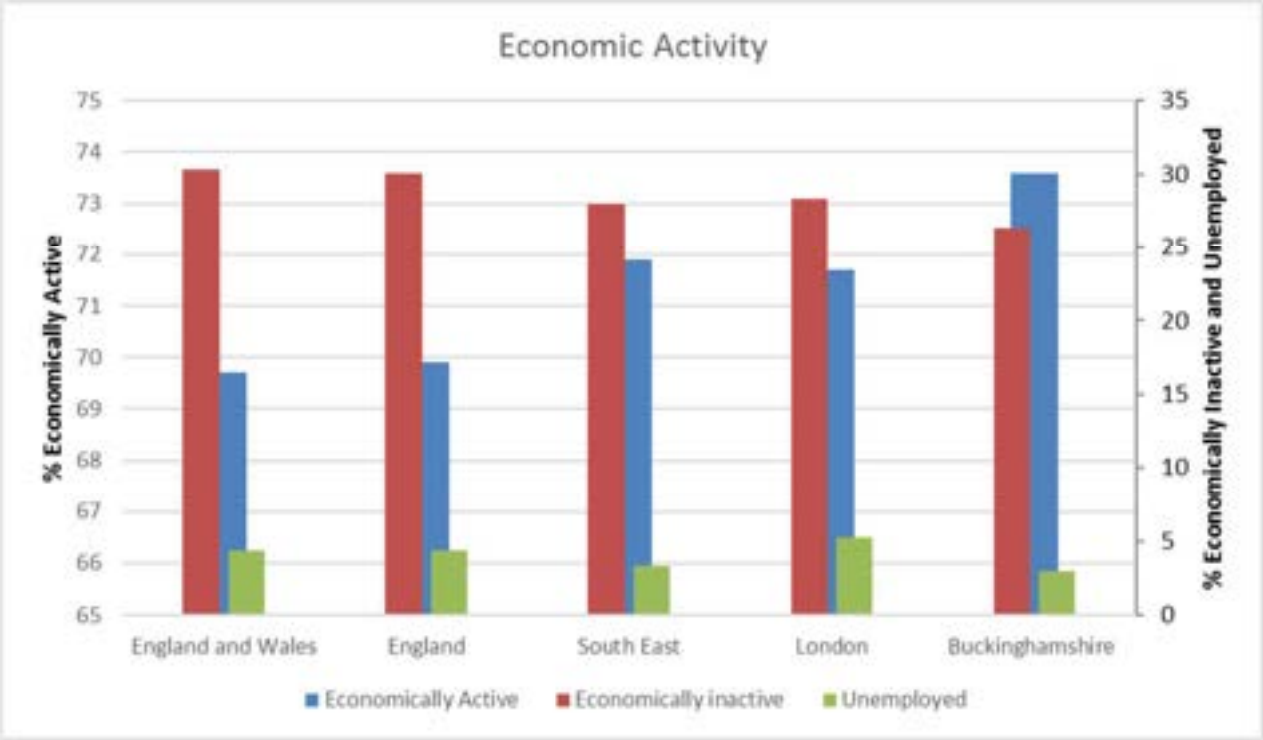
Also, although West Berkshire and Reading don't appear to have a particularly high number of jobs when compared to other districts in the study area, their job density is very high, at 1.14 and 1.09 respectively, offering more than a job per person living in the district.

Figure 2-3 Number of Jobs per District



According to the 2011 Census, the economy of the study area is characterised by not only a highly skilled labour force, with 44% of residents within Buckinghamshire and 42% within Wycombe district having a National Vocational Qualification of level 4 or above (well above the national average of 35%), but also by its high employment rates, with low levels of economic inactivity when compared to the national average. This is summarised in Figure 2-4 below:

Figure 2-4 Employment, Unemployment and Economic Activity

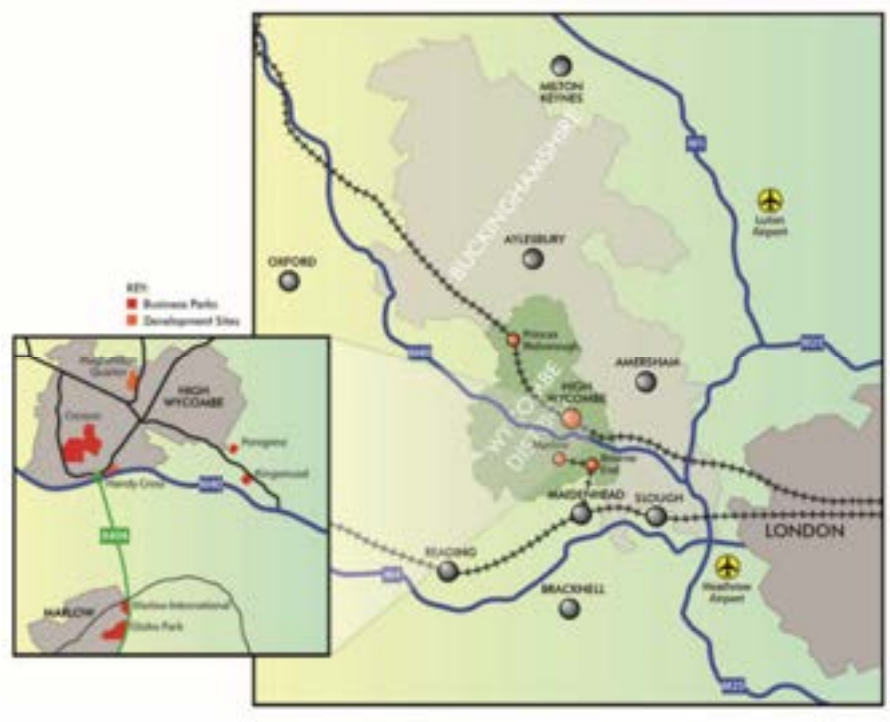


Within Buckinghamshire's four districts there is little variation in terms of proportions of economically active, economically inactive and unemployed. Aylesbury Vale has the highest economically active proportion at 75.3%. Aylesbury Vale and Wycombe are the dominant economic districts with over 95,000 and over 91,000 economically active residents respectively. The Royal Borough of Windsor and Maidenhead also has a particularly high level of economic activity, with over 77,000 economically active residents representing a proportion of 74.5%

Due to the location of the study area, with easy access to London, the M40, M25 and M4 corridors, as well as Heathrow Airport supporting international business activity, the region has been chosen by a large number of global businesses, such as John Lewis, Johnson and Johnson and Hyundai, as the location for their corporate headquarters. This helps to demonstrate the contribution of the region to the national economy.

According to Wycombe's District Economic Overview, there were 1,163 firms formed in the Wycombe district in the first nine months of 2014, more than a quarter above the national rate, proving the area's recent economic growth and potential future growth. Figure 2-5 shows some of the business parks located within Wycombe district. It is likely that many of these new firms, along with existing firms, will be concentrated on these business parks and as such they would be conveniently located to make use of the services that would run on the new link.

Figure 2-5 Wycombe District Business Parks

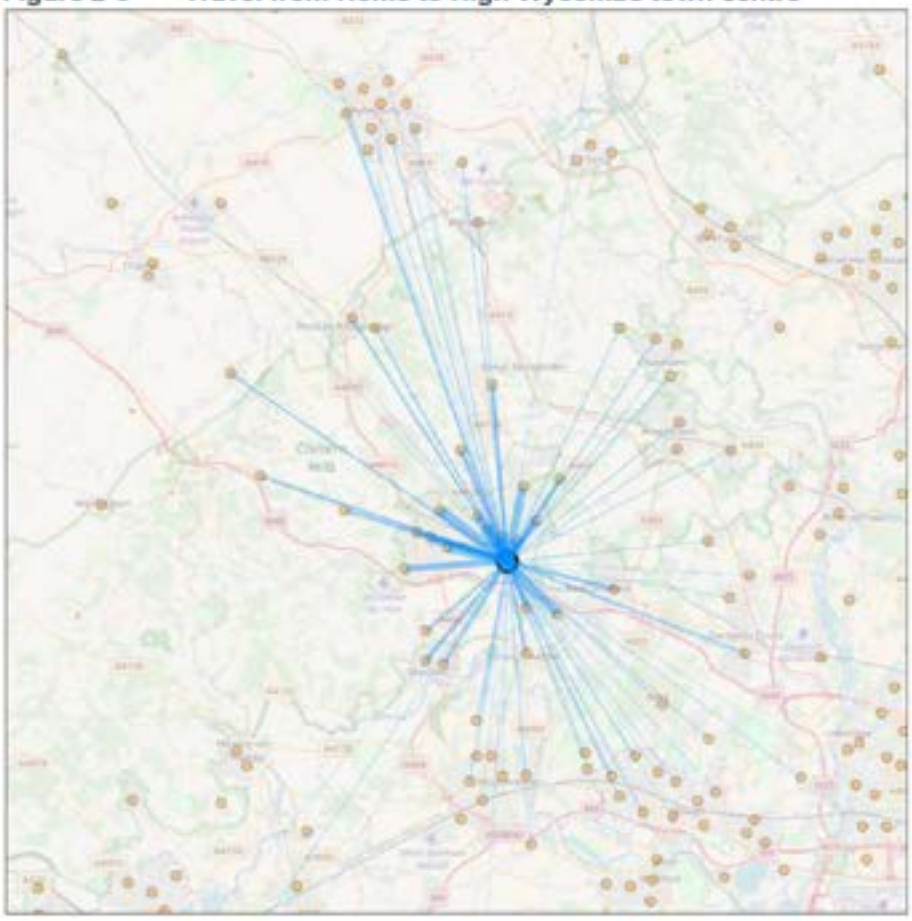


On top of these local employment centres, Heathrow Airport is the UK's biggest air freight and passenger airport and the second busiest airport in the world. It directly employs 69,700 people on site, 7,000 off-site, and a further 40,000 full time equivalent jobs through its supply chain, making it the largest single employment location in the study area. Current access to and from Heathrow Airport within the study area is predominantly by road, although WRLtH would be a significant factor in improving sustainable access options and then services using the High Wycombe to Bourne End link would expand rail access to Heathrow Airport to an even wider area.

2.3.2.3. Current Demand Drivers – Commuting

Employment centres in the study area are characterised by extensive travel to work catchment areas, with a higher than average proportion of employees undertaking long commuting journeys to reach their workplace. In the case of High Wycombe town centre (as defined by the Middle Layer Super Output Area (MSOA) geographic areas), this includes people commuting all the way from Buckingham and Milton Keynes to the north, past Oxford to the west, and Ascot and Reading to the south, as can be observed in Figure 2-6, based on the 2011 Census.

Figure 2-6 Travel from Home to High Wycombe town centre



This is also proven in other locations in the study area, where people commuting into key employment centres could benefit from a north-south rail link, without having to travel via London, travel by car or interchange as many times. This includes the following examples, which are illustrated in Appendix A:

- Maidenhead: people commute all the way from Guilford and Basingstoke in the south, west-central London in the east, Newbury in the west and Aylesbury and Hemel Hempstead in the north.
- Beaconsfield: people commute all the way from Aylesbury to the north, and from many locations in the south such as Slough, Maidenhead, Windsor and Marlow.
- Reading: people commute all the way from Marlow and High Wycombe to the north, Swindon to the west, Basingstoke and Farnborough to the south and Slough to the east.
- Slough: people commute from key locations in the north such as Princes Risborough, Amersham and Aylesbury, London to the east, and many locations from the south.

Factors contributing to longer distance commuting include the concentration of jobs to resident workers in key economic centres within Buckinghamshire. Based on 2015 data collected by the Office for National Statistics, Buckinghamshire has an overall job density of 0.83. That is, within the county, there are 83 jobs for every 100 residents aged 16-64, which, although lower than the average of the South East (0.86) and London (0.98), is still extremely high.

In terms of the key locations for flows in to and out of Wycombe and Windsor and Maidenhead, these are summarised in Figure 2-7 and Figure 2-8 respectively.

Figure 2-7 Key Locations to and from Wycombe

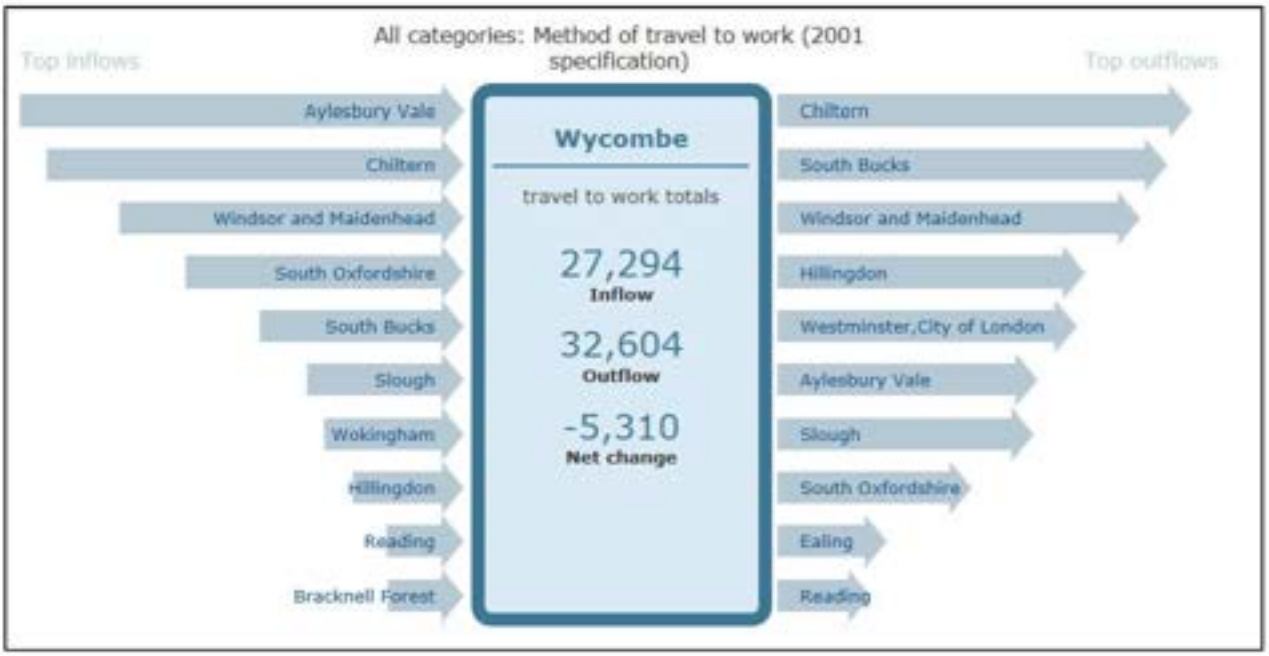
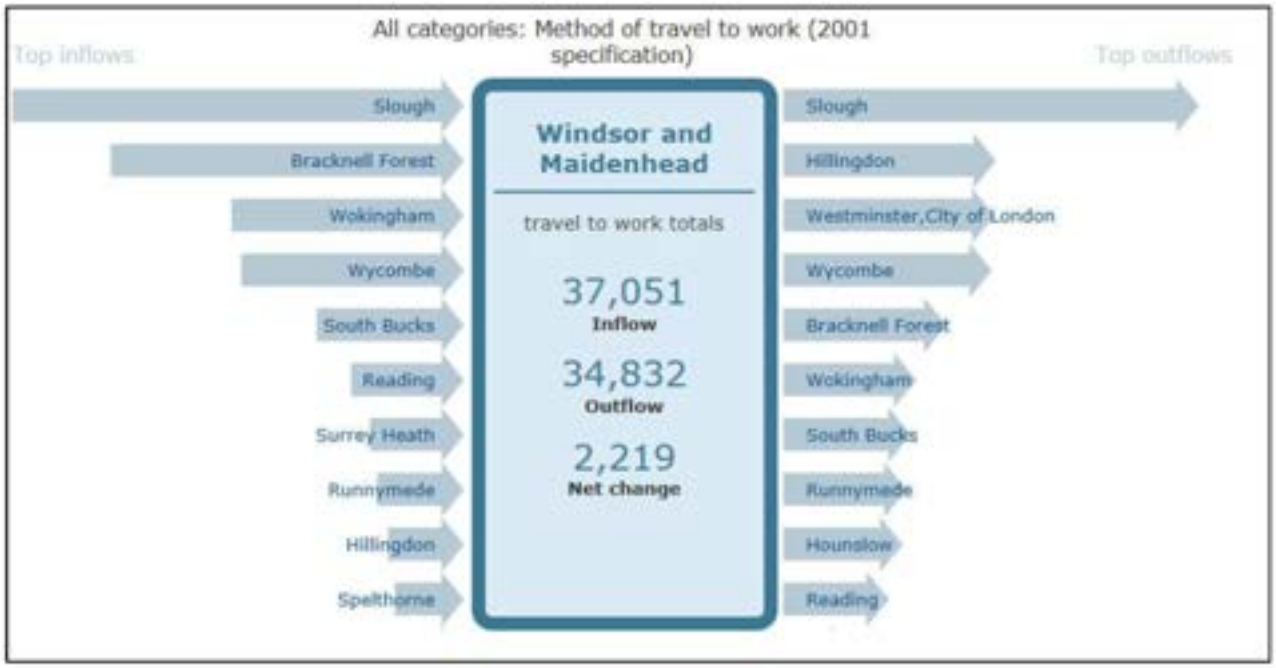


Figure 2-8 Key Locations to and from Windsor and Maidenhead



These figures reinforce the importance of the commuting corridor from Aylesbury through Buckinghamshire to Wycombe and on to Maidenhead and Slough.

Furthermore, these locally important centres of economic activity, with busy town centres and active office sites throughout the study area, such as Milton Keynes or Slough, lead to complex travel movements in the area. These can often realistically only be made on the already congested road network, by car or bus, as can be observed from the mode share data in Table 2-1 based on 2011 Census data. The majority of trips travelling from home into High Wycombe are made by car, with a very small proportion of trips made via sustainable modes such as bus and train, which together only account for about 6% of commuters travelling to High Wycombe.

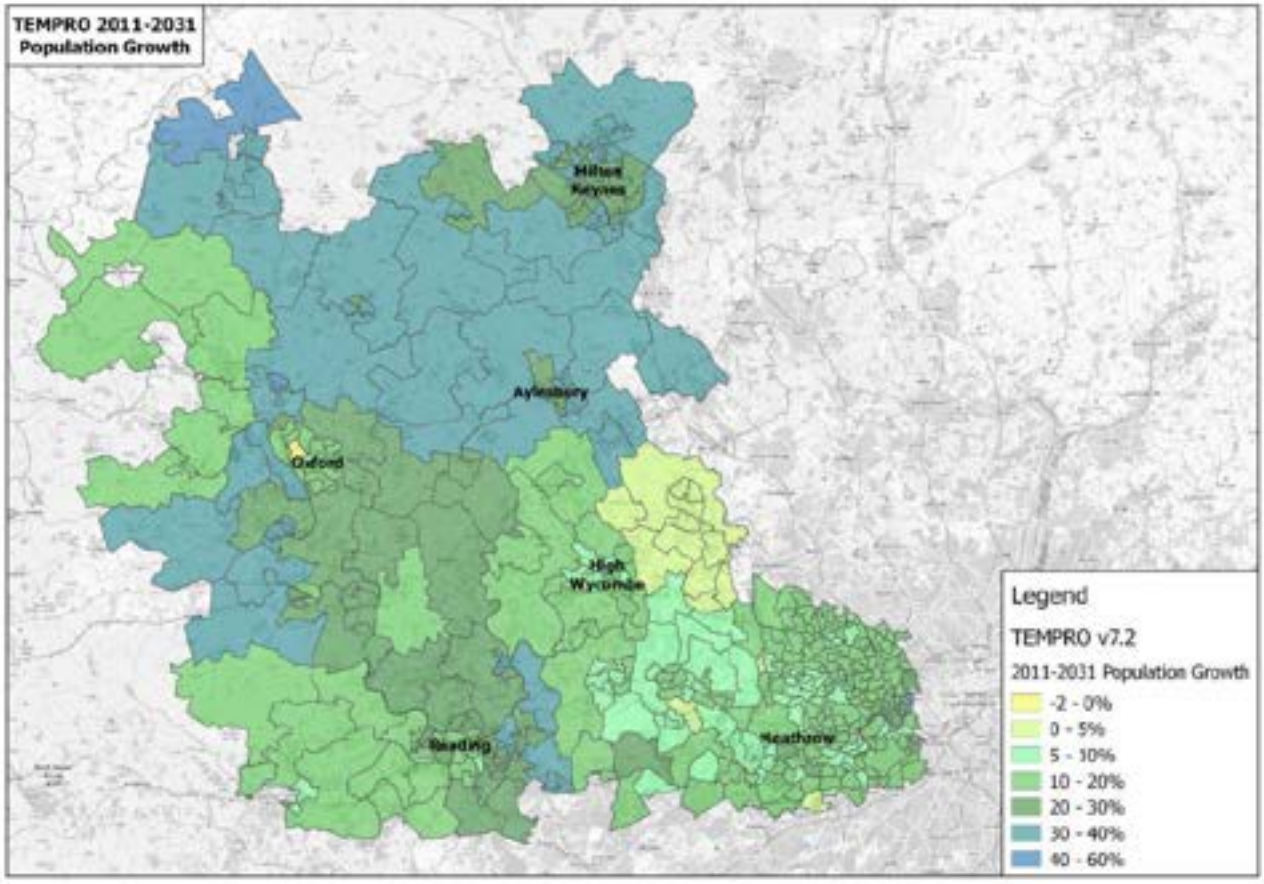
Table 2-1 Mode Share into High Wycombe

Mode	Proportion of trips
All modes	100.00%
Car	62.66%
Train	0.25%
Bus	5.57%
Other (including taxi, motorbike, bike and on foot)	31.51%

2.3.2.4. Local and Regional Growth Ambitions

The local and regional economic success within the study area has led to significant growth ambitions and it is expected that there will be substantial planned population and employment growth in the study area. Figure 2-9 below illustrates forecast population growth within the study area between 2011 and 2031 according to TEMPRO 7.2 growth forecasts. TEMPRO growth forecasts are based on data from the National Transport Model (NTM) and provide a nationally consistent set of forecasts for use in DfT investment appraisal controlled by thresholds for overall growth across the UK.

Figure 2-9 TEMPRO 2011-2031 Population Growth



The distribution of growth across the study area is quite uneven and, although virtually all locations will experience growth between 2011 and 2031, it is the areas around Milton Keynes and Aylesbury, to the north of the study area, that will experience the most growth along with locations to the north-east and south-west of Oxford and to the west of Reading. These areas are typically due to see population growth of 30-40%. The area around High Wycombe is due to see lower levels of growth, although still 10-20% growth between 2011 and 2031.

Aylesbury Vale, Chiltern, South Bucks and Wycombe District Councils undertook a joint Housing and Economic Development Needs Assessment (HEDNA) for the Buckinghamshire Housing Market Area (HMA) and Functional Economic Market Area (FEMA) which was published in December 2016 together with a HEDNA Addendum (September 2017). The HEDNA and subsequent update identified the Objectively Assessed Housing Need (OAHN) for the three Local Plan areas comprising the Buckinghamshire HMA, which is summarised in Table 2-2 below:

Table 2-2 OAHN in the Buckinghamshire HMA

Local Planning Authority Area	OAHN
Aylesbury Vale	**19,400 dwellings**
Chiltern and South Bucks	**12,900 dwellings***
Wycombe	**13,200 dwellings**
Buckinghamshire HMA	**45,500 dwellings**

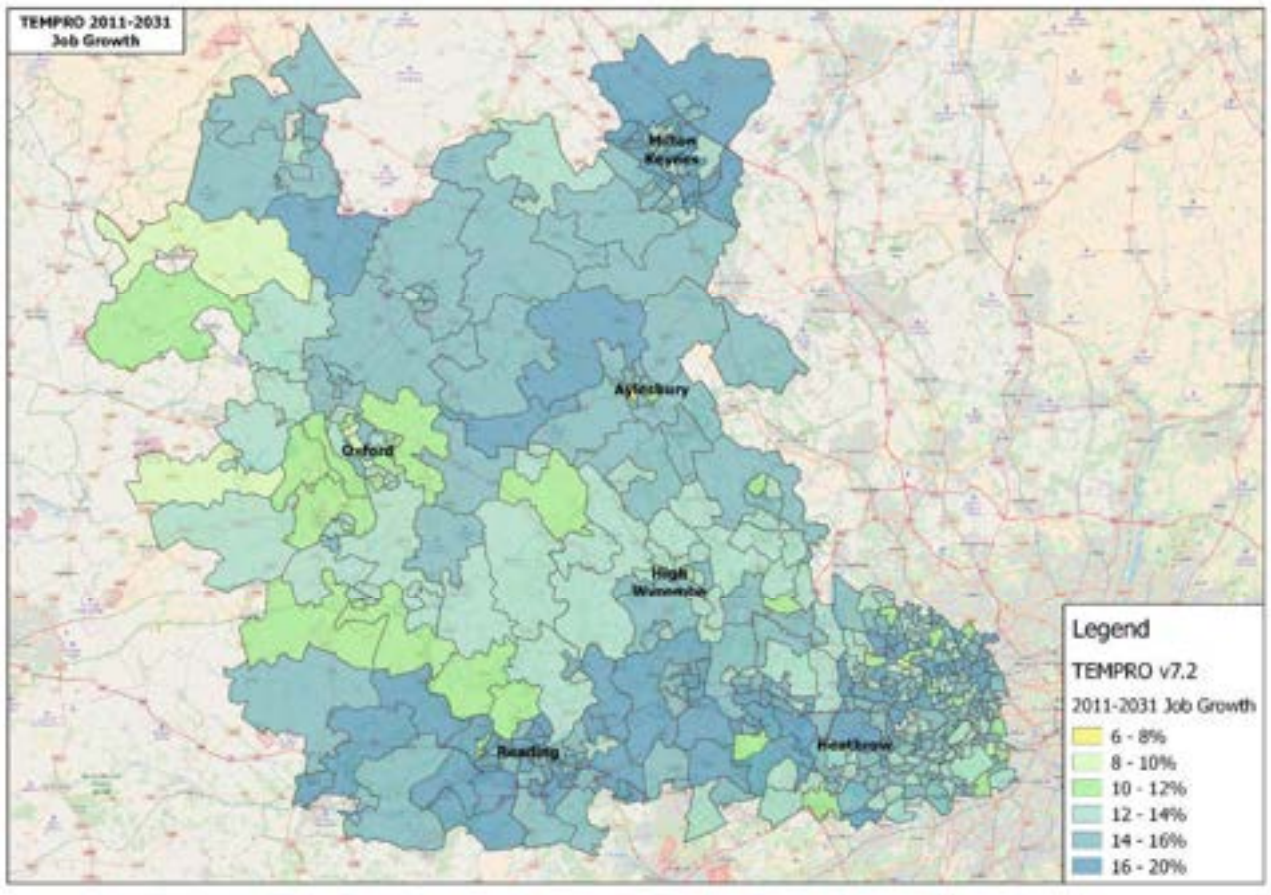
***Note that the Chiltern and South Bucks plan period is 2014-36 but figure shown are 2014-33 for consistency purposes in relation to the end date of the Wycombe and Aylesbury Vale plan periods.**

In addition to the above, the Local Plan for the Royal Borough of Windsor and Maidenhead sets out the following housing delivery targets:

- 420 units per annum between 2013/14 and 2017/18;
- 730 units per annum between 2018/19 and 2022/23; and
- 850 units per annum between 2023/24 and 2032/33.

In terms of employment growth, Figure 2-10 below illustrates forecast employment growth within the study area between 2011 and 2031 according to TEMPRO 7.2 growth forecasts.

Figure 2-10 TEMPRO 2011-2031 Employment Growth



The distribution of employment growth across the study area is more even than the distribution of population growth. The greatest levels of growth will be seen along the M4 corridor, at locations such as Slough, Maidenhead and Reading, and in the north of the study area around Aylesbury and Milton Keynes. In these locations job growth will be up to 20%. There will be lower levels of growth along the M40 corridor, especially around Oxford. However, growth will still be at least 10% there and around 15% around High Wycombe.

The other key growth story in the study area is Heathrow Airport. After the Government established the Independent Airports Commission in September 2012, a new Northwest Runway at Heathrow Airport was identified as the option which would deliver more substantial economic and strategic benefits than alternatives. If Heathrow meets the requirements set out in the Airports National Policy Statement published in October 2017 and gains development consent, demand for movement in and out of Heathrow will be increased even further.

2.3.2.5. Spatial Context Summary

The study area is characterised by discrete areas of population and employment density with high economic activity across the region. Local business hubs are supplemented by key employment centres like Milton Keynes and Heathrow Airport. There is a high degree of long-distance commuting to these economic centres, with high dependency on travel by car. Population growth will be particularly high to the north of the study area, while employment growth will be high along the M4 corridor. This means that there is potential for the scheme to serve strategic as well as local demand, provided that the rail service offers competitive journey times with highway travel and existing rail journey times.

The anticipated levels of new employment and housing, combined with aviation expansion centred on Heathrow Airport, will increase the demand for travel across the area. This will place substantial additional strain on transport networks and services. The economic success in the area is likely to continue to contribute to significant transport congestion, threatening the connectivity advantage the region has when competing with other areas, and hence restricting further economic growth. Economic growth is therefore

dependent on investing in physical infrastructure capacity that addresses key connectivity issues and a congested transport network, in line with the vision and relevant policies for the area.

2.3.3. Transport Context

2.3.3.1. Public Transport Network

Geographical Context

The rail network is illustrated in Figure 2-1. A defining characteristic of the rail network serving the study area is its radial nature. Routes serving London terminals dominate the pattern of service and provide good connectivity between settlements along each route and into London. Therefore, opportunities to make orbital journeys by rail tend to be more fragmented, realistically having to be made circuitously by rail via London or Oxford. This radial characteristic limits the ability of the rail network to cater effectively for the wide variety of orbital or long-distance journeys taking place, as well as connecting economic centres within the study area.

Rail Demand

UK rail demand has grown strongly over the last two decades, increasing by 69.5% from 975 million journeys in 2002/03 to approximately 1.65 billion journeys in 2014/15 according to ORR Passenger Rail Usage data. In the West Midlands, rail use has increased by 4.3% per annum since 2013/14, with annual journeys now standing at 48.5 million according to figures from Centro. Between 2011 and 2015, the number of passengers travelling in and out of London Marylebone at peak times increased by 20%. This rate of growth is faster than the national average. Over the next 25 years the peak hour demand for travel in and out of London Marylebone is expected to grow by 76% according to Network Rail's West Midlands and Chilterns Route Study. This will inevitably increase seat utilisation levels, especially in the AM Peak, as shown by Figures 2-11 to 2-13 below based on data from the PLANET South model:

Figure 2-11 2014 AM Peak Rail Crowding in and out of London Terminals

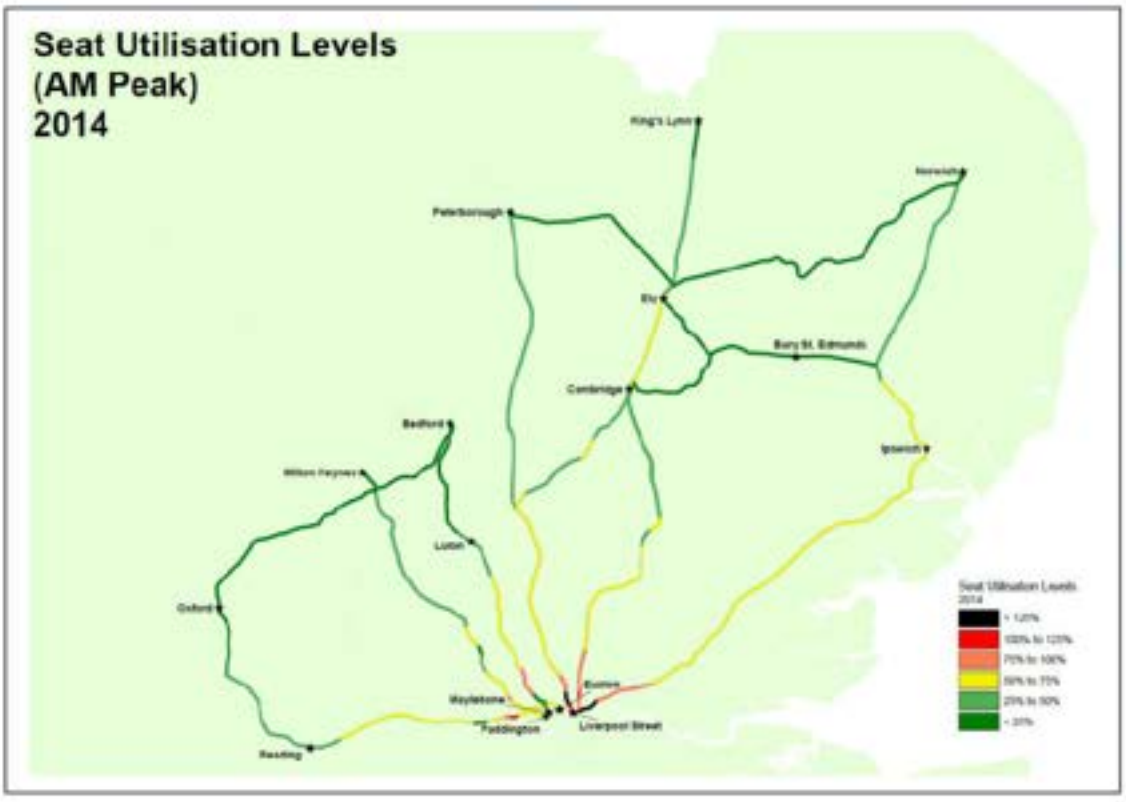


Figure 2-12 2026 AM Peak Rail Crowding in and out of London Terminals

Figure 2-13 2036 AM Peak Rail Crowding in and out of London Terminals

AM peak crowding is most severe on the radial routes in to London, getting worse as services approach London (note that crowding severity is suppressed as the data cover both directions across the whole 3 hour

AM Peak period). Crowding levels on AM peak services to/from London will deteriorate by 2026 and further by 2036.

In many places on the Chiltern Main Line and the Great Western Main Line, the rail network is running at capacity, not just in terms of levels of passenger crowding on trains but also in terms of the number of services which can operate on lines. In Network Rail's West Midlands and Chilterns Route Study, it is recognised that London Marylebone is approaching capacity both in terms of the number and length of trains it can serve and the passenger handling capability on the station. Similarly, many AM peak hour services into London Paddington are approaching full seating capacity, with strong demand growth expected to continue according to Network Rail's Western Route Study.

Passenger demand on a number of long distance services will be affected by the arrival of HS2. The HS2 strategic case forecasts that long distance passengers will 'switch' to HS2 services. However, while this could release passenger capacity for services on the existing network, it is likely that suppressed demand would be unlocked. Similarly, the opening of Crossrail will have a large impact on rail services, particularly on the Great Western Main Line. Although both schemes are anticipated to relieve the pressure on the rail network, they are also likely to further stimulate future rail demand growth. Therefore, the impact of HS2 and Crossrail must be considered when examining any schemes proposed for this area.

Rail demand in the study area is largely constrained to the radial nature of the railway network. This means that passengers wishing to make orbital journeys are forced to travel via London on crowded or more expensive routes, or by alternative modes. Future rail improvements are largely focussed on improving or adding to these radial connections. However, there is likely to be suppressed demand for orbital travel which could be unlocked by the reinstatement of heavy rail between High Wycombe and Bourne End. There is also the potential for this scheme in combination with WRLtH and East West Rail to build up a long-distance orbital rail market, abstracting demand from congested highway corridors. This could better connect population centres with employment growth, enabling better labour market participation and business – business interaction, thereby promoting economic growth and development.

Wycombe District Bus Services

Bus services in the area tend to radiate out from, and terminate in, a relatively limited number of hubs, either significant town centres or trip attractors. There are direct bus services between High Wycombe and Bourne End (4 buses per hour) and High Wycombe and Marlow (2 buses per hour). Some of the bus services between High Wycombe and Bourne End continue to Maidenhead, however this is typically only 1 bus per hour with a journey time of 50-55 minutes. There are also services between High Wycombe and Aylesbury via Princes Risborough (4 buses per hour) with an end-to-end journey time of around an hour and services between High Wycombe and Reading (3 buses per hour) with an end-to-end journey time of around 80 minutes. Service frequencies are greater during the morning and evening peak periods.

As a result, bus journeys tend to be short in distance, with average trip lengths being about 5 miles, and therefore serve local travel demand unless passengers are willing to interchange multiple times or incur long journey times.

There are also National Express coach services from High Wycombe to Heathrow Airport, Central London and Oxford. Rather than journey times, the main obstacle with these services would appear to be the low frequencies that are operated.

2.3.3.2. Highway Network

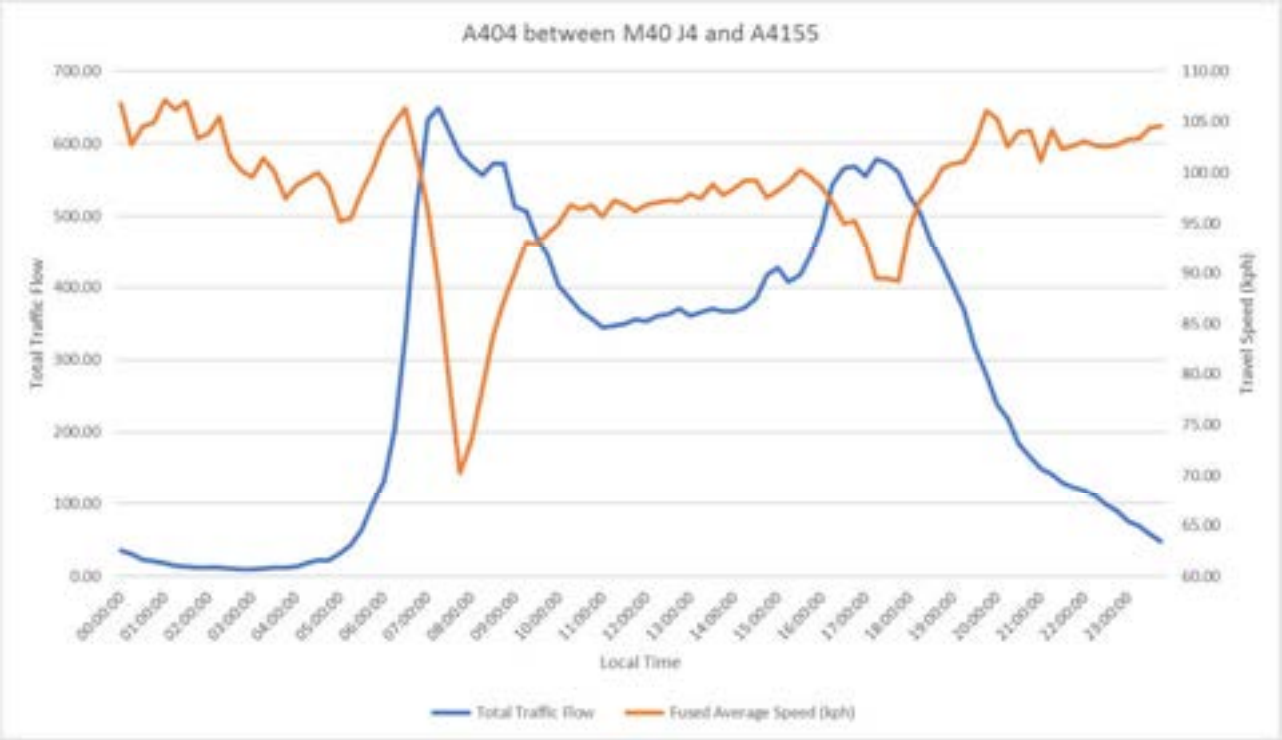
As mentioned previously, many national and international businesses have established in the study area due to its unique and outstanding location, a short distance from the M25 and central London. Furthermore, the M40 provides connections with the Midlands and North of England and the M4 provides access to the Thames Valley and South West. The motorways are connected by a relatively dense strategic and inter-urban 'A' and 'B' road network, as shown in Figure 2-14.

Figure 2-14 Strategic Road Network in Study Area

The network accommodates a wide variety of journey purposes, including the complex and long-distance pattern of commuting journeys to the large number of economic centres across the study area as demonstrated in section 2.3.2.3 above. However, this has led to an intensive use of the whole network, and to significant congestion in the peak periods.

A prime example of the congested network is the A404 south of High Wycombe, which provides access to the M4 and the M40. Based on Highways England's TRIS database, Figure 2-15 demonstrates traffic flows and speeds on the A404 between M40 J4 and the A4155 south of High Wycombe, with traffic flows being significantly higher in the morning and evening peaks, and consequently average speed dropping by up to 35kph in the peaks. Those travelling between High Wycombe and Maidenhead along the A404 would experience significantly longer and more unreliable journey times in the peak periods, with average journeys varying between 24-50mins in the morning peak and 30-60mins in the evening peak during weekdays, when compared to 20mins in the off peak. Congestion during the middle of the day is quite limited with speeds close to free-flow.

Figure 2-15 A404 between M40 J4 and A4155 Traffic Flows and Speeds



Congestion can be amplified when journeys spill over from other strategic routes, including the M25, particularly when incidents disrupt these routes. The M25 South West Quadrant Strategic Stage 3 Study identifies the M25 South West Quadrant section to have consistently been the busiest section of the UK motorway network since it opened in the late 1980s, with nine of the ten busiest sections of the Strategic Road Network (SRN) in this area.

Congestion on the highway network in the study area restricts access to major employment sites and strategic locations such as Heathrow Airport, which limits the contributions of the study area to economic growth. This strengthens the strategic case for a scheme that would provide an alternative means of travelling from north to south and vice versa.

The strategic corridors within the study area are mostly radial routes leading to/from London. There are only a limited number of routes, such as the A329 between the M3 and M4, the A404 between the M4 and M40 and the A4010//A418/A505 between the M40 and M1, which could be defined as providing north-south alternatives to the M25 for some strategic journeys. The absence of high quality alternatives affects the overall resilience of the road network and places extra pressure on the M25 to fulfil this role.

These north-south alternatives to the M25 provide individual but disconnected links between radials, leading to relatively long journey times for north-south movements. This is compounded by congestion on those routes during peak periods, which is expected to worsen in the future. This can be observed for the A404 and M25 in Figures 2-16 and 2-17, which demonstrate congestion on the Strategic Road Network in 2010 and how this is expected to change by 2040 (with the study area highlighted) as sourced from DfT's National Transport Model.

Figure 2-16 Congestion on the Strategic Road Network in 2010

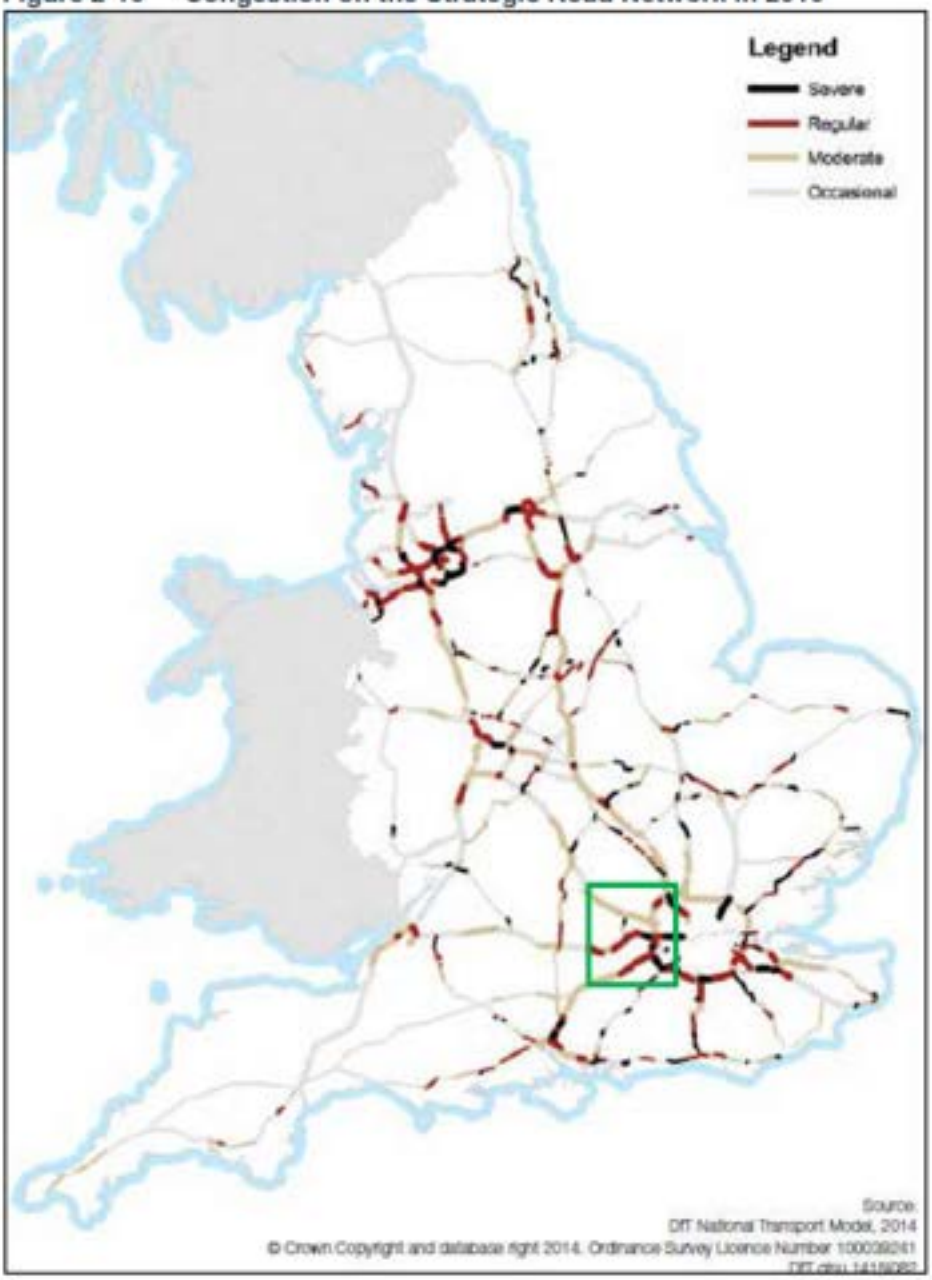
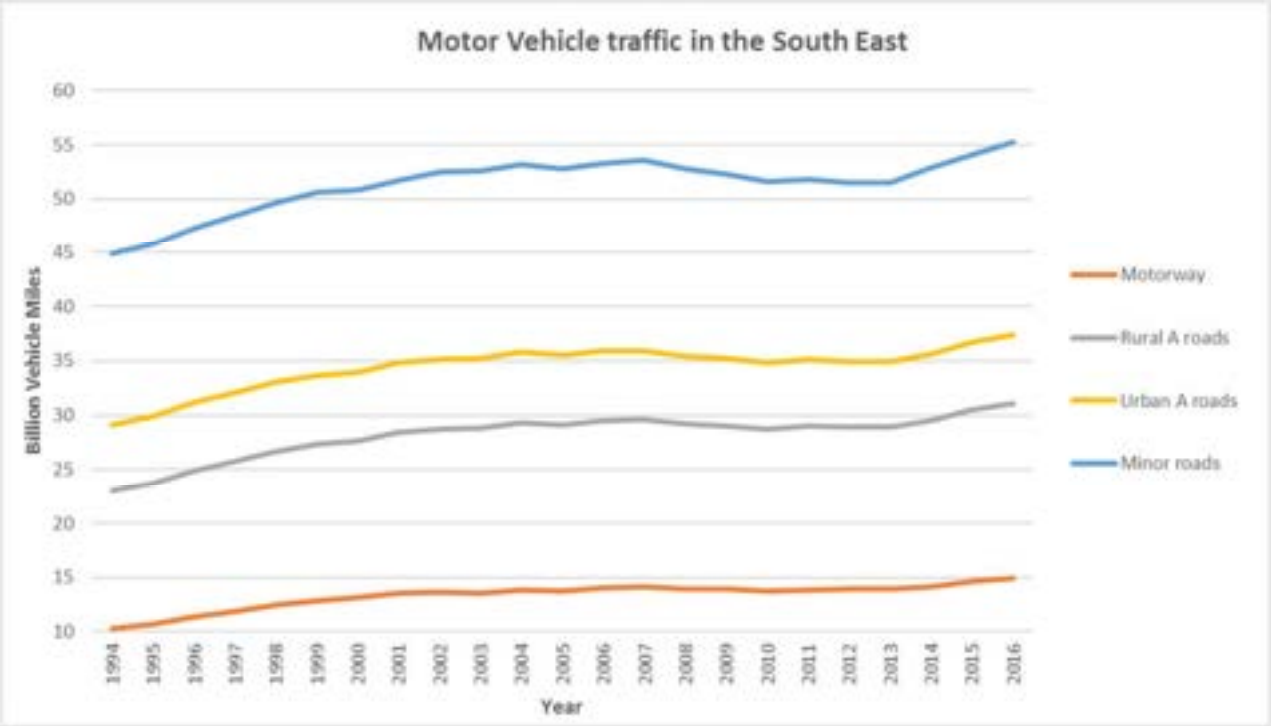


Figure 2-17 Predicted Congestion on the Strategic Road Network in 2040

The additional level of housing and jobs that is expected to come forward in the study area will bring with it additional pressure on existing road infrastructure. Motor vehicle traffic data published by the DfT reflect a consistent trend of road traffic increasing in the South East, as shown in Figure 2-18.

Figure 2-18 Motor Vehicle Traffic by Road Class in the South East (annual billion vehicle miles)



It can be observed that vehicle traffic in the South East has, with the exception of the recession, consistently increased since 1993. Most significant has been the distance travelled by motorway users, which has increased by 52% since 1993. In the last few years, growth levels have been at their highest since the late 1990s.

The Buckinghamshire Countywide Local Plan Revised Phase 3 Modelling Study forecasts significant increases in journey times throughout the whole network due to the higher levels of traffic brought forward by the ambitious development plans of the county. It highlights that High Wycombe already experiences significant congestion in the Do-Minimum scenario, and from the modelling expects there to be relatively significant increases in travel time in both peak periods when considering the Local Plan growth expectations across the area. Consequently, these high levels of congestion lead to the area being sensitive to small changes in traffic flows, with even very small increases resulting in significant travel time increases.

To understand the transport network performance in future years, where potential accessibility and connectivity issues may arise or where gaps in the network will still remain, it is important to have a clear view and understanding of what the future network will be. Highways England's Regional Investment Programme (RIP), building on from the DfT's Road Investment Strategy (RIS) outlines a series of major improvements for the SRN in the area, including:

- M25 Smart Motorway – an upgrade to the section between J12 and J16 through a mixture of enhancements, including hard shoulder running between J15 and J16, as well as four-lane through-junction running between J10 and J12;
- Key sections of the M4 leading up to the M25 are also programmed to be converted to Smart Motorway; and
- Schemes within the Oxford to Cambridge corridor, including those recommended by the Oxford to Cambridge Expressway Strategic Study.

While there is uncertainty around the Oxford to Cambridge corridor, these schemes are unlikely to improve the traffic conditions for north-south journeys along the corridor from Milton Keynes in the north via Aylesbury and High Wycombe to Maidenhead in the south.

2.3.3.3. Transport Context Summary

The transport network serving the study area is largely of a radial nature. Opportunities to make orbital journeys are constrained by the requirement for rail interchanges on crowded or more expensive routes, bus journeys that are infrequent and incur long journey times or travel on the highway network, which experiences congestion and high journey times during peak periods.

The scheme could provide improved north-south connectivity and new journey opportunities. However, the extent of mode shift generated will be dependent upon the competitiveness of journey times between rail and highway modes.

2.3.4. Policy Context and Strategic Fit

To ensure that any schemes appraised and conclusions drawn are consistent with adopted policy and strategy, it is important to examine and review the existing policies of relevance and the associated ambitions for the economy, transport and the built and physical environment in the study area.

This section outlines the key strategies and policies relating to planning and transport as articulated at the National, Regional and Local level, as well as the key studies undertaken to date around the development of the scheme. The overall policy framework is illustrated in Figure 2-19.

Figure 2-19 National, Regional and Local Policies

2.3.4.1. National Policy

The Strategic Road Network and the Delivery of Sustainable Development

The DfT Circular 02/2013 'The Strategic Road Network and the Delivery of Sustainable Development' (September 2013) sets out that the effective and efficient operation of the SRN will contribute to creating 'the conditions that support the realisation of the aspirations of business and communities' and is an important factor in the delivery of national economic growth.

Policy reduces the burden on developers of mitigating the impacts of traffic generation on the SRN. The requirement is now that all development generated traffic and background growth can be accommodated at the date of opening of the development. It is considered that this will incentivise the delivery of development by ensuring that where development comes forward soon after receiving consent there is a significant reduction in the obligations on developers to provide capacity or demand management measures.

National Planning Policy Framework

In March 2012, the Department for Communities and Local Government (DCLG) published the 'National Planning Policy Framework (NPPF)', which sets out the Government's economic, environmental and social planning policies.

The NPPF aims to reform the planning system and is underpinned by a presumption in favour of sustainable development which for plan making means that 'local planning authorities should positively seek opportunities to meet the development needs of their area'. There is a focus on planning for prosperity, people and places, promoting increased levels of development and supporting infrastructure, whilst also protecting and enhancing the natural and historic environment.

In particular, the NPPF states that great weight should be given to conserving the landscape and natural beauty in designated Areas of Natural Beauty, which should have the highest status of protection in relation to landscape and scenic beauty. The conservation of wildlife and cultural heritage are important considerations in these areas.

Environmental Policy

There are a number of policies which seek to achieve reduced levels of air and noise pollution. Some of which are stated below:

- EU Ambient Air Quality Directive;
- UK Air Quality Strategy (2011);
- National Networks NPS;
- Local Air Quality Management;
- Defra's Air Quality Plan for Achievement of EU Air Quality Limit Values for Nitrogen Dioxide in the UK (2015);
- Environmental Noise Directive (Directive 2002/49/EC);
- National Planning Policy Framework; and
- Noise Policy Statement for England (2010).

These policies state that the UK must comply with EU Directives on pollutants (NOx, PM10) and noise levels, and new developments must consider the impacts which may be had on existing Air Quality Management Areas (AQMAs) and Noise Important Areas (NIAs).

2.3.4.2. Regional Policy and Studies

Buckinghamshire Thames Valley LEP Strategic Economic Plan (2012-2031)

The Buckinghamshire Thames Valley LEP Strategic Economic Plan (2012-2031) identified improving connectivity between major settlements and existing/new rail connections as a strategic transport objective and in particular noted the potential of achieving a Milton Keynes – Aylesbury – High Wycombe – Thames Valley strategic public transport route. The re-opening of the High Wycombe to Bourne End rail link was deemed worthy of investigation.

In contrast with other policy documentation to date, here there was a proposition that the route could utilise the remaining parts of the original rail alignment and therefore avoid interaction with general traffic and provide a good quality light rail scheme possibly connecting Maidenhead and High Wycombe. A light rail service would provide easy access to, and increase the catchment for, Crossrail at Maidenhead, with electrified services along the Great Western Main Line and possible access to Heathrow Airport.

It was emphasised that the daily commuter mileage of 278,000 miles between Wycombe District and the three Thames Valley towns of Slough, Maidenhead and Reading is effectively car mileage, because there is limited public transport suitable for commuting. The strategic importance of the 'missing link' between High Wycombe and Bourne End should therefore not be underestimated.

Most of the five-mile route remains undeveloped, even though the service closed in 1970. Two feasibility studies (Scott Wilson in June 2008 and Egis Mobilite in February 2009) have demonstrated that reinstatement is possible. A commutable connection to the Thames Valley would give High Wycombe access to the Thames Valley and vice versa.

Thames Valley Berkshire LEP Strategic Economic Plan (2015/16-2020/21)

The Thames Valley Berkshire LEP Strategic Economic Plan (2015/16-2020/21) sets out an evidence base on north-south connections, including the A404/A404M, which it recognises as an important alternative to the M25 as well as a commuter route for people from Buckinghamshire travelling into Slough and other Thames Valley Berkshire towns. Junction capacity is recognised as the main constraint, especially the junctions at High Wycombe for the M40, where there has previously been heavy investment, and Bisham, where Highways England pinch point funding is planned. It is also noted that the area around Reading, Wokingham and Bracknell is poorly served by north-south routes and a significant amount of traffic on the M4 in this area is travelling to and from other north-south routes.

Buckinghamshire County Council Local Transport Plan 4 (2016-2036)

Buckinghamshire County Council's Local Transport Plan 4 (2016-2036) set out the Council's transport policies and priorities, including working to improve the connectivity and reliability of the Buckinghamshire transport network in order to stimulate economic growth and promote safer and more sustainable travel. The plan also highlights the importance of working with key stakeholders to develop a reliable transport network that not only provides effective access within the county but also to the rest of the country and which integrates with other modes of transport, including airports. Alongside these priorities, it is recognised that Buckinghamshire's unique countryside and other special environments must be protected and air quality managed by encouraging more sustainable travel.

Thames Valley Multi-Modal Study

Atkins' Thames Valley Multi-Modal Study (2003) presented a strategy for the Thames Valley for 2016 and a framework for policy interventions and transport investment for the period beyond 2016 to 2031. The overall aim of the study was "to identify transport problems and opportunities within the study area and to develop an integrated transportation strategy to address these". The potential scope of using the track-bed of the former High Wycombe to Bourne End heavy rail link was identified as a post 2016 long term solution. However this identified the possibility of converting the route to light rail.

Analysis of the economic and financial case for the scheme, in combination with a conversion of the current Marlow-Maidenhead line to light rail to provide a continuous system between the towns, identified the difficulty in making a funding case due to high capital costs and fare-box revenue unlikely to exceed operating costs in the absence of road user charging. Wider economic benefits were deemed unlikely to justify the capital expenditure involved.

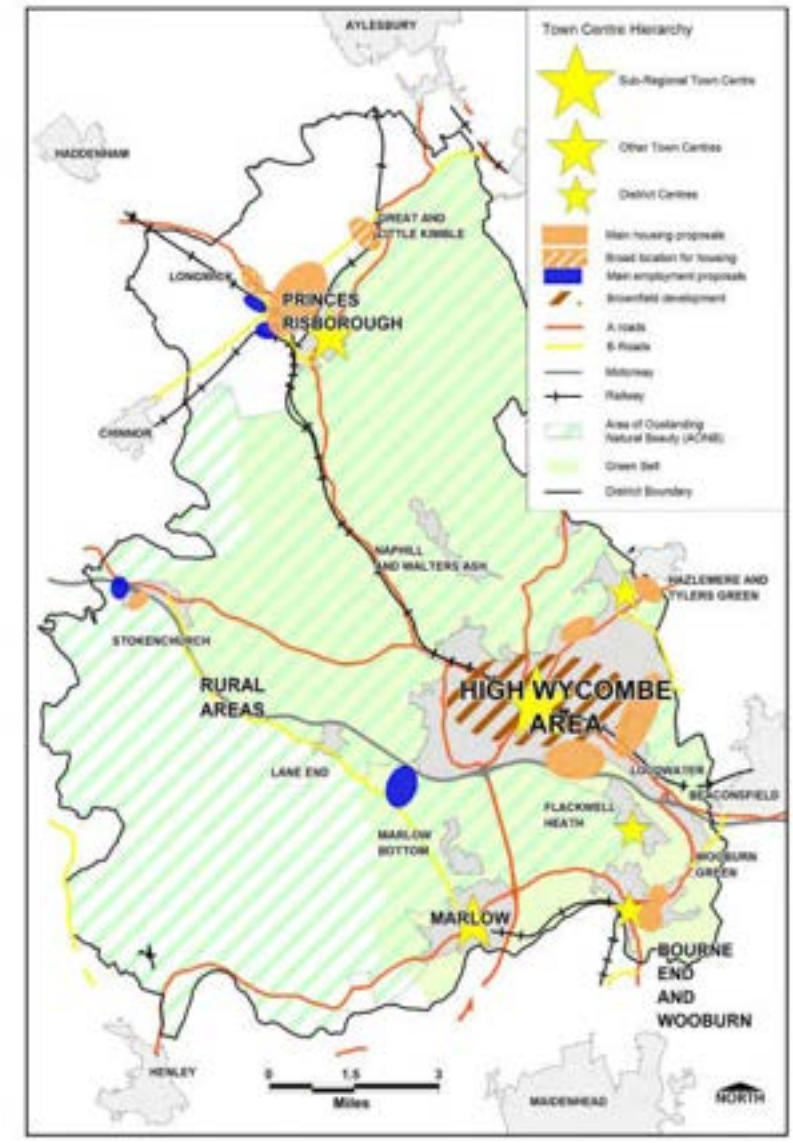
However, the long-term opportunity to attract heavily car-based commuting movements to a new north-south public transport link across the Thames Valley was recognised, as well as the possibility of increased public transport patronage closing the gap between operating costs and revenues. As such the study recommended that the relevant local authorities prevent further development along the alignment, so that the route would be preserved in the event of the case for re-instatement of the public transport route here strengthening in the future.

2.3.4.3. Local Policy and Studies

Wycombe District Local Plan (WDLP)

Wycombe District Council is preparing a new Local Plan, the Wycombe District Local Plan (WDLP), which sets out policies and proposals to address the District's growth aspirations for the period 2013-33. In line with the growth ambitions discussed in section 2.3.2.4, the plan identifies the need for 46,200 homes across Buckinghamshire, of which 13,200 homes are in Wycombe District, equivalent to 660 homes per annum. In terms of employment, growth of just over 7,650 full-time equivalents is anticipated. Figure 2-20 below sets out the spatial strategy for development, showing that the main housing proposals are targeted around High Wycombe, Bourne End and Wooburn.

Figure 2-20 WDLP Spatial Strategy for Development



The Local Plan is seeking to bring forward sustainable growth in the District, in line with the Corporate Plan's objective of sustainably regenerating the area. A key objective of the Local Plan is in delivering the Place priority of the Corporate Plan, including bringing forward the infrastructure provision to support that growth in line with the current emphasis on ensuring that new development is supported by the right infrastructure.

It is also identified as critical that there are clear mechanisms for the delivery of this infrastructure, and that housing is also bought forward in a timely way.

The Local Plan vision is, "*Wycombe District: economically strong and the place to live, work and visit*." The eight strategic objectives are to:

1. **Cherish the Chilterns**
   Cherish the Chilterns by conserving and enhancing the natural beauty of the landscape of the Chiltern Hills.
2. **Strengthen the Sense of Place**
   Strengthen the sense of place throughout Wycombe District by:
   - protecting and enhancing the District's natural and built environment, including landscape, biodiversity, green and blue infrastructure, historic and cultural assets;
   - maintaining place identity by using Green Belt to keep main settlements separate; and
   - securing high quality, bespoke responses in the design of new development.

3. **Foster economic growth**
   Foster the economic strength of the M40/A404 location and that of the rural economy.
4. **Improve strategic connectivity**
   Improve strategic transport connectivity within Buckinghamshire by road and rail; this includes strategic connectivity between the South East Midlands, Aylesbury, Princes Risborough, High Wycombe, London as well as the Thames Valley.
5. **Facilitate local infrastructure**
   Facilitate timely improvements to local infrastructure by focused investment and by securing appropriate benefits from new development.
6. **Deliver housing**
   Contribute our fair share towards tackling the need for more housing including for affordable housing and other specific housing needs of the community, including catering for a growing aging population.
7. **Champion town centres**
   Champion thriving town and business centres to provide the focus of our social and economic activity.
8. **Mitigate Climate Change**
   Reduce CO2 emissions by reducing the need for travel by private car, and aid public transport viability, through intensifying existing urban areas by re-use of brownfield sites, locating development in settlements with the widest range of services and facilities, and by clustering development to achieve high quality walking, cycling and public transport provision.

Delivery and Sites Allocation (DSA) Plan

The only area which the WDLP does not cover is that covered by the Delivery and Site Allocations (DSA) Plan. The DSA Plan has a particular focus on delivering regeneration and improvement to High Wycombe District Centre as well as proposals aimed at supporting and improving Marlow and Princes Risborough town centres and some other development management policies.

The DSA Plan was adopted by Wycombe District Council in July 2013. It is intended that the WDLP will sit alongside the DSA Plan when adopted.

The DSA Plan included **Policy DM4 – Former Bourne End to High Wycombe Railway**, which proposed as the preferred option a new walk/cycle lane, stating the following:

- Planning permission will not be granted for developments that would prejudice the construction of a 5m wide walking and cycling corridor between High Wycombe town centre/railway station and Bourne End, as defined on the Policies Map, utilising the track bed of the Bourne End to High Wycombe disused railway line. Wherever possible this route should be separated from vehicular traffic.
- The development of sites near to the corridor will be required to provide convenient links to the route, in order to maximise the opportunities for walking and cycling.
- Any future development proposals that would prevent suitable diversions being created, in order to provide the walking and cycling corridor, will be refused planning permission. In the event of making such diversions from the former railway track bed, the route chosen will not be significantly less direct or attractive.

It was identified that on the whole the majority of the route is still intact, although there are some sections that have been developed on or have become part of residential gardens that back onto the line. However, it is noted that the safeguarding of the route in this way also allows for any future plans or investment decisions that could deliver a public transport corridor along this route.

Infrastructure Delivery Plan

Wycombe District Council's Infrastructure Delivery Plan (September 2017) identified the need for strategic north-south connections through Buckinghamshire, and that highway improvements are not a long-term solution. The pressing issue of resolving the most effective north-south route between High Wycombe and Aylesbury is highlighted. The longer-term possibility of a 'London rail bypass' by using some or all of the disused railway line that would link East West Rail and Crossrail is also recommended for investigation.

Former Bourne End to High Wycombe Railway Line Background Paper

In June 2010, Buckinghamshire County Council's Former Bourne End to High Wycombe Railway Line Background Paper recommended protecting a 5-metre line to provide a wide "green corridor". This would achieve a high quality, segregated traffic free walking and cycling route with provision for the inclusion of a bridle way. This was the preferred re-use of the former track bed in the foreseeable future.

If in the longer term, if circumstances were to change and a strategic business case led by Central Government were to emerge, a different mechanism for delivery could be employed depending on the line of route. Whilst the route would not be safeguarded for this purpose, this approach would ensure that the potential to implement an alternative use in the longer term would remain.

2.3.5. Summary of Problems to be Addressed

As mentioned previously, the case for intervention is informed by the analysis of evidence in terms of how the transport network currently operates, the nature of the economy and the environmental context, and how a potential intervention would assist in achieving the ambitions and strategic objectives identified in existing policies.

Based on the context of the study area, as well as priorities and wider strategic objectives identified in policies and studies mentioned above, this section summarises the drivers for intervention identified in the previous sections.

2.3.5.1. Radial Transport System

A defining characteristic of the current rail network is its radial nature, with routes serving London terminals dominating the pattern of service and providing good connectivity between settlements along routes into London. This radial characteristic limits the ability of the rail network to cater effectively for the wide variety of short and long-distance orbital journeys taking place. The connectivity between the economic centres within the study area is therefore limited to the road network or to be made circuitously via London or Oxford.

On top of this, outside the already congested M25, strategic north-south highway route alternatives suffer from congestion during peak periods (e.g. A404). Longer distance journeys (e.g. Milton Keynes to Thames Valley) require routing along numerous individual but disconnected links between radials, again leading to high journey times.

Furthermore, a common thread running through the majority of the major investment programmes is the further emphasis on radial interventions enhancing connectivity in and out of London, such as Crossrail. However, there are fewer interventions planned to improve orbital connections between the economic centres in the study area. As such the issues of increased journey times that will be brought forward by the expected future growth within the study area will not be addressed. This identifies a gap in the transport network and highlights the need for interventions to improve north-south connectivity in the area.

This issue is highlighted in the Buckinghamshire Thames Valley LEP Strategic Economic Plan (2012-2031) where improving connectivity between major settlements and existing/new rail connections was identified as a strategic transport objective and in particular noted the potential of achieving a Milton Keynes – Aylesbury – High Wycombe – Thames Valley strategic public transport route.

2.3.5.2. Worsening Transport Network Performance

Key highway corridors are subject to high levels of congestion and high journey times, particularly in the peak periods, while the rail network experiences crowding and is largely running at capacity in terms of service operation due to strong growth in demand in recent decades.

Factors such as population growth, the ambitious housing and job growth plans of the area and the Heathrow Airport expansion will all continue to place additional strain on the transport network. These will combine to further increase levels of traffic and, without any further intervention, will lead to more unreliable journey times, threatening the position of the region, which to date has been well connected and attractive for businesses.

2.3.5.3. Poor Connectivity of Key Economic Centres

The study area is a critical component of the UK's economy, its contribution to the country's GDP is vital, and any constraint on its success would negatively impact economic performance at a national level.

However, the economic success and growth in the area is now contributing to significant transport barriers, threatening the connectivity advantage the region has when compared with other competing areas, and hence restricting further economic growth. Economic growth is therefore dependent on investing in physical infrastructure capacity that addresses key connectivity issues and a congested transport network, in line with the vision and relevant policies for the area.

2.3.5.4. Shift to More Sustainable Modes

The locally important centres of economic activity with busy town centres and active office sites throughout the study area lead to complex travel movements.

These can often only be made on the congested road network, by car or bus, or circuitously by rail via London or Oxford, although realistically this would not be done as journey times cannot compete with highway journey times in those instances. As an example, less than 6% of the trips travelling from home into High Wycombe are made by sustainable modes (train or bus) with high car dependency.

To support sustainable economic growth, modal shift from car is required rather than providing additional capacity on existing roads. Providing new rail connections in the study area may lead to more competitive journey times as well as a higher number of route options, encouraging uptake in rail travel.

2.3.5.5. Poor Air Quality and Noise

Awareness of the importance of maintaining appropriate air quality and noise levels, or improving them, has increased in recent years in policies at a national, regional and local level.

Road transport contributes significantly to poor air quality and noise problems for residents and businesses across the study area. These have the potential to worsen in the near future if road traffic levels continue to increase, and so modal shift of demand to more sustainable modes should be encouraged.

2.3.6. Potential Markets

There is an opportunity for improved north-south service provision to address a gap in the rail network associated with high car demand or where rail demand may be generated by opening up new commuting or business-to-business journeys between locations of sufficient size. This could reduce car dependency, potentially easing the pressure on the highway network and supporting a change in the shape of the regional economy. The improved connectivity would increase opportunities to access jobs and business opportunities.

Potential markets for services operating on the new link are as follows:

- Local trips between Maidenhead, Bourne End, Marlow and High Wycombe.
- Regional trips between Reading/Slough and High Wycombe/Aylesbury.
- Long distance trips that avoid travel via London or Oxford (e.g. Milton Keynes via East West Rail to Thames Valley).
- Trips to Heathrow Airport from locations on the Chiltern Main Line and beyond via WRLtH.
- Trips that access the Great Western Main Line from the Chiltern Main Line and vice versa (e.g. Slough to Bicester Village or High Wycombe to Old Oak common).

As well as identifying the potential markets for the scheme, it is important to highlight markets that will be outside the scope of the scheme. Such markets include trips already well served by rail in the Do Minimum scenario (e.g. Milton Keynes to Reading due to the East West Rail Western Section) and trips where the rail journey time with the new link struggles to compete with highway journey times. Achievement of significant modal shift would only be expected if the scheme has a significant catchment area and provides a competitive route alternative to the existing transport network, both in terms of journey times and crowding. The potential for the scheme to serve strategic as well as local demand is also dependent on the competitiveness of the rail service offering.

2.4. Measures of Success

The scheme itself would be considered successful, should the problems outlined above be addressed and the objectives of the scheme be achieved. Scheme objectives are discussed in more detail in section 3.

Key measures that would reflect successful planning, design and implementation of the scheme would include:

- An increase in the number of north-south journeys that are served by direct or interchanging rail services;
- An increase in the modal share of rail in the study area;
- Reductions in highway congestion and journey times, especially during peak periods;
- Continued high levels of economic performance in the region and significant contribution to the national economy; and
- No worsening of air quality and noise levels in the study area.

Achievement of significant modal shift would only be expected if the scheme has a significant catchment area and provides a competitive route alternative to the existing transport network, both in terms of journey times and crowding. Even so, car travel is likely to remain dominant and mode shift across the region as a whole is likely to be quite limited.

2.5. Impact of Not Changing

Without appropriate intervention to improve the identified gap in the transport network in terms of north-south connectivity within the study area, the performance of the transport network is expected to deteriorate further in the future as traffic levels increase.

Travel in the study area will continue to be dominated by the car, which will make highway routes and junctions even more congested than current levels. The resulting rise in journey times, especially during peak periods would threaten the status of the region as a key contributor to the national economy as it would become a less attractive location for people to live and work. Air quality and noise levels would also worsen, threatening the quality of life in the study area.

3. Scheme Objectives

As well as addressing existing problems, the scheme has the potential to bring new transport opportunities to the study area. Both issues to be addressed and new opportunities are summarised in the scheme objectives below, noting that some objectives should be considered as Primary Objectives while others should only be considered as Secondary Objectives:

- Primary Objectives:
  - Improved connectivity, new journeys and reduced journey times;
  - Improved sustainable access to Heathrow Airport;
  - Opportunities to avoid travelling via London; and
  - Diversion from highway to rail.
- Secondary Objectives:
  - Use of the route as a strategic diversion route;
  - Use of the route by rail freight services;
  - Reduced or delayed investment in the SRN; and
  - Wider Economic Impacts including expanding employment catchments.

The case for the scheme is unlikely to be driven by these Secondary Objectives.

3.1. Primary Objectives

3.1.1. Improved Connectivity, New Journeys and Reduced Journey Times

A major objective of the scheme is enabling north-south connectivity in the Wycombe district and surrounding regions through a link between the Chiltern Main Line and the Great Western Main Line. Restoring the link between Bourne End and High Wycombe would allow passengers to travel directly from Maidenhead to High Wycombe and potentially beyond to Princes Risborough or even Aylesbury. There would also be further routing opportunities once interchanges with other services are considered. This would significantly reduce rail journey times for a large number of origin to destination movements in the study area.

The scheme also provides an opportunity to create synergies from linking up committed and proposed rail investments in the area. Restoring the link between Bourne End and High Wycombe would allow passengers to travel from East West Rail stations via Aylesbury and High Wycombe to Maidenhead where they can access Crossrail or Heathrow Airport via WRLtH.

3.1.2. Improved Sustainable Access to Heathrow Airport

Heathrow Airport is planning major expansion, which includes a new runway, potential expansion of the terminal infrastructure, a realignment of the M25 and a number of changes to local roads and junctions. This expansion has the potential to trigger an increase in travel into Heathrow Airport (noting the aspirations of the airport for there to be no additional vehicle traffic accessing and egressing the airport), which would put additional pressure on private and public transport links to the airport.

Heathrow Airport is currently accessible by rail only from the eastern approach via the Great Western Railway (GWR). Passengers wanting to travel to Heathrow Airport from the South Coast, South West, South Wales and West Midlands must either use a private car on the M4, or travel into London and change to Heathrow Connect or Heathrow Express services at London Paddington.

WRLtH is a scheme that proposes a rail link that would create an additional connection between Heathrow Airport and the Great Western Main Line. It would allow passengers travelling from the South Coast, South West, South Wales and West Midlands to access Heathrow Airport via the Great Western Main Line, without travelling into London Paddington or using the motorway. A key objective of WRLtH is to provide a sustainable alternative to the M4.

The reinstatement of rail between Bourne End and High Wycombe would further allow passengers travelling on Chiltern Railways to connect with WRLtH via interchange at Maidenhead. Their current option is to travel to London Marylebone and use London Underground services to reach London Paddington. Alternatively, they can interchange for the Great Western Main Line at Oxford. The Bourne End – High Wycombe link would provide a shorter route between Chiltern Railways and the Great Western Main Line, thus providing further sustainable access to Heathrow Airport.

3.1.3. Opportunities to Avoid Travelling via London

The scheme would provide a new orbital route, which would allow passengers to travel between various locations on the Chiltern Main Line and Great Western Main Line while avoiding London. The transport network in London is highly congested and travelling on it, particularly at peak times, can be challenging due to crowding and unreliable journey times. By restoring the connection between High Wycombe and Bourne End, many journeys that potentially take passengers via London, could be made without such travel requirements. This would potentially reduce the strain on London Marylebone and London Paddington, as well as on the services approaching these London terminals.

3.1.4. Diversion from Highway to Rail

Where the scheme can provide competitive journey times, it could encourage private car users to consider travelling via rail, by providing an alternative route to the north-south highway corridors such as the A404. Currently, the most direct way of traveling between Maidenhead and High Wycombe is via the A404 but it is affected by high levels of congestion in peak periods. Restoring the link between Bourne End and High Wycombe would provide an alternative connection between Maidenhead and High Wycombe, and could encourage car users to consider travelling by rail instead. This is just one example of many cases across the

study area where residents and employees are reliant on travelling by car and where new rail connections could encourage mode shift. This would subsequently bring about environmental benefits in terms of air quality and noise levels as discussed previously.

3.2. Secondary Objectives

3.2.1. Use of the Route as a Strategic Diversion Route

The rail link could also serve as a strategic diversion route, bringing additional network resilience either on a permanent basis to address peak capacity constraints at London termini or during planned or unplanned disruption. Given the constraints on future expansion at London Marylebone identified in Network Rail's Chiltern and West Midlands Route Strategy, the link could be a practical alternative. Use of the link during planned or unplanned disruption could include CrossCountry trains currently running via Oxford and Reading, Great Western trains during disruption west of Maidenhead, Chiltern Railways and/or East West Rail trains, during disruption east of High Wycombe or Aylesbury or Chiltern Railways and/or East West Rail trains, during disruption between Oxford and Bicester or Claydon Junction. However, London Paddington is unlikely to be better placed to handle the extra traffic and even if it were, better routes are available than the High Wycombe to Bourne End line. There would also be a challenge in terms of the capacity likely to be available to accommodate diverted trains and the operating characteristics of the trains and traincrew involved, and their fit with the characteristics of the new link and the connecting routes. Use of the link as a diversionary route would be as a substitute to rather than in addition to planned passenger services.

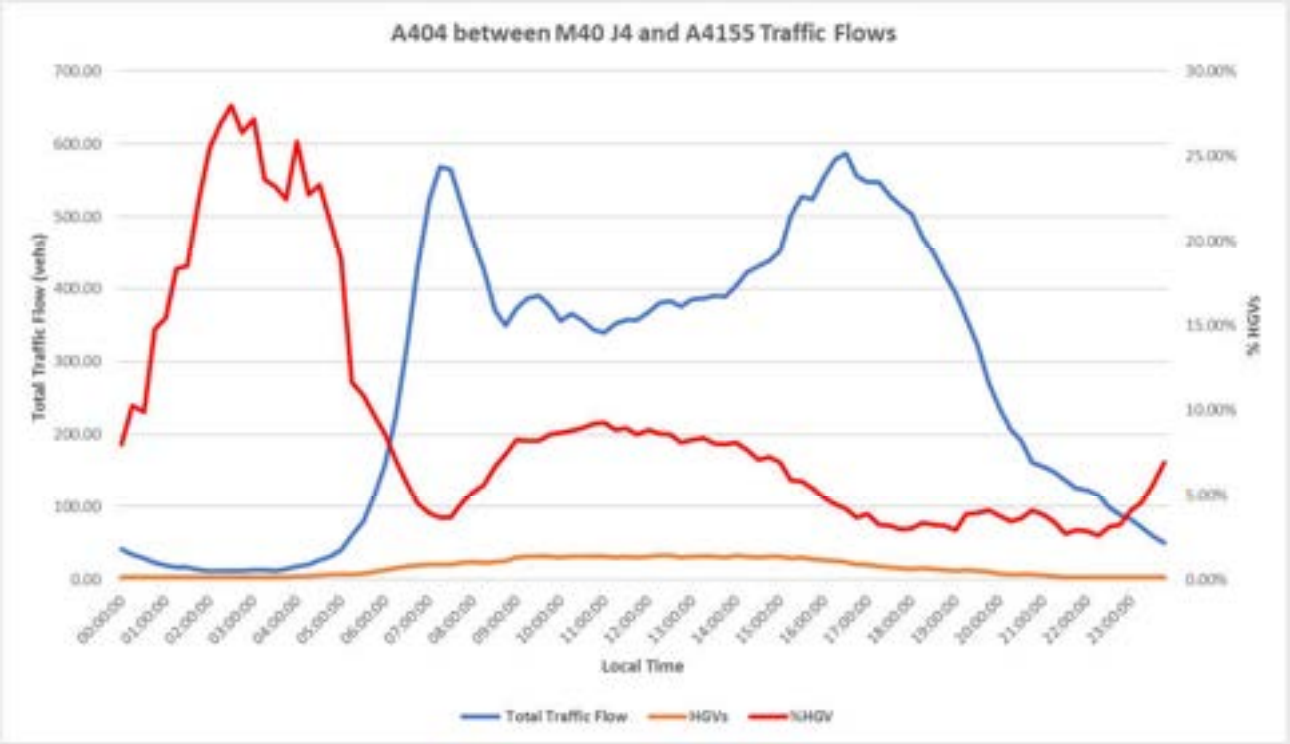
3.2.2. Use of the Route by Rail Freight Services

The Great Western Main Line is the second busiest freight corridor into London after the West Coast Main Line, with a mix of freight traffic including inter-regional flows. There are a number of goods loops and freight yards on the Great Western Main Line which are normally accessible via the Greenford Branch Line or the Wycombe Single Line. Restoring the connection between Bourne End and High Wycombe could offer an alternative route for freight services travelling on the Chiltern Main Line, allowing them access to several depots and goods loops between Maidenhead and Old Oak Common, also providing an alternative route into the Old Oak Common depot.

Accommodating freight paths will be constrained by the proposed passenger service timetable on the new link and the surrounding network, to which freight services would need to run alongside. It is likely that this would only be possible as a diversionary route overnight. There are also limited freight services currently running on the Chiltern Main Line (2-3 per day) so this is likely to be a limited market for the link. Rail freight is also more common for long-distance flows of bulk materials or containers.

In terms of road freight, there are a considerable number of HGVs travelling on key highway corridors such as the A404 due to the large number of businesses located in the study area, and there could be benefits from such transportation switching to rail freight. Figure 3-1, based on Highways England's TRIS data, shows that the A404 has a significant proportion of HGV traffic during the Inter Peak period. These HGVs currently contribute significantly to the congestion, high journey times and high noise levels seen on the highway network. Again, this would be dependent on rail becoming a more competitive means of transporting freight and constrained to paths available outside the passenger service timetable. It would also be dependent on the potential for rail to distribute the kind of goods that the HGVs transport.

Figure 3-1 A404 between M40 J4 and A4155 HGV Traffic Flows



3.2.3. Reduced or Delayed Investment in the SRN

As well as environmental benefits, diversion from highway to rail and any subsequent decongestion effects on key highway corridors in the study area could reduce or delay the need to make future improvements to the SRN, investment in which has significant associated costs. As above, this is dependent on the scheme providing competitive journey times and it is not anticipated that congestion relief levels will significantly reduce or delay investment needs.

3.2.4. Wider Economic Impacts

It is intended that the new link will provide a means to travel north to south and south to north relieving the congested road network. There could be an impact upon the road network because orbital travel around London by rail is difficult. This re-instated piece of track and associated services running on it will enable these orbital movements.

In terms of direct impacts, the area is likely to become increasingly attractive to commuters and residents because of the increased number of jobs that could be reached within commuting timeframes. This will generate additional demand for homes in the area and could lead to substantial housing growth given the level of new services.

There are numerous urban centres to the north and south of High Wycombe and Bourne End which could be better served by an orbital rail link. Aylesbury, Milton Keynes, Maidenhead and Slough would be among the main beneficiaries of connecting High Wycombe and Bourne End via the railway line. Connecting these significant urban centres, although small relative to London, would enhance the economy of the area making it a more attractive place to live and work. These benefits will arise because of agglomeration economies, imperfect competition and increased numbers entering the labour market. The three types of impacts are described in greater detail in WebTAG Unit A2.1 but are summarised below.

Agglomeration economies support greater productivity, enhancing the economy. They are concentrations of economic activity that benefit from knowledge spillovers, faster transfers of knowledge and enhanced competition which spurs on growth. Agglomeration is often observed in rail schemes because they connect

urban centres which often contain dense employment centres. This scheme provides the means of supporting agglomeration economies both in the areas directly affected but more subtly further afield by improving journey times on the road network like on the M25.

Imperfect Markets is a consequence of the 'price-cost gap'. It is an observation that higher value is placed on an extra unit of good being produced than the value of the cost of producing the good. Hence the reduction in costs due to the new scheme, and the extra output that generates, arises as a benefit.

Labour Market Impacts can take the form of either a move to more productive jobs or through greater participation in the labour market. As more jobs are available to the residents of the area they may take up employment that they would not have done otherwise, albeit these benefits are typically small.

There are numerous, more subtle, indirect impacts that form part of the benefits of the scheme. The Wider Economic Impacts of the scheme are not restricted to the rail nodes in the region that would benefit from the new railway. A primary focus of providing north-south rail routes is to relieve the congestion of the M25 south western quadrant that is heavily congested which would allow faster and more movements from other destinations, creating capacity in the entire transport network; this allows for Wider Economic Impacts elsewhere.

The scale of these benefits can vary significantly depending upon the location of the scheme, the type of scheme and they demography of the area.

4. Constraints

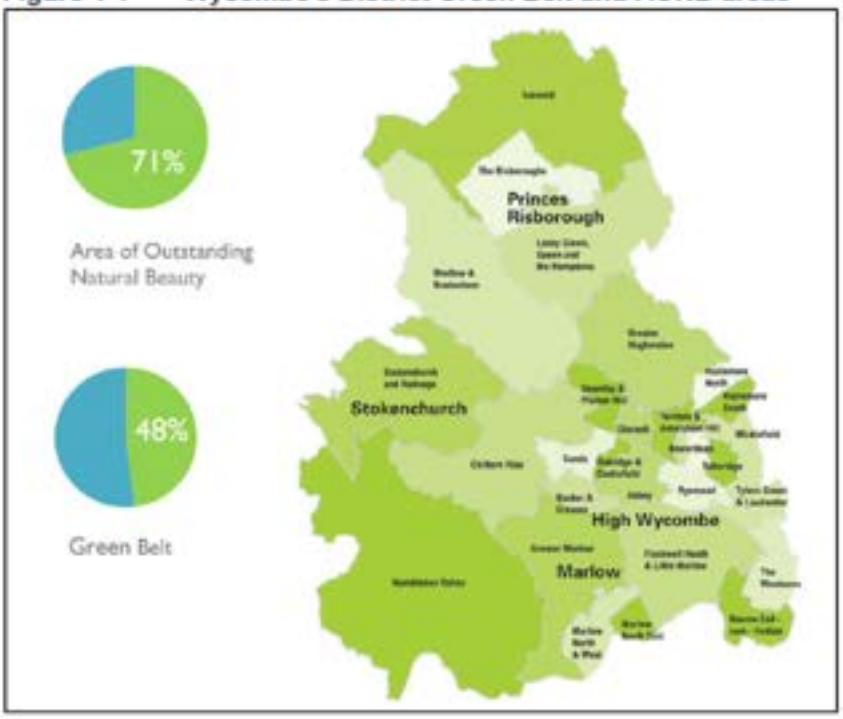
4.1. Land and Environmental Constraints

Following the closure of the High Wycombe – Bourne End section, parts of the original track bed have been reallocated for alternative uses. Several locations along the original route have been used for retail parks, housing estates and a golf club. Restoring the High Wycombe – Bourne End section would require several land take agreements and a number or property demolitions, which would further increase the cost of the scheme. In some cases, it may be difficult to reinstate the original track sections and route alterations may need to be considered.

As shown in Figure 4-1, the district is also significantly constrained by the Areas of Outstanding Natural Beauty (AONB), which make up 71% of the district, and Green Belt, which makes up 48% of the district. In policy terms, they have the same planning status as National Parks.

This 'duty of regard' recognises that a wide range of bodies have a direct influence over the future of these protected landscapes. Wycombe District Council and the Chilterns Conservation Board (CCB) have a statutory duty for managing the Chilterns. The objectives of the CCB are to conserve and enhance the natural beauty of the AONB, increase the understanding and enjoyment of the AONB and seek to foster the economic and social well-being of local communities within the AONB, without incurring significant expenditure in doing so.

Figure 4-1 Wycombe's District Green Belt and AONB areas



The NPPF states that great weight should be given to conserving the landscape and natural beauty in designated AONBs, which should have the highest status of protection in relation to landscape and scenic beauty. The conservation of wildlife and cultural heritage are important considerations in these areas.

Furthermore, the NPPF identifies that AONBs are a constraint to development (footnote 9 to paragraph 14). This states that planning permission should be refused for major developments within an AONB except in exceptional circumstances and where it can be demonstrated that they are in the public interest.

The identification of development that is 'major' (as distinct from 'not major') is a matter of judgement and one which is important in considering whether development is appropriate. One of the factors to consider whether a development is major is the following:

"*Impact from ancillary infrastructure*

a. *Would there be a need for significant highway improvements?*
b. *Would the site require infrastructure improvements? "*

This therefore highlights the need to deal with the additional demand brought forward by planned growth in a sustainable manner. There may be pressure from local conservation groups and local liaison committees, which may affect or alter development of the scheme.

While air quality in Buckinghamshire is of a generally good standard compared to the National Air Quality Standard, car availability and usage is high and some AQMAs have been declared and are focused around major transport routes or road junctions within urban areas - the M40 throughout Wycombe and South Bucks, the M4 and M25 that pass through South Bucks, and in Aylesbury and Chesham. Road traffic generates nitrogen dioxide pollution and so measures to reduce car use should be encouraged.

4.2. Operational Constraints

The surrounding rail network is constrained and running at capacity in several locations. This study reviewed the operating constraints on sections of the existing network that would be used by the proposed services and has identified that, in addition to the provision of a new rail link between Bourne End and High Wycombe, existing adjoining rail infrastructure to be used by the new services will require upgrading.

For all options, re-signalling is necessary between Maidenhead and Bourne End and a third platform would need to be constructed at Bourne End. Options that involve trains terminating at High Wycombe are expected to require an additional bay platform to be constructed at High Wycombe. Options involving 2tph running to Aylesbury will require partial doubling of the single line between Princess Risborough and Aylesbury as well as remodelling at Princes Risborough.

5. Dependencies

The case for the scheme and the scale of value for money that it generates is likely to be dependent on a number of major railway investments in the area that would interact with the new link:

Crossrail/Elizabeth Line: From 2019, Maidenhead will become part of the Elizabeth Line, allowing access to Crossrail services. On top of offering connections to the standard locations on the Great Western Main Line, Crossrail will allow further access to strategic locations in London and beyond, such as Tottenham Court Road, Canary Warf and Stratford.

The new High Wycombe – Bourne End link would allow access to Crossrail from the Chiltern Main Line. This would be particularly beneficial when travelling to the east side of London, as Maidenhead would offer an interchange outside of Central London. Therefore, passenger traffic on Crossrail needs to be taken into account, as it could have a substantial impact on the proposed High Wycombe – Bourne End link.

HS2: HS2 is a planned high-speed railway which will link London to Birmingham, Leeds and Manchester. Before departing London, HS2 will stop at Old Oak Common. The High Wycombe – Bourne End link would allow passengers on the Chiltern Main Line to reach Old Oak Common without travelling to Central London. Therefore, HS2 needs to be taken into account, as it could draw a substantial number of passengers to travel via the proposed High Wycombe – Bourne End link.

East West Rail: This is a scheme to establish a strategic railway connecting East Anglia with Central, Southern and Western England. The complete East West Rail link will act as a strategic rail route that will link Ipswich, Norwich and Cambridge, with Bedford/Luton, Milton Keynes, Bicester and Oxford, allowing connections to the South Coast, South West England and South Wales. The route comprises three distinct sections as follows:

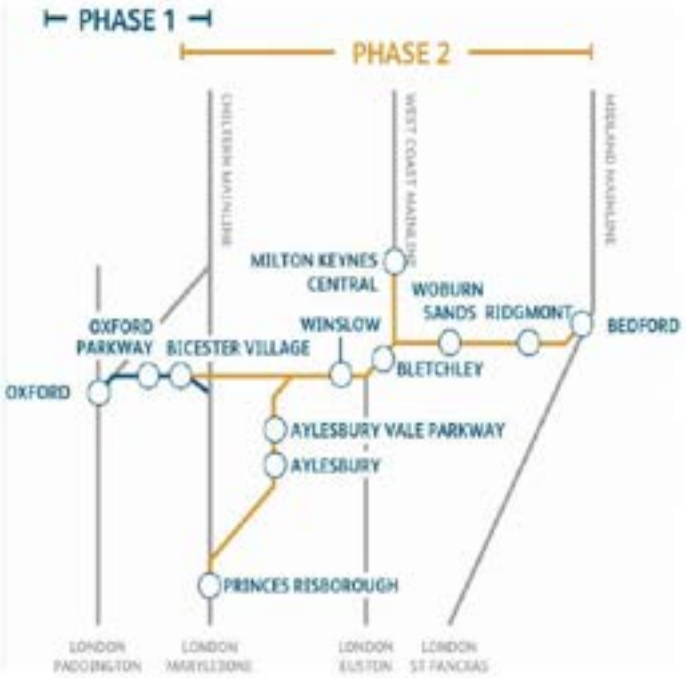
- Western Section (Oxford to Bedford/Aylesbury to Milton Keynes);
- Central Section (Bedford to Cambridge); and
- Eastern Section (Cambridge to Norwich/Ipswich and beyond).

The Western Section route is on existing lines between Bedford and Oxford, Milton Keynes and Aylesbury Vale. Phase 1 of the Western Section involved upgrades between Oxford and Bicester Town. Chiltern Railways services started running between the new Oxford Parkway station and Bicester Town on 26th October 2015 and from Oxford to London Marylebone on 12th December 2016. Phase 2 of the Western Section covers the route from Bicester Town to Bedford together with connections to Milton Keynes and to Aylesbury Vale and Princes Risborough. As currently defined, this will include line upgrades for passenger services, reconstruction and a new station at Winslow. It is further anticipated that train services could extend to Reading, using existing operational lines. Phase 2 of the Western Section is expected to be operational from 2022.

Buckinghamshire County Council has been actively leading on the Western Section for many years on behalf of the surrounding local authorities – it is the Council's highest rail priority.

Passengers from East West Rail services could use the new High Wycombe – Bourne End link as an alternative for reaching the Great Western Main Line and London Paddington, instead of travelling via Oxford. As a result, East West Rail needs to be taken into account, as it could generate passengers travelling on the High Wycombe – Bourne End link. Figure 5-1 below illustrates the route of the Western Section of East West Rail:

Figure 5-1 East West Rail Western Section Route



Source: East West Rail Consortium

Western Rail Link to Heathrow (WRLtH): WRLtH is a proposed rail link that will create an additional connection between Heathrow Airport and the Great Western Main Line. When completed, WRLtH will allow trains to access Heathrow Airport from the west without travelling via London. The High Wycombe – Bourne End link would offer passengers on the Chiltern Main Line a radial route to Heathrow Airport without needing an interchange in Central London (although needing to change at Maidenhead). Therefore, WRLtH needs to be taken into account, as it could draw a substantial number of passengers to travel to Heathrow Airport via the proposed High Wycombe – Bourne End link. Figure 5-2 below shows the proposed alignment of WRLtH:

Figure 5-2 WRLtH Proposed Alignment

Source: Network Rail

Link between Chiltern Main Line and Old Oak Common: Another significant dependency is the planned link between the Chiltern Main Line at West Ruislip, and the Great Western Main Line at Old Oak Common. This scheme is being progressed by the DfT, in partnership with Chiltern Railways, and is also supported by Buckinghamshire County Council as plans for the HS2 station at Old Oak Common progress. Outline designs have been prepared, as has a positive business case. The Department plans to proceed with the scheme over the forthcoming year with the view to secure necessary powers and funding to deliver. Delivery of such a link would significantly undermine some key aspects of the strategic case for this scheme as it would link the Chiltern and Great Western Main Lines and therefore enhance connectivity to Heathrow Airport.

6. Key Stakeholders

The following list identifies the stakeholders that will have an interest in the High Wycombe – Bourne End scheme:

- Wycombe District Council
- Royal Borough of Windsor and Maidenhead
- Bucks County Council
- Buckinghamshire Thames Valley LEP
- DfT
- Network Rail
- Highways England
- Chiltern Railways
- Great Western Railway (GWR)

As the scheme develops, it will be important to gauge the views of these stakeholders, their contributions to the project and any potential conflicts that arise.

7. Options and Outline Selection Criteria

7.1. Bourne End – High Wycombe Infrastructure Characteristics

In terms of the physical alignment and capability of the route, there are two broad options in the ITT documents, each with an associated cost. Following the old alignment as much as possible would present major challenges with at least 6 new road or rail bridges required and potentially some 40-60 properties and some businesses needing to be acquired. There may be an option to cut back into the hillside to avoid the gas pipeline and properties but this would impact on sensitive landscape and Fennels Wood. An alternative alignment would join the Chiltern Main Line near Loudwater from a new railway line at Wooburn Green. This would require significant tunnelling but less track, structures and property acquisition.

For the purposes of this study, the alignment between Bourne End and High Wycombe is assumed to:

- Follow the former track bed north of Bourne End (approximately level);
- Diverge from the former track bed in the vicinity of Wooburn Park in order to minimise impact to areas further north where the track bed has been built on;
- Cross to the River Wye via a reverse curve (assumed min 300m radius);
- Follow a new alignment, joining the Chiltern Main Line close to the western portal of Whitehouse Tunnel (Whitehouse Tunnel Junction). This will require the railway to climb approximately 40m. A ruling gradient of 1 in 60 has been assumed for modelling, but this could be reduced with increased earthworks. A tunnel will be required beneath the M40; and
- Be single track between Bourne End and Whitehouse Tunnel Junction.

The following speed restrictions were assumed:

- 40mph departing Bourne End to allow for turnouts onto the single line;
- 30mph reverse curves in the vicinity of Wooburn Park;
- 40mph over Whitehouse Tunnel Junction for trains to/from Bourne End; and
- Existing line speeds between Whitehouse Tunnel Junction and High Wycombe.

Elsewhere, line speeds were unconstrained. When modelled, it was found that trains did not reach more than around 50mph. Therefore, there would be little benefit from engineering the route to accommodate speeds above the 50 – 60mph range.

The non-stop journey time between Bourne End and High Wycombe was modelled using RailSys using Class 166 timing load (Class 165 data was not available). The findings are summarised in Table 7-1 below:

Table 7-1 Bourne End to High Wycombe Running Times

From	To	Journey time (mins)
Bourne End (stop)	Whitehouse Tunnel Junction (pass)	5
Whitehouse Tunnel Junction (pass)	High Wycombe (stop)	4
High Wycombe (stop)	Whitehouse Tunnel Junction (pass)	3
Whitehouse Tunnel Junction (pass)	Bourne End (stop)	5½

The journey time between High Wycombe and Whitehouse Tunnel Junction was also modelled for Chiltern services to inform timetable development using Class 170 timing load (Class 168 data was not available). The findings are summarised in Table 7-2 below:

Table 7-2 High Wycombe to Whitehouse Tunnel Junction Running Times

From	To	Journey time (mins)
High Wycombe (stop)	Whitehouse Tunnel Junction (pass)	3
Whitehouse Tunnel Junction (pass)	High Wycombe (stop)	3
High Wycombe (pass)	Whitehouse Tunnel Junction (pass)	2½
Whitehouse Tunnel Junction (pass)	High Wycombe (pass)	2½

7.2. Substitution of Existing Services

GWR operate an hourly service between Maidenhead and Marlow during the daytime, reversing at Bourne End. At peak times, the service level increases to half hourly, but the service is split into two shuttles:

- Maidenhead – Bourne End; and
- Bourne End – Marlow.

This is because the existing signalling system does not currently allow a half hourly direct service to operate between Maidenhead and Marlow. All trains call at all stations. It has been assumed that the service options tested would replace all existing GWR services on the Maidenhead – Bourne End – Marlow route.

Chiltern Railways operate an hourly service between Marylebone and Aylesbury via High Wycombe during the daytime. At peak times, this service is reduced to a shuttle service between Princes Risborough and Aylesbury.

It has been assumed that options involving running to Aylesbury would substitute this Chiltern service. At off-peak times, the Marylebone – Aylesbury service is assumed to be curtailed at High Wycombe. At peak times, the Princes Risborough – Aylesbury service is assumed to be substituted, but no changes are proposed to services between Marylebone and Princes Risborough.

7.3. Maidenhead – High Wycombe Timetable

Using the calculated running times, a 'core timetable' was created for the Maidenhead to High Wycombe section, including the Marlow branch. The single-track sections fix the northbound and southbound timings in the 'core timetable' relative to each other. At Maidenhead, the route is segregated from the Great Western Main Line and, therefore, the relief line timetable is not considered to be a constraint. At High Wycombe, the entire 'core timetable' can be shifted in the clock face as required to interface with the Chiltern Line timetable. The interface with the Chiltern timetable varies by option and is described in Section 9.

A special feature of the 'core timetable' is the connectivity it offers at Bourne End. Although it is inevitable that some options will result in a loss of direct services between Maidenhead and Marlow, the trade-off will be minimised by providing a good connection between Marlow and both Maidenhead and High Wycombe at Bourne End. This feature necessitates a total of three platforms to be provided at Bourne End (two through platforms for trains running to / from High Wycombe and one bay platform for the Marlow branch, with a slight variation to this layout for Option T5).

The capability for trains to arrive at Bourne End simultaneously from the north and the south is required and this may not be possible on the existing track layout using the existing 'No Signaller Token' method of working on the branch. Modifications to the track layout and the signalling system are likely to be required. It is assumed that trains can reoccupy both single lines with a margin of 2 minutes.

The Maidenhead to High Wycombe service could operate hourly (using 1 unit) or half hourly (using 2 units). Omitting Furze Platt and Cookham would save 2 mins northbound and 1 min southbound. The Bourne End to Marlow service could operate as a self-contained shuttle (using 1 unit). The journey time saving from omitting Furze Platt and Cookham would increase to 4 minutes in each direction if modifications were made to the level crossings at these stations. The driver currently has to stop and press a plunger to operate the crossings in one direction, and approach at no more than 30mph in the other direction. Table 7-3 below summarises journey times for the core timetable assuming all trains call at all stations:

Table 7-3 Core Timetable Journey Times

From	To	Time (mins)
Maidenhead	High Wycombe	22
Maidenhead	Marlow	23
Marlow	Maidenhead	22
Marlow	High Wycombe	20
High Wycombe	Maidenhead	22
High Wycombe	Marlow	21

7.4. Service Options

In terms of service options, the ITT documents set out a range of potential service options based on previous studies. These are summarised in Table 7-4 below. These alternate services reflect the trade-offs between markets and growth that can be served, journey times between key demand driver locations and operational costs. The ITT documents state that the preferred option is likely to be Option T3C, a half hourly Aylesbury to Maidenhead service which alternates between:

- a fast service calling only at Princes Risborough, High Wycombe, Bourne End and Maidenhead; and
- a stopping service calling at Little Kimble, Monks Risborough, Princes Risborough, Saunderton, High Wycombe, Bourne End, Cookham and Furze Platt.

This option presumes available passing points at Monks Risborough (new), High Wycombe (existing double track railway) and Bourne End (new).

Table 7-4 ITT Service Options

Maidenhead to High Wycombe Services	
Option T1	A half hourly all stations Maidenhead to High Wycombe service in the peaks dropping to an hourly service for the rest of the day
Option T1A	A half hourly all stations Maidenhead to High Wycombe service all day
Option T1B	A half hourly Maidenhead to High Wycombe service in the peaks dropping to an hourly service for the rest of the day with alternate peak trains calling at High Wycombe, Bourne End and Maidenhead only.
Option T1C	A half hourly Maidenhead to High Wycombe service with alternate trains calling at High Wycombe, Bourne End and Maidenhead only.
Extend the range of Option T1 services to Princes Risborough	

Option T2	A half hourly all stations Maidenhead to Princes Risborough service in the peaks dropping to an hourly service for the rest of the day
Option T2A	A half hourly all stations Maidenhead to Princes Risborough service all day
Option T2B	A half hourly Maidenhead to Princes Risborough service in the peaks dropping to an hourly service for the rest of the day with alternate peak trains calling at High Wycombe, Bourne End and Maidenhead only.
Option T2C	A half hourly Maidenhead to Princes Risborough service with alternate trains calling at Princes Risborough, High Wycombe, Bourne End and Maidenhead only.
Extend the range of Option T1 services to Aylesbury	
Option T3	A half hourly all stations Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day
Option T3A	A half hourly all stations Maidenhead to Aylesbury service all day
Option T3B	A half hourly Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day with alternate peak trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only.
Option T3C	A half hourly Maidenhead to Aylesbury service with alternate trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only.
Option T4	Extend the current Marlow to Bourne End service to High Wycombe and continue the existing Maidenhead to Bourne End service.
Option T5	Provide an hourly Maidenhead to Aylesbury service, an hourly Maidenhead to Bourne End service and an hourly Marlow to High Wycombe service.

In Options T1 to T4 above, it is assumed that Marlow to Bourne End runs as a shuttle service to match the service frequency at Bourne End (hourly or half hourly).

7.5. Option Assessment and Selection Criteria

A review of the options specified has been carried out. For all options, there are trade-offs between the range of places that can be connected and the risk of interfaces with the wider rail network in terms of timetabling feasibility.

In order to begin the process of identifying the preferred option, and given the large number of service options set out, an initial high-level option sift of the long list of timetable options provided has been carried out with any other options developed during the review process also incorporated. A qualitative option assessment matrix has been developed and used to compare options against each other. This ensures a value approach to modelling, ruling out options where show stoppers have been identified, or the option does not align with the strategic aims of the scheme.

The outcomes of the high-level option sift are summarised in Table 7-5 below:

Table 7-5 High Level Option Sift

Option	Operational Review	Markets Served and Journey Times	Operating Cost	Recommendation
T1	Likely to require an additional bay platform at High Wycombe.	Marlow loses direct service in OP. High Wycombe half-hourly service in peaks only.	Low	A sensitivity to T1A
T1A	Likely to require an additional bay platform at High Wycombe. Could not run half hourly throughout the day owing to freight conflicts between Whitehouse Tunnel Junction and High Wycombe in some hours.	Marlow loses direct service in OP but gains 2 indirect services. Bourne End frequencies doubled in OP. High Wycombe half-hourly service all day.	Low	Take forward as a service option
T1B	Likely to require an additional bay platform at High Wycombe. Very little journey time benefit for through passengers is gained from omitting Furze Platt and Cookham. There would be a reduction in peak service compared to today and the service interval would not be strictly half hourly.	Marlow loses direct service in OP. Furze Platt and Cookham lose 1tph in the peak. High Wycombe half hourly service in peaks only. Slightly quicker than T1	Low	Discontinue. Only consider the option of a semi-fast service in longer distance options where a more considerable benefit is achieved for longer distance passengers.
T1C	Likely to require an additional bay platform at High Wycombe. Could not run half hourly throughout the day owing to freight conflicts between Whitehouse Tunnel Junction and High Wycombe in some hours. Very little journey time benefit for through passengers is gained from omitting Furze Platt and Cookham. There would be a reduction in peak service compared to today and the service interval would not be strictly half hourly.	Marlow loses direct service in OP but gains 2 indirect services. Furze Platt and Cookham lose 1tph in the peak. Bourne End frequencies doubled in OP. High Wycombe half-hourly service all day. Slightly quicker than T1A.	Low	Discontinue (as above)
T2	The Princes Risborough options would require turnback infrastructure at Princes Risborough. Significant trade off if existing Chiltern services are substituted.	As per T1 but extended to Princes Risborough. Trade-off with Chiltern services.	Medium	Discontinue
T2A	The Princes Risborough options would require turnback infrastructure at Princes	As per T1A but extended to Princes Risborough. Trade-	Medium	Discontinue

	Risborough. Significant trade off if existing Chiltern services are substituted.	off with Chiltern services.		
T2B	The Princes Risborough options would require turnback infrastructure at Princes Risborough. Significant trade off if existing Chiltern services are substituted.	As per T1B but extended to Princes Risborough. Trade-off with Chiltern services. Quicker than T2 in the peaks.	Medium	Discontinue
T2C	The Princes Risborough options would require turnback infrastructure at Princes Risborough. Significant trade off if existing Chiltern services are substituted.	As per T1C but extended to Princes Risborough. Trade-off with Chiltern services. Quicker than T2A in the peaks.	Medium	Discontinue
T3	Would require partial doubling between Princes Risborough and Aylesbury. *Monks Risborough may only have an hourly service in each direction to preclude the need to build a second platform on the passing loop.	As per T2 but extended to Aylesbury.	High	A sensitivity on Option T3A
T3A	Would require partial doubling between Princes Risborough and Aylesbury. *Monks Risborough may only have an hourly service in each direction to preclude the need to build a second platform on the passing loop.	As per T2A but extended to Aylesbury.	High	Take forward as a service option
T3B	Would require partial doubling between Princes Risborough and Aylesbury.	As per T2B but extended to Aylesbury. Quicker than T3 in the peaks.	High	A sensitivity on Option T3C
T3C	Would require partial doubling between Princes Risborough and Aylesbury.	As per T2C but extended to Aylesbury. Quicker than T3A in the peaks.	High	Take forward as a service option
T3D (New)	This is similar to the Option T3A, but is likely to have less impact on Chiltern operations and require less new infrastructure. An additional bay platform may be required at High Wycombe. Peak service may have to omit Saunderton owing to capacity constraints. Assumes existing off-peak Marylebone – Aylesbury service turns back at High Wycombe. Could be accommodated within the	As per T3A with peak service omitting Saunderton but less impact on Chiltern operations.	High	Take forward as a service option

	structure of the existing Chiltern timetable.			
T4	The infrastructure is capable of supporting Option T5, which is considerably better for passengers than T4.	Link between High Wycombe and Marlow via Bourne End but otherwise unchanged.	Low	Discontinue
T5	The proposed method of working at Bourne End creates a half hourly service between all stations on the local network, with alternate trains being direct / involving an interchange. Same interaction with Chiltern as T3D.	Half hourly service between all stations on the local network, with alternate trains being direct / involving an interchange.	High	Take forward as a service option

The outcomes of the high-level option sift are that the following options should be modelled and reported on in the Economic Case:

- Option T1A – a half-hourly all stations Maidenhead to High Wycombe service all day;
- Option T3A – a half-hourly all stations* Maidenhead to Aylesbury service all day;
- Option T3C – a half-hourly Maidenhead to Aylesbury service with alternate trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only;
- Option T3D (new) – an hourly Maidenhead to Aylesbury service and an hourly Maidenhead to High Wycombe service; and
- Option T5 – provide an hourly Maidenhead to Aylesbury service, an hourly Maidenhead to Bourne End service and an hourly Marlow to High Wycombe service.

The following options should be considered for sensitivity testing:

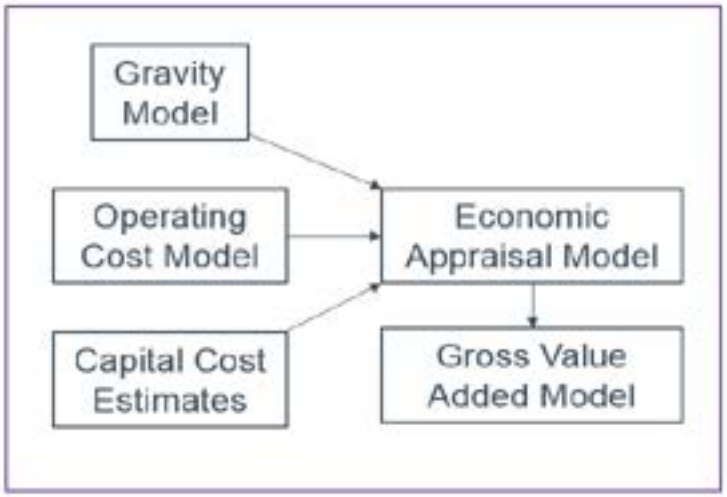
- Option T1 as a sensitivity to Option T1A – a half-hourly all stations Maidenhead to High Wycombe service in the peaks dropping to an hourly service for the rest of the day;
- Option T3 as a sensitivity to Option T3A – a half-hourly all stations* Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day; and
- Option T3B as a sensitivity to Option T3C – a half-hourly Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day with alternate peak trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only.

*Monks Risborough may only have an hourly service in each direction to preclude the need to build a second platform on the passing loop

8. Outline Assessment Approach

Following on from the review and sift of service options, we have developed an Economic Case through WebTAG compliant modelling techniques. The overall modelling suite is summarised in Figure 8-1 below:

Figure 8-1 Modelling Suite



8.1. Gravity Modelling

To forecast the demand impact of the scheme we have made use of a bespoke demand forecasting tool that was originally developed to support the development of the East West Rail scheme.

This model offers several advantages over other industry forecasting models such as PLANET South or MOIRA which due to their purely elasticity based approach are only suitable for modelling incremental changes to existing rail services.

We have therefore developed a two-stage modelling process using Generalised Journey Time (GJT) elasticities to forecast changes in demand and a gravity model to more accurately forecast the impact of large changes in journey time and where current rail demand is minimal. When the GJT change is less than 30% compared to the Do Nothing (present day) scenario, the elasticity approach is adopted; otherwise the higher of the Gravity Model forecast and the elasticity forecast is selected.

The gravity forecast is a function of:

$$Forecast\ demand = GJT^{a} \times OriginEmployment^{b} \times OriginPopulation^{c} \times DestinationEmployment^{d} \times £/mile^{e}$$

Where *a, b, c, d, e* are gravity model parameters:

Base rail demand and revenue have been taken from MOIRA (2016 data rebased to a 2011 model base year), split between season ticket and non-season ticket journeys in order to apply elasticities from the Passenger Demand Forecasting Handbook (PDFH) at a disaggregate level. For the purposes of quantifying time benefits, demand has been further disaggregated into business, commute and leisure trips using mappings from PDFH.

Base population and employment data for study area station catchments have been derived from the 2011 Census. Base, Do Minimum and Do Something GJTs have been extracted from MOIRA based on assumptions around Do Minimum schemes and running times between High Wycombe and Bourne End.

Given our defined study area of station to station origin-destination pairs, it has not been deemed necessary to recalibrate the model as the study area is very similar to the original model. The origin-destination pairs used in the calibration of the original model cover a full range of:

- Areas of low and high population;
- Areas of low and high employment;
- Journey lengths; and
- Levels of low and high rail accessibility.

Forecast demand has been grown from 2011 to future years using exogenous growth factors. The model caps demand at 2038. Exogenous growth factors for population, employment and non-car ownership have been taken from TEMPRO 7.2, while GDP and road journey times factors have been taken from the December 2017 version of the WebTAG Data Book[2] and fares factors are based on latest policy (RPI+1% to 2016, then RPI to 2021, then RPI+1% to 2036). Table 8-1 summarises the fare, GDP and road journey times exogenous growth factors at five-year intervals.

Table 8-1 Exogenous Growth Factors

	2011	2016	2021	2026	2031	2036
Fares Growth	1.00	1.05	1.05	1.10	1.16	1.22
GDP Growth	1.00	1.07	1.12	1.21	1.32	1.44
Road Journey Times	1.00	1.00	1.01	1.02	1.03	1.04

Table 8-2 presents the elasticity values that have been adopted for the model from PDFH.

Table 8-2 Elasticity Values

	Non-London South East	
	Non-seasons	**Seasons**
GDPpc	1.20	N/A
Population	1.00	1.00
Employment	0.00	1.00
Car Ownership	0.71	0.00
Fares	-0.72	-0.60
Road Journey Times	0.30	0.30

8.2. Cost and Economic Appraisal Modelling

Capital cost estimates for the construction of the railway were provided by Wycombe District Council (WDC). The old alignment had an estimated cost of £300m and the new alignment had an estimated cost of £150m. These estimates were not reviewed or verified by Atkins as part of the initial commission. However, as an extension to the initial commission Atkins were subsequently commissioned to provide high level capital and life cycle cost estimates for the construction of the new alignment and wider network infrastructure upgrades required to enable services to operate. The cost estimates have had Optimism Bias (64% in line with rail network enhancement projects at GRIP Stage 1) and real inflation applied before being rebased, discounted and converted to market prices in line with WebTAG guidance[3]. We have also incorporated calculations for mileage-based rail operating costs and station operating costs and drawn together an appraisal that collates opex, capex, revenue and benefits, and produces financial and economic outputs.

Passenger forecasts generated by the Gravity Model form the basis for producing the associated projected fare-box income and socioeconomic benefits. These elements have been assessed over a 60-year appraisal period. The model adopts the latest approach to values of time with business user values of time applied by distance band. Benefits captured include:

- Journey time benefits;
- User charge impacts (fare benefits);
- Revenue (treated as a negative cost); and

[2] https://www.gov.uk/government/publications/webtag-tag-data-book-december-2017
[3] https://www.gov.uk/government/publications/webtag-tag-unit-a1-2-scheme-costs-july-2017

- Mode shift impacts (decongestion, accident savings, highway investment savings, environmental impacts, bus revenues and indirect tax).

The following impacts are not captured within the modelling suite:

- Crowding impacts;
- Freight impacts;
- Resilience; and
- Transformation of land-use (although fixed land-use GVA impacts are captured in a separate model as set out in the next section).

For the mode shift impacts, our approach estimates highway decongestion impacts using the global highway km displacement factor from WebTAG[4]. There is no mode choice modelling.

The following assumptions have been made:

- The scheme opening year is 2028;
- Real fares growth of 1% to 2014, 0% to 2021 and 1% to 2037; and
- There is a demand lag from the opening year until 2031.

The results from the different elements of the economic assessment have been summarised in tables with the following key economic statistics used to demonstrate and compare the case for the options:

- The Present Value of Benefits (PVB) represents the total monetised benefits from the scheme, including the impact of the scheme on central government indirect tax revenues;
- The Present Value of Costs (PVC) represents the total scheme investment costs;
- The Net Present Value (NPV) represents the absolute difference between the PVB and PVC; and
- The Benefit-Cost Ratio (BCR) is the ratio of PVB to PVC and represents the overall value for money of the scheme. DfT guidance states that a BCR of greater than 2.0 represents high value for money.

All costs and benefits have been converted to 2010 market prices to provide a consistent unit of account, and discounted to 2010 to represent the preference for benefits sooner rather than later and costs later rather than sooner.

8.3. GVA Modelling

We have also estimated the Gross Value Added (GVA) impact of the scheme in terms of enhanced connectivity between key knowledge-based centres as a key driver for increased economic productivity through more efficient business to business (B2B) activity. This has incorporated a bespoke fixed land use model that generates GVA impacts from service improvements. These impacts are separate from, and can be treated as additional to, those inherent in conventional transport benefits.

The methodology associated with measuring the impacts of agglomeration relies upon the measurement of effective densities between origin-destination pairs and elasticities taken from the DfT's Wider Impacts data set. Effective density is a measurement of the travel time, for business and commuting purposes, and the number of employees at the destination. Agglomeration elasticities are recommended by DfT to estimate productivity increases as a result of the uplift of effective density (due to the scheme), which is multiplied by the output per worker and the number of workers at the destination. This analysis is aggregated to give an indication of the total productivity increase due to enhancement in agglomeration brought by the transport improvement. Agglomeration impacts are externalities that are not captured in the conventional transport user benefits and therefore are entirely additional to the previously quantified benefits. A flow chart of the process is presented in Figure 8-2 below.

[4] https://www.gov.uk/government/publications/webtag-tag-unit-a5-4-marginal-external-costs-may-2018

Figure 8-2 Flowchart of the Calculation of Agglomeration Benefits

The model uses generalised cost changes from the gravity model, journey to work mode shares from the 2011 Census, population and employment data for station catchments, growth factors to 2031, average GDP per worker and national average decay parameters and agglomeration elasticities. The results of this analysis provide a guide to the potential GVA impacts, in terms of supporting business to business travel.

The Gravity Model is a trip end model, however WebTAG guidance requires a zonal model as the basis for this GVA modelling. The trip end model will (i) underestimate the agglomeration benefits because we will only be able to account for the study area but also (ii) overestimate the benefits in the study area. Whether or not these impacts balance out is unknown so to counteract this, a Midlands Connect zonal system with estimates of generalised cost between zones within the study area and zones outside was used to improve the estimate of effective density. These generalised costs were the same in both the Do Minimum and the Do Something scenarios.

As well as agglomeration benefits, a simple methodology can be applied for estimating the impact of imperfectly competitive markets. WebTAG recommends quantifying such impacts by applying a 10% uplift to the total business user benefits.

There are also likely to be GVA impacts through the labour market with increased attractiveness of commuting via rail. However, it is anticipated that these impacts will be minor compared to business to business activity. There could also be regeneration around stations, although this will be limited given that all the locations in the study area already have operational rail stations.

8.4. Limitations of the Modelling Approach

The study area includes Heathrow Airport as well as the proposed new stations at Old Oak Common and Winslow. While data for Heathrow Airport is included in the Gravity Model, it should be noted that Heathrow Airport is really a unique case which typically requires bespoke modelling. The Gravity Model features low base rail demand to and from Heathrow Airport and so if the change in GJT generated by the scheme is modest, the elasticity method will be applied to the low base rail demand, meaning that Heathrow Airport will not emerge as a key market.

In the cases of Old Oak Common and Winslow, the Gravity Model requires reliable Do Minimum data for trips to and from these stations and so they have been excluded. If the Gravity Model were to be combined with PLANET modelling, trips from, say, High Wycombe via Old Oak Common to the HS2 network could be captured. The Gravity Model is rail only rather than multi-modal.

9. Shortlisted Options for Testing

9.1. Overview

A long-list of service options was provided in the brief and has been sifted as part of our initial Operational Assessment. A more detailed Operational Assesment was carried out on the shortlisted options to highlight

the impact on other operators' services and identify what infrastructure enhancements might be required on the existing network to accommodate the new services. The following core options have been tested in the modelling suite:

- Option T1A – a half-hourly all stations Maidenhead to High Wycombe service all day;
- Option T3A – a half-hourly all stations* Maidenhead to Aylesbury service all day;
- Option T3C – a half-hourly Maidenhead to Aylesbury service with alternate trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only;
- Option T3D – an hourly Maidenhead to Aylesbury service and an hourly Maidenhead to High Wycombe service; and
- Option T5 – provide an hourly Maidenhead to Aylesbury service, an hourly Maidenhead to Bourne End service and an hourly Marlow to High Wycombe service.

*Monks Risborough may only have an hourly service in each direction to preclude the need to build a second platform on the passing loop

With the exception of Option T5, it is assumed that Marlow to Bourne End runs as a shuttle service to match the service frequency at Bourne End (hourly or half hourly).

Across all the options, the following consequential changes have also been made to existing services:

- Removal of 2 tph between Marlow and Bourne End and 2 tph between Bourne End and Maidenhead during peak hours;
- Removal of 1 tph between Marlow and Maidenhead during off-peak hours;
- 1 tph between Aylesbury and London Marylebone via High Wycombe during off-peak hours instead starts/terminates at High Wycombe (except for Option T1A); and
- Removal of the peak hours shuttle service between Aylesbury and Princes Risborough (except for Option T1A).

In all options, trains are assumed to be 2 carriages in length.

9.2. Operational Impact of Shortlisted Options

The initial Operational Assessment which supported the option sifting process identified the layout required at Bourne End and highlighted some of the likely capacity challenges on the existing network. Once the options to be assessed were identified, a more detailed review of the timetable was undertaken to clarify the journey times to be used for the demand forecasts and to understand the option-by-option impact on network capacity and on the Chiltern timetable.

Base Timetable

A standard off-peak hour in the December 2017 timetable was used as the basis for the Operational Assessment. Variations to the standard off-peak pattern during the morning and evening peak were also considered.

Although Chiltern stated that some evolution of the timetable was likely to be undertaken during the coming years, this had not been sufficiently developed to be used as a base. Any changes are unlikely to change the quantum of trains operating. There are longer term plans for Chiltern to serve Old Oak Common, but these had not been sufficiently developed to use as the basis for this study.

In the December 2017 timetable, Chiltern operates 7tph between Whitehouse Tunnel Junction and High Wycombe, decreasing to 6tph between High Wycombe and Princes Risborough. Note that in service options that involve running to Aylesbury, the new service would substitute one existing service north of High Wycombe.

The structure of the timetable is such that the fastest 4tph (2 Birmingham and 2 Oxford) are flighted in pairs at roughly half hourly intervals, although in the Up (southbound) direction, one of the pairs of trains in each hour are not as closely flighted as the rest.

Currently, a limited number of freight services use the Chiltern Line between Whitehouse Tunnel Junction and Aylesbury. These freight services impact on the standard hour timings of passenger services, necessitating pathing time to be added to affected Birmingham and Oxford services in the hours when the freight trains operate. It is likely that the number of freight trains will increase in connection with HS2 spoil flows, but it has been assumed that the quantum of freight would not exceed 1tph.

Pathing of New Services

The nature of the Chiltern timetable means that gaps open up behind the flighted pairs of Birmingham and Oxford services in the Down (northbound) direction, and preceding the Birmingham and Oxford services in the Up (southbound) direction. These would be the natural paths for new services. This pattern would mean that Maidenhead services would have good connections with Banbury (stopping) services, but relatively poor connections with fast Birmingham and Oxford services (the route via Reading would be expected to be faster for these longer distance flows).

The pair of Up (southbound) trains that are not as closely flighted as the other pairs creates a problem when accommodating options involving running 2tph to Aylesbury and these options will require changes to the Chiltern timetable (see below).

Depots and Stabling

Up to 5 units would need to be available to operate the service. Given the ongoing electrification of the Great Western Main Line, there is a logic to resourcing this diesel operated service from the north, rather than the south. Chiltern have stated that Aylesbury depot is at capacity, but capacity currently exists at Wembley. Therefore, it has been assumed in this study that depot capacity already exists for the new services. Note that the substitution of existing Chiltern services in some options is likely to release a unit for the new services.

Level Crossings

There are three public highway level crossings (Furze Platt, Cookham and Marsh Lane) on the existing network to be used between Maidenhead and Aylesbury. A further two level crossings (Brooksby and Marina) exist in the Marlow branch. These crossings are all Automatic Barrier Crossings (Locally Monitored).

Table 9-1 below summarises the expected change in the number of trains operating in each hour over these level crossings. Only Options T3A and T3C increase the service level above the maximum existing service level (at Marsh Lane Crossing). Off-peak service levels generally increase compared to today, but, in most cases, this could be avoided by considering a reduced off-peak service (as expressed in some of the original options and considered in this study as a sensitivity test).

Table 9-1 Change in Trains Operating at Level Crossings

	T1A (off-peak)	T1A (peak)	T3A/T3C (off-peak)	T3A/T3C (peak)	T3D (off-peak)	T3D (peak)	T5 (off-peak)	T5 (peak)
Furze Platt	+1	0	+1	0	+1	0	+1	0
Cookham	+1	0	+1	0	+1	0	+1	0
Marsh Lane	0	0	+1	+1	0	0	0	0
Brooksby	+1	0	+1	0	+1	0	+1	0
Marina	+1	0	+1	0	+1	0	+1	0

Option T3C involved 1tph running semi-fast between Maidenhead and Aylesbury. Owing to the type and method of working at Furze Platt and Cookham level crossings, only 1 minute (southbound) and 2 minutes (northbound) would be saved between Maidenhead and Bourne End. The saving would increase to 4 minutes in both directions if the type of level crossing were changed. To explore the full potential benefits that semi fast running might achieve, it has been assumed that these level crossings will be upgraded in Option T3C.

Option T1A Impacts

This option has a short interface with Chiltern services between Whitehouse Tunnel Junction and High Wycombe. Sufficient capacity exists to timetable the new service on the Chiltern Line, including the at grade crossing move at Whitehouse Tunnel Junction. However, there is insufficient capacity at High Wycombe station to accommodate the service and a new bay platform would be required.

Options T3A and T3C Impacts

These options involve 2tph continuing to Aylesbury and would require infrastructure upgrades as well as changes to the Chiltern timetable. The principal infrastructure constraint is the single-track Princes Risborough – Aylesbury line which cannot accommodate the required 2tph (passenger) and 1tph (freight) in each direction. These options would, as a minimum, necessitate partial doubling of the route, with a loop at Little Kimble (where passenger trains would pass), and alterations to the layout at Princes Risborough. Currently, trains running to and from the Aylesbury branch have to use Platform 2, which is also shared with Up services calling at Princes Risborough. To provide the necessary capacity, a new connection would be required from Platform 3 to the branch. Ideally, the layout would also have the capability for a freight train to be held clear of the Down line if it were necessary to await a path on the single line. Line speed upgrades between Princes Risborough and Aylesbury, especially for freight, would allow trains to clear the single line quicker, thereby increasing capacity. This would almost certainly require upgrades to level crossings on the route.

The December 2017 timetable cannot accommodate these options without amendment to Chiltern services. This is because, in the Up direction, one pair of Oxford and Birmingham services is not closely flighted and leaves an insufficient gap for the second Aylesbury service. The timetable for these options has been developed on the basis that the Chiltern service could evolve such that the Oxford and Birmingham services were more closely flighted. It is recognised that constraints on other parts of the Chiltern route may prevent this at present and a more detailed review of the feasibility of this would be required if these options were taken forward.

The existing Marylebone – Aylesbury via High Wycombe service would be curtailed at High Wycombe. With no further changes to the Chiltern timetable, this would require an additional bay platform to be provided. However, it may be possible to amend the Chiltern timetable to enable both services from Marylebone to terminate in the existing bay platform.

Options T3D and T5 Impacts

As these options substitute an existing service between High Wycombe and Aylesbury, the infrastructure upgrades and changes to the Chiltern timetable required in Options T3A and T3C are avoided. An additional bay platform would be required at High Wycombe to accommodate the terminating service.

10. Do Minimum Assumptions

In line with WebTAG guidance, the starting point for the Do Minimum scenario is committed schemes. However, we have also chosen to include WRLtH as, although this scheme is not yet committed, it is deemed to be highly likely and was specifically referenced in the ITT. We are aware of the proposed link from the Chiltern Main Line to Old Oak Common and plans to increase frequencies on the Marlow branch line but these have not been included in the Do Minimum scenario for this study. As the modelling approach is rail only rather than multi-modal, any highway works, including improvements to the A404 are not applicable. A link between the Chiltern Main Line and Old Oak Common would reduce the case for the scheme, although this has not proven to be a key market. A detailed timetable for the link would be required for inclusion in the Do Minimum scenario.

The Do Minimum scenario consists of assumptions around WRLtH, the Western Section of East West Rail, and Crossrail from Paddington. It is assumed that all of these schemes are in place when rail is reinstated between High Wycombe and Bourne End.

10.1. WRLtH

The WRLtH scheme provides access to Heathrow T5 from the west, allowing journeys direct from Reading. It involves a new 5.5km route between Langley and Heathrow T5. 4 trains per hour (tph) are planned, calling at Reading, Slough, Heathrow T5, and alternately at Maidenhead or Twyford. The service has been assumed to take 30 minutes end-to-end, based on existing provision and information from Network Rail.

10.2. East West Rail Western Section

The Western Section of East West Rail will improve regional connectivity by allowing direct journeys between Oxford, Milton Keynes and Bedford through a new link between Bletchley and Bicester Village, and Bletchley and Aylesbury Vale Parkway. It will also introduce a new station on the link at Winslow.

The Western Section of East West Rail will have three services, each at 1 tph:

- Milton Keynes – Bletchley – Winslow – Bicester Village – Oxford Parkway – Oxford – Reading
- Bedford – Ridgmont – Woburn Sands – Bletchley – Winslow – Bicester Village – Oxford Parkway – Oxford – Reading
- Milton Keynes – Bletchley – Winslow – Aylesbury Vale Parkway – Aylesbury – Princes Risborough – High Wycombe – London Marylebone

The three services will have end-to-end journey times of 56, 76, and 74 minutes respectively, based on journey times in the existing timetable and on information from East West Rail.

10.3. Crossrail/Elizabeth Line

The timetable for Crossrail is based upon a Freedom of Information request on the Crossrail timetable in 2017. The assumed timetable replaces 2 tph between Paddington and Heathrow T4 with a 4 tph Crossrail service between Paddington and Heathrow T5. A 2 tph service between Reading and Paddington is replaced with both a 2 tph Crossrail service between Reading and Paddington, and a 2 tph Crossrail service between Maidenhead and Paddington. Finally, a 2 tph all stops service between Oxford and Reading is replaced with a 2tph all stops to Reading, followed by semi-fast service after.

11. Scheme Costs

11.1. Capital Costs

As stated above, capital cost estimates for the construction of the railway were provided by WDC.

It was anticipated that following or closely following the old alignment would present major challenges and costs. There would need to be at least 6 new road or rail bridges and potentially 40-60 properties and some businesses needing to be acquired. There may be an option to cut back into the hillside to avoid a gas pipeline and properties but this would affect sensitive landscape and Fennels Wood. The high-level cost estimate provided by WDC for the old alignment was c. £300m.

The new alignment would involve construction of a new railway line from the gap between Wooburn and Wooburn Green, to the east side of the valley, to join the existing Chiltern Main Line near Loudwater. It would require significant tunnelling but less new track, structures and property acquisition. The high-level cost estimate provided by WDC for the new alignment was c. £150m.

It was expected that these cost estimates did not include any upgrade costs on existing routes (e.g. between Princes Risborough and Aylesbury as required for some options) and may also have excluded possession costs at the interface with the existing network and any incremental depot/stabling costs.

Due to the high-level nature of the estimates provided by WDC, and uncertainty around what these estimates included, Atkins were subsequently commissioned to develop their own high-level capital and life cycle cost estimates for the construction of the new alignment and wider network infrastructure upgrades required to enable services to operate. This was carried out for the new alignment only as services operating

on the old alignment based on the capital cost estimate provided by WDC did not demonstrate value for money and so the old alignment was not considered for further analysis.

In addition to the new alignment, the following wider network infrastructure upgrades were included in the cost estimation:

- Signalling upgrade Maidenhead – Bourne End: the separation between trains at key locations and operational flexibility required by the now more complex railway operation would not be achievable with the current token operated railway. Track circuit block signalling is therefore proposed. This intervention is proposed for all options.
- Bourne End remodelling: an additional bay platform to the north of the current station and remodelling of approach tracks from the west (Cookham and Marlow) are required to accommodate the proposed train movements. A slightly different layout is needed for Option T5 due to the different movements proposed.
- Furze Platt and Cookham level crossing upgrade: currently these crossings operate as Automatic Barrier Crossings with road warning lights and barriers monitored by train crew, requiring trains to traverse them at low speeds/after stopping. Option T3C includes a limited stop service not calling at Cookham and Furze Platt. For this option only, upgrading the level crossings to CCTV (manual level crossing (full barriers) remotely supervised via closed circuit television) or OD (manual level crossing (full barriers) normally automatically operated with obstacle detection) are proposed to enable trains to pass at full line speed.
- Princes Risborough remodelling: Options T3A and T3C increase the number of trains between High Wycombe and Aylesbury by 1 tph in each direction. To provide the necessary capacity at Princes Risborough, a new connection would be required from Platform 3 to the Aylesbury branch, with the layout having the capability for a freight train to be held clear of the Down line if it were necessary to await a path on the single line.
- Little Kimble remodelling: the additional tph between High Wycombe and Aylesbury in Options T3A and T3C necessitate a loop at Little Kimble to allow trains to pass each other on the single-track section. Option T3A requires Little Kimble station to be doubled (785m loop) with an additional platform on the loop line, with the Up and Down trains timed to call at Little Kimble roughly simultaneously. Option T3C, in which one train per hour runs limited stop, requires a different solution. A longer loop (approximately 3,000m) to the north of Little Kimble station is required, without a new platform, due to the times trains are anticipated to pass each other.
- High Wycombe bay platform: all options involve terminating additional trains at High Wycombe, necessitating installation of an additional bay platform to provide the terminating capacity. Option T1A requires terminating capacity for the new 2tph Maidenhead – High Wycombe services. These are assumed to be 3-car Class 166 units of 69m in length. An 80m-length platform is assumed to the south of Platform 1 (east of the multi-storey car park). The other options involve terminating the current London Marylebone – Aylesbury via High Wycombe service at High Wycombe. As these use longer trains, it is assumed the new platform needs to be the same length as the current Platform 1 (approximately 150m). In order to accommodate this platform length, the multi-storey car park would need to be demolished and rebuilt.

Detailed measurements for each of these elements and a summary of which elements are required for each service option are provided in Appendix B.

The capital cost estimates have included:

- Preliminaries at a rate of 25%;
- Contractor Overheads and Profit at a rate of 12%;
- Project Design Team Fees at a rate of 15%; and
- Project Management Team Fees at a rate of 12%.

A further uplift, ranging between 10% and 35%, has also been applied to cover night time working and possession management.

The cost estimates have assumed tunnelling through chalk and do not include any allowances for:

- Land purchase (permanent or temporary);

- TWAO/Planning costs;
- TOC/FOC compensation costs;
- Contamination and hazardous materials;
- Electrification;
- Service diversions;
- Network Rail costs (beyond those covered in the Project Management and Design uplifts); and
- Other third-party costs.

Table 11-1 summarises the capital cost of each element, while Table 11-2 summarises the capital cost for each service option based on the elements required.

Table 11-1 Capital Cost by Element

Element	Capital Cost
Bourne End to Whitehouse Tunnel	£218,671,910
Signalling Upgrade Maidenhead to Bourne End	£14,194,790
Bourne End Station Remodelling Option A	£4,901,514
Bourne End Station Remodelling Option B	£6,252,787
Furze Platt and Cookham Level Crossing Upgrade	£865,536
Princes Risborough Remodelling	£3,372,976
Little Kimble Loop Option A	£9,385,508
Little Kimble Loop Option B	£22,778,924
High Wycombe Bay Platform Option A	£1,444,542
High Wycombe Bay Platform Option B	£17,927,576

Table 11-2 Capital Cost by Service Option

Service Option	Capital Cost
Option T1A	£239,212,757
Option T3A	£268,454,275
Option T3C	£282,713,227
Option T3D	£255,695,791
Option T5	£257,047,064

The scope of the life cycle cost estimates includes the renewal and maintenance costs post-construction for a period of 60 years for the tunnels, tracks, platforms, bridges, lifts, tie-ins and signalling plus the scheduled replacement and redecoration of major systems and components.

The life cycle cost estimates have included:

- Preliminaries at a rate of 12.5%;
- Contractor Overheads and Profit at a rate of 12%;
- Project Design Team Fees at a rate of 7.5%; and
- Project Management Team Fees at a rate of 6%.

The life cycle cost estimates do not include any allowances for:

- Train power systems;
- Electric power and plant;
- Rolling stock;

- Testing and commissioning costs;
- Migration costs;
- Enabling works; and
- Land purchasing.

Table 11-3 summarises the life cycle costs for each service option.

Table 11-3 Life Cycle Costs by Service Option

Service Option	Life Cycle Costs
Option T1A	£101,296,744
Option T3A	£144,893,895
Option T3C	£174,284,068
Option T3D	£118,211,197
Option T5	£123,232,085

For the capital costs, the following spend profile has been assumed based on benchmarking against similar projects:

- 2024: 7%
- 2025: 16%
- 2026: 34%
- 2027: 35%
- 2028: 9%

The cost estimates have been provided in 2019 prices. Optimism Bias has been added at 64% in line with WebTAG guidance for schemes at GRIP Stage 1 and real inflation has been applied before rebasing, discounting and conversion to market prices in line with WebTAG guidance.

11.2. Operating Costs

Operating costs are assumed to be identical for each alignment (i.e. any mileage difference is negligible) and are outlined below.

11.2.1. Rolling Stock Leasing Costs

The new services have been assumed to use existing Class 165 diesel units already used for similar services, such as the Bourne End to Maidenhead service. The rolling stock for the Do Minimum services have been assumed to be what is currently used for similar services, apart from the Crossrail services which use Class 345 units. The rolling stock has been assumed to need replacement every 35 years.

Leasing costs have been sourced from Train Operating Company accounts, with future costs of diesel (DMU) and electric (EMU) units based on current costs. The costs given in Table 11-4 below are applied to each service, per carriage needed for that service.

Table 11-4 Rolling Stock Leasing Costs

Class	Lease Cost per Year per Carriage (2016/17 price base)	Introduction Year	Replacement Rolling Stock
165	£135,000	1990/91	New DMU
345	£198,000	2017/18	New EMU
360	£170,000	2002/03	New DMU
387	£135,000	2014/15	New EMU
New DMU	£156,000	-	New DMU
New EMU	£140,000	-	New EMU

The rolling stock requirements (additional to the Do Minimum) for each service option in terms of the number of sets required (assuming 2 vehicles per set for all options) is summarised in Table 11-5 below:

Table 11-5 Service Option Rolling Stock Requirements

Service Option	Required Sets
T1A	1
T3A	2
T3C	2
T3D	1
T5	1

11.2.2. Mileage-Based Costs

Various other costs are incurred on a per mile basis. These include Capacity Charges for appropriate service groups (based on Control Period 5 Capacity Charge rates), fuel and maintenance costs, Track Access charges and Electric Asset Use charges. Table 11-6 below outlines the fuel and maintenance costs applied per vehicle mile. Diesel fuel costs are sourced from the WebTAG Data Book and the remaining rates have been assumed based on historical trends.

Table 11-6 Fuel & Maintenance Costs

Fuel Type	Fuel cost (£ / Vehicle Mile 2010/11 price)	Maintenance cost (£ / Vehicle Mile 2010/11 price)
Diesel	0.40	0.73
Electric	0.23	0.48

Fixed Track Access Charges are applied at a constant rate per mile. Based on information from the ORR data portal on Control Period 4 train miles and annual fixed charges for relevant operators, an average value of £0.45 per vehicle mile (2010/11 prices) was calculated. This has been assumed to apply for all services.

Variable Track Access Charges are applied at a different rate per mile depending on the rolling stock used. The values come from the Network Rail Control Period 5 charges and are summarised in Table 11-7 below:

Table 11-7 Variable Track Access Charges

Rolling Stock	Variable Track Access Charge (£ / Vehicle Mile 2010/11 price)	Comments
165	0.05	
345	0.06	Not in list of CP5 charges, so Class 379 charge used.
360	0.09	
387	0.06	Not in list of CP5 charges, so Class 379 charge used.

Use of electrical assets also incurs a charge. This only applies for the Do Minimum services, as all Do Something services are diesel. From the Control Period 5 charges, this is £0.015 per mile.

11.2.3. Staff Costs

Staff costs have been based on incremental diagrams and derived by assuming 230 working days per year with an 18-hour service span, 7.25 hours per shift and one guard and one driver at all times per train. Salaries of £43,000 for a driver and £25,000 for a guard (2014/15 prices) have also been assumed based on similar operators. National Insurance and pension contributions have also been added.

11.2.4. Factoring

Components of the annual costs are expected to increase at different rates. Over the lifespan of the scheme, all costs have been scaled to rise with RPI as per the WebTAG Data Book, except diesel fuel forecasts (including changes in diesel duty and expected efficiency improvements) and electricity costs, which have been sourced from the WebTAG Data Book, and rolling stock leasing costs, which are fixed over the contract term. Rolling stock leasing costs at contract replacement have been scaled using GDP Deflator data from the WebTAG Data Book.

A 60-year appraisal period has been applied with an opening year of 2028. Optimism Bias has been assumed at 41%, consistent with a GRIP Stage 1 assessment and the costs have been rebased to 2010 prices using GDP Deflator data from the WebTAG Data Book.

11.2.5. Results

Operating costs by component for each of the service options over the 60-year appraisal period are summarised in Table 11-8 below:

Table 11-8 Operating Cost Summary (£m, 2010 prices, discounted to 2010)

Component	T1A DS-DM	T3A DS-DM	T3C DS-DM	T3D DS-DM	T5 DS-DM
Capital Leasing	+5.7	+11.5	+11.5	+5.7	+5.7
Fuel	+4.9	+11.7	+11.7	+6.3	+6.3
Maintenance	+9.0	+21.6	+21.6	+11.7	+11.7
Staff	+15.2	+30.4	+30.4	+15.2	+15.2
Track Access (Fixed)	+5.3	+12.7	+12.7	+6.9	+6.9
Track Access (Variable)	+0.6	+1.5	+1.5	+0.8	+0.8
Electric Asset Usage	+0.0	+0.0	+0.0	+0.0	+0.0
Capacity Charge	+0.7	+2.3	+2.3	+1.1	+1.1
Total	**+41.5**	**+91.7**	**+91.7**	**+47.8**	**+47.8**

Where

- Option T1A is a half-hourly all stations Maidenhead to High Wycombe service all day;
- Option T3A is a half-hourly all stations* Maidenhead to Aylesbury service all day;
- Option T3C is a half-hourly Maidenhead to Aylesbury service with alternate trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only;
- Option T3D is an hourly Maidenhead to Aylesbury service and an hourly Maidenhead to High Wycombe service; and
- Option T5 is an hourly Maidenhead to Aylesbury service, an hourly Maidenhead to Bourne End service and an hourly Marlow to High Wycombe service.

*Monks Risborough may only have an hourly service in each direction to preclude the need to build a second platform on the passing loop

With the exception of Option T5, it is assumed that Marlow to Bourne End runs as a shuttle service to match the service frequency at Bourne End (hourly or half hourly).

12. Scheme Appraisal Results

12.1. Demand Forecasting Results

In the Strategic Case we identified the following potential markets:

- **Local trips** between Maidenhead, Bourne End, Marlow and High Wycombe.
- **Regional trips** between Reading/Slough and High Wycombe/Aylesbury.
- **Long distance trips** that avoid travel via London or Oxford (e.g. Milton Keynes via East West Rail to Thames Valley).
- **Trips to Heathrow Airport** from locations on the Chiltern Main Line and beyond via WRATH.
- **Trips that access the Great Western Main Line from the Chiltern Main Line and vice versa** (e.g. Slough to Bicester Village or High Wycombe to Old Oak common).

For each service option, outputs from the Gravity Model have been analysed in detail to understand which flows contribute most to the GJT benefits and, for these key flows, what the level of demand is in the Do Something scenario.

For Option T1A, the top flows based on total GJT benefits are:

- High Wycombe to/from Maidenhead;
- High Wycombe to/from Furze Platt;
- High Wycombe to/from Bourne End;
- High Wycombe to/from Cookham;
- High Wycombe to/from Marlow;
- High Wycombe to/from Heathrow Airport; and
- Trips that require interchange at High Wycombe or Maidenhead (e.g. Beaconsfield/Aylesbury to Maidenhead or High Wycombe to Slough).

For Option T3A, the top flows based on total GJT benefits are:

- High Wycombe to/from Maidenhead;
- High Wycombe to/from Furze Platt;
- High Wycombe to/from Bourne End;
- High Wycombe to/from Cookham;
- High Wycombe to/from Marlow;
- Aylesbury to/from Maidenhead;
- Aylesbury to/from Furze Platt;
- Aylesbury to/from Bourne End;
- Aylesbury to/from Marlow; and
- Trips that require interchange at High Wycombe (e.g. Beaconsfield to Maidenhead).

For Option T3C, the top flows based on total GJT benefits are:

- High Wycombe to/from Maidenhead;
- High Wycombe to/from Furze Platt;
- High Wycombe to/from Bourne End;
- High Wycombe to/from Cookham;
- High Wycombe to/from Marlow;
- Aylesbury to/from Maidenhead;
- Aylesbury to/from Furze Platt;
- Aylesbury to/from Bourne End;
- Aylesbury to/from Marlow; and
- Trips that require interchange at High Wycombe (e.g. Beaconsfield to Maidenhead).

For Option T3D, the top flows based on total GJT benefits are:

- High Wycombe to/from Maidenhead;
- High Wycombe to/from Furze Platt;
- High Wycombe to/from Bourne End;
- High Wycombe to/from Cookham;
- High Wycombe to/from Marlow;
- Aylesbury to/from Maidenhead;
- Aylesbury to/from Furze Platt;
- Aylesbury to/from Bourne End;
- Aylesbury to/from Marlow; and
- Trips that require interchange at High Wycombe (e.g. Beaconsfield to Maidenhead).

For Option T5, the top flows based on total GJT benefits are:

- High Wycombe to/from Marlow;
- High Wycombe to/from Bourne End;
- High Wycombe to/from Maidenhead;
- High Wycombe to/from Furze Platt;
- Aylesbury to/from Maidenhead;
- Aylesbury to/from Bourne End; and
- Trips that require interchange at High Wycombe (e.g. Beaconsfield to Maidenhead).

Table 12-1 below illustrates for each service option the level of additional rail demand generated by the scheme in 2031 (when the scheme would have opened and overcome any lag in demand):

Table 12-1 Additional Scheme Demand

	2031 Annual Journeys	2031 Annual Return Journeys	2031 Average Daily Return Journeys
Option T1A	1,259,306	629,653	1,725
Option T3A	1,637,365	818,683	2,243
Option T3C	1,635,228	817,614	2,240
Option T3D	1,488,574	744,287	2,039
Option T5	1,148,051	574,026	1,573

Additional demand generated by the scheme in 2031 ranges from 1.15m to 1.65m journeys, equivalent to between 1,500 and 2,250 daily return journeys on average. It would be expected that additional demand during weekdays would be higher than this average and additional demand during weekends would be lower than this average. 2,250 daily return journeys is equivalent to 70 return journeys (or 140 single trips) per train (assuming 2tph over 16 hours) across the whole network, although demand would be higher during peak periods. This demand is heavily skewed towards the top flows summarised above, with the top 20 flows typically making up over 30% of the additional demand. In Option T3C, there are around 96,000 journeys between High Wycombe and Maidenhead and around 58,000 journeys between Aylesbury and Maidenhead in 2031. In Option T1A, there are around 58,000 journeys between High Wycombe and Heathrow Airport in 2031. This compares with around 75,000 journeys between High Wycombe and Aylesbury in 2016 from MOIRA.

The scheme appraisal results are presented below separately for the two alignments and for each service option. It should be noted that the operating costs include reduced highway infrastructure costs and have had Track Access charges removed due to the inclusion of Whole Life Costs.

12.2. Old Alignment Appraisal Results

Tables 12-2 to 12-6 summarise the scheme appraisal results for each service option with the old alignment.

Table 12-2 Option T1A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,739,030	92,365,026	50,630,496	**157,734,552**
	Crowding	0	0	0	**0**
	User Charge	7,883,621	34,364,487	56,762,068	**99,010,176**
	Indirect tax				**-10,477,147**
	Rail indirect tax				**672,083**
	Carbon benefits				**-2,581,902**
	NOX				**-858,861**
	Marginal external				**25,798,606**
	Wider Economic Impacts				**77,929,006**
	PVB				**347,226,512**
Costs					
	Revenue				**-65,620,027**
	Operating Costs				**36,014,809**
	Capital Costs				**330,504,360**
	Whole Life Costs				**134,994,739**
	PVC				**435,893,881**
	NPV				**-88,667,369**
	BCR				**0.80**

Table 12-3 Option T3A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	21,158,785	126,170,706	69,149,249	**216,478,739**
	Crowding	0	0	0	**0**
	User Charge	9,643,668	42,602,213	69,434,411	**121,680,292**
	Indirect tax				**-15,909,001**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**36,072,089**
	Wider Economic Impacts				**82,725,113**
	PVB				**434,405,743**
Costs					
	Revenue				**-99,640,588**
	Operating Costs				**78,717,113**
	Capital Costs				**330,504,360**
	Whole Life Costs				**134,994,739**
	PVC				**444,575,624**
	NPV				**-10,169,880**
	BCR				**0.98**

Table 12-4 Option T3C Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	20,912,005	124,504,546	68,358,749	**213,775,299**
	Crowding	0	0	0	**0**
	User Charge	9,518,862	41,875,696	68,535,805	**119,930,363**
	Indirect tax				**-15,369,678**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**35,016,975**
	Wider Economic Impacts				**88,046,382**
	PVB				**434,757,853**
Costs					
	Revenue				**-96,262,723**
	Operating Costs				**78,724,417**
	Capital Costs				**330,504,360**
	Whole Life Costs				**134,994,739**
	PVC				**447,960,793**
	NPV				**-13,202,940**
	BCR				**0.97**

Table 12-5 Option T3D Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	18,942,818	113,488,397	62,505,521	**194,936,736**
	Crowding	0	0	0	**0**
	User Charge	8,512,388	38,983,479	61,289,195	**108,785,062**
	Indirect tax				**-13,663,779**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**31,506,897**
	Wider Economic Impacts				**78,821,711**
	PVB				**396,786,334**
Costs					
	Revenue				**-85,578,403**
	Operating Costs				**40,667,983**
	Capital Costs				**330,504,360**
	Whole Life Costs				**134,994,739**
	PVC				**420,588,679**
	NPV				**-23,802,344**
	BCR				**0.94**

Table 12-6 Option T5 Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,590,160	88,383,306	48,727,361	**151,700,827**
	Crowding	0	0	0	**0**
	User Charge	6,707,884	30,634,940	48,296,768	**85,639,593**
	Indirect tax				**-9,813,936**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**23,292,929**
	Wider Economic Impacts				**70,115,971**
	PVB				**317,335,090**
Costs					
	Revenue				**-61,466,231**
	Operating Costs				**40,724,628**
	Capital Costs				**330,504,360**
	Whole Life Costs				**134,994,739**
	PVC				**444,757,495**
	NPV				**-127,422,405**
	BCR				**0.71**

12.3. New Alignment Appraisal Results

Tables 12-7 to 12-11 summarise the scheme appraisal results for each service option with the new alignment based on the initial cost estimate for the new alignment provided by WDC.

Table 12-7 Option T1A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,739,030	92,365,026	50,630,496	**157,734,552**
	Crowding	0	0	0	**0**
	User Charge	7,883,621	34,364,487	56,762,068	**99,010,176**
	Indirect tax				**-10,477,147**
	Rail indirect tax				**672,083**
	Carbon benefits				**-2,581,902**
	NOX				**-858,861**
	Marginal external				**25,798,606**
	Wider Economic Impacts				**77,929,006**
	PVB				**347,226,512**
Costs					
	Revenue				**-65,620,027**
	Operating Costs				**36,014,809**
	Capital Costs				**165,252,180**
	Whole Life Costs				**67,497,369**
	PVC				**203,144,332**
	NPV				**144,082,180**
	BCR				**1.71**

Table 12-8 Option T3A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	21,158,785	126,170,706	69,149,249	**216,478,739**
	Crowding	0	0	0	**0**
	User Charge	9,643,668	42,602,213	69,434,411	**121,680,292**
	Indirect tax				**-15,909,001**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**36,072,089**
	Wider Economic Impacts				**82,725,113**
	PVB				**434,405,743**
Costs					
	Revenue				**-99,640,588**
	Operating Costs				**78,717,113**
	Capital Costs				**165,252,180**
	Whole Life Costs				**67,497,369**
	PVC				**211,826,074**
	NPV				**222,579,669**
	BCR				**2.05**

Table 12-9 Option T3C Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	20,912,005	124,504,546	68,358,749	**213,775,299**
	Crowding	0	0	0	**0**
	User Charge	9,518,862	41,875,696	68,535,805	**119,930,363**
	Indirect tax				**-15,369,678**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**35,016,975**
	Wider Economic Impacts				**88,046,382**
	PVB				**434,757,853**
Costs					
	Revenue				**-96,262,723**
	Operating Costs				**78,724,417**
	Capital Costs				**165,252,180**
	Whole Life Costs				**67,497,369**
	PVC				**215,211,244**
	NPV				**219,546,609**
	BCR				**2.02**

Table 12-10 Option T3D Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	18,942,818	113,488,397	62,505,521	**194,936,736**
	Crowding	0	0	0	**0**
	User Charge	8,512,388	38,983,479	61,289,195	**108,785,062**
	Indirect tax				**-13,663,779**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**31,506,897**
	Wider Economic Impacts				**78,821,711**
	PVB				**396,786,334**
Costs					
	Revenue				**-85,578,403**
	Operating Costs				**40,667,983**
	Capital Costs				**165,252,180**
	Whole Life Costs				**67,497,369**
	PVC				**187,839,129**
	NPV				**208,947,205**
	BCR				**2.11**

Table 12-11 Option T5 Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,590,160	88,383,306	48,727,361	**151,700,827**
	Crowding	0	0	0	**0**
	User Charge	6,707,884	30,634,940	48,296,768	**85,639,593**
	Indirect tax				**-9,813,936**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**23,292,929**
	Wider Economic Impacts				**70,115,971**
	PVB				**317,335,090**
Costs					
	Revenue				**-61,466,231**
	Operating Costs				**40,724,628**
	Capital Costs				**165,252,180**
	Whole Life Costs				**67,497,369**
	PVC				**212,007,946**
	NPV				**105,327,145**
	BCR				**1.50**

Tables 12-12 to 12-16 summarise the scheme appraisal results for each service option with the new alignment based on the capital and life cycle cost estimates for the new alignment and any wider network infrastructure upgrades required to enable services to operate that have subsequently been developed as part of this commission.

Table 12-12 Option T1A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,739,030	92,365,026	50,630,496	**157,734,552**
	Crowding	0	0	0	**0**
	User Charge	7,883,621	34,364,487	56,762,068	**99,010,176**
	Indirect tax				**-10,477,147**
	Rail indirect tax				**672,083**
	Carbon benefits				**-2,581,902**
	NOX				**-858,861**
	Marginal external				**25,798,606**
	Wider Economic Impacts				**77,929,006**
	PVB				**347,226,512**
Costs					
	Revenue				**-65,620,027**
	Operating Costs				**35,385,084**
	Capital Costs				**248,833,176**
	Whole Life Costs				**35,600,892**
	PVC				**254,199,126**
	NPV				**93,027,385**
	BCR				**1.37**

Table 12-13 Option T3A Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	21,158,785	126,170,706	69,149,249	**216,478,739**
	Crowding	0	0	0	**0**
	User Charge	9,643,668	42,602,213	69,434,411	**121,680,292**
	Indirect tax				**-15,909,001**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**36,072,089**
	Wider Economic Impacts				**82,725,113**
	PVB				**434,405,743**
Costs					
	Revenue				**-99,640,588**
	Operating Costs				**77,206,532**
	Capital Costs				**279,250,700**
	Whole Life Costs				**51,553,767**
	PVC				**308,370,410**
	NPV				**126,035,333**
	BCR				**1.41**

Table 12-14 Option T3C Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	20,912,005	124,504,546	68,358,749	**213,775,299**
	Crowding	0	0	0	**0**
	User Charge	9,518,862	41,875,696	68,535,805	**119,930,363**
	Indirect tax				**-15,369,678**
	Rail indirect tax				**1,612,188**
	Carbon benefits				**-6,193,448**
	NOX				**-2,060,228**
	Marginal external				**35,016,975**
	Wider Economic Impacts				**88,046,382**
	PVB				**434,757,853**
Costs					
	Revenue				**-96,262,723**
	Operating Costs				**77,213,835**
	Capital Costs				**294,083,103**
	Whole Life Costs				**61,397,402**
	PVC				**336,431,618**
	NPV				**98,326,234**
	BCR				**1.29**

Table 12-15 Option T3D Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	18,942,818	113,488,397	62,505,521	**194,936,736**
	Crowding	0	0	0	**0**
	User Charge	8,512,388	38,983,479	61,289,195	**108,785,062**
	Indirect tax				**-13,663,779**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**31,506,897**
	Wider Economic Impacts				**78,821,711**
	PVB				**396,786,334**
Costs					
	Revenue				**-85,578,403**
	Operating Costs				**39,849,111**
	Capital Costs				**265,979,108**
	Whole Life Costs				**41,851,960**
	PVC				**262,101,776**
	NPV				**134,684,558**
	BCR				**1.51**

Table 12-16 Option T5 Appraisal Results (2010 prices, discounted to 2010)

Benefits		Business	Commute	Leisure	Total
	GJT	14,590,160	88,383,306	48,727,361	**151,700,827**
	Crowding	0	0	0	**0**
	User Charge	6,707,884	30,634,940	48,296,768	**85,639,593**
	Indirect tax				**-9,813,936**
	Rail indirect tax				**873,953**
	Carbon benefits				**-3,357,415**
	NOX				**-1,116,831**
	Marginal external				**23,292,929**
	Wider Economic Impacts				**70,115,971**
	PVB				**317,335,090**
Costs					
	Revenue				**-61,466,231**
	Operating Costs				**39,905,755**
	Capital Costs				**267,384,725**
	Whole Life Costs				**43,720,838**
	PVC				**289,545,087**
	NPV				**27,790,003**
	BCR				**1.10**

13. Conclusions

The benefits and costs of the scheme have been assessed, considering each alignment and five service options. Weighing the benefits and revenue generated against the costs incurred gives a BCR. Wider Economic Impacts are excluded in the Initial BCR and included in the Adjusted BCR in line with WebTAG guidance given the lower level of robustness around these estimates. The BCRs for each alignment and the five service options are summarised in Table 13-1 below:

Table 13-1 BCR Summary

Benefit Cost Ratio	Old Alignment (without WEIs)	New Alignment (without WEIs)	Old Alignment (with WEIs)	New Alignment (with WEIs)
Option T1A	0.62	1.06	0.80	1.37
Option T3A	0.79	1.14	0.98	1.41
Option T3C	0.77	1.03	0.97	1.29
Option T3D	0.76	1.21	0.94	1.51
Option T5	0.56	0.85	0.71	1.10

The DfT's requirement for demonstration of high value for money is a BCR of 2.0 or greater. From the summary above it is clear that none of the service options using the old alignment would represent value for money, with all options giving a BCR below 1.0 even with Wider Economic Impacts included. The new alignment would bring the same level of benefits and revenues in all options but at a lower capital cost. None of the options meet the threshold BCR of 2.0 to represent high value for money but one of the options gives a BCR greater than 1.5, which represents medium value for money, with the inclusion of Wider Economic Impacts. Option T3D, an hourly Maidenhead to Aylesbury service and an hourly Maidenhead to High

Wycombe service, gives the highest Adjusted BCR at 1.51. In all options the bulk of the benefits are journey time and fare benefits with net mode shift and environmental benefits typically only making up 3-4% of scheme benefits. In terms of the impact on the rail industry and public funding, all of the options result in revenues that exceed operating costs.

Delivering an attractive and competitive combination of multiple passenger service opportunities between sizeable business activity and labour market locations is likely to maximise the economic growth potential the scheme can offer. The longer the journey distance and time, especially if the journey time is greater than 60 minutes or 90 minutes, the greater the scale of business activity or labour market needs to be to generate sufficient demand for services to offset the impact of time on the propensity to travel, noting that businesses and workers will often have alternatives within more attractive journey time bands available to them.

This is why locations like Milton Keynes do not feature in the top flows and demand is mostly local trips. For example, for journeys between Milton Keynes and Maidenhead, the reduction in GJTs compared to the Do Minimum is only small across all of the service options tested, typically 5-10 minutes. Similarly trips to and from London are largely unaffected by the scheme. From High Wycombe it will still be quicker to access London Marylebone via the Chiltern Main Line rather than accessing London Paddington via interchange at Maidenhead. Trips that use Crossrail services and trips to Heathrow Airport, both of which require interchange at Maidenhead, are not key drivers of the business case for the scheme.

Achievement of significant modal shift could only be expected if the scheme had a significant catchment area and provides a competitive route alternative to the existing transport network, both in terms of journey times and crowding.

13.1. Sensitivity Testing

Sensitivity testing has been carried out on inputs to and assumptions within the Gravity Model to attempt to better account for Heathrow Airport. The Gravity Model applies population and employment growth at a local authority level to stations (London Borough of Hillingdon in the case of Heathrow Airport) so in the first instance growth projections for Heathrow Airport have been adjusted to match one of the higher growth local authorities in the study area (Vale of White Horse) according to TEMPRO 7.2 forecasts. However, this resulted in no significant changes to key flows and negligible impacts on BCRs.

As discussed previously in section 8.4, this is because Heathrow Airport is really a unique case which typically requires bespoke modelling. The Gravity Model features low base rail demand to and from Heathrow Airport and so if the change in GJT generated by the scheme is modest, the elasticity method will be applied to the low base rail demand, meaning that Heathrow Airport will not emerge as a key market. Adjusting the Gravity Model threshold from 30% to 20% has more of an impact across both alignments and all service options with trips from High Wycombe to Heathrow Airport (and Aylesbury to Heathrow Airport where relevant) becoming more significant (albeit still typically outside the top 20 flows in terms of journey time benefits). Rather than adjusting such key assumptions, further bespoke modelling work is recommended.

As recommended from the high-level option sift, the following options have also been considered:

- Option T1 as a sensitivity to Option T1A – a half-hourly all stations Maidenhead to High Wycombe service in the peaks dropping to an hourly service for the rest of the day;
- Option T3 as a sensitivity to Option T3A – a half-hourly all stations* Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day; and
- Option T3B as a sensitivity to Option T3C – a half-hourly Maidenhead to Aylesbury service in the peaks dropping to an hourly service for the rest of the day with alternate peak trains calling at Aylesbury, Princes Risborough, High Wycombe, Bourne End and Maidenhead only.

For Option T1 (when compared against Option T1A) and Option T3 (when compared against Option T3A), the reduction in operating costs is more than offset by reductions in journey time and fare benefits, revenue, mode shift benefits and wider impacts. As such the BCR for Option T1 with the old alignment is 0.61 (against a BCR for Option T1A with the old alignment of 0.80) and the BCR for Option T1 with the new alignment is 1.02 (against a BCR for Option T1A with the new alignment of 1.37). Likewise the BCR for Option T3 with

the old alignment is 0.81 (against a BCR for Option T3A with the old alignment of 0.98) and the BCR for Option T3 with the new alignment is 1.17 (against a BCR for Option T3A with the new alignment of 1.41).

However, for Option T3B (when compared against Option T3C), there are negligible changes in benefits and revenues so the reduction in operating costs leads to an increase in the old alignment BCR from 0.97 to 1.02 and an increase in the new alignment BCR from 1.29 to 1.37. There is therefore merit in considering this option further.

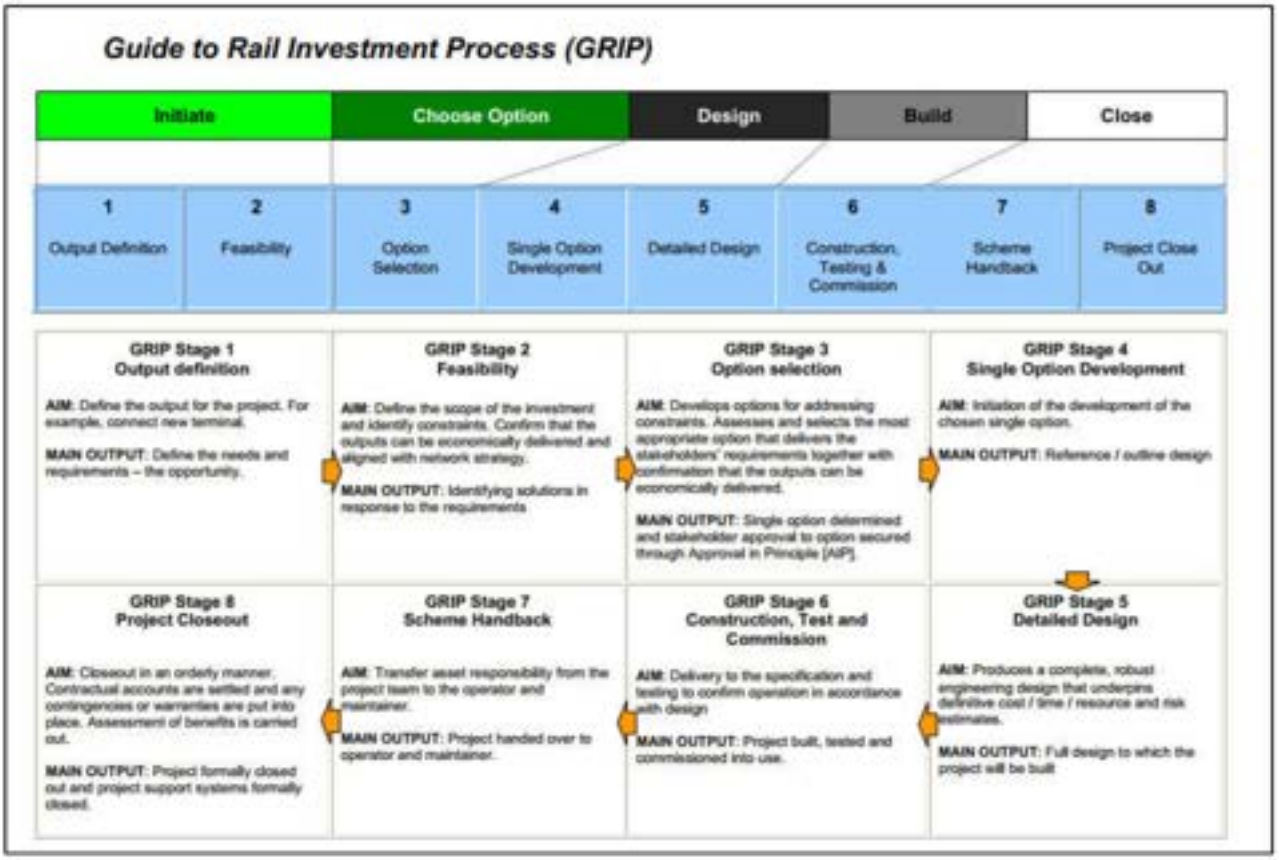
These sensitivity tests around the service options do not result in any significant changes in key flows. The peak periods have been assumed to be 06:30-09:30 and 16:00-19:00. It is conservatively assumed that the rolling stock and staff cost requirements for the sensitivity test service options are controlled by peak period requirements, and hence do not change relative to their baseline Do Something service options. The remaining costs are controlled by mileages.

14. Next Steps

Further modelling work is recommended to fully capture the impacts to and from Heathrow Airport (bespoke methodology) and any longer-distance markets via Old Oak Common and HS2 (PLANET modelling).

In terms of understanding at which GRIP Stage the scheme is currently at, Figure 14-1 below sets out the overall process:

Figure 14-1 GRIP Process



We would recommend that the expectations for GRIP Stage 1 have been fulfilled and some elements of GRIP Stage 2 have also been completed, with outline alignments and service options being put forward. At GRIP Stage 2 a key factor is in identifying constraints. This could include, but is not limited to, railway operational constraints, constraints of constructing around a live railway, the impact on the local community and the impact on the highway network. For GRIP Stage 3, a preferred option will need to be defined from

those considered to date and any additional options put forward, with further designs developed. It is important that there is stakeholder consensus regarding the preferred option.

In terms of further operational assessments, in order to differentiate between the benefits of the different alignments and service options, performance modelling could be incorporated, which would require timetables to be agreed and then modelled in RailSys. However, the requirement for this would be dependent on the level of industry buy-in. If this were carried out, journey times from RailSys could feed back into the demand forecasting and appraisal modelling.

In terms of capital costs, additional detail would be required to progress through the GRIP process. Each of the proposed alignments would need design development and cost estimates and value management exercises to be completed. Given the sensitivity of the business case for the scheme to the capital cost estimates, we would recommend that a value management workshop is undertaken in the not too distant future to identify the key drivers for construction scope and to see if there are modifications that could be made to bring better value.

In terms of funding, the Local Enterprise Partnership is a good start but they should be seen as a potential funder of development works. It is therefore important to engage with the DfT at an early stage to explain the proposals and understand any funding conditions. The biggest funding contributions should come from farebox revenues, car park revenues and developer contributions.

Each GRIP Stage has a set of deliverables that need to be completed in order to move on to the next GRIP Stage. These deliverables include Approval in Principle (AiP) documents that cover new infrastructure and any alterations to the existing track, signalling systems, stations, power and telecoms systems as well as multi-discipline documents that include an Engineering Management Plan, a Hazard Identification (HAZID) workshop and report, a Common Safety Method (CSM) System Definition and Interdisciplinary Check (IDC) certificate(s). These deliverables would likely need to be supported by surveys, including Topographical and Ground Investigation surveys.

In the first instance, for the scheme to progress through the GRIP process, it is important that it is verified by Network Rail with the necessary legal agreements put in place so that the scheme can be committed as a project.

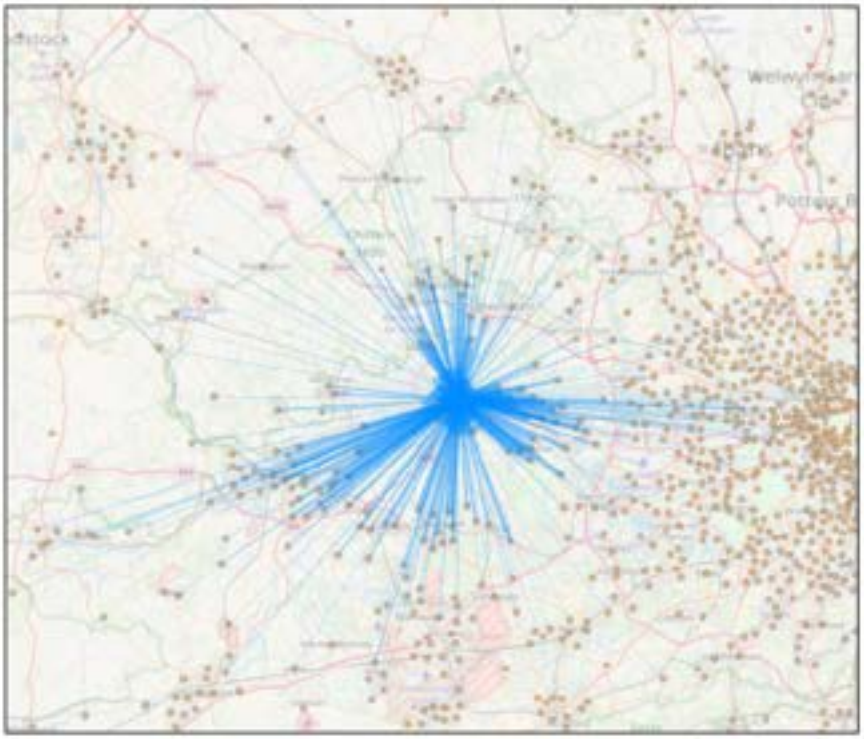
In conjunction with the GRIP process, the SOBC will need to be developed into firstly an Outline Business Case (OBC) and finally a Full Business Case (FBC). As well as refinement and updating of the Strategic and Economic cases, the OBC and FBC will need to cover the Financial, Commercial and Management cases in detail. Continued stakeholder engagement and collaboration will be required throughout this process.

The outcomes of this study should be considered alongside any studies into alternative transport schemes such as light rail, bus, highway or active mode schemes.

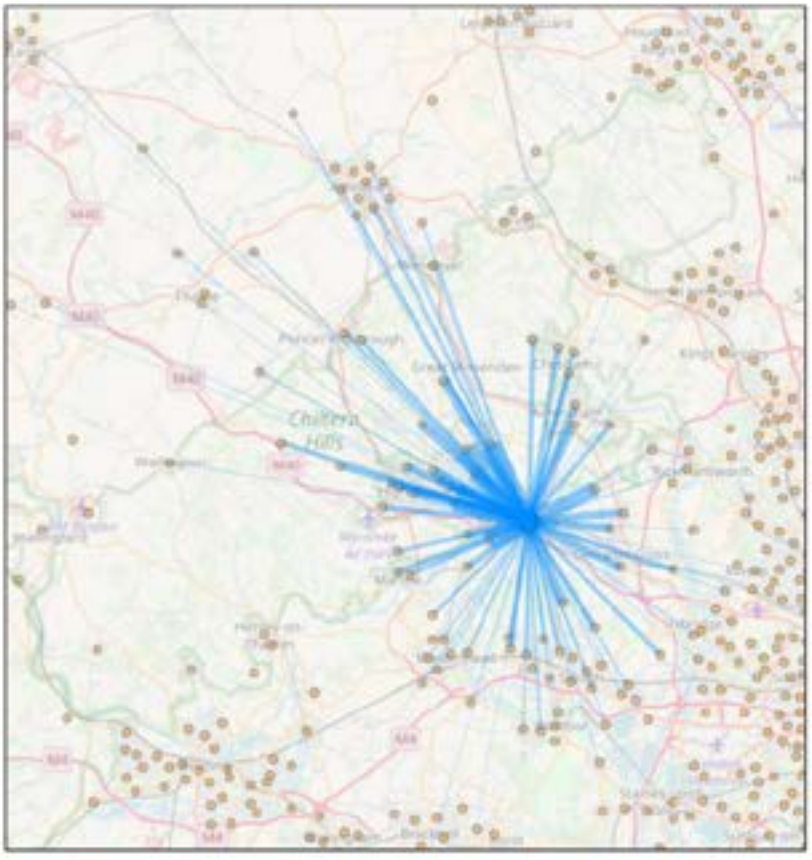
In terms of the addition of intermediate stations between High Wycombe and Bourne End, there would be value in considering such options in more detail. This is because our operational analysis has identified that there is very little journey time benefit for through passengers from omitting Furze Platt and Cookham. For shorter options stopping at such stations should be considered. The impact on the business case will be dependent on trade-offs between additional journey times incurred for through passengers plus the capital and operating costs of the new stations versus the markets that could be served in the catchments around the stations. The operational analysis suggests that the impact on the business case could be positive but this could only be verified by establishing station costs and the scale of demand around the stations.

Appendix A: Commuting Patterns

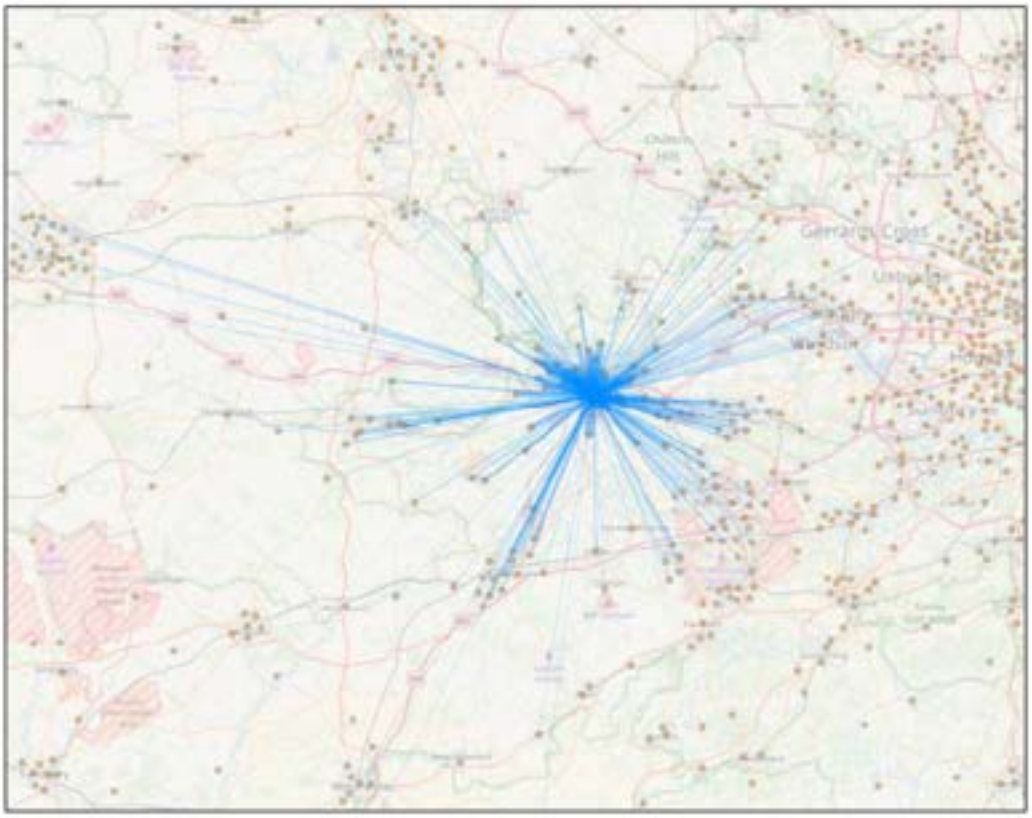
Travel into Maidenhead



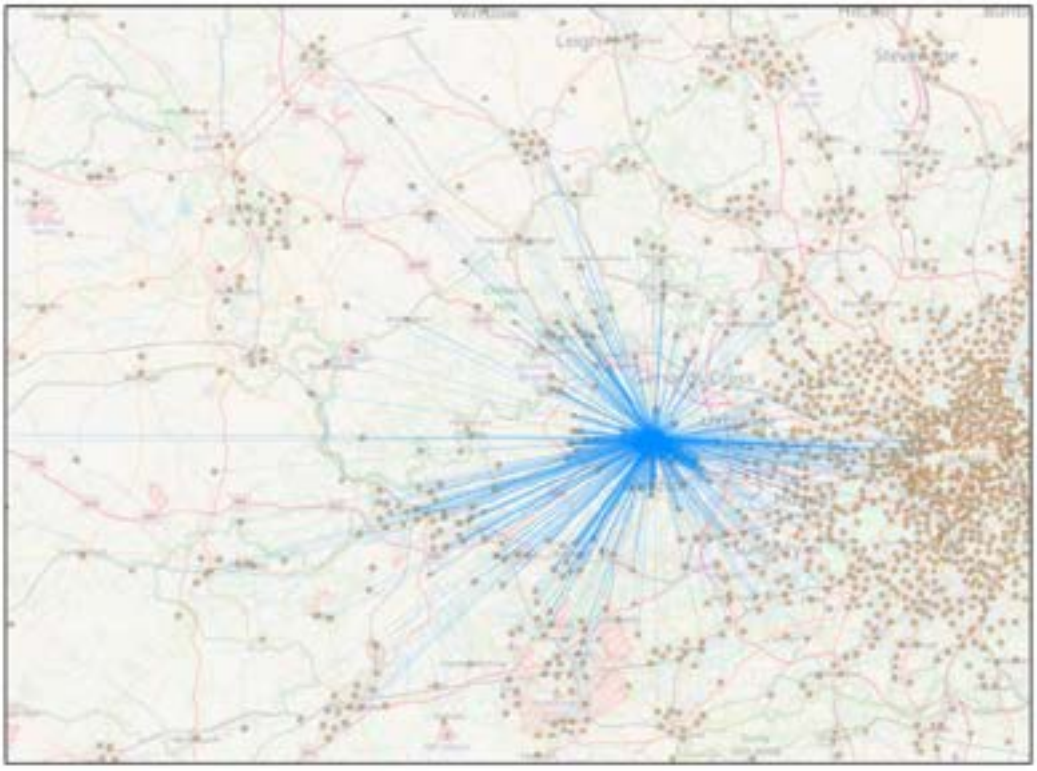
Travel into Beaconsfield



Travel into Reading



Travel into Slough



Appendix B: Service Option Elements and Key Measurements

Element	Description	Key measurements	Half-hourly all stations Maidenhead to High Wycombe	Half-hourly all stations Maidenhead to Aylesbury	Half-hourly Maidenhead to Aylesbury with fast / slow patterns	Hourly Maidenhead to Aylesbury and hourly Maidenhead to High Wycombe	Hourly Maidenhead to Aylesbury, hourly Maidenhead to Bourne End, hourly Marlow to High Wycombe
Bourne End - Whitehouse Tunnel Junction	Re-use former alignement from Bourne End to Wooburn Park From Wooburn, take new alignment - single track, unelectrified new railway up to 'Whitehouse Tunnel Junction' 40m climb from Bourne End to Whitehouse Tunnel Junction, ruling gradient 1 in 60 Curve out of Wooburn 400m radius (30mph); curve into White House Junction 500m radius (40mph), rest of new alignment 60mph capable Bridge over A4094 / River Wye (or road bridge keeping railway level - to be discussed) Tunnel under M40 Whitehouse Tunnel Junction - flat junction	Overall length of single track railway: 5.3km Length of tunnel 1: 0.775km Length of tunnel 2: 0.450km Length of viaduct: 0.150km Road over rail bridges: 2 (Station Road / Cores End Road) No. of new turnouts (40mph): 3 (at Whitehouse Tunnel Junction)	Yes	Yes	Yes	Yes	Yes
Signalling upgrade Maidenhead - Bourne End	Track circuit block signalling to be installed between Maidenhead and Bourne End	6 - 7 km	Yes	Yes	Yes	Yes	Yes
Bourne End station remodelling A	Third platform Track layout changes Revised curve from Marlow branch to bay platform - 150m radius New footbridge (including two staircases and lifts) Land take and demolition of 2 buildings required	Length of removed tracks: 175m Length of new tracks: 340m No. of new turnouts: 3 No. of new footbridges: 1	Yes	Yes	Yes	Yes	
Bourne End station remodelling B	Third platform Track layout changes New curve from Marlow branch to bay platform - 150m radius New footbridge (including two staircases and lifts) Land take and demolition of 2 buildings required	Length of new tracks: 340m No. of new turnouts: 2 No. of fixed diamond crossings: 1 No. of new footbridges: 1					Yes
Furze Plat and Cookham Level Crossing Upgrade	Level crossings upgraded to CCTV or OD				Yes		
Princes Risborough remodelling	Additional chord from Princes Risborough Platform 3 to single line	New track: 175m No. of new turnouts: 2 No. of new fixed diamond crossings: 2		Yes	Yes		
Little Kimble loop and platform A	Loop at Little Kimble New platform plus footbridge	Length of new track: 785 metres No. of new platform: 1 No. of new turnouts: 2 No. of new footbridges: 1		Yes			
Little Kimble loop B (no platform)	Loop at Little Kimble, from south of Little Kimble station to just south of Marsh Lane level crossing New / widened underbridge over Grove Lane Widened trackbed throughout - may require retaining walls through Little Kimble village to maintain existing embankment footprint	Length of new track: 3000 metres No. of existing level crossings doubled: 2 (user worked, minimal infrastructure)			Yes		
High Wycombe bay platform A	New bay platform (Platform 0) to the south of Platform 1 and behind (east of) multi-storey car park Platform to start 20 metres behind car park	Length of new track: 135m No. of new turnouts: 1 Platform length: 80m	Yes				
High Wycombe bay platform B	New bay platform (Platform 0) to the south of Platform 1 Requires demolishing of existing multi-storey car park and building a replacement (assume like-for-like)	Length of new track: 245m No. of new turnouts: 1 Platform length: 150m		Yes	Yes	Yes	Yes

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