East West Rail – Eastern Section

Conditional Outputs Statement

East West Rail Consortium

Final Report

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Table of contents

Executive Summary

Background to Study

The East West Rail Consortium (EWRC) have been promoting a scheme to establish a strategic railway connecting East Anglia with Central, Southern and Western England. The complete East West Rail (EWR) 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), which is the subject of this study.

The existing railway east of Cambridge is extensively used by freight as well as providing passenger services, though there are opportunities to dramatically improve the railway connections as well as connecting into the rest of EWR to achieve long distance east-west movements. There were no direct passenger trains between Cambridge and Norwich until an hourly service was introduced in September 2002. In December 2004, the train operator, ONE, introduced an hourly service from Ipswich to Cambridge to reflect the increasing strategic importance of this rail corridor. Now that the Western and Central sections are progressing, it is time to focus on the Eastern Section of EWR (EWR-ES) and review what an EWR-ES scheme should aim to achieve and why.

The adopted New Anglia Local Enterprise Partnership (LEP) Strategic Economic Plan (SEP) states that, '**rail routes from Norwich and Ipswich to Cambridge and Peterborough are increasingly important for businesses. These require additional capacity to cater for our growing economy**'. The plan also highlights that '**connectivity and travel times are major obstacles to productivity**', and '**faster connections … are vital to improve productivity and access to markets**'.

EWR-ES has the potential to build on the rail connectivity brought about by the implemented and planned EWR Western Section and Central Section infrastructure, by enhancing journey times and frequency east of Cambridge to Norwich, Ipswich and beyond. The published New Anglia LEP prospectus for East Anglia, ***"Our Counties Connected"*** highlights the potential of EWR in this capacity, stating that:

'**The ultimate aim is to join up the cities of Bristol, Oxford, Milton Keynes, Bedford, Cambridge, Norwich and Ipswich and there are excellent economic benefits to connecting this series of important commercial and educational centres**.'

EWR-ES offers the potential to be a core ingredient of enhancing access from East Anglia to businesses and markets in Cambridge and beyond, and providing ample capacity for both passenger and freight traffic to unlock growth of the key local economic sectors identified in the Strategic Plan.

The EWRC have developed a set of strategic objectives for EWR, which we have adapted specifically for the EWR-ES:

- Improve east west public transport connectivity;
- Increase economic growth, prosperity and employment within the East of England through improvements to east west rail links;
- Provide faster, more reliable and additional rail links from the west to Cambridge, Norwich, Ipswich and beyond;
- Improve journey times and reliability of inter-regional and commuter journeys;
- Increase capacity for inter-regional and commuter journeys;
- Maintain and enhance capacity for rail freight, especially from key ports; and
- Contribute to tackling climate change by removing traffic from congested inter-regional highway corridors.

These objectives will guide the creation of the Conditional Outputs for the EWR-ES based upon a detailed analysis of future housing and employment developments, population growth and journey patterns.

Purpose of a Conditional Outputs Statement (COS) and COS in the Context of the Scheme Development Process

Atkins has been commissioned to develop a Conditional Outputs Statement (COS) for the EWR-ES, which sets out what will be required to deliver the EWRC's Strategic Objectives and provide a clear guide for the development of future rail infrastructure and services such that the business case for it is optimised.

The focus of the study is to understand the economic drivers and linkages that will form the basis of a potential future business case for enhancing rail links to the east of Cambridge to improve connectivity to areas including Norwich and Ipswich. The COS therefore determines what the rail industry should aim to achieve from an EWR-ES scheme. These aims are based on a sound evidence base of the key economic and transport drivers for intervention looking forward (identifying the most economically valuable journey pairs), and a recognition of the key constraints and challenges that will need to be addressed, both now and in the future.

The Conditional Outputs provide a set of target service outcomes without consideration being given to feasibility, deliverability or the adoption of specific routes for new infrastructure that may need to be provided. The focus has been on identifying service performance outcomes that have the prospect of delivering significant economic benefits and supporting economic growth that subsequent phases of the study can consider the design, operational feasibility and cost implications of achieving.

Study Approach

The COS captures and presents the evidence on drivers for change and intervention with respect to:

- Economic activity and growth, including trends in population and employment, employment sectoral make-up and labour market characteristics;
- Transport network efficiency and performance, including multi-modal comparisons, analysis on journey times and service frequency;
- Passenger travel demand; and
- Freight demand (particularly in the context of the strategic Felixstowe – Nuneaton freight route and traffic associated with the Haven ports).

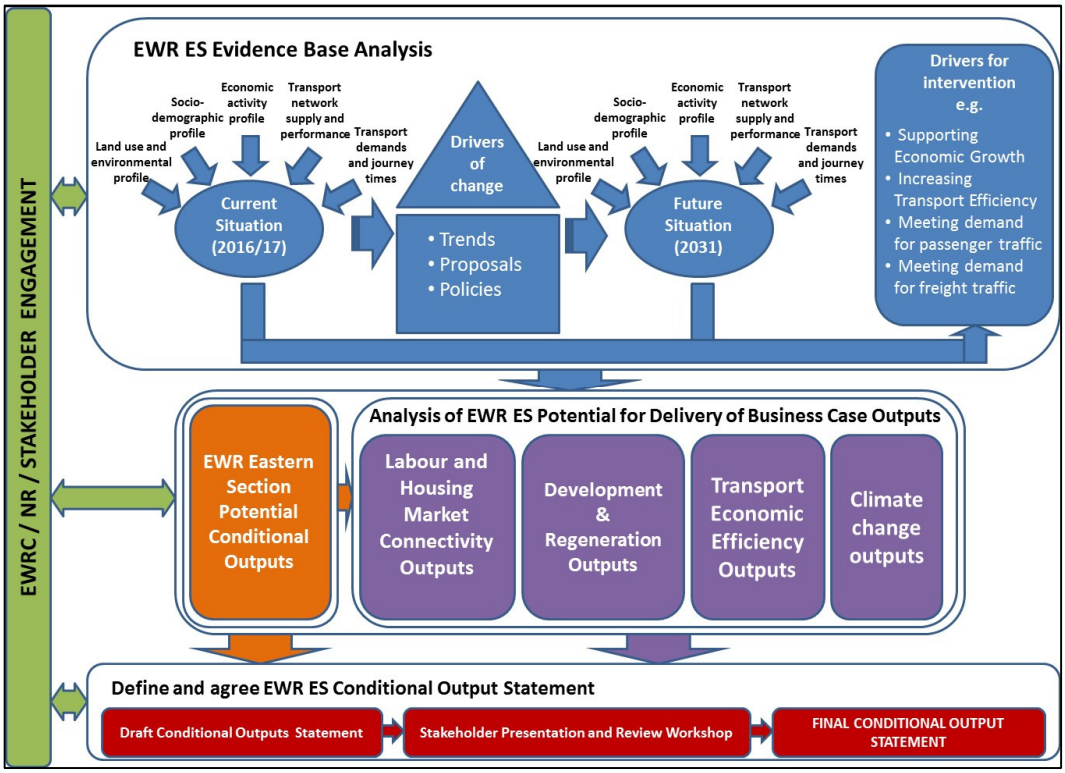
These are all themes reflected in the EWRC's Strategic Objectives.

The COS also indicates, based on analysis of the evidence base, the scope and potential for key business case outputs to be realised should an EWR-ES scheme be delivered – this as a precursor to any formal business case being developed. We have examined key areas that are consistent with both the EWRC's Strategic Objectives and the economic and VfM appraisal of major transport investments in keeping with WebTAG and major scheme appraisal guidance.

In addition, the COS ensures that potential constraints and challenges to delivering these outcomes are identified, understood and clearly presented. This includes how the existing rail network context may influence the definition of outputs. I.e. any new railway route that may be required would be constrained by where it links into the existing rail network.

Figure E-1 below presents our approach to the development of the EWR-ES COS:

Figure E-1 Approach to delivering a Conditional Outputs Statement for the EWR Eastern Section



Key Population and Economic Centres

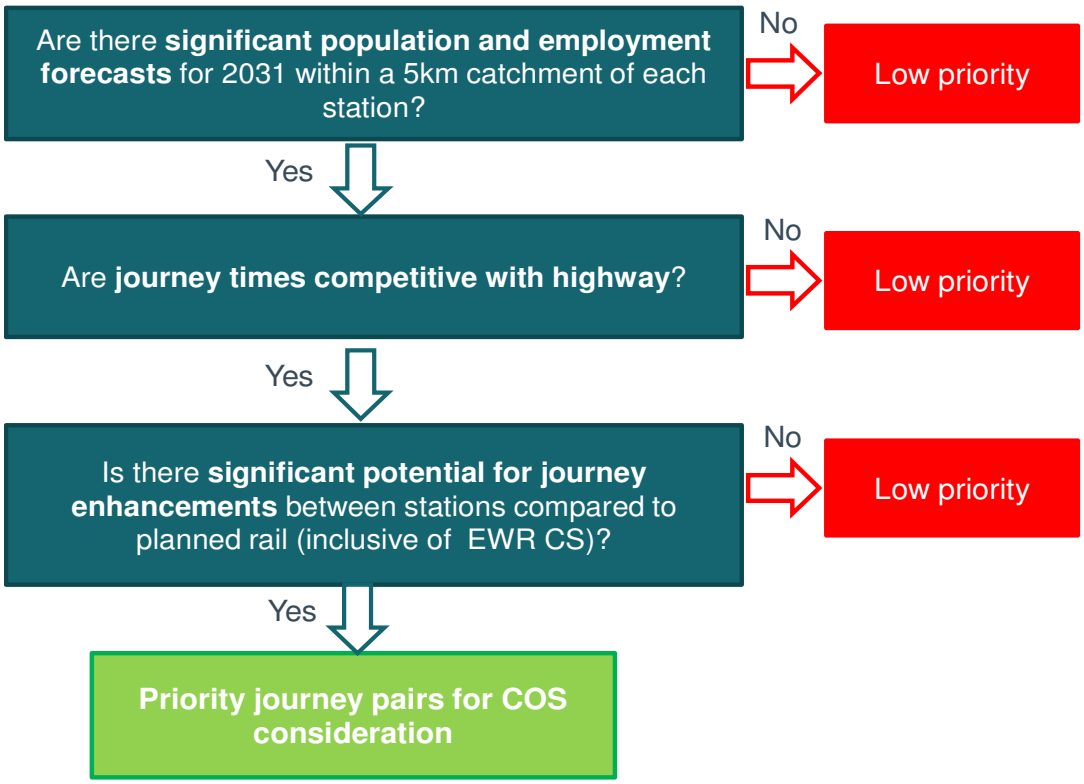
The economic and socio-demographic characteristics of locations in the study area have been analysed to understand the key locations that will drive potential rail demand. Enhanced connectivity between such locations through the EWR-ES could facilitate economic growth. Based on our analysis, key locations for population, employment and GVA are **Milton Keynes, Bicester, Aylesbury, Luton, Bedford, Peterborough, King's Lynn, Cambridge, Ipswich and Norwich**. Key commuting corridors identified are from **Ely, Bury St Edmunds and Newmarket to Cambridge, Thetford and Attleborough to Norwich, to Norwich from the Norfolk coast, and Aylesbury and Central Bedfordshire to Milton Keynes**. Further key locations for high productivity/output are **Harlow, Stevenage, Suffolk Coastal, Bury St Edmunds, South Cambridgeshire and Uttlesford**. Further areas of deprivation that would benefit from regeneration are **Great Yarmouth, Tendring (Harwich), North Norfolk (Cromer) and Waveney (Lowestoft)**. There is an opportunity for rail to improve connectivity between complementary locations in terms of industrial composition and to serve a range of demand markets.

Key Journey Pairs

There are a number of factors that will have an influence on the potential use of future rail services which make use of the EWR-ES such as size and type of market, journey distance and mode competition. These factors have been considered in identifying the overall Conditional Outputs in terms of the station to station journeys to be enabled and the service performance level (in terms of journey time and service frequency) to be delivered. All of these factors are intrinsic within the analytical processes we have adopted to determine the Conditional Outputs.

The flowchart in Figure E-2 identifies key criteria in identifying priority journey pairs for COS consideration. This involves utilising the evidence base analysis on population and employment, further interrogating journey time competitiveness between rail and highway, and gauging the potential for enhancing rail service provision. Where all of these criteria are met, the journey pair will be considered a priority.

Figure E-2 Process for Identifying Priority Journey Pairs



The next step was to use these priority journey pairs to derive an indicative view on the potential for EWR-ES services to deliver benefits through the use of a gravity model. The range of impact and benefit that the journey pairs generated was examined for three growth scenarios. The key findings were as follows:

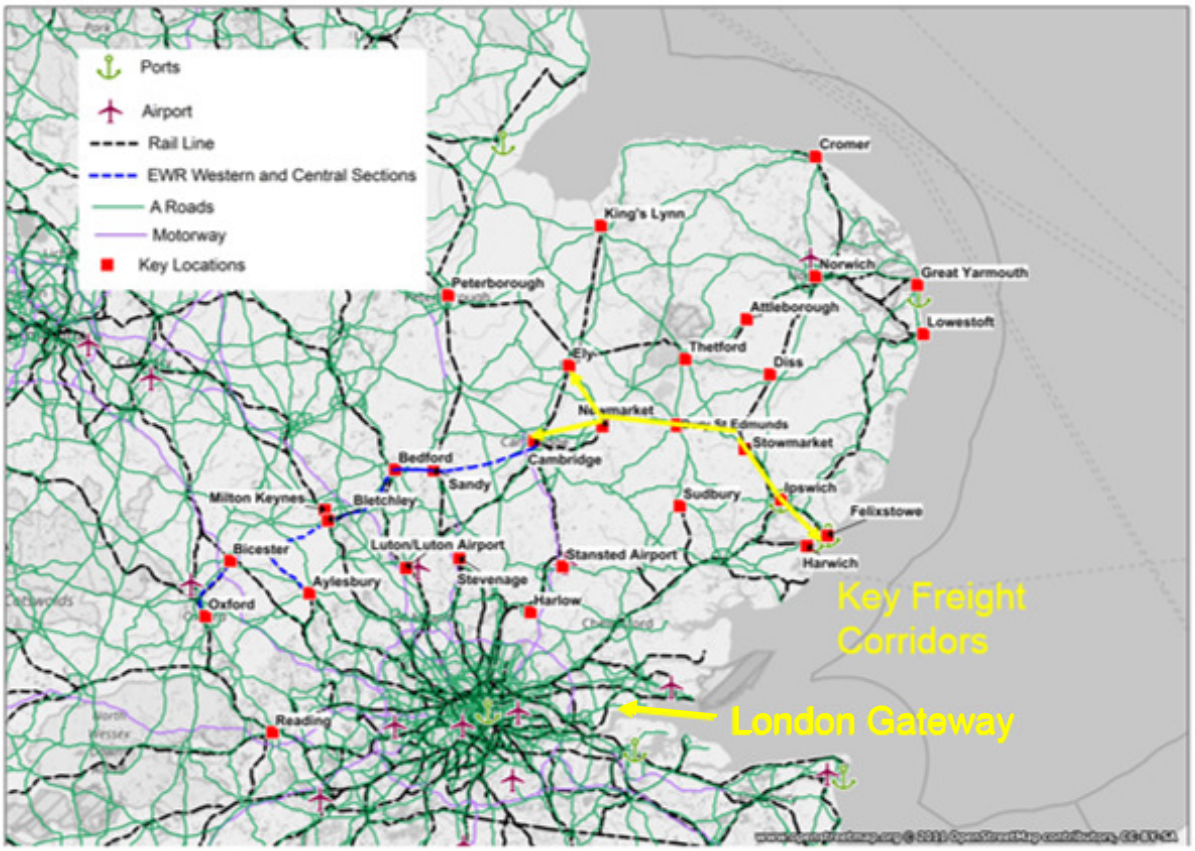
- For journeys up to 30 minutes, the top ranked journey pairs include commuting trips to/from Cambridge, Norwich and Ipswich and leisure trips to/from the coastal towns.
- For journeys between 30 and 60 minutes, the top ranked journey pairs include trips from east of Cambridge (e.g. Bury St Edmunds) to west of Cambridge (Bedford, Milton Keynes, Aylesbury, Oxford) and trips from Cambridge to Norwich, Felixstowe and Harwich.
- For journeys between 60 and 90 minutes, the top ranked journey pairs include business trips from Reading, Oxford, Aylesbury and Milton Keynes via Cambridge towards Norwich and Ipswich.
- For journeys of more than 90 minutes, the top ranked journey pairs include trips along the full extent of EWR, from Aylesbury, Bedford, Milton Keynes, Oxford and Reading to the coastal towns and ports of East Anglia.
- Trips to/from Luton/Luton Airport do not appear in the top ranked journey pairs when treated separately but would be more of a priority if Luton and Luton Airport were merged.

Figures 6-1 to 6-4 in the main report plot the top ranked journey pairs based on 2031 benefits performance for the TEMPRO growth scenario for different journey time categories on maps.

Freight Movements

Pressure to secure and expand paths for rail freight on the Strategic Rail Freight Network is an ongoing challenge in the context of parallel pressures to provide paths for passenger services. The London Gateway freight terminal will be developed, which will add freight onto the London orbital routes and there is planned expansion of both Felixstowe and Harwich ports. London orbital routes for freight are already congested so alternative routes from Felixstowe and Harwich will be needed to accommodate this growth and compete with road freight. A new rail chord at Ipswich was opened in 2014 to enable direct freight service movements from Felixstowe towards Ely without the need to reverse at Ipswich station. Infrastructure enhancements to enable up to five freight paths per hour between Ipswich and Ely are proposed in the Network Rail Anglia Route Study. The EWR-ES would complement the delivery of the Ipswich chord by enhancing the onward route via Bury St Edmunds to Chippenham Junction. It would also offer an alternative to the existing route via Ely by providing a new link via Newmarket and Cambridge for onward routing to/from the north of the UK via the Midland Main Line (MML), or to/from the west of England, the South Coast and Wales via Oxford. Figure E-3 illustrates the key freight corridors in the study area:

Figure E-3 Key Freight Corridors



Conditional Outputs Statement

Figure E-4 below summarises the top-priority flows in each of four categories that the analysis has identified:

Figure E-4 Priority Flows

Short Distance	Medium Distance	Long Distance	Very Long Distance
Norwich-Lowestoft	Bedford-Bury St Edmunds	Reading-Bury St Edmunds	Norwich-Reading
Norwich-Great Yarmouth	Aylesbury-Bury St Edmunds	Reading-Ipswich	Reading-Lowestoft
Lowestoft-Great Yarmouth	Milton Keynes-Bury St Edmunds	Norwich-Bedford	Norwich-Aylesbury
Cambridge-Bury St Edmunds	Oxford-Bury St Edmunds	Norwich-Oxford	Ipswich-Bicester
Ipswich-Felixstowe	Ipswich-King's Lynn	Ipswich-Oxford	Bedford-Lowestoft
Cambridge-Newmarket	Norwich-Cambridge	Ipswich-Bedford	Reading-Great Yarmouth
Ipswich-Harwich	Ipswich-Bletchley	Ipswich-Aylesbury	Oxford-Lowestoft
	Cambridge-Harwich	Norwich-Milton Keynes	Milton Keynes-Lowestoft
	Cambridge-Felixstowe	Ipswich-Milton Keynes	Aylesbury-Lowestoft
	Norwich-Bury St Edmunds		Milton Keynes-Great Yarmouth

The Passenger Service Conditional Outputs, based on the results above, provide a set of journey opportunities that should be the primary focus for further examination and development of EWR-ES proposals. It is recognised that not all journey opportunities will be realisable together, and in practice choices will need to be made as to the combination of pairs to incorporate in a service timetable. They present a range of journey opportunities one would explore the feasibility of enabling by new/upgraded EWR-ES infrastructure as yet to be defined. Operational, feasibility and cost considerations, as well as the potential to deliver services within target journey parameters and at a level of service to deliver benefits, will all have a bearing on ultimate choice of journey pairs for inclusion in proposed EWR-ES service timetable.

The EWR-ES Passenger Conditional Outputs present a set of key station to station passenger journey opportunities that have been assessed to offer the greatest potential to:

- Deliver economic benefits;
- Improve connectivity;
- Ease highway congestion;
- Support development; and
- Generate new rail demand and revenue.

It is anticipated that a selection of these key journey pairs in combination will form the core service specification within an EWR-ES enabled timetable.

Target performance for the journey pairs identified should be considered to be the delivery of a service journey time below the upper threshold for the journey time category (as defined above) they have been identified with, at a service frequency of 2 tph (or 2 extra tph). This is a target to aim for in considering design options but this does not mean that if this target were not met the journey pair would not be worthy of inclusion as part of an EWR-ES service specification or timetable. That would be determined by more detailed consideration of the value a service would provide to an overall EWR-ES business case to be developed in due course.

It should also be stressed that the identification of the Conditional Output journey pairs does not preclude the inclusion of other journey pairs as part of an ultimate EWR-ES service timetable. The COS identifies the key pairs on which to focus examination of deliverability. In developing a business case for an EWR-ES scheme in the future it would be expected that the additional value that can be realised from enabling other journey pairs to the core ones will be explored as part of the process of business case optimisation. Consequently, other pairs not identified as Conditional Outputs, particularly where they generate significantly more benefit

and revenue relative to the incremental cost of enabling them, could form part of the ultimate EWR-ES scheme specification for which a business case is presented.

The Freight Service Conditional Outputs consider the additional paths/capacity required given the planned growth of the Haven and Thames Ports combined with congestion on London orbital routes as well as new proposed rail freight terminals that could depend upon the opening of EWR-ES to access key parts of the country. Table E-1 shows the Conditional Outputs for Rail Freight.

Table E-1 Rail Freight Conditional Outputs

Conditional Output	Description
Freight CO 1	Provide sufficient freight paths/capacity to enable the planned growth of the Haven (Felixstowe, Ipswich and Harwich) and Thames Ports whilst providing an alternative route to the Midlands and West of England avoiding the North London Line.
Freight CO 2	Provide sufficient freight paths/capacity to support potential development of a rail freight terminal in proximity to the M1. Capacity would need to be compatible with that planned for the Western and Central Sections of EWR.
Freight CO 3	Provide sufficient freight paths/capacity to enable the planned development of a rail freight terminal at MOD Bicester. Capacity would need to be compatible with that planned for the Western and Central Sections of EWR.

Potential Routes that Respond to the COS

The COS has identified key journey pairs that generate the most significant demand and economic benefit to focus examination of deliverability on. However, it should also be stressed that the identification of the Conditional Output journey pairs does not preclude the inclusion of other journey pairs as part of an ultimate EWR-ES service timetable. 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.

Route options between Cambridge and Norwich/Ipswich and beyond to Great Yarmouth, Lowestoft and Felixstowe have been formulated that reflect the mix of major conurbations and smaller settlements in the top ranked journey pairs, and considering a trade-off between journey times and infrastructure requirements/cost so a mixture of fast and slow services has been proposed. The same service levels and journey times as the Conditional Outputs work have been assumed – 2tph or 2 extra tph for all flows and theoretical journey times assuming average 80mph running. These considerations have resulted in the three following proposed route options to be considered further:

- Route Option 1 – Incremental Upgrades (Low infrastructure requirement/cost).
- Route Option 2 – Substantially Upgraded Cambridge-Ipswich Line (Medium infrastructure requirement/cost).
- Route Option 3 –New Railway (High infrastructure requirement/cost).

Figure E-5 Route Option 1

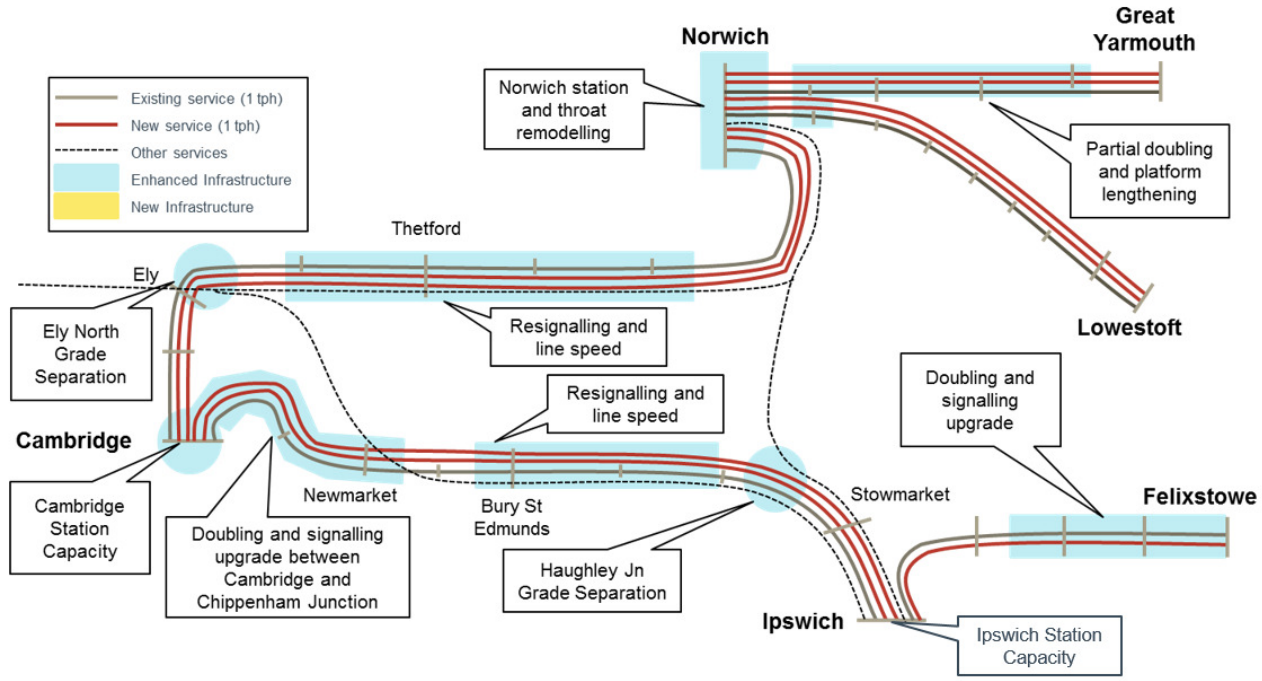


Figure E-6 Route Option 2

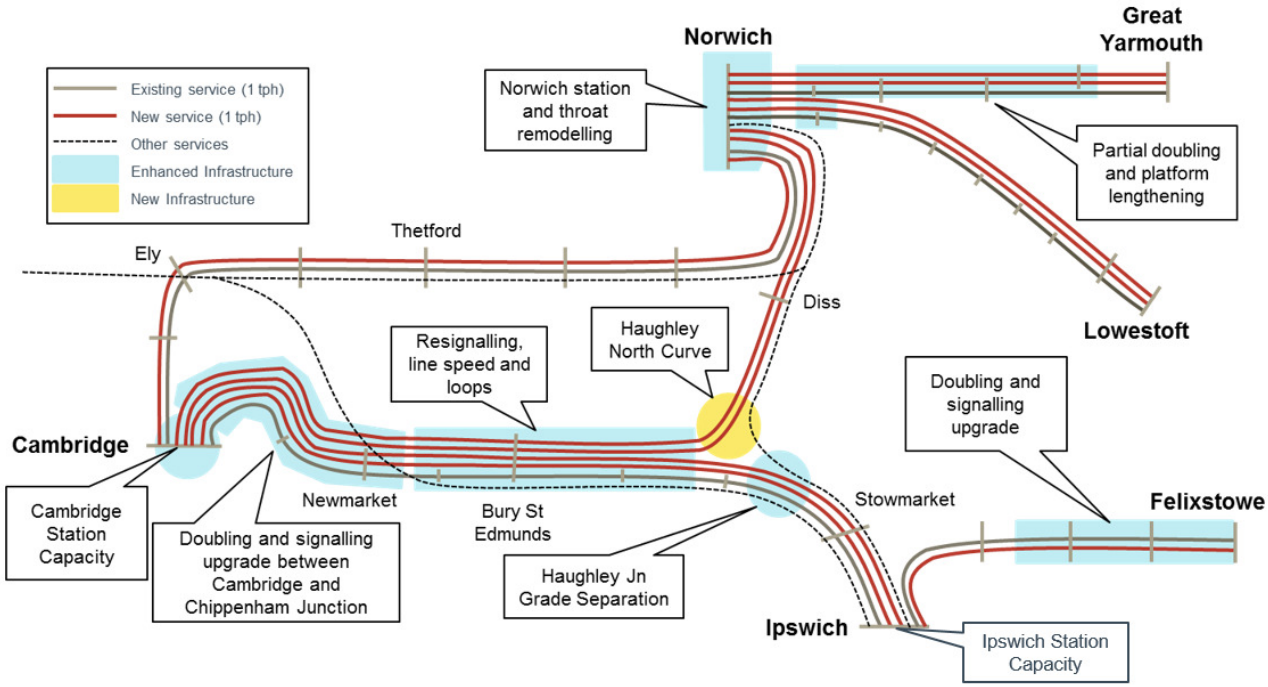
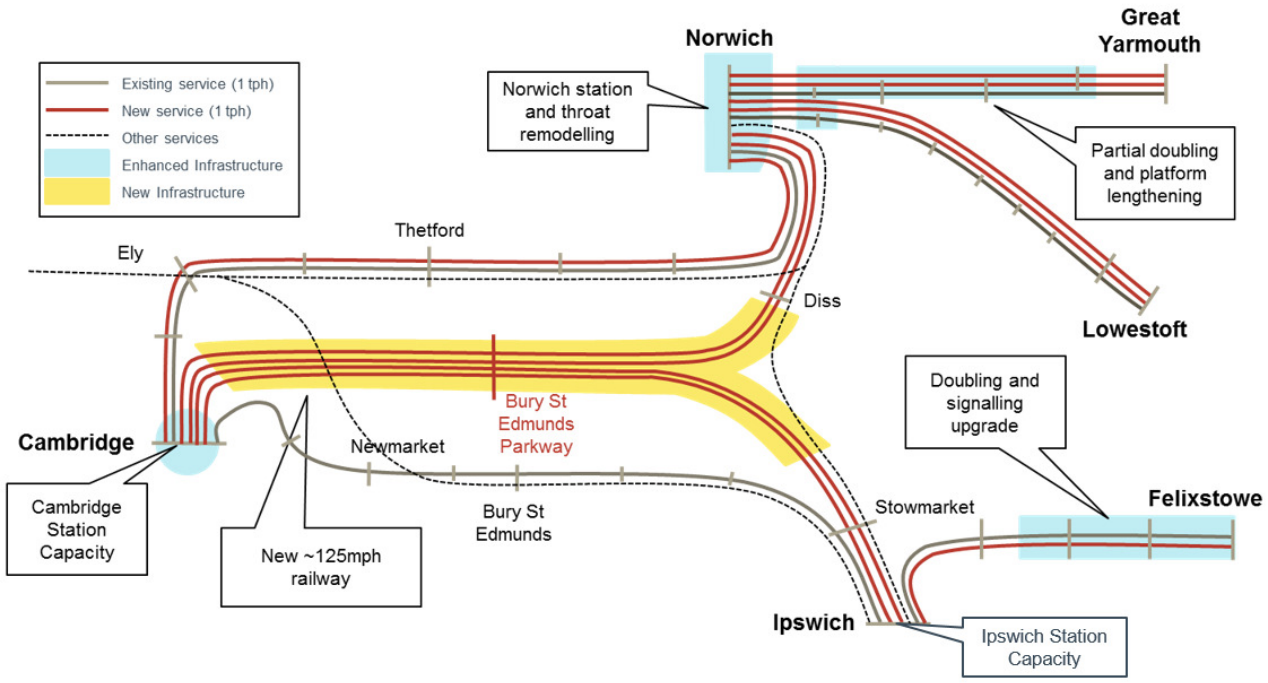


Figure E-7 Route Option 3



Route Option 1 considers incremental upgrades to rail infrastructure across existing lines within the current footprint. The rationale behind Route Option 2 is that, given aspirations of additional freight capacity from Felixstowe, work is likely to be needed on the line via Bury St Edmunds. This route option focuses infrastructure requirements to this line to give a substantially upgraded Cambridge-Ipswich line, which becomes a strategic corridor. Route Option 3 proposes a new railway from Cambridge towards Norwich/Ipswich. It is acknowledged that this is an extreme case but it helps for comparison of options in terms of the trade-off between scheme objectives.

There are trade-offs to be considered when comparing the route options. Route Option 1 is likely to be the least costly and will serve a range of markets. By comparison Route Option 2 could be quite costly, although the 4 tracking between Chippenham Junction and Haughley Junction may not be necessary. It would also risk accommodating the growth potential of Breckland given that it would only provide one additional slow service between Cambridge and Norwich. Local connectivity aspirations would also be an issue in Route Option 3. While it would provide a straight, fast route between Cambridge and Diss/Stowmarket, the key issue with this option is that it does not make best use of the existing infrastructure and therefore it would be the most expensive option. There would not be enough value in the passenger flows to justify the land requirements/costs so this option should be ruled out at this stage. Table E-2 below summarises the comparison of route options:

Table E-2 Very Early Options Assessment

Route Option	Cost	Markets Served	Journey Times
Route Option 1 (Norwich via Thetford and Ely via Bury St Edmunds, existing routes)	Medium infrastructure requirement	All necessary markets served	Cambridge to Norwich/Ipswich in 60 minutes
Route Option 2 (All via existing Bury St Edmunds route with Haughley north curve)	Medium infrastructure requirement	Breckland growth less well served	Slightly faster than Route Option 1
Route Option 3 (New railway between Cambridge and vicinity of Haughley junction)	High infrastructure requirement	Local markets between Cambridge and Norwich/Ipswich less well served	Considerably faster than Route Options 1 and 2

Conclusions

The Problem and Opportunity: Consideration of the economic and socio-demographic characteristics of locations in the study area indicates that there are key locations that will drive potential rail demand, mode shift and economic growth. Currently this demand is constrained by a congested highway network and a rail network where there are limited direct links and low service frequencies. This means that travel is restricted to shorter distance journeys, while those who do make long distance trips experience disproportionately high journey times and often have no viable or time competitive public transport opportunity. In the case of rail, passengers who wish to make east-west journeys often have to travel on crowded routes via London involving multiple interchanges and expensive ticket prices.

The EWR Western and Central sections will create some new direct rail links in the study area and improve journey times. The EWR-ES would build on these improvements and enhanced connectivity through the EWR-ES could unlock demand, including abstraction from highway, and increase the rail market. In turn this would facilitate economic growth, especially if complementary locations are better connected. In addition to the passenger market, significant rail freight growth is forecast to 2043 and the Felixstowe-Ely-Nuneaton corridor is a priority for freight. The case for an intervention such as the EWR-ES is therefore strong, in terms of both catering for existing demand and forecast growth, as well as acting as a catalyst and driver for further development and regeneration.

The EWR-ES could serve a range of markets as follows:

- Commuting within the region east of Cambridge (e.g. between Cambridge and Norwich, Bury St Edmunds to Cambridge, Stowmarket to Ipswich plus new commuting corridors e.g. Bury St Edmunds to Bedford);
- Main Line Connections (trips to/from Bedford, Milton Keynes and Reading for interchange with inter-regional routes);
- Longer distance business and leisure journeys (from Reading/Oxford/Milton Keynes/Bedford/Aylesbury to Norwich, Ipswich and the coastal towns beyond – Lowestoft/Great Yarmouth);
- Felixstowe-Ely-Nuneaton for freight; and
- Airport Connections (e.g. Luton Airport).

Key Drivers of the Case for the EWR-ES

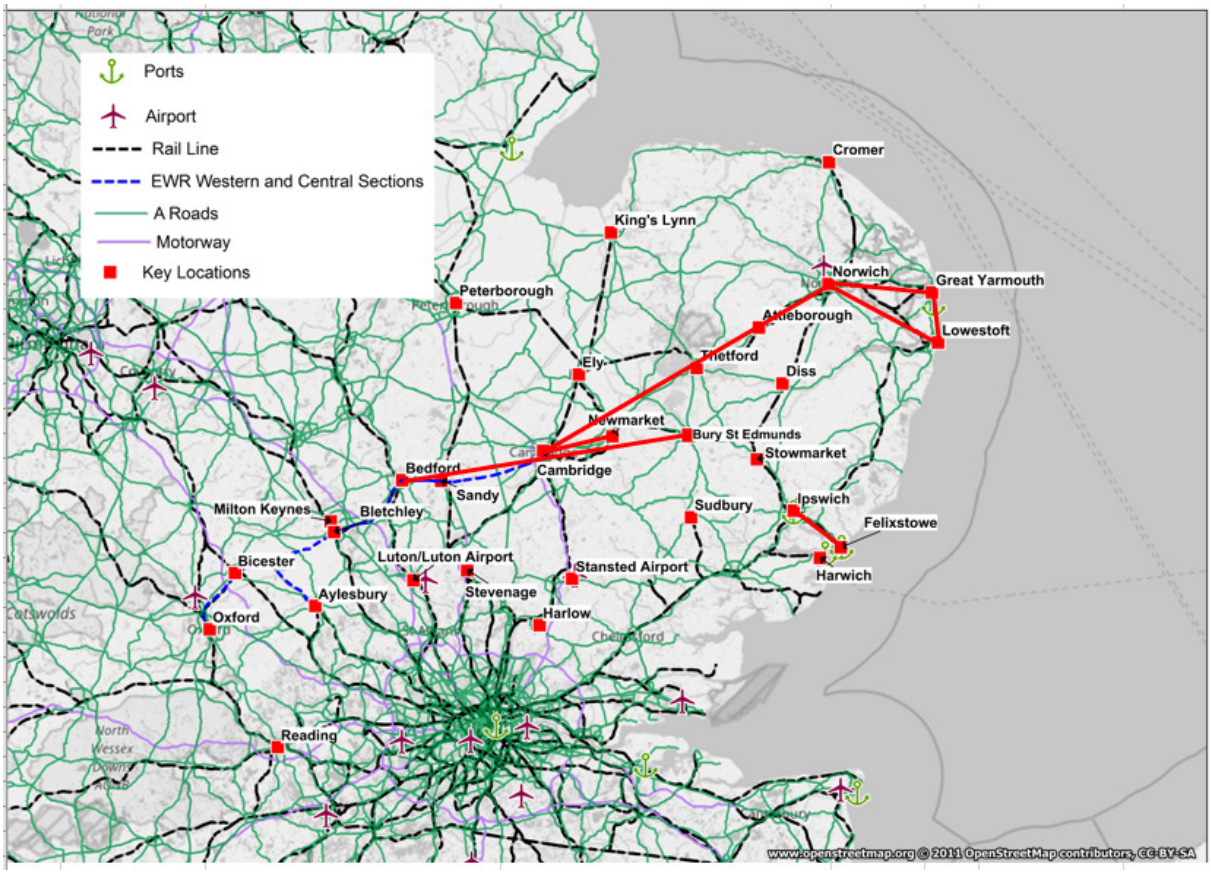
Local Commuters: There are key local markets that if better served by rail shift demand from car, reducing city centre congestion as people access employment areas via rail instead. Currently the vast majority of passenger journeys in the study area are relatively short in distance – up to 40 miles – and this would remain the case without any EWR interventions. Adding the EWR Western and Central sections leads to a

significant increase in longer distance trips, although shorter distance trips are still subject to the highest demand. The EWR-ES, in addition to the EWR Western and Central sections, leads to an increase in trips of all distances so short trips will be a key component of EWR-ES passenger journeys. Shorter distance priority trips are more focussed on commuting, which has a weighted average journey distance in 2031 of 35 miles. Key OD pairs for commuting include:

- Great Yarmouth – Norwich;
- Lowestoft – Norwich;
- Great Yarmouth – Lowestoft;
- Newmarket – Cambridge;
- Felixstowe – Ipswich;
- Cambridge – Norwich; and
- Bury St Edmunds – Bedford.

Figure E-8 below presents these OD pairs on a map of the study area:

Figure E-8 Key Commuting OD Pairs



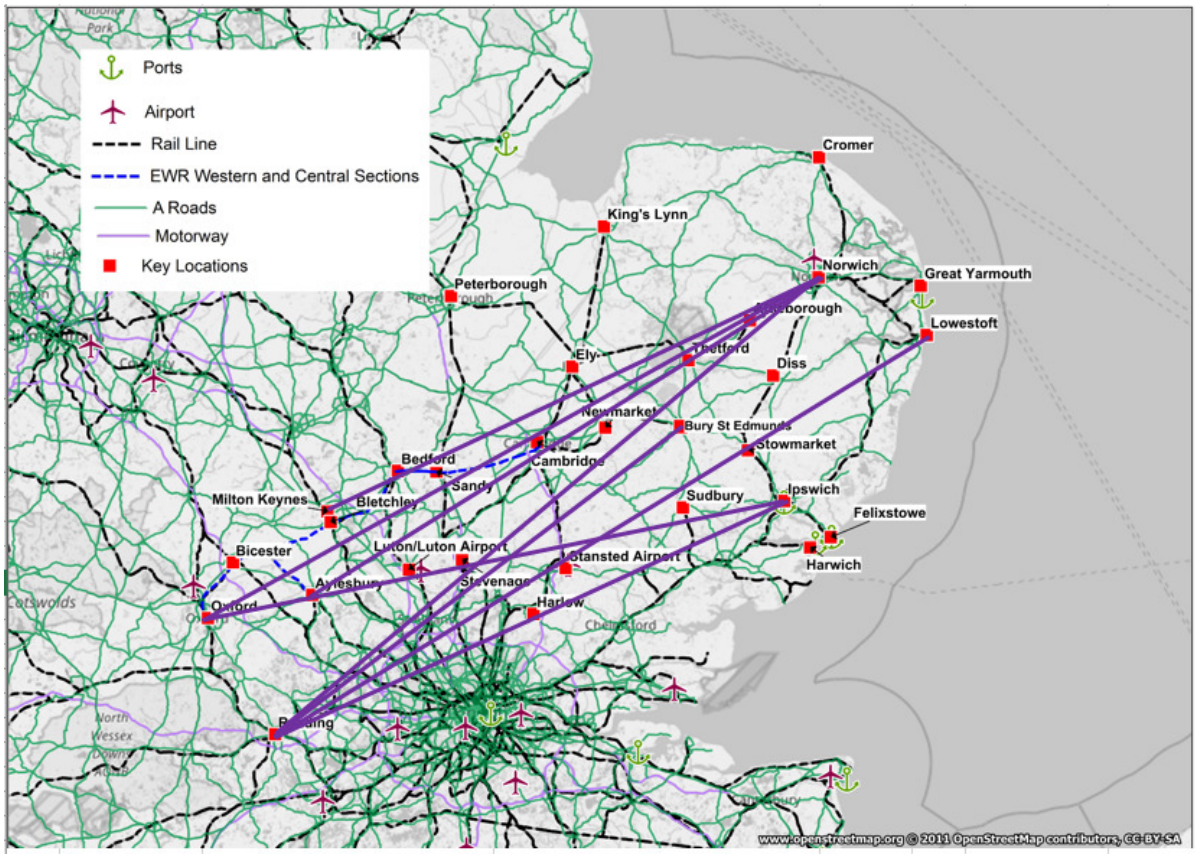
Long Distance Business and Leisure Journeys: Linking the EWR-ES to destinations and employment centres on the Central and Western sections, many of which provide an interchange with inter-regional routes, is a key driver of benefits. The introduction of the EWR Western and Central sections leads to a significant increase in longer distance trips. Furthermore, the EWR-ES leads to an increase in trips of all distances but the increase in demand is most significant for longer distance trips, such that long-distance trips become dominant. Longer distance trips are particularly valuable and are essential for the scheme – a large proportion of trips using EWR-ES will reach destinations on the Central and Western sections. Longer distance priority trips are more focussed on business and leisure travel, which have a weighted average journey distance in 2031 of 73 miles. Key OD pairs for business and leisure travel include:

- Norwich - Reading;
- Ipswich - Reading;
- Reading – Lowestoft;

- Reading – Bury St Edmunds;
- Norwich - Oxford;
- Norwich - Aylesbury;
- Ipswich – Oxford; and
- Norwich – Milton Keynes.

Figure E-9 below presents these OD pairs on a map of the study area:

Figure E-9 Key Business and Leisure OD Pairs



Based on latest EWR Central Section modelling assumptions and the findings of this study we can consider the journey time competitiveness of rail journeys between Norwich and Oxford/Reading for a route via London and a route along EWR. This gives an early indication of the attractiveness of EWR and the likelihood that it would be utilised for such strategic journeys.

Norwich – Oxford via EWR-ES will present a marked improvement over existing journeys via London, whilst Norwich – Reading via EWR-ES will be on-par with crossing London in terms of pure journey times, although the benefits of EWR-ES in terms of not requiring interchange and most likely lower fares would be substantial. This further strengthens the case for EWR-ES and means that journeys from East Anglia to the South West via EWR rather than via London become feasible. If Western Rail Access to Heathrow were to go ahead, this would also make Heathrow Airport accessible via EWR and an interchange at Reading rather than via London. Trips from Cambridge and Ipswich to Oxford would also be quicker via EWR than via London, although trips from Cambridge and Ipswich to Reading would still be quicker via London (albeit EWR could still be an appealing option for these trips given the lack of interchange required and most likely lower fares).

Freight: Additional routes and capacity are needed to accommodate forecast growth in freight movements, which will facilitate economic growth and also provide a competitive mode with road. EWR-ES has the opportunity to generate benefits by providing an onward route via Bury St Edmunds to Chippenham Junction to maximise the benefits of the already delivered Ipswich chord and also EWR-ES could facilitate an alternative route to the MML via Newmarket and Cambridge rather than Ely, adding capacity for freight.

Connectivity with Airports: As well as serving locations that offer interchanges with inter-regional rail routes, EWR could serve each of the four main London airports (Heathrow, Gatwick, Luton and Stansted) via a single interchange. With the exception of Gatwick (and assuming that Western Rail Access to Heathrow were to go ahead), these airports could be accessed without the need to travel via London. As such, international markets and opportunities would be brought in closer proximity to locations along the EWR route.

Operational and Infrastructure Constraints and Considerations for the Routes

The route options are conditional upon suitable infrastructure being provided to enable the target journey times, or times close to these, to be achieved. Our conditions also include a minimum 2 train per hour level of service. The cost of relieving the potential capacity and operational constraints will clearly drive the case for achieving the journey pairs, and in the next stage of scheme development beyond this project scope, these considerations will be joined up. Potential capacity and operational constraints and challenges to delivering the desired outputs vary by route option but an initial high level analysis has been carried out and is summarised below:

- The potential for the number of passenger train services per hour will be dependent on whether the route is double track (or more) or has any single line sections, such as between Cambridge and Chippenham Junction through Dullingham and Newmarket, and over Trowse Swing Bridge.
- There could be operational issues at any junction points with existing routes i.e. Great Eastern Main Line between Haughley Junction and Ipswich, and between Trowse Junction and Norwich, the Fen line between Cambridge and Ely, including the Ely area, approaches to Cambridge and platform capacity issues at Cambridge, which may or may not impact upon the EWR-ES scheme.
- There could be interactions with likely booked passenger and freight services already using the above routes, presenting limitations on new passenger train paths and / or timings, so there will need to be consideration of whether EWR-ES services can be combined with planned services on existing routes between Cambridge and Norwich / Ipswich.
- Likely new passenger service timings, achieved in combination with increasing service frequency on existing routes, will be dependent on whether a skip stop pattern is adopted (where intermediate calling points are shared between services) or a fast and slow pattern.
- Achieving improved passenger service timings on existing routes will be dependent on possible line speed improvements or additional infrastructure.
- Infrastructure upgrades on existing routes may be needed to limit operational risk and train path capacity constraints both for normal and perturbed train running.
- There could be issues with any of the level crossings on the existing routes between Cambridge and Norwich / Ipswich.

The **case for electrification** would be dependent on surrounding infrastructure. Electrification of the Central Section is desirable and if this were to materialise, there would be a strong case for electrifying the EWR-ES. It would make sense for services from the Central Section to continue as electric to avoid using somewhat expensive bi-modes (though bi-mode cost premium may now be lower than electrification).

At Norwich station, it may be more economical to operate as two independent cells rather than running services through Norwich. Services from Cambridge to Norwich are likely to be 4-car services, whereas services east of Norwich are likely to be a shorter formation. Keeping these separate also simplifies Norwich station workings, in that the station can operate as two independent cells, making it more operationally robust. There may need to be infrastructure investments at Cambridge and Ipswich station too. Another potential approach could be for services to split/join at Cambridge, with half going to/from Norwich and half to/from Ipswich.

Consideration should also be given to **line speeds that are achievable** on different sections of routes. For example, there may be opportunities to go above 80mph and even beyond 100mph, especially on the straight sections of track between Newmarket and Ipswich. Alternatively, there may be some sections of track where it may be necessary or advantageous in terms of reduced operating costs to run at lower speeds.

There could be issues with any of the **level crossings** on the existing routes between Cambridge and Norwich/Ipswich. A significant number of levels crossings were removed on the Western Section to enable increased line speeds. This would need to build on work carried out as part of the Anglia Level Crossings Programme with the EWR-ES acting as an incentive and catalyst for closures. Local perspectives and input

would be required to determine solutions that are safe. Sites within towns are likely to be the most troublesome. Removal of level crossings could also alleviate local issues associated with highway congestion, severance and air quality (e.g. Brandon).

Doubling the Ipswich to Felixstowe line – detailed options would need to be considered but this could take the form of a tram-train through the centre of Ipswich. The line east of Derby Road (approximately) would be doubled in the normal way, but the line between Westerfield and Derby Road includes a high viaduct and is in an urban setting so is difficult to double. One solution may be to reroute all passenger services through Ipswich town centre as tram-train, then the single line curve would be sufficient for freight.

The Conditional Outputs have led to the identification of **interventions across a wide area and including a number of discrete elements**. Ipswich – Felixstowe, for example, does not have any direct interaction with the other elements or with other sections of EWR. Especially if the tram-train is identified as a feasible solution to develop fully, it may be spun off into a separate project.

Network Rail's Anglia Route Strategy includes planned enhancements in terms of Trowse Swing Bridge doubling, level crossing closures, Felixstowe branch capacity enhancements, Ely North Junction and Haughley Junction doubling. EWR-ES could be the catalyst for these enhancements, serving as a **holistic route package with strategic services**.

Next Steps

The Conditional Outputs provide a robust evidence-based starting point for further EWR-ES scheme development activities. The work demonstrates that there are clear and strong strategic economic and transport drivers for scheme development, and that the potential scale of demand and benefits that EWR-ES could generate are significant enough to make presenting a viable and robust business case a realistic prospect since they are comparable with the other sections of EWR.

In terms of further activity beyond this study, we recommend the following next steps in the context of the COS generated above and with a view to creating options that are tested in cost-benefit terms and their ability to meet the scheme objectives and COS:

- Undertake a planning constraints analysis and operational deliverability appraisal of each EWR-ES Route Option to gauge achievable journey times and frequencies through an iterative process. Consider what land the railway already holds that could be used. If land acquisition is required, it can have significant impacts on the programme, costs, complexity and political sensitivity. Identify level crossings that should be removed as a priority task. Consider what enhancements are committed for the Do Minimum scenario, including what Digital Signalling could achieve in terms of the interaction of freight and passenger services. Questions around stabling would need to be considered with brownfield sites investigated.
- Progress with more detailed operational and early engineering feasibility design study to develop key operational and design outputs (alignments, realisable service performance parameters, indicative timetables, high level cost estimates etc), keeping the COS in mind and in order to support the production of a Business Case.
- Undertake the various technical analyses and assessments on feasibility designs necessary, including updated modelling and forecasting, environmental scoping level assessment and economic analysis and appraisal. Growth should capture both underlying trends and dependent development that would be unlocked by the scheme. There will be interdependencies between the EWR-ES and the Central and Western sections and the EWR-ES could enhance the case for these sections.
- Undertake holistic scheme planning in terms of electrification assumptions, rolling stock types and formations, traction power supply, optimum frequencies, line speeds, achievable journey times and the potential performance of proposed station stops compared to faster journey times of not stopping.
- Undertake optioneering, narrowing down to a preferred option based on cost-benefit analysis and consideration of the EWR-ES objectives and considering a wide variety of OD pairs inclusive of in-scope non-Conditional Output pairs. For infrastructure that is determined to be in-scope, consider whether additional services could be operated to realise benefits at low cost.
- Prepare and present the EWR-ES Strategic Outline or Outline Business Case in line with the DfT's Five Cases Model template.
- Continued stakeholder collaboration across relevant local authorities, LEPs, Network Rail, DfT and potentially Chambers of Commerce and passenger / freight operators and groups.

1. Introduction

1.1. Background to Study

The East West Rail Consortium (EWRC) have been promoting a scheme to establish a strategic railway connecting East Anglia with Central, Southern and Western England. The complete East West Rail (EWR) 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), which is the subject of this study.

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.

The Central Section of EWR will extend the Western Section of EWR east of Bedford to Cambridge. Within the overall scheme, this is the most difficult and costly part of the route to reinstate as the former railway has been dismantled and the land disposed of. The Consortium is now working with Network Rail to identify how the Central Section rail network may be enhanced to deliver new train services and connections across the region.

The existing railway east of Cambridge is extensively used by freight as well as providing passenger services, though there are opportunities to dramatically improve the railway connections as well as connecting into the rest of EWR to achieve long distance east-west movements. There were no direct passenger trains between Cambridge and Norwich until an hourly service was introduced in September 2002. In December 2004, the train operator, ONE, introduced an hourly service from Ipswich to Cambridge to reflect the increasing strategic importance of this rail corridor. Now that the Western and Central sections are progressing, it is time to focus on the Eastern Section of EWR (EWR-ES) and review what an EWR-ES scheme should aim to achieve and why.

The adopted New Anglia Local Enterprise Partnership (LEP) Strategic Economic Plan (SEP) states that, '**rail routes from Norwich and Ipswich to Cambridge and Peterborough are increasingly important for businesses. These require additional capacity to cater for our growing economy**'. The plan also highlights that '**connectivity and travel times are major obstacles to productivity**', and '**faster connections … are vital to improve productivity and access to markets**'.

EWR-ES has the potential to build on the rail connectivity brought about by the implemented and planned EWR Western Section and Central Section infrastructure, by enhancing journey times and frequency east of Cambridge to Norwich, Ipswich and beyond. The published New Anglia LEP prospectus for East Anglia, ***"Our Counties Connected"*** highlights the potential of EWR in this capacity, stating that:

'**The ultimate aim is to join up the cities of Bristol, Oxford, Milton Keynes, Bedford, Cambridge, Norwich and Ipswich and there are excellent economic benefits to connecting this series of important commercial and educational centres**.'

EWR-ES offers the potential to be a core ingredient of enhancing access from East Anglia to businesses and markets in Cambridge and beyond, and providing ample capacity for both passenger and freight traffic to unlock growth of the key local economic sectors identified in the Strategic Plan.

1.2. Strategic Objectives

The EWRC have developed a set of strategic objectives for EWR, which we have adapted specifically for the EWR-ES:

- Improve east west public transport connectivity;
- Increase economic growth, prosperity and employment within the East of England through improvements to east west rail links;
- Provide faster, more reliable and additional rail links from the west to Cambridge, Norwich, Ipswich and beyond;
- Improve journey times and reliability of inter-regional and commuter journeys;
- Increase capacity for inter-regional and commuter journeys;
- Maintain and enhance capacity for rail freight, especially from key ports; and
- Contribute to tackling climate change by removing traffic from congested inter-regional highway corridors.

These objectives will guide the creation of the Conditional Outputs for the EWR-ES based upon a detailed analysis of future housing and employment developments, population growth and journey patterns.

1.3. Purpose of a Conditional Outputs Statement (COS) and COS in the Context of the Scheme Development Process

Atkins has been commissioned to develop a Conditional Outputs Statement (COS) for the EWR-ES, which sets out what will be required to deliver the EWRC's Strategic Objectives and provide a clear guide for the development of future rail infrastructure and services. The purpose of this study is to assess and understand the economic drivers and linkages that will form the basis of a potential future business case for enhancing rail links to the east of Cambridge to improve connectivity to areas including Norwich and Ipswich. The COS therefore determines what the rail industry should aim to achieve from an EWR-ES scheme. These aims are based on a sound evidence base of the key economic and transport drivers for intervention looking forward, and a recognition of the key constraints and challenges that will need to be addressed, both now and in the future. The COS presents the key outputs that an EWR-ES scheme should deliver in terms of the key travel and traffic demands it should meet and the levels and characteristics of rail service performance it should offer. The COS provides the basis for the engineering feasibility assessments and design of potential solutions to deliver the Conditional Outputs, which would be undertaken as part of a separate project. It will eventually help set the context to ensure the scheme business case is optimised.

The Conditional Outputs provide a set of target service outcomes without consideration being given to feasibility, deliverability or the adoption of specific routes for new infrastructure that may need to be provided. The focus has been on identifying service performance outcomes that have the prospect of delivering significant economic benefits and supporting economic growth that subsequent phases of the study can consider the design, operational feasibility and cost implications of achieving. The purpose of this exercise is therefore to demonstrate the most valuable journey pairs. However, lower ranked journey pairs should not be ruled out altogether. Subsequent development of logical service propositions will assess how lower value pairs are deliverable amongst higher value pairs by understanding the trade-offs.

1.4. The Study Area

The study area for the EWR-ES Conditional Outputs was identified by considering:

- Key economic centres and growth locations east of Cambridge towards Norwich, Ipswich and beyond;
- Key locations on the EWR Western and Central sections; and
- Key locations on main inter-regional rail lines for interchange.

The New Anglia LEP SEP identifies key economic centres, links and growth locations. Key economic centres include Cambridge, Norwich, Ipswich and Peterborough. The A12, A47, A11 and A14 corridors are the key highway links in the region. Growth locations are located along the above corridors, plus the ports of Great Yarmouth, Lowestoft, Felixstowe and Harwich.

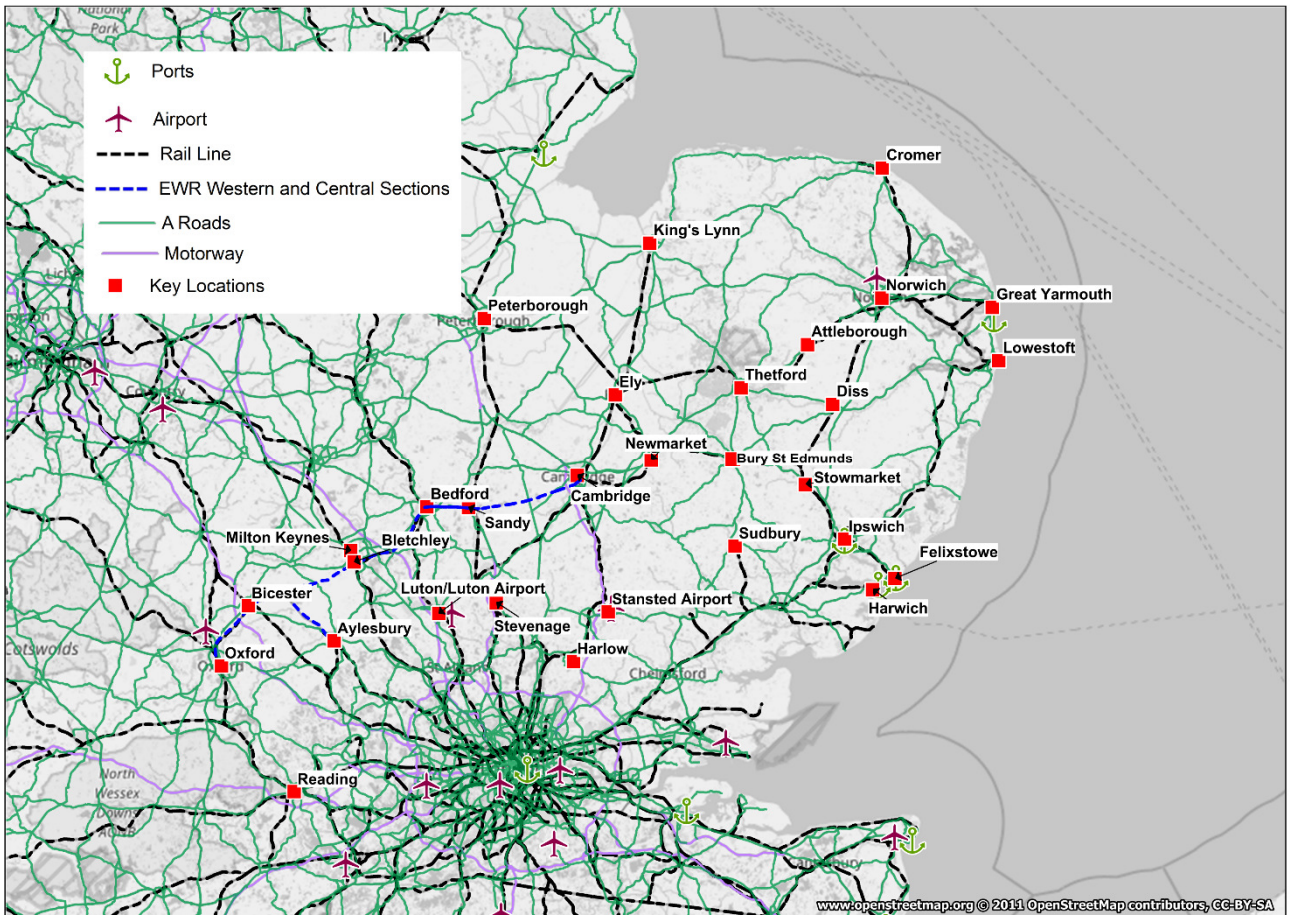
As well as serving short-distance trips within the region east of Cambridge, the EWR-ES could support long-distance trips by linking to areas on the EWR Western Section and EWR Central Section networks. Based on the proposed new passenger services on the EWR Western Section and the preferred corridor for the EWR Central Section, this brings all major locations along the EWR Western and Central Section corridor into the study area, from Reading to Cambridge, including Oxford, Aylesbury, Milton Keynes and Bedford.

Cambridge, Sandy and Bedford provide interchanges with the West Anglia Main Line, East Coast Main Line and Midland Main Line respectively. Further west, Milton Keynes provides an interchange with the West Coast Main Line and Reading provides an interchange with the Great Western Main Line. This underlines the importance of including these locations in the study area and also brings locations such as Peterborough, Stevenage, Harlow, Stansted Airport and Luton/Luton Airport into the study area.

Drawing all the above information together, a matrix of location pairs has been developed, which will form the basis of the evidence base analysis. There are a total of 30 locations in the study area.

Figure 1-1 shows the study area of key locations in relation to the road and rail networks, ports and airports.

Figure 1-1 EWR-ES Study Area



1.5. Study Approach

The COS captures and presents the evidence on drivers for change and intervention with respect to:

- Economic activity and growth, including trends in population and employment, employment sectoral make-up and labour market characteristics;
- Transport network efficiency and performance, including multi-modal comparisons, analysis on journey times and service frequency;
- Passenger travel demand; and
- Freight demand (particularly in the context of the strategic Felixstowe – Nuneaton freight route and traffic associated with the Haven ports).

These are all themes reflected in the EWRC's Strategic Objectives.

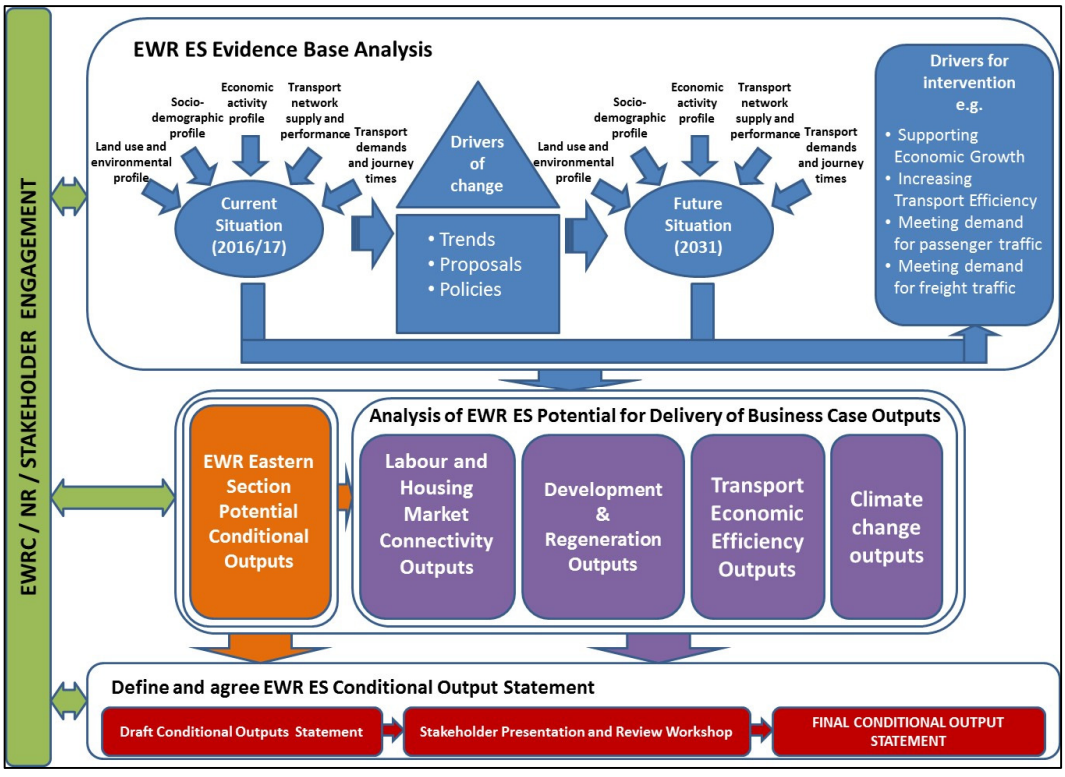
A key stage of the process towards the COS has been the distillation of the key drivers for intervention and translation of these into specific rail journey opportunities for consideration. This has involved bringing together and analysing the various strands of evidence. Key themes have been identified and primary challenges and opportunities have been identified that provide a convincing rationale for transport intervention. Analysis has been undertaken on a location and journey pair (OD Matrix) basis and has enabled locational opportunities in the form of stations and journeys to be ranked against a range of key characteristics.

The COS also indicates, based on analysis of the evidence base, the scope and potential for key business case outputs to be realised should an EWR-ES scheme be delivered – this as a precursor to any formal business case being developed. We have examined key areas that are consistent with both the EWRC's Strategic Objectives and the economic and VfM appraisal of major transport investments in keeping with WebTAG and major scheme appraisal guidance.

In addition, the COS ensures that potential constraints and challenges to delivering these outcomes are identified, understood and clearly presented. This includes how the existing rail network context may influence the definition of outputs. I.e. any new railway route that may be required would be constrained by where it links into the existing rail network.

Figure 1-2 below presents our approach to the development of the EWR-ES COS:

Figure 1-2 Approach to delivering a Conditional Outputs Statement for the EWR Eastern Section



2. Economic Analysis Evidence Base

2.1. National Context

Introduction

This section reviews the strategic role of EWR in terms of its ability to contribute to the UK's growth objectives. It focuses on the importance of delivering growth within the Greater South East, as well as the role improved connectivity can play in facilitating development.

Importance of Greater South East to the National Economy

The Greater South East[1] is the engine of the UK's high value innovation driven economy, having developed into an internationally focussed highly inter-dependent region defined by flows of people, goods, money and ideas. The increasing agglomeration of high-wage financial, business and professional services in Greater London and neighbouring parts of the Greater South East (GSE) undoubtedly confers major benefits – both nationally and regionally – as a result of highly productive, internationally competitive and vital export earning activities.

In 2010 Centre for Cities published a report, "***Private Sector Cities***", which looked at private sector jobs growth in cities between 1998 and 2008 and ranked cities as buoyant, stable or struggling based on their performance. It concluded that, while private sector jobs grew in cities across the country, the largest grouping of buoyant cities over that period, with growing economies and new private sector employment was in the GSE. The GSE cities created approximately 338,000 private sector jobs in the 10 years prior to the recession. This suggests that the future performance of GSE cities will be fundamental to the UK's future growth prospects.

Constraints to Growth

Despite continuing to outperform the rest of the UK, the GSE economy is starting to show signs of underperformance. More recently growth has been lower, with London now performing more strongly than the rest of the GSE.

The reasons for this relative dip in performance are complex. However, they partly relate to the fact that businesses are now increasingly looking to be located closer to other businesses, rather than being driven primarily by cost factors. The London Office Policy Review[2] sets out a number of reasons why office employment has declined in suburban office locations since the late-1980s:

Changes to property cost differential

A steep rental gradient from Central London in the past persuaded businesses to relocate to the GSE to reduce costs. This role of the GSE has been usurped by the emergence of campus-style schemes around the periphery of Central London, including Broadgate, London Bridge City, More London and Paddington: a new generation of high quality environments with better connectivity to the West End and City.

Changes to salary cost differential

In this too, the historic advantage of the suburbs has been upstaged. The Central London salary weighting has all but disappeared and back office functions are now more likely to be relocated to Bangalore or Glasgow than the GSE as advances in technology have eroded the need of physical proximity.

Changing work styles

Work styles have changed dramatically in response to technology and business priorities. One symptom of this is the virtual disappearance of the typing pool and large clerical, back office functions, staples of the suburban office market. Many such jobs have simply disappeared.

Outmoded physical environment

The environmental quality of some locations is tired and poorly maintained, with office accommodation and other employment premises ill-suited to modern business needs, often due to being provided as lip service to planning requirements.

These structural changes can be illustrated by the fact that, whereas 20 years ago, Microsoft decided to base themselves in the Thames Valley, Google have now decided to locate their UK HQ at Kings Cross. In

[1] Defined as the East, South East and London regions
[2] London Office Policy Review 2012: Ramidus Consulting Ltd for GLA

short, connectivity is a hugely significant factor in locational decisions made by high value growth sectors (explored further below).

A further potential constraint to growth is the lack of housing supply, with a shortage of sites for new housing pushing prices up and workers out, as well as preventing workers from moving to the GSE from other parts of the country. House prices have continued to rise, with levels of affordability across the GSE now at record lows in some areas. This is particularly an issue in Cambridge and so is especially relevant to the EWR-ES.

Importance of Connectivity to Growth

Transport matters for the GSE region. More people commute to work, and travel further to do so, than anywhere else in the UK. The region therefore has a particularly high dependence on efficient road and rail connections, and any problems with transport infrastructure often have multiplied economic costs for the UK as a whole[3].

Knowledge driven economies operate with numerous systems including those of innovation, venture capital provision and the development of highly qualified labour. Connectivity both within and between these systems is therefore critically important to system functioning. Connectivity takes many forms including physical road, rail and air connections, electronic telecommunications, and business networks. Further analysis of the academic literature on the relationship between connectivity and development is set out below.

Commercial and Retail Development

Public transport use tends to lead to a concentration of economic activity in core areas served by its stops or stations[4]. This concentration of economic activity has been demonstrated as a key driver of economic development and innovation in economic cluster theory. Concentrated economic activity (in its widest sense) also brings a degree of 'buzz' to an area, enhancing its image and leading to further investment, so starting a virtuous circle.

However, this concentration of development is not facilitated by public transport alone. Hall and Marshall[5] noted two particularly important contextual items regarding the impact of transport investment on development in general: the general economic situation and the regulatory context. It has been found that infrastructure investment has led to land use development in buoyant economic contexts, and that public transport-led development in particular had tended to flourish where planning policy favoured public transport orientated development and restricted car orientated development.

Walmsley and Perrett[6] state that public transport systems had the greatest effect on development where there was a long process of urban planning in conjunction with the rail system. There is a risk that developers will not make the most of the increased accessibility unless they are given a planning framework to work within and incentives to do so.

Of course, the accessibility improvements facilitated by transport investment are a critical factor in the eventual impact on development. Ryan[7] notes that it is where time savings are noted that increases in property values are likely to accrue. In other words, if the change in accessibility is sufficiently large (e.g. new metro in poor public transport area) then palpable time savings will be made (by at least some sectors of the population who would use the system). Whereas a public transport investment that hardly changed travel times to any significant degree would not expect to see so much impact.

A study into the potential property impacts of Crossrail[8] estimated that:

- Commercial office values around Crossrail stations in central London will increase due to Crossrail over the next decade, with an uplift of 10 per cent in capital value above a rising baseline projection.

[3] East-West Rail: The Economic Case for Investment – Oxford Economics
[4] Siraut, J: Economic and regeneration impacts of Croydon Tramlink in Urban Transport X
[5] Hall, P & Marshall S (2000): Report on Transport and Land Use/Development for Independent Transport Commission, cited in RICS: Land Value and Public Transport: Stage 1 Report
[6] Walmsley, D & Perrett, K: The Effects of Rapid Transit on Public Transport and Urban Development, cited in RICS: Land Value and Public Transport: Stage 1 Report
[7] Ryan, S. Property Values and Transport Facilities: Finding the Transportation-Land Use Connection, cited in RICS: Land Value and Public Transport: Stage 1 Report
[8] Crossrail Property Impact Study 2012, GVA Grimley

- Urban realm improvements and the development of new schemes above Crossrail stations will act as a highly visible and beneficial driver for further development activity. Crossrail will have a transformative effect on the property market and development activity over time.

Residential Development

Siraut[9] notes that land accumulation for private residential redevelopment is difficult and this tends to limit such development along the route of new transit systems especially where the system is a conversion of an existing heavy rail route serving well established localities, for example, Tyne & Wear Metro and the first section of the Manchester Metrolink. Where there is space available for development, for example, Don Valley in Sheffield, Beckton on the Docklands Light Railway and Salford Quays on Manchester Metrolink extensions, new residential development has been facilitated. In North America, where land tends to be more readily available there have been numerous examples of high density residential development being attracted to transit served locations.

A Study by RICS[10] notes that there are many factors that influence property prices of which transport is just one. Access to open space and the quality of local schools can impact house prices by as much as local transport accessibility.

The Role of East West Rail

Drawing upon the above, we estimate that EWR will contribute to the following at a national level:

It will help to unlock higher levels of housing growth that is urgently required in the GSE.
It will do this by making town centre locations (and other areas with new stations, if developed) more attractive to residential development as a result of their improved connectivity. The impact is likely to be variable at each station location depending on the change in connectivity expected.
It will help to alleviate labour market constraints in the South East by expanding the size of the potential labour force within an acceptable commuting period. This may have the effect of making some locations more attractive for commercial development, bringing forward additional jobs at some locations.
It will help to drive agglomeration benefits at key high value clusters by bring businesses closer to each other, thereby increasing business growth in key sectors vital for the UK.
It will reinforce the image of the 'Golden Triangle' as being a coherent economic entity and could attract further inward investment to key locations along the route.
It will help to rebalance some of the growth away from the London economy, which is subject to its own labour market and congestion constraints, towards a series of locations in the GSE where there is space to grow.

2.2. Regional and Sub-Regional Context

Introduction

This section reviews the growth aspirations within the East of England region and along the East West Rail route to understand how improved rail links might benefit the study area.

East of England Forecasting Model

The East of England Forecasting Model (EEFM) is prepared by independent forecasting house Cambridge Econometrics, who produce economic forecasts for the East of England region. This dataset has been analysed to identify key locations that will drive potential rail demand. The EEFM covers all local authorities in the East of England region and has been filtered to authorities in the study area. The dataset comprises actual annual data to 2016 then annual forecasts to 2045. The latest data available at the time of carrying out the analysis have been used here. For Oxford and Reading, which fall outside the geographic scope of the EEFM, supplementary data from the ONS and NOMIS have been acquired. Economic forecasts should be treated as broadly indicative due to the inherent uncertainties of long-term forecasting and the limitations of providing forecasts at the local level.

For the East of England region as a whole, net inward migration in 2016 was 36,000. This is predicted to drop to approximately 27,600 by 2019 and then remain stable until the end of the forecast period (2045). Between 2016 and 2045 the top sectors for employment growth are anticipated to be Real Estate (1.7%),

[9] Siraut, J: Economic and regeneration impacts of Croydon Tramlink in Urban Transport
[10] RICS Policy Unit: Land value and public transport: Stage two – summary of findings

Accommodation and Food Services (1.3%) and Business Services (1.2%). The worst performing sectors for employment growth are forecast to be Mining and Quarrying (-3.8%), Chemical Manufacturing (-3.3%) and Electronic Manufacturing (-3.3%). In real numbers the largest employment sectors will continue to be Health and Care (488,500), Retail (346,300), Construction (303,500) and Professional Services (300,900). Employment is expected to grow by 1% until 2031, before falling to near current levels of 69.1%. Sectors predicted to drive GVA growth over the forecast period are Professional Business Services, IT and Communications and Other Business Services. The GVA per capita in the East of England region in 2016 was £20,700 (2011 prices), below the national average of £22,500. Hertfordshire is the only LEP area in the East of England which outperforms the UK average.

In terms of population growth, Milton Keynes has experienced population growth beyond any of the other local authority areas over the period 2001-2016, closely followed by Peterborough and Uttlesford. This strong growth is predicted to continue to 2031, outperforming other areas identified with growth hubs. East Cambridgeshire, Ipswich, Cambridge, Peterborough, South Norfolk and South Cambridgeshire are also expected to see strong growth above the regional and national average during the forecast period. North Norfolk, Waveney, Broadland, Babergh, Harlow and Epping Forest are anticipated to see the lowest level of % change population growth in the study area.

Figure 2-1 below presents population growth by authority for 2001-2016 and forecast growth for 2016-2031:

Figure 2-1 Population Growth 2001-2031

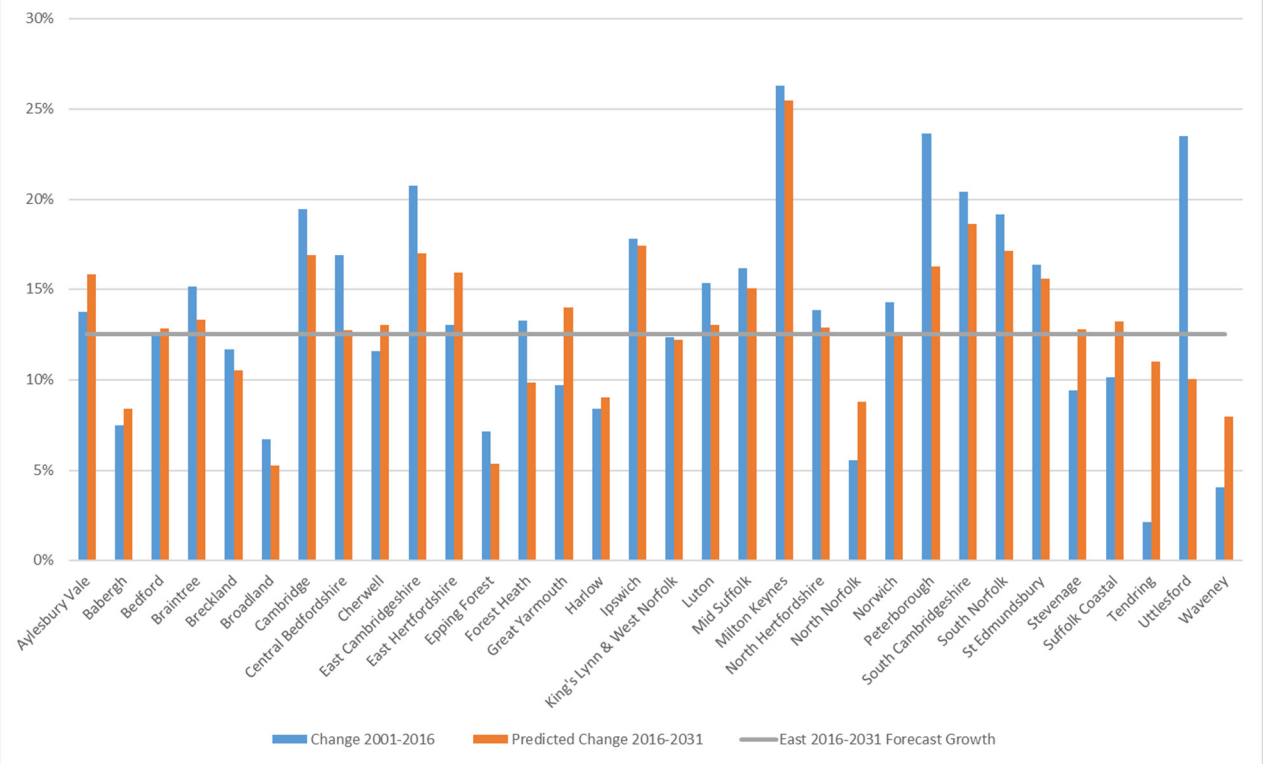
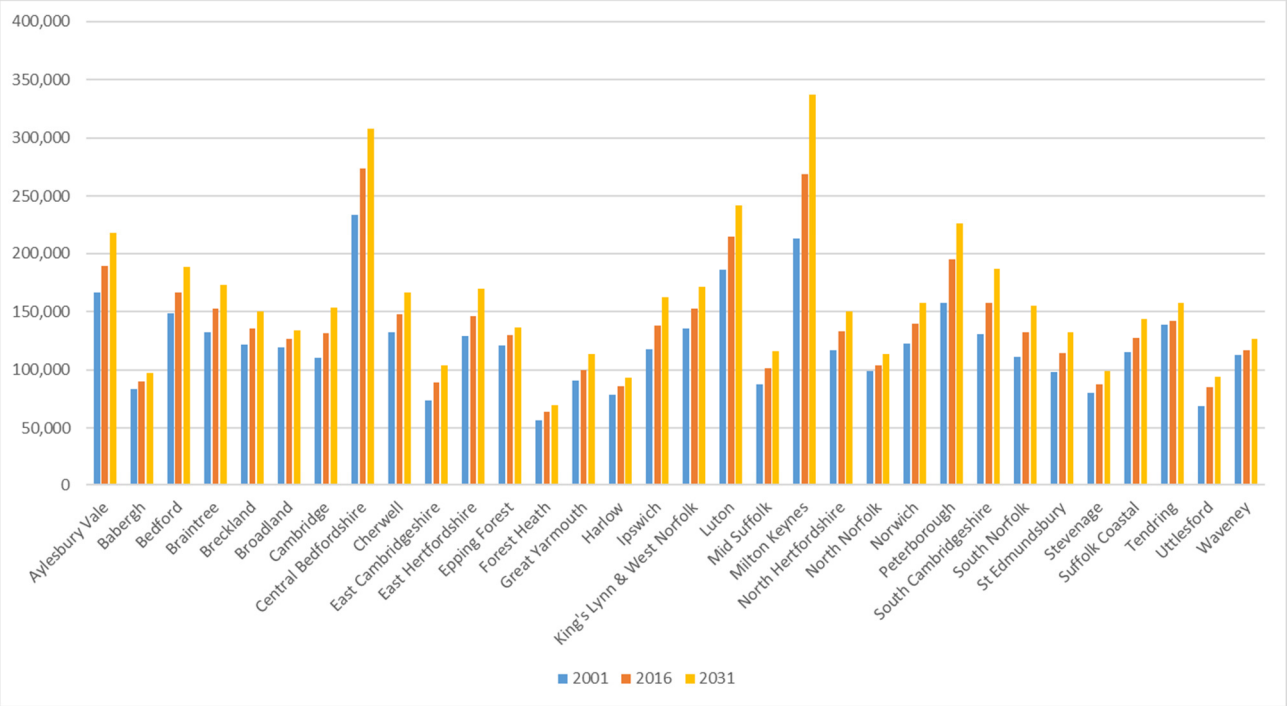


Figure 2-2 below presents absolute population by authority for 2001, 2016 and 2031. Key locations for labour supply are identified as Milton Keynes, Central Bedfordshire, Aylesbury Vale, Peterborough and Luton.

Figure 2-2 Absolute Population



In terms of employment growth, East Cambridgeshire (56%) and South Norfolk (59%) saw exceptionally strong employment growth over the period 2001-2016. Both these areas will continue to grow but at a significantly reduced rate. Ipswich and Milton Keynes are forecast to have the strongest employment growth between 2016 and 2031. Aylesbury Vale, Milton Keynes and St Edmundsbury are projected to continue to have stronger employment growth than national and regional averages. Ipswich, Norwich, Cambridge and East Hertfordshire are expected to move from average or below average growth rates (2001-2016) to among the highest projected growth rates over the forecast period.

Figure 2-3 below presents employment growth by authority for 2001-2016 and forecast growth for 2016-2031:

Figure 2-3 Employment Growth 2001-2031

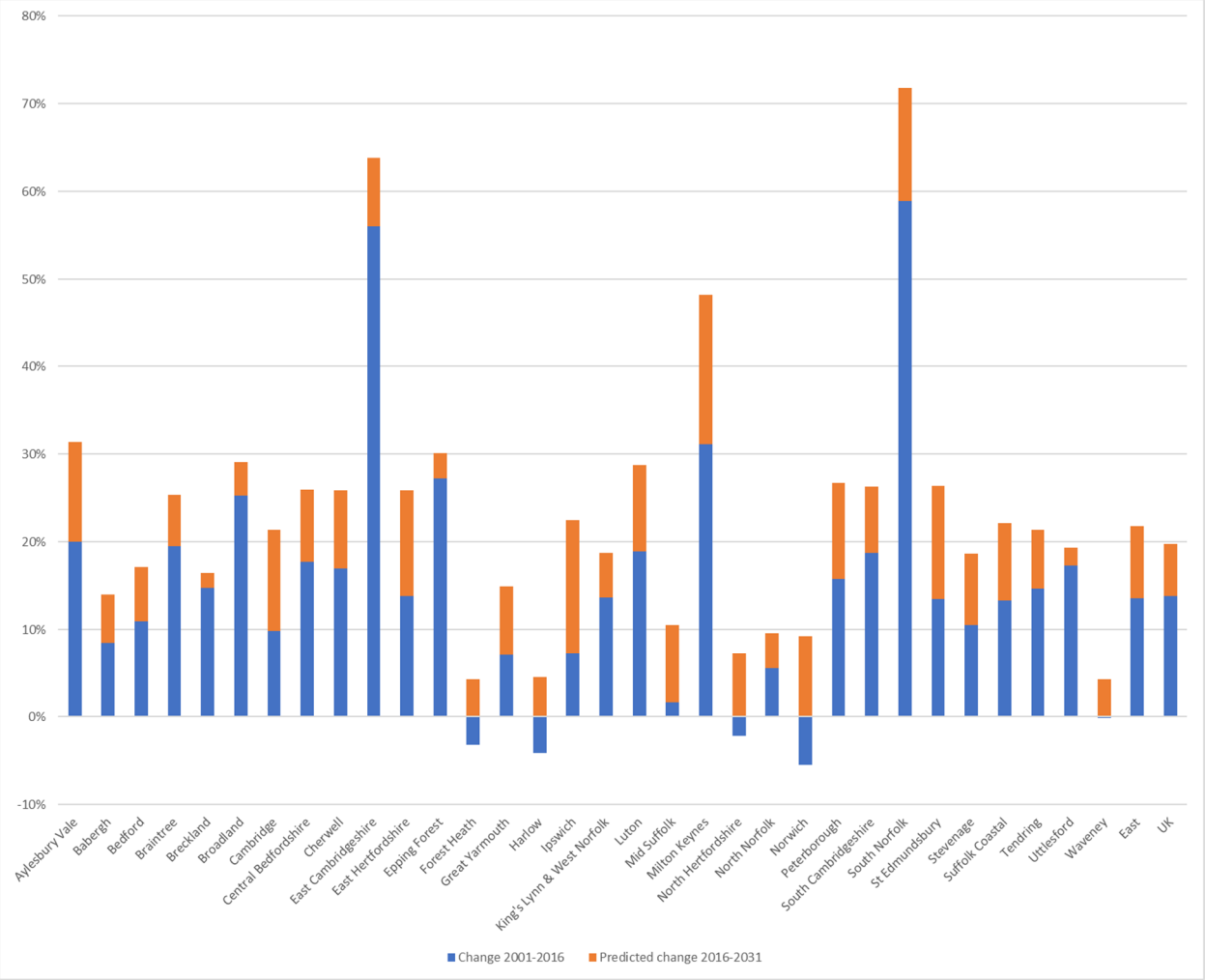
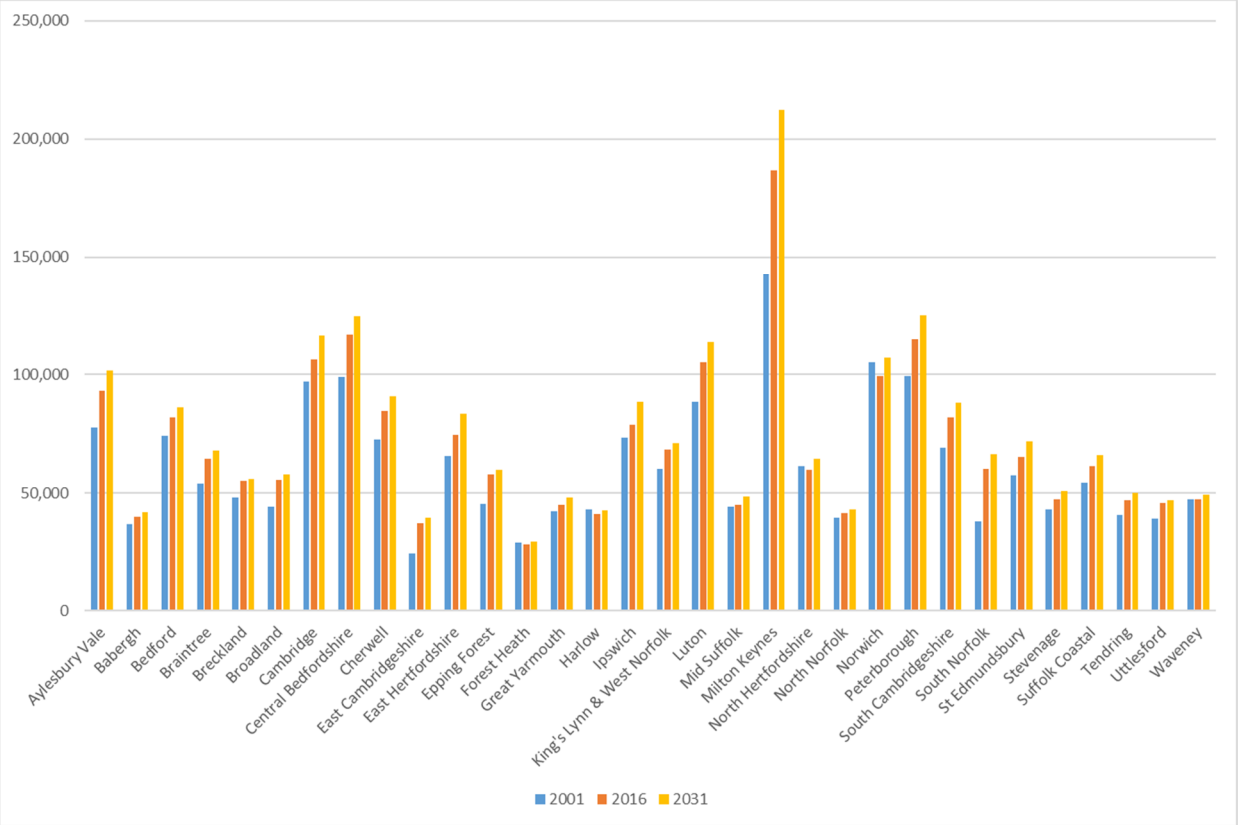


Figure 2-4 below presents absolute employment by authority for 2001, 2016 and 2031. Key locations for employment mass are identified as Milton Keynes, Peterborough, Central Bedfordshire, Cambridge, Luton, Aylesbury Vale and Norwich.

Figure 2-4 Absolute Employment



In addition to locations with high population and employment, EEFM data have been used to identify locations of high output (measured by Gross Value Added, GVA) and labour productivity.

Figures 2-5 to 2-7 present GVA, GVA per capita and labour productivity by authority:

Figure 2-5 GVA by Local Authority

	GVA total £m 2011 prices				
Area	**2001**	**2008**	**2016**	**2031**	**2045**
Aylesbury Vale	2,946	3,420	3,923	5,422	7,217
Babergh	1,215	1,271	1,358	1,816	2,298
Bedford	2,731	3,111	3,422	4,382	5,476
Braintree	1,810	2,271	2,613	3,445	4,409
Breckland	1,644	1,773	1,873	2,314	2,862
Broadland	1,355	1,948	2,378	3,090	3,835
Cambridge	3,814	4,259	4,536	6,003	7,792
Central Bedfordshire	3,869	4,212	5,033	6,604	8,397
Cherwell	2,633	3,328	3,816	5,176	6,818
East Cambridgeshire	789	1,120	1,349	1,806	2,371
East Hertfordshire	2,820	3,618	3,616	4,684	5,968
Epping Forest	1,592	2,061	2,262	2,858	3,430
Forest Heath	919	959	1,002	1,257	1,556
Great Yarmouth	1,392	1,407	1,650	2,112	2,689
Harlow	1,605	2,371	1,845	2,372	3,042
Ipswich	2,515	3,143	3,172	4,410	5,857
King's Lynn & West Norfolk	2,033	2,172	2,515	3,320	4,245
Luton	4,001	4,465	5,235	6,841	8,834
Mid Suffolk	1,472	1,625	1,685	2,281	2,922
Milton Keynes	6,608	8,071	10,448	15,053	20,916
North Hertfordshire	2,406	2,145	2,539	3,386	4,409
North Norfolk	1,192	1,171	1,341	1,758	2,236
Norwich	3,727	3,886	3,662	4,825	6,105
Peterborough	3,585	4,487	4,771	6,453	8,358
South Cambridgeshire	2,928	4,346	4,796	6,194	7,784
South Norfolk	1,327	1,971	2,277	3,114	4,208
St Edmundsbury	1,913	2,193	2,506	3,433	4,587
Stevenage	1,730	2,040	2,324	3,122	4,053
Suffolk Coastal	2,156	2,544	2,726	3,721	4,913
Tendring	1,242	1,453	1,614	2,143	2,765
Uttlesford	1,919	2,003	2,356	3,054	3,916
Waveney	1,408	1,542	1,610	2,121	2,737
East	100,791	117,375	126,598	166,687	213,455
UK	1,174,167	1,360,073	1,474,904	1,938,127	2,505,301

Figure 2-6 GVA per capita by Local Authority

GVA per capita (£) per head of population					
Area	**2001**	**2008**	**2016**	**2031**	**2045**
Aylesbury Vale	17,757	20,041	20,789	24,811	29,948
Babergh	14,541	14,566	15,121	18,655	22,451
Bedford	18,440	20,181	20,550	23,319	26,829
Braintree	13,659	15,781	17,129	19,925	23,406
Breckland	13,518	13,754	13,790	15,419	17,884
Broadland	11,401	15,784	18,759	23,148	28,029
Cambridge	34,688	36,654	34,539	39,118	45,415
Central Bedfordshire	16,534	16,914	18,405	21,426	25,086
Cherwell	19,945	23,869	25,918	31,107	37,949
East Cambridgeshire	10,750	13,819	15,217	17,412	20,521
East Hertfordshire	21,834	26,834	24,769	27,680	31,747
Epping Forest	13,160	16,707	17,456	20,923	24,483
Forest Heath	16,375	16,684	15,751	18,000	20,957
Great Yarmouth	15,311	14,668	16,535	18,576	21,507
Harlow	20,364	29,673	21,603	25,475	30,785
Ipswich	21,471	24,673	22,975	27,203	32,406
King's Lynn & West Norfolk	14,994	14,922	16,515	19,434	22,937
Luton	21,524	23,243	24,418	28,226	33,523
Mid Suffolk	16,911	17,182	16,673	19,618	22,759
Milton Keynes	31,068	34,253	38,894	44,660	52,912
North Hertfordshire	20,554	17,245	19,061	22,516	26,991
North Norfolk	12,105	11,603	12,899	15,539	18,724
Norwich	30,457	30,351	26,193	30,650	35,987
Peterborough	22,772	25,492	24,506	28,518	33,479
South Cambridgeshire	22,439	30,268	30,525	33,221	36,999
South Norfolk	11,971	16,597	17,236	20,121	24,281
St Edmundsbury	19,454	20,408	21,910	25,977	31,330
Stevenage	21,682	25,000	26,622	31,701	37,753
Suffolk Coastal	18,712	20,541	21,484	25,897	31,302
Tendring	8,944	10,350	11,389	13,626	16,334
Uttlesford	27,830	26,527	27,660	32,574	39,354
Waveney	12,517	13,260	13,754	16,780	20,770
East	18,663	20,562	20,706	24,231	28,627
UK	19,863	21,999	22,493	27,028	32,941

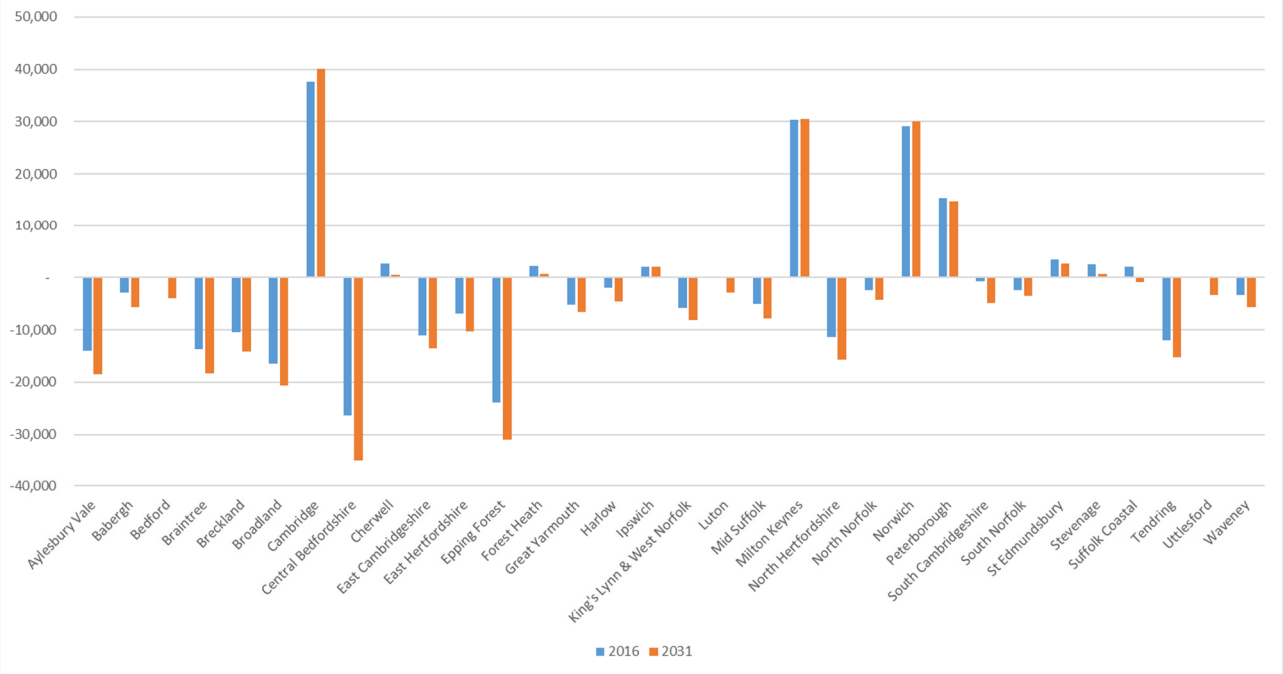
Figure 2-7 Labour Productivity by Local Authority

Labour productivity (£ per job)					
Area	**2001**	**2008**	**2016**	**2031**	**2045**
Aylesbury Vale	37,883	39,570	42,032	52,182	63,567
Babergh	32,933	32,637	33,912	42,994	52,886
Bedford	36,903	37,863	41,691	50,264	59,919
Braintree	33,617	37,270	40,631	50,574	62,056
Breckland	34,077	34,922	33,837	41,083	49,510
Broadland	30,478	37,990	42,721	53,481	65,994
Cambridge	39,312	44,093	42,575	50,530	59,899
Central Bedfordshire	39,013	40,169	43,111	52,275	62,233
Cherwell	36,330	41,651	45,044	56,090	69,550
East Cambridgeshire	32,982	35,795	36,133	44,856	55,026
East Hertfordshire	43,031	52,368	48,477	56,048	65,037
Epping Forest	34,880	38,004	38,963	47,832	57,181
Forest Heath	31,328	35,319	35,253	42,435	50,998
Great Yarmouth	33,019	32,960	36,551	43,388	51,906
Harlow	37,314	49,804	44,776	55,102	68,248
Ipswich	34,224	40,390	40,241	48,546	58,210
King's Lynn & West Norfolk	33,770	34,130	36,773	46,198	56,518
Luton	45,135	46,501	49,669	59,095	69,533
Mid Suffolk	33,091	38,308	37,287	46,339	55,468
Milton Keynes	46,442	50,220	55,987	68,879	83,588
North Hertfordshire	39,265	37,764	42,360	52,659	66,111
North Norfolk	30,125	30,412	32,119	40,467	50,512
Norwich	35,420	37,917	36,825	44,414	52,784
Peterborough	36,103	39,522	41,479	50,589	60,261
South Cambridgeshire	42,409	56,087	58,497	70,251	82,906
South Norfolk	34,983	37,390	37,761	45,743	55,252
St Edmundsbury	33,205	36,389	38,332	46,519	56,204
Stevenage	40,181	44,537	48,857	60,661	74,159
Suffolk Coastal	39,749	44,917	44,330	55,635	68,572
Tendring	30,387	31,718	34,445	42,894	52,985
Uttlesford	48,982	46,088	51,276	65,087	82,378
Waveney	29,601	31,762	33,891	42,806	54,397
East	37,654	40,908	41,644	50,666	61,017
UK	39,314	42,383	43,369	53,813	66,252

The locations of high GVA and labour productivity are largely consistent with the locations of high population and employment, however Harlow, Stevenage, Suffolk Coastal, Bury St Edmunds, South Cambridgeshire and Uttlesford emerge as further key locations based on high output/productivity.

Finally, EEFM data has been used to identify key commuting patterns in the study area. Figure 2-8 presents net commuting patterns by authority for 2016 and 2031:

Figure 2-8 Net Commuting by Local Authority



Cambridge, Milton Keynes, Norwich and Peterborough see net inward commuting patterns, whilst Aylesbury Vale, Central Bedfordshire, Breckland, Broadland, East Cambridgeshire, Braintree, Epping Forest, North Hertfordshire and Tendring have the greatest number of out-commuters.

Population and Employment Rankings

Based on the population and employment data from the EEFM, rankings have been produced for 2016 and 2031 to give an indication of the key locations that drive demand in the study area. Enhanced connectivity between such locations through the EWR-ES could facilitate economic growth. Figures 2-9 and 2-10 present the local authority rankings in terms of absolute population and employment in 2016 and 2031.

Figure 2-9 2016 Absolute Population and Employment Rankings

Ranking	2016 Absolute Population (000s)	Ranking	2016 Absolute Employment (000s)
1	Central Bedfordshire	1	Milton Keynes
2	Milton Keynes	2	Central Bedfordshire
3	Luton	3	Peterborough
4	Peterborough	4	Cambridge
5	Aylesbury Vale	5	Luton
6	Bedford	6	Norwich
7	South Cambridgeshire	7	Aylesbury Vale
8	Braintree	8	Cherwell
9	King's Lynn & West Norfolk	9	Bedford
10	Cherwell	10	South Cambridgeshire
11	East Hertfordshire	11	Ipswich
12	Tendring	12	East Hertfordshire
13	Norwich	13	King's Lynn & West Norfolk
14	Ipswich	14	St Edmundsbury
15	Breckland	15	Braintree
16	North Hertfordshire	16	Suffolk Coastal
17	South Norfolk	17	South Norfolk
18	Cambridge	18	North Hertfordshire
19	Epping Forest	19	Epping Forest
20	Suffolk Coastal	20	Broadland
21	Broadland	21	Breckland
22	Waveney	22	Stevenage
23	St Edmundsbury	23	Waveney
24	North Norfolk	24	Tendring
25	Mid Suffolk	25	Uttlesford
26	Great Yarmouth	26	Mid Suffolk
27	Babergh	27	Great Yarmouth
28	East Cambridgeshire	28	North Norfolk
29	Stevenage	29	Harlow
30	Harlow	30	Babergh
31	Uttlesford	31	East Cambridgeshire
32	Forest Heath	32	Forest Heath

Figure 2-10 2031 Absolute Population and Employment Rankings

Ranking	2031 Absolute Population (000s)	Ranking	2031 Absolute Employment (000s)
1	Milton Keynes	1	Milton Keynes
2	Central Bedfordshire	2	Peterborough
3	Luton	3	Central Bedfordshire
4	Peterborough	4	Cambridge
5	Aylesbury Vale	5	Luton
6	Bedford	6	Norwich
7	South Cambridgeshire	7	Aylesbury Vale
8	Braintree	8	Cherwell
9	King's Lynn & West Norfolk	9	Ipswich
10	East Hertfordshire	10	South Cambridgeshire
11	Cherwell	11	Bedford
12	Ipswich	12	East Hertfordshire
13	Norwich	13	St Edmundsbury
14	Tendring	14	King's Lynn & West Norfolk
15	South Norfolk	15	Braintree
16	Cambridge	16	South Norfolk
17	North Hertfordshire	17	Suffolk Coastal
18	Breckland	18	North Hertfordshire
19	Suffolk Coastal	19	Epping Forest
20	Epping Forest	20	Broadland
21	Broadland	21	Breckland
22	St Edmundsbury	22	Stevenage
23	Waveney	23	Tendring
24	Mid Suffolk	24	Waveney
25	Great Yarmouth	25	Mid Suffolk
26	North Norfolk	26	Great Yarmouth
27	East Cambridgeshire	27	Uttlesford
28	Stevenage	28	North Norfolk
29	Babergh	29	Harlow
30	Uttlesford	30	Babergh
31	Harlow	31	East Cambridgeshire
32	Forest Heath	32	Forest Heath

For Oxford and Reading, which are outside the scope of the EEFM, an evidence base has been sourced from the ONS and NOMIS databases. In 2015 Oxford had a population of 159,574 while Reading had a population of 161,739. Between October 2015 and September 2016, employment in Oxford was 89,900 while employment in Reading was 86,400. Based on these metrics, Oxford and Reading are similar in scale to Norwich and Ipswich.

Core Strategies/Local Plans/LEP SEPs

A review of Local Plan documents and LEP SEPs has been carried out to further understand key growth areas as well as identify economic and housing projections. Key data taken includes target new job growth, predicted population growth and target number of houses in plan period. These data are presented and discussed in section 2.3. These may contain elements of optimism bias and are aspirational targets. The key strategic growth areas identified in Local Plans and SEPs were used to validate growth locations identified through the EEFM study. These were broadly in line with the EEFM data with substantial growth in Cambridge, Ipswich and Milton Keynes.

Key aspirational employment growth sectors identified in SEPs included Advanced Manufacturing, Aerospace Engineering, Civil Aviation, Agri-tech, Biosciences, Life Sciences and Pharmaceuticals, Energy, Offshore Renewable Engineering and Digital Creative. Trends in the study area follow UK trends with growth anticipated in the Real Estate, Professional Services, Arts and Entertainment, and Information and Communication sectors. Manufacturing and Public Administration are expected to see stagnation and decline across most of the East of England. However, some manufacturing sub-sectors are likely to continue to perform well.

Greater Norwich has a strong position in Life and Environmental Science, Technology and Manufacturing, and has ambitions to deliver 1,000 jobs in these sectors and develop a Digital Creative cluster. A Civil Aviation cluster is emerging around Norwich International Airport. Greater Ipswich is one of the faster growing towns in the country but has a relatively low-wage and low-skill economy. Lowestoft and Great Yarmouth are the main centres for Offshore Renewables and support a growing number of Energy sector jobs and in combination are a designated Enterprise Zone. The coastal towns also have a large tourism and leisure sector. Felixstowe is home to the UK's largest container port, handling 44% of national container traffic, and capacity is expected to grow by an additional million containers by 2025.

There is an opportunity for rail to improve connectivity between complementary locations in terms of industrial composition and to serve a range of demand markets.

English Indices of Deprivation 2015

The English Indices of Deprivation (2015) identify locations that suffer from income, employment, education, health, housing or environmental deprivation. More deprived areas would benefit more from regeneration, which could be driven by enhanced connectivity. Figure 2-11 presents local authorities in the study area, ranked according to their Index of Multiple Deprivation.

Figure 2-11 Index of Multiple Deprivation by Local Authority

Local authority	Index of Multiple Deprivation rank (1 = most deprived, 326 = least deprived)
Great Yarmouth	29
Luton	40
Norwich	47
Tendring	49
Peterborough	58
Harlow	71
Ipswich	74
King's Lynn and West Norfolk	89
North Norfolk	93
Waveney	95
Breckland	129
Stevenage	137
Forest Heath	140
Bedford	154
Milton Keynes	181
St Edmundsbury	196
Braintree	197
Epping Forest	199
Babergh	200
Cambridge	227
South Norfolk	229
Mid Suffolk	239
Suffolk Coastal	240
East Cambridgeshire	255
Cherwell	256
Central Bedfordshire	264
North Hertfordshire	271
Broadland	273
Aylesbury Vale	283
Uttlesford	297
South Cambridgeshire	314
East Hertfordshire	315

Based on the Index of Multiple Deprivation rankings for local authorities in the study area, Great Yarmouth, Tendring (Harwich), North Norfolk (Cromer) and Waveney (Lowestoft) are further key locations beyond those identified so far in the analysis.

Summary

The economic and socio-demographic characteristics of locations in the study area have been analysed to understand the key locations that will drive potential rail demand. Enhanced connectivity between such locations through the EWR-ES could facilitate economic growth. Key locations for population, employment and GVA are **Milton Keynes, Bicester, Aylesbury, Luton, Bedford, Peterborough, King's Lynn, Cambridge, Ipswich and Norwich**. Key commuting corridors identified are from **Ely, Bury St Edmunds and Newmarket to Cambridge, Thetford and Attleborough to Norwich, to Norwich from the Norfolk coast, and Aylesbury and Central Bedfordshire to Milton Keynes**. Further key locations for high productivity/output are **Harlow, Stevenage, Suffolk Coastal, Bury St Edmunds, South Cambridgeshire and Uttlesford**. Further areas of deprivation that would benefit from regeneration are **Great Yarmouth, Tendring (Harwich), North Norfolk (Cromer) and Waveney (Lowestoft).** These key locations and commuting movements will be kept in scope when identifying prioritised journey pairs in section 5.1. There is an opportunity for rail to improve connectivity between complementary locations in terms of industrial composition and to serve a range of demand markets.

2.3. Basis for the Economic Analysis

Base Population and Employment

For the economic analysis, further refinements to current population and employment levels in the study area have been required. The analysis uses population and employment data for catchments around stations and the model base year is 2011 so Census data at ward level has been used and aggregated to catchment areas around stations. For population levels around stations, a catchment has been defined as those for whom the given station is closest to where they live, up to a radius of 5km. For employment levels around stations, separate catchments have been defined at 500m, 2km and 5km from the station.

Table 2-1 below summarises the base population for catchments around each station in the study area.

Table 2-1 Base Population for Study Area Station Catchments (Census 2011)

Station	Population Catchment
Cambridge	168,968
Ely	46,279
King's Lynn	64,303
Newmarket	38,695
Thetford	39,549
Attleborough	31,275
Norwich	213,869
Cromer	24,122
Great Yarmouth	86,286
Bury St Edmunds	60,403
Diss	27,176
Lowestoft	80,850
Stowmarket	41,056
Sudbury	44,087
Ipswich	166,663
Felixstowe	33,626
Harwich Town	7,703
Harwich International	20,886
Sandy	49,819
Bedford	145,044
Milton Keynes Central	153,315
Bletchley	83,778
Bicester	52,691
Aylesbury	109,624
Oxford	169,186
Reading	266,873
Stevenage	127,279
Peterborough	198,070
Stansted Airport	35,290
Harlow Town	57,385
Harlow Mill	49,931
Luton	140,682
Luton Airport	102,707

Table 2-2 summarises the base employment for catchments around each station in the study area.

Table 2-2 Base Employment for Study Area Station Catchments (Census 2011)

Station	0 - 0.5 km	0 - 2 km	0 - 5 km
Cambridge	4,235	49,497	108,657
Ely	824	6,256	11,902
King's Lynn	2,803	19,578	29,783
Newmarket	0	5,489	12,864
Thetford	1,711	11,337	11,970
Attleborough	1,788	4,383	6,578
Norwich	4,406	51,338	101,779
Cromer	514	4,096	5,807
Great Yarmouth	1,883	14,297	29,046
Bury St Edmunds	1,494	22,900	34,411
Diss	1,419	4,971	8,892
Lowestoft	2,631	16,087	26,483
Stowmarket	3,767	8,610	11,485
Sudbury	3,143	11,238	14,054
Ipswich	1,031	38,973	75,352
Felixstowe	1,429	6,245	14,617
Harwich Town	1,030	4,805	16,194
Harwich International	720	5,139	13,291
Sandy	0	3,957	11,029
Bedford	8,517	65,233	122,023
Milton Keynes Central	1,084	39,482	99,149
Bletchley	2,211	18,076	63,798
Bicester	4,799	26,479	35,112
Aylesbury	3,715	29,732	38,602
Oxford	2,179	39,656	83,281
Reading	18,141	56,985	113,913
Stevenage	8,091	28,854	48,835
Peterborough	1,405	32,785	83,093
Stansted Airport	429	8,706	15,639
Harlow Town	1,374	19,201	42,569
Harlow Mill	2,425	10,427	40,094
Luton	2,465	17,237	46,819
Luton Airport	1,227	14,103	38,155

Forecasting Population and Employment Growth

Three population and employment growth scenarios have been developed based upon forecasts from alternative data sources as follows:

- NTEM[11]/Tempro 7.2[12] (DfT) trend-based growth forecasts – These forecasts include population, employment, households by car ownership, trip ends and simple traffic growth factors based on data

[11] National Trip End Model
[12] Trip End Model Presentation Program

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.
- East of England Forecasting Model (EEFM) as above.
- A detailed review of growth "plans" as set out in local planning documents – based on actual or proposed allocations of land for housing or employment uses.

To a large extent, the forecast growth contained in Local Plans reflects both local and national policy as much as economic potential. The plans recognise the strengths of locations with respect to the existing employment sectoral profile, connectivity and characteristics of the local labour market. It should be noted that the local planning documents are in different stages of review and subject to change. In particular, there is currently some uncertainty on how housing growth levels and locations will be agreed across Local Planning Authorities and what level of job growth will result as LEPs implement their SEPs. As the East West Rail project is progressed it will be necessary to review the planning forecasts used, but it is not believed this uncertainty affects the robustness of the conclusions reached in this piece of work. It is also important to note that the outturn population increases are highly dependent upon build rates that materialise. It should also be noted that the growth scenarios do not include dependent development – growth that would be unlocked by the scheme.

For the Local Plan growth scenario, target numbers of new jobs and new houses have been sourced and an average household occupancy of 2.5 has been assumed in order to derive the growth factors.

Table 2-3 below presents target new jobs by local authority for the stated time frame.

Table 2-3 Target New Jobs by Local Authority

District	Target New Jobs	Time frame
Norwich	8,000	2008-2026
Breckland	6,000	2001-2026
Great Yarmouth	Unknown	2013-2030
King's Lynn and West Norfolk	5,000	2001-2026
North Norfolk	Unknown	2001- 2021
South Norfolk	Unknown	2008-2026
Cambridge	Unknown	2011-2031
East Cambridgeshire	9,200	2011-2031
Babergh and Mid Suffolk	9,700	2011-2031
Forest Heath	7,300	2006-2026
St. Edmundsbury	13,000	2010-2026
Suffolk Coastal	Unknown	2010-2027
Ipswich	12,500	2011-2031
Waveney	5,000	2001-2021
Stevenage	Unknown	2011-2031
Central Bedfordshire	Unknown	2001-2021
Luton	18,000	2011- 2031
Bedford	16,000	2006-2021
Aylesbury Vale	Unknown	2016-2033
Milton Keynes	42,000	2010-2026
Harlow	12,000	2011-2031
Tendring	Unknown	2013-2033
Uttlesford	Unknown	2000-2011
Cherwell	Unknown	2011-2031
Oxford	14,000	2006-2026

District	Target New Jobs	Time frame
Wycombe	10,000	2013-2033
South Cambridgeshire	Unknown	2011-2031
Broadland	Unknown	2008-2026
East Hertfordshire	11,110	2011-2033
Epping Forest	Unknown	1998-2011
Dacorum	10,000	2006-2031
North Hertfordshire	Unknown	2011-2031
St. Albans	8,000	2011-2031
South Oxfordshire	1,000	2011-2031
Vale of White Horse	23,000	2011-2031
Peterborough	Unknown	2011-2031
Fenland	7,200	2011-2031
Huntingdonshire	13,000	2001-2026
Braintree	Unknown	2001-2026
Welwyn Hatfield	16,900	2013-2032

Table 2-4 below presents target new houses by local authority for the stated time frame.

Table 2-4 Target New Houses by Local Authority

District	Target New Houses	Time frame
Norwich	3,300	2008-2026
Breckland	19,100	2001-2026
Great Yarmouth	7,140	2013-2030
King's Lynn and West Norfolk	16,500	2001-2026
North Norfolk	8,000	2001- 2021
South Norfolk	6,000	2008-2026
Cambridge	14,191	2011-2031
East Cambridgeshire	11,500	2011-2031
Babergh and Mid Suffolk	5,975	2011-2031
Forest Heath	4,960	2016-2031
St. Edmundsbury	12,240	2009-2031
Suffolk Coastal	7,900	2010-2027
Ipswich	13,550	2001-2021
Waveney	5,800	2001-2021
Stevenage	7,600	2011-2031
Central Bedfordshire	14,230	2001-2021
Luton	6,700	2011- 2031
Bedford	16,270	2006-2021
Aylesbury Vale	33,000	2016-2033
Milton Keynes	28,000	2010-2026
Harlow	15,000	2011-2031
Tendring	11,000	2013-2033
Uttlesford	5,052	2000-2011
Cherwell	16,870	2011-2031

District	Target New Houses	Time frame
Oxford	8,000	2006-2026
Wycombe	10,000	2013-2033
South Cambridgeshire	19,500	2011-2031
Broadland	7,000	2008-2026
East Hertfordshire	16,390	2011-2033
Epping Forest	2,400	1998-2011
Dacorum	10,750	2006-2031
North Hertfordshire	38,100	2011-2031
St. Albans	8,720	2011-2031
South Oxfordshire	19,500	2011-2031
Vale of White Horse	20,560	2011-2031
Peterborough	22,809	2011-2031
Fenland	11,000	2011-2031
Huntingdonshire	14,000	2001-2026
Braintree	9,625	2001-2026
Welwyn Hatfield	12,000	2013-2032

In the EEFM growth scenario, TEMPRO data is retained for Oxford and Reading, which fall outside the EEFM scope. In the Local Plan growth scenario, where data is not available, TEMPRO/EEFM data is used. In all three scenarios, growth forecasts have been determined at a local authority level, with each station catchment in the study area defined by the proportions of local authorities that it comprises, giving weighted growth rates for each station catchment. Growth rates have been developed from the 2011 base year to forecast years of 2016, 2021, 2026 and 2031. There are significant differences between forecasts across the three growth scenarios. In terms of population growth from 2011 to 2031, there are similarities between the TEMPRO 7.2 and Local Plan growth scenarios for stations east of Cambridge. To the west of Cambridge, Local Plan growth exceeds TEMPRO 7.2 growth. Overall the EEFM growth scenario predicts less growth than the other scenarios. In terms of employment growth from 2011 to 2031, the EEFM and Local Plan growth scenarios are similar across the study. The TEMPRO 7.2 growth scenario predicts less growth across the study area than the other scenarios.

Tables 2-5 and 2-6 below summarise population and employment growth between 2011 and 2031 across the study area for the different growth scenarios.

Table 2-5 Population Growth 2011-2031 by Growth Scenario

Station	Local Authority	2011-2031 TEMPRO Growth	2011-2031 EEFM Growth	2011-2031 Local Plan Growth
Cambridge	Cambridge (75%), South Cambridgeshire (25%)	1.26	1.25	1.30
Ely	East Cambridgeshire (100%)	1.32	1.23	1.35
King's Lynn	King`s Lynn and West Norfolk (100%)	1.32	1.15	1.23
Newmarket	East Cambridgeshire (47%), Forest Heath (53%)	1.30	1.20	1.32
Thetford	Breckland (79%), Forest Heath (15%), St. Edmundsbury (7%)	1.31	1.15	1.29
Attleborough	Breckland (64%), South Norfolk (36%)	1.32	1.18	1.24
Norwich	Broadland (30%), Norwich (63%), South Norfolk (7%)	1.27	1.16	1.10
Cromer	North Norfolk (100%)	1.20	1.11	1.20
Great Yarmouth	Broadland (4%), Great Yarmouth (96%)	1.17	1.16	1.21
Bury St Edmunds	St. Edmundsbury (100%)	1.21	1.19	1.25
Diss	Mid Suffolk (34%), South Norfolk (66%)	1.26	1.23	1.12
Lowestoft	South Norfolk (4%), Waveney (96%)	1.12	1.10	1.13
Stowmarket	Mid Suffolk (100%)	1.11	1.20	1.08
Sudbury	Babergh (75%), Braintree (25%)	1.11	1.12	1.10
Ipswich	Babergh (7%), Ipswich (80%), Mid Suffolk (5%), Suffolk Coastal (8%)	1.15	1.20	1.23
Felixstowe	Suffolk Coastal (100%)	1.18	1.15	1.19
Harwich Town	Tendring (100%)	1.22	1.14	1.20
Harwich International	Babergh (30%), Tendring (70%)	1.18	1.13	1.16
Sandy	Bedford (7%), Central Bedfordshire (83%), South Cambridgeshire (10%)	1.25	1.21	1.17
Bedford	Bedford (96%), Central Bedfordshire (4%)	1.28	1.19	1.34
Milton Keynes Central	Aylesbury Vale (4%), Milton Keynes (96%)	1.31	1.34	1.36
Bletchley	Aylesbury Vale (7%), Central Bedfordshire (6%), Milton Keynes (88%)	1.30	1.33	1.36
Bicester	Aylesbury Vale (9%), Cherwell (91%)	1.35	1.17	1.31
Aylesbury	Aylesbury Vale (97%), Wycombe (3%)	1.32	1.32	1.55
Oxford	Cherwell (3%), Oxford (83%), South Oxfordshire (3%), Vale of White Horse (11%)	1.16	1.16	1.18
Reading	Reading (59%), South Oxfordshire (4%), West Berkshire (12%), Wokingham (25%)	1.20	1.20	1.20
Stevenage	East Hertfordhsire (4%), North Hertfordshire (25%), Stevenage (66%), Welwyn Hatfield (5%)	1.20	1.18	1.37
Peterborough	Peterborough (90%), Fenland (5%), Huntingdonshire (6%)	1.28	1.22	1.30
Stansted Airport	East Hertfordhsire (38%), Uttlesford (62%)	1.22	1.19	1.29
Harlow Town	East Hertfordshire (10%), Harlow (90%)	1.13	1.14	1.44
Harlow Mill	East Hertfordshire (23%), Epping Forest (13%), Harlow (60%), Uttlesford (4%)	1.13	1.15	1.36
Luton	Central Bedfordshire (11%), Dacorum (2%), Luton (83%), North Hertfordshire (1%), St Albans (3%)	1.09	1.19	1.10
Luton Airport	Central Bedfordshire (11%), Dacorum (2%), Luton (83%), North Hertfordshire (1%), St Albans (3%)	1.09	1.19	1.10

Table 2-6 Employment Growth 2011-2031 by Growth Scenario

Station	Local Authority	2011-2031 TEMPRO Growth	2011-2031 EEFM Growth	2011-2031 Local Plan Growth
Cambridge	Cambridge (75%), South Cambridgeshire (25%)	1.13	1.24	1.24
Ely	East Cambridgeshire (100%)	1.12	1.25	1.28
King's Lynn	King`s Lynn and West Norfolk (100%)	1.14	1.16	1.06
Newmarket	East Cambridgeshire (47%), Forest Heath (53%)	1.10	1.17	1.21
Thetford	Breckland (79%), Forest Heath (15%), St. Edmundsbury (7%)	1.10	1.13	1.09
Attleborough	Breckland (64%), South Norfolk (36%)	1.12	1.17	1.09
Norwich	Broadland (30%), Norwich (63%), South Norfolk (7%)	1.12	1.18	1.10
Cromer	North Norfolk (100%)	0.99	1.11	1.11
Great Yarmouth	Broadland (4%), Great Yarmouth (96%)	1.01	1.16	1.16
Bury St Edmunds	St. Edmundsbury (100%)	1.00	1.12	1.27
Diss	Mid Suffolk (34%), South Norfolk (66%)	1.04	1.19	1.19
Lowestoft	South Norfolk (4%), Waveney (96%)	0.94	1.09	1.11
Stowmarket	Mid Suffolk (100%)	0.88	1.14	1.12
Sudbury	Babergh (75%), Braintree (25%)	0.89	1.15	1.12
Ipswich	Babergh (7%), Ipswich (80%), Mid Suffolk (5%), Suffolk Coastal (8%)	0.98	1.24	1.17
Felixstowe	Suffolk Coastal (100%)	0.95	1.18	1.18
Harwich Town	Tendring (100%)	1.02	1.12	1.12
Harwich International	Babergh (30%), Tendring (70%)	0.98	1.13	1.13
Sandy	Bedford (7%), Central Bedfordshire (83%), South Cambridgeshire (10%)	1.16	1.21	1.21
Bedford	Bedford (96%), Central Bedfordshire (4%)	1.23	1.15	1.28
Milton Keynes Central	Aylesbury Vale (4%), Milton Keynes (96%)	1.24	1.37	1.34
Bletchley	Aylesbury Vale (7%), Central Bedfordshire (6%), Milton Keynes (88%)	1.23	1.36	1.34
Bicester	Aylesbury Vale (9%), Cherwell (91%)	1.29	1.20	1.20
Aylesbury	Aylesbury Vale (97%), Wycombe (3%)	1.24	1.24	1.24
Oxford	Cherwell (3%), Oxford (83%), South Oxfordshire (3%), Vale of White Horse (11%)	1.17	1.17	1.13
Reading	Reading (59%), South Oxfordshire (4%), West Berkshire (12%), Wokingham (25%)	1.16	1.16	1.16
Stevenage	East Hertfordhsire (4%), North Hertfordshire (25%), Stevenage (66%), Welwyn Hatfield (5%)	1.14	1.12	1.12
Peterborough	Peterborough (90%), Fenland (5%), Huntingdonshire (6%)	1.13	1.23	1.23
Stansted Airport	East Hertfordhsire (38%), Uttlesford (62%)	1.09	1.18	1.18
Harlow Town	East Hertfordshire (10%), Harlow (90%)	1.08	1.07	1.29
Harlow Mill	East Hertfordshire (23%), Epping Forest (13%), Harlow (60%), Uttlesford (4%)	1.07	1.10	1.29
Luton	Central Bedfordshire (11%), Dacorum (2%), Luton (83%), North Hertfordshire (1%), St Albans (3%)	1.08	1.24	1.19
Luton Airport	Central Bedfordshire (11%), Dacorum (2%), Luton (83%), North Hertfordshire (1%), St Albans (3%)	1.08	1.24	1.19

3. Transport Networks Evidence Base

3.1. Highway Networks

The highway networks within the study area reflect the rail network to a large extent in that the strategic routes (Motorways and Trunk Roads) are mostly radial routes leading to/from London or strategic east-west highway routes east of Cambridge. Key corridors in the study area include the A12, A47, A11 and A14 corridors. Long-distance east-west journeys require the use of a combination of 'A' class roads. This leads to relatively long journey times for east-west movements, which is compounded by congestion on those routes. For example, at present a car journey between Oxford and Cambridge could typically take over 2 hours. Highway congestion is especially an issue on the A14 east of Cambridge during the peak periods and this is compounded by a lack of resilience and limited diversionary routes in the Newmarket area. Figures 3-1 and 3-2 below demonstrate congestion on the Strategic Road Network in 2010 and predicted congestion for 2040 (with the A14 east of Cambridge highlighted).

Figure 3-1 Congestion on the Strategic Road Network in 2010

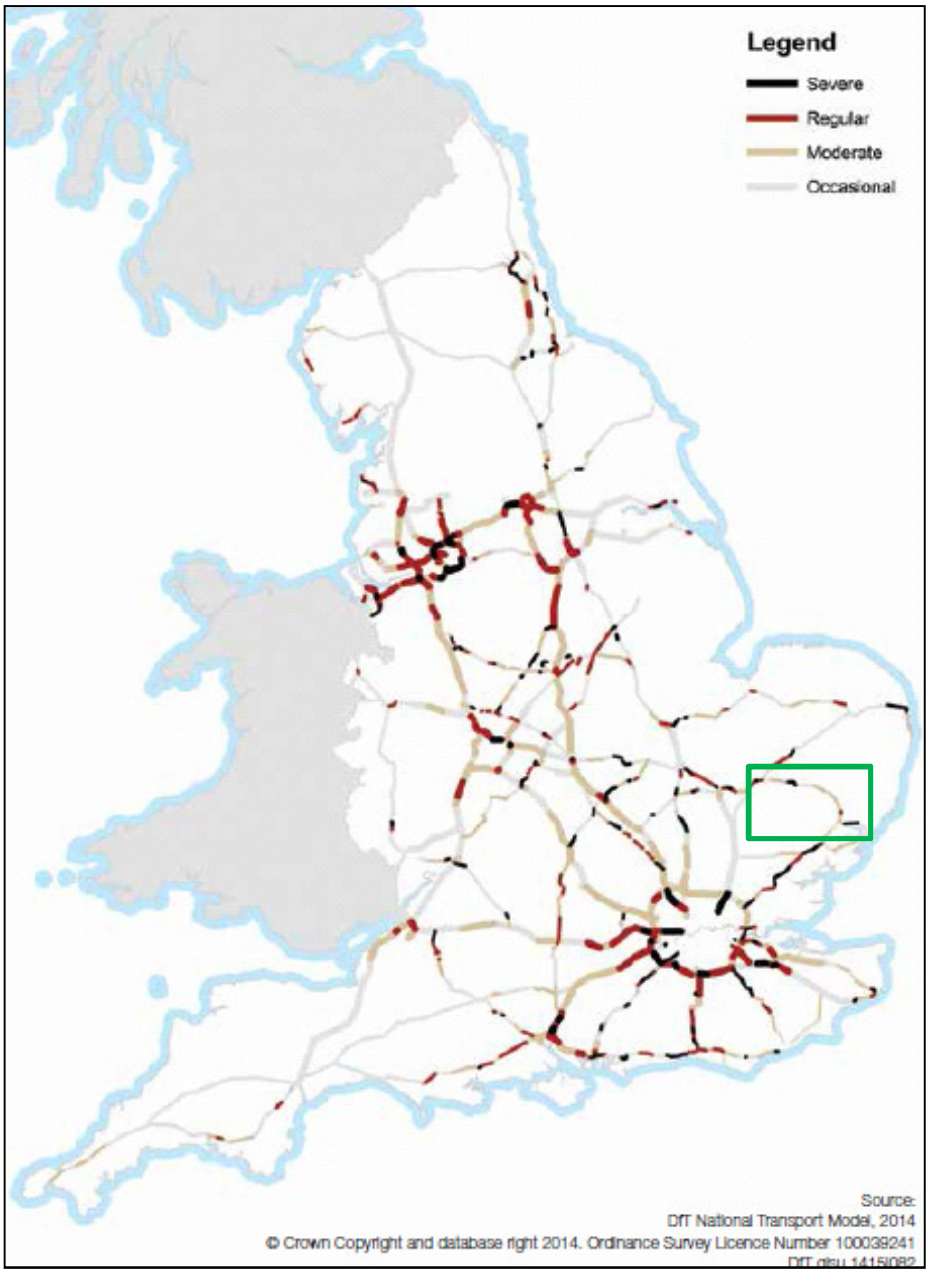
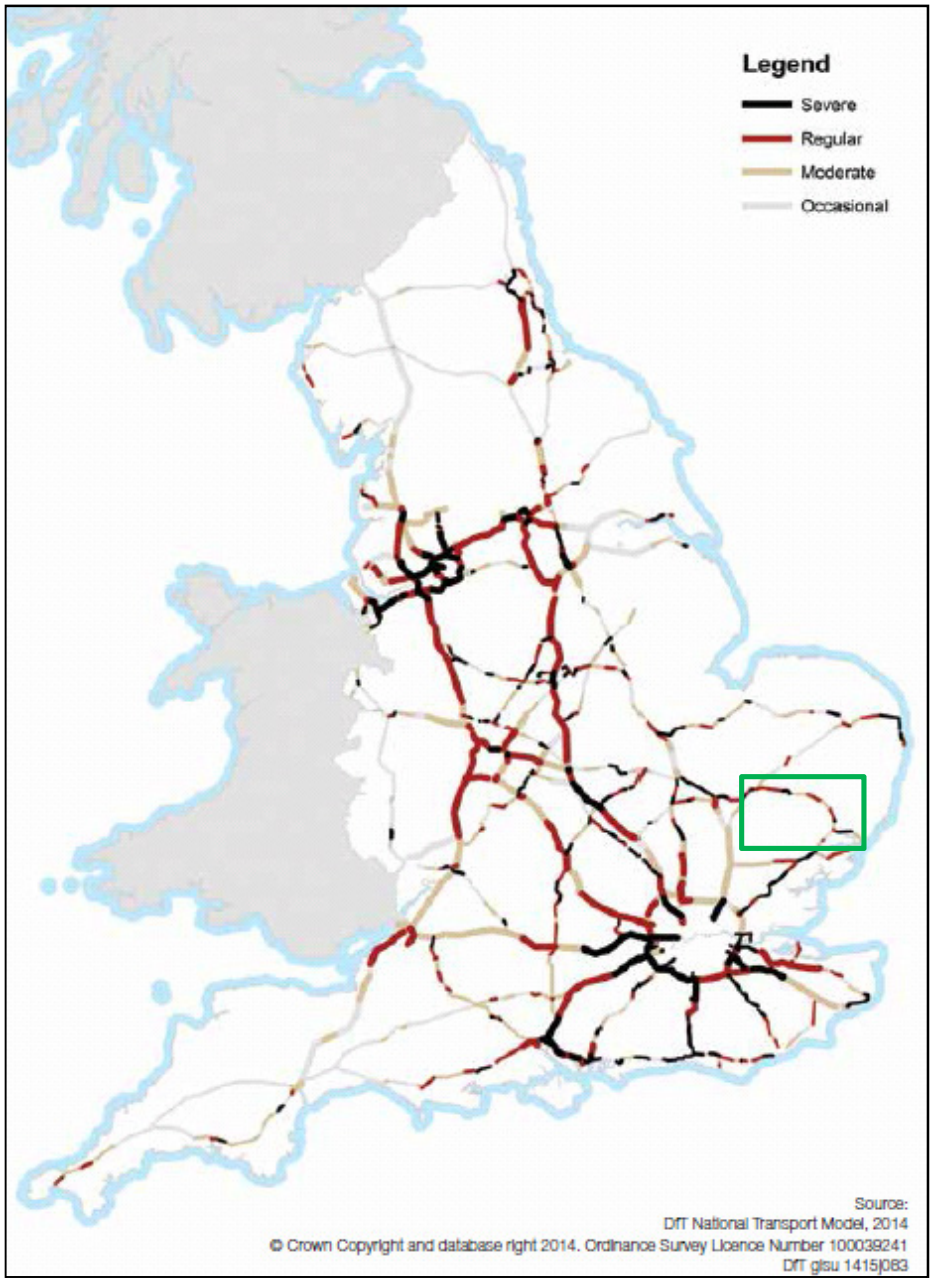


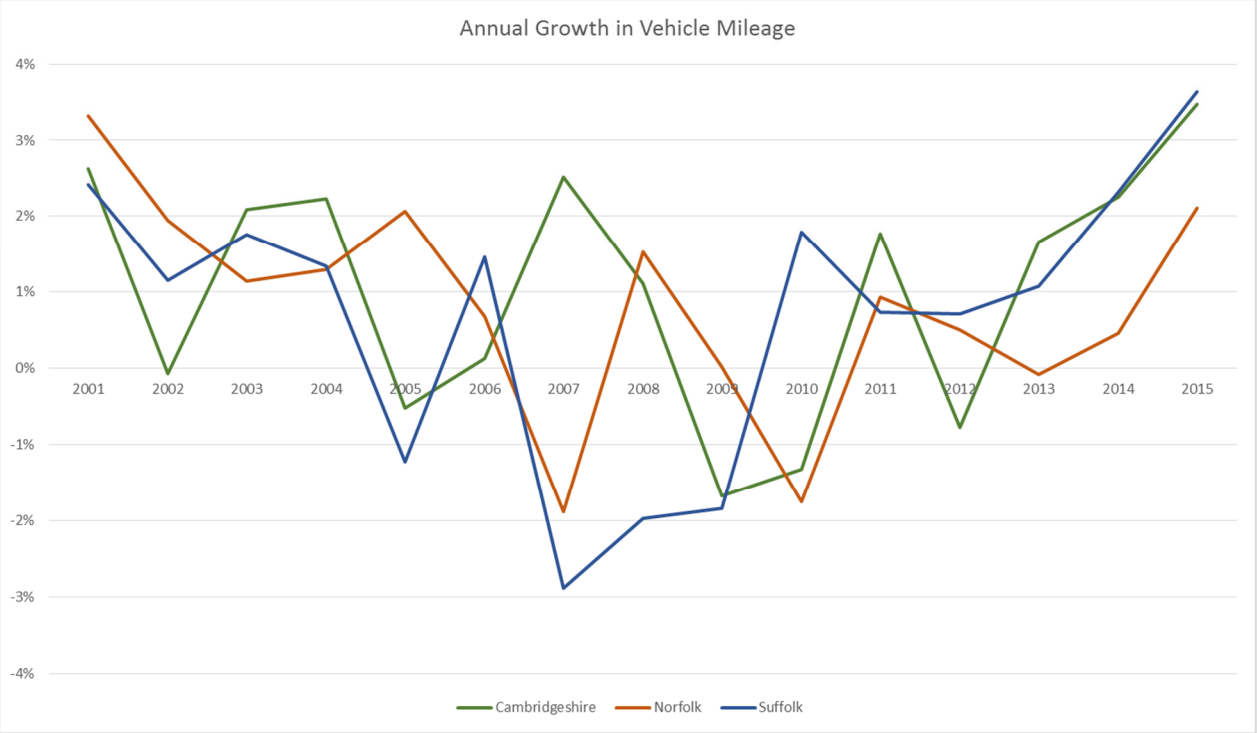
Figure 3-2 Predicted Congestion on the SRN in 2040



The EWR-ES will not only assist in making current east-west rail journeys quicker and more convenient, it will also potentially be highly competitive with the car. Therefore, we need to understand the current car journey times between locations in the study area (so that we can ascertain those movements for which a rail alternative will be truly competitive) and also the current level of highway demand (so that we can understand the size of the potential market which could be attracted to use a competitive EWR-ES service).

After a dip through the recession, vehicle mileage in Cambridgeshire, Norfolk and Suffolk has grown rapidly in recent years, as demonstrated by the trends in Figure 3-3 below based on data from DfT traffic Statistics.

Figure 3-3 Annual Growth in Vehicle Mileage



To understand highway travel patterns, issues experienced by passengers and opportunities to improve connectivity, demand (weekday AM/IP/PM) and journey time matrices (weekday AM peak) from the A14 Highway Model have been analysed for the model base year of 2014 and forecast years of 2020 and 2035. Further investigation of current journey times has been enabled through the AA Route Planner website.

We will discuss the findings of each of these analyses over the following sections.

Highway Journey Times

Table 3-1 shows the journey times (in minutes) between locations in the study area.

Table 3-1 2016/17 Weekday AM Peak Highway Journey Times (minutes) – Source: AA Route Planner

2016/17 Weekday AM Peak (mins)	Cambridge	Ely	King's Lynn	Newmarket	Thetford	Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge		34	75	28	47	58	83	118	98	42	69	113	54	67	69	82	96	40	50	65	67	98	89	123	120	52	50	44	54	67
Ely	37		45	23	42	53	77	97	93	37	64	107	48	62	64	77	91	53	34	79	80	111	102	137	134	68	50	56	66	84
King's Lynn	77	45		62	50	59	68	68	84	68	70	98	79	93	95	107	121	86	94	110	111	140	133	161	173	108	51	95	105	118
Newmarket	28	26	63		28	39	63	98	79	24	50	93	35	48	51	63	77	46	56	71	72	104	95	129	119	53	57	40	51	68
Thetford	49	45	51	27		19	44	78	59	24	25	73	34	49	49	62	76	67	47	92	94	125	116	150	140	74	78	61	72	90
Attleborough	60	55	59	37	18		27	62	43	40	23	57	47	65	63	75	90	77	58	103	104	135	126	161	150	84	88	72	82	100
Norwich	84	80	69	62	43	27		44	37	64	47	51	66	89	75	88	102	101	83	147	128	160	150	185	175	109	109	96	107	124
Cromer	117	97	70	95	76	60	44		57	98	80	73	103	123	112	125	139	135	145	160	161	193	184	218	208	142	111	129	140	158
Great Yarmouth	100	95	64	77	58	42	36	56		80	61	20	78	105	88	91	114	117	98	143	144	175	166	201	190	124	124	112	122	140
Bury St Edmunds	44	41	69	23	24	42	66	101	82		41	85	21	30	37	49	63	62	42	87	88	120	111	145	135	69	73	56	67	84
Diss	71	67	71	49	24	23	44	83	60	40		56	34	64	44	56	71	88	69	114	115	147	137	172	162	96	100	83	94	111
Lowestoft	114	110	99	92	72	56	50	73	22	85	56		74	108	74	75	103	131	142	157	158	183	180	215	205	139	139	126	137	154
Stowmarket	55	52	80	35	34	49	63	102	79	22	34	74		41	22	34	49	73	84	99	100	131	122	157	146	81	84	68	78	96
Sudbury	66	61	90	44	46	63	88	122	104	28	61	105	39		37	50	48	83	67	108	109	139	109	146	133	85	94	49	65	97
Ipswich	71	67	96	50	49	64	62	112	89	38	44	74	22	39		24	40	88	69	114	115	147	119	156	143	96	100	63	79	107
Felixstowe	85	81	110	64	63	78	86	126	95	51	58	76	36	55	25		49	102	113	128	129	160	130	167	154	110	114	74	90	118
Harwich	96	94	122	76	76	91	99	138	115	64	70	102	49	48	40	48		113	125	128	132	149	119	156	142	101	124	63	78	107
Sandy	41	52	86	48	67	78	102	137	118	62	89	132	73	87	89	101	113		22	36	37	68	59	94	92	24	41	60	51	39
Bedford	51	60	92	56	75	86	110	145	126	70	97	140	81	94	97	109	123	18		29	30	61	52	87	92	39	47	70	66	37
Milton Keynes	68	77	109	73	92	103	127	182	143	87	114	157	98	111	114	126	128	35	29		9	39	34	64	88	53	64	80	73	33
Bletchley	69	78	110	74	93	104	128	163	144	88	115	158	99	113	115	127	131	37	33	8		36	31	61	92	56	65	83	77	37
Bicester	100	110	141	105	124	135	160	194	176	119	146	189	131	135	146	159	146	68	98	39	36		30	28	62	83	96	98	92	68
Aylesbury	94	103	135	97	118	129	153	188	169	113	140	183	124	108	119	129	119	62	58	36	33	30		52	68	55	90	71	65	43
Oxford	125	134	160	130	149	160	184	219	200	144	171	214	155	142	154	163	153	92	123	64	60	27	51		54	90	115	105	99	78
Reading	116	134	171	117	137	148	173	207	189	132	160	202	144	128	140	150	139	91	94	85	89	60	67	57		76	126	92	85	64
Stevenage	50	67	107	54	74	85	109	144	125	69	96	139	81	83	96	109	99	24	42	51	55	83	53	90	77		62	46	32	27
Peterborough	52	49	52	59	78	89	110	111	126	73	100	139	84	97	100	112	124	42	50	66	67	97	89	117	129	63		72	82	74
Stansted Airport	45	59	97	43	63	73	98	133	114	58	85	127	69	47	64	73	63	61	73	80	84	101	71	108	94	50	73		27	59
Harlow	53	68	105	51	71	82	107	141	123	66	93	136	78	62	79	88	78	52	54	74	78	95	65	102	88	34	81	26		50
Luton/Luton Airport	65	82	118	69	89	100	125	159	140	84	111	154	96	94	106	115	105	39	42	33	37	68	41	79	66	28	73	57	51	

Table 3-1 highlights the severe journey times for trips from east of Cambridge to west of Cambridge and vice versa. The A14 Highway Model journey time matrices (see Appendix A) also suggest that east-west journeys are an issue, especially for trips along the A11 and A14 corridors and beyond to Cromer/Great Yarmouth.

These journeys are significantly slower than what could be achieved when travelling on a radial motorway route or competing radial railway service. This is indicative that rail could potentially be very competitive in terms of attracting car users to rail for east-west rail journeys across the study area.

Highway Demand

The A14 Highway Model demand matrices (see Appendix A) suggest that demand is concentrated on short trips and key corridors including the A11, A14 and M11. If the EWR-ES served these trips it would abstract demand from highway to rail and build up the rail market in the study area. Demand growth is spread evenly across the study area so demand remains concentrated on short trips and key corridors.

Origin-Destination (OD) pairs which currently have large highway demand offer potential for a mode shift to rail if they are not currently well served by rail links, subject to the rail service being time and cost competitive. ODs without significant car demand may still generate demand if journey times and the basis for travel become attractive through journey times which are significantly faster than that possible by car, as well as growth in employment or population/housing at either or both ends of the trip.

Highway Schemes

Changes to the highway networks, in terms of the opening of major highway improvement schemes are likely to have an impact upon the overall levels of highway travel demand and journey times.

Tables 3-2 and 3-3 summarise the proposed highway schemes in the study area up to 2031, either through Highways England's Road Investment Strategy (RIS)/Route Strategy/Delivery Plan or the New Anglia Local Transport Board (LTB)/Growth Deal.

Table 3-2 Proposed Highway Schemes to 2031: HE RIS/Route Strategy/Delivery Plan

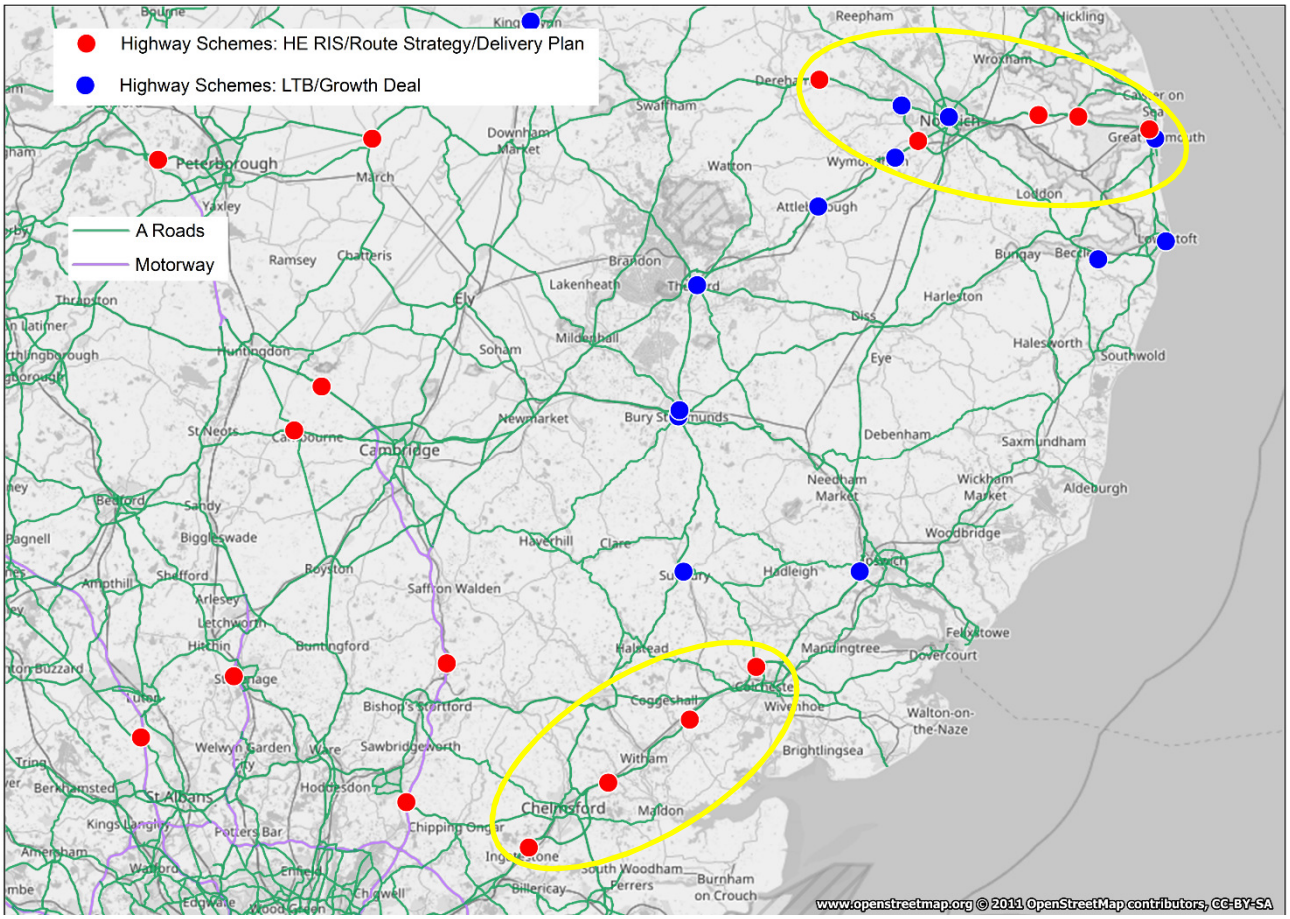
ID	Scheme Name	Timescales
D1	A14 Cambridge to Huntingdon	Works 2016/17 Q3, open 2020/21
D2	A5-M1 Link Road	Works started, open 2017/18 Q1
D3	A47 North Tuddenham to Easton	Construction starts 2020
D4	A47 Blofield to North Burlingham dualling	Construction starts 2020
D5	A47 Acle Straight	Construction starts 2020
D6	A47 and A12 junction enhancements	Construction starts 2020
D7	A47/A11 Thickthorn Junction	Construction starts 2020
D8	A47 Guyhirn Junction	Construction starts 2020
D9	A47 Wansford to Sutton	Construction starts 2020
D10	A428 Black Cat to Caxton Gibbet	Works 2019/20
D11	M11 Junctions 8 to 14 – technology upgrade	Works 2019/20
D12	A12 Chelmsford to A120 widening	Construction starts by end 2019/20
D13	A12 whole-route technology upgrade	Construction starts by end 2019/20
D14	A1(M) Junctions 6-8 Smart Motorway	Works 2019/20
D15	M11 Junction 7 upgrade	Works 2019/20
D16	A12 Colchester Bypass widening	Construction starts Road Period 2
D17	A12 M25 to Colchester	Construction starts Road Period 2

Table 3-3 Proposed Highway Schemes to 2031: New Anglia LTB/Growth Deal

Scheme Name	Growth Deal Contribution
Bury St Edmunds Eastern Relief Road	£10m
Lynnsport access road in King's Lynn	£1m
Lowestoft third river crossing development study	£2m
A47/A1074 Longwater Junction improvements	£2m
Norwich City Centre transport improvement	£7m
Improvements to the A11 Corridor	£4.175m
Sudbury Western Bypass development study	£100k
Beccles Southern Relief Road	£5m
Great Yarmouth transport improvements	£9.03m
Ipswich Radial Corridor transport improvements	£3.5m
Thetford town centre transport improvements	£2.281m
Attleborough town centre transport improvements	£4.6m
Bury St Edmunds sustainable transport improvements	£2.25m
Felbrigg Junction improvements	£42k

Figure 3-4 plots these schemes on a map to help to understand whether any of the transport issues in the study area would be resolved without the EWR-ES. In terms of improving east-west connectivity in the study area, the proposed highway schemes will only partially address this issue as the schemes are focussed on the A47 and A12 corridors, or within city/town centres.

Figure 3-4 Proposed Highway Schemes to 2031



Highway Summary

The most severe highway journey times are from east of Cambridge to west of Cambridge and vice versa. For example, Oxford to Cambridge is 125 mins, Oxford to Norwich is 184 mins, Oxford to Great Yarmouth is 200 mins, Oxford to Lowestoft is 214 mins and Oxford to Felixstowe is 163 mins. Journey times along the corridor from Cambridge to Norwich and beyond to Cromer and Great Yarmouth are an issue. This is owing to a mixture of low quality road infrastructure and congestion.

Demand is concentrated on short trips and key corridors including the A11, A14 and M11. Demand growth is spread evenly across the study area. The high demand and high journey times on key highway corridors in the study area suggest that there is an issue of congestion.

Highway schemes are largely focussed on the A47 and A12 corridors, or within city/town centres. This will improve highway journey times within Norfolk and within Suffolk but longer distance east-west journeys will remain an issue. If the EWR-ES served east-west trips it would abstract demand from highway to rail and build up the rail market in the study area.

3.2. Rail Network

Service Levels

In the Do Minimum scenario, there are very few location pairs in the study area that are served by a direct rail link (although the EWR Western and Central sections will partially address this issue). Where there are direct services, frequencies are generally low. There is therefore potential to improve the rail service offer and grow the rail market. Journeys that are either not served by a direct rail link, or which have low service frequencies, should be prioritised.

Current service levels for Cambridge – Norwich are as follows:

- 3tph Cambridge – Ely.
- 2tph Ely – Norwich.

Current service levels for Cambridge – Ipswich are as follows:

- 1tph Cambridge – Kennett.
- 1.5tph Kennett – Stowmarket.
- 3.5tph Stowmarket – Ipswich.

Future service levels for Cambridge – Ipswich are as follows:

- Kennett – Stowmarket increasing to 2tph.
- Stowmarket – Ipswich increasing to 4tph.

Current service levels beyond Norwich and Ipswich are as follows:

- 1tph on each branch from Norwich to Sheringham, Great Yarmouth and Lowestoft.
- 1tph on each branch from Ipswich to Felixstowe and Lowestoft.

All the above are regular interval services and are supplemented, especially at peak times, by additional trains.

Rail Schemes

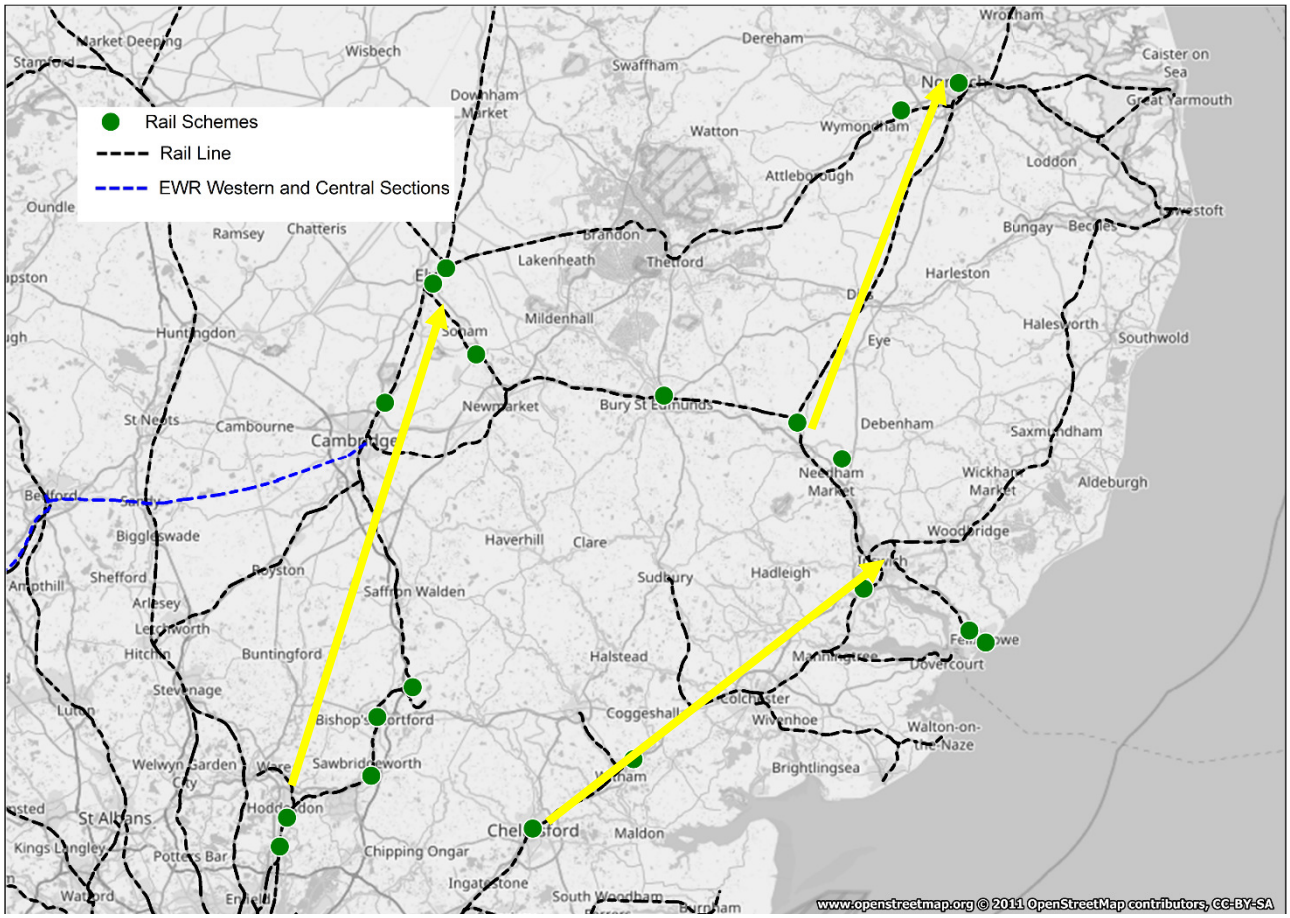
The proposed rail schemes inform whether any of the transport issues in the study area would be resolved without the EWR-ES. In terms of improving east-west connectivity in the study area, the proposed rail schemes will only partially address this issue as the schemes are focussed on the radial routes to/from London. The EWR-ES could enhance the case for these improvements as well as the Central and Western sections.

Table 3-4 and Figure 3-5 present the proposed rail schemes in the study area up to 2031, compiled from the East Anglia Franchise Specification, Thameslink Programme/TSGN Franchise Commitments and the Network Rail Anglia Route Study.

Table 3-4 Proposed Rail Schemes to 2031

Source	Route	Scheme Description
East Anglia Franchise Specification	Greater Anglia	Additional services from Ipswich to Cambridge (AM Peak) and Norwich to Cambridge (PM Peak)
		Extension of majority of Norwich to Cambridge services to Stansted Airport
		New rolling stock with free Wi-Fi introduced on both routes from 2019
		Current 2-horly service between Peterborough and Ipswich via Ely doubled in frequency
		At least four 90-minute services between London and Norwich each weekday and two 60-minute services per day between London and Ipswich
Thameslink Programme/TSGN Franchise Commitments	Great Northern	Improved rail frequency and connectivity between Ely, Cambridge and London
Network Rail Anglia Route Study	Great Eastern Main Line	Improvements at Liverpool Street station including more passenger space and additional platform(s)
		Improvements to signalling to allow more trains to run between Chelmsford and Stratford (through Digital Railway)
		Passing loop north of Witham
		Doubling of Trowse Swing Bridge
		Level crossing closures or improved safety mitigations
	Cross Country corridor via Ely	Felixstowe Branch capacity enhancements
		Ely area improvements, including signalling improvements to allow more trains to run, Ely North junction and level crossings
		Partial doubling of the Ely to Soham single line
		Improvements to signalling to allow more trains to run at Ely and Bury St Edmunds
		Haughley Junction doubling
		Level crossing closures or improved safety mitigations
	West Anglia Main Line	Longer trains on peak services
		Line speed improvements to support faster journeys
		Preparatory works for a major intervention such as Crossrail 2

Figure 3-5 Proposed Rail Schemes to 2031



To understand rail travel patterns, issues experienced by rail passengers and opportunities to improve the rail service, outputs from the PLANET South sub-model within the PLANET Forecasting Model v6.1b have been analysed. These include demand matrices by journey purpose, commuting journey times and crowding plots for the 2014 base year and forecast years of 2026 and 2036. PLANET South is a 3 hour AM Peak model with HS2 and EWR Western section services coded. Demand data for 2031 has been derived through linear interpolation, while 2031 journey times are assumed to equal 2026 journey times. Journey time is calculated as uncrowded IVT + (waiting time – first waiting time).

We discuss the findings of each of these analyses over the following sections.

Rail Journey Times

Currently the most severe rail journey times are from east of Cambridge to west of Cambridge and vice versa, although travelling west to east is the worse direction in the AM peak. By 2031 the Western section will have dramatically improved journey times and opportunities between Reading/Oxford and Milton Keynes and Bedford but journey times from east of Cambridge to west of Cambridge and vice versa will remain unsatisfactory. Figures 3-6 and 3-7 present AM peak journey times between locations in the study area for 2014 and 2031 respectively (note that the Ipswich and Felixstowe zones overlap).

Figure 3-6 2014 Rail Journey Times

AM peak mins, Uncrowded IVT + (Waiting Time - First Wait Time)	Cambridge	Ely	King's Lynn	Newmarket	Thetford / Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	-	16	62	22	65	103	214	182	40	114	204	59	219	77	77	180	82	130	127	138	166	159	147	124	44	78	38	41	39
Ely	14	-	31	101	26	64	175	143	119	101	165	125	240	136	136	193	108	154	147	158	188	180	169	146	73	41	71	67	67
King's Lynn	40	30	-	133	87	124	235	203	151	161	225	170	268	186	186	249	140	181	171	183	212	205	193	171	102	101	106	99	96
Newmarket	30	63	122	-	113	120	231	200	18	85	220	37	184	55	55	128	127	198	187	198	228	221	209	187	89	122	85	82	103
Thetford / Attleborough	48	25	101	132	-	38	149	117	160	75	139	87	213	98	98	163	138	196	186	198	227	220	208	185	107	83	104	100	101
Norwich	79	57	133	132	32	-	51	34	111	17	41	29	155	43	43	105	170	192	185	197	222	215	203	180	149	115	135	128	127
Cromer	163	141	217	200	116	48	-	127	179	85	149	97	223	109	109	173	253	258	251	263	288	282	269	247	214	199	219	189	193
Great Yarmouth	149	127	203	185	101	34	145	-	165	71	135	83	209	92	92	159	238	242	234	246	272	265	253	230	200	184	205	173	175
Bury St Edmunds	50	83	143	20	145	91	202	171	-	71	190	23	170	41	41	102	149	202	194	206	233	226	214	191	111	144	105	111	123
Diss	141	113	189	115	88	20	131	99	94	-	121	12	138	25	25	88	186	174	167	179	205	198	186	163	147	173	179	141	154
Lowestoft	160	138	214	198	113	45	156	124	178	82	-	100	220	102	102	169	253	255	248	259	285	279	266	244	214	196	223	196	199
Stowmarket	73	117	187	43	100	32	143	111	22	12	154	-	126	14	14	73	169	163	155	167	193	186	174	151	131	170	150	130	136
Sudbury	186	206	253	199	211	143	254	222	179	123	209	114	-	84	84	105	183	172	165	177	203	196	183	161	144	177	175	135	154
Ipswich	123	131	202	93	110	43	154	122	72	22	133	13	113	-	-	60	163	150	143	154	180	173	161	138	124	158	148	118	131
Felixstowe	123	131	202	93	110	43	154	122	72	22	133	13	113	-	-	60	163	150	143	154	180	173	161	138	124	158	148	118	131
Harwich	162	175	236	136	156	88	199	167	116	68	182	55	127	35	35	-	185	175	168	180	205	199	186	164	147	180	174	140	158
Sandy	83	110	179	165	154	191	302	270	183	205	287	201	224	174	174	207	-	128	122	133	161	153	142	119	21	37	119	95	34
Bedford	137	163	206	219	215	213	324	293	237	193	297	188	215	164	164	198	136	-	66	40	158	152	140	117	98	131	145	110	10
Milton Keynes	131	157	200	213	209	215	326	294	231	195	298	190	216	166	166	199	135	99	-	4	153	149	141	111	92	125	136	103	81
Bletchley	142	168	211	224	220	226	337	305	242	206	310	201	227	177	177	210	146	35	7	-	170	159	149	120	103	136	147	114	73
Bicester	144	170	213	226	222	225	336	305	244	205	309	200	227	176	176	210	144	133	125	137	-	89	62	97	105	138	155	118	115
Aylesbury	152	178	221	234	230	233	344	312	252	213	316	208	234	183	183	217	151	141	132	144	58	-	115	110	113	146	162	126	122
Oxford	158	184	227	240	236	240	351	320	258	220	324	216	242	191	191	225	157	147	133	145	50	142	-	20	119	152	163	127	128
Reading	136	162	205	218	214	219	330	298	236	199	303	194	220	170	170	203	136	125	112	123	92	125	21	-	97	130	142	106	107
Stevenage	44	90	137	126	134	171	282	250	144	174	271	162	192	142	142	175	19	96	89	101	129	121	110	87	-	37	97	72	6
Peterborough	60	39	115	144	79	115	226	194	162	152	216	160	223	172	172	209	31	128	123	135	159	152	141	118	52	-	115	108	68
Stansted Airport	59	92	151	141	140	177	288	257	159	176	270	165	198	148	148	181	124	122	113	124	158	152	139	117	90	126	-	10	92
Harlow	58	90	150	140	139	167	278	246	158	161	259	155	182	131	131	164	104	106	95	107	138	133	120	98	69	111	23	-	76
Luton/Luton Airport	60	87	133	142	138	155	266	235	160	167	256	153	195	145	145	178	35	13	99	80	135	129	117	94	6	59	100	79	-

Figure 3-7 2031 Rail Journey Times

AM peak mins, Uncrowded IVT + (Waiting Time - First Wait Time)	Cambridge	Ely	King's Lynn	Newmarket	Thetford / Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	-	16	40	22	63	100	209	177	40	129	201	69	231	101	101	244	75	133	115	127	145	153	141	120	39	75	45	44	32
Ely	15	-	31	104	24	61	170	138	116	102	162	109	255	121	121	237	106	162	138	150	167	174	165	144	77	40	77	74	70
King's Lynn	40	30	-	135	84	121	230	198	153	158	222	165	283	177	177	293	145	185	164	176	195	204	189	168	108	96	113	106	101
Newmarket	40	70	124	-	145	135	244	212	18	95	236	47	205	68	68	194	132	190	168	180	203	210	218	197	96	129	100	96	91
Thetford / Attleborough	51	25	92	136	-	37	146	114	157	79	138	96	240	106	106	221	135	200	178	190	208	216	202	181	109	82	112	108	102
Norwich	82	57	124	149	32	-	49	32	99	17	41	30	177	44	44	159	167	225	204	216	232	240	219	198	141	113	144	134	132
Cromer	166	141	208	216	116	48	-	125	173	91	149	108	251	118	118	233	250	289	268	280	296	304	285	264	224	197	227	197	196
Great Yarmouth	150	125	192	200	100	32	141	-	157	75	133	92	235	102	102	217	234	273	252	264	280	288	269	248	208	181	211	181	180
Bury St Edmunds	67	83	139	29	145	98	207	175	-	73	199	25	183	46	46	172	153	227	205	218	234	242	223	202	124	136	127	126	126
Diss	142	113	180	126	88	20	129	97	82	-	121	12	160	27	27	142	215	205	185	197	211	220	197	176	185	169	195	167	165
Lowestoft	162	137	204	214	112	44	153	121	170	87	-	113	240	105	105	225	248	284	263	276	290	299	278	257	235	193	226	218	191
Stowmarket	88	115	176	65	100	32	141	109	21	12	139	-	148	17	17	129	181	196	176	188	202	211	188	167	150	170	161	146	146
Sudbury	205	215	259	208	209	143	252	220	164	123	234	112	-	85	85	172	193	186	167	179	193	201	178	157	159	185	179	130	159
Ipswich	101	129	190	79	111	43	152	120	35	23	133	13	121	-	-	111	179	175	155	167	181	189	167	146	149	165	163	125	145
Felixstowe	101	129	190	79	111	43	152	120	35	23	133	13	121	-	-	111	179	175	155	167	181	189	167	146	149	165	163	125	145
Harwich	177	178	240	153	160	94	203	171	111	74	186	61	130	38	38	-	191	183	163	175	189	198	175	154	157	182	175	128	160
Sandy	78	103	163	160	148	184	293	261	192	201	286	199	237	173	173	260	-	134	111	123	147	153	140	119	21	34	112	89	30
Bedford	136	157	195	218	208	212	321	289	236	192	310	186	228	163	163	250	131	-	52	34	69	102	93	109	97	122	131	100	10
Milton Keynes	119	141	179	201	192	197	306	274	219	177	295	171	213	148	148	235	113	69	-	4	50	82	66	86	79	105	111	80	73
Bletchley	128	149	188	210	201	205	314	282	228	185	304	180	222	156	156	244	122	45	6	-	12	20	30	73	88	114	120	89	66
Bicester	153	174	213	235	225	227	336	304	253	207	326	202	242	178	178	266	153	63	33	9	-	79	16	60	119	139	152	118	73
Aylesbury	150	172	210	233	223	224	333	301	251	204	322	199	239	175	175	262	151	105	71	52	67	-	88	104	117	137	149	117	118
Oxford	144	165	204	226	216	205	314	282	235	185	303	180	221	156	156	243	138	90	50	29	20	77	-	20	104	130	133	100	104
Reading	133	154	193	215	205	194	303	271	224	174	292	169	211	145	145	232	127	100	85	67	54	112	17	-	93	119	122	89	93
Stevenage	38	72	121	120	119	156	265	233	138	175	257	166	207	142	142	229	19	103	85	97	117	124	110	89	-	50	94	70	6
Peterborough	61	39	106	147	80	116	225	193	143	150	218	154	227	160	160	249	28	124	104	116	133	141	130	109	49	-	125	103	53
Stansted Airport	58	88	141	140	136	174	283	251	158	180	275	171	215	152	152	239	122	133	109	121	142	150	128	107	87	127	-	10	86
Harlow	61	91	144	143	139	175	284	252	161	164	274	156	188	131	131	218	104	116	91	103	125	133	112	91	70	113	21	-	72
Luton/Luton Airport	57	84	122	139	126	143	252	220	157	169	236	160	212	146	146	234	37	14	71	66	93	122	104	94	8	65	95	74	-

Rail Demand and Crowding

Current rail demand in the study area is constrained to relatively short-distance journeys. There is little or no rail demand between geographically close locations on different radial routes. Highway based modes are currently the only practical option for travelling between these locations. Rail demand is forecast to increase to 2031 but is expected to follow a similar pattern to current rail demand and continue to be constrained to radial routes rather than east-west journeys, reflecting service provision. EWR Western Section will have a significant impact upon future demand levels where new direct rail journey opportunities are created as a consequence of reopening this route. Rail demand matrices are presented in Appendix B.

AM peak crowding is most severe on the radial routes in to London, getting worse as services approach London. Crowding levels on AM peak services to/from London will deteriorate by 2026 and further by 2036. Figures 3-8 to 3-10 present AM peak crowding in terms of seat utilisation for 2014, 2026 and 2036 respectively (note that crowding severity is suppressed as the data cover both directions across the whole 3 hour AM Peak period).

Figure 3-8 2014 AM Peak Rail Crowding

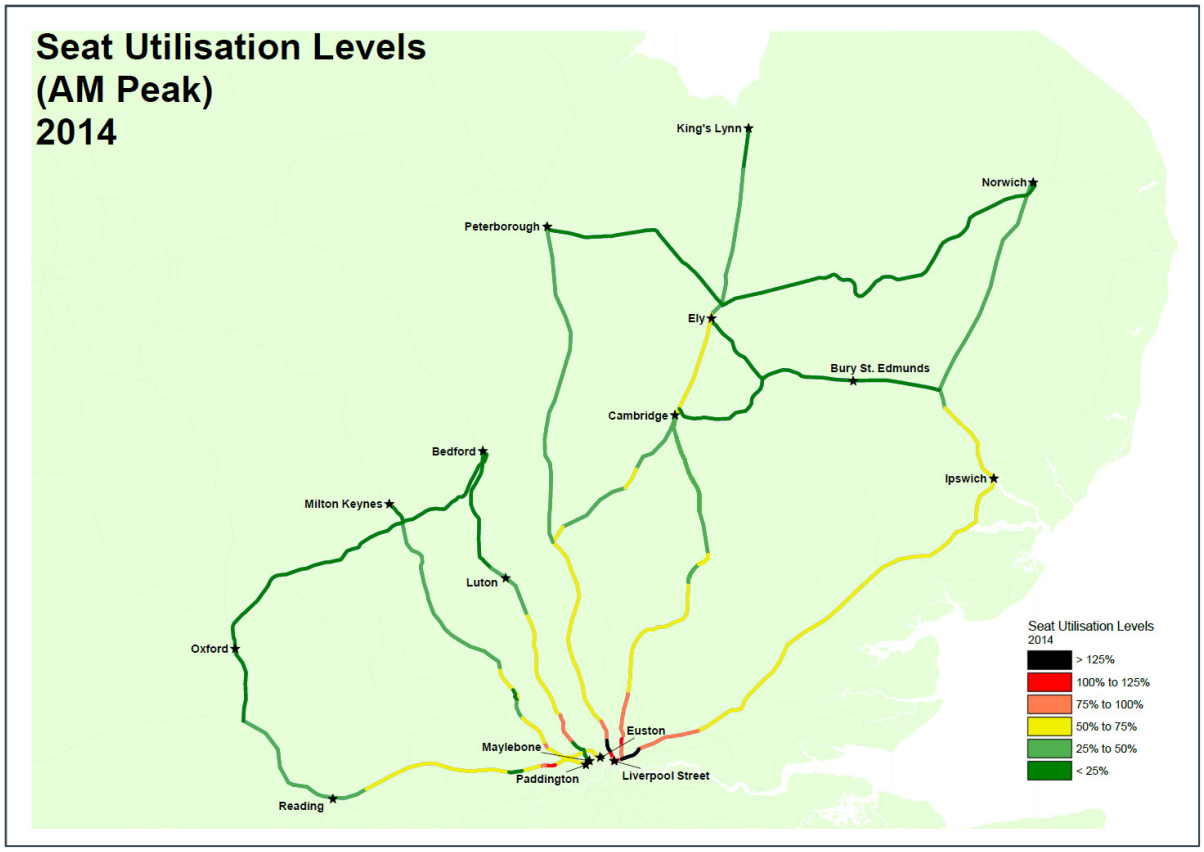


Figure 3-9 2026 AM Peak Rail Crowding

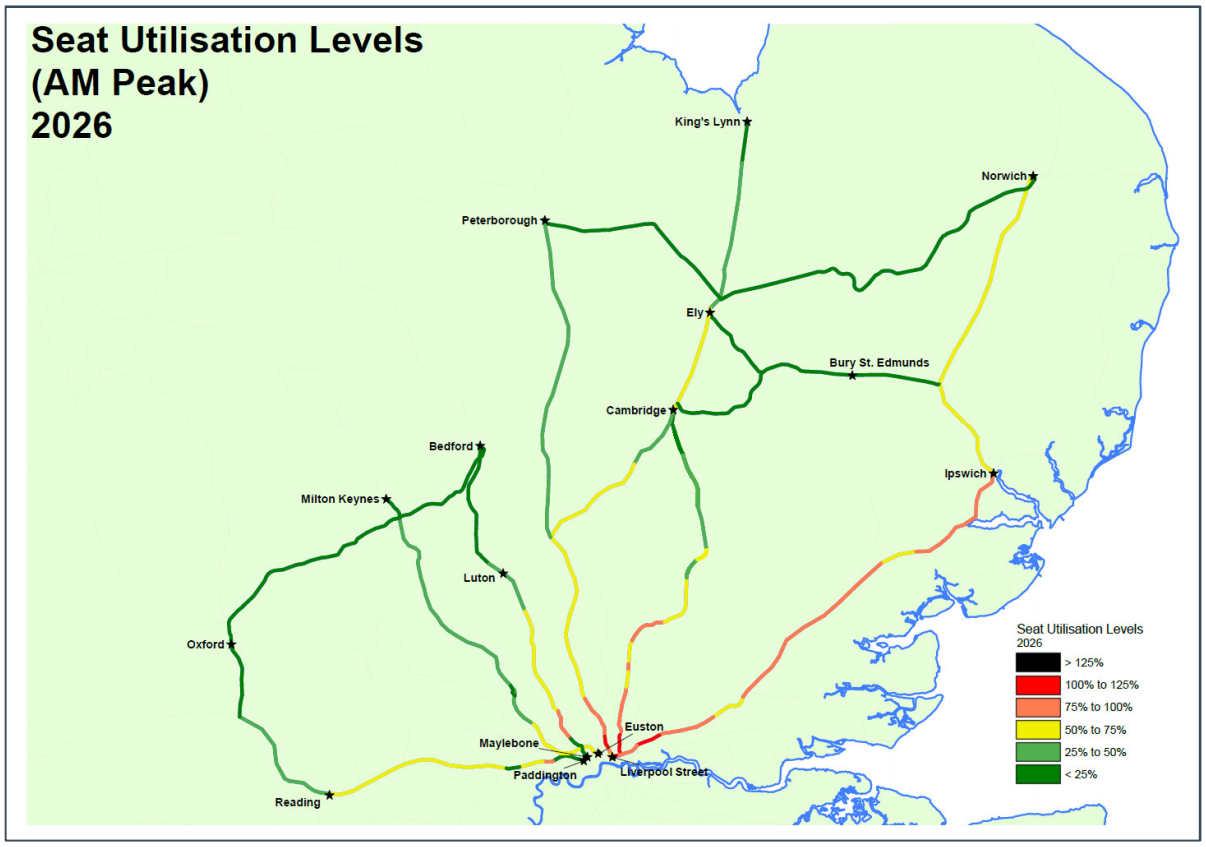
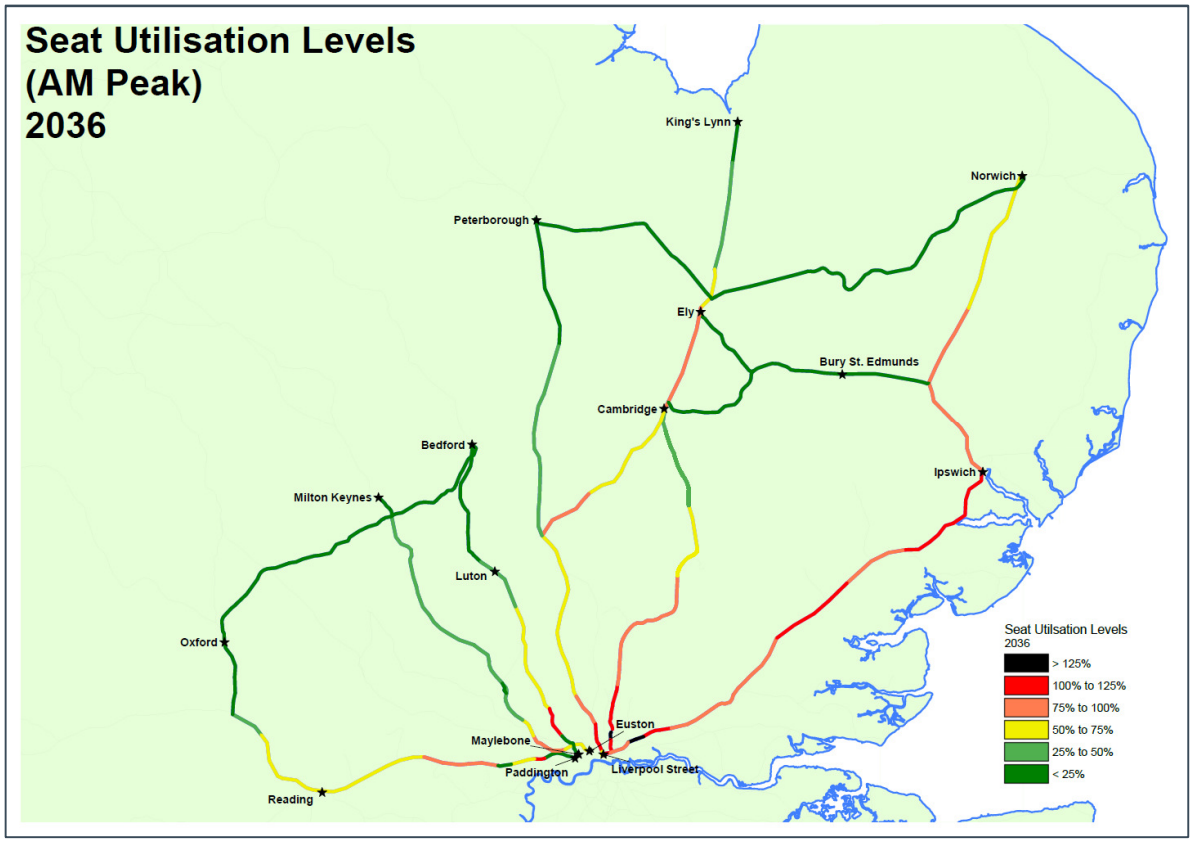


Figure 3-10 2036 AM Peak Rail Crowding



Rail Summary

There are very few location pairs within the study area that are served by a direct rail link with many journeys requiring 2 or 3 interchanges. Where there is a direct rail link, service frequencies are low. As such there is potential to improve the rail service offer in the study area, enabling better labour market participation and business – business interaction, thereby promoting economic growth.

The most severe rail journey times are from east of Cambridge to west of Cambridge and vice versa, as journeys must be made via London, although travelling west to east is the worse direction in the AM peak. For example, Oxford to Cambridge is 158 mins, Oxford to Norwich is 240 mins, Oxford to Great Yarmouth is 320 mins, Oxford to Lowestoft is 324 mins and Oxford to Felixstowe is 191 mins. Long-distance rail journeys have high journey times due to the requirement for multiple interchanges. As a result, business connectivity is poor and Anglia is effectively cut off from key business markets west of London.

The EWR Western and Central sections will create some new direct rail links in the study area. The EWR Western and Central sections will dramatically improve journey times between Oxford and Cambridge, eliminating the need to go via London. The EWR-ES would build on the improvements that the EWR Western and Central sections will bring. Without Eastern Section improvements rail journey times from east of Cambridge to west of Cambridge and vice versa remain poor due to poor infrastructure.

Current rail demand in the study area is constrained to relatively short-distance journeys. For example, Cambridge-Ely, Ipswich-Stowmarket, Bedford-Luton and Oxford-Reading. Demand is focussed on radial routes rather than east-west journeys reflecting service provision. If east-west rail connectivity were enhanced it could unlock demand and increase the rail market, and better connect population centres with employment growth, facilitating growth and development.

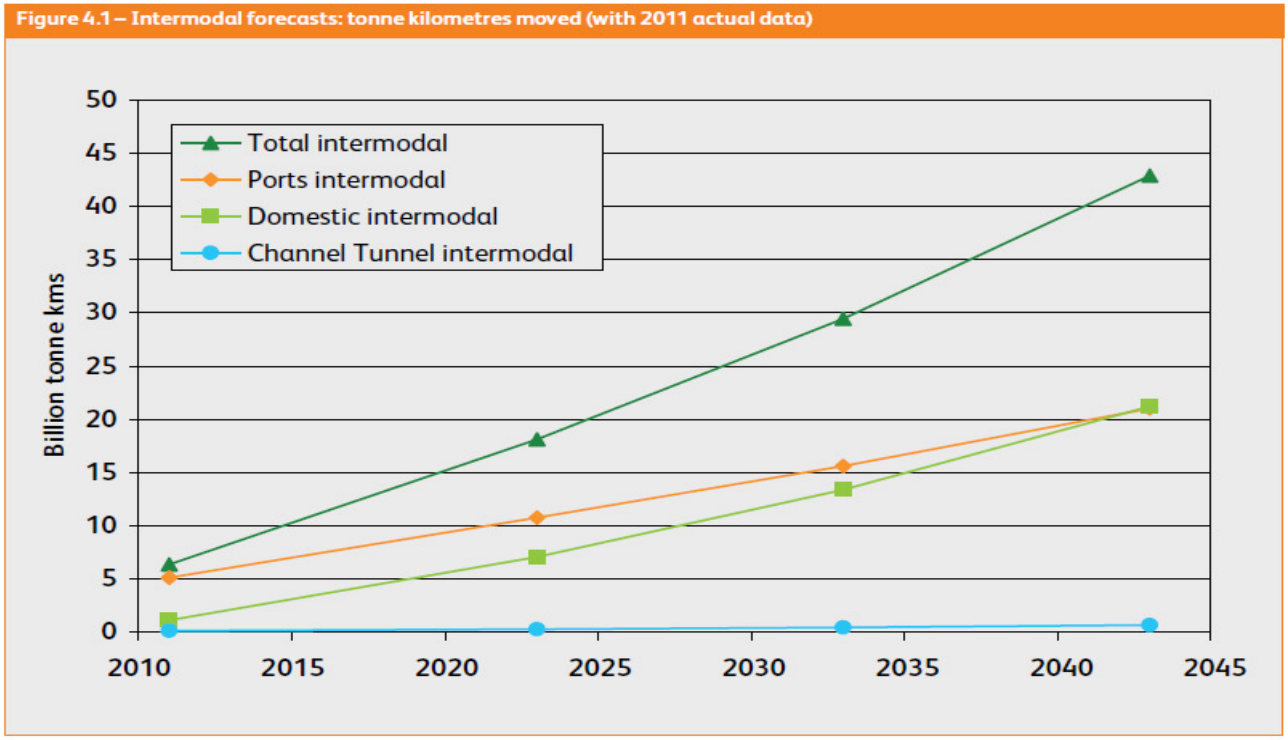
Rail demand is forecast to increase to 2031 but is expected to follow a similar pattern to current rail demand. Crowding levels on AM Peak services to/from London are set to deteriorate. Improved east-west rail

connectivity would remove the requirement to travel via London for east-west journeys and reduce crowding on radial routes.

Rail Freight

Since the mid-1990s, rail freight has increased at about 2.5% per annum. Great Britain imports a wide range of goods due to manufacturing decline and containerised freight has become the single largest commodity conveyed on rail. According to the Network Rail Freight Market Study, the overall forecast for freight growth is for an increase in total tonne kilometres of 2.9% annual growth to 2043. Figure 3-11 presents the intermodal freight growth forecasts.

Figure 3-11 Intermodal Freight Growth Forecasts – Source: Network Rail Freight Market Study



Pressure to secure and expand paths for rail freight on the Strategic Rail Freight Network is an ongoing challenge in the context of parallel pressures to provide paths for passenger services. The London Gateway freight terminal will be developed and there is planned expansion of both Felixstowe and Harwich ports. London orbital routes for freight are already congested so alternative routes from Felixstowe and Harwich are needed. A new rail chord at Ipswich was opened in 2014 to enable direct freight service movements from Felixstowe towards Ely without the need to reverse at Ipswich station. Infrastructure enhancements to enable up to five freight paths per hour between Ipswich and Ely are proposed in the Network Rail Anglia Route Study. The EWR-ES would complement the delivery of the Ipswich chord by enhancing the onward route via Bury St Edmunds to Chippenham Junction. It would also offer an alternative to the existing route via Ely by providing a new link via Newmarket and Cambridge for onward routing to/from the north of the UK via the MML, or to/from the west of England, the South Coast and Wales via Oxford.

Wales and the West Country is a largely under developed region for rail freight and a fully connected EWR link would enable any potential to be fully realised. Additionally, it would enable the possibility of partial separation of passenger and freight traffic, depending on the passenger service specification that has been assumed. This has the potential to offer a significant improvement in train mileage, time and potentially path availability, over alternative routings, most notably via the London orbital lines, that would be required otherwise, though the issue of competition for paths with passenger services would still be a key consideration.

4. Evidence Base Conclusions

Following our review and analysis of the evidence base in terms of the economic and socio-demographic characteristics, and transport demand, networks and performance, we can identify some key conclusions and drivers for a rail based intervention which will guide the development of the Conditional Outputs for the EWR-ES. These are as follows:

- Key population and employment centres east and west of Cambridge that are poorly connected – EWR-ES could substantially improve connectivity, increasing opportunities to access jobs and business opportunities.
- Norfolk and Suffolk coastal towns are targets for regeneration and growth – improving connectivity from these towns through EWR-ES could be key to achieving this and will help to tackle deprivation by opening up new job and travel opportunities.
- Congestion on rail routes to/from London – EWR-ES could provide a viable alternative to travelling via London, connections to alternative job locations and alternative leisure routes.
- High demand and journey times suggesting congestion on the highway network, specifically the A11 and A14 corridors – EWR-ES could ease pressure on the highway network by encouraging mode shift.
- High demand and journey times on the East Anglia regional rail network – improved journey times through EWR-ES would bring significant benefits.
- Significant rail freight growth forecast to 2043 – EWR-ES could provide the necessary track capacity to accommodate this growth.
- Opportunities for improved east-west rail service provision due to gaps 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 – EWR-ES has the opportunity to reduce car dependency and support a change in the shape of the regional economy.

These drivers for intervention will act as a framework in further analysis of passenger journey times and demand, and the identification of priority journey pairs.

Analysis so far has led to the identification of the following target markets, which represent a set of competing needs. The subsequent processes of prioritisation and developing specimen specifications considered balancing these needs as far as possible:

- Main Line Connections;
- Airport Connections;
- Commuting within the region east of Cambridge;
- Longer distance business and leisure journeys; and
- Felixstowe-Ely-Nuneaton for freight.

5. The Approach to Identifying Passenger Service Conditional Outputs

5.1. Factors that will Influence EWR-ES Service Viability

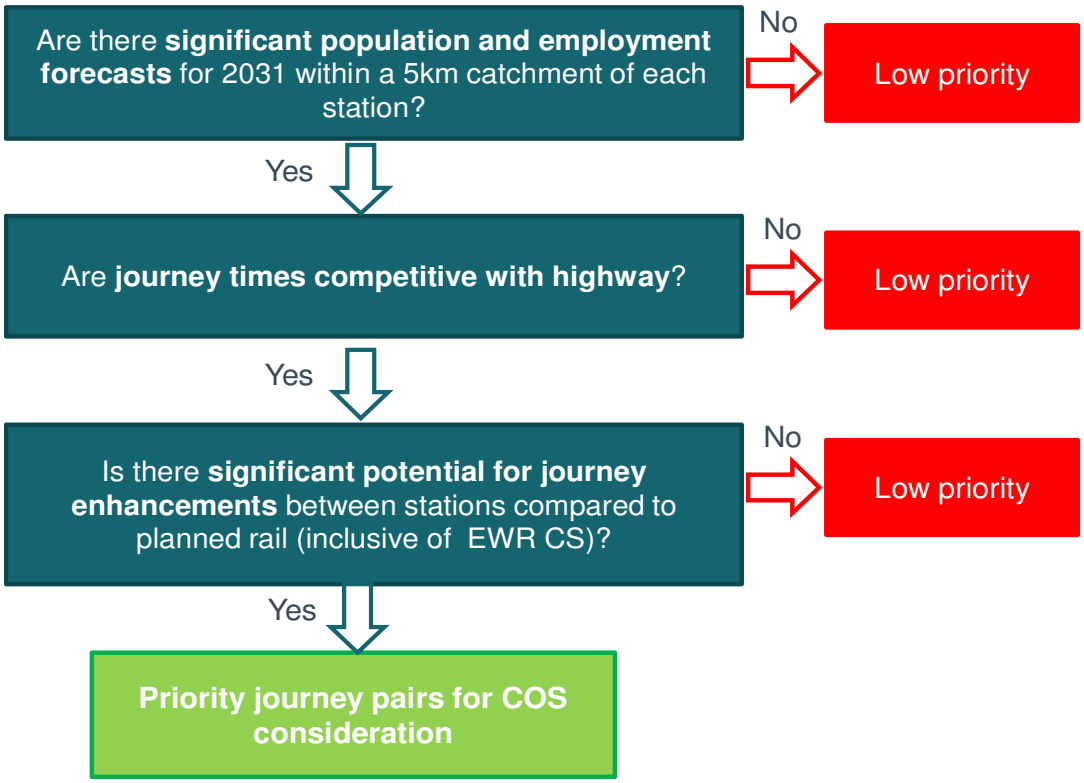
There are a number of factors that will have an influence on the potential use of future rail services which make use of the EWR-ES. These include:

- Size and type of the potential travel market being served;
- Journey distance involved;
- Extent to which the service will be competitive against car; and
- Extent to which the service enhances journey time and convenience relative to what rail already offers.

These factors need to be considered in identifying the overall Conditional Outputs in terms of the station to station journeys to be enabled and the service performance level (in terms of journey time and service frequency) to be delivered. All of these factors are intrinsic within the analytical processes we have adopted to determine the Conditional Outputs.

The flowchart in Figure 5-1 identifies key criteria used to identify priority journey pairs for COS consideration. This involves utilising the evidence base analysis on population and employment, further interrogating journey time competitiveness between rail and highway, and gauging the potential for enhancing rail service provision. Where all of these criteria are met, the journey pair will be considered a priority.

Figure 5-1 Process for Identifying Priority Journey Pairs



Firstly, the study area location pairs have been defined as either a predominantly commuting or business route. This is because journey time competitiveness between rail and highway is assessed using different criteria depending on whether the location pair is predominantly a commuting or business route. This assessment is described in more detail later in this section. Location pairs that do not include a location of significant population, employment, output or growth, or are not part of a significant commuting corridor, as per the evidence base analysis, have been excluded. This is based on the evidence base analysis in sections 2.2 and 2.3. Figure 5-2 below summarises these definitions.

Figure 5-2 Defining OD Pairs as Commuting or Business Routes

	Cambridge	Ely	King's Lynn	Newmarket	Thetford	Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	0	C	B	C	C	B	B	B	B	C	B	B	B	B	B	B	B	C	C	B	B	B	B	B	B	B	B	B	B	B
Ely	C	0	C	0	C	C	C	0	B	C	0	B	0	0	B	B	0	0	B	B	0	B	B	B	B	B	C	B	B	B
King's Lynn	B	C	0	C	C	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	B	B	B
Newmarket	C	0	C	0	0	0	B	0	B	C	0	B	C	0	B	B	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Thetford	C	C	C	0	0	C	C	0	B	C	0	B	0	0	B	B	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Attleborough	B	C	C	0	C	0	C	0	B	C	0	B	0	0	B	B	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Norwich	B	C	C	B	C	C	0	C	C	B	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Cromer	B	0	B	0	0	0	C	0	B	B	0	B	0	0	B	B	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Great Yarmouth	B	B	B	B	B	B	C	B	0	B	B	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Bury St Edmunds	C	C	B	C	C	C	B	B	B	0	C	B	C	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Diss	B	0	B	0	0	0	C	0	B	C	0	C	0	0	C	B	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Lowestoft	B	B	B	B	B	B	C	B	C	B	C	0	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Stowmarket	B	0	B	C	0	0	B	0	B	C	0	B	0	0	C	C	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Sudbury	B	0	B	0	0	0	B	0	B	C	0	B	0	0	C	C	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Ipswich	B	B	B	B	B	B	B	B	B	C	C	B	C	C	0	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B
Felixstowe	B	B	B	B	B	B	B	B	B	B	B	B	C	C	C	0	C	B	B	B	B	B	B	B	B	B	B	B	B	B
Harwich	B	0	B	0	0	0	B	0	B	B	0	B	0	0	C	C	0	0	B	B	0	B	B	B	B	B	B	0	B	B
Sandy	C	0	B	0	0	0	B	0	B	B	0	B	0	0	B	B	0	0	C	C	0	B	B	B	B	C	B	0	B	B
Bedford	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	0	C	C	B	B	B	B	C	B	B	B	B
Milton Keynes	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	0	C	C	C	B	B	B	B	B	B	B
Bletchley	B	0	B	0	0	0	B	0	B	B	0	B	0	0	B	B	0	0	C	C	0	C	C	B	B	B	B	0	B	B
Bicester	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	0	C	C	B	B	B	B	B	B
Aylesbury	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	C	0	C	B	B	B	B	B	B
Oxford	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	0	C	B	B	B	B	B
Reading	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	0	B	B	B	B	B
Stevenage	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	B	B	B	B	B	B	0	B	B	C	B
Peterborough	B	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	0	B	B	B
Stansted Airport	B	B	B	0	0	0	B	0	B	B	0	B	0	0	B	B	0	0	B	B	0	B	B	B	B	B	B	0	C	B
Harlow	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	B	C	0	B
Luton/Luton Airport	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	0

Further analysis of the relationship between journey times and passenger demand, based on data from PLANET South and the A14 Highway Model, has been carried out. Rail is identified as the relatively faster mode for shorter trips while highway is preferable for longer trips. There are very few trips of more than 60 minutes by rail in the study area. However, this would likely change with improved east-west rail connectivity making rail more attractive. In terms of identifying priority journey pairs, this analysis has influenced the criteria that we have used to ascertain the journey time competitiveness of business to business and commuting journeys using EWR-ES. This is described in more detail later in this section.

Figures 5-3 to 5-6 show the relationship of demand and journey time for highway and rail currently and in the future.

Figure 5-3 Highway Demand vs Journey Time 2014

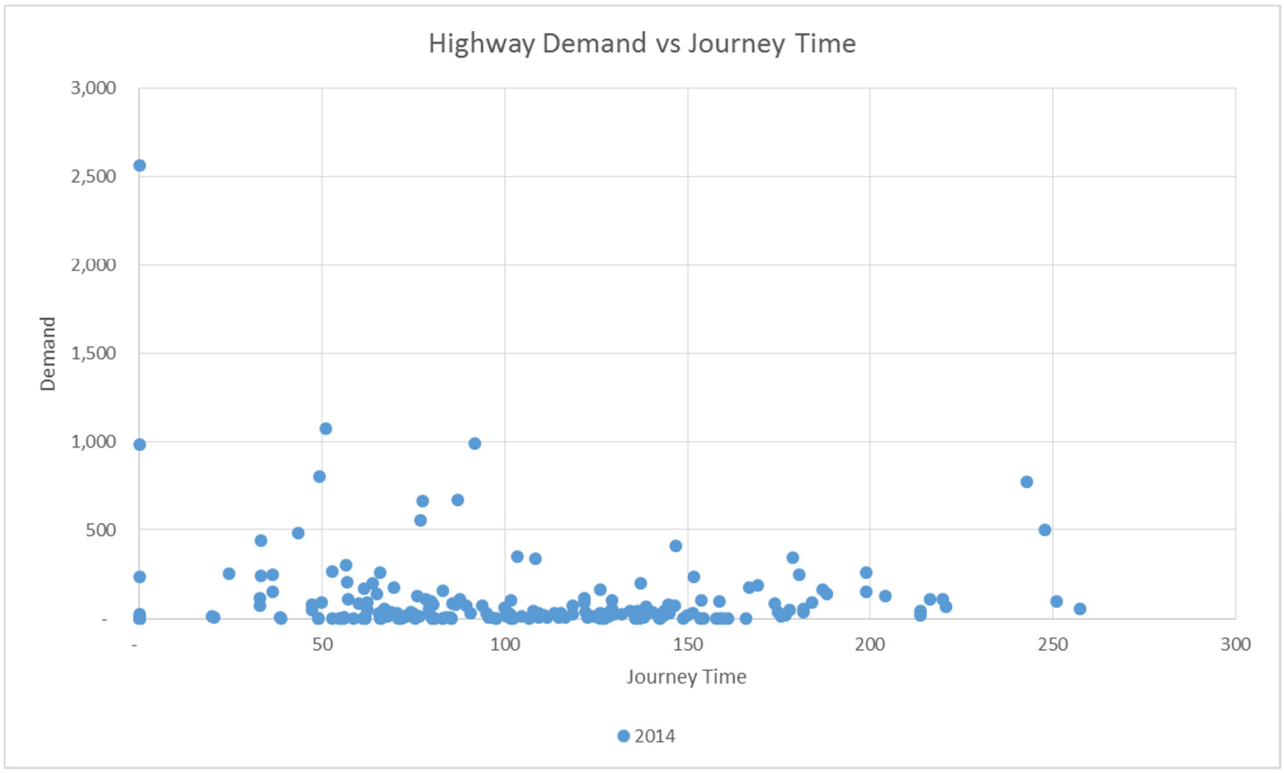


Figure 5-4 Highway Demand vs Journey Time 2035

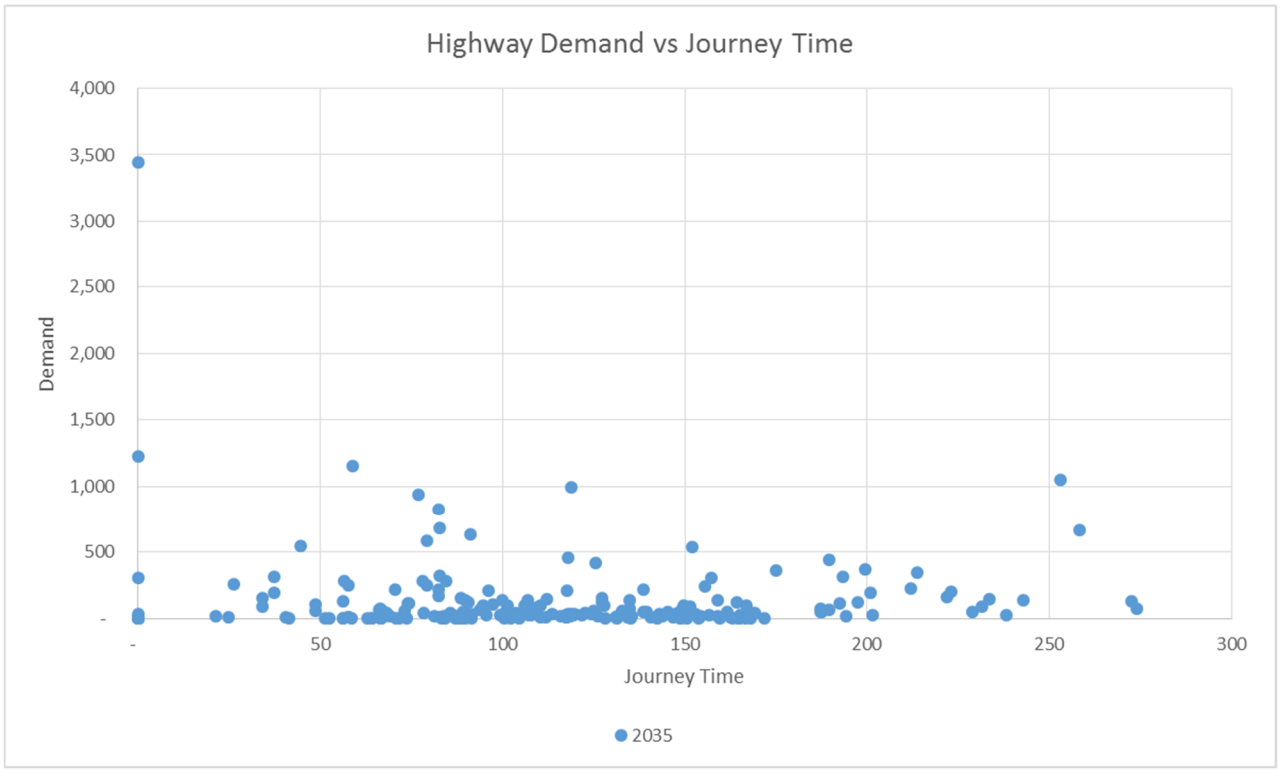


Figure 5-5 Rail Demand vs Journey Time 2014

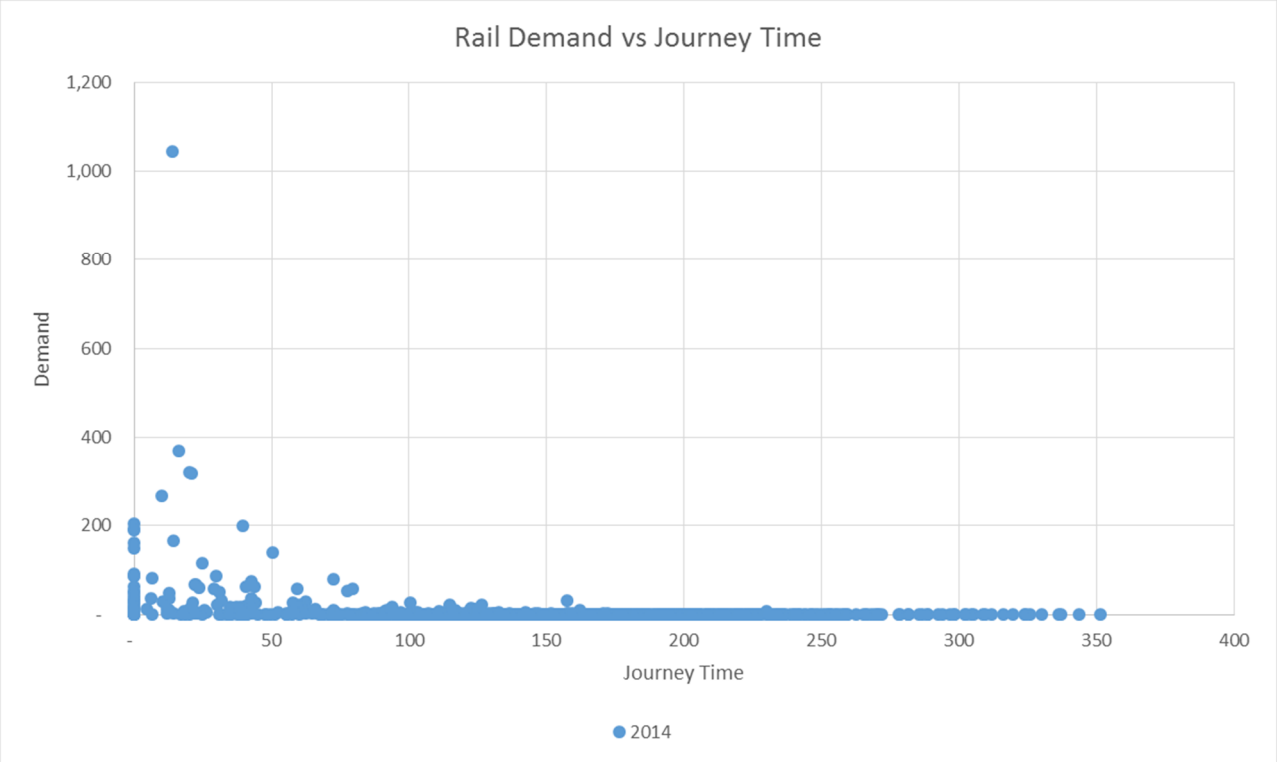
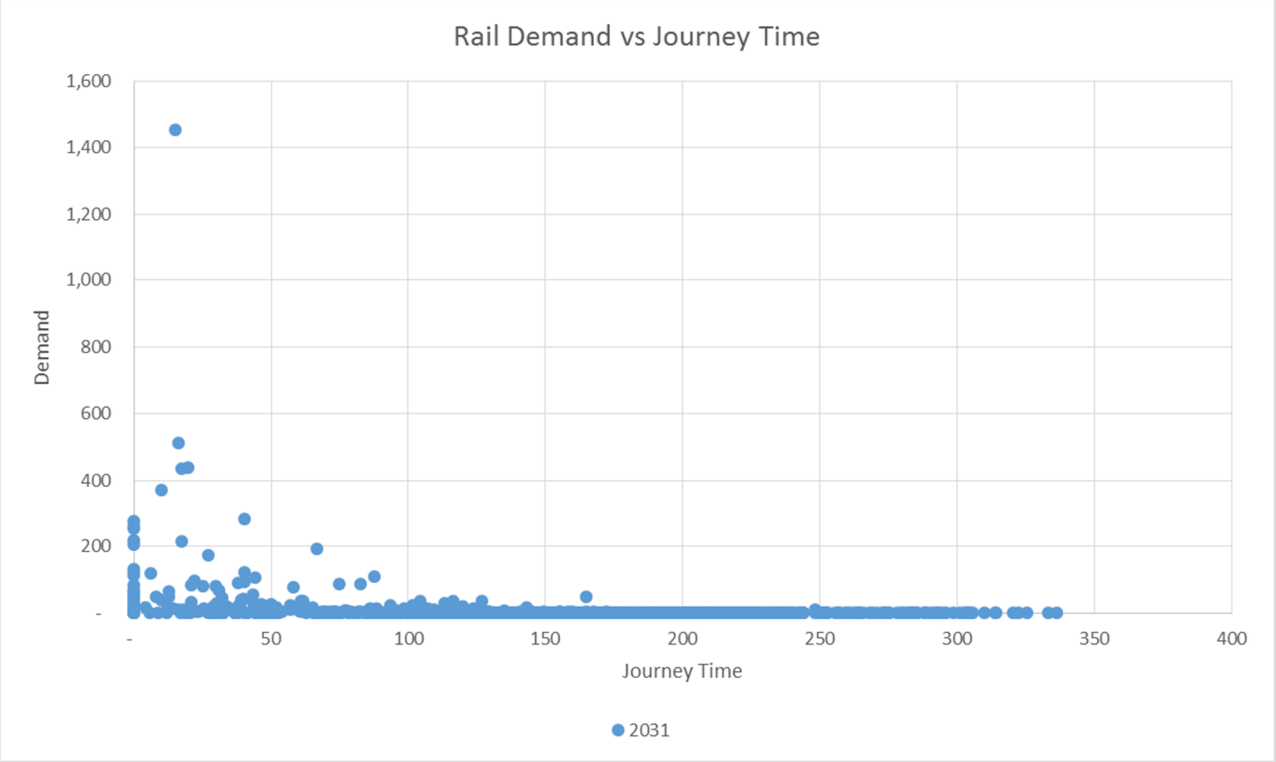


Figure 5-6 Rail Demand vs Journey Time 2031



In order to give an early indication of journey time competitiveness between highway and rail for location pairs in the study area, 2031 highway journey times have been derived from current highway journey times and growth based on the A14 Highway Model. These have then been compared against 2031 rail IVTs from PLANET South. Assumed IVTs between Bedford and Cambridge have been based on the Central Section COS with OD pairs routing via the EWR Western, Central and Eastern sections. The potential for rail journey

enhancement is then based on the availability of direct services (with EWR Western and Central sections) and service frequencies.

Journey Time Competitiveness: Business to Business

For each station pair, the level of rail journey time competitiveness with highway was assessed comparing the indicative EWR-ES times to car times using the following set of criteria:

Very strong: rail journey time is at least 40% quicker than highway and less than 60 minutes;

Strong: rail journey time is at least 20% quicker than highway and less than 120 minutes;

Moderate: rail journey time is quicker than highway (with no interchanges) and/or has a journey time greater than 120 minutes; and

Weak: rail journey time is longer than highway or under 20% quicker but has at least one interchange.

These criteria recognise the need to account for access/egress and wait components to rail journeys versus car, whilst also recognising the propensity to travel longer journey times and distances for business to business purpose.

Journey Time Competitiveness: Commuting

The observed reduced willingness to commute for longer periods is reflected in the criteria which we have adopted:

Very strong: rail journey time is at least 40% quicker than highway and less than 30 minutes;

Strong: rail journey time is at least 20% quicker than highway and less than 60 minutes;

Moderate: rail journey time is quicker than highway (with no interchanges) and/or has a journey time greater than 60 minutes; and

Weak: rail journey time is longer than highway or under 20% quicker but has at least one interchange

It is important to note that commuting in-vehicle times by rail to London from within the study area are often less than 60 minutes.

Potential for Rail Journey Enhancement

The potential for EWR-ES to enhance journeys between station pairs vs a 2031 reference case with EWR Western and Central Sections was assessed:

Very strong: No direct journey available

Strong: Direct journey but low level of service frequency (<1tph)

Moderate: Direct journey and reasonable level of service frequency (1-2 tph)

Weak: Direct journey and good level of service frequency (>2tph)

Overall assessment

Criteria were then combined to give an overall level of priority for each station pair according to the following criteria:

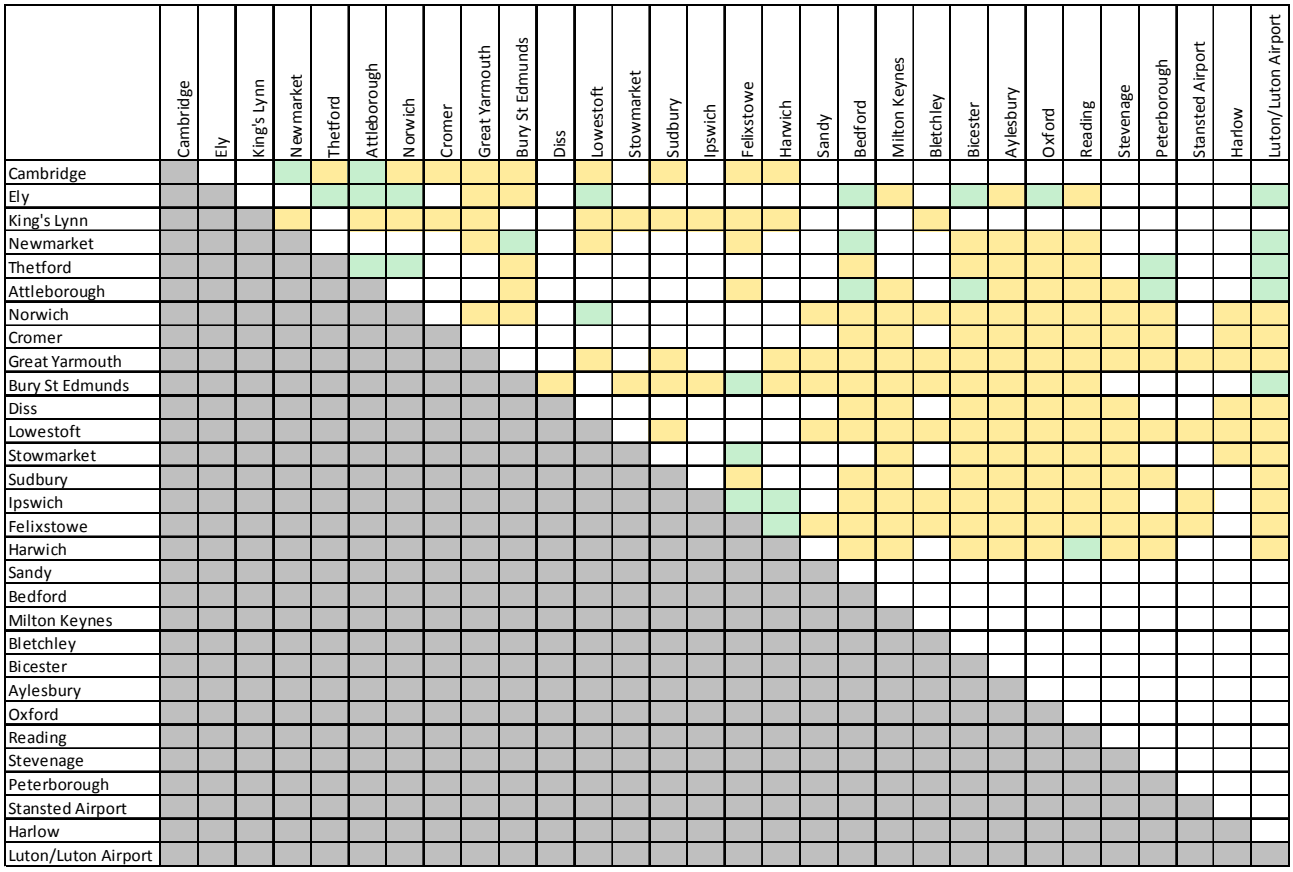
High priority: Very strong/strong journey time competitiveness and very strong/strong potential for journey enhancement

Moderate priority: Moderate journey time competitiveness and very strong/strong potential for journey enhancement

Low priority: Weak journey time competitiveness or moderate/weak potential for journey enhancement

The prioritisation process is summarised in Appendix C. A final set of priority pairs has been produced by selecting High and Moderate pairs only, removing duplicates and removing pairs that are out of scope, either because they are part of a committed scheme or outside the objectives of the EWR-ES. These High and Moderate priority pairs are presented in Figure 5-7 below:

Figure 5-7 High and Moderate Priority Pairs



Based on location pairs in the study area where rail journey times could compete with highway and there is scope to introduce direct services or enhance service frequencies:

- The commuting corridor between Cambridge and Norwich (via Ely, Thetford and Attleborough) is a priority covering all OD pairs.
- Similarly the commuting corridors from Bury St Edmunds via Newmarket to Cambridge, and via Stowmarket to Ipswich are priorities.
- There are opportunities for improved rail connectivity to the ports of Felixstowe and Harwich, as well as the coastal towns of Lowestoft and Great Yarmouth targeted for regeneration and where in some locations there are typically higher levels of deprivation. These opportunities are for both passengers and freight.
- In terms of longer distance trips, there are opportunities to serve demand to Bedford, Milton Keynes, Bicester and Aylesbury and further beyond to Oxford and Reading.
- Some of these locations have already been identified as providing interchanges with inter-regional rail lines (e.g. Bedford for the Midland Main Line, Milton Keynes for the West Coast Main Line and Reading for the Great Western Main Line).
- Access to Luton/Luton Airport is also seen as a priority, more so than Stansted Airport where highway journey times outperform rail even with the EWR-ES improvements.
- The results reiterate the target markets as follows:
    - Main Line Connections (e.g. Bedford, Milton Keynes, Reading);
    - Airport Connections (e.g. Luton Airport);
    - Commuting within the region east of Cambridge (e.g. between Cambridge and Norwich, Bury St Edmunds to Cambridge, Stowmarket to Ipswich);

- Longer distance business and leisure journeys (e.g. from East Anglia to Oxford and Reading or trips to/from Great Yarmouth and Lowestoft); and
- Felixstowe-Ely-Nuneaton for freight.

The next step is to use these priority journey pairs to derive an indicative view on the potential for EWR-ES services to deliver benefits through the use of a gravity model.

5.2. Deriving an Indicative View on the Potential for EWR-ES Services to Deliver Benefits

5.2.1. Transport User Benefits

Drawing on the evidence base analysis and identification of related transport network and travel demand drivers for intervention, we have assessed the extent to which the introduction of rail services enhancements enabled by an EWR-ES scheme would **enhance transport network performance and its capacity to meet and unlock latent travel demand**. Change in Generalised Journey Time (GJT) benefits has been calculated on a journey pair basis to enable the value of specific potential Conditional Output enhancements to be understood relative to one another.

There is also the potential for the **extraction of trips from the highway network**. The introduction of a viable and attractive and efficient rail alternative to travel by car on east-west routes and associated **car to rail mode shift** that these services could achieve has the potential to reduce CO_2 emissions. We have analysed the potential for congestion relief along key routes assuming a level of mode shift from car to rail based on a WebTAG-compliant proportion of the increase in rail demand driven by the GJT change. This would generate climate change benefits given the issues already outlined with respect to pressures for growth, poor rail connectivity and associated problems with respect to ongoing use of the road as a mode of transport despite increases in delay and congestion, all having potentially adverse implications in terms of significant increases in transport related CO_2 emissions.

Transport user benefits were calculated in a fashion consistent with WebTAG with the main driver for these benefits being changes in journey times. The level of rail demand forecast in the gravity model was used to provide a high-level indication of the potential to deliver mode shift from car based on an assumed level of diversion from car to rail. Benefits were calculated for the three growth scenarios.

5.2.2. Estimating GVA Impacts

Connectivity between key knowledge-based centres is a key potential driver for increased economic productivity (GVA) through more efficient business to business (B2B) activity. **Improvements to rail frequency, journey times and reliability on these corridors will increase the attractiveness of public transport compared with highway for journeys to centres of employment in the East of England.** 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.

A fixed land use model has been developed that generates GVA impacts from service improvements that are separate from, but should not be treated as additional to, those inherent in conventional transport 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. Due to the experimental nature of these results it should be noted that the values of these GVA benefits should only be used to compare journey pairs and locations in a relative sense rather than using the absolute values. These results, together with the transport user benefits will provide a comprehensive set of data from which we can identify key journey pairs for inclusion in the overall Conditional Outputs.

Guidance on how to measure Wider Economic Impacts can be found in WebTAG unit A2.1. To rank journey pairs that experience a service enhancement, variants of formulas 2.1a and 2.2 were used to estimate agglomeration impacts for each journey pair. Agglomeration economies are found in areas where economic activity is concentrated and as improved transport increases the connectivity to other jobs and markets, the

scale of benefits from agglomeration increases. The main drivers for agglomeration are knowledge spillovers, greater market specialisation and B2B interaction.

The number of jobs in 2km catchments around each destination divided by the cost it takes to reach them, after having a decay parameter applied to this cost, gives the effective density of each destination. This is a score of how many jobs can be reached in a reasonable time frame. The increase in effective density between Do Minimum and Do Something has an agglomeration elasticity applied to it, which is then multiplied by the number of workers and their productivity to give the agglomeration impact.

5.3. Gravity Modelling

High and Moderate priority journey pairs were tested against a reference case which included the EWR Western and Central Sections. Three versions of the model were created based on the three growth scenarios. The economic assessment identified movements on which the greatest benefit will be derived and is based on a two-stage modelling process using MOIRA to forecast changes in demand and a gravity model to more accurately forecast the impact of large changes in journey time.

The model produces demand and passenger mileage forecasts for each station to station OD pair identified. For each OD pair contained in the model, there are two sets of demand forecast subject to the change in Generalised Journey Time (GJT). When the GJT change is less than 30% compared to the Do Nothing (present day) scenario, the elasticity approach is adopted; otherwise the higher number between the gravity model forecast and the elasticity forecast is selected. This demand is then grown to future years (2016, 2021, 2026, and 2031) by the exogenous demand factors.

The demand modelling has used a split between season ticket and non-season ticket journeys in order to apply elasticities at a disaggregate level. For the purposes of quantifying time benefits, demand has been further disaggregated into business, commute and leisure trips. User benefits have been driven by changes in GJTs, taking into account the relevant perceived values of 'In Vehicle Time' (IVT), walking, waiting and interchanging time.

Base rail demand is taken from MOIRA (2013). For the nature of the project and simplicity, this demand is treated as 2011 base year demand. MOIRA provides more detail than PLANET South (split by season ticket and non-season ticket journeys) and provides annual data but the two sources have been checked for consistency.

Exogenous growth factors for population and employment have been outlined in section 2.3. Further exogenous growth factors include non-car ownership (from TEMPRO 7.2), GDP, road journey times and fares (all from PDFH 5.1 guidance). Table 5-1 summarises the exogenous growth factors from PDFH 5.1.

Table 5-1 PDFH Exogenous Growth Factors

	2011	2016	2021	2026	2031
Fares Growth	1.00	1.05	1.10	1.16	1.22
GDP Growth	1.00	1.020	1.04	1.06	1.08
Road Journey Times	1.00	1.02	1.04	1.06	1.08

5.3.1. Elasticity Approach

Table 5-2 presents the elasticity values that have been adopted for the model from PDFH 5.1.

Table 5-2 Elasticity Values

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

5.3.2. Gravity Approach

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:

GJT (a)
the number of jobs within 2km of origin (b)
the number of population within 2km of origin (c)
the number of jobs within 2km of destination (d)
£/mile (e)

The model parameters are shown below in Table 5-3.

Table 5-3 Gravity Model Parameters

Ticket Type	*a*	*b*	*c*	*d*	*e*
Non-Season	-1.46	0.23	0.40	0.70	-0.95
Season	-4.55	0.92	1.03	0	-3.17

For application within forecasting an average fare per mile of £0.07/mile for Non-Season and £0.13/mile for Season tickets has been applied.

The gravity model parameters have been taken from the gravity model used in the latest EWR Central Section business case. Given that our study area largely falls within the area for which these parameters were calibrated, it was not deemed proportionate to recalibrate the model. The OD pairs used in the calibration covered 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.

For each OD pair, MOIRA was used to extract the existing bi-directional demand and revenue by Full/Reduced/Season ticket types, the GJT, the average rail yield (fare), and the rail distance. The highway distances and journey times were imported from an external source. Population and employment were extracted from Census data around each station in buffers ranging from 0.5km to 5km.

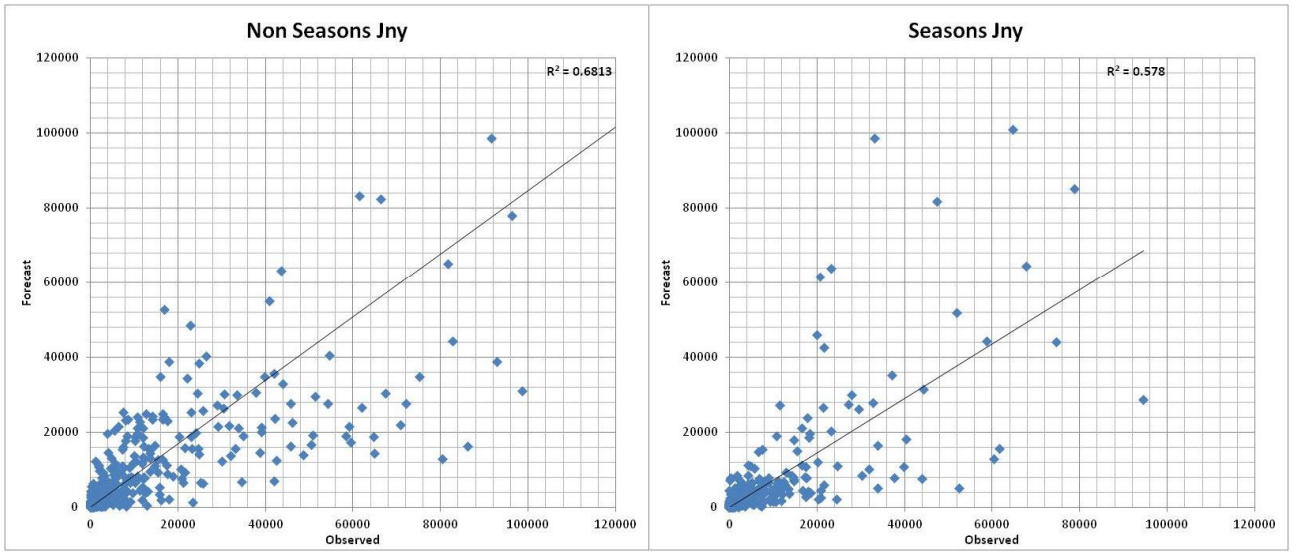
The above provided the input dataset for calibration where the single dependent variable (rail demand) is affected by the multiple independent variables (e.g. population, employment, fare/km, GJT, relative levels of accessibility by rail and highway).

As the original function of the gravity model is a power function, a log transformation was conducted to allow a least squared multiple linear regression to be carried out to provide a best fit regression between demand and the set of explanatory variables.

Over a hundred possible gravity model structures were tested in this way separately for season and non-season ticket journeys. The resulting models are those that provided the best fit to the calibrated data.

Figure 5-8 below shows observed flows against forecast flows for the dataset used to calibrate the gravity model, separately for non-season and season journeys.

Figure 5-8 Gravity Model Calibration



The figure shows that although variation remains between the observed and forecast demand, the gravity model explains a considerable amount of the variation between station pairs. This is considered suitable for forecasting demand between OD pairs where step changes in rail accessibility make forecasting an incremental change via GJT elasticity unreliable. Factors which are not considered within the gravity model, but which may account for some of the remaining variation in demand between OD pairs include:

- Varying catchment areas – for instance stations may attract passengers from varying areas depending on the direction of travel, or on the total length of the journey.
- Socio-economic factors – for instance the University associations.
- The spatial setting of each station – for example relatively isolated areas may attract a higher number of trips than stations within an urban conglomeration.

5.4. Deriving Target EWR-ES Service Specifications

GJTs for the Do Nothing and Do Minimum scenarios are obtained from MOIRA, split by Full, Reduced and Season tickets. MOIRA provides more detail than PLANET South but the two sources have been checked for consistency.

For the Do Something scenario, target journey times that might be delivered between the priority journey pairs have been refined using a set of assumptions on potential average train speeds and a geographical basis for deriving indicative journey distances. It should be noted that these are aspirational journey times based on a broad alignment rather than a specific route.

OD distances were assumed to be unchanged from the Do Minimum. A speed of 80mph was then assumed to calculate IVTs for the Do Something scenario for each OD pair. This is a starting point for analytical purposes and reflects that any new/upgraded routes would be built to a high standard and would be operated by modern diesel or electric traction which would be capable of 125mph, rapid acceleration and deceleration.

A further consideration is the frequency of service. It is important to note that EWR-ES services are assumed to operate at a 2 tph service frequency (per direction). This is therefore a key service specification assumption which is intrinsic to the derivation of the potential benefits of the scheme. Do Nothing/Do Minimum service frequencies were derived from MOIRA and where journey pairs replicate the Do Nothing/Do Minimum networks, the Do Something is treated as an extension and frequency enhancement.

Do Something GJTs are then based on the following calculation:

GJT = In Vehicle Time (IVT) + Interchange Penalty + Service Frequency Penalty

The interchange and service frequency penalties are taken from PDFH 5.1 guidance as per tables 5-4 and 5-5 below.

Table 5-4 Service Frequency Penalty

Headway (mins)	Full\Season (mins)	Reduced (mins)
5	5	5
10	10	10
15	15	14
20	19	17
30	26	21
40	31	23
60	39	27
90	51	33
120	63	39
180	87	51

Table 5-5 Interchange Penalty

Distance (miles)	Full\Reduced (mins)	Season (mins)
0	10	7
15	15	10
30	19	12
50	25	16
70	31	20
100	40	26
150	55	36
200	65	36
300	85	36
over 325	90	36

As the GJTs for the Do Something scenario are based on calculations while for the Do Nothing and Do Minimum they are from the MOIRA output, there are potentially instances where the Do Minimum GJTs are lower than those of the Do Something. When these instances occur, the lowest GJT is selected. For numerous long distance routes, journeys via London may be “quicker” in terms of in-vehicle time, but would require interchanges and wait times between services.

6. Prioritisation Results

6.1. Journey Pair Benefits Analysis

Process for identification of priority journey pairs

Having established the indicative benefits performance of each journey pair (in terms of transport user benefits and GVA impacts) the relative performance of all journey pairs was assessed. **GJT benefits have been monetised using WebTAG values of time. For business users, this has involved the application of a continuous function of values of time by distance.**

The number of journey pairs tested was very significant and for analysis purposes the pairs were identified with one of four target EWR IVT categories:

- 0 – 30 minutes;
- 30 – 60 minutes;
- 60 – 90 minutes; and
- 90+ minutes.

The range of impact and benefit that the journey pairs generated was examined for all three growth scenarios. The key findings were as follows:

- In the TEMPRO growth scenario, for journeys up to 30 minutes, the top ranked journey pairs include commuting trips to/from Cambridge, Norwich and Ipswich and leisure trips to/from the coastal towns.
- For journeys between 30 and 60 minutes, the top ranked journey pairs include trips from east of Cambridge (e.g. Bury St Edmunds) to west of Cambridge (Bedford, Milton Keynes, Aylesbury, Oxford) and trips from Cambridge to Norwich, Felixstowe and Harwich.
- For journeys between 60 and 90 minutes, the top ranked journey pairs include business trips from Reading, Oxford, Aylesbury and Milton Keynes via Cambridge towards Norwich and Ipswich.
- For journeys of more than 90 minutes, the top ranked journey pairs include trips along the full extent of EWR, from Aylesbury, Bedford, Milton Keynes, Oxford and Reading to the coastal towns and ports of East Anglia.
- Trips to/from Luton/Luton Airport do not appear in the top ranked journey pairs when treated separately but would be more of a priority if Luton and Luton Airport were merged.
- The other growth scenarios (EEFM and Local Plans) produce similar top ranked journey pairs for each journey time category.
- A sensitivity test that assumed average 60mph running revealed the same conclusions, albeit some journey pairs moved to a different journey time category (e.g. Oxford to/from Bury St Edmunds moves from 30-60 mins to 60-90 mins).

Tables 6-1 to 6-12 present the 2031 benefits performance of the top 20 ranked journey pairs (according to a combined ranking of GJT benefits, mode shift from car to rail and GVA impacts), by each of the four journey time categories for all three growth scenarios. A glossary of station codes is provided in Appendix D.

Table 6-1 2031 Benefits Performance of Top Ranked Journey Pairs, TEMPRO Growth, 0-30 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	NRW - LWT	761,679	2,879,003	748,541
2	LWT - NRW	1,130,270	3,672,998	954,979
3	GYM - NRW	1,150,392	3,318,453	862,798
4	NRW - GYM	466,918	1,033,052	268,593
5	GYM - LWT	538,178	506,960	131,809
6	LWT - GYM	433,460	432,338	112,408
7	BSE - CBG	220,038	926,215	240,816
8	IPS - FLX	251,485	431,101	112,086
9	NMK - CBG	294,771	657,768	171,020
10	IPS - HWC	121,844	484,712	126,025
11	IPS - HPQ	120,204	495,076	128,720
12	NMK - KLN	187,316	659,073	171,359
13	TTF - NRW	226,381	679,336	176,627
14	CBG - NMK	149,079	268,629	69,843
15	SMK - BSE	152,857	499,959	129,989
16	HPQ - IPS	135,104	530,456	137,919
17	BSE - DIS	65,964	199,970	51,992
18	FLX - IPS	187,707	176,926	46,001
19	CBG - BSE	72,992	198,889	51,711
20	FLX - HPQ	80,769	204,942	53,285

Table 6-2 2031 Benefits Performance of Top Ranked Journey Pairs, TEMPRO Growth, 30-60 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	Bedford - BSE	510,526	1,596,580	415,111
2	AYS - BSE	537,904	1,988,426	516,991
3	MKC - BSE	480,212	1,544,444	401,555
4	OXF - BSE	482,355	2,286,801	594,568
5	IPS - KLN	400,699	1,373,231	357,040
6	BSE - Bedford	544,943	1,820,509	473,332
7	BSE - OXF	429,818	2,064,498	536,770
8	NRW - CBG	596,956	1,823,335	474,067
9	BLY - IPS	389,357	1,686,936	438,603
10	IPS - BLY	290,891	1,289,209	335,194
11	BSE - MKC	360,652	1,205,298	313,378
12	CBG - FLX	235,390	722,778	187,922
13	BLY - BSE	294,530	1,240,721	322,588
14	BSE - NRW	316,922	1,256,702	326,743
15	CBG - HPQ	212,979	599,332	155,826
16	CBG - HWC	211,295	576,753	149,956
17	KLN - IPS	309,323	975,477	253,624
18	CBG - NRW	331,174	992,686	258,098
19	LUT - BSE	285,960	871,356	226,553
20	OXF - NMK	171,105	668,764	173,879

Table 6-3 2031 Benefits Performance of Top Ranked Journey Pairs, TEMPRO Growth, 60-90 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - BSE	802,307	2,942,249	764,985
2	RDG - IPS	973,045	3,337,355	867,712
3	Bedford - NRW	611,924	1,969,442	512,055
4	NRW - OXF	752,939	3,474,332	903,326
5	OXF - IPS	688,310	3,000,740	780,192
6	IPS - RDG	904,517	3,140,895	816,633
7	NRW - Bedford	791,038	2,590,808	673,610
8	RDG - TTF	445,673	1,515,161	393,942
9	NRW - SVG	543,788	2,050,132	533,034
10	OXF - NRW	696,620	3,230,174	839,845
11	Bedford - IPS	482,416	1,499,381	389,839
12	MKC - IPS	583,391	1,910,738	496,792
13	MKC - NRW	646,498	2,086,353	542,452
14	IPS - OXF	673,520	3,012,577	783,270
15	IPS - AYS	561,811	1,728,060	449,296
16	AYS - IPS	586,746	1,854,234	482,101
17	BSE - RDG	692,996	2,485,318	646,183
18	CBG - LWT	378,362	1,249,015	324,744
19	IPS - Bedford	572,745	1,800,900	468,234
20	RDG - SMK	335,311	1,222,163	317,762

Table 6-4 2031 Benefits Performance of Top Ranked Journey Pairs, TEMPRO Growth, 90+ mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - NRW	1,068,384	3,809,292	990,416
2	RDG - LWT	668,945	1,828,722	475,468
3	NRW - RDG	1,064,173	3,812,952	991,367
4	NRW - AYS	697,997	2,404,301	625,118
5	RDG - GYM	549,482	1,547,444	402,336
6	OXF - LWT	516,324	1,656,903	430,795
7	Bedford - LWT	518,680	1,239,221	322,197
8	MKC - LWT	547,521	1,308,071	340,098
9	NRW - Bicester	535,902	1,343,795	349,387
10	Bedford - GYM	456,255	1,156,776	300,762
11	AYS - NRW	705,338	2,335,663	607,272
12	NRW - MKC	576,748	1,871,604	486,617
13	AYS - LWT	507,361	1,255,563	326,446
14	OXF - GYM	425,454	1,419,797	369,147
15	RDG - FLX	402,145	1,062,928	276,361
16	IPS - Bicester	520,842	1,506,167	391,603
17	MKC - GYM	438,331	1,103,159	286,821
18	LWT - RDG	802,063	2,433,204	632,633
19	Bicester - IPS	466,167	1,337,889	347,851
20	LWT - Bedford	669,939	1,776,713	461,945

Table 6-5 2031 Benefits Performance of Top Ranked Journey Pairs, EEFM Growth, 0-30 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	NRW - LWT	709,532	2,783,938	723,824
2	LWT - NRW	1,117,372	3,652,213	949,575
3	GYM - NRW	1,148,746	3,362,743	874,313
4	GYM - LWT	547,133	521,419	135,569
5	NRW - GYM	434,752	969,506	252,072
6	LWT - GYM	436,796	440,437	114,514
7	IPS - FLX	271,439	507,765	132,019
8	BSE - CBG	217,407	938,444	243,995
9	IPS - HWC	128,561	518,249	134,745
10	IPS - HPQ	128,015	539,870	140,366
11	NMK - CBG	274,769	635,205	165,153
12	NMK - KLN	171,848	605,116	157,330
13	TTF - NRW	201,113	616,394	160,262
14	SMK - BSE	168,775	580,341	150,889
15	CBG - NMK	151,992	277,665	72,193
16	HPQ - IPS	132,718	536,391	139,462
17	BSE - DIS	65,127	199,768	51,940
18	FLX - IPS	190,710	188,529	49,018
19	FLX - HPQ	79,800	203,423	52,890
20	IPS - BSE	82,035	218,823	56,894

Table 6-6 2031 Benefits Performance of Top Ranked Journey Pairs, EEFM Growth, 30-60 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	Bedford - BSE	478,172	1,501,507	390,392
2	MKC - BSE	495,529	1,599,064	415,757
3	AYS - BSE	539,215	1,998,292	519,556
4	OXF - BSE	484,252	2,309,295	600,417
5	IPS - KLN	417,793	1,432,584	372,472
6	BSE - Bedford	532,206	1,772,721	460,907
7	BSE - OXF	420,796	2,021,163	525,502
8	IPS - BLY	304,061	1,355,273	352,371
9	NRW - CBG	545,922	1,668,288	433,755
10	BLY - IPS	400,740	1,752,577	455,670
11	BSE - MKC	353,868	1,186,183	308,407
12	CBG - FLX	234,963	724,875	188,468
13	BLY - BSE	302,828	1,286,257	334,427
14	BSE - NRW	311,120	1,239,044	322,151
15	CBG - HPQ	212,174	598,624	155,642
16	CBG - HWC	210,239	574,687	149,419
17	LUT - BSE	312,407	956,224	248,618
18	CBG - NRW	329,076	987,029	256,628
19	OXF - NMK	171,341	670,766	174,399
20	KLN - IPS	271,526	863,010	224,383

Table 6-7 2031 Benefits Performance of Top Ranked Journey Pairs, EEFM Growth, 60-90 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - IPS	977,130	3,366,205	875,213
2	RDG - BSE	804,608	2,958,903	769,315
3	IPS - RDG	942,669	3,273,377	851,078
4	NRW - OXF	688,282	3,175,980	825,755
5	IPS - AYS	585,508	1,800,949	468,247
6	Bedford - NRW	571,611	1,842,183	478,968
7	MKC - IPS	602,394	1,982,499	515,450
8	OXF - IPS	692,009	3,040,800	790,608
9	IPS - OXF	701,929	3,139,647	816,308
10	NRW - Bedford	722,092	2,358,890	613,311
11	RDG - TTF	445,855	1,516,390	394,261
12	MKC - NRW	665,725	2,150,733	559,191
13	NRW - SVG	496,882	1,872,237	486,782
14	OXF - NRW	697,420	3,240,737	842,592
15	Bedford - IPS	451,674	1,411,043	366,871
16	AYS - IPS	588,470	1,866,413	485,267
17	IPS - Bedford	596,079	1,869,647	486,108
18	BSE - RDG	678,450	2,433,149	632,619
19	IPS - MKC	516,871	1,716,585	446,312
20	CBG - LWT	376,751	1,247,407	324,326

Table 6-8 2031 Benefits Performance of Top Ranked Journey Pairs, EEFM Growth, 90+ mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - NRW	1,069,143	3,815,492	992,028
2	RDG - LWT	669,602	1,831,946	476,306
3	NRW - RDG	972,789	3,485,521	906,236
4	NRW - AYS	638,058	2,197,836	571,437
5	RDG - GYM	549,958	1,550,009	403,002
6	MKC - LWT	563,992	1,348,435	350,593
7	OXF - LWT	516,983	1,660,806	431,809
8	Bedford - LWT	484,554	1,158,501	301,210
9	IPS - Bicester	542,425	1,567,450	407,537
10	AYS - NRW	705,677	2,338,307	607,960
11	AYS - LWT	507,763	1,257,242	326,883
12	Bedford - GYM	426,293	1,081,759	281,257
13	OXF - GYM	425,983	1,423,288	370,055
14	NRW - Bicester	489,700	1,227,399	319,124
15	RDG - FLX	402,973	1,066,575	277,310
16	MKC - GYM	451,454	1,137,051	295,633
17	NRW - MKC	527,995	1,717,873	446,647
18	LWT - RDG	791,326	2,400,633	624,164
19	LWT - Bedford	660,487	1,750,472	455,123
20	GYM - RDG	645,767	1,756,178	456,606

Table 6-9 2031 Benefits Performance of Top Ranked Journey Pairs, Local Plan Growth, 0-30 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	NRW - LWT	675,061	2,655,859	690,523
2	LWT - NRW	1,141,790	3,703,339	962,868
3	GYM - NRW	1,189,364	3,414,103	887,667
4	GYM - LWT	572,117	545,691	141,880
5	NRW - GYM	413,048	921,106	239,488
6	LWT - GYM	447,527	451,259	117,327
7	IPS - FLX	278,338	520,671	135,374
8	BSE - CBG	229,837	992,100	257,946
9	IPS - HWC	131,828	531,421	138,169
10	NMK - CBG	302,408	699,101	181,766
11	IPS - HPQ	131,269	553,591	143,934
12	NMK - KLN	188,081	658,766	171,279
13	TTF - NRW	223,390	665,614	173,060
14	CBG - NMK	161,366	297,566	77,367
15	SMK - BSE	156,397	568,346	147,770
16	HPQ - IPS	135,880	544,942	141,685
17	BSE - DIS	68,851	211,190	54,910
18	FLX - IPS	195,250	190,611	49,559
19	CBG - BSE	75,564	205,897	53,533
20	FLX - HPQ	82,480	210,257	54,667

Table 6-10 2031 Benefits Performance of Top Ranked Journey Pairs, Local Plan Growth, 30-60 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	Bedford - BSE	541,647	1,709,208	444,394
2	AYS - BSE	637,574	2,370,007	616,202
3	MKC - BSE	503,746	1,632,191	424,370
4	OXF - BSE	494,228	2,373,546	617,122
5	IPS - KLN	427,059	1,458,948	379,326
6	BSE - Bedford	564,671	1,889,097	491,165
7	BSE - OXF	444,412	2,131,274	554,131
8	IPS - BLY	311,631	1,387,662	360,792
9	BSE - MKC	373,894	1,252,383	325,620
10	BLY - IPS	406,926	1,775,097	461,525
11	NRW - CBG	518,669	1,585,003	412,101
12	CBG - FLX	244,895	755,515	196,434
13	BSE - NRW	327,715	1,297,647	337,388
14	BLY - BSE	309,642	1,328,276	345,352
15	CBG - HPQ	221,142	623,926	162,221
16	CBG - HWC	219,126	598,978	155,734
17	CBG - NRW	342,797	1,027,311	267,101
18	LUT - BSE	289,893	892,125	231,953
19	BSE - LUT	234,188	760,613	197,759
20	KLN - IPS	288,183	913,993	237,638

Table 6-11 2031 Benefits Performance of Top Ranked Journey Pairs, Local Plan Growth, 60-90 mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - IPS	976,007	3,358,276	873,152
2	RDG - BSE	807,416	2,979,233	774,601
3	IPS - RDG	966,629	3,356,575	872,709
4	Bedford - NRW	644,169	2,072,300	538,798
5	IPS - AYS	600,390	1,846,723	480,148
6	OXF - IPS	701,872	3,077,495	800,149
7	IPS - OXF	719,115	3,212,057	835,135
8	NRW - OXF	653,390	3,010,414	782,708
9	MKC - IPS	609,764	2,004,111	521,069
10	Bedford - IPS	509,082	1,588,161	412,922
11	RDG - TTF	445,633	1,514,891	393,872
12	MKC - NRW	673,907	2,174,033	565,249
13	NRW - Bedford	687,478	2,254,433	586,152
14	OXF - NRW	707,322	3,277,518	852,155
15	AYS - IPS	693,195	2,196,390	571,061
16	BSE - RDG	717,241	2,572,266	668,789
17	NRW - SVG	472,076	1,778,771	462,480
18	IPS - Bedford	612,483	1,928,145	501,318
19	AYS - TTF	429,602	1,326,647	344,928
20	CBG - LWT	392,749	1,300,668	338,174

Table 6-12 2031 Benefits Performance of Top Ranked Journey Pairs, Local Plan Growth, 90+ mins

Rank	OD Pair	2031 GJT Benefits (£)	2031 Additional Pax Miles	2031 Reduced Car Miles
1	RDG - NRW	1,068,136	3,807,260	989,888
2	RDG - LWT	669,651	1,832,190	476,369
3	NRW - RDG	924,225	3,311,516	860,994
4	RDG - GYM	549,958	1,550,009	403,002
5	NRW - AYS	606,204	2,088,115	542,910
6	Bedford - LWT	546,633	1,306,991	339,818
7	MKC - LWT	571,470	1,366,390	355,261
8	OXF - LWT	525,174	1,687,254	438,686
9	AYS - LWT	598,643	1,482,326	385,405
10	Bedford - GYM	480,877	1,220,272	317,271
11	IPS - Bicester	556,211	1,607,289	417,895
12	AYS - NRW	831,399	2,752,518	715,655
13	OXF - GYM	432,690	1,445,697	375,881
14	MKC - GYM	457,406	1,152,040	299,530
15	RDG - FLX	402,973	1,066,575	277,310
16	LWT - RDG	810,769	2,459,615	639,500
17	NRW - Bicester	465,253	1,166,124	303,192
18	NRW - MKC	501,454	1,630,467	423,921
19	SVG - LWT	446,416	1,194,957	310,689
20	LWT - Bedford	677,451	1,797,217	467,276

Figures 6-1 to 6-4 below plot the top ranked journey pairs based on 2031 benefits performance for the TEMPRO growth scenario for each journey time category on maps.

Figure 6-1 Map of Top Ranked Journey Pairs, TEMPRO Growth, 0-30 mins

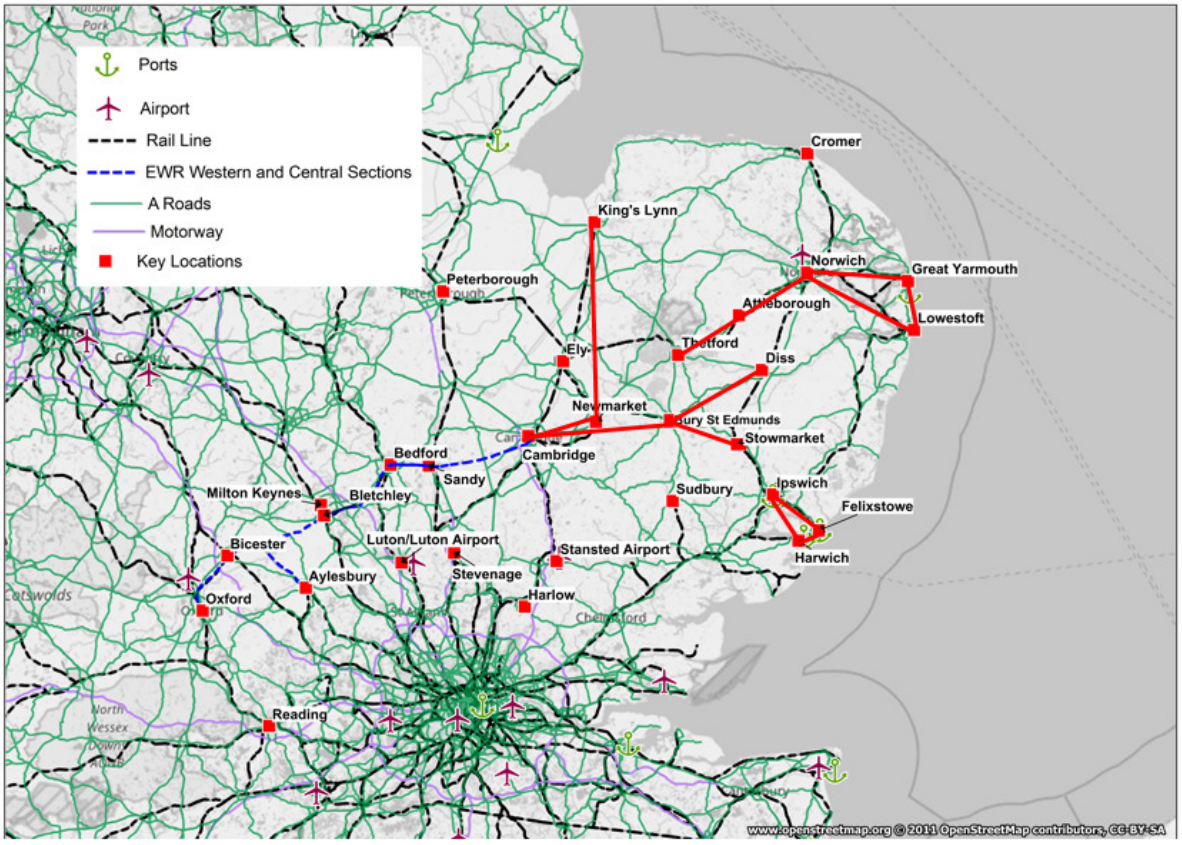


Figure 6-2 Map of Top Ranked Journey Pairs, TEMPRO Growth, 30-60 mins

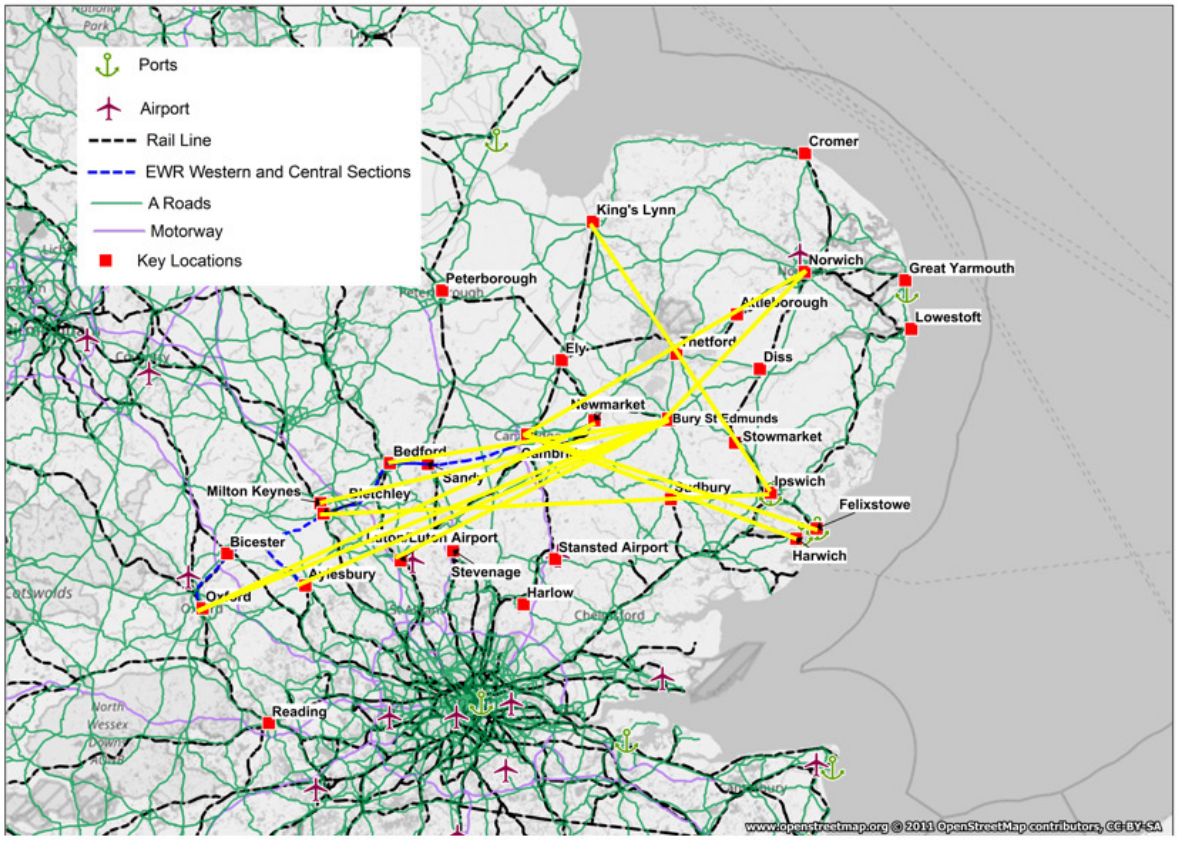


Figure 6-3 Map of Top Ranked Journey Pairs, TEMPRO Growth, 60-90 mins

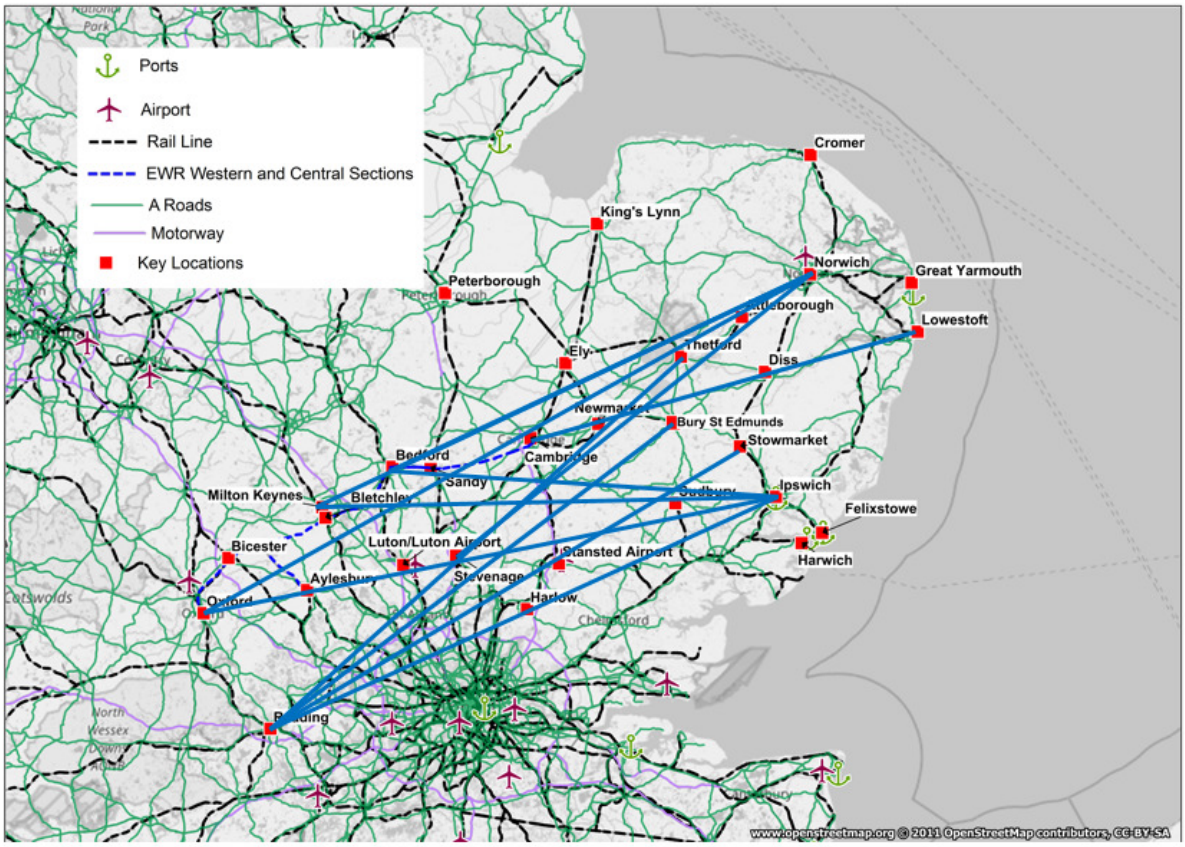
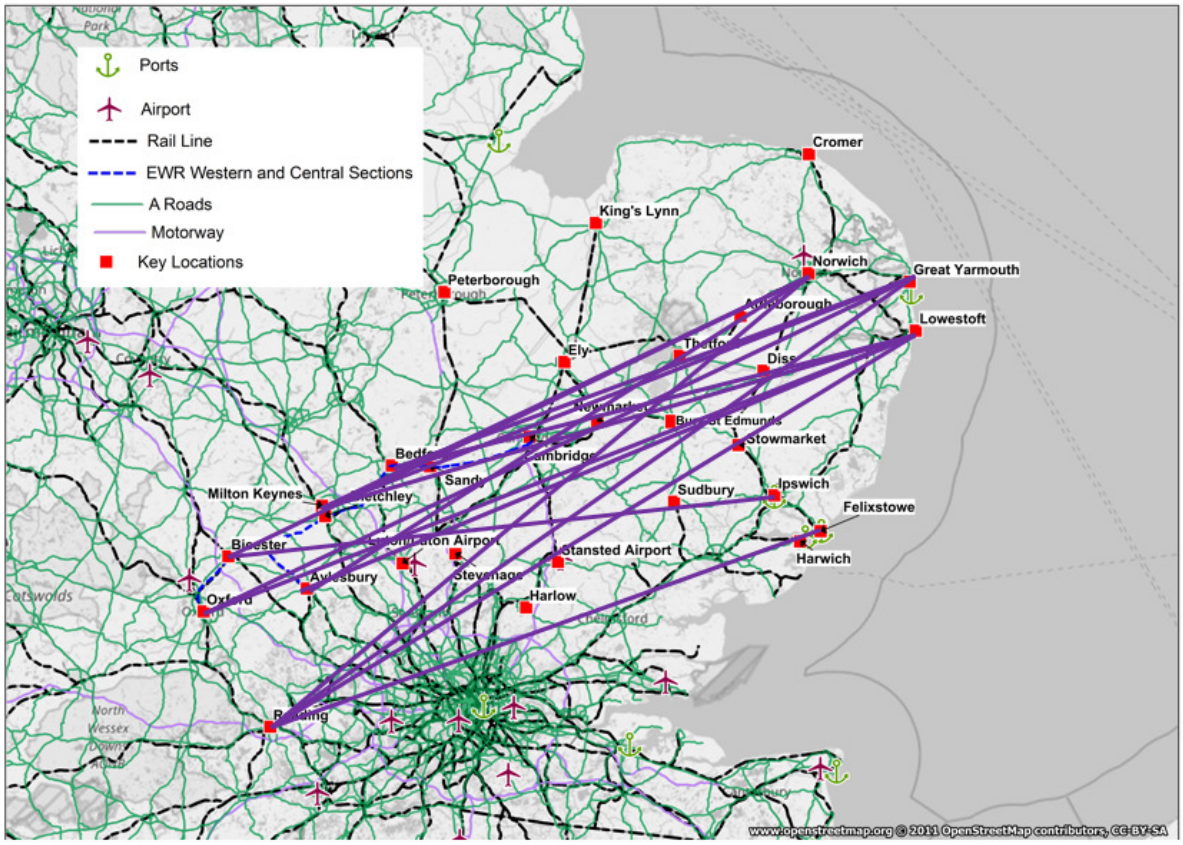
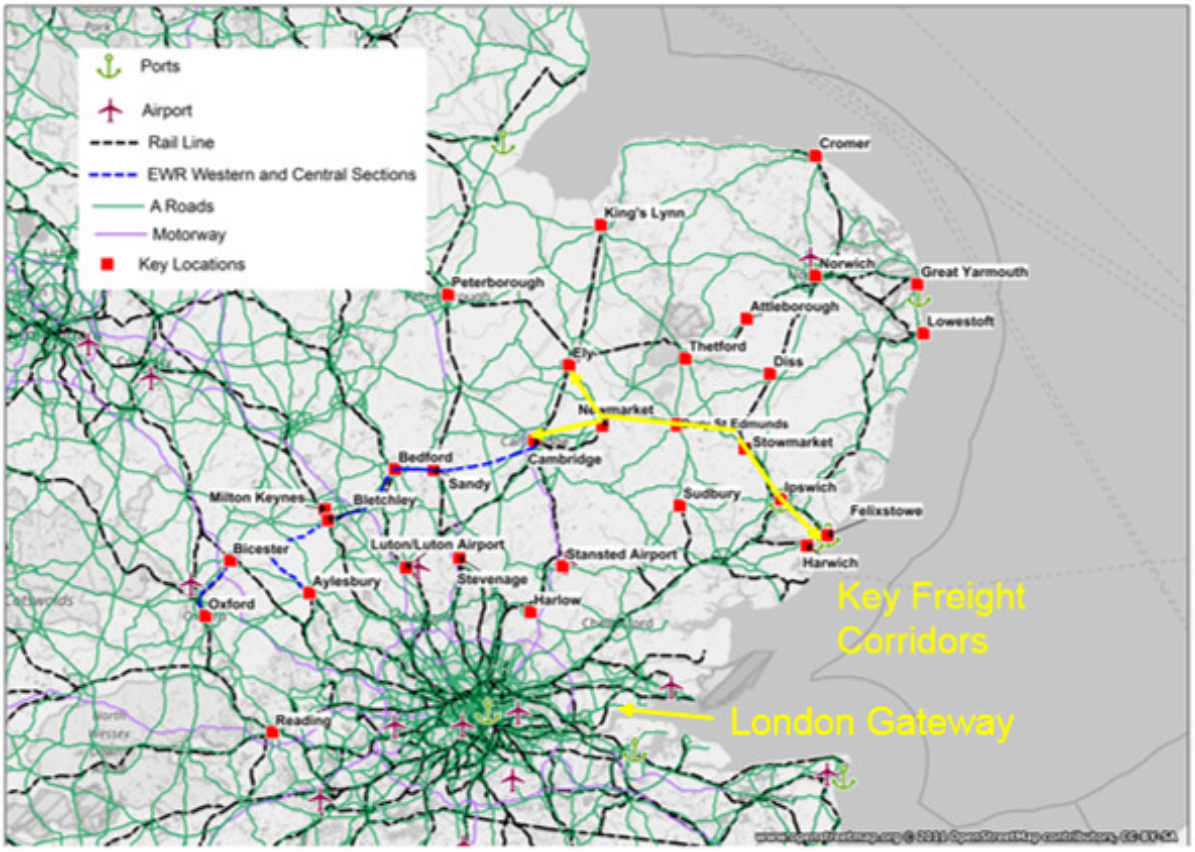


Figure 6-4 Map of Top Ranked Journey Pairs, TEMPRO Growth, 90+ mins



In addition to the key passenger journey pairs, it is important to reiterate the key freight corridor in the study area between Felixstowe and Ely and the alternative route via Cambridge and beyond to other parts of the UK that the EWR-ES would enable. Figure 6-5 below shows these routes on a map of the study area:

Figure 6-5 Key Freight Corridors



6.2. Conclusions

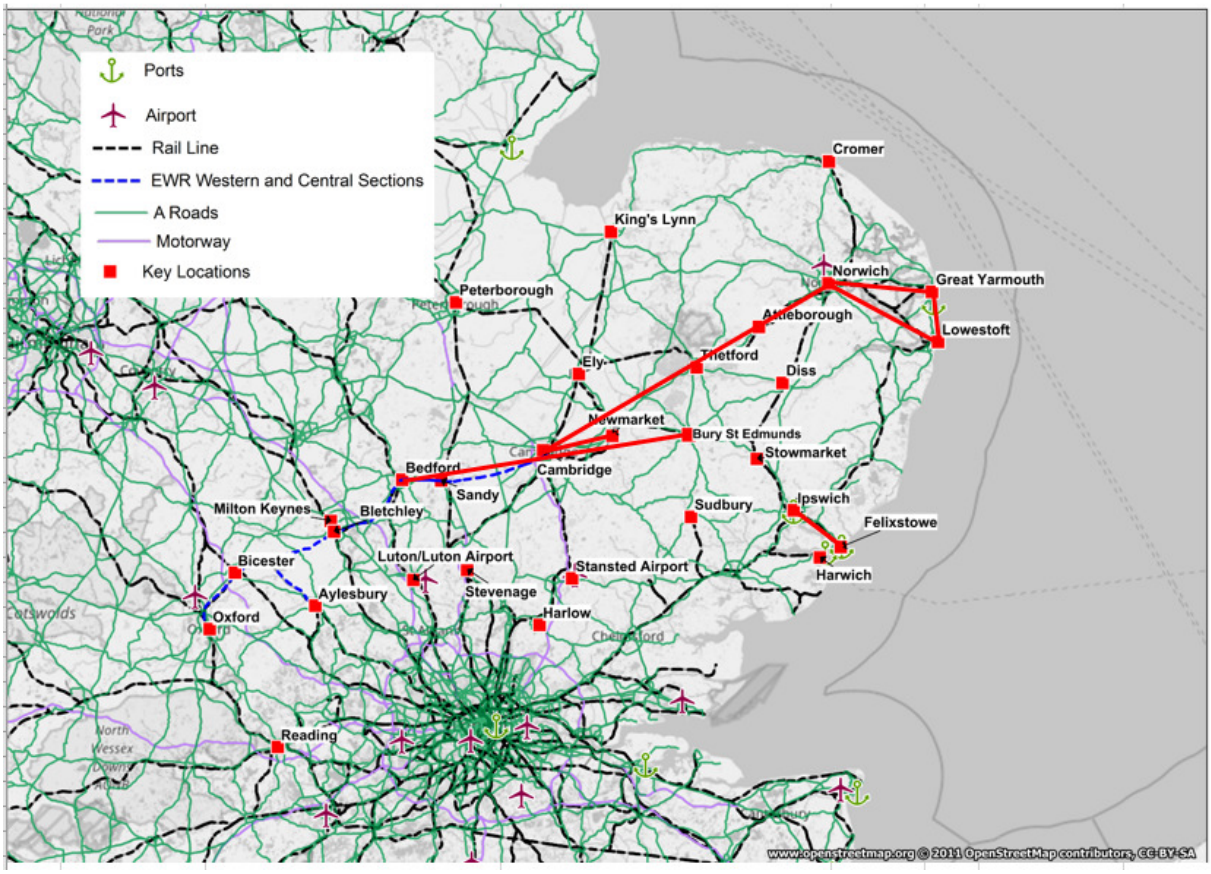
Economic benefits are delivered due to the impact on journey times from significant enhancements in connectivity and demand for services between key locations. Shorter distance priority trips are more focussed on commuting with a weighted average journey distance in 2031 of 35 miles, while longer distance priority trips are more focussed on business and leisure travel with a weighted average journey distance in 2031 of 73 miles.

Key OD pairs for commuting include:

- Great Yarmouth – Norwich;
- Lowestoft – Norwich;
- Great Yarmouth – Lowestoft;
- Newmarket – Cambridge;
- Felixstowe – Ipswich;
- Cambridge – Norwich; and
- Bury St Edmunds – Bedford.

Figure 6-6 below presents these OD pairs on a map of the study area:

Figure 6-6 Key Commuting OD Pairs

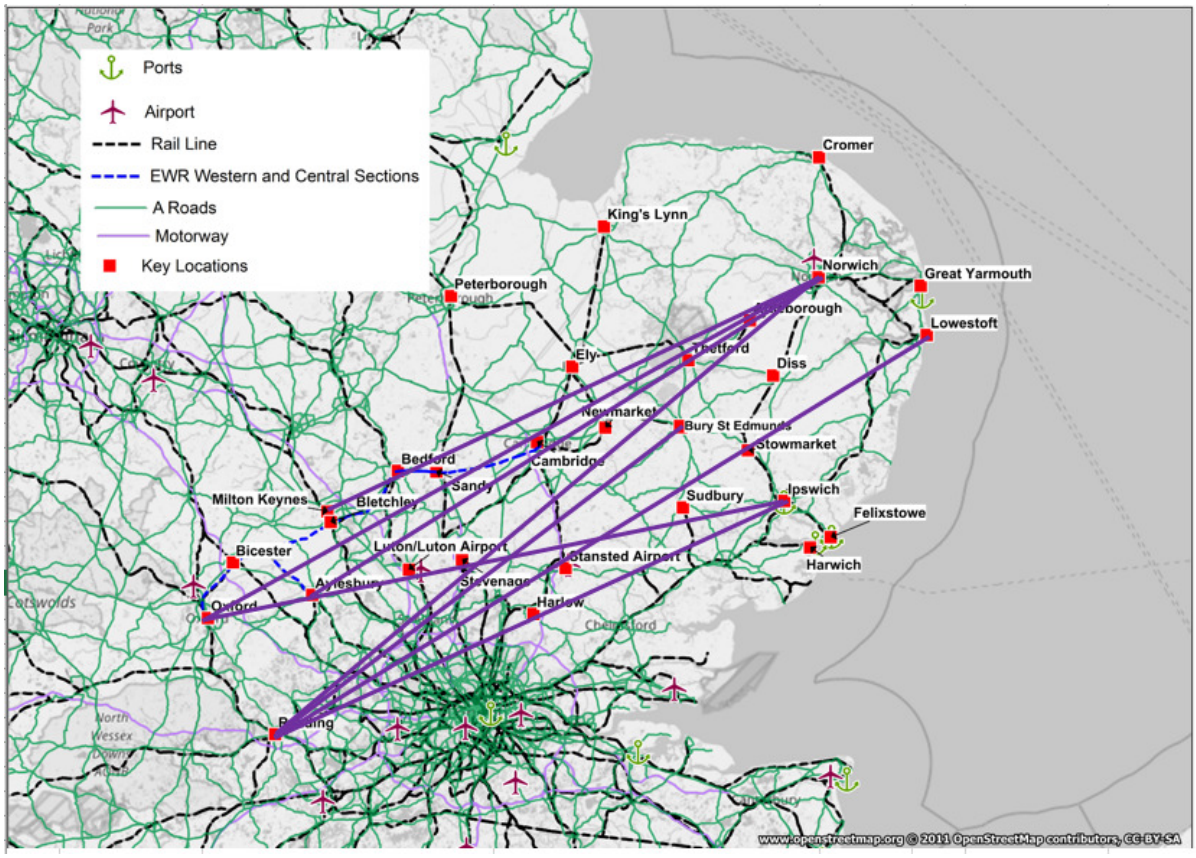


Key OD pairs for business and leisure travel include:

- Norwich - Reading;
- Ipswich - Reading;
- Reading – Lowestoft;
- Reading – Bury St Edmunds;
- Norwich - Oxford;
- Norwich - Aylesbury;
- Ipswich – Oxford; and
- Norwich – Milton Keynes.

Figure 6-7 below presents these OD pairs on a map of the study area:

Figure 6-7 Key Business and Leisure OD Pairs



Following on from the list above and based on latest EWR Central Section modelling assumptions and the findings of this study, we can consider the journey time competitiveness of rail journeys between Norwich and Oxford/Reading for a route via London and a route along EWR. This gives an early indication of the attractiveness of EWR and the likelihood that it would be utilised for such strategic journeys.

For the EWR Central Section, Oxford – Cambridge could be achieved in around 80 minutes (noting uncertainties around ongoing Western Section developments and electrification). Reading – Cambridge could be achieved in 130 minutes. Based on Route Option 1 above, Cambridge – Norwich could be achieved in 60 minutes.

For routing via London, the Greater Anglia 2019 timetable and Crossrail could potentially shave 30 minutes from the current journey time, given a limited number of 90-minute Norwich services and Crossrail shaving 15 minutes off cross-London journeys.

For Norwich – Oxford:

- The current fastest journey time via London is 3h 50min.
- With GA 2019 and Crossrail, the trip via London could be reduced by up to 30 mins to 3h 20min.
- Via EWR with the Western and Central sections only, the journey time would be 2h 40min.
- Via EWR also including EWR-ES, the journey time would be 2h 20min.

For Norwich – Reading:

- The current fastest journey time via London is 3h 10min.
- With GA 2019 and Crossrail, the trip via London could be reduced by up to 30 mins to 2h 40min.
- Via EWR with the Western and Central sections only, the journey time would be at least 3h 30min.
- Via EWR also including EWR-ES, the journey time would be 3h 10min, or possibly 3h.

Norwich – Oxford via EWR-ES will therefore present a marked improvement over existing journeys via London, whilst Norwich – Reading via EWR-ES will be on-par with crossing London in terms of pure journey

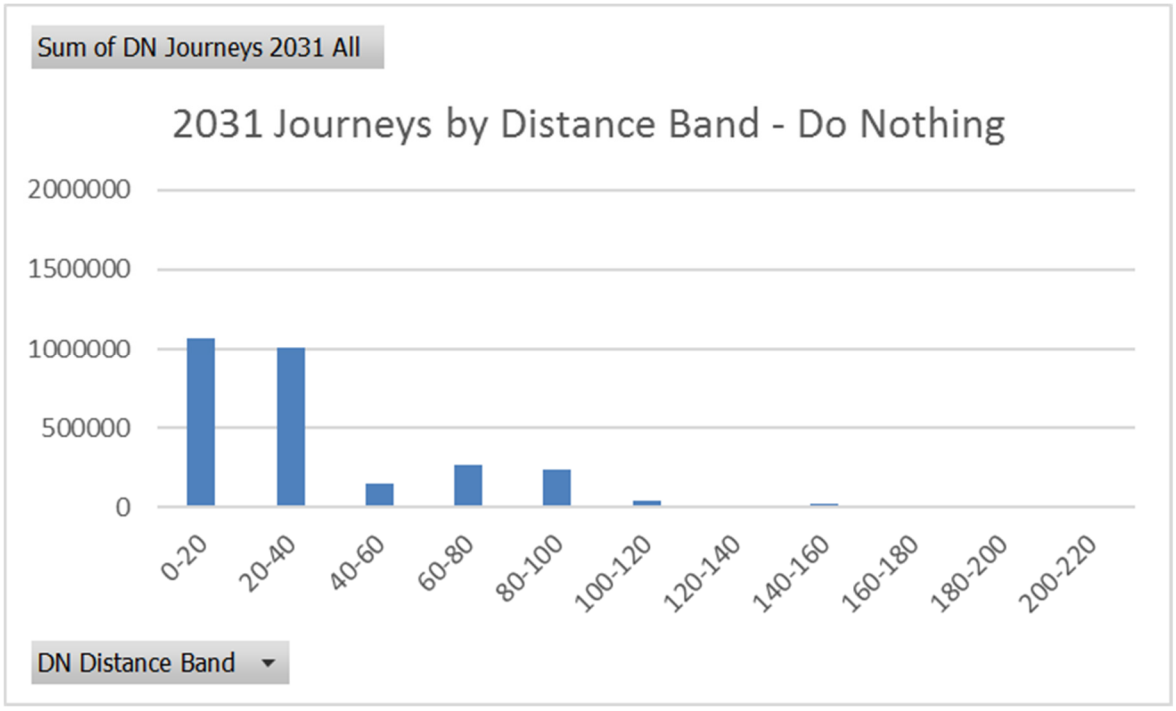
times, although the benefits of EWR-ES in terms of not requiring interchange and most likely lower fares would be substantial. This further strengthens the case for EWR-ES and means that journeys from East Anglia to the South West via EWR rather than via London become feasible. If Western Rail Access to Heathrow were to go ahead, this would also make Heathrow Airport accessible via EWR and an interchange at Reading rather than via London. Trips from Cambridge and Ipswich to Oxford would also be quicker via EWR than via London, although trips from Cambridge and Ipswich to Reading would still be quicker via London (albeit EWR could still be an appealing option for these trips given the lack of interchange required and most likely lower fares).

The results reiterate the target markets as follows:

- Commuting within the region east of Cambridge: Including improved commuting links from coastal towns of Lowestoft and Great Yarmouth; new commuting corridors also emerge from East Anglia (Bury St Edmunds) to Bedford, Milton Keynes and Aylesbury.
- Main Line Connections: Trips to/from Bedford, Milton Keynes and Reading for interchange with inter-regional routes.
- Longer distance business and leisure journeys: From Reading/Oxford/Milton Keynes/Bedford/Aylesbury to Norwich, Ipswich and the coastal towns beyond (Lowestoft, Great Yarmouth).
- Felixstowe-Ely-Nuneaton for freight.
- Airport Connections: Although Luton Airport is not a priority location in its own right, combining with Luton makes it a priority location.

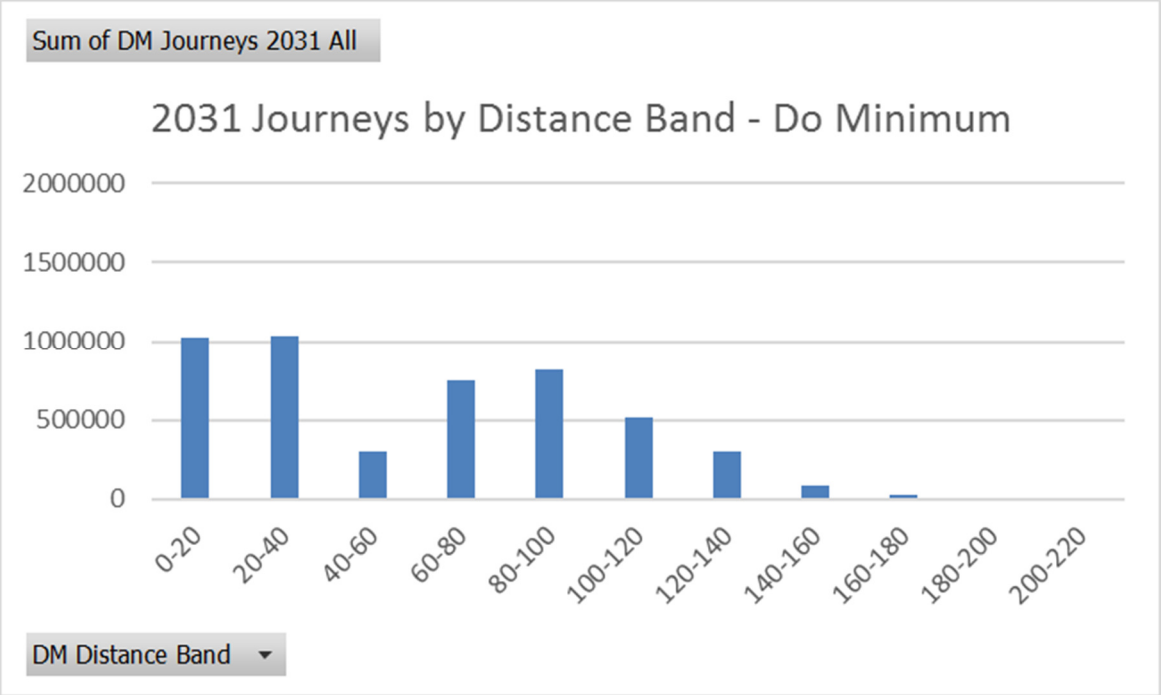
Longer distance trips are particularly valuable and are essential for the scheme – a large proportion of trips using EWR-ES will reach destinations on the Central and Western sections. Currently the vast majority of journeys in the study area are relatively short in distance – up to 40 miles – and this would remain the case without any EWR interventions, as shown by Figure 6-9 below:

Figure 6-9 2031 Journeys by Distance Band – Do Nothing



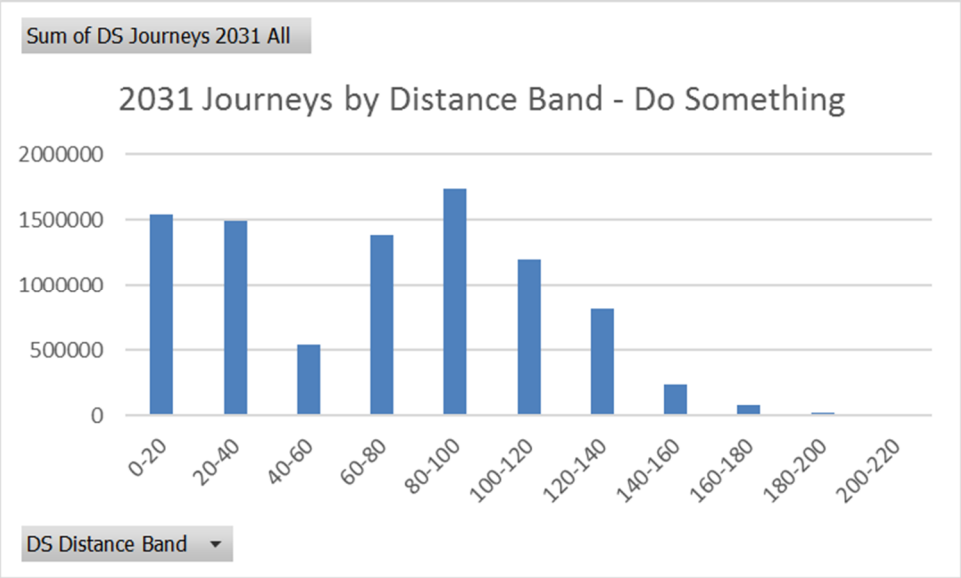
Adding the EWR Western and Central sections leads to a significant increase in longer distance trips, although shorter distance trips are still subject to the highest demand, as shown by Figure 6-10 below:

Figure 6-10 2031 Journeys by Distance Band – Do Minimum



The EWR-ES, in addition to the EWR Western and Central sections, leads to an increase in trips of all distances. However, the increase in demand is most significant for longer distance trips, such that long-distance trips become dominant. This is illustrated in Figure 6-11 below:

Figure 6-11 2031 Journeys by Distance Band – Do Something



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. It should also be stressed that the identification of the Conditional Output journey pairs does not preclude the inclusion of other journey pairs (e.g. Thetford – Ely or Bury St Edmunds – Stowmarket) as part of an ultimate EWR-ES service timetable. The COS identifies the key pairs that generate the most significant demand and economic benefit to focus examination of deliverability on.

For longer distance journeys that exhibit commensurately longer journey times of greater than 60 minutes or 90 minutes, the scale of business activity or labour market needs to be very sizeable to generate sufficient

demand for service 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.

What clearly has not been considered fully at this stage, and which may prove challenging, is the feasibility and deliverability of achieving the target level of connectivity underpinning the analysis presented.

7. Passenger Service Conditional Outputs

Figure 7-1 below summarises the top-priority flows in each of four categories that the analysis has identified:

Figure 7-1 Priority Flows

Short Distance	Medium Distance	Long Distance	Very Long Distance
Norwich-Lowestoft	Bedford-Bury St Edmunds	Reading-Bury St Edmunds	Norwich-Reading
Norwich-Great Yarmouth	Aylesbury-Bury St Edmunds	Reading-Ipswich	Reading-Lowestoft
Lowestoft-Great Yarmouth	Milton Keynes-Bury St Edmunds	Norwich-Bedford	Norwich-Aylesbury
Cambridge-Bury St Edmunds	Oxford-Bury St Edmunds	Norwich-Oxford	Ipswich-Bicester
Ipswich-Felixstowe	Ipswich-King's Lynn	Ipswich-Oxford	Bedford-Lowestoft
Cambridge-Newmarket	Norwich-Cambridge	Ipswich-Bedford	Reading-Great Yarmouth
Ipswich-Harwich	Ipswich-Bletchley	Ipswich-Aylesbury	Oxford-Lowestoft
	Cambridge-Harwich	Norwich-Milton Keynes	Milton Keynes-Lowestoft
	Cambridge-Felixstowe	Ipswich-Milton Keynes	Aylesbury-Lowestoft
	Norwich-Bury St Edmunds		Milton Keynes-Great Yarmouth

The Passenger Service Conditional Outputs, based on the results presented in section 6, provide a set of journey opportunities that should be the primary focus for further examination and development of EWR-ES proposals. It is recognised that not all journey opportunities will be realisable together, and in practice choices will need to be made as to the combination of pairs to incorporate in a service timetable. They present a range of journey opportunities one would explore the feasibility of enabling by new/upgraded EWR-ES infrastructure as yet to be defined. Operational, feasibility and cost considerations, as well as the potential to deliver services within target journey parameters and at a level of service to deliver benefits, will all have a bearing on ultimate choice of journey pairs for inclusion in proposed EWR-ES service timetable.

The EWR-ES Passenger Conditional Outputs present a set of key station to station passenger journey opportunities that have been assessed to offer the greatest potential to:

- Deliver economic benefits;
- Improve connectivity;
- Ease highways congestion;
- Support development; and
- Generate new rail demand and revenue.

It is anticipated that a selection of these key journey pairs in combination will form the core service specification within an EWR-ES enabled timetable.

Target performance for the journey pairs identified should be considered to be the delivery of a service journey time below the upper threshold for the journey time category (as defined in Section 6.1) they have been identified with, at a service frequency of 2 tph (or 2 extra tph). This is a target to aim for in considering design options but this does not mean that if this target were not met the journey pair would not be worthy of inclusion as part of an EWR-ES service specification or timetable. That would be determined by more

detailed consideration of the value a service would provide to an overall EWR-ES business case to be developed in due course.

It should also be stressed that the identification of the Conditional Output journey pairs does not preclude the inclusion of other journey pairs as part of an ultimate EWR-ES service timetable. The COS identifies the key pairs on which to focus examination of deliverability. In developing a business case for an EWR-ES scheme in the future it would be expected that the additional value that can be realised from enabling other journey pairs to the core ones will be explored as part of the process of business case optimisation. Consequently, other pairs not identified as Conditional Outputs, particularly where they generate significantly more benefit and revenue relative to the incremental cost of enabling them, could form part of the ultimate EWR-ES scheme specification for which a business case is presented.

As part of the study we have given some initial consideration to the scale of economic benefits and the potential to deliver new rail demand and revenue associated with the pairs identified. Further work is needed to establish the value for money case over the standard 60-year appraisal period and the likelihood that benefits over the scheme life would be sufficient to support significant rail investment costs.

7.1. Initial High Level Operational Constraints Analysis

All of the journey pairs highlighted are conditional upon suitable infrastructure being provided to enable the target journey times, or times close to these, to be achieved. Our conditions also include a minimum 2 train per hour level of service. The cost of relieving the potential capacity and operational constraints will clearly drive the case for achieving the journey pairs, and in the next stage of scheme development beyond this project scope, these considerations will be joined up. Potential capacity and operational constraints and challenges to delivering the desired outputs have been identified and are summarised below:

- The potential for the number of passenger train services per hour will be dependent on whether the route is double track (or more) or has any single line sections, such as between Cambridge and Chippenham Junction through Dullingham and Newmarket, and over Trowse Swing Bridge.
- There could be operational issues at any junction points with existing routes i.e. Great Eastern Main Line between Haughley Junction and Ipswich, and between Trowse Junction and Norwich, the Fen line between Cambridge and Ely, including the Ely area, approaches to Cambridge and platform capacity issues at Cambridge, which may or may not impact upon the EWR-ES scheme.
- There could be interactions with likely booked passenger and freight services already using the above routes, presenting limitations on new passenger train paths and / or timings, so there will need to be consideration of whether EWR-ES services can be combined with planned services on existing routes between Cambridge and Norwich / Ipswich.
- Likely new passenger service timings, achieved in combination with increasing service frequency on existing routes, will be dependent on whether a skip stop pattern is adopted (where intermediate calling points are shared between services) or a fast and slow pattern.
- Achieving improved passenger service timings on existing routes will be dependent on possible line speed improvements or additional infrastructure.
- Infrastructure upgrades on existing routes may be needed to limit operational risk and train path capacity constraints both for normal and perturbed train running.
- There could be issues with any of the level crossings on the existing routes between Cambridge and Norwich / Ipswich.

Capacity constraints on the route to Norwich include:

- Ely Dock Junction to Ely North Junction:
  - There are a large number of train movements, increasing between Ely and Ely North Junction because of trains reversing to call at Ely.
  - There are also restrictive freight headways.
  - There is a single lead at Ely North Junction.
- Ely North Junction to Trowse Junction:
  - There are restrictive signalling headways.
  - There is also a mix of stopping patterns.
- Trowse Swing Bridge:
  - There is a single-track section over the swing bridge.

    - There are a large number of train movements as the line from Ely joins the Great Eastern Main Line south of the swing bridge.
- There are station capacity constraints at Cambridge and Norwich.

Capacity constraints on the route to Ipswich include:

- Cambridge to Chippenham Junction:
    - There is a long single track section with only a static passing loop at Dullingham.
- Chippenham Junction to Haughley Junction:
    - There are restrictive signalling headways.
    - This section experiences high freight usage.
    - There is a single lead at Haughley Junction.
- Haughley Junction to Ipswich:
    - There are a large number of train movements ranging from East Coast Main Line expresses to slower freight services.
    - There are freight movements at Europa Junction.
- There are station capacity constraints at Cambridge and Ipswich.

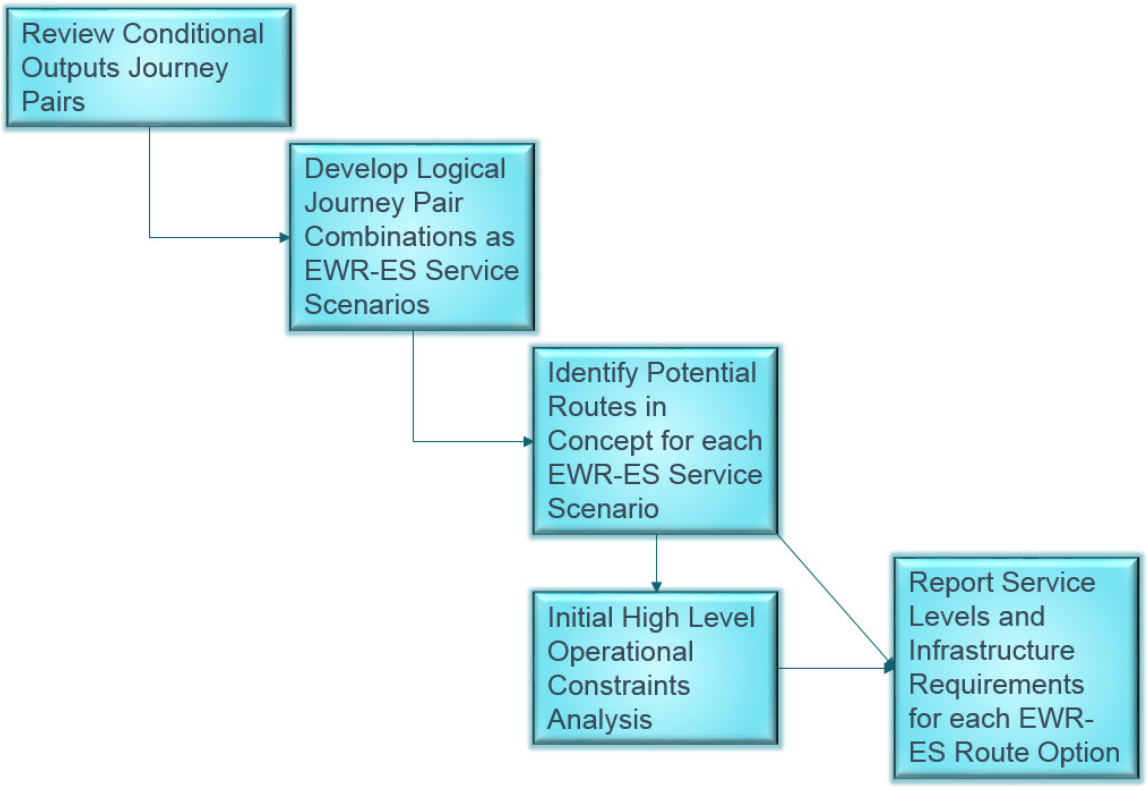
Capacity constraints beyond Norwich and Ipswich include:

- Norwich to Sheringham:
    - This section is a single track with limited passing opportunities.
    - There is a single platform terminus at Sheringham.
- Norwich to Great Yarmouth and Lowestoft:
    - There are restrictive signalling headways between Norwich and Brundall.
    - There is a single-track section between Brundall and Great Yarmouth with a static passing loop at Acle.
    - There is an alternative route to Great Yarmouth via Reedham, which is currently less heavily used.
- Ipswich to Lowestoft:
    - There are numerous single track sections.
    - Sizewell nuclear traffic must also be accommodated.
- Ipswich to Felixstowe:
    - This section is predominantly a single track.
    - There are a large number of freight movements.
    - There is a single platform terminus at Felixstowe.
- Ipswich to Harwich:
    - There is a single-track section between Harwich International and Harwich Town, although this could be avoided by terminating at Harwich International.

7.2. Development of Route Options

The top ranked journey pairs summarised in section 6 have been reviewed and developed into route options by combining logical journey pairs into service scenarios and identifying potential routes in concept. Our initial high level operational constraints analysis from above has been refined for each route option so that proposed service levels and infrastructure requirements for each route option can be reported. The process for developing route options is summarised in Figure 7-1 below:

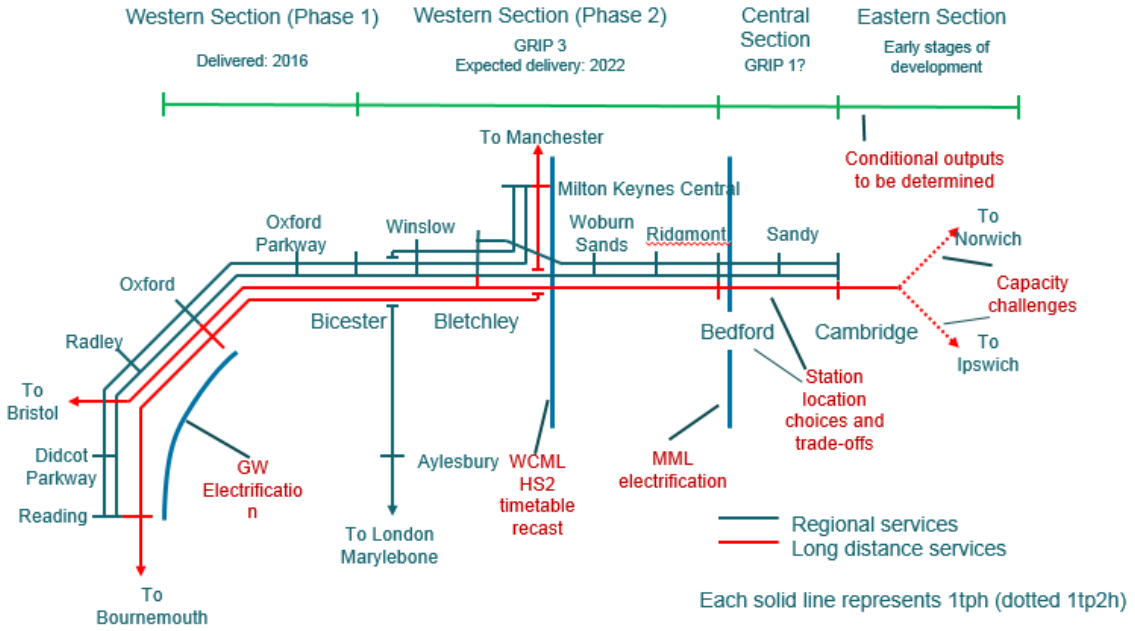
Figure 7-1 Process for Development of Route Options



The route options have been developed considering a Do Minimum scenario of service assumptions consistent with our analysis to date. The reference case specification should therefore reflect the following:

- Latest business case scenarios for EWR Western Section and Central Section (as per the specifications in the Figure 7-2 below);
- Include Thameslink with increased services on MML and GN routes (from 2018 onwards);
- Include Crossrail (Dec 2018 onwards);
- Include HS2 (Full 'Y' network could impact upon number of services on MML 2033 onwards);
- IEP Timetable on the East Coast Main Line;
- Chiltern Evergreen 3; and
- Greater Anglia timetable and service commitments (rolling stock and journey times).

Figure 7-2 EWR Western Section and Central Section Specifications



Route options between Cambridge and Norwich/Ipswich and beyond to Great Yarmouth, Lowestoft and Felixstowe have been formulated that reflect the mix of major conurbations and smaller settlements in the top ranked journey pairs, and considering a trade-off between journey times and infrastructure requirements/cost so a mixture of fast and slow services has been proposed. The same service levels and journey times as the Conditional Outputs work have been assumed – 2tph or 2 extra tph for all flows and theoretical journey times assuming average 80mph running. These considerations have resulted in the three following proposed route options to be considered further:

- Route Option 1 – Incremental Upgrades (Low infrastructure requirement/cost).
- Route Option 2 – Substantially Upgraded Cambridge-Ipswich Line (Medium infrastructure requirement/cost).
- Route Option 3 –New Railway (High infrastructure requirement/cost).

7.2.1. Route Option 1

Route Option 1 considers incremental upgrades to rail infrastructure across existing lines within the current footprint. The proposed service pattern would be as follows:

- 2 tph Cambridge - Norwich fast (~55-60 minutes), calling at Cambridge North(?), Ely and Thetford;
- 2 tph Cambridge – Ipswich fast (~55-60 minutes), calling at Newmarket, Bury St Edmunds and Stowmarket;
- 1 tph Cambridge – Norwich slow via Ely and Thetford (existing);
- 1 tph Cambridge – Ipswich slow via Bury St Edmunds (existing);

(3 of the fast services run through to Central and Western sections, the other fast service and all slow services are likely to be self-contained)

- 3 tph Norwich – Great Yarmouth;
- 3 tph Norwich – Lowestoft; and
- 2 tph Ipswich – Felixstowe.

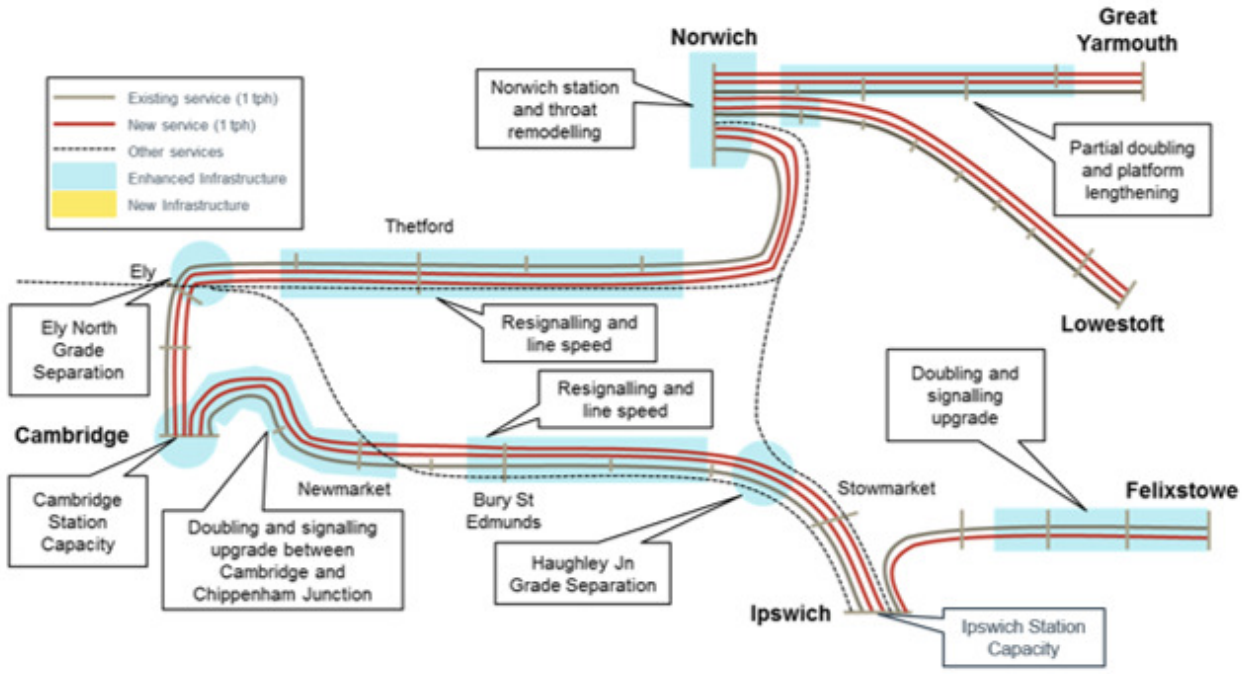
The infrastructure requirements for Route Option 1 would be as follows:

- Ely North grade separation;
- Line speed improvement and resignalling of Breckland Line;

- Double tracking and signalling upgrade between Cambridge and Chippenham Jn;
- Line speed improvement and resignalling of Cambridge – Ipswich Line;
- Haughley Junction grade separation;
- Norwich station and throat remodelling;
- Cambridge and Ipswich station capacity enhancements;
- Felixstowe – Ipswich doubling and signalling upgrade;
- Route beyond Norwich would require at least partial doubling. Both platforms at Brundall Gardens and the Down platform at Acle would require lengthening; and
- Trowse Swing Bridge doubling (assumed in the Do Minimum).

Figure 7-3 below illustrates the new and existing services and enhanced infrastructure required in Route Option 1:

Figure 7-3 Route Option 1



7.2.2. Route Option 2

The rationale behind Route Option 2 is that, given aspirations of additional freight capacity from Felixstowe, work is likely to be needed on the line via Bury St Edmunds. This route option focuses infrastructure requirements to this line to give a substantially upgraded Cambridge-Ipswich line, which becomes a strategic corridor. The proposed service pattern would be as per Route Option 1 except:

- 2 tph Cambridge – Norwich fast (~**50 minutes**), calling at **Bury St Edmunds and Diss**;
- 2 tph Cambridge – Ipswich fast (~**55-60 minutes**), calling at **Bury St Edmunds and Stowmarket**; and
- **2 tph Cambridge – Norwich slow via Ely and Thetford (one of these existing)**.

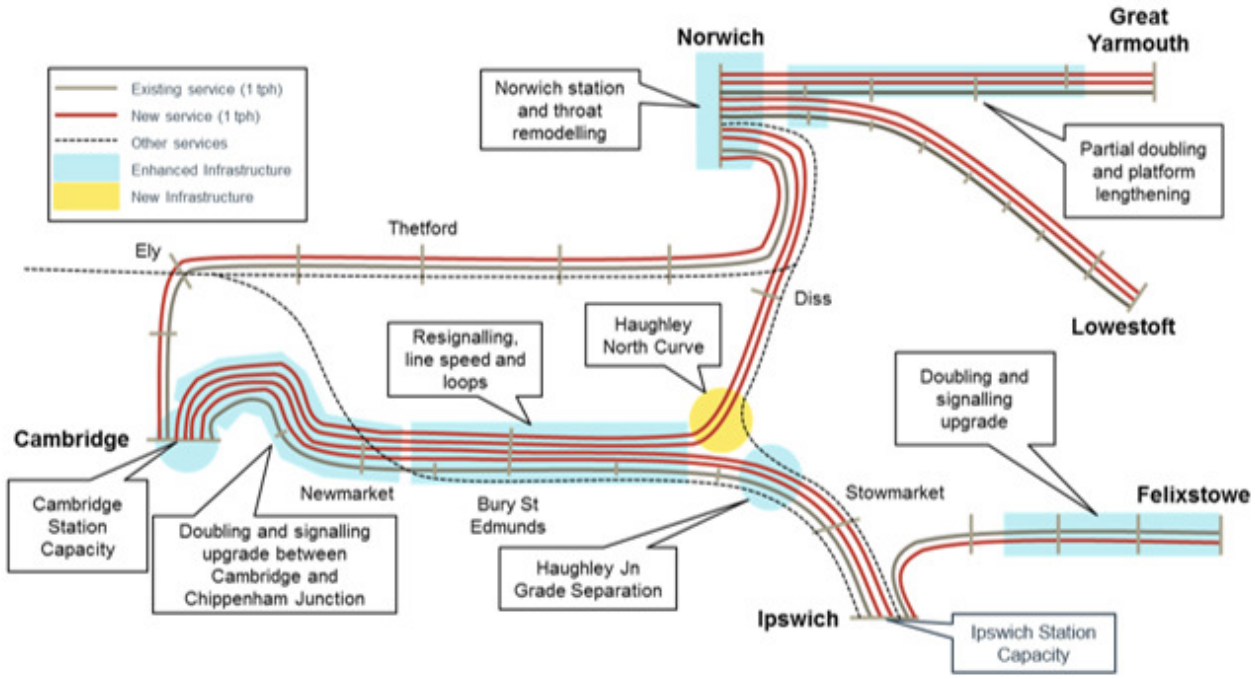
The infrastructure requirements for Route Option 2 would be as follows:

- Double tracking and signalling upgrade between Cambridge and Chippenham Jn, with resignalling, line speed improvement and loops from Chippenham Jn to Haughley Jn;
- Haughley North Curve;
- Haughley Junction grade separation;
- Norwich station and throat remodelling;
- Cambridge and Ipswich station capacity enhancements;
- Felixstowe – Ipswich doubling and signalling upgrade;

- Route beyond Norwich would require at least partial doubling. Both platforms at Brundall Gardens and the Down platform at Acle would require lengthening; and
- Trowse Swing Bridge doubling (assumed in the Do Minimum).

Figure 7-4 below illustrates the new and existing services and the new and enhanced infrastructure required in Route Option 2:

Figure 7-4 Route Option 2



7.2.3. Route Option 3

Route Option 3 proposes a new railway from Cambridge towards Norwich/Ipswich. It is acknowledged that this is an extreme case but it helps for comparison of options in terms of the trade-off between scheme objectives. The proposed service pattern would be as per Route Option 2 except:

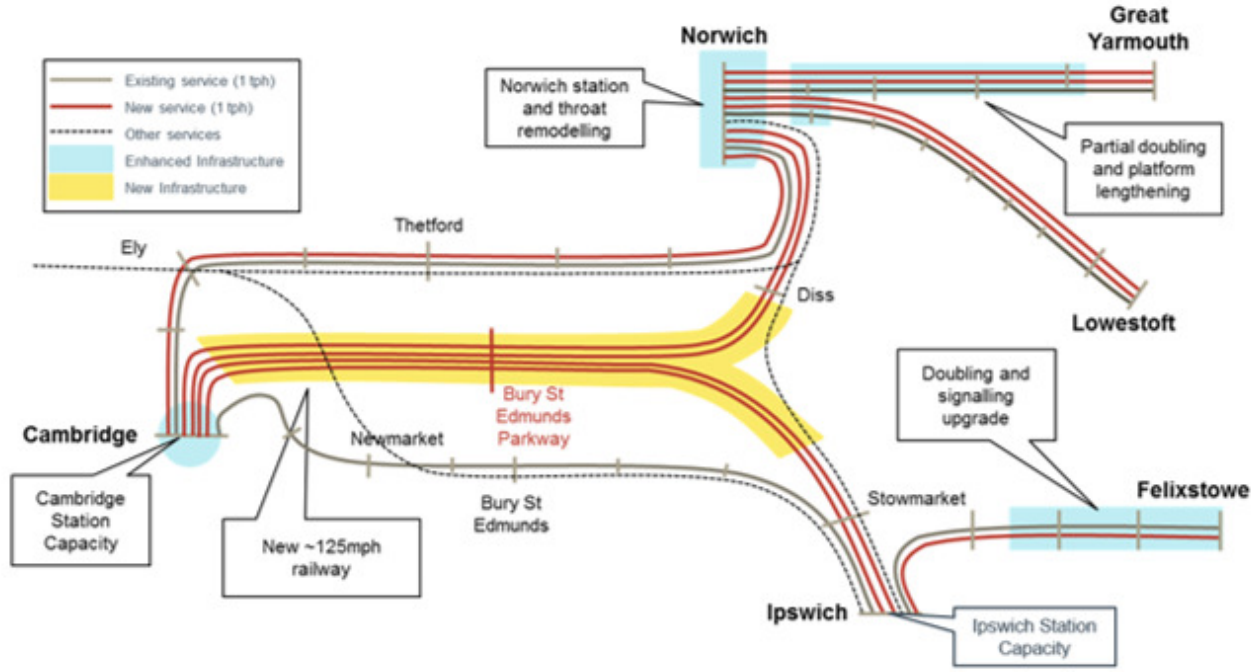
- 2 tph Cambridge - Norwich fast (**~40 minutes**), calling at **Bury St Edmunds Parkway and Diss**; and
- 2 tph Cambridge – Ipswich fast (**~40 minutes**), calling at **Bury St Edmunds Parkway and Stowmarket**.

The infrastructure requirements for Route Option 3 would be as follows:

- New railway between Cambridge and Diss/Stowmarket, with a new Bury St Edmunds Parkway station (specific location to be determined and could be further west towards Newmarket or beyond), grade separated junctions near Diss and Stowmarket;
- Norwich station and throat remodelling;
- Cambridge and Ipswich station capacity enhancements;
- Felixstowe – Ipswich doubling and signalling upgrade;
- Route beyond Norwich would require at least partial doubling. Both platforms at Brundall Gardens and the Down platform at Acle would require lengthening; and
- Trowse Swing Bridge doubling (assumed in the Do Minimum).

Figure 7-5 below illustrates the new and existing services and the new and enhanced infrastructure required in Route Option 3:

Figure 7-5 Route Option 3



7.2.4. Comparison of Route Options and Further Considerations

There are trade-offs to be considered when comparing the route options. Route Option 1 is likely to be the least costly and will serve a range of markets. By comparison Route Option 2 could be quite costly, although the 4 tracking between Chippenham Junction and Haughley Junction may not be necessary. It would also risk accommodating the growth potential of Breckland given that it would only provide one additional slow service between Cambridge and Norwich. Local connectivity aspirations would also be an issue in Route Option 3. While it would provide a straight, fast route between Cambridge and Diss/Stowmarket, the key issue with this option is that it does not make best use of the existing infrastructure and therefore it would be the most expensive option. There would not be enough value in the passenger flows to justify the land requirements/costs so this option should be ruled out at this stage. Table 7-1 below summarises the comparison of route options:

Table 7-1 Very Early Options Assessment

Route Option	Cost	Markets Served	Journey Times
Route Option 1 (Norwich via Thetford and Ely via Bury St Edmunds, existing routes)	Medium infrastructure requirement	All necessary markets served	Cambridge to Norwich/Ipswich in 60 minutes
Route Option 2 (All via existing Bury St Edmunds route with Haughley north curve)	Medium infrastructure requirement	Breckland growth less well served	Slightly faster than Route Option 1
Route Option 3 (New railway between Cambridge and vicinity of Haughley junction)	High infrastructure requirement	Local markets between Cambridge and Norwich/Ipswich less well served	Considerably faster than Route Options 1 and 2

The **case for electrification** would be dependent on surrounding infrastructure. Electrification of the Central Section is desirable and if this were to materialise, there would be a strong case for electrifying the EWR-ES. It would make sense for services from the Central Section to continue as electric to avoid using somewhat expensive bi-modes (though bi-mode cost premium may now be lower than electrification).

At Norwich station, it may be more economical to operate as two independent cells rather than running services through Norwich. Services from Cambridge to Norwich are likely to be 4-car services, whereas services east of Norwich are likely to be a shorter formation. Keeping these separate also simplifies Norwich station workings, in that the station can operate as two independent cells, making it more operationally robust. There may need to be infrastructure investments at Cambridge and Ipswich station too. Another potential approach could be for services to split/join at Cambridge, with half going to/from Norwich and half to/from Ipswich.

Consideration should also be given to **line speeds that are achievable** on different sections of routes. For example, there may be opportunities to go above 80mph and even beyond 100mph, especially on the straight sections of track between Newmarket and Ipswich. Alternatively, there may be some sections of track where it may be necessary or advantageous in terms of reduced operating costs to run at lower speeds.

There could be issues with any of the **level crossings** on the existing routes between Cambridge and Norwich/Ipswich. A significant number of levels crossings were removed on the Western Section to enable increased line speeds. This would need to build on work carried out as part of the Anglia Level Crossings Programme with the EWR-ES acting as an incentive and catalyst for closures. Local perspectives and input would be required to determine solutions that are safe. Sites within towns are likely to be the most troublesome. Removal of level crossings could also alleviate local issues associated with highway congestion, severance and air quality (e.g. Brandon).

Doubling the Ipswich to Felixstowe line – detailed options would need to be considered but this could take the form of a tram-train through the centre of Ipswich. The line east of Derby Road (approximately) would be doubled in the normal way, but the line between Westerfield and Derby Road includes a high viaduct and is in an urban setting so is difficult to double. One solution may be to reroute all passenger services through Ipswich town centre as tram-train, then the single line curve would be sufficient for freight.

The Conditional Outputs have led to the identification of **interventions across a wide area and including a number of discrete elements**. Ipswich – Felixstowe, for example, does not have any direct interaction with the other elements or with other sections of EWR. Especially if the tram-train is identified as a feasible solution to develop fully, it may be spun off into a separate project.

Network Rail's Anglia Route Strategy includes planned enhancements in terms of Trowse Swing Bridge doubling, level crossing closures, Felixstowe branch capacity enhancements, Ely North Junction and Haughley Junction doubling. EWR-ES could be the catalyst for these enhancements, serving as a **holistic route package with strategic services**.

8. Freight Service Conditional Outputs

Pressure to secure and expand paths for rail freight on the Strategic Rail Freight Network is an ongoing challenge in the context of parallel pressures to provide paths for passenger services. The London Gateway freight terminal will be developed and there is planned expansion of both Felixstowe and Harwich ports. London orbital routes for freight are already congested so alternative routes from Felixstowe and Harwich are needed. A new rail chord at Ipswich was opened in 2014 to enable direct freight service movements from Felixstowe towards Ely without the need to reverse at Ipswich station. Infrastructure enhancements to enable up to five freight paths per hour between Ipswich and Ely are proposed in the Network Rail Anglia Route Study. The EWR-ES would complement the delivery of the Ipswich chord by enhancing the onward route via Bury St Edmunds to Chippenham Junction. It would also offer an alternative to the existing route via Ely by providing a new link via Newmarket and Cambridge for onward routing to/from the north of the UK via the Midland Main Line (MML), or to/from the west of England, the South Coast and Wales via Oxford.

Wales and the West Country is a largely under developed region for rail freight and a fully connected EWR link would enable any potential to be fully realised. Additionally, it would enable the possibility of partial separation of passenger and freight traffic, depending on the passenger service specification that has been assumed. This has the potential to offer a significant improvement in train mileage, time and potentially path availability, over alternative routings, most notably via the London orbital lines, that would be required otherwise, though the issue of competition for paths with passenger services would still be a key consideration. It is not proposed to prioritise rail freight over passenger services, but instead to enhance the case for passenger services.

In addition to this, two new proposed rail freight terminals could to a large extent depend upon the opening of EWR-ES to access key parts of the country. Proposals for freight terminals have been suggested for:

- M1 Junction 13; and
- MOD Bicester.

With further potential terminals/railheads at:

- Sundon, in Central Bedfordshire (accessed from the MML); and
- Rookery South, near to Stewartby (accessed from the Marston Vale Line).

Based upon our analysis, Table 8-1 shows the Conditional Outputs for Rail Freight.

Table 8-1 Rail Freight Conditional Outputs

Conditional Output	Description
Freight CO 1	Provide sufficient freight paths/capacity to enable the planned growth of the Haven (Felixstowe, Ipswich and Harwich) and Thames Ports whilst providing an alternative route to the Midlands and West of England avoiding the North London Line.
Freight CO 2	Provide sufficient freight paths/capacity to support potential development of a rail freight terminal in proximity to the M1. Capacity would need to be compatible with that planned for the Western and Central Sections of EWR.
Freight CO 3	Provide sufficient freight paths/capacity to enable the planned development of a rail freight terminal at MOD Bicester. Capacity would need to be compatible with that planned for the Western and Central Sections of EWR.

Network Rail's Freight Network Study summarises the key freight corridors (of which Felixstowe to the West Midlands and the North via London or Ely is a key priority) and sets out the short-term (next 10 years, including options for consideration in Control Period 6, 2019-2024) strategy for creating "a core arterial, nationally cohesive freight network with complete 'line of route' enhancements to reflect the forecast growth in intermodal traffic". Short-term capacity and capability priority schemes include those that are also likely to

have passenger benefits. This study supports the findings of this study and strengthens the case for the EWR-ES.

For the Felixstowe to the West Midlands and the North corridor, the following short-term capacity and capability options are recommended:

- Loop facility at Haughley Junction, including doubling of the junction (highest priority);
- Headway restrictions at Bury St Edmunds (highest priority);
- Full doubling between Soham and Ely (highest priority);
- Infrastructure works at Ely (highest priority);
- Signalling enhancements Syston east Junction to Peterborough (highest priority);
- Leicester area capacity (highest priority);
- Anglia remove sections of low line speed (highest priority);
- Further doubling of the Felixstowe branch (medium priority);
- Line of route gauge upgrade to W12, on the cross-country route via Ely subject to emerging market demands (medium priority);
- Anglia remove speed restrictions for Heavy Axle Weight traffic (medium priority);
- West Midlands 775m train length (medium priority); and
- East Midlands remove speed restrictions for Heavy Axle Weight traffic (other options).

9. Conclusions

The Problem and Opportunity

Consideration of the economic and socio-demographic characteristics of locations in the study area indicates that there are key locations that will drive potential rail demand, mode shift and economic growth. Currently this demand is constrained by a congested highway network and a rail network where there are limited direct links and low service frequencies. This means that travel is restricted to shorter distance journeys, while those who do make long distance trips experience disproportionately high journey times and often have no viable or time competitive public transport opportunity. In the case of rail, passengers who wish to make east-west journeys often have to travel on crowded routes via London involving multiple interchanges and expensive ticket prices.

The EWR Western and Central sections will create some new direct rail links in the study area and improve journey times. The EWR-ES would build on these improvements and enhanced connectivity through the EWR-ES could unlock demand, including abstraction from highway, and increase the rail market. In turn this would facilitate economic growth, especially if complementary locations are better connected.

In addition to the passenger market, significant rail freight growth is forecast to 2043 and the Felixstowe-Ely-Nuneaton corridor is a priority for freight. The case for an intervention such as the EWR-ES is therefore strong, in terms of both catering for existing demand and forecast growth, as well as acting as a catalyst and driver for further development and regeneration.

As such the EWRC have developed a set of strategic objectives for EWR, which we have adapted specifically for the EWR-ES:

- Improve east west public transport connectivity;
- Increase economic growth, prosperity and employment within the East of England through improvements to east west rail links;
- Provide faster, more reliable and additional rail links from the west to Cambridge, Norwich, Ipswich and beyond;
- Improve journey times and reliability of inter-regional and commuter journeys;
- Increase capacity for inter-regional and commuter journeys;
- Maintain and enhance capacity for rail freight, especially from key ports; and
- Contribute to tackling climate change by removing traffic from congested inter-regional highway corridors.

The EWR-ES could serve a range of markets as follows:

- Commuting within the region east of Cambridge (e.g. between Cambridge and Norwich, Bury St Edmunds to Cambridge, Stowmarket to Ipswich plus new commuting corridors e.g. Bury St Edmunds to Bedford);
- Main Line Connections (trips to/from Bedford, Milton Keynes and Reading for interchange with inter-regional routes);
- Longer distance business and leisure journeys (from Reading/Oxford/Milton Keynes/Bedford/Aylesbury to Norwich, Ipswich and the coastal towns beyond – Lowestoft/Great Yarmouth);
- Felixstowe-Ely-Nuneaton for freight; and
- Airport Connections (e.g. Luton Airport).

Key Drivers of the Case for the EWR-ES

Local Commuters: There are key local markets that if better served by rail shift demand from car, reducing city centre congestion as people access employment areas via rail instead. Currently the vast majority of passenger journeys in the study area are relatively short in distance – up to 40 miles – and this would remain the case without any EWR interventions. Adding the EWR Western and Central sections leads to a significant increase in longer distance trips, although shorter distance trips are still subject to the highest demand. The EWR-ES, in addition to the EWR Western and Central sections, leads to an increase in trips of

all distances so short trips will be a key component of EWR-ES passenger journeys. Shorter distance priority trips are more focussed on commuting. Key OD pairs for commuting include:

- Great Yarmouth – Norwich;
- Lowestoft – Norwich;
- Great Yarmouth – Lowestoft;
- Newmarket – Cambridge;
- Felixstowe – Ipswich;
- Cambridge – Norwich; and
- Bury St Edmunds – Bedford.

Long Distance Business and Leisure Journeys: Linking the EWR-ES to destinations and employment centres on the Central and Western sections, many of which provide an interchange with inter-regional routes, is a key driver of benefits. The introduction of the EWR Western and Central sections leads to a significant increase in longer distance trips. Furthermore, the EWR-ES leads to an increase in trips of all distances but the increase in demand is most significant for longer distance trips, such that long-distance trips become dominant. Longer distance trips are particularly valuable and are essential for the scheme – a large proportion of trips using EWR-ES will reach destinations on the Central and Western sections. Longer distance priority trips are more focussed on business and leisure travel. Key OD pairs for business and leisure travel include:

- Norwich - Reading;
- Ipswich - Reading;
- Reading – Lowestoft;
- Reading – Bury St Edmunds;
- Norwich - Oxford;
- Norwich - Aylesbury;
- Ipswich – Oxford; and
- Norwich – Milton Keynes.

Following on from the list above and based on latest EWR Central Section modelling assumptions and the findings of this study, we can consider the journey time competitiveness of rail journeys between Norwich and Oxford/Reading for a route via London and a route along EWR. This gives an early indication of the attractiveness of EWR and the likelihood that it would be utilised for such strategic journeys.

For the EWR Central Section, Oxford – Cambridge could be achieved in around 80 minutes (noting uncertainties around ongoing Western Section developments and electrification). Reading – Cambridge could be achieved in 130 minutes. Based on Route Option 1 above, Cambridge – Norwich could be achieved in 60 minutes.

For routing via London, the Greater Anglia 2019 timetable and Crossrail could potentially shave 30 minutes from the current journey time, given a limited number of 90-minute Norwich services and Crossrail shaving 15 minutes off cross-London journeys.

For Norwich – Oxford:

- The current fastest journey time via London is 3h 50min.
- With GA 2019 and Crossrail, the trip via London could be reduced by up to 30 mins to 3h 20min.
- Via EWR with the Western and Central sections only, the journey time would be 2h 40min.
- Via EWR also including EWR-ES, the journey time would be 2h 20min.

For Norwich – Reading:

- The current fastest journey time via London is 3h 10min.
- With GA 2019 and Crossrail, the trip via London could be reduced by up to 30 mins to 2h 40min.
- Via EWR with the Western and Central sections only, the journey time would be at least 3h 30min.
- Via EWR also including EWR-ES, the journey time would be 3h 10min, or possibly 3h.

Norwich – Oxford via EWR-ES will therefore present a marked improvement over existing journeys via London, whilst Norwich – Reading via EWR-ES will be on-par with crossing London in terms of pure journey

times, although the benefits of EWR-ES in terms of not requiring interchange and most likely lower fares would be substantial. This further strengthens the case for EWR-ES and means that journeys from East Anglia to the South West via EWR rather than via London become feasible. If Western Rail Access to Heathrow were to go ahead, this would also make Heathrow Airport accessible via EWR and an interchange at Reading rather than via London. Trips from Cambridge and Ipswich to Oxford would also be quicker via EWR than via London, although trips from Cambridge and Ipswich to Reading would still be quicker via London (albeit EWR could still be an appealing option for these trips given the lack of interchange required and most likely lower fares).

Freight: Additional routes and capacity are needed to accommodate forecast growth in freight movements, which will facilitate economic growth and also provide a competitive mode with road. EWR-ES has the opportunity to generate benefits by providing an onward route via Bury St Edmunds to Chippenham Junction to maximise the benefits of the already delivered Ipswich chord and also EWR-ES could facilitate an alternative route to the MML via Newmarket and Cambridge rather than Ely, adding capacity for freight.

Connectivity with Airports: As well as serving locations that offer interchanges with inter-regional rail routes, EWR could serve each of the four main London airports (Heathrow, Gatwick, Luton and Stansted) via a single interchange. With the exception of Gatwick (and assuming that Western Rail Access to Heathrow were to go ahead), these airports could be accessed without the need to travel via London. As such, international markets and opportunities would be brought in closer proximity to locations along the EWR route.

Route Options

The COS has identified key journey pairs that generate the most significant demand and economic benefit to focus examination of deliverability on. However, it should also be stressed that the identification of the Conditional Output journey pairs does not preclude the inclusion of other journey pairs as part of an ultimate EWR-ES service timetable. 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.

Route options between Cambridge and Norwich/Ipswich and beyond to Great Yarmouth, Lowestoft and Felixstowe have been formulated that reflect the mix of major conurbations and smaller settlements in the top ranked journey pairs, and considering a trade-off between journey times and infrastructure requirements/cost so a mixture of fast and slow services has been proposed. The same service levels and journey times as the Conditional Outputs work have been assumed – 2tph or 2 extra tph for all flows and theoretical journey times assuming average 80mph running. These considerations have resulted in the three following proposed route options to be considered further:

- Route Option 1 – Incremental Upgrades (Low infrastructure requirement/cost).
- Route Option 2 – Substantially Upgraded Cambridge-Ipswich Line (Medium infrastructure requirement/cost).
- Route Option 3 –New Railway (High infrastructure requirement/cost).

There are trade-offs to be considered when comparing the route options. Route Option 1 is likely to be the least costly and will serve a range of markets. By comparison Route Option 2 could be quite costly, although the 4 tracking between Chippenham Junction and Haughley Junction may not be necessary. It would also risk accommodating the growth potential of Breckland given that it would only provide one additional slow service between Cambridge and Norwich. Local connectivity aspirations would also be an issue in Route Option 3. While it would provide a straight, fast route between Cambridge and Diss/Stowmarket, the key issue with this option is that it does not make best use of the existing infrastructure and therefore it would be the most expensive option. There would not be enough value in the passenger flows to justify the land requirements/costs so this option should be ruled out at this stage.

Network Rail's Anglia Route Strategy includes planned enhancements in terms of Trowse Swing Bridge doubling, level crossing closures, Felixstowe branch capacity enhancements, Ely North Junction and Haughley Junction doubling. EWR-ES could be the catalyst for these enhancements, serving as a holistic route package with strategic services.

10. Next Steps

The Conditional Outputs provide a robust evidence-based starting point for further EWR-ES scheme development activities. The work demonstrates that there are clear and strong strategic economic and transport drivers for scheme development, and that the potential scale of demand and benefits that EWR-ES could generate are significant enough to make presenting a viable and robust business case a realistic prospect since they are comparable with the other sections of EWR.

In terms of further activity beyond this study, we recommend the following next steps in the context of the COS generated above and with a view to creating options that are tested in cost-benefit terms and their ability to meet the scheme objectives and COS:

- Undertake a planning constraints analysis and operational deliverability appraisal of each EWR-ES Route Option to gauge achievable journey times and frequencies through an iterative process. Consider what land the railway already holds that could be used. If land acquisition is required, it can have significant impacts on the programme, costs, complexity and political sensitivity. Identify level crossings that should be removed as a priority task. Consider what enhancements are committed for the Do Minimum scenario, including what Digital Signalling could achieve in terms of the interaction of freight and passenger services. Questions around stabling would need to be considered with brownfield sites investigated.
- Progress with more detailed operational and early engineering feasibility design study to develop key operational and design outputs (alignments, realisable service performance parameters, indicative timetables, high level cost estimates etc) to support production of a Business Case.
- Undertake the various technical analyses and assessments on feasibility designs necessary, including updated modelling and forecasting, environmental scoping level assessment and economic analysis and appraisal. Growth should capture both underlying trends and dependent development that would be unlocked by the scheme. There will be interdependencies between the EWR-ES and the Central and Western sections and the EWR-ES could enhance the case for these sections.
- Undertake holistic scheme planning in terms of electrification assumptions, rolling stock types and formations, traction power supply, optimum frequencies, line speeds, achievable journey times and the potential performance of proposed station stops compared to faster journey times of not stopping.
- Undertake optioneering, narrowing down to a preferred option based on cost-benefit analysis and consideration of the EWR-ES objectives and considering a wide variety of OD pairs inclusive of in-scope non-Conditional Output pairs. For infrastructure that is determined to be in-scope, consider whether additional services could be operated to realise benefits at low cost.
- Prepare and present the EWR-ES Strategic Outline or Outline Business Case in line with the DfT's Five Cases Model template.
- Continued stakeholder collaboration across relevant local authorities, LEPs, Network Rail, DfT and potentially Chambers of Commerce and passenger / freight operators and groups.

Appendix A. Highway Networks Evidence Base

A.1. Highway Journey Times

Table A-1 Current (2014) Highway Journey Times – Weekday AM Peak (mins) - Source: A14 Highway Model

	Cambridge	Ely	King's Lynn	Newmarket	Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	Bury St Edmunds	Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	Sandy, Bedford	Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge		33	73	87	167	126	58	53	66	102	66	50	61	51	24
Ely	43		94	83	187	145	80	81	71	98	39	69	66	72	20
King's Lynn	71	90		143	159	138	55	56	101	151	122	62	105	47	74
Newmarket	92	83	143		248	199	129	128	139	126	118	123	115	122	66
Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	169	188	158	243		182	154	145	179	251	221	126	204	147	174
Bury St Edmunds	132	142	137	199	182		161	109	137	214	175	84	176	154	136
Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	57	75	55	129	159	166		80	104	137	108	86	90	33	60
Sandy, Bedford	57	75	56	128	146	110	81		77	142	108	36	95	73	65
Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	71	72	101	134	181	139	108	77		149	85	62	111	101	72
Reading	107	98	150	126	257	214	136	143	153		142	137	129	128	81
Stevenage	76	39	130	119	220	178	115	113	85	142		102	102	108	56
Peterborough	57	67	62	124	127	85	87	36	62	139	100		101	79	61
Stansted Airport	67	66	109	112	216	177	95	102	117	126	101	101		88	49
Harlow	49	68	47	122	152	159	33	72	96	130	100	78	83		53
Luton/Luton Airport	33	20	77	66	184	140	62	70	80	80	55	64	49	55	

Table A-2 Future (2035) Highway Journey Times – Weekday AM Peak (mins) - Source: A14 Highway Model

	Cambridge	Ely	King's Lynn	Newmarket	Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	Bury St Edmunds	Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	Sandy, Bedford	Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge		45	81	91	175	139	67	57	73	106	78	56	66	59	26
Ely	79		110	90	212	168	96	100	84	105	40	86	72	88	25
King's Lynn	99	106		150	165	147	56	58	107	169	139	64	118	49	89
Newmarket	119	87	150		258	223	135	144	153	131	124	141	118	127	69
Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	199	201	163	253		187	160	150	189	272	232	131	222	152	192
Bury St Edmunds	167	157	143	214	187		166	114	145	229	188	87	194	159	149
Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	85	91	56	135	165	172		91	118	154	125	97	104	34	74
Sandy, Bedford	83	88	58	147	151	117	95		83	162	122	37	112	87	82
Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	101	83	107	139	193	149	125	83		154	89	67	119	118	74
Reading	134	102	165	131	274	238	151	159	168		149	156	133	143	84
Stevenage	118	41	148	128	233	190	134	123	89	149		107	110	126	63
Peterborough	88	78	64	135	135	91	101	37	67	150	109		116	94	70
Stansted Airport	100	71	134	117	243	201	120	128	131	133	108	119		112	53
Harlow	77	84	49	127	157	164	34	83	110	147	117	90	96		67
Luton/Luton Airport	58	21	89	68	197	162	74	83	91	83	59	79	51	66	

A.2. Highway Demand

Table A-3 Current (2014) Highway Demand – Weekday 12 hour PCUs, All User Classes, Trips via A14 - Source: A14 Highway Model

	Cambridge	Ely	King's Lynn	Newmarket	Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	Bury St Edmunds	Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	Sandy, Bedford	Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	12,401	439	12	671	175	163	2	267	28	0	257	89	0	1,079	256
Ely	484	2,567	71	1	164	33	22	3	5	1	5	35	2	14	10
King's Lynn	11	73	-	41	1	5	-	5	16	32	35	-	16	79	35
Newmarket	994	-	17	0	499	154	57	13	24	5	27	9	7	92	17
Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	189	141	0	779	10	36	-	77	341	100	70	1	126	408	84
Bury St Edmunds	27	21	2	260	55	0	-	30	40	41	36	5	12	106	44
Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	203	28	-	106	-	-	-	96	350	15	43	85	32	119	87
Sandy, Bedford	303	3	8	27	75	14	79	984	553	10	23	249	5	12	139
Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	31	7	31	43	248	28	339	668	-	0	2	49	20	25	0
Reading	0	2	18	11	57	19	4	14	0	-	1	201	49	30	0
Stevenage	128	3	23	75	111	48	31	30	4	0	-	106	22	14	-
Peterborough	110	31	-	17	1	7	81	151	16	67	63	-	17	54	170
Stansted Airport	57	1	8	10	108	18	29	3	10	31	20	27	27	112	1
Harlow	805	11	47	114	234	97	74	7	8	23	17	112	159	238	1
Luton/Luton Airport	239	14	13	30	92	41	92	174	0	0	-	197	2	3	-

Table A-4 Future (2035) Highway Demand – Weekday 12 hour PCUs, All User Classes, Trips via A14 - Source: A14 Highway Model

	Cambridge	Ely	King's Lynn	Newmarket	Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	Bury St Edmunds	Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	Sandy, Bedford	Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	15,835	544	18	636	365	218	73	281	56	49	284	131	64	1,152	258
Ely	590	3,441	94	1	223	44	28	4	6	2	7	46	3	19	13
King's Lynn	24	98	-	54	1	6	-	6	23	41	48	-	20	105	47
Newmarket	995	-	22	0	665	203	74	17	31	7	35	13	9	123	22
Thetford, Attleborough, Norwich, Cromer, Great Yarmouth, Diss	370	191	1	1,047	13	47	-	98	446	130	90	1	165	540	115
Bury St Edmunds	100	28	2	348	73	1	-	38	53	53	48	7	16	139	57
Lowestoft, Stowmarket, Sudbery, Ipswich, Felixstowe, Harwich	280	37	-	140	-	-	-	124	455	19	56	109	41	153	114
Sandy, Bedford	322	4	10	35	93	18	97	1,228	685	12	29	313	6	15	172
Milton Keynes, Bletchley, Bicester, Aylesbury, Oxford	54	9	38	54	317	36	416	830	-	0	2	62	25	31	0
Reading	45	2	22	14	72	23	5	18	0	-	1	244	61	38	0
Stevenage	212	4	30	98	143	63	40	40	5	0	-	138	28	18	-
Peterborough	156	41	-	22	1	9	99	194	21	84	82	-	22	68	220
Stansted Airport	142	2	11	13	142	24	37	4	13	41	26	34	35	147	1
Harlow	943	14	61	151	304	125	94	9	11	30	22	139	207	309	2
Luton/Luton Airport	247	17	17	39	120	51	114	216	0	0	-	249	2	4	-

Appendix B. Rail Network Evidence Base

B.1. Rail Demand

Table B-1 Current (2014) Rail Demand – 3 Hour AM Peak Passengers, All Purposes - Source: PLANET South

3 hour AM peak passengers, all purposes	Cambridge	Ely	King's Lynn	Newmarket	Thetford / Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	191	369	29	68	3	4				1		3		1									2	12	28	54		19	
Ely	1044	15	51	27	5	7			2					1	2									3	4	62	3	2	
King's Lynn	200	23	87	5	1	1			1					1	1									3	3	5			
Newmarket	88	3	9	3					8			3														2		1	
Thetford / Attleborough		10	1																							1			
Norwich	57	6	1	2					5			59	1	75	2	1										19	1		
Cromer																													
Great Yarmouth														1										7		1			
Bury St Edmunds	139	2	1	14		8			5	1		59		18	1	2										1			
Diss		1							1			12		114															
Lowestoft														5															
Stowmarket	80			12		31			67	3		41		165	2	1													
Sudbury						1							1	6															
Ipswich	15	2				36			10	3		48		87	29	1			3							2			1
Felixstowe	9	1				22			8	2		37	1	62	16	2			2							30			1
Harwich												1		16		203													
Sandy																	2								26	12			
Bedford																		9	11	13		3		7					268
Milton Keynes														1				2	33	11				7					
Bletchley																		4	83	29				2					1
Bicester																					27	3	8	4					
Aylesbury																						91							
Oxford	3																				1	4	51	322			1		
Reading	1											1									4		321	149		1			2
Stevenage	64	2																2						4	160	18			
Peterborough	23	17			1	22			9					2										2	5	16	3		
Stansted Airport	57	11	1			1			1			1		1					3			1		9		22	16	28	1
Harlow	26																							1		1	4	51	
Luton/Luton Airport	16																	9				3		17	35	3			191

Table B-2 Future (2031) Rail Demand – 3 Hour AM Peak Passengers, All Purposes - Source: PLANET South

3 hour AM peak passengers, all purposes	Cambridge	Ely	King's Lynn	Newmarket	Thetford / Attleborough	Norwich	Cromer	Great Yarmouth	Bury St Edmunds	Diss	Lowestoft	Stowmarket	Sudbury	Ipswich	Felixstowe	Harwich	Sandy	Bedford	Milton Keynes	Bletchley	Bicester	Aylesbury	Oxford	Reading	Stevenage	Peterborough	Stansted Airport	Harlow	Luton/Luton Airport
Cambridge	276	512	42	95	5	5				1		4		2	1		1				1		4	18	39	86		28	
Ely	1454	19	66	34	7	10			2					1	2									4	5	92	4	2	
King's Lynn	283	30	111	7	1	1			1					1	1									4	4	8	1		
Newmarket	122	3	11	4		1			10			3														3		1	
Thetford / Attleborough		14	1																							2			
Norwich	86	8	1	2					8			82	1	107	3	1										28	1		
Cromer																													
Great Yarmouth														2										9		1			
Bury St Edmunds	194	2	1	18		13			6	1		79		25	1	2										1			
Diss		1							1			15		172												1			
Lowestoft												1		7															
Stowmarket	110			16		45			84	3		54		214	2	2													
Sudbury						1							1	8															
Ipswich	22	2				54			14	4		65	1	118	42	1			5							3	1		2
Felixstowe	13	1				31			10	2		47	1	85	21	3			2							48			1
Harwich	1											2		20	1	258													
Sandy																	3								34	17			
Bedford																		13	15	19		4		10					371
Milton Keynes														1				2	46	16				11					
Bletchley															1			5	119	43				2					1
Bicester																					38	3	10	6					
Aylesbury																				1		133		1					
Oxford	4																				1	5	68	439			2		
Reading	2								1			1									5		437	206		1			3
Stevenage	91	2																2						5	218	27			
Peterborough	35	25			2	37			16			1		4										4	7	24	4		
Stansted Airport	76	14	2	1		1			2			1		1					5			2		13		34	23	37	1
Harlow	36	1		1																				2		1	5	65	1
Luton/Luton Airport	24													1				12				4		23	48	5			252

Appendix C. Developing the Conditional Outputs

Table C-1 Journey Time Competitiveness

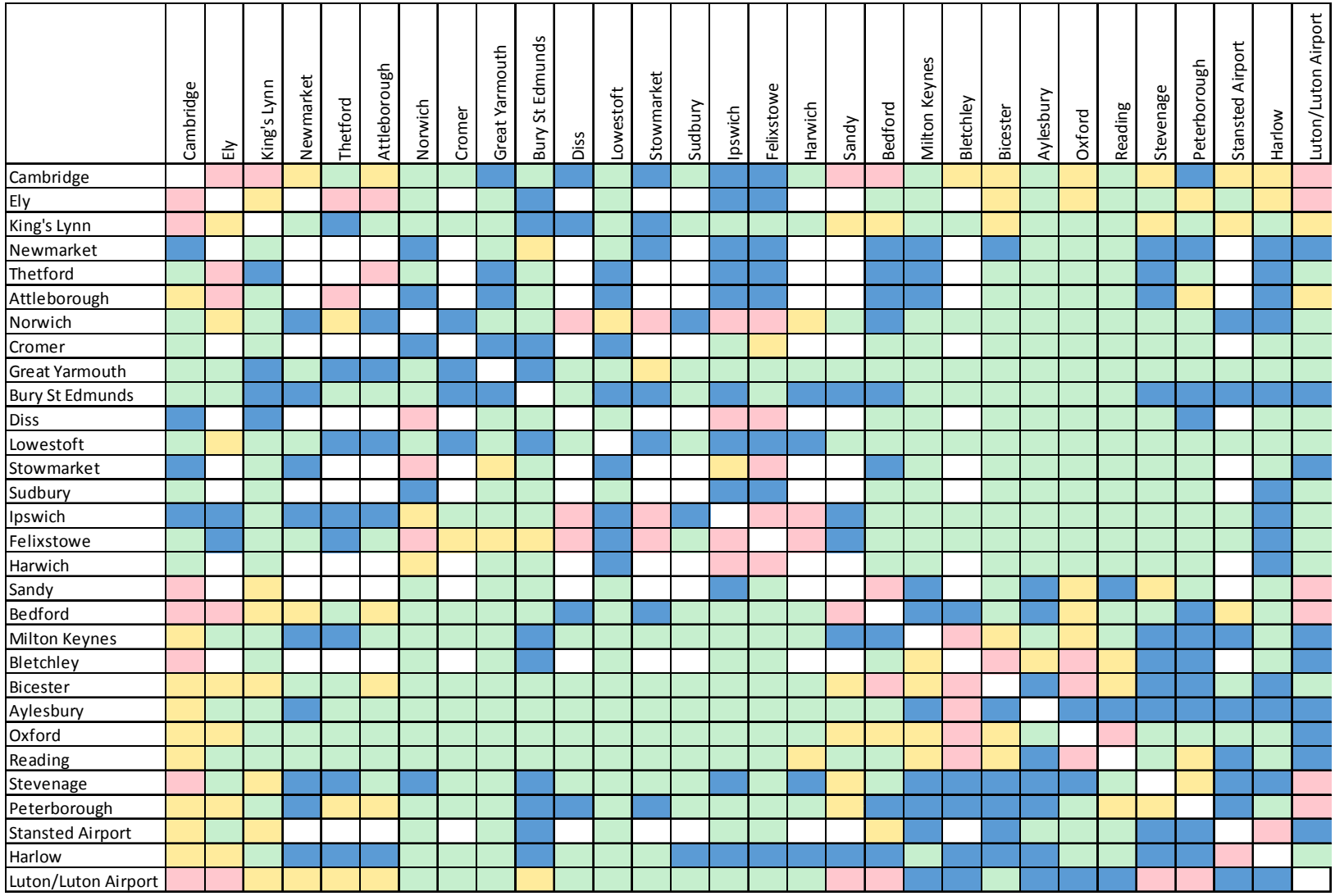


Table C-2 Potential for Journey Enhancement

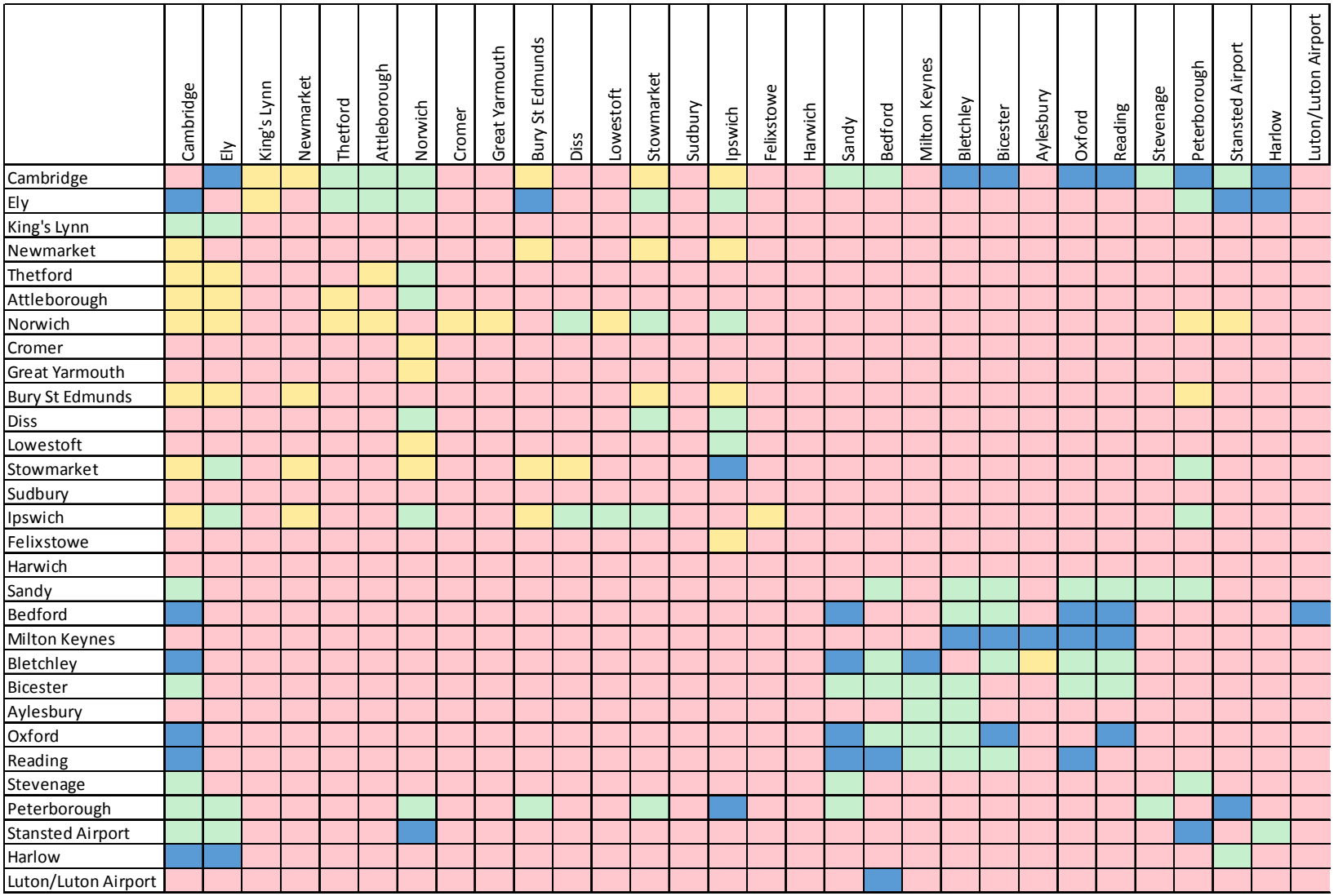
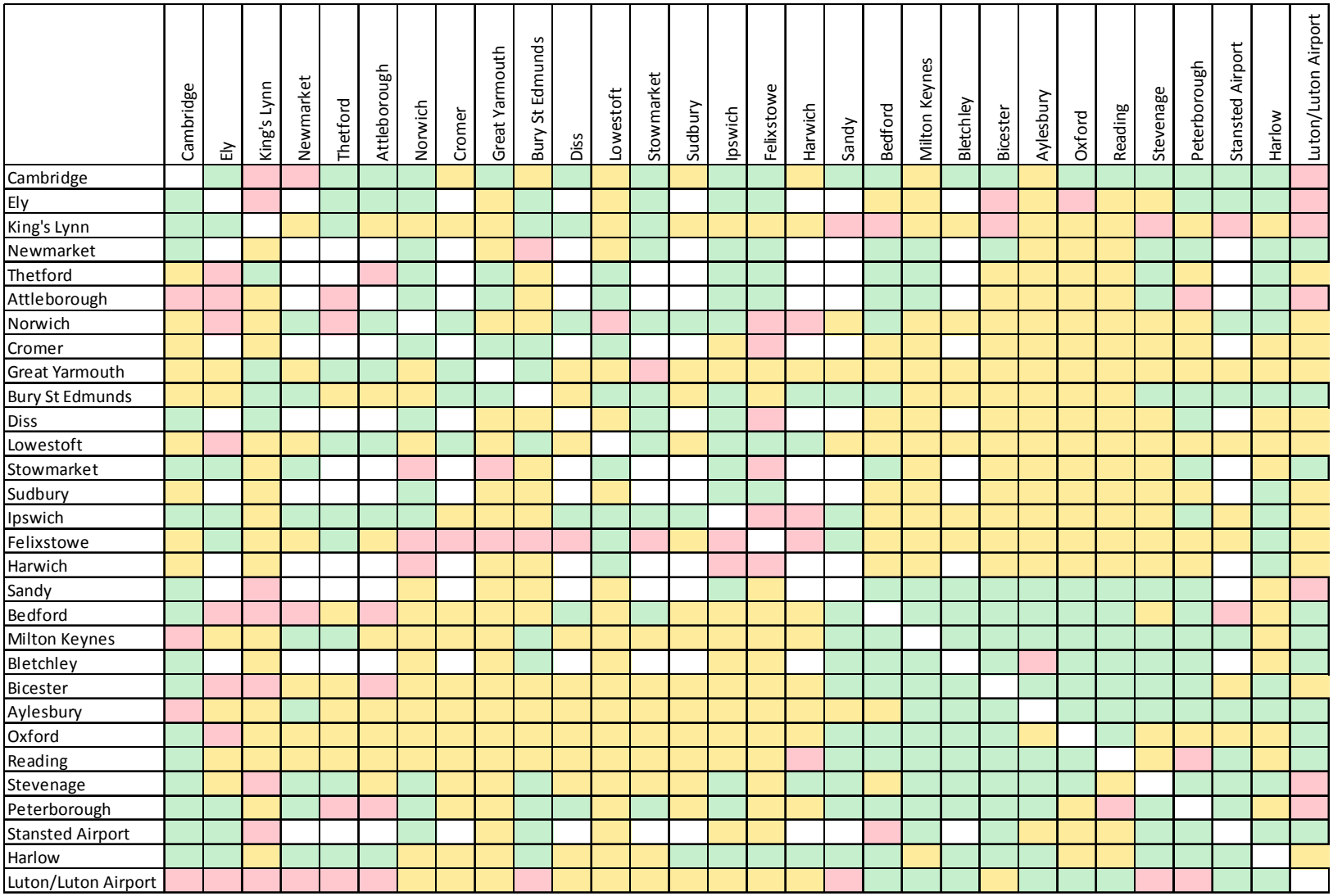


Table C-3 Overall Assessment



Appendix D. Glossary of Station Codes

Table D-1 Glossary of Station Codes

Cambridge	CBG
Ely	ELY
King's Lynn	KLN
Newmarket	NMK
Thetford	TTF
Attleborough	ATL
Norwich	NRW
Cromer	CMR
Great Yarmouth	GYM
Bury St Edmunds	BSE
Diss	DIS
Lowestoft	LWT
Stowmarket	SMK
Sudbury	SUY
Ipswich	IPS
Felixstowe	FLX
Harwich Town	HWC
Harwich International	HPQ
Sandy	SDY
Bedford	Bedford
Milton Keynes Central	MKC
Bletchley	BLY
Bicester	Bicester
Aylesbury	AYS
Oxford	OXF
Reading	RDG
Stevenage	SVG
Peterborough	PBO
Stansted Airport	SSD
Harlow Town	HWN
Harlow Mill	HWM
Luton	LUT
Luton Airport	LTN

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