

ESSEX THAMESIDE STUDY

Railway investment choices

July 2020



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1 FOREWORD

The Essex Thameside corridor is a key rail route into London on the north Thames estuary serving key towns such as Southend-on-Sea, Basildon, Grays and Tilbury as well as large catchments in East London in areas such as Barking and Dagenham. Although relatively small and quite self-contained compared to many other routes into London, the challenges that it faces in the future are significant. Population growth in this area is expected to be one of the highest in the country and, alongside expected growth in freight handling along the corridor, the solutions for meeting this growth are particularly challenging.

This study seeks to identify the generational challenge related to growth by assessing forecast passenger and freight growth over the next 30 years. It identifies a series of potential infrastructure and station improvements to help funders make informed decisions about enhancing this part of the national rail network.

The study builds upon the findings of the 2016 Anglia Route Study and forms part of Network Rail's programme of Continuous Modular Strategic Planning (CMSP). The study has been facilitated by Network Rail, developed in partnership with key organisations in the

area including the train operator, c2c, the Department for Transport, Transport for London, Essex County Council and the Association of South Essex Local Authorities, who have formed part of the study's 'board'.

Although a broad ranging study, it has focussed on long-term capacity and has assessed the corridor under the overall question of '*What interventions are required to support the expected growth in passenger and freight services in the Essex Thameside area over the next 30 years?*'. This was supported by five sub-questions to help establish the required infrastructure and station interventions to support demand for passenger and freight services in the long-term.

The publication of this study is expected to be the start of further consideration of enhancement options for this corridor. These options will provide rail investment choices for the Secretary of State for Transport through the Department for Transport and Network Rail's investment pipeline. The study will also provide guidance to other Government departments and sub-regional organisations on how this part of the rail network could develop to meet the employment and population growth expectations for this area.

2 EXECUTIVE SUMMARY

This study seeks to inform long-term investment choices for this strategically important south Essex corridor. It assesses a number of Strategic Questions, the answers and outputs to

which will help determine what infrastructure and station interventions may be required on this corridor over the next generation.¹

2.1 THE NEED FOR A STUDY

Conducting this study was considered a priority for several reasons:

- the pressures on this corridor from both passenger and freight demand are set to grow significantly over the next few decades due to housing and population growth, the growth of London Gateway and Tilbury ports, and regeneration proposals (including new stations) opening up new markets to travel.
- the 2016 Anglia Route Study identified several interventions for this part of the route but did not develop these recommendations. The core recommendation of introducing some longer trains in the short-term will be implemented in 2021.
- the Train Operating Company (TOC), c2c, which is currently franchised to operate passenger services along the corridor until 2029, has commenced development work into digital

signalling solutions. This study complements this work, considering all capacity options and a longer planning horizon for the period up to 2050.

- recent studies have highlighted pedestrian capacity pressures at London Fenchurch Street, West Ham and Barking stations. This study considers these findings in one place, assesses their recommendations and presents the most valuable options for further investigation in light of refreshed demand forecasts.
- studies are being completed for the other two key main lines on the Anglia route, i.e. the Great Eastern Main Line (GEML) and the West Anglia Main Line (WAML). An equivalent study for Essex Thameside ensures that all three main corridors have been subject to a detailed assessment of future options.

2.2 EXPECTED GROWTH

Overall passenger demand in the high peak is projected to grow 35 % by 2050,

with growth at the critical load point (between Barking and West Ham) being

¹ Assumed to be 30 years for the purpose of this study.

approximately 42 %, from a 2018 base. In the short-term, 9 % growth is expected by 2025 which is likely to result in capacity challenges on parts of the corridor, particularly between Barking and West Ham, and on both lines immediately east of Upminster. This growth in demand is primarily driven by growth in Central London employment

combined with high population growth expected in east London boroughs and Thurrock.

Growth in rail freight is also projected to be strong, with unconstrained² demand forecasted to increase four-fold by 2043, primarily driven by the key intermodal and bulk aggregates markets.

Coronavirus (Covid-19) Impact

It is recognised that, as of April 2020, passenger demand has fallen sharply as a result of the Coronavirus pandemic.

The growth forecasts for both passenger and freight were carried out in 2019 before the pandemic and its restrictions started. Further work to consider the long-term impacts of this will take place with any adjustment to assumed growth reported and applied. The growth assessments carried out in this study do include an assumption of increased home working (not Coronavirus-linked) in the future and it remains likely that the expected rail growth will continue to be driven by many factors including mode shift to rail and increasing population, which is particularly important in the Essex Thameside area.

2.3 OPTIONS DEVELOPMENT

The study has identified and assessed various interventions, including rolling stock, infrastructure and signalling enhancement options. One of the options considered as part of this study is c2c's operator-led proposal for implementation of European Train Control System (ETCS) Level 2 signalling³ between London Fenchurch Street and Upminster by 2025.

The strategy options recommended in this study have placed an emphasis on developing a staged or phased approach to delivering long-term capacity enhancements on this corridor so that capacity improvements can be achieved in the most efficient way.

It should be noted that the provision of additional infrastructure, for example, additional tracks and passing loops, on the approach to London Fenchurch

² Potential industry growth where there are no limits to the operation of services.

³ European Train Control System (ETCS) Level 2 is a form of digital in-cab signalling which removes the need for physical lineside signals. In-cab signalling provides continuous communication between track and train removing the need for fixed blocks between physical signals. This results in more efficient network usage and improved train performance. See more information on digital signalling at <https://digitalrailway.co.uk/> and <https://www.networkrail.co.uk/running-the-railway/railway-upgrade-plan/digital-railway/>

Street station has not been assessed in detail by this study as it is unlikely to be

feasible due to physical constraints and very significant cost associated with it.

2.3.1 SIGNALLING ENHANCEMENT

A long-term increase in capacity can be achieved by each of the options identified, including a signalling headway improvement between Upminster and Barking. A signalling improvement and corresponding increase in train service is likely to

provide the greatest amount of short-term capacity without reducing seating. This could be delivered using ETCS, as per part of c2c's proposal, and would deliver the required capacity in the short-term should it be deliverable by 2025.

2.3.2 TRAIN LENGTHENING

A short-term option is to lengthen all remaining 8-car services on the corridor to create a full 12-car operation. Although this option is considered more conventional due to its regular application as a capacity solution, and likely to be lower in terms of cost than signalling changes, it is not without other infrastructure and operational challenges. This includes the need for platform extensions at Grays and Shoeburyness. The cost and detailed challenges which would be associated with delivering these enhancements, including timescales for completion and

level of disruption to normal train services which would occur, require further investigation. There may also be some negative operational implications resulting from poorer punctuality due to longer average running times for 12-car trains as well as increased likelihood of delay, particularly from on-train equipment faults. Longer average running times for 12-car trains may also reduce the maximum possible frequency below 20 trains per hour, offsetting the capacity gains which 12-car trains bring. Further detail on these concerns are highlighted in section 6.

2.3.3 INCREASED STANDING DENSITY ON TRAINS THROUGH FLEET RECONFIGURATION

Reconfiguring the interior of trains to offer more standing room (at the expense of seating) has also been assessed as an option. Converting all trains operating in the high peak hour would provide sufficient capacity for the expected passenger growth in the medium-term and would be a relatively straightforward option to deliver. A recent example of such an option is the

introduction of Class 700 rolling stock on Thameslink services, providing increased standing capacity compared to previous rolling stock. This is, however, not considered to be a desirable option by some key stakeholders who participated in the development of this study, principally due to the negative passenger experience implications which increasing the rate of standing would bring.

2.3.4 STATIONS

Future passenger growth expected on this corridor is also expected to contribute to increased congestion and crowding issues for at least three stations on the corridor that will need to be addressed in the short- to medium-term. At present, capacity enhancement schemes are required at London

Fenchurch Street and Barking by 2025, and at West Ham by 2027. Development and delivery of significant station enhancements can take several years, so it is important that consideration of potential options is given as soon as possible.

2.3.5 FREIGHT

Growth in freight demand is forecast to be significant, however, it is not expected that specific infrastructure upgrades on the Essex Thameside corridor would be required to accommodate it. Freight to and from the Essex Thameside corridor must cross the North London orbital routes, where capacity upgrades are likely to be required to accommodate long-term growth. The interfacing London Rail Freight Strategy is assessing the strategy options to enable greater

cross-London freight amongst rising passenger demand.

Decarbonisation of freight operations on the corridor through increasing the ability for freight trains to be powered electrically is also an important long-term aim. This may also provide improved performance. Further electrification 'infill' is recommended, and it is currently being assessed through Network Rail's Traction Decarbonisation Network Strategy.

2.4 RECOMMENDATIONS

The options identified in this study have been proposed by Network Rail and informed by undertaking economic growth, timetable and route capacity assessments. The options have been reviewed by the study's 'board', which includes the corridor's principal train operator, c2c. It is recommended that these options are considered further under the Rail Network Enhancements Pipeline. It is noted that the operator,

c2c, has already undertaken initial development activity on an ETCS option.

This study also seeks to establish wider support from other Government departments and sub-regional organisations for investment in this part of the rail network. An enhanced rail network is critical to achieving the wider growth objectives that are expected for this area.

3 THE ESSEX THAMESIDE CORRIDOR

This section describes the characteristics of the Essex Thameside corridor, including current level of service, recent

growth trends as well as upcoming committed rail schemes and third-party developments.

3.1 RAIL INDUSTRY PLANNING

Greater devolution of economic planning, transport planning and decision-making means that strategic planning of the railway involves a greater level of complexity compared to plans produced in the past. Network Rail has previously published Route Studies, which provided a high-level study of the rail network across a whole region. For the area including the Essex Thameside corridor, the last Route Study was published in 2016, and covered the whole Anglia Route, including the Great Eastern and West Anglia Main Lines, and London Orbital routes, in addition to the Essex Thameside corridor.

To become more focussed and targeted in its long-term planning, Network Rail has recently changed its approach and has commenced a programme of Continuous Modular Strategic Planning (CMSP), of which this study forms a part. CMSP is more focussed on a specific area of the rail network, so this study is able to provide a more detailed assessment of the Essex Thameside corridor than previous Route Studies.

For this study, Network Rail has worked with its industry partners and stakeholders to:

- determine short- (2025), medium- (2035) and long-term (2050) passenger and freight growth forecasts for the corridor;
- identify the short-, medium- and long-term passenger and freight service requirements to support this growth;
- identify additional infrastructure that may be required to achieve these requirements, and;
- identify station enhancements that may be required to safely accommodate increasing passenger numbers.

The production of a more focused study such as this, provides greater ownership by key stakeholders bringing the case for investment to Government and other funders through the Rail Network Enhancements Pipeline (RNEP).⁴

⁴ For more information on the RNEP, see <https://www.gov.uk/government/publications/rail-network-enhancements-pipeline>

3.2 GEOGRAPHY & SCOPE

The Essex Thameside corridor runs from London Fenchurch Street to Shoeburyness with a loop line between Barking and Pitsea via Tilbury formed of two tracks and a single line section between Upminster and Grays. These lines carry a mixture of commuter and leisure traffic along with substantial freight movements to and from various destinations, including the growing ports at Tilbury and London Gateway. The corridor is wholly electrified with overhead line equipment with the exception of some freight facilities.

The route suffers from several significant physical constraints, especially between Upminster and London Fenchurch Street.

These mostly consist of dense urban environments close to the railway line, parallel running with parts of the London Underground and Docklands Light Railway networks and most of the section between London Fenchurch Street and West Ham stations being elevated on a viaduct. Combined, these factors severely restrict the opportunity to construct additional infrastructure between these points.

Running west to east, the route originates on the eastern edge of the City of London, passing through four London Boroughs and four south Essex local authorities, as shown below in Figure 1.⁵

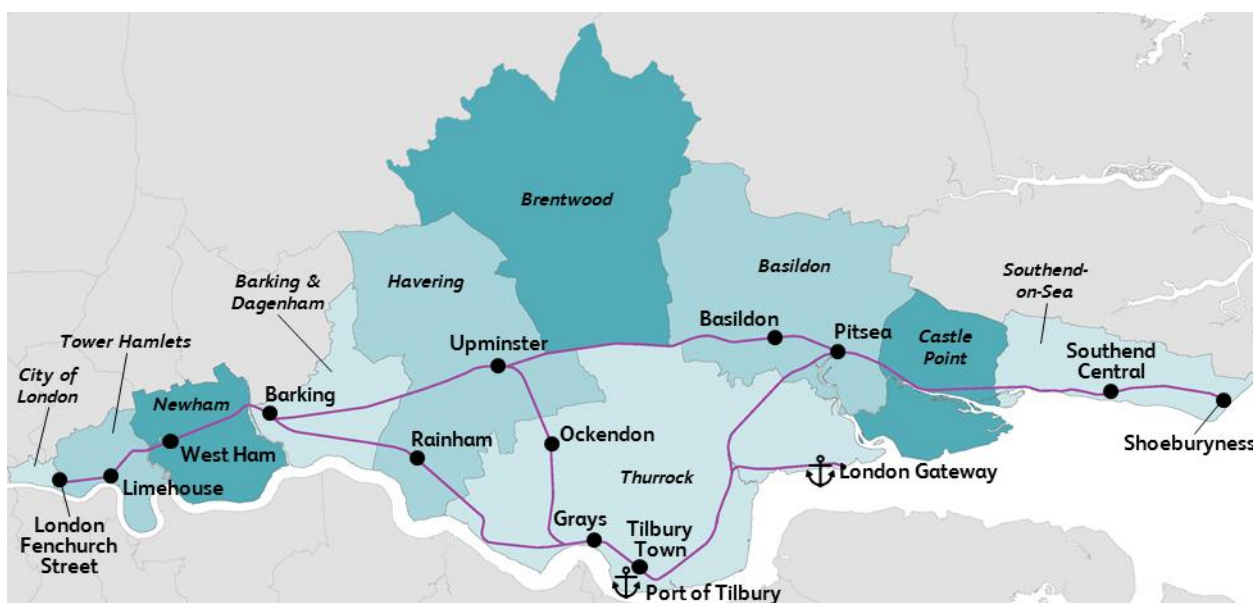


Figure 1 – A geographic representation of the Essex Thameside corridor, in purple, which connects key population centres and freight sites in south Essex and east London.

⁵ The railway also forms the southern boundary of a fifth Essex local authority; Brentwood.

Figure 2 below shows a diagrammatic representation of the Essex Thameside corridor, with the different parts of corridor highlighted in different colours. The orange dash indicates the western extent of this study's freight analysis, as far as Woodgrange Park Junction, where freight traffic from Essex Thameside can split between the two different North London orbital routings. This has been chosen as the most westerly point where all freight traffic must pass through. It is acknowledged that freight trains travel

nationwide, far beyond the scope of this study, and Network Rail is currently conducting other work to ensure that future operational requirements for the connecting cross-London routes are identified.

The geographical scope of this study is as per this diagram, and references to the three different lines of the Essex Thameside corridor within this study refer to their representation on the diagram.

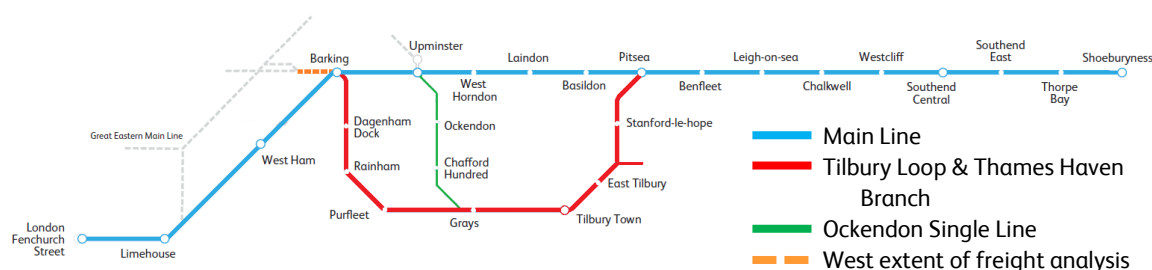


Figure 2 – A diagrammatic view of the Essex Thameside corridor, with its constituent lines distinguished accordingly.

The corridor is largely separated from the rest of the Anglia Route,⁶ however it does have key passenger interchanges with other rail lines, particularly Transport for London-operated services at Barking and West Ham.

Interchange is also possible at Upminster for London Overground services to Romford and for connection to the

District Line, as well as Limehouse for Docklands Light Railway (DLR) services to Bank. London Fenchurch Street is the only National Rail terminus in London without a direct connection to the London Underground, but is a recognised out-of-station interchange⁷ with the Circle and District Lines from Tower Hill. A diagram of these key interchanges is shown below at Figure 3.

⁶ Network Rail's Anglia Route covers principally the rail network in the East of England.

⁷ See <https://tfl.gov.uk/corporate/publications-and-reports/out-of-station-interchanges> for more information.

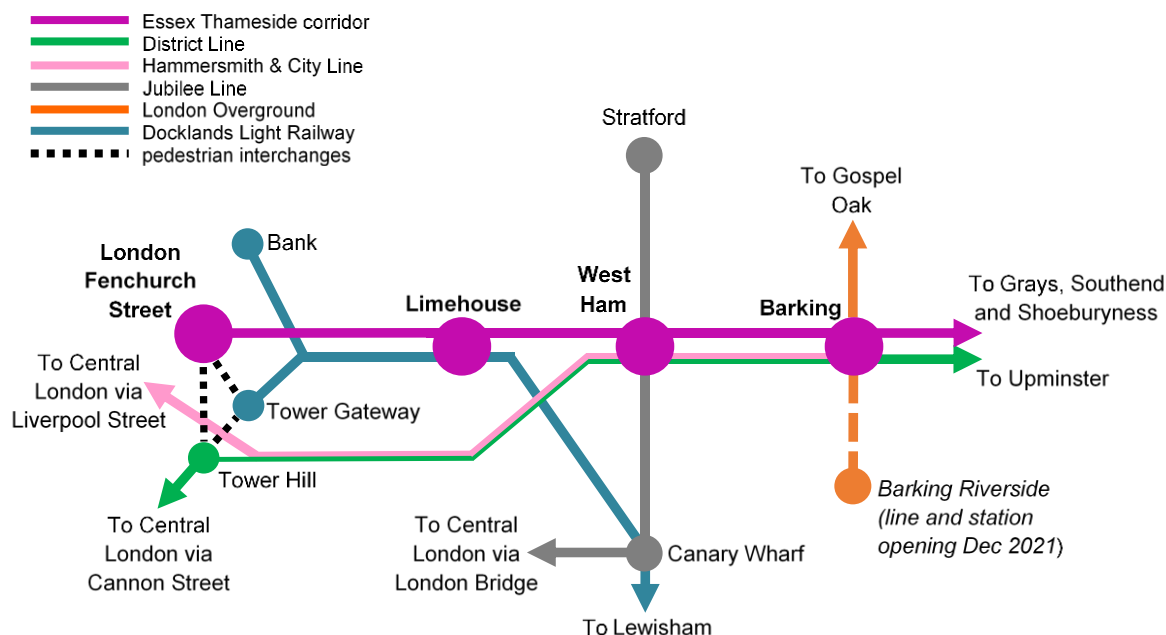


Figure 3 – Interchanges at the four inner stations (shown in bold) on the Essex Thameside corridor.

3.3 PASSENGER SERVICES

All passenger services along the corridor are currently provided by the train operator, c2c, owned by Trenitalia UK. The current off-peak passenger timetable operates trains from London Fenchurch Street to;

- Shoeburyness via Basildon – 4 trains per hour (tph);
- Southend Central via Ockendon – 2tph, and;
- Grays via Rainham – 2tph⁸

Patronage is dominated by traditional peak hours commuter traffic to and from London Fenchurch Street and the train service in the peak is intensified significantly to cater for this demand, culminating in 20 arrivals at London Fenchurch Street between 0800 and 0859, and 19 departures from London Fenchurch Street between 1700 and 1759. Most services are operated with Class 357 rolling stock with two different seating configurations, as shown in Table 1 below.

	Seats	Standing	Total 4-car train capacity	Total 8-car train capacity	Total 12-car train capacity
4-Car Class 357	282	124	406	812	1,218
4-Car “Metro” Class 357	222	334	556	1,112	1,668

Table 1 – Capacity of Class 357 rolling stock.

⁸ Note, morning high peak trains via Ockendon start at Grays and morning high peak trains via Rainham start at Southend Central or Pitsea.

The Class 357 fleet is currently in the middle of its design life and is not due for replacement until the mid-2030s. Six 4-car Class 387 trains with a total 12-car capacity of 1,128 each are also operated. The Class 387s will be replaced by new, longer trains in 2021.

All stations on the corridor are able to accommodate 12-car trains, with two notable exceptions – platform 3 at Grays and platform 3 at Shoeburyness. These shorter platforms place operational constraints on the extent of 12-car services available. These issues are described in full in section 6.

3.4 FREIGHT SERVICES

Essex Thameside is also a significant and complex freight corridor, generating about 40-45 freight movements per day. These freight trains transport a diverse range of cargoes to and from various destinations along the corridor, including;

- maritime and domestic intermodal freight handled at London Gateway, Tilbury, Barking and Purfleet;
- inbound bulk cement and crushed rock for processing or distribution at various aggregates facilities, plus outbound marine-dredged sands and gravels and recycled aggregate substitutes;
- finished and semi-finished metals via Tilbury, and;
- components and completed vehicles to and from the Ford factory in Dagenham.

The majority of freight connectivity to and from the Essex Thameside corridor is with destinations in the Midlands and northern England, although there is also some traffic to and from southern and western England, Wales and the Scottish Central Belt. A proportion of the traffic arriving on the corridor, including imports

to the Ford factory, arrives from Europe via the Channel Tunnel Rail Link.

All domestic services pass through Barking and then west of Woodgrange Park Junction connect either with the line to Gospel Oak or the North London Line (after traversing the Great Eastern Main Line between Forest Gate Junction and Stratford station). Any uplift in freight traffic to and from Essex Thameside destinations would require consideration of capacity on the north London routes (including the Great Eastern Main Line) and beyond, in conjunction with any improvements on the Essex Thameside corridor itself, most notably in connection with the high-frequency London Overground service on the North London Line. This will be explored as part of the London Rail Freight Strategy, currently underway, and due to report later in 2020. Figure 4 below shows the connectivity from the Essex Thameside corridor with the East Coast, Midland and West Coast Main Lines.

Due to gaps in electrification, most freight services on the corridor are hauled by diesel locomotives, despite the key West and East Coast routes being able to cater for electric trains via both north London routes.

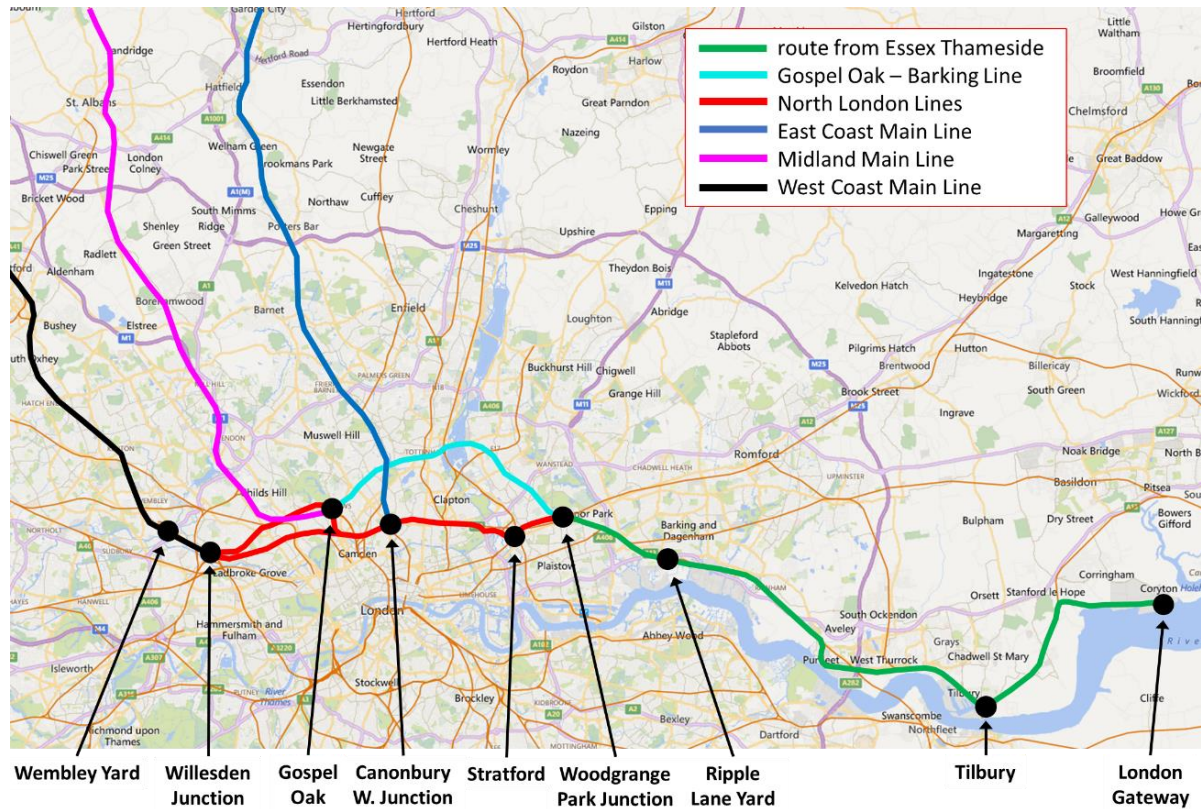


Figure 4 – Freight connectivity across North London from the Essex Thameside route, with key locations.



3.5 RECENT GROWTH – PASSENGER⁹

Passenger numbers have been increasing on the Essex Thameside corridor over the last decade. Figure 5 below shows the total numbers of passenger journeys travelling on c2c services each year between 2011/12 and 2018/19, growing by approximately 34.9 % between these dates. This equates to an average 5.1 % year-on-year growth rate.

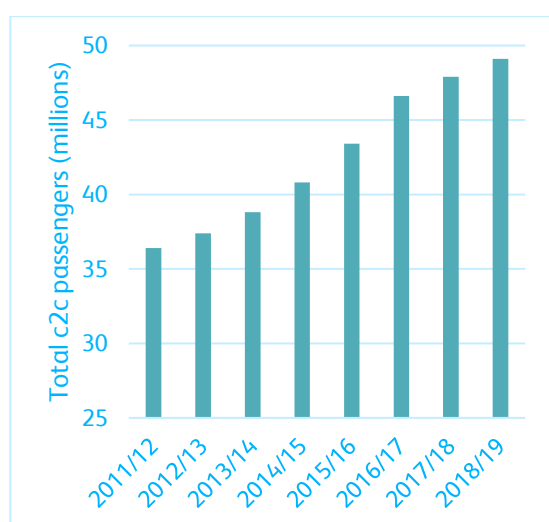


Figure 5 – Total c2c passengers (millions) 2011/12 – 2018/19.

This growth has been consistent and has begun to differ from the national picture in recent years. Growth was closely aligned to the national trend up to 2015/16, however where the national rate of growth began to reduce after 2015/16, the number of passengers on Essex Thameside has continued to increase at a relatively consistent rate, as illustrated in Figure 6.

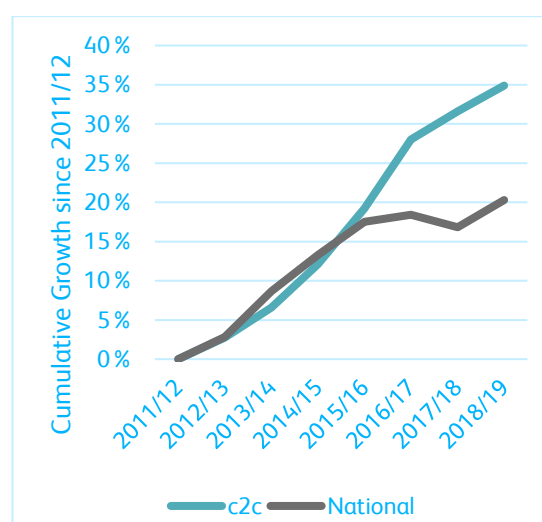


Figure 6 – Growth in c2c and National passenger numbers since 2011/12.

Over the last decade passenger footfall has increased significantly at Barking and West Ham, as indicated by Figure 7 opposite. These two stations offer the greatest opportunity for interchange with the TfL network. London Fenchurch Street has seen relatively modest growth, albeit from a much higher base.

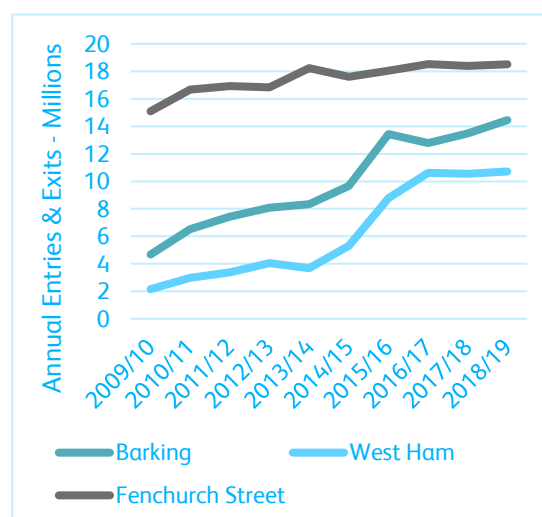


Figure 7 – Total Entries & Exits (National Rail) at Barking, West Ham and London Fenchurch Street 2009/10 – 2018/19.

⁹ All graph data from ORR Data Portal

National Rail statistics do not reveal the whole picture at West Ham and Barking as London Underground and Docklands Light Railway station usage statistics are recorded separately. These are shown

below in Table 2. These show high growth trends at West Ham, in particular, over a similar period, although National Rail growth figures are much higher than both TfL modes at both stations.

	West Ham			Barking	
	National Rail	LU	DLR	National Rail	LU
	Users (millions)	Users (millions)	Users (millions)	Users (millions)	Users (millions)
2012	4.1	3.3	2.4	8.1	14.5
2013	3.7	3.4	2.0	8.3	15.2
2014	5.3	3.5	2.2	9.7	15.6
2015	8.8	3.8	2.8	13.4	16.1
2016	10.6	3.5	3.1	12.8	15.9
2017	10.6	4.4	3.3	13.5	18.2
2018	10.7	4.4	3.5	14.5	16.8
% chg since 2012	+ 164.2%	+ 34.1%	+ 42.0%	+ 79.0%	+ 15.7%

Notes:

National Rail figures from ORR estimates of station usage statistics.

LU and DLR figures from TfL statistics.

National Rail figures for Barking also include estimates for London Overground's Gospel Oak-Barking service

Table 2 – Annual entries and exits at West Ham and Barking stations by rail mode.

This increase in passenger usage, particularly at West Ham and Barking stations, has increased pressure on operations at peak times. West Ham experiences heavy demand in the morning peak hours from passengers interchanging from c2c services onto the Jubilee Line, with Barking experiencing similar issues from passengers changing from the District Line to c2c services. The reverse happens at both stations in the evening peak hours.

These flows lead to overcrowding on the narrow stairs to/from the c2c platforms at West Ham with people queuing on the platform in the morning peak, and high volumes of passengers on the footbridge at Barking. The Barking Riverside extension of the London Overground is expected to add more complexity to the

interchange pattern at Barking, increasing pressure on the footbridge.

Between 2011 and 2018, total daily numbers of passengers arriving at London Fenchurch Street in the three-hour morning peak (07:00-09:59) increased by almost 7 %,¹⁰ suggesting an increase in the number of commuters to central London jobs. The central London employment rate is, however, just one factor that could have influenced growth in rail usage along the Essex Thameside corridor as the growth rate at London Fenchurch Street is much lower than the overall c2c growth rate over the same period (34.9 %) and the growth in central London employment (13 %). This suggests that there are other factors influencing rail demand in this region, most likely employment growth in other areas of London, such as Canary Wharf

¹⁰ DfT

or Stratford. Both of these hubs benefit from connectivity via the Jubilee Line from West Ham and are forecast to

continue developing with an associated increase in employment opportunities.

3.5.1 POPULATION FORECASTS¹¹

Between 2010 and 2016, working age population (ages 16-64) in the South Essex and East London local authority areas served by the Essex Thameside corridor grew by an average of 6.6 %. This growth was primarily in the London Boroughs of Newham and Barking & Dagenham, which grew by 15.9 % and 13.4 % respectively. Outside of London, Thurrock grew the most at 4.2 %.

Future forecast projections remain high in these areas with Barking & Dagenham (27.9 %), Newham (15.0 %) and Thurrock (18.3 %) each forecasted to have

significant growth over the next 20 years. Growth in the London Borough of Havering is projected to outstrip Newham from the mid-2020s, with 22.2 % growth expected by 2040. Average 16-64 population growth across the corridor between 2016 and 2040 is projected to be 15.9 %.

Castle Point is the only local authority area where working age population declined between 2010-2016, and up to 2040 registers low growth of 1.9 %. Figure 8 below shows the forecast for each area.

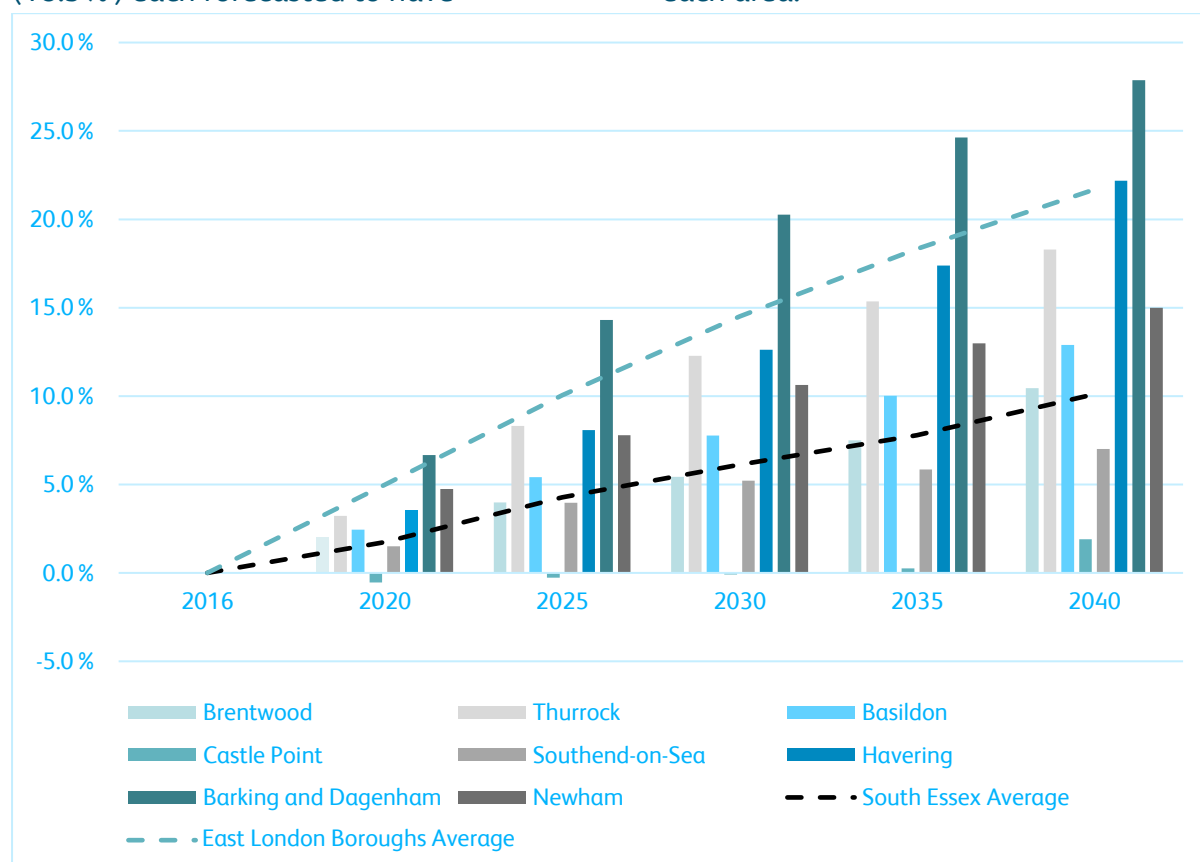


Figure 8 – Projected population change by local authority area over the next 20 years.

¹¹ Office for National Statistics

3.6 RECENT GROWTH – FREIGHT

Nationally, over the last decade, the key intermodal and construction materials markets – the core commodities hauled nationally, and on the Essex Thameside corridor – have grown by 22 % and 30 % respectively. Intermodal container traffic (including international) has grown from 15.2 million tonnes hauled in 2009/10 to 18.6m tonnes in 2018/19. Haulage of construction materials has grown from 17.2m tonnes in 2009/10 to 22.3m tonnes in 2018/19 with a peak in 2016/17 of 24.3m tonnes. The trends over the last decade can be seen below at Figure 9.

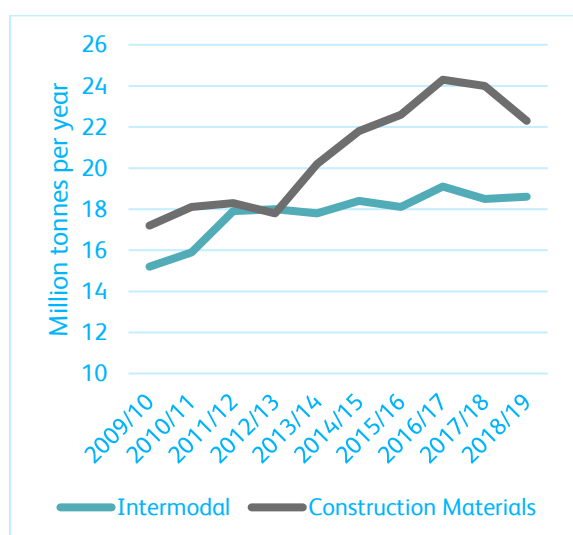


Figure 9 – The two main freight types carried nationally have seen moderate growth over the last decade.¹²

Statistics at a more localised level are difficult to compile accurately due to the nature of the national freight market, however, two key developments have significantly increased the freight handling potential of the corridor in recent years.

London Gateway port opened in November 2013, complete with a rail freight terminal, vastly increasing the international container handling potential of the south Essex coast and contributing significantly to the growth in the freight traffic on the corridor. The port is not yet operating at its maximum capacity, currently operating three berths for ships to dock. A further three berths and a second rail terminal are able to be developed in the future, subject to demand.

In addition, DB Cargo's Barking Eurohub has also been developed, offering direct access to HS1 and providing an interface between the varying maximum loading gauges between Great Britain and Europe, although demand for continental rail freight remains low at this time.

¹² Network Rail freight forecasts: Scenarios for 2033/34 & 2043/44

3.7 COMMITTED SCHEMES

There are several rail enhancement programmes and significant third-party developments currently ongoing or committed which will have an impact on

the Essex Thameside corridor. All of these projects have completion dates in the early/mid-2020s and are included in this study's baseline growth forecasts.

3.7.1 BARKING RIVERSIDE

Barking Riverside is a large mixed-use development in Barking, being built on brownfield land formerly occupied by Barking Power Station adjacent to the River Thames. The site has planning permission for 10,900 homes and associated commercial and community facilities. The development also features a new station, accessed on new infrastructure.

extended to serve this new station and is expected to begin in January 2022 with a frequency of 4tph. New, longer, 4-car Class 710 electric trains began operation in mid-2019 on the existing Gospel Oak to Barking section, replacing the 2-car diesel trains used prior to electrification. Land has been safeguarded for a station west of Renwick Road, however there are no plans to develop the proposal at this time.

The current London Overground service from Gospel Oak to Barking will be

3.7.2 BEAM PARK STATION

Beam Park is a station currently in development to be sited between Rainham and Dagenham Dock stations on the Tilbury Loop. The station is proposed to serve a new housing development of 3,000 homes and is expected to open in May 2022 with a

peak service frequency provided by c2c to London Fenchurch Street of 4tph and an off-peak service frequency of 2tph. Further parcels of nearby land are expected to be developed after the initial 3,000 homes.

3.7.3 NEW C2C TRAINS

c2c will introduce longer trains to aid peak demand in the short-term. This will consist of six 10-car Bombardier *Aventra* trains, expected to be in service in 2021,

ahead of the originally planned date of 2024. These trains will replace six 4-car Class 387 trains, providing an increase in train capacity in the peak hours.

3.7.4 FOUR LINES MODERNISATION ('4LM')

London Underground is currently undertaking a programme of works to

increase capacity and improve journey times on its Circle, District, Hammersmith

& City and Metropolitan Lines. The current peak hours service to Barking is 24tph, with 12 continuing to Upminster. This is planned to increase to 32tph to Barking with 16 continuing to Upminster.

As a result, LU passengers travelling on the sections of the District and Hammersmith & City Lines which run in parallel with c2c services between

Upminster and West Ham will see a significant service frequency enhancement. However, this isn't expected to result in any notable abstraction of passengers from c2c services onto LU services due to the quicker journey times available on c2c trains. Completion of the 4LM programme is scheduled for May 2023.

3.7.5 NEW DLR TRAINS AND SERVICE ENHANCEMENTS

New walk-through trains are programmed to operate across the DLR from 2024. These trains will be 90m long and in a fixed formation, replacing trains made up of two or three separate 30m units with no ability for passengers to move between them. The walk-through formation will offer greater capacity and allow passengers to distribute more easily along the full length of the train. Forty-three new trains will be introduced, working alongside existing rolling stock and replacing some of the oldest trains operating across the network.

The peak service frequency from Stratford International to Woolwich Arsenal via London City Airport will be doubled from 7.5tph to 15tph. A new service from Stratford International to Beckton will also be introduced with a peak frequency of 7.5tph, bringing the total peak hours frequency via West Ham up from 7.5tph today to 22.5tph. The service frequencies to Bank and Tower Gateway via Limehouse will not change.

3.7.6 TILBURY2

The Port of Tilbury has recently expanded onto brownfield land to the east of its existing site. A new rail terminal capable of handling 775m trains is under construction and is expected to primarily handle construction materials and bulk aggregates as well as some domestic

intermodal container traffic. The facility commenced operations in summer 2020, with the freight terminal expected to open before the end of the year. Once operational it is expected to generate in the region of eight additional freight train circulations per day across intermodal and bulk handling activities.

3.7.7 STEPHENSON STREET DEVELOPMENT & WEST HAM STATION

Planning permission has been granted for a large, high-rise development on land adjacent to West Ham station

formerly occupied by a Parcelforce depot. The Stephenson Street development will deliver 3,800 new homes, commercial

and community space, as well as a new entrance to West Ham station, linking the development directly with the station on the bridge above the Jubilee Line.

The new station entrance is expected to open in autumn 2022.

3.7.8 PURFLEET CENTRE REGENERATION

Outline planning permission has been granted for the redevelopment of Purfleet town centre, focussed around the existing railway station. The proposed redevelopment includes up to 2,800 new homes, new community facilities, business and leisure space, including 135,000m² of film and TV studios. The masterplan also aims to redevelop the station and close the

adjacent level crossing on London Road, replacing it with a bridge. The first phase, including around 1,000 homes, is expected to be complete by April 2023. Planning conditions specify that the bridge and station must be completed prior to certain residential or commercial elements of the scheme, however, a delivery date is not confirmed at this stage.

3.7.9 GRAYS STATION AND LEVEL CROSSING

Thurrock Council, Network Rail and c2c are currently developing a proposal to close Grays High Street Level Crossing. This pedestrian only crossing, adjacent to Grays station sees high levels of misuse, and its replacement with an underpass is expected to improve the safety and performance of this part of the network.

The scheme is likely to require the realignment of Crown Road on the north side of the railway and reconfiguration of the adjacent station drop-off and taxi facilities. The project is currently undergoing option selection, with a target delivery date in 2024.

3.7.10 STANFORD-LE-HOPE STATION

Stanford-le-Hope station on the Tilbury Loop is currently being redeveloped by Thurrock Council and c2c to provide a new modern station entrance, step-free

access and improved cycle parking and bus interchange. The new station facilities are due to open in May 2021.

Figure 10 below indicates the current expected completion dates for the projects listed above on the Essex Thameside corridor and interfacing TfL network.

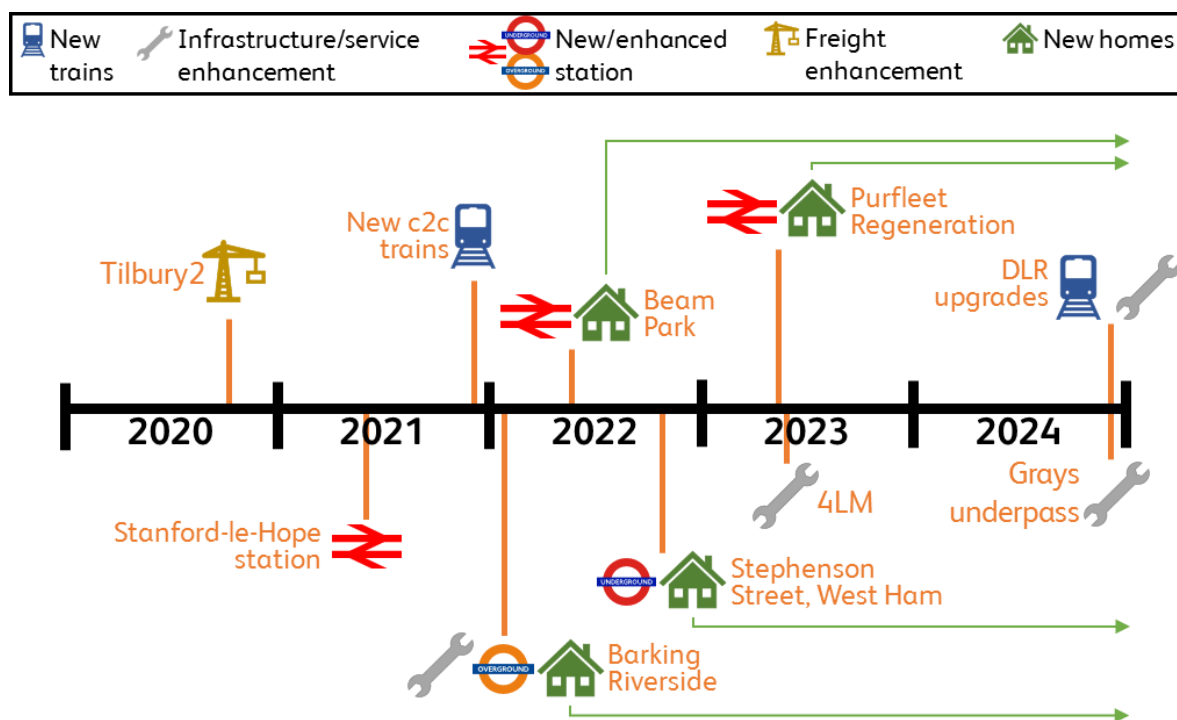


Figure 10 – Current expected delivery timeline of committed enhancements and developments. Note, arrows indicate onward phased delivery of housing.

3.8 UNCOMMITTED SCHEMES AND ASPIRATIONS

As well as committed schemes there are a number of proposals in development which, if delivered, would have an impact

upon passenger and freight services on the Essex Thameside corridor.

3.8.1 C2C EUROPEAN TRAIN CONTROL SYSTEM (ETCS) PROPOSAL

c2c has developed a business case for the introduction of ETCS Level 2 digital signalling. c2c's aspiration is to introduce a 24tph high peak hour timetable from May 2025, which, with a further introduction of rolling stock is projected to be able to provide sufficient network

capacity for passengers until 2035. The proposed signalling would have the capability to increase train frequency up to 28tph (subject to other required enhancements). This study has worked with c2c to establish this as an option for accommodating future growth.

3.8.2 RIPPLE LANE NODAL YARD

Ripple Lane West Yard is an existing freight yard between Barking and Dagenham Dock on the Tilbury Loop. The yard is planned to be enhanced into

a nodal yard to enable it to accommodate 775m freight trains, GB2 gauge freight from HS1, and provide a regulation point between the Tilbury

Loop and the London orbital routes, maximising freight capacity within the parameters of existing interfacing passenger timetables.

It is important to note that the enhancement to the yard will not provide additional on-network capacity, as infrastructure enhancements would also be required elsewhere to support this. Rather, it will help to ensure that existing

capacity is best utilised and enable route performance to be better managed at a key location before joining the busy London orbital network at Barking. The project is currently in the Design/Final Business Case phase of the Rail Network Enhancement Pipeline and a Decision to Deliver is expected in 2020. If approved, the scheme is expected to be delivered in Control Period 6 (CP6, 2019-2024).

3.8.3 BARKING STATION ACCESS FOR ALL BID

The DfT's Access for All (AfA) programme was launched in 2006 to address the issues faced by disabled passengers and passengers facing mobility restraints (such as heavy luggage or pushchairs) when using railway stations in Great Britain. Since its

launch, over 150 stations have benefited from the scheme. In 2018, c2c submitted a bid to improve Barking station from the CP6 fund. This bid was unsuccessful, however the concept designs proposed in the bid have been considered under this study.

3.8.4 LONG-TERM DLR ASPIRATIONS

A long-term aspiration exists to extend the DLR to Thamesmead and Belvedere, south of the River Thames, via a new tunnel or bridge from Gallions Reach,

along with a potential to connect this extension northwards to Barking station, opening up more interchange opportunities.

3.8.5 JUBILEE LINE OPTIMISATION

Signalling improvements on the Jubilee Line has enabled the maximum train frequency from Stratford to be increased from 24tph to 30tph, which improves capacity for Essex Thameside passengers

interchanging at West Ham during peak hours. It may be possible to increase frequency up to 32tph, subject to further improvements.

3.8.6 BARKING REGENERATION PROPOSALS

BeFirst, a regeneration company wholly owned by the London Borough of Barking and Dagenham, is currently developing a masterplan for the town centre surrounding Barking station.

When options presented by this study are taken forward into further development, an investigation into the viability of incorporating capacity enhancements at Barking station with

commercial opportunities is recommended. However, funders should be mindful that the timeframe for designing and building a development of this nature could take significantly longer

than a purely station-based intervention and that long lead times for developing a commercial opportunity should not jeopardise safe and efficient station operation.

3.8.7 REDEVELOPMENT PROPOSALS

At least two large scale planning applications are currently under consideration by Thurrock Council, which could increase residential and commercial activity in the area. The Arena Essex application proposes up to 2,500 homes near to Chafford Hundred station and the Lakeside Shopping Centre. If this application was approved, this could increase passenger demand at Chafford Hundred station.

Secondly, the Thames Enterprise Park proposal promotes a phased redevelopment of the former Coryton Oil Refinery, beyond London Gateway port at the end of the Thames Haven branch line to provide up to 480,000m² of

commercial and industrial facilities, including a rail terminal. If this application proceeds, this could increase rail freight traffic to and from the Essex Thameside corridor.

Brentwood Borough Council is also promoting significant new housing developments in the south of the borough near the Essex Thameside corridor, including the Dunton Hills Garden Village. This site, to the north east of West Horndon station could developed to include up to 4,000 new homes. It is proposed that West Horndon station would be improved along with these housing developments, improving car, bus and cycle access.

3.8.8 MINOR STATION ENHANCEMENT PROPOSALS

Previous studies have highlighted an opportunity to install a second gateline at Barking station near to the stairs to platforms 5/6 and 7/8. Although this is a minor proposal, a second gateline at Barking station could bring an improvement in passenger flow at the station entrance and ease congestion on the footbridge. c2c has also raised the prospect of installing an escalator at West Ham to relieve crowding and

improve access to and from the island platform in the short-term.

As neither of these proposals are committed, they have not been used in this study's baseline for future station capacity modelling, however the proposed layouts have been tested as a sensitivity to understand their likely effectiveness in relieving passenger congestion and viability as short-term enhancement options.

3.8.9 RAIL FREIGHT ELECTRIFICATION

Network Rail's 2017 Freight Network Study highlighted gaps in capability for running electric freight trains on this part of the network. Despite the Essex Thameside corridor and its connections to the Great Eastern Main Line (including the onward connection to the North London Line) and Gospel Oak-Barking Line being electrified, allowing full use of electric passenger trains, the 2.5 mile Thames Haven branch line to London Gateway port is unelectrified, preventing the use of electric freight locomotives. It is also worth noting that electrification of several other lines and terminals across the country would need to be completed to unlock more end-to-end electrically-hauled freight journeys. In London, the 0.7 mile connection from the Gospel Oak-Barking Line to the Midland Main Line

(the Tottenham North Curve between Junction Road Junction and Carlton Road Junction) prevents use of electric traction between Essex Thameside locations and the Midland Main Line. Several other similar examples exist outside of London. If these gaps in electrification could be bridged then this could contribute to the decarbonisation of rail freight in this region.

Network Rail's Traction Decarbonisation Network Strategy is likely to propose the electrification of some of these gaps. Given their relatively short lengths and potential to realise an increase in the number of electrically hauled services they are likely to be identified as a high priority for delivery.



4 STUDY APPROACH

The study commenced in spring 2019 and with support from industry partners, sought to answer the following key question;

What interventions are required to support the expected growth in passenger and freight services in the Essex Thameside area over the next 30 years?

Passenger and freight demand over the next 30 years has been forecasted and solutions to increase capacity have been identified. Impacts of increased

passenger journeys upon the three key stations has also been assessed and suitable proposals from existing source material have been investigated further.

4.1 STRATEGIC QUESTIONS

Network Rail agreed with its stakeholders at the outset of the study five Strategic Questions to understand these required interventions. These questions are;

SQ1: What is the expected growth in passenger demand over the next 30 years and what challenges does this present?

SQ2: What interventions are required to provide sufficient capacity post-2035, when the capacity provided by the initial ETCS proposal is expected to be exhausted?

SQ3: What are the capacity challenges at the three 'key stations' and how can these be addressed?

SQ4: What is the expected future growth in rail freight to and from Essex Thameside destinations and how can this be supported?

SQ5: Should the ETCS proposal not proceed, what other options exist to increase capacity in the long-term?

4.2 METHODOLOGY

The broad methodology used in the study to answer the Strategic Questions is shown in the diagram below;



As outlined above, for passenger services, the Essex Thameside corridor is primarily a commuter railway. The study has, therefore, focussed on ensuring that traditional peak hours passenger services continue to have enough capacity in the long-term, while also assuring that increasing freight demand can be accommodated during the off-peak hours.

Network Rail has forecasted demand for passenger services in the short-, medium-, and long-term. Recent national freight forecasts have been assessed to identify whether any infrastructure changes are needed to support freight growth. Timetables, rolling stock formations and infrastructure capabilities have been analysed to understand opportunities for efficient

enhancement. Where necessary, the most suitable locations for infrastructure enhancements to support improved services have been identified. Current committed schemes identified above have been included in the baseline analysis for this study.

While concepts for station enhancements normally wouldn't be presented at this stage of study, several recent reports regarding options for enhancement at West Ham and Barking stations exist. As there is an opportunity to use this source material as part of this study, Network Rail and stakeholders have selected suitable concepts from these existing reports to be modelled for pedestrian capacity following the outputs of demand forecasting.

4.3 STUDY PLANNING HORIZON

Network Rail and stakeholders have chosen to assess the corridor at three reference years in order to present a staged, short-, medium- and long-term picture of the corridor. These years are 2025, 2035 and 2050. The short-term horizon of 2025 was chosen to mirror

c2c's proposed introduction date of a 24tph timetable under ETCS to make it possible to draw comparisons with alternative options. The long-term, 2050 horizon was chosen as the current extent of long-range forecasting offered by TfL's Railplan model. 2035 is a central,

medium-term horizon, which also aligns with the projection c2c has made regarding the longevity of its proposed 24tph timetable. This is, therefore, an ideal medium-term year to propose

interventions beyond the original ETCS proposal, as well as a second horizon for considering other capacity enhancement options.

4.4 GOVERNANCE

This study has used a similar governance methodology to other studies recently completed. The study has been facilitated by Network Rail and was primarily supported by a study board consisting of stakeholders from the region, as well as the Department for Transport and Transport for London. The board agreed the scope of the Strategic Questions and had a role in selecting and reviewing strategy and enhancement concepts developed by Network Rail.

Focussed workshops were held to develop understanding and inform decisions on freight and stations matters, and to establish understanding of planned enhancements on the TfL network. This study also had input from the Rail Freight Group. Freight operators have been engaged in the study through the London Rail Freight Strategy working group and have been consulted on the findings of the rail freight workshop.

Study Board Members

Network Rail
c2c
Transport for London
Department for Transport
Rail Delivery Group

Essex County Council
Thurrock Council
Southend-on-Sea Borough Council
Opportunity South Essex
Association of South Essex Local Authorities
South East Local Enterprise Partnership



5 LONG-TERM GROWTH ASSESSMENT

This section presents Network Rail's view of growth in both passenger and freight demand on the corridor and sets out the shortfall in the number of passenger carriages on the network in the morning high peak as well as the total number of freight paths per hour recommended in the off-peak. Growth forecasts for each have been conducted and are discussed

in turn below. This section also describes the likely impact of this growth upon stations. A single, central passenger forecast was produced for this study, however, a sensitivity test of higher growth across the corridor has been applied and the effect of this is set out in the final section of this document.

5.1 GROWTH ASSESSMENT – PASSENGER

The assessment of passenger growth has been based on Transport for London's Railplan model. Railplan was used to forecast passenger demand for morning peak c2c services arriving at London Fenchurch Street between 07:00-09:59.

for years 2031 and 2050, and interpolated to reflect this study's reference years of 2025, 2035 and 2050. The number of additional carriages required on top of expected future capacity was calculated.

Railplan outputs were used to calculate the growth in the number of passengers travelling between each adjacent pair of stations, or 'arc'. Future demand was compared to expected future capacity to determine levels of crowding including standing density. Demand was forecast

Table 3 below shows the average growth (from a 2018 base) in high peak passengers across the Essex Thameside corridor in each of this study's reference years, as well as the growth at the busiest point on the corridor between Barking and West Ham.

	2025	2035	2050
Average Corridor Growth Rate	9 %	20 %	35 %
Growth at Critical Load Point (Barking – West Ham)	11 %	25 %	42 %

Table 3 – Forecast growth rates on the Essex Thameside corridor.

These growth rates represent an increase of approximately 1.2 % per year across the whole corridor and approximately 1.6 % per year at the critical load point by 2025, and an average 2018-2050 rate of 0.9 %, and 1.1 % at the critical load point. These rates were endorsed by the study's board, however as this growth

rate is lower than the average of all routes into London, it was agreed that as a sensitivity test, the high-level impacts of higher growth scenario would be established to understand how much sooner interventions would be needed if a higher rate of growth is realised. This is set out in the final section.

What is Railplan?

Railplan is a Transport for London model that assigns public transport demand to various transport modes, including National Rail, London Underground, DLR, and buses. Railplan predicts the mode of public transport that passengers choose, and the routes they take on that mode. It also considers the impact of crowding in assigning passengers to services. Railplan uses input from another Transport for London model, the London Transportation Studies (LTS) model, which uses demographic, economic, transport, policy and planning information to forecast future trip numbers, origins, destinations, and use of public transport.

Both Railplan and LTS models are compliant with TAG (DfT's Transport Appraisal Guidance) and are considered more suitable for modelling peak travel on the Essex Thameside corridor than traditional EDGE/PDFH/MOIRA method because they;

- use planning data from the Mayor's spatial strategy for areas in Greater London, e.g. for Canary Wharf, Stratford, and planned housing developments in London Boroughs along the c2c route. Outside Greater London, Railplan reverts to NTEM/TEMPRO planning data;
- contain a future baseline for planned changes to all transport modes, such as the Barking Riverside extension;
- can model multi-modal journeys and interchanges, such as National Rail to London Underground or DLR at West Ham and Barking, and;
- can model new stations, such as Beam Park

Railplan is stronger in these aspects than the EDGE/PDFH/MOIRA approach and was therefore chosen as the more suitable approach to robustly model future demand on the Essex Thameside corridor.

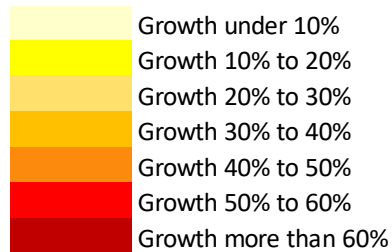
Publication of this material does not convey Transport for London's approval of either the material or the scheme it purports to represent. This approval shall only be granted through the statutory planning process.

Being a commuter railway, demand is primarily associated with changes in employment in Central London, as well as other key employment areas, such as Canary Wharf and Stratford.

Generally, the highest passenger demand growth rates were found in areas closer to London; with all stations as far as Upminster on the Main Line, all stations on the Tilbury Loop as far east as Grays,

and both stations on the Ockendon Single Line all experiencing at least 20 % growth to 2035. By 2050, these areas show continued strong growth, and the Main Line as far as Basildon shows growth of around one third. The eastern end of the corridor around the Southend area indicates long-term growth of around 20 % . Figures 11-13 below show growth heat maps¹³ at each of the reference years.

¹³ Heat maps based upon a map designed by Andrew Smithers © 2017 www.projectmapping.co.uk, and reproduced with permission.



Growth maps show growth in passenger demand from 2018 to chosen year in high peak hour.

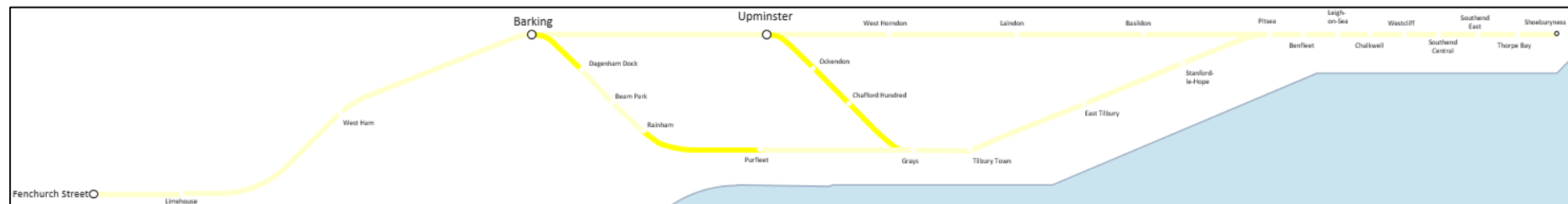


Figure 11 – Growth between 2018 and 2025 is less than 20% across the whole corridor.

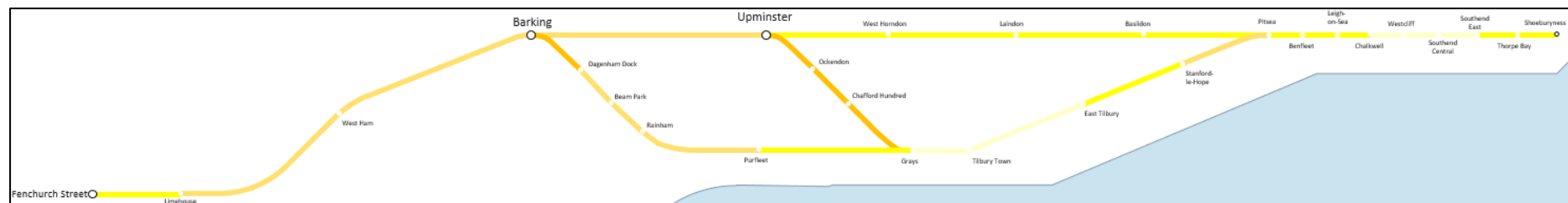


Figure 12 – The higher rates of growth in Barking & Dagenham and Thurrock begin to show between 2025 and 2035.

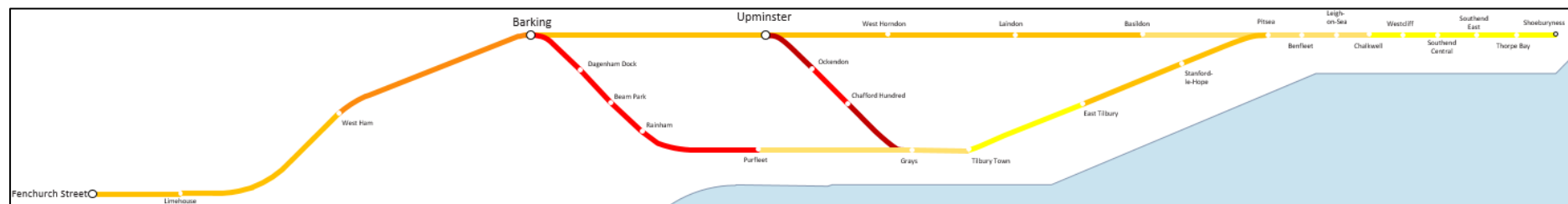


Figure 13 – The growth trend from 2035 continues to 2050 with total growth of >50% seen between Purfleet and Barking and >60% between Grays and Upminster.

These growth rates result in the following total capacity required in the high peak hour in each reference year. The maximum capacity currently committed is 23,213, after the introduction of new trains in 2021.

	2025	2035	2050
Total Capacity Required in the High Peak Hour	25,500	28,000	31,500







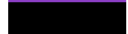
Table 4 – Total capacity required by year.

Without intervention the rate of growth would increase average crowding density on trains at much of the London end of the corridor in the morning peak, especially up to the key interchange at West Ham. Following the planned introduction of new trains and increase in capacity in 2021, crowding is forecasted to reduce on most parts of the corridor compared to 2018 levels. However, after 2025 crowding is expected to return to a similar level experienced in 2018 across much of the corridor, particularly on the Ockendon Single Line. On average, crowding is expected to be between two and three passengers standing per square metre on the core part of the network between Upminster and West Ham by 2035.

Figures 14-17¹⁴ below show the average level of crowding at 2018, 2025, 2035 and 2050 respectively. The crowding assessments and future capacity requirements which follow all take into account the planned rolling stock introduction and capacity increase due to take place in 2021, but no other enhancements.

It is acknowledged that due to the aggregating nature of this modelling methodology over the three hour morning peak, the popularity of some specific trains over the high peak hour could be disguised and therefore some individual trains may be considerably busier than the average suggests. The arc with the greatest level of crowding in 2035, for example, is Ockendon-Upminster with more than three passengers per square metre on average, so it is highly likely that all high peak trains on the Grays-London Fenchurch Street via Ockendon service in this year will be highly congested, well above the average of 2-3 passengers per square metre between Upminster and West Ham, shown by the purple colour.

The key for the crowding plans below is as follows;

	Up to 70% of seats occupied on average
	Between 70% and 85% of seats occupied on average
	Between 85% and 100% of seats occupied on average
	Passengers standing, up to 1 passenger per square metre on average
	Passengers standing, between 1 and 2 passengers per square metre on average
	Passengers standing, between 2 and 3 passengers per square metre on average
	Passengers standing, over 3 passengers per square metre on average

¹⁴ Heat maps based upon a map designed by Andrew Smithers © 2017 www.projectmapping.co.uk, and reproduced with permission.

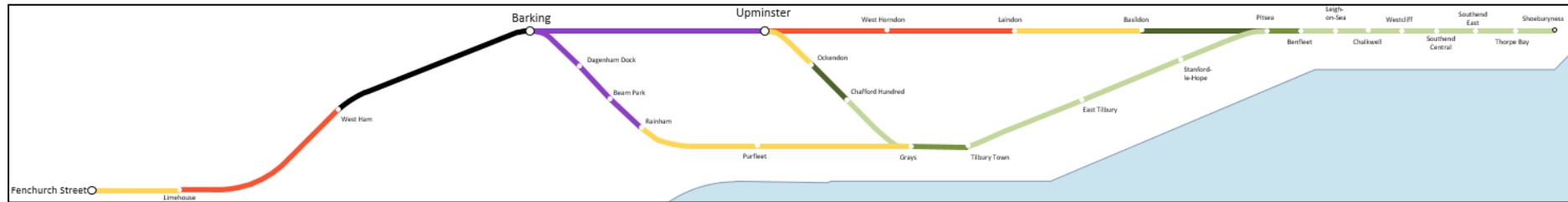


Figure 14 – 2018 crowding heat map, illustrating the baseline position with severe crowding particularly from Upminster and Rainham as far as West Ham.

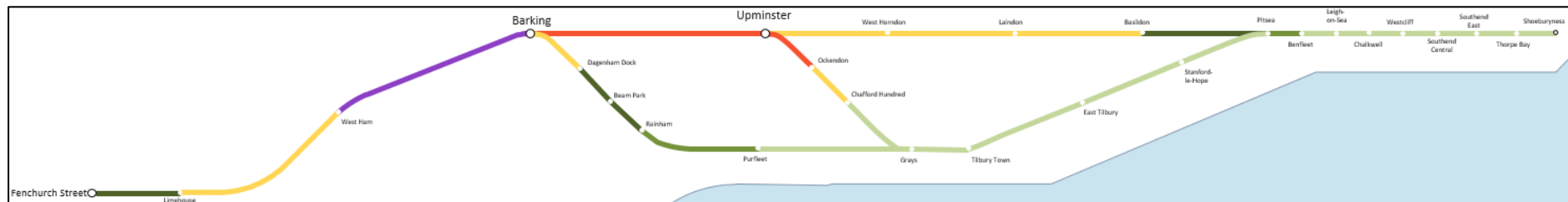


Figure 15 – 2025 crowding heat map, after the planned introduction of additional rolling stock, showing an improvement in the standing density on most of the corridor, except for the Ockendon Single Line.

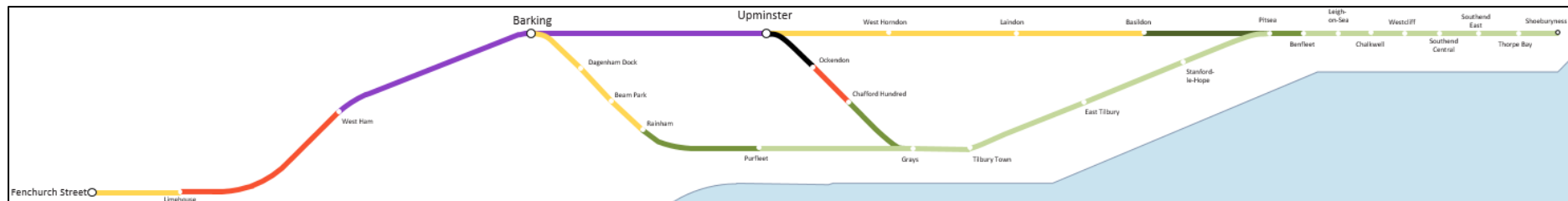


Figure 16 – 2035 crowding heat map, showing standing density increasing at the London end of the corridor. The Ockendon-Upminster arc begins to show severe crowding.

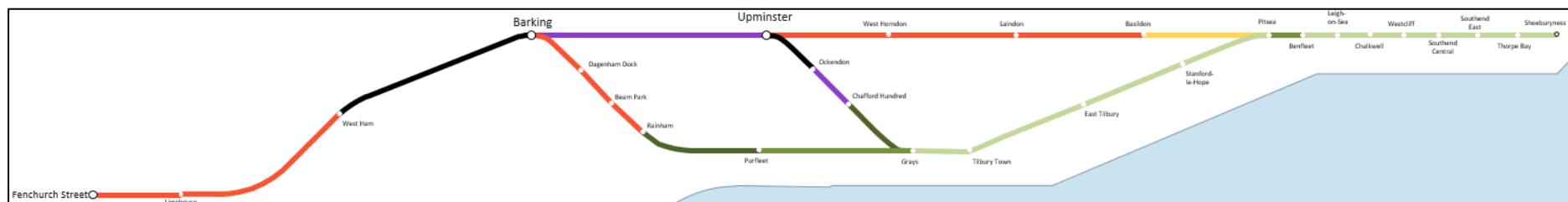


Figure 17 – 2050 crowding heat map, showing crowding levels deteriorating on most parts of the corridor west of Pitsea, most notably between Basildon and Upminster.

Based on these crowding plans, on average, passengers are forecasted to be consistently standing from the following

destinations in each of the reference years, if no additional capacity was provided;

Passengers standing from... (fastest journey time to London in minutes in brackets)			
	Main Line	Tilbury Loop	Ockendon Single Line
2018	Basildon (34)	Grays ^a (39)	Ockendon (33)
2025	Basildon (34)	Dagenham Dock (24)	Chafford Hundred (37)
2035	Basildon (34)	Rainham (28)	Chafford Hundred (37)
2050	Pitsea ^b (41)	Rainham (28)	Grays ^c (42)

Notes:

Fastest journey time in minutes to London Fenchurch Street arriving in the high peak hour as per December 2019 timetable.

^a Seats are available via Ockendon, with a slightly slower journey time.

^b Seats are available from Pitsea via Grays, with a significantly longer journey time of 58 minutes.

^c Seats are available via Rainham, with a slightly quicker journey time.

Table 5 – Indicative standing durations by line of route with no interventions.

As can be seen from Table 5 above, passengers are currently required to stand from destinations with journey times to London Fenchurch Street above 30 minutes whereas general industry standards recommend a maximum standing time of 20 minutes. As this is an average indication, it is likely that some trains will have standing room only further east than what is indicated in Table 5.

Analysis provided by c2c shows that small proportions of passengers on some popular services currently stand from stations such as Benfleet, Leigh-on-Sea, Chalkwell and Tilbury Town in the morning high peak. Journey times from these stations to London Fenchurch Street are at least 45 minutes. Growth in demand on the corridor is likely to increase the proportion of passengers standing from these stations, and possibly introduce standing to passengers travelling from stations further east with even longer journey times.

The committed introduction of longer trains in 2021 by c2c improves capacity and reduces the standing density, especially on the Tilbury Loop. However, without further intervention this capacity is quickly used up, and between 2025 and 2035 passengers boarding at stations such as Basildon and Chafford Hundred are likely to still be required to stand.

Although the point at which people begin to stand does not extend further east in some years, it is important to highlight that crowding density is projected to become steadily more severe between these dates, reducing journey quality and passenger comfort. In addition, this represents an average situation based on total demand and capacity on all services across the high peak hour, so seat utilisation on some individual trains may be 100 % before the stated station in some circumstances.

There is a shortfall of capacity in the high peak hour in each of the reference years, if average crowding across the high peak hour is to be kept at a level of

2.2 passengers per square metre on all services; the target maximum standing density for the corridor. It is impossible to achieve in practice a completely even distribution of demand that perfectly matches the capacity provided to achieve a maximum standing density of 2.2 on all individual high peak services. Therefore, the average standing density to be planned for across the high peak needs to be significantly less than 2.2.

Network Rail has undertaken a review of count data from all high peak hour trains to establish the average level of standing density to be planned for to achieve a maximum density of 2.2 on most high peak trains in each of the study's

reference years. This average has been calculated as 1.35.

c2c has undertaken its own demand forecasts for the short-term, the results of which are very similar to Network Rail's forecast, requiring the same order of uplift in the busiest part of the network between Barking and West Ham. These similar results from two independent pieces of analysis also gives Network Rail confidence in the accuracy of the requirements established in both the short- and longer-term. As indicated in Table 6 below, analysis suggests the following carriage shortfall in the high peak hour in each of the study's reference years;

Arriving at...	Carriage Shortfall in the High Peak		
	2025	2035	2050
Upminster (via West Horndon)	0	1	3
Upminster (via Ockendon)	4	8	12
Barking (via Upminster)	7	16	34
Barking (via Dagenham Dock)	0	1	2
West Ham	22	44	70
Limehouse	0	3	13
London Fenchurch Street	0	0	0

Table 6 – Number of additional carriages required from each station towards London in the high peak hour (arriving London between 08:00 and 08:59) – no maximum standing duration requirements.

As the figures in the table show, the greatest requirement for additional capacity is in the existing busiest area of the network between Barking and West Ham, with an additional 70 carriages required by 2050 – the equivalent of six additional 12-car trains – to maintain standing density at a maximum of 2.2 passengers per square metre on most individual high peak services. Without intervention to provide greater capacity it is likely that most high peak services between Upminster and West Ham will remain heavily crowded, even with the planned rolling stock intervention in

2021, and passengers may begin to be displaced onto earlier or later services in the late 2020s. The calculations capture people standing from any origin to any destination, without applying a target maximum standing time. This means that the capacity shortfall is driven only by the density of standing passengers.

When applying a requirement to ensure that passengers travelling from destinations with longer journey times are able to be seated, it is logical to apply this from stations beyond Upminster on the Main Line and Ockendon Single Line

and beyond Barking on the Tilbury Loop. If it was an aspiration to ensure all high peak hour travellers from beyond these points were seated, an additional 54 carriages are required on the Main line

east of Upminster by 2050 (divided between the Main Line and Ockendon Single Line), and an additional 14 on the Tilbury Loop between Barking and Grays, as per Table 7 below.

Arriving at...	Carriage Shortfall in the High Peak (with higher seating requirement east of Barking/Upminster)		
	2025	2035	2050
Upminster (via West Horndon)	11	24	41
Upminster (via Ockendon)	12	19	28
Barking (via Upminster)	7	16	34
Barking (via Dagenham Dock)	1	9	16
West Ham	22	44	70
Limehouse	0	3	13
London Fenchurch Street	0	0	0

Table 7 – Number of additional carriages required from each station towards London in the high peak hour (arriving London between 08:00 and 08:59) – with maximum standing duration requirements.

Overall, applying this requirement has no effect on the total number of additional carriages required, as the highest requirement by far remains between Barking and West Ham, but it does help define where trains should be routed and ensure that the capacity challenge is addressed in the most appropriate way. Therefore, the figures in Table 7 have been used for the basis of assessing future train service requirements.

The analysis suggests there is no carriage shortfall into London Fenchurch Street, even in the long-term, and the demand forecast suggests the desire for passengers to interchange at West Ham onto the TfL network remains strong.

At the eastern ends of the corridor, there is no forecast carriage shortfall east of Grays on the Tilbury Loop or beyond

Basildon on the Main Line. However, when planning additional services to cater for the growth in demand towards the London end of the corridor, it is logical to begin services east of these points where the opportunity to turn around trains currently exists, such as at Leigh-on-Sea or Southend Central. This would ensure that standing passengers from stations such as Basildon benefit from an enhanced train service and a greater opportunity to be seated and enjoy a better quality journey.

These figures have been calculated as carriage shortfall figures upon which to identify options for capacity enhancement and the findings of this analysis are discussed in the following section. The likely impact of this growth on stations is also discussed below.

Flexible Working Patterns

There may be changes to working patterns that impact future demand, such as working from home, part-time working, and flexible hours. The forecast demand is driven by future levels of employment in Central London, so implicitly includes the effect of jobs fully based at home. Ongoing Network Rail research into the impact of other changes in working patterns suggests a minor impact on overall levels of peak demand, with most effects seen at the start and end of the week. Mid-week demand is expected to be relatively unaffected by these changes.

It is recognised that greater home working may result from trends established in the early 2020 Coronavirus pandemic. Further assessment of this will take place following publication of this study.

5.2 GROWTH ASSESSMENT – FREIGHT

The expected changes to the demand for rail freight on the Essex Thameside corridor have been considered as part of this study. National forecasts published by Network Rail were produced under five scenarios, of which two used assumptions which favour rail freight relative to road freight, two used assumptions which favour road freight, along with a balanced, central scenario. The central scenario was chosen as a basis for modelling for this study. These forecasts were produced by consultants MDS Transmodal, following consultation with industry stakeholders.¹⁵ All of these forecasts were not constrained by the capacity of the network.

Under the central scenario, rail freight volumes on the Essex Thameside corridor were forecast to increase by more than three-fold between the base year and 2043, from 15 circulations per day to 53.

Most of the growth (around 84 % of the total) relates to the intermodal sector, with the construction materials sector accounting for 15 % of the growth. It is, however, recognised that growth potential of the construction materials sector could be stronger than the 15 % total suggests. Other sectors, including automotive and engineering, were projected to contribute about 1 % of the growth. By 2043, it is forecasted that around 73 % of total volumes in the area will be intermodal, followed 20 % for construction materials and 7 % other.

The unconstrained forecast growth in demand on the Essex Thameside corridor is strong compared with other regions of Great Britain. Table 8 below shows the forecasted number of trains per day in each direction. High growth is even seen under the two scenarios which favour road relative to rail transportation.

¹⁵ See <https://www.networkrail.co.uk/industry-and-commercial/rail-freight/freight-growth/> for published forecasts.

	2016/17 (base year)	2023/24	2033/34	2043/44
Scenario A	15	23	41	63
Scenario B	15	28	53	70
Scenario C	15	14	25	42
Scenario D	15	17	34	48
Scenario E	15	N/A	37	53
Average of scenarios A to D	15	20	38	55

Notes:

- Scenarios A and B favour rail freight to road freight, Scenarios C and D favour road freight to rail freight, and Scenario E is the central case.
- Scenario E is not available for 2023/24.
- Table refers to total volumes (all commodities) on section between Dagenham and Barking.
- Forecasts for 2023/24 are from *Rail freight forecasts: scenarios for 2023/24*, May 2018. Forecasts for 2033/34 and 2043/44 are from *Rail freight forecasts: scenarios for 2033/34 and 2043/44*, July 2019. Scenarios A to D for 2023/24 refer to Scenarios A2 to D2 in the 2018 report.

Table 8 – Essex Thameside freight forecasts, showing total trains per weekday in each direction.

To produce concept train plans incorporating freight at all three reference years and advise any infrastructure interventions required to support growth on the Essex Thameside

corridor, the published forecasts have been analysed further to establish a forecast number of paths per hour required by freight class, based on Scenario E, as shown in Table 9 below.

	2025	2035	2050
Class 4 (intermodal and automotive)	2	3	4
Class 6 (construction materials, metals, other)	1	1	2
Total	3	4	6

Notes:

- The paths per hour numbers refer to weekdays and assume a standard operating window of 18 hours (assumed to be generally off-peak and night-time hours) and based on path utilisation rates which vary by commodity sector.
- The 2025 reference year values have been derived from 50 % of the growth forecasted at 2035 and the 2035 and 2050 reference years are based upon the Scenario E forecasts produced for 2033/34 and 2043/44.

Table 9 – Essex Thameside forecast freight paths per hour in each direction.

As discussed above, all freight departing or arriving on the Essex Thameside corridor must use the North London Line or Gospel Oak-Barking Line. This forecasted volume will likely be constrained by the capability of the wider London network and the interaction with passenger services,

especially the London Overground, without any enhancement of these cross-London routes. These forecasts are the same as those being used by Network Rail's London Rail Freight Strategy (LRFS), to ensure consistency of freight recommendations between studies.

Interfacing Study: London Rail Freight Strategy (LRFS)

The LRFS is an interfacing study being undertaken by Network Rail's Freight & National Passenger Operators (FNPO) Strategic Planning team which, in turn, forms part of Network Rail and TfL's joint London Rail Strategy. The study will assess long-term freight and passenger demand across London and the South East and will advise recommendations to support anticipated growth. This includes the North London orbital routes, critical for freight operations on the Essex Thameside corridor.

The key Strategic Question of the LRFS is: *How do we accommodate future rail freight requirements in the London area in a context of increasing passenger and freight demand?*

The LRFS will test an aspirational level of growth for cross-London freight traffic which will include an additional two Class 6 paths. The Essex Thameside Study will also test this higher level to ensure consistency of study and outputs between studies. The LRFS is due to report in autumn 2020 and will incorporate and build upon the findings from this study into its own recommendations for wider freight-enabling schemes across the region.

The forecast for both passenger and freight growth will have an impact upon an already constrained network.

Concepts to provide long-term capacity on the network are discussed in the following section.

5.3 IMPACT ON STATIONS

The growth in passenger demand described above is expected to increase pressure on the corridor's busiest stations; London Fenchurch Street, West Ham and Barking. Pedestrian movements at these stations have been modelled with LEGION pedestrian modelling software. The outputs of the growth forecast have been used to understand how growth will impact upon each of the stations over the next 30 years, and to help identify areas of enhancement. Modelling focused on the morning peak for three demand years; 2025, 2035 and 2050.

The study's growth assessments focused on c2c services, therefore for West Ham

and Barking stations the relative growth in c2c alighting passengers for each modelled demand year has been used to determine demand growth for London Underground, DLR and London Overground services which serve these stations.¹⁶

Modelling outputs in the form of cumulative mean density (CMD) maps are presented for the peak 15-minute period at each station. Maps illustrate density levels in relation to Fruin's Walkways Level of Service (LoS) scale, with the amber and red areas indicating the heaviest pedestrian flows.

¹⁶ Detailed modelling of these TfL modes should be undertaken as part of station option identification in later stages of development.

5.3.1 LONDON FENCHURCH STREET

London Fenchurch Street is the London terminus of the Essex Thameside corridor, consisting of four platforms (two island platforms), elevated on a viaduct. These platforms join a viaduct-level concourse with the main station gateline, ticket office and retail outlets. Escalators, stairs and a lift take passengers down to the main entrance. This entrance, which is Grade II listed, is on Fenchurch Place and provides the primary access to and from the City of London.

A secondary entrance on Coopers Row offers access to and from the centre of the platforms and provides the closest interchange with Tower Hill Underground station and Tower Gateway DLR station. Step-free access is only possible via the main entrance.

Opportunity to modify the station is severely constrained by the viaduct and surrounding buildings, including two office buildings – 8 Fenchurch Place and 1 America Square – partially built above the station, shown opposite in Figure 18.



Figure 18 – London Fenchurch Street is severely constrained by its immediate environment. 8 Fenchurch Place can be seen above the railway at the top of the photograph, and 1 America Square in the centre. Source: Google

Modelling shows that if the station layout is unchanged, by 2025 increased demand means the platforms will start to suffer from severe pedestrian congestion and fail to meet station capacity guidance.¹⁷ Figure 19 below illustrates congestion levels during the 2025 morning peak 15-minute period, under the current train service.

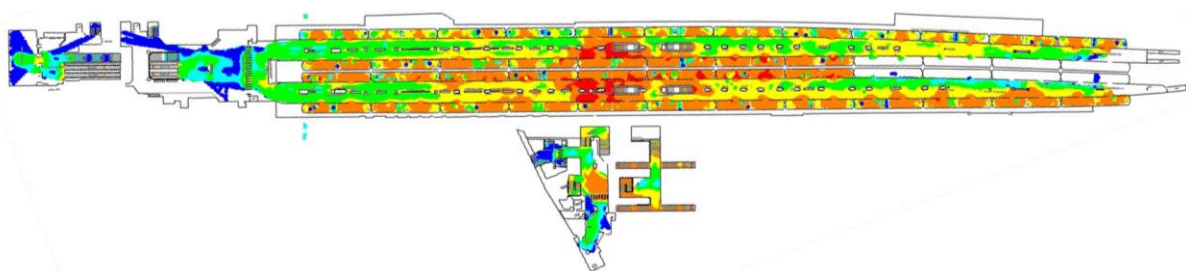


Figure 19 – London Fenchurch Street CMD Map – 2025 AM Peak (08:30-08:45) – Current Timetable

¹⁷ Network Rail Station Capacity Planning Guidance (SCPG), 2016

Congestion builds at the top of the mid-platform stairs to the Coopers Row exit.¹⁸ The primary impact of this will be on the platforms, as passengers are forced to walk closer to the platform edge, especially in locations where the width is restricted by the stairs. This causes safety issues as crowding intensifies closer to the platform edges. There is a potential risk of platforms not clearing before the next train arrives on the same island platform. c2c currently ensures that successive trains do not arrive on the same island platform to ensure pedestrian flows are as steady as possible. However, modelling shows that even using this technique, pedestrian flow exceeds station capacity guidance in the short-term.

The main gateline has sufficient capacity to accommodate the assumed demand, should passengers utilise this efficiently. However, this is sensitive to the exit split assumption and will be difficult to implement an operational strategy to achieve an optimised balance. Adjusting

the split of passengers exiting through the main entrance by 10 %, increasing its split to 61 %, reduces the congestion around the mid-platform stairs slightly, transferring some of the issues to the main gateline. Using these exit split assumptions matches demand and capacity more closely, and the station performs slightly better, however congestion remains, particularly near the mid-platform stairs, and enhancement is required between 2030 and 2035 to provide the required level of capacity.

An enhancement to the main gateline would likely have a marginal impact on the station operation, as the width of the head of platforms act as a pinch point prior to flows reaching the gateline.

c2c has developed a proposal to enhance the appearance and ambience of the station, mainly focussed on enhancing the retail and ticket office facilities at concourse level. It should be assessed whether any more wide-ranging capacity benefits could be included in this scope.

5.3.2 WEST HAM

West Ham is a strategically important interchange between c2c and TfL services and has seen the largest percentage increase in usage over the last decade, driven primarily by the growth of nearby destinations on the Jubilee Line, such as Stratford and Canary Wharf. The station suffers congestion from its layout of four island platforms and eight platform faces across two levels.

Access to the c2c platforms is by two narrow staircases and a lift at the London-end of the platform. During peak hours these stairs act as a bottleneck, resulting in congestion on the stairs and the London-end of the platform as passengers take longer to clear the platform. Due to the positioning of the access, in the evening peak congestion can also occur as passengers fail to move along the platform, partially blocking the

¹⁸ Modelling assumes 49 % of passengers use the Coopers Row exits and 51 % use Fenchurch Place, based on survey data.

circulation space and forcing people to walk along the platform edge.

Pedestrian modelling of the station focused on operation of the c2c platforms and connecting vertical circulation. Modelling shows that the current c2c platform layout is able to cope with forecast 2025 demand, but by 2035 increased demand means the station suffers from severe congestion on the platform. Figure 21 below shows the density levels under the 2035 morning peak 15-minute demand period, using current layout and current train service.



Figure 20 – West Ham station provides excellent interchange opportunities but capacity of the c2c island platform (top centre) is hindered by its access and width. Source: Google.

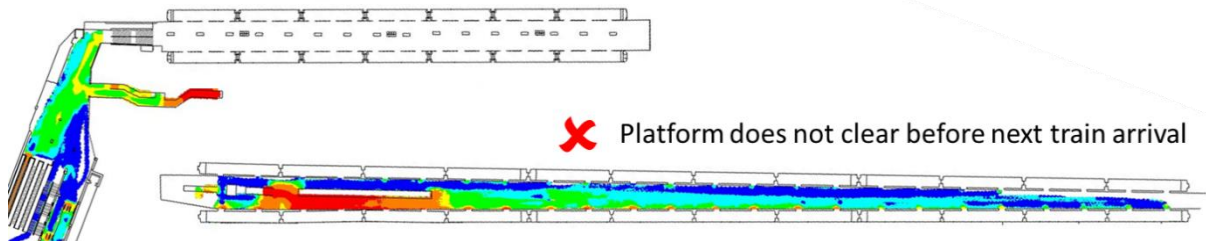


Figure 21 – West Ham CMD Map – 2035 AM Peak (08:00-08:15) – Current Timetable

Sensitivity testing shows that a 5 % increase in 2025 demand flows (broadly equivalent to 2027 demand levels) leads to platforms being unable to clear before the next train arrival, making it unacceptable under the station capacity planning guidance.

By 2050 modelling shows a complete breakdown of passenger flows, due to the insufficient off-platform stair capacity. Congestion continues to build

at the stairs and London end of the platform, as demand increases, causing safety issues on the platform and stairs, with queuing backing up along the platform. The platform also struggles to clear before the next train arrives on single the island platform, which could lead to dispatch issues as well as safety concerns. It is likely that the station would be unable to operate without infrastructure improvement.

5.3.3 BARKING

Barking is another important interchange between c2c and TfL services and has seen a similar rate of passenger growth to West Ham over the last decade. The sole access to the station's eight

platforms is through a large, Grade II listed entrance building, built in the 1960s. c2c services use four platforms, with London Underground and London Overground using the other four. A

bridge and a dive-under for the westbound District Line either side of the station ensures that cross-platform interchange with the up/down Main Line is possible, however passengers using the up/down Tilbury Loop or London Overground who wish to change onto the London Underground must interchange via the footbridge or subway towards the centre of the platforms. This complex pattern of interchange movements, combined with increasingly high numbers of entries and exits through a single gateline results in congestion on the footbridge during peak hours.

Modelling of the current layout aligned with previous TfL modelling, that the station faces severe congestion by 2025, with a breakdown of flows localised to the footbridge and gateline. It is likely that even in the short-term the station would experience severe pedestrian flow issues without capacity improvement. The 2025 model of Barking led to a complete breakdown in pedestrian flows

due to excessive levels of congestion. The model was therefore unable to run through to completion, meaning a mapped output could not be generated.

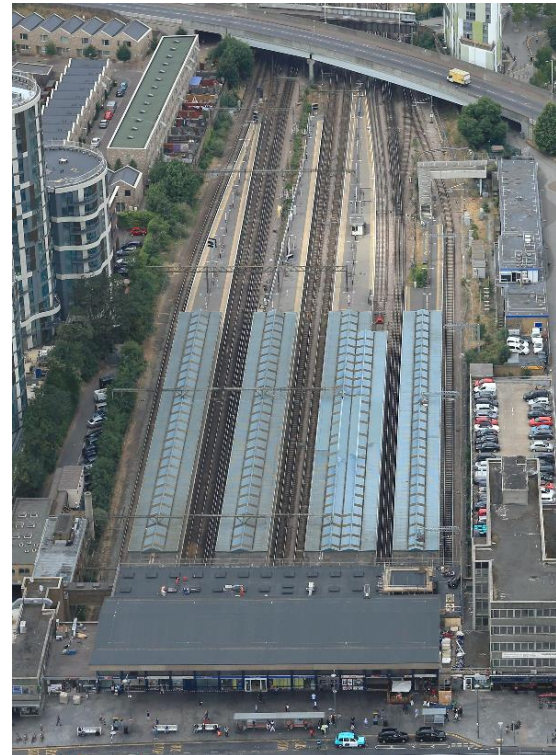


Figure 22 – Barking station offers interchange between c2c, London Underground and London Overground services.

5.3.4 STATIONS SUMMARY

Pedestrian flow challenges are expected at all stations by 2027 as demand increases. A summary of the issues faced by each of the stations is included in

Table 10 below. Potential enhancements to improve the stations and their effectiveness are discussed in the following section.

Station	Year station operates consistently above NR SCPG	Areas of focus for capacity improvement
London Fenchurch Street	By 2025 ^a	Mid-platform stair capacity (to/from Coopers Row entrance) Gateline capacity (main concourse)
West Ham	By 2027 ^b	Platform access Platform width
Barking	By 2025	Gateline capacity Footbridge and stair capacity

Notes:

^a Or between 2030 and 2035, based on alternate exit assumptions.

^b Based on analysis of a 5% increase in 2025 flows, broadly equivalent to 2027 demand levels.

Table 10 – Summary of expected station enhancements required.

6 MEETING THE FORECAST DEMAND

This section describes the different ways that increasing passenger and freight demand could be accommodated on the network in each of the study's reference

years. It also articulates how increased passenger demand could be accommodated at stations.

6.1 NETWORK CAPABILITY AND CAPACITY – PASSENGER

This study has reviewed requirements to provide increased capacity for the three reference years. A summary of the findings is set out below.

6.1.1 VIABLE OPTIONS CAPABLE OF SHORT-TERM IMPLEMENTATION

The growth forecast shows that even with the planned introduction of longer trains in 2021, additional capacity is required in the mid-2020s to avoid exceeding the desired passenger crowding threshold. Various short-term capacity enhancement options have been identified and assessed for their suitability. Of the options assessed, three broad methods can potentially provide this short-term capacity requirement, with varying degrees of suitability:

- train lengthening;
- increasing standing density through fleet reconfiguration, and;
- increasing train frequency by reducing signalling headways.

In both the train lengthening and signalling headway options, additional rolling stock would need to be sourced to operate the required train service. Providing additional track infrastructure such as passing loops and new platforms has not been deemed feasible as a short-term solution, due to the lineside

constraints at the London end of the corridor but has been assessed for the medium- and long-term.

The bay platform at Grays is a constraint to running 12-car services via Ockendon, as it can only accommodate 8-car trains. A high-level analysis of the platform shows that a combination of track junction layouts, public realm and/or station buildings could all be impacted if the platform was extended.

The proposal to replace Grays High Street Level Crossing with an underpass would potentially prevent extension beyond the buffer stops, as the proposal is likely to require a realignment of Crown Road into the current taxi rank area, reducing the space available at this end. If extension is not deliverable, the alternatives for capacity provision would be by increasing frequency or by further fleet reconfiguration.

Wider timetable changes could also be considered, such as running 12-car trains on the Ockendon Single Line which originate further east, rather than

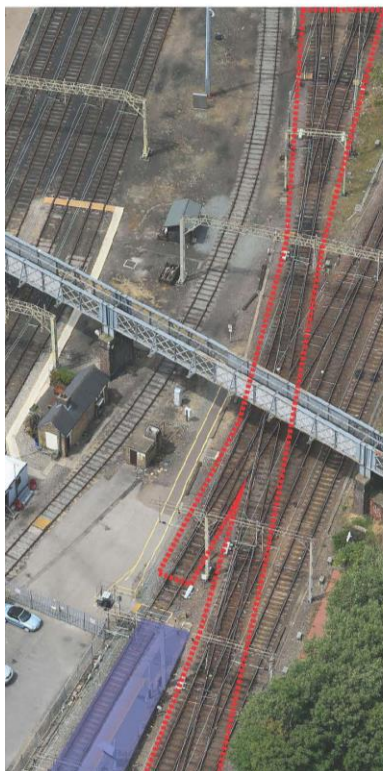
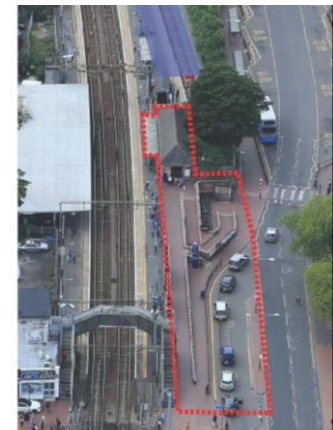
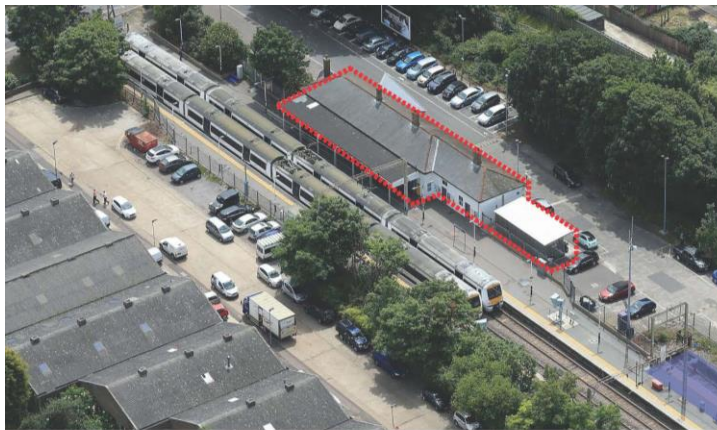
starting at Grays. However, this may need to run empty until Grays so that capacity isn't taken up by passengers from stations east of Grays.

Similarly, one of the platforms at Shoeburyness is also limited to 8-car trains. Extending this to the west end is not an option as access to Shoeburyness depot – critical for efficient operations – would be severed. Extension to the east end is technically possible, however the station building would need to be

demolished and re-provided in a relatively constrained site.

If it was chosen to proceed with platform extensions at both sites, careful consideration would also need to be given to how extending these platforms could be carried out without impacting on day-to-day operations.

The four photographs below show the various constraints at both stations, with the short platforms highlighted blue, and the key constraints outlined with red dotted lines.



Top Left: the station building at Shoeburyness prevents easy extension to the east.

Bottom Left: the entrance to Shoeburyness depot from Shoeburyness station prevents easy extension to the west.

Top Right: the station building, station entrance and taxi rank at Grays prevents easy extension to the east. Crown Road, seen on the right of the photograph, is likely to be realigned into this area as a result of the level crossing closure and underpass scheme.

Bottom Right: the proximity of the signal gantry and crossovers as well as width available at Grays could prevent easy extension to the west.

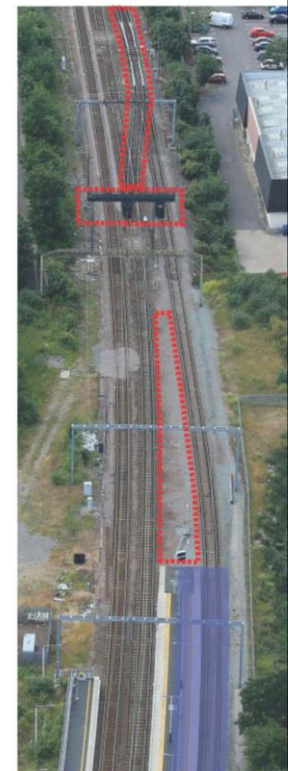


Figure 23 – Two key areas of constraint to extending platforms exist at both Grays and Shoeburyness.

6.1.1.1 TRAIN LENGTHENING

Train lengthening is considered to be a standard first step to capacity enhancement across the national rail network. Although platform extensions and other infrastructure modifications may be required, it is typically considered to be a low risk option in terms of capital costs. However, as mentioned above, the platform extensions required to support further train lengthening on the Essex Thameside corridor may not be straightforward to implement and could carry a significant cost.

Train lengthening is a feasible option which could be implemented on the Essex Thameside corridor in the short-term or form part of a wider strategy. However, as a standalone option it does not address the long-term capacity needs of the corridor. Similar types of rolling stock to the existing Class 357s could be sourced to provide an uplift in capacity and the existing fleet of Class 357s can be operated in 12-car sets.

After the introduction of the new Aventura trains in 2021 only seven trains in the high peak hour are able to be lengthened. These are likely to be the four services on the Ockendon Single Line, two Main Line services and one Tilbury Loop service. Therefore, to deliver the maximum benefit from train lengthening, the bay platform at Grays would need to be extended.

Various combinations of lengthening could be implemented, with an indicative maximum (seating and standing) capacity of between 24,431¹⁹ and 27,105²⁰ being achievable in the high peak, depending on the seating configuration of the additional rolling stock and number of trains lengthened.

Once capacity created from the introduction of more carriages is used up, a solution would need to be found which increases capacity through either a frequency enhancement or by introducing higher capacity rolling stock.

Concerns have been raised regarding expanding 12-car operations and how it could affect operations and performance. The following key points have been highlighted;

- capacity and resilience of depot and stabling facilities;
- analysis of actual train running data indicates consistently higher likelihood of delay for 12-car trains over 4- or 8-car trains, when en route and dwelling at stations;
- the slower average running of 12-car trains mentioned above could reduce the maximum possible frequency below 20tph, offsetting any gains which train lengthening might bring;

¹⁹ 24,431 is the post-Aventura timetable plus an additional three trains lengthened to 12-car using Standard Class 357 rolling stock. This is the minimum option with the four Grays starters remaining as 8-car.

²⁰ 27,105 is the post-Aventura timetable plus an additional seven trains lengthened to 12-car using Metro Class 357 rolling stock. This is the maximum option with all trains lengthened.

- the lost ability to cancel an 8-car train at Barking to recover performance. Experience indicates that the time it takes to empty and lock the doors on a 12-car train, before running into East Ham depot, takes too long and therefore doesn't allow any time to be recovered by following trains;
- there would be more instances of splitting and joining units before and after peak hours which has implications on platform utilisation at termini and staffing, and;
- a lack of 12-car Driver Only Operation (DOO) equipment in multiple locations.

These concerns are similar to some of those raised in the South Western Railway Performance Review,²¹ which investigated declining performance on the South Western Main Line.

While capacity improvement is the key driver for this study and this option appears to deliver the required short-term increase, the performance concerns raised above will need to be thoroughly assessed to determine whether they would have a critical negative impact on the viability of this option.

6.1.1.2 INCREASED STANDING DENSITY BY OPERATING HIGHER CAPACITY ROLLING STOCK

Increased standing density, like train lengthening, could also be feasible in the short-term. This is an option which has been implemented on the Thameslink network in recent years, with a full fleet replacement of high capacity Class 700 trains introduced.

Two methodologies could be employed to increase density. Firstly, by converting some or all existing Class 357 rolling stock to Metro configuration, or secondly, by a fleet replacement to more capacious trains. Converting the existing Class 357 fleet could give a total maximum seating and standing capacity of between 28,163²² and 32,055²³.

A full fleet replacement, ahead of the fleet's design end of life, is not expected to be desirable, however it would provide flexibility of choice in being able to procure the most suitable rolling stock for the corridor. Several London operators are beginning to use even higher density rolling stock to provide greater standing space (at the expense of seating), such as the Class 345s used by Crossrail or the Class 710s currently being introduced by London Overground. Taking the Class 710 as an example, it is possible to increase capacity further by using similar seating configurations to these trains. If a full fleet replacement was implemented using Class 710s a total maximum seating and standing capacity

²¹ <https://www.southwesternrailway.com/other/about-us/independent-performance-review>

²² 28,163 is the post-Aventra timetable with all Class 357 rolling stock converted to Metro configuration.

²³ 32,055 is the post-Aventra timetable with all Class 357 rolling stock converted to Metro configuration and all trains lengthened to 12-car using similar rolling stock.

of 35,934²⁴ could be achieved, and up to 40,680 if all trains were 12-car.

While using higher density rolling stock appears to give a large capacity increase (especially when combined with train lengthening) and could benefit from being specifically tailored and procured for its intended operating routes, this capacity can only be achieved at the expense of seating.

Reducing the number of seats will mean that more passengers would be standing and for longer durations. This would likely result in passenger dissatisfaction, local stakeholder opposition and does not appear to be the best solution in terms of passenger comfort. Operating a timetable only with Class 710-style seating configurations would mean the ratio of seating capacity to standing capacity would worsen from 66:34 % to 29:71 %.²⁵ Clearly the example of Class 710s is an extreme case, but even reconfiguring the entire Class 357 fleet to a metro layout would reduce this ratio to 40:60 %. More densely loaded trains are also likely to increase performance

and timetable risk through longer dwell times, possibly reducing the achievable frequency and are likely to cause greater pedestrian flow issues at some stations than other methods of capacity improvement due to more people arriving on a single train.

It is suggested by some of the board members that while this option is technically feasible and could provide the required overall capacity, it is not considered to be desirable due to the levels of seat reduction required and the certain reduction in passenger satisfaction that would follow, especially for passengers travelling longer distances who might no longer be able to sit down if the number of seats was reduced. The Class 357 fleet is currently in the middle of its design life, with replacement not due until at least the mid-2030s, reducing the attractiveness of a fleet replacement in the short-term. Full or partial fleet reconfiguration could, however, provide a short-term option or a step in a longer strategy incorporating one or more of the other options presented in this study.

²⁴ 35,934 is the post-Aventra timetable with all trains Class 710/2.

²⁵ The 66:34 % figure is based on the proposed 2021 timetable after the 10-car Aventras are introduced. The 29:71 % figure is based on the capacity numbers for a 12-car Class 710/2 with 585 seats and a standing capacity of 1449.

6.1.1.3 INCREASING TRAIN FREQUENCY BY REDUCING SIGNALLING HEADWAYS²⁶

c2c has developed a proposal to install ETCS Level 2 signalling²⁷ between Upminster and London Fenchurch Street providing a consistent 2-minute planning headway between these points by 2025.²⁸ The ETCS proposal recommends operating 24tph in the high peak hour using a combination of standard- and metro-configured Class 357s, the new 10-car Aventras and additional mid-life Electrostars (similar to the existing Class 357s with comparable capacity). The total capacity expected to be provided is 27,105.

The same headway and capacity could also theoretically be provided using conventional signalling, subject to signalling design, including assessment of physical and sighting constraints. ETCS, however, has advantages over conventional signalling due to its flexibility (for example, ability to signal trains in either direction on either line) and performance and service recovery benefits.

ETCS is planned to be introduced to the Essex Thameside corridor in approximately 20 years, as per the current Digital Railway deployment plan, when the current conventional signalling system needs to be renewed.²⁹ The early introduction on the Upminster to London Fenchurch Street section could be a viable strategy for solving existing and upcoming capacity constraints, while not resulting in sunk costs on conventional signalling enhancements, which would only have a 20 year operating life. Consideration as to how early introduction of ETCS on the Essex Thameside corridor could support the progression of the national deployment plan, or impact on its timings would need to be evaluated.

The introduction and ultimate extension of ETCS to cover the whole of the Essex Thameside corridor could provide wider long-term benefits beyond peak hours capacity, such as increased capacity for freight (subject to onward capacity on other areas of the network), improved safety and operational flexibility.

²⁶ A signalling headway is the minimum time permitted between trains. Reducing the headway would allow trains to run closer together.

²⁷ European Train Control System (ETCS) Level 2 is a form of digital in-cab signalling which removes the need for physical lineside signals. In-cab signalling provides continuous communication between track and train removing the need for fixed blocks between physical signals. This results in more efficient network usage and improved train performance. See more information on digital signalling at <https://digitalrailway.co.uk/> and <https://www.networkrail.co.uk/running-the-railway/railway-upgrade-plan/digital-railway/>

²⁸ c2c has noted that this proposal has been prepared to the standard of RNEP Outline Business Case and submitted in final draft form in December 2019. This was prepared with the assistance and support of Network Rail Anglia Route and Eastern Region. The business case is unable to be finalised as a result of Covid-19 and has not been fully appraised by DfT.

²⁹ Network Rail's Digital Railway deployment plan prioritises deployment of ETCS based on asset remaining life. Deployment on Essex Thameside is expected in CP10 (2039-2044). See <https://www.networkrail.co.uk/running-the-railway/railway-upgrade-plan/digital-railway/digital-railway-strategy/digital-railway-long-term-deployment-plan> for more information.

The proposed intervention would be capable of greater frequency than 24tph so frequency could then be increased as required in the 2030s and 2040s, subject to additional infrastructure and station enhancements.

Although this is possibly the most costly and complex of the available short-term options, it is the only suitable solution able to accommodate long-term capacity requirements, while simultaneously

maintaining a similar proportion of seating capacity to today. Adoption of ETCS would provide the required capacity in the short-term, providing the necessary foundations for future requirements, without the need for short-term seating changes. Modelling undertaken by c2c also shows that the current high levels of performance on the corridor are expected to be maintained by the introduction of ETCS.

6.1.2 2025

By 2025 at least another 22 carriages are required to be in service during the high peak hour not to breach the standing density threshold. This could be provided by either introducing additional trains to the network or lengthening existing trains, noting that the other feasible option of increasing standing density

may be undesirable. This increase is driven by the demand between Barking and West Ham as well as the requirement to provide more seats in the areas immediately east of Upminster. Table 11 below shows the shortfall at all stations between Upminster and London Fenchurch Street.

Arriving at...	Carriage Shortfall in the High Peak – 2025
Upminster (via West Horndon)	11
Upminster (via Ockendon)	12
Barking (via Upminster)	7
Barking (via Dagenham Dock)	1
West Ham	22
Limehouse	0
London Fenchurch Street	0

Table 11 – 2025 carriage shortfall.

6.1.2.1 PROVIDING CAPACITY WITH ADDITIONAL SERVICES

To deliver this capacity to the correct part of the network, as a minimum, the following additional services on top of the post-Aventra timetable would be required.

- One Grays-Ockendon-Fenchurch Street (12-car)
- One Main Line (12-car)

These services would be able to be accommodated by c2c's proposed ETCS introduction to improve signalling headways, which provides additional capacity between Upminster and Barking. Under c2c's proposal up to 24tph could be operated, so two additional services to provide additional operational flexibility could be operated

if needed, and provide capacity resilience further into the future.

Analysis indicates a fifth 8-car 'up' service could be introduced on the Ockendon Single Line without any changes to infrastructure or signalling, although due to the nature of the single line infrastructure, services are not able to be evenly spaced. A fifth 'up' service would, however, increase line utilisation (of the single line sections) to 88 %, which is around the maximum usually allowed in timetable planning. This would increase performance risk to the single line and the wider corridor, since any delays on the single line could create knock-on effects when they mix with services on the Main Line. However, the assumed increase in service recovery ability of an ETCS system may offset some of this increased risk.

To operate a 12-car train via Ockendon, the bay platform at Grays would need to be extended. If a platform extension wasn't viable at this stage, the additional service may need to remain as an 8-car service with the potential for some

undesirable crowding as a result, unless longer trains could start eastwards of Grays. It should be assessed whether at least one of the Ockendon Single Line services starting in Grays could be replaced longer through-service from the east to provide additional capacity without the requirement to extend the bay platform. Careful assessment would need to be undertaken to determine whether this would actually result in an increase in capacity for passengers from Chafford Hundred and Ockendon, when the train may have already been filled up at stations east of Grays. Alternatively, the train could run empty until Grays to avoid this. c2c's proposed 24tph timetable has indicated that this may be possible.

The additional services on the Main Line could be provided without any other interventions required. These services could start from any point where the ability to turn around trains currently exists, e.g. Leigh-on-Sea or Southend Central, giving flexibility of choice in timetable composition.

6.1.2.2 PROVIDING CAPACITY THROUGH TRAIN LENGTHENING

To provide the required capacity through train lengthening, the following services would need to be lengthened, with each train providing an additional four carriages.

- Three Grays-Ockendon-Fenchurch Street
- Three Main Line

In order to provide this capacity, the bay platforms at Grays and Shoeburyness

would need to be lengthened to allow them to take 12-car trains, which, as discussed above, are not straightforward interventions due to various constraints. Only one train in a lengthening-based proposal remains as 8-car, highlighting the limitations in this option's long-term offering.

A 20tph timetable could be maintained but only by lengthening all-but-one train. However, part 6.1.1.1 highlights the risks

associated with running longer trains; the most notable being the possibility that increased running times for 12-car trains may reduce overall capacity below 20tph offsetting the capacity gained.

By 2025, the level of demand in the high peak hour begins to cause serious pedestrian flow issues at stations (under both an increased frequency or train lengthening scenario), and the implications of this are discussed below.

6.1.3 2035

By 2035 at least another 44 carriages are required (or 22 more than 2025) to be in service compared to today during the

high peak hour to not breach the standing density threshold, as shown in Table 12.

Arriving at...	Carriage Shortfall in the High Peak – 2035
Upminster (via West Horndon)	24
Upminster (via Ockendon)	19
Barking (via Upminster)	16
Barking (via Dagenham Dock)	9
West Ham	44
Limehouse	3
London Fenchurch Street	0

Table 12 – 2035 carriage shortfall.

By this stage, a headway improvement would be effective because;

- all-but-one train is required to be lengthened in 2025, if a lengthening strategy is chosen as a short-term intervention (so there would only be one more train available for lengthening by this time);
- reducing the amount of seating is likely to be deemed unsuitable from a passenger experience perspective, and;
- the physical and financial challenges of providing additional infrastructure to reach London are insurmountable.

Various combinations of additional 8- and 12-car services could be used and several examples of how to provide the

required capacity (on top of the current service level) are set out below.

- Two Grays-Ockendon-Fenchurch Street (8-car)
- Three Main Line (8-car)
- One Tilbury Loop (8-car)
- or
- One Grays-Ockendon-Fenchurch Street (8-car)
- One Grays-Ockendon-Fenchurch Street (12-car)
- Two Main Line (12-car)
- One Tilbury Loop (8-car)
- or
- Lengthen all Grays-Ockendon-Fenchurch Street
- Three Main Line (8-car)
- One Tilbury Loop (8-car)

A service level of between 24 and 26tph is required depending on the split between and additional services

introduced, the lengths of these, and whether any existing services are lengthened.

The two additional services via Ockendon would require a dynamic loop³⁰ between Ockendon and Upminster to be built. It should be assessed whether there would be an opportunity to construct this to coincide with wider ETCS deployment. Using the alternative strategy to lengthen services via Ockendon to 12-cars, the bay platform at Grays would need to be lengthened.

Analysis has shown that the current maximum capacity of London Fenchurch Street is 25tph, so providing the total trains entering and leaving London Fenchurch Street does not breach this limit, the corridor could continue to operate with its current platform provision and existing operational working. c2c has suggested that reducing turnaround times by adjusting the way cab set-up is managed could provide a means to increase this maximum.

6.1.4 2050

By 2050 at least another 70 carriages are required compared to today (or 26 more than 2035) to be in service during the

high peak hour not to breach the standing density threshold, as shown in Table 13.

Arriving at...	Carriage Shortfall in the High Peak – 2050
Upminster (via West Horndon)	41
Upminster (via Ockendon)	28
Barking (via Upminster)	34
Barking (via Dagenham Dock)	16
West Ham	70
Limehouse	13
London Fenchurch Street	0

Table 13 – 2050 carriage shortfall.

In order to provide this capacity additional services are required, with a total service frequency around 27 or 28tph likely. Examples of how these could be provided (on top of the current service level) are as follows:

- Two Grays-Ockendon-Fenchurch Street (12-car)
- Two Main Line services (12-car)
- Two Main Line services (8-car)
- Two Tilbury Loop services (8-car)
- Two Main Line services (8-car)
- Two Tilbury Loop services (8-car)
- Lengthen all Grays-Ockendon-Fenchurch Street
- One Grays-Ockendon-Fenchurch Street (12-car)
- Two Main Line services (12-car)
- Two Main Line services (8-car)
- Two Tilbury Loop services (8-car)

³⁰ A 'dynamic' loop is one which allows a train to keep moving while being passed by another train, therefore reducing the amount of acceleration and deceleration needed on the running line. This enables the train to clear the line faster, resulting in greater possible track capacity than a 'static' loop, where trains must come to a stop.

By 2050, to provide the required capacity on the Ockendon Single Line some trains will need to be 12-car length, needing the bay platform at Grays to be extended (if other operational solutions such as running trains from further east through Grays are unviable).

As mentioned above, a fifth service on the Ockendon Single Line could be provided on existing infrastructure (although with potential performance concerns), but a sixth service would require a dynamic loop to be built between Ockendon and Upminster.

As mentioned in the 2035 analysis, changes to operational practices or additional platforms would be required at London Fenchurch Street (or at West Ham as the peak demand point on the corridor) to provide a train service above 25tph.

Both locations are severely constrained, as described above, and providing additional platforms would be a major undertaking, requiring close coordination with multiple rail and non-rail stakeholders. Alongside any intervention at either London Fenchurch Street or West Ham to increase the number of platforms, requirements for pedestrian flow improvement should be taken into account to minimise the number of individual enhancements required. Requirements for pedestrian flow improvements are detailed in below and the various options to intervene are set out in turn.

Detailed performance modelling would need to be undertaken in order to provide an analysis of whether a timetable of greater than 25tph could be operated robustly without additional platforms.

Depots and stabling

Increasing the number of carriages which run in the peak hours (either through train lengthening or operating more frequent services) will need to consider the requirements for stabling and maintaining the extra rolling stock. As part of any proposal to enhance the service level it will be necessary to assess the impact upon East Ham and Shoeburyness depots to identify any requirements for improvements to stabling and/or maintenance depot facilities.

c2c's depot and stabling analysis to support its ETCS business case has identified that East Ham and Shoeburyness depots have enough capacity to accommodate the additional units required to support its proposed 24tph timetable, however capacity is nearing full utilisation. Shoeburyness depot is at capacity, so a proposal to increase frequency above 24tph or operate a full 12-car fleet would necessitate a requirement to reassess stabling and maintenance requirements on the corridor.

Power supply

Any option where additional carriages are introduced to the network, by lengthening trains or running more services closer together (or if more freight services are hauled by electric locomotives) could have implications on the power supply. Under either of these options, an assessment of capability would need to be carried out to determine whether a power supply upgrade is required.

6.2 PRIORITY STATION INTERVENTIONS

Pedestrian capacity was modelled using LEGION pedestrian modelling software at London Fenchurch Street, West Ham and Barking. Existing station layouts in each of the reference years were tested with different train service operating models to advise how these could impact upon station pedestrian flow. The scenarios modelled were;

- increased train frequency;
- longer trains, and;
- more densely loaded trains (metroisation).

Further modelling was undertaken to understand how potential infrastructure options at the stations would perform. Two preferred options chosen from existing source material were modelled at both West Ham and Barking, based on the results of a stations workshop with c2c and TfL. A second gateline proposal has also been modelled at Barking.

As no equivalent level of development has taken place for London Fenchurch Street, modelling of a proposed solution has not been possible. This modelling is

to better inform the types and scale of intervention required as a result of growing demand, rather than propose or promote specific enhancements.

The study's growth assessments focused on c2c services, therefore for West Ham and Barking stations the relative growth in c2c alighting passengers for each modelled demand year has been used to determine demand growth for London Underground, DLR and London Overground services which serve these stations. Usage and interchange to and from these modes is expected to increase due to increased capacity and frequency set to be provided on the London Underground District and Hammersmith & City Lines as a result of the 4LM project and similar improvements on the DLR network. Further detailed modelling is recommended when options begin to be developed at each of these stations.

Cumulative mean density (CMD) maps are presented for each station, showing the peak 15-minute period. These maps illustrate density levels in relation to Fruin's Walkways Level of Service (LoS) scale, with the amber and red areas indicating the heaviest pedestrian flows.

6.2.1 LONDON FENCHURCH STREET

The study's demand forecasting and station capacity analysis of the existing layout has indicated that pedestrian capacity at London Fenchurch Street is

set to exceed Network Rail's station capacity planning guidance around the mid-platform stairs by 2025, regardless of how the train service is assembled.³¹

³¹ Assuming a split of 51 % of exits to Fenchurch Place, and 49 % to Coopers Row via the mid-platform stairs. As per the explanation in 5.3.1, changing this assumption to 61-39 % slightly improves pedestrian flow at the mid-platform stairs, but not enough under any operating model to avoid needing to enhance the station.

Modelling shows that the impact of increased train frequency and longer trains on the existing station layout both provide marginal improvements to pedestrian flow, with increased train frequency providing the greatest relative benefits, as shown in Figures 24-26 below. More densely loaded trains have a detrimental effect on the station, due to the greater concentration of passenger arrivals.

Decluttering the platforms, where possible, could help circulation on

platforms and may help reduce congestion in the short-term, however it is recognised that the opportunity to do so is limited.

Figures 24-26 below, illustrate the levels of congestion at London Fenchurch Street station in 2025 during the peak 15-minute morning demand under the current timetable, train lengthening and increased frequency scenarios, respectively.

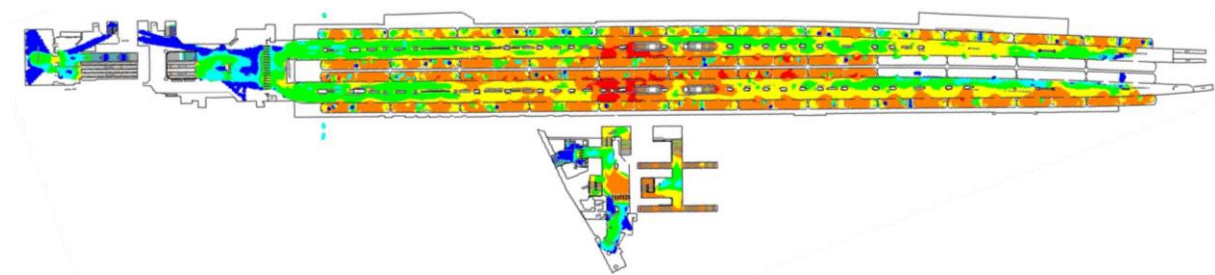


Figure 24 – Fenchurch Street CMD Map – 2025 AM Peak (08:30-08:45) – Current Timetable.

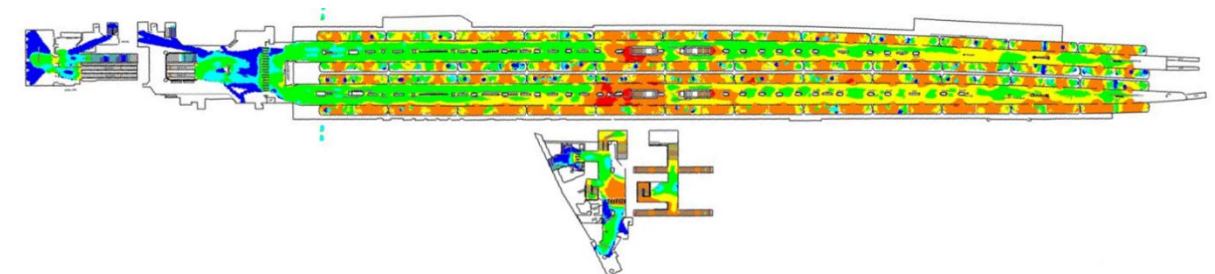


Figure 25 – Fenchurch Street CMD Map – 2025 AM Peak (08:30-08:45) – Train Lengthening.

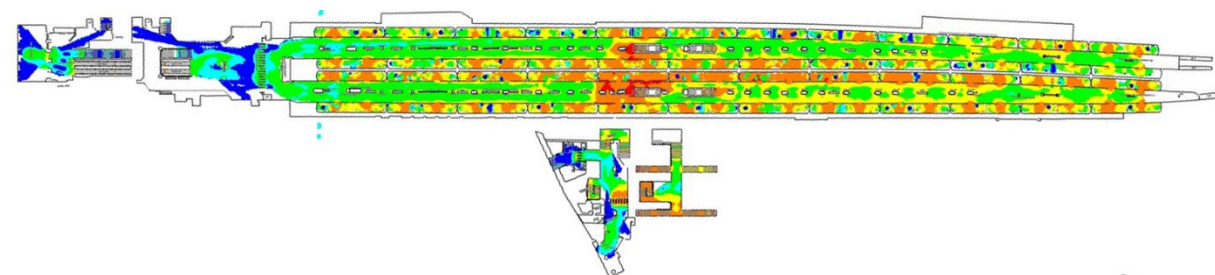


Figure 26 – Fenchurch Street CMD Map – 2025 AM Peak (08:30-08:45) – Increased Train Frequency.

The four platform London terminus of the Essex Thameside corridor at Fenchurch Street is a key constraint to increasing the frequency of train services.

Network Rail analysis has indicated that under existing timetable planning rules, a service above 25tph would not be advisable without increasing the number

of platforms, although it has been suggested that creative changes to cab set-up activities could reduce turnaround times, increasing the maximum capacity. Increasing the number of platforms is not straightforward due to significant constraints around the station, chiefly comprising the elevated railway position on a viaduct, multiple surrounding buildings, and the over-site developments (OSDs) of 8 Fenchurch Place and 1 America Square, built above the station in the 1980s and 1990s.

In 2018 c2c commissioned consultants WestonWilliamson + Partners to undertake a 'Masterplanning' study into the longer-term future of the station and its immediate surroundings, involving key stakeholders such as Network Rail, TfL and the City of London. The study concluded that the preferred way to

improve capacity at London Fenchurch Street would be to construct a new six platform terminus approximately 350m to the east, taking up the site of the existing Tower Gateway DLR station. This would involve the decommissioning of Tower Gateway, and would provide commercial opportunities on areas of the existing station which are currently not covered by OSDs.

The Mayor of London's *London Infrastructure Plan 2050* points towards the opportunity of closing Tower Gateway and providing a subsurface interchange with Tower Hill Underground station in the existing tunnels to Bank station. Closing Tower Gateway and diverting all DLR trains to Bank would give much more capacity on the more heavily used Bank branch of the DLR.

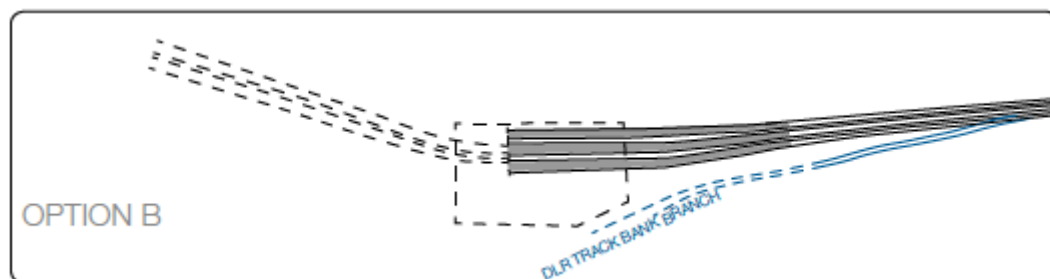


Figure 27 – The Masterplan envisages rebuilding London Fenchurch Street to the east, removing Tower Gateway, but has not gone into detail about how such an option could be achieved.

It has not been possible to undertake pedestrian modelling for this proposal due to its complexity and the lack of a developed scheme diagram to use. Network Rail has, however, undertaken some initial feasibility of building a six-platform station on this site to understand the land requirements for a new station building, platforms and track layout.

The track-led design work, building on the outputs of the Masterplan, has indicated that a six-platform terminus is able to be accommodated in this area, however an element of land acquisition would be required, including Tower Gateway DLR station and adjacent third-party buildings to the south of the existing rail corridor.

Although it is technically possible to fit a new station on this site, constructability

is a key concern, as well as the extent and cost of acquiring the land needed. As a result of these factors, it is likely that this sort of proposal would be unfeasible without private commercial investment into a wider redevelopment of the area. Due to the location of the station on the fringe of the City of London it is feasible that the site could be of interest to commercial developers, which should be explored when developing the strategy for the corridor further. An enlarged station here could also provide added benefits, such as a direct interchange with Tower Hill Underground station, and could potentially integrate Tower Gateway DLR station if its loss was undesirable.

Further investigation would be required to fully confirm the scale of land acquisition required, the performance of track infrastructure and how the station might perform in terms of pedestrian modelling.

If the opportunity to relocate London Fenchurch Street is not achievable, an alternative location to provide additional platforms will need to be found to accommodate the higher service frequencies required. The only other existing location would be at West Ham station, which, as the demand forecast shows, is the point where additional capacity is most required.

6.2.2 WEST HAM

Modelling of the existing station layout suggests that by 2027,³² the platform does not clear before the next train arrival and the station will not conform to station capacity planning guidance. The impact of increased train frequency and longer trains both provide marginal density improvements in the medium-term, with increased train frequency providing the greatest relative benefits. More densely loaded trains have a detrimental effect on the station, due to more passengers arriving at the same time.

Conditions under all options do not meet station capacity planning guidance with respect to density levels near the top of the stairs at platform level and platform clearance times. An enhancement would be necessary for the station to operate safely and efficiently in the long term.

Figures 28-30 below, illustrate the levels of congestion at West Ham station in 2035 during the peak 15-minute morning demand under the current timetable, train lengthening and increased frequency scenarios, respectively.

³² Based on 5 % increase in 2025 flows, broadly equivalent to 2027 demand levels.

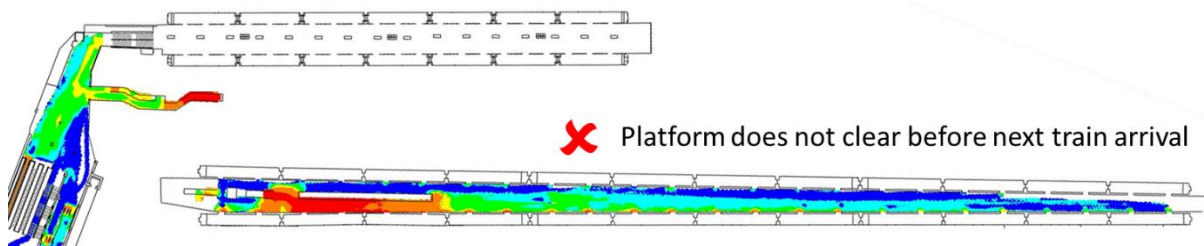


Figure 28 – West Ham CMD Map – 2035 AM Peak (08:00-08:15) – Current Timetable.

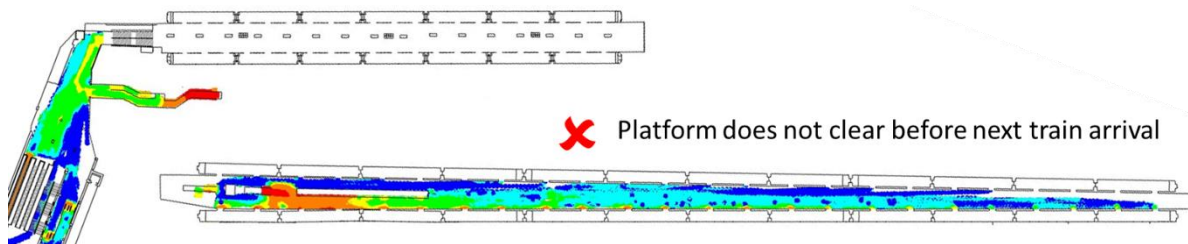


Figure 29 – West Ham CMD Map – 2035 AM Peak (08:00-08:15) – Train Lengthening.

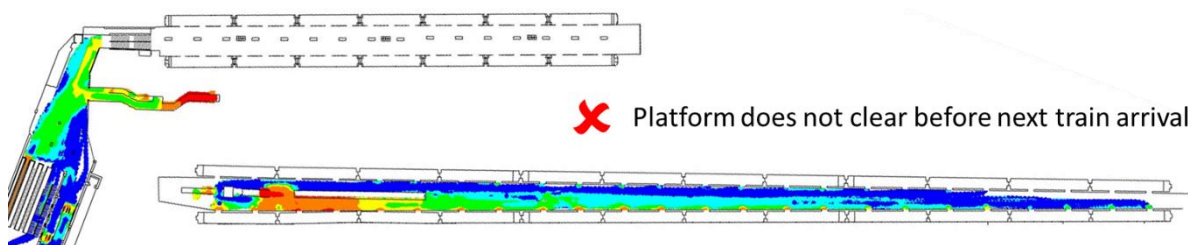


Figure 30 – West Ham CMD Map – 2035 AM Peak (08:00-08:15) – Increased Train Frequency.

A proposal to replace a set of stairs from the c2c platform with an escalator was put forward with the intention of reducing crowding at platform level in the short-term by speeding up the rate of egress from the platform and hence delay the requirement for a larger enhancement. However, modelling has shown no significant improvement to platform operations under this option.

In 2017 TfL undertook a GRIP 2 study to identify options for relieving station congestion at West Ham. Several solutions were presented in the report, primarily aimed at improving access to the c2c island platform and improving interchange with the Jubilee Line. These proposals were narrowed down to three

options for modelling and costing. The shortlisted options have been reviewed again. Two preferred options from the report (Option 9 and Option 12) were recommended to be re-modelled using the updated demand forecasting to advise the scale of intervention required to accommodate future demand levels.

Both options selected propose to enhance the station by improving the interchange from the c2c platforms to the Jubilee Line, with Option 9 also including an extra platform for London-bound c2c services.³³

Modelling has shown that both options alleviate congestion on the c2c platforms, with Option 9 doing so more

³³ Modelled with 70 % passengers exiting to the new platform, and 30 % to the existing platform.

effectively due to the additional platform and stairs. Both schemes allow the c2c platforms to clear before the next train arrival for all modelled demand years as per Figures 31 and 32. Areas of higher density are seen at the top of the stair at the end of the footbridge in both options, where flows from all vertical circulation combine, resulting in increased walking times. The possibility of widening the stairs should be assessed for these options to meet station capacity planning guidance.

Similar to what was seen modelling the existing layout, increased train frequency and longer trains both provide marginal density improvements.

Figures 31 and 32 below, illustrate the levels of congestion at West Ham station during the peak 15-minute 2050 morning demand for the current timetable for Option 9 and Option 12, respectively.

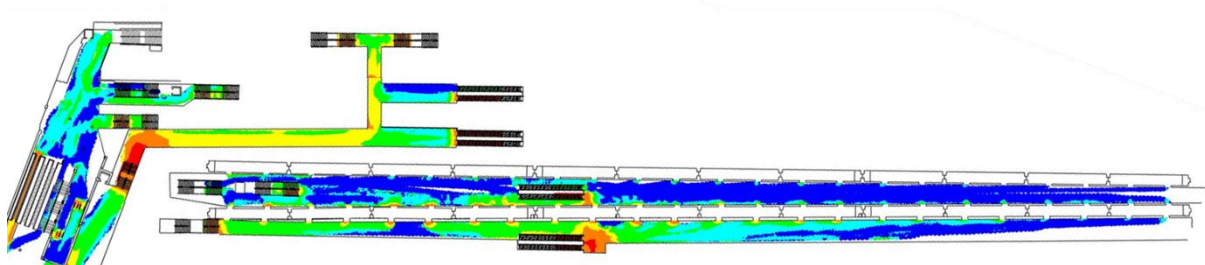


Figure 31 – West Ham CMD Map – 2050 AM Peak (08:00-08:15) – Current Timetable – Option 9

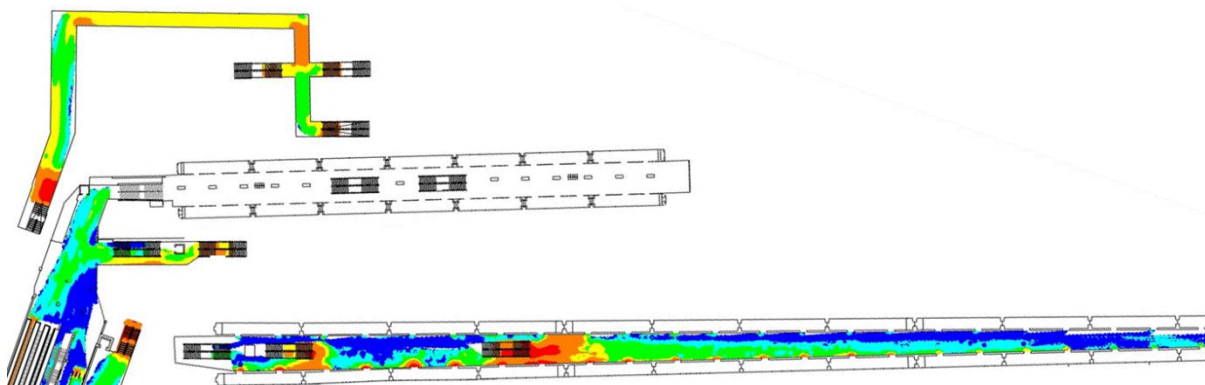


Figure 32 – West Ham CMD Map – 2050 AM Peak (08:00-08:15) – Current Timetable – Option 12

The report costed these options between £8m and £19m. These estimates have not been renewed for this study and the figures are intended to demonstrate the order of magnitude of funding required to undertake an enhancement of this nature.

Both proposals reviewed include an element of land take (of residential property) to the south of the corridor,

expected to be undesirable to funders, especially in the option involving an additional platform. It is therefore recommended that enhancement options which do not impact upon residential property are sought, most likely involving undeveloped land to the north-west of the station.

Track-led Network Rail concept design indicates that several different options

could be employed to move platforms here (including the potential to provide additional c2c platforms if required). The feasibility undertaken indicates that while a six platform³⁴ high-level station could be accommodated to the west of the Jubilee Line corridor, the track curvature required restricts maximum platform widths and potentially the ability to improve interchange flows compared to today.

Constructability and cost are significant factors which would need to be assessed by any further development work. Further investigation would also be required to fully confirm the scale of land acquisition required, the performance of track infrastructure and how the station might perform in terms of pedestrian modelling.

6.2.3 BARKING

Modelling of the existing station layout shows a breakdown of pedestrian flows at the station by 2025, with issues localised to the footbridge and gateline. The impact of increased train frequency and longer trains is less significant at this station, as flows to and from London Underground and London Overground are not affected and operate from shared or nearby platforms. An infrastructure improvement would, therefore, likely be required under any c2c train specification.

TfL commissioned a study of Barking station, concurrently with the West Ham study, presenting two shortlisted options. More recently, in 2018, c2c commissioned a study to provide step-free access and a capacity enhancement to support a bid for Access for All (AfA) funding from the DfT. At the workshop it was agreed to take a single option from both the 2017 and 2018 reports for modelling.

The option from the 2017 TfL report (Option C1) proposes to enhance the existing subway with stairs and lifts, replacing the existing long ramps. It also proposes a new entrance to the north of the station to connect to Wakering Road. As per the TfL modelling, it has been assumed that 15 % of all passengers entering the station and 10 % of all passengers exiting the station use the new entrance.

Option E3 from c2c's report proposes to enhance the existing station entrance by adding additional stairs and lifts as well as an additional bridge span to increase interchange capacity.

The current layout along with both options were modelled with and without a gateline enhancement. The modelled gateline enhancement includes an additional five gates³⁵ on the main concourse, replacing one of the retail units.

³⁴ Two platforms for the District/Hammersmith & City Line and four for c2c, arranged in three island platforms.

³⁵ Four standard and one wide gate, modelled as three standard 'in', one standard 'out', and a bi-directional wide gate.

Modelling has shown that under the current station layout, without a gateline improvement, station flows breakdown by 2025. A gateline enhancement to the current layout helps spread passengers entering and exiting the station, reducing pressure around the position of the existing gateline in front of the stairs to platforms 1 and 2-4.

The installation of a second gateline allows the current station layout to operate in 2025 (see Figure 33 below), but capacity is exhausted by 2035. The impact of increased train frequency and longer trains is insignificant.

A gateline improvement scheme could, therefore, delay the requirement for much a larger enhancement, such as either of the option types modelled, although such enhancements would still be necessary for the station to operate safely and efficiently in the medium- to long-term.

Figure 33 below, illustrates the levels of congestion at Barking station during the peak 15-minute 2025 morning period for the current timetable and under the existing layout, with a gateline enhancement.

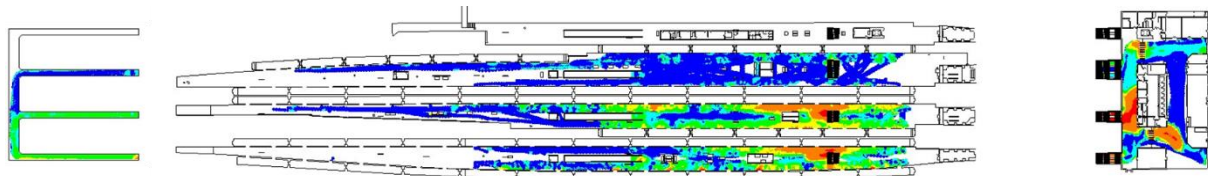


Figure 33 – Barking CMD Map – 2025 AM Peak (08:15-08:30) – Current Timetable – Current Layout with Gateline Enhancement

Both the TfL option and the c2c option allow the station to operate in 2025. However, both breakdown by 2035 without the addition of a gateline improvement.

With the addition of a second gateline, the proposed c2c layout allows Barking station to operate to 2050 (see Figure 34). Under the proposed TfL layout, by 2035 high densities are seen on the

footbridge between platform 2-4 and platform 5-6 stairs (see Figure 35 below). This is due to the reduced circulation capacity at the main entrance compared to the c2c option, with around 90 % of entering and exiting passengers still using this route.

The impact of increased train frequency and longer trains is insignificant under all modelled layouts.

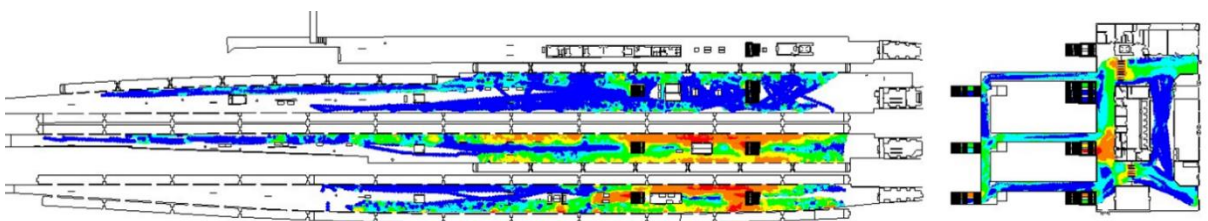


Figure 34 – Barking CMD Map – 2050 AM Peak (08:15-08:30) – Current Timetable – c2c E3 Layout with Gateline Enhancement

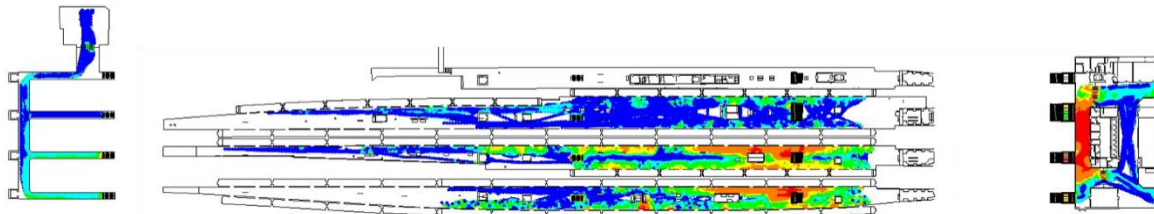


Figure 35 – Barking CMD Map – 2035 AM Peak (08:15-08:30) – Current Timetable – Tfl C1 Layout with Gateline Enhancement

TfL's 2017 option was estimated at approximately £8m whereas the option from c2c's AfA bid was estimated at approximately £10m. These estimates have not been renewed for this study

and the figures are intended to demonstrate the order of magnitude of funding required to undertake an enhancement of this nature.

6.2.4 SUMMARY

Enhancements are required at all stations in the short-term to ease pedestrian congestion expected as a result of increasing demand. A gateline enhancement at Barking is critical in the short-term, which would be able to defer a larger interchange-focussed intervention. It should be noted, however, that this major east London station lacks step-free access, and a larger scale intervention could be a vehicle for delivering this.

At London Fenchurch Street and West Ham, more significant interventions are required due to the constrained nature of both stations. As a result, it is important that consideration is given to the enhancements required at all stations as soon as possible so that they are able to be delivered at the appropriate time.

Schemes at London Fenchurch Street and West Ham could be extremely complex, even if additional platforms weren't provided. If significant changes to either of these stations were made, including moving platforms and associated track and signalling, it should be assessed how this would interact with an ETCS scheme, if this option was chosen as the preferred solution of increasing on-track capacity. For example, it should be assessed from a programmatic perspective whether it would be beneficial in terms of project complexity and cost to change track layouts after an ETCS scheme was implemented.

A summary of the performance of each option under each scenario is included in the Tables 13 and 14 below;

West Ham Test 1 – interchange improvement only (Option 12)	West Ham Test 2 – interchange improvement & additional platform (Option 9)
Benefits <ul style="list-style-type: none"> Reduced congestion on c2c platforms, allowing platforms to clear within acceptable time limits. 	Benefits <ul style="list-style-type: none"> Reduced congestion on c2c platforms, allowing platforms to clear within acceptable time limits.
Disbenefits <ul style="list-style-type: none"> Reduced vertical circulation provision on c2c platforms compared to Test 2. High density levels on footbridge and especially at top of stair at end of footbridge, where vertical circulation flows combine. Width of footbridge and stair to be investigated further. 	Disbenefits <ul style="list-style-type: none"> High density levels on footbridge and especially at top of stair at end of footbridge, where vertical circulation flows combine. Width of footbridge and stair to be investigated further.

Table 13 – West Ham options test summary.

Barking Test 1 – subway interchange improvement & new entrance (Option C1)	Barking Test 2 – bridge interchange improvement (Option E3)
Benefits <ul style="list-style-type: none"> Additional entrance, which may be beneficial to certain station users. 	Benefits <ul style="list-style-type: none"> Increased vertical circulation and interchange provision allows footbridge to operate acceptably.
Disbenefits <ul style="list-style-type: none"> Assumed usage of new entrance does not take strain away from current footbridge and gateline, with majority of flows still using this route. 	Disbenefits <ul style="list-style-type: none"> Vertical circulation limited to one end of the platform, increasing journey time for some passengers.

Table 14 – Barking options test summary.

6.3 OTHER STATION INTERVENTIONS

While most Essex Thameside stations offer full step-free access, and a high proportion³⁶ have benefited from the DfT's AfA programme, there is a desire from local stakeholders for full step-free access across the Essex Thameside corridor. Four stations on the Essex Thameside corridor – Grays, Chalkwell, Southend East and Ockendon³⁷ – have

been successful in securing AfA funding in CP6 which will further improve the number of accessible journey opportunities across the corridor.

Network Rail's system-wide *Railway for Everyone* (RfE) study has assessed the differing barriers to accessing the railway, including ticketing, connectivity

³⁶ Currently 21/26 Essex Thameside stations have full step-free access. Four more have partial step-free access. Currently only Chalkwell has no step-free access. Four stations (Laindon, Limehouse, Pitsea and Tilbury Town) have already benefited from previous rounds of AfA funding.

³⁷ The funding for Grays and Southend East was awarded in CP5, but deferred until CP6. Funding for Ockendon was confirmed as part of the March 2020 budget.

and station environments. For station environments, the study is likely to highlight the importance of;

- ease of navigation, including clear and consistent wayfinding and signage;
- accessible service information provision, including quality visual and audio systems and accessible ticketing facilities, and;
- modern, accessible station facilities, such as toilets, waiting rooms and seating designed for use by persons with reduced mobility or other, often hidden, disabilities.

It is important that these factors are incorporated when designing station enhancements, and the draft RfE study highlights several case studies where inclusive facilities have been successfully implemented. It is recommended that the franchisee and funders investigate the opportunity of funding discreet packages of RfE recommendations, and whether step-free access can be achieved at the remaining few stations (or parts of stations) which currently lack this to make the Essex Thameside corridor fully step-free. The study is currently in draft and is expected to be consulted upon publicly, following the outcome of the Williams Rail Review.

6.4 NETWORK CAPABILITY AND CAPACITY – FREIGHT

The geographical scope of this study's freight investigation was the Essex Thameside corridor and between Barking and Woodgrange Park Junction. The LRFS, outlined above, will assess capacity, capability and potential enhancements on the London orbital routes (i.e. the North London Line and Gospel Oak-Barking Line) beyond this point.

The number of paths indicated as being required to accommodate freight growth, as established above, have been analysed alongside the current c2c off-peak passenger timetable specification, taking into account the extended London Overground service to Barking Riverside, due to be operational from January 2022 and the new station at Beam Park, due to open in May 2022. The services on the Tilbury Loop (including platforms 7 and 8 at Barking) included in the analysis was therefore;

- c2c services from London Fenchurch Street to Grays (via Rainham) (2tph);
- London Overground services from Gospel Oak to Barking Riverside (4tph);
- Class 4 freight (4tph), and;
- Class 6 freight (2tph).

The analysis indicates that the long-term forecasted growth can be accommodated on the existing infrastructure as well as ensuring c2c and London Overground passenger services are evenly spaced throughout the hour.

Network Rail recognises the rail freight market is changeable and is closely influenced by fluctuating demand in the wider UK economy. For example, increased commercial and residential

property development could grow demand for construction materials in the London and south Essex area. A concentration of aggregate processing facilities exists on the Essex Thameside corridor so an increased demand for construction materials, often handled in bulk by rail, could increase demand for Class 6 freight services.

The increasing prominence of the desire to reduce emissions of greenhouse gases, particularly in light of the government's commitment to net-zero carbon emissions by 2050 increases the likelihood that demand for all types of rail freight could increase above this forecast over the medium- and long-term, as rail haulage (especially if electric traction is possible) is increasingly viewed as a 'greener' alternative to long-distance road haulage.

It has also been highlighted that express logistics could become a significant new market on Essex Thameside in the near future, delivering parcels using express passenger-like services from London Gateway port to London Liverpool Street station. The potential impacts of this market on the Essex Thameside corridor and wider London rail network will be considered by the LRFS.

Network Rail's Traction Decarbonisation Network Strategy will be developed throughout 2020 and will assess how alternative traction options can replace diesel haulage in line with Government's net-zero carbon commitment, including where infrastructure enhancements, such

as additional overhead line equipment, are required.

As a result of these two factors, as well as the potential of both Tilbury and London Gateway ports to grow their operations significantly in the short- to medium-term, it is possible that growth on the corridor could be higher than the central forecast that this study has assessed. Therefore, the analysis also sought to test the maximum number of Class 4 or Class 6 paths which could be accommodated on the Essex Thameside corridor using the existing infrastructure. The results of this test indicate that running two more freight trains above the base central case forecast³⁸ is possible, although track utilisation is increased to 80 % through platforms 7 and 8 at Barking station where freight, c2c Tilbury Loop services and London Overground services (post-Barking Riverside extension) all share the same infrastructure. It is not possible to increase freight paths further due to conflicting crossing movements accessing freight terminals. Passenger train dwell times at Barking station would also need to be reduced.

While this study has identified that additional freight paths could be timetabled in the off-peak hours, it is important to emphasise the interconnectivity and interdependencies between Essex Thameside and other corridors, most notably, the Gospel Oak-Barking line, Great Eastern Main Line and the North London Line. Although current capacity on the Essex Thameside corridor is suitable even for the higher forecasts,

³⁸ For a total of eight freight paths, four London Overground paths and two c2c paths through platforms 7 and 8 at Barking onto the Tilbury Loop.

this capacity will be of limited use if constraints remain on other interacting corridors. Therefore, the LRFS will incorporate these freight-focussed findings its own recommendations for the wider London freight picture so that recommendations for enhancement across a wider area can be established.

Finally, installing overhead line equipment on the Thames Haven branch and the connection between the Gospel Oak-Barking line and Midland Main Line would enable electric locomotives to serve London Gateway port, contributing to the decarbonisation of the Essex Thameside corridor.

6.5 LEVEL CROSSINGS

There are currently 41 level crossings (in 37 locations) operating on the Essex Thameside corridor, as shown below in Figure 36. Types of crossing vary from ‘passive’ public footpaths where the user makes the decision whether it’s safe to cross, to ‘protected’ crossings such as public highways, entrances to industrial sites and access between farmers’ fields.³⁹ The majority, 27, are located on the Tilbury Loop; the line carrying freight accessing all the major freight facilities on the Essex Thameside corridor, including the growing ports of Tilbury and London Gateway.

It is Network Rail’s strategy⁴⁰ to reduce the risk that level crossings pose by closing them wherever possible. Where this is not possible, safety is improved and risk is kept under continuous review. On the Essex Thameside Corridor, Network Rail is currently awaiting approval from the Secretary of State for Transport on a Transport and Works Act Order (TWAO) to close ten⁴¹ of these level crossings (indicated with orange dots in Figure 36). In addition, projects

are currently in development which aim to close Grays High Street and Purfleet (London Road) level crossings. Grays is proposed to be replaced with a pedestrian underpass and Purfleet with a road bridge.

Any increase in train frequency for either passenger or freight services will have an impact upon level crossing barrier down time and have an impact upon each level crossing’s risk profile. Proposals to introduce more trains to the network, even to take advantage of currently unused capacity, may need to take multiple level crossing upgrades or closures into account to ensure that risk continues to be managed.

Although closure would be desirable in many cases, the consents required can often take a significant amount of time to achieve, especially where public or private rights have been granted across the railway and diversions or new bridges or underpasses are required. These interventions can also contribute a significant cost to a programme of

³⁹ Currently there are 21 public footpaths, 7 public highways and 13 private crossings (e.g. access to industrial sites and farmers’ fields).

⁴⁰ <https://cdn.networkrail.co.uk/wp-content/uploads/2020/03/Enhancing-Level-Crossing-Safety-2019-2029.pdf>

⁴¹ The ten crossings are: Whipps Farm, Brown & Tarse, Ferry, Brickyard Farm, Woodgrange Close, No. 131, Jeffries, Howells Farm, Motorbike, Eve’s.

works. Other enhancement programmes in the east of England, for example the Ely Area Capacity Enhancements, have encountered challenges due to the risk that level crossings pose, demonstrating that the importance of level crossing risk to both programme and cost should not be underestimated. Further study would be needed to understand the upgrade or closure requirements for each level crossing.

Support from other stakeholders, such as local authorities and highways authorities is critical to achieving level crossing closures. It is important to highlight that closing level crossings can often bring benefits to the road network as well as the railway. For example, the closure of level crossings can improve local traffic flows and road journey times, reduce congestion and unlock new development opportunities.

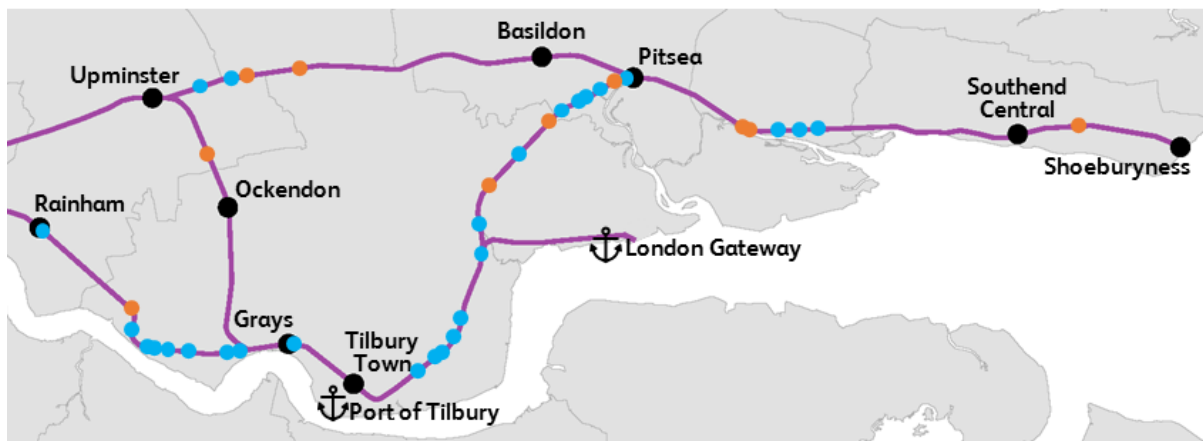


Figure 36 – The middle and eastern end of corridor with each blue or orange dot showing the approximate location of a level crossing.



7 STRATEGY OPTIONS

The analysis carried out as part of this study has sought to inform the choices for enhancing the rail network with growth forecasted over the next 30 years. This section provides summary

answers to the Strategic Questions posed by the study and outlines the strategy options recommended to taken forward for further consideration and development.

7.1 RESPONSES TO THE STRATEGIC QUESTIONS

The study sought to answer five strategic questions. Responses to these questions are summarised below.

SQ1: What is the expected growth in passenger demand over the next 30 years and what challenges does this present?

On average, passenger demand in the high peak hour is expected to grow by 35 % by 2050. Between Barking and West Ham – the ‘critical load point’ – this growth is expected to be 42 % by 2050. In the short-term, 9 % growth is expected by 2025.

With no capacity interventions other than the planned introduction of 10-car trains in 2021, average levels of crowding are set to increase at the London end of the corridor. Passengers are expected to be standing from as far as Chafford Hundred and Basildon by 2035, with crowding density gradually increasing. At the critical load point, existing crowding will become more severe.

Overcrowding is likely to become an issue in the high peak hour at London Fenchurch Street, West Ham and Barking within the next 5-7 years.

SQ2: What interventions are required to provide sufficient capacity post-2035, when the capacity provided by the initial ETCS proposal is expected to be exhausted?

A signalling enhancement-led programme, as per c2c’s proposed 24 trains per hour (tph) ETCS proposal, provides sufficient capacity until the mid-2030s. Beyond 2035, further growth requires additional capacity on the Main Line and Ockendon Single Line.

To support growth in the period after 2035 it is likely that a dynamic loop and/or a platform extension at Grays station will be required to provide the capacity needed on the Ockendon Single Line. It is possible for London Fenchurch Street station to accommodate up to 25tph under the existing timetable planning rules, however, either additional platforms or a change to operational practises is required to increase this capacity further.

By 2050 it is likely a timetable with a frequency between 26 and 28tph is required, which will require additional platforms at London Fenchurch Street or West Ham stations to ensure that a high level of performance can be maintained.

SQ3: What are the capacity challenges at the three ‘key stations’ and how can these be addressed?

The three key stations on the Essex Thameside corridor assessed by this study are London Fenchurch Street, West Ham and Barking. Due to the intense demand in the peak hours driven by the London commuter market all three are currently experiencing capacity issues in both peaks, which is set to worsen and breach Network Rail Station Capacity Planning Guidance as demand increases. All three stations were modelled in the morning high peak.

At London Fenchurch Street, pedestrian flow challenges are expected from 2025, particularly around the mid-platform stairs. Opportunities to resolve the issues are limited due to the severely constrained nature of the station. Ensuring trains do not arrive consecutively on the same island platform is critical to ensuring crowding on the platforms is managed as well as possible before a more significant intervention

is undertaken. Modelling has shown that the station's pedestrian performance is particularly sensitive to the assumptions on the usage of each exit. Encouraging the use of the main entrance could delay the need for a more significant scheme to the early 2030s.

At West Ham, severe congestion is expected by 2027. This is primarily at platform level, as passengers take time to descend the stairs. By this time the platform will consistently fail to clear before the next train arrival. A significant capital investment is required to provide more circulation space due to the constrained nature of the station.

At Barking, the result of passengers entering the station combining with those interchanging between platforms via the footbridge is likely to result in a breakdown in pedestrian flow by 2025. Analysis shows that the installation of a second gateline could improve the situation before an interchange-focused intervention is required around 2035.

All three stations will need to be jointly assessed to decide how and where enhancements need to be delivered, especially with the expectation that additional platforms are required at either London Fenchurch Street or West Ham after 2035, driving a significant investment in at least one of the stations.

SQ4: What is the expected future growth in rail freight to and from Essex Thameside destinations and how can this be supported?

The average growth figures from the latest freight forecasts produced by Network Rail in summer 2019 show that demand could more than triple its 2016/17 base (if it can be accommodated elsewhere on the network) by 2043. Higher growth could be possible in certain circumstances, such as if the maritime intermodal market develops at a higher rate. Decarbonisation targets and the emergence of new express rail freight markets could also play a key role in the growth in freight demand on the Essex Thameside corridor. The electrification of the Thames Haven branch is likely to support in the performance and efficiency of rail freight services.

The analysis conducted concludes that growth aligned with the central forecast can be accommodated in the off-peak hours without changes to the infrastructure. Higher levels of growth, up to eight freight trains per hour, could also be accommodated on the corridor. However, this growth potential is unlikely to be able to be accommodated without investment in the adjoining rail network. The London Rail Freight Strategy, due to be published in autumn 2020, will build on this study by identifying the key capacity challenges – and recommendations to address them – on the interfacing London orbital routes.

SQ5: Should the ETCS proposal not proceed, what other options exist to increase capacity in the long-term?

The analysis conducted by this study shows that, while train lengthening is an obvious and 'tried and tested' alternative, the expected increase in demand cannot be accommodated by train lengthening alone in the long-term and would require the later deployment of an ETCS or the increased density of the train fleet.

Additional infrastructure, such as providing a third track for peak directional flows is not considered to be feasible due to the severe lineside constraints which exist at the London end of the corridor. If the option to deploy much higher density rolling stock is discounted, then providing an increase in capacity by a headway reduction via ETCS is believed to be the most comprehensive way of providing this additional capacity in the long-term.

The only non-ETCS option able to deliver the required long-term capacity totals is to deploy much higher density rolling stock, that is the removal of seating to provide extra space for passengers to stand. This option is not deemed desirable by some board members due to the reduction in seats and the high likelihood that this option would result in passengers from further east being forced to stand in the high peak hour. It could also lead to unacceptable standing density at the London end of the corridor.

7.2 SUMMARY OF OPTIONS

The study board proposes further work on all the options proposed in this study. It is recognised that the replacement or reconfiguration of the rolling stock is not

deemed suitable by some board members due to its disadvantages for passenger satisfaction.

7.2.1 STRATEGY A – SIGNALLING ENHANCEMENT (ETCS)-LED

Implement ETCS as per c2c's proposal and increase frequency as required.

This strategy proposes to implement ETCS between Upminster and London Fenchurch Street as per c2c's business case. Train frequency would be increased to 24tph in 2025 as per c2c's proposed timetable. This would provide the required capacity until the mid-2030s. A further increase in train frequency would be required around 2035 and then around 2045-2050 to maintain the same level of journey quality. The deployment of ETCS in the early 2040s happens on the remainder of the corridor as currently planned.

To provide the required level of capacity on the Ockendon Single Line after 2035, either the bay platform at Grays would need to be extended or a dynamic loop would need to be built between Ockendon and Upminster.

It is expected that additional platforms would be required at London Fenchurch Street in the late 2030s/early 2040s in order to provide the platforming capacity needed in the late 2040s. If it was preferred to provide these platforms at West Ham, then it is recommended they are provided alongside a pedestrian capacity improvement. Pedestrian capacity schemes would be required at Barking by 2025, West Ham by 2027 and London Fenchurch Street between 2025 and 2035, depending on pedestrian modelling assumptions.

2025		2030		2035		2050	
Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity
ETCS 24tph TT	27,100	No change		2025 + 2 12-car	29,500	2035 + 2 12-car	32,000
Key Advantages <ul style="list-style-type: none">• Early investment in future signalling technology with no sunk costs in conventional signalling renewal.• Ability to bring in 2035/2050 requirements earlier or later subject to demand.• Relatively smooth, but sustained, spend profile across the next 30 years (depending on stations investment strategy).• Maintains high percentage of seating (over 60 %).• Could provide more flexibility in deploying longer trains to meet capacity demands.				Key Disadvantages <ul style="list-style-type: none">• No change in capacity on the single line in the timetable proposed.• Risks associated with introducing new technology.• High cost in short-term.			
Indicative investment timeline (date works are required to be delivered by)							
2025 <ul style="list-style-type: none">• ETCS• Additional rolling stock• Barking station gateline• Fenchurch Street station capacity		2030 <ul style="list-style-type: none">• West Ham station capacity (2027)		2035 <ul style="list-style-type: none">• Additional rolling stock• Barking station capacity• Grays platform 3 extension		2050 <ul style="list-style-type: none">• Additional rolling stock• New platforms at Fenchurch Street or West Ham• Dynamic Loop on Single Line	

Table 15 – Summary of potential strategy and investment timeline if ETCS was chosen as the preferred short-term intervention.

7.2.2 STRATEGY B – TRAIN LENGTHENING-LED

Lengthen trains in the short-term, deferring ETCS deployment until 2030.

Any trains which remain as 8-car after the 2021 timetable is implemented could be increased to 12-car with rolling stock similar to the existing Class 357s (“Standard” configuration), including the Grays via Ockendon services. The short bay platforms at Grays and Shoeburyness would both require lengthening to accommodate these longer services. ETCS between Upminster and London Fenchurch Street is deployed in 2030, with the c2c’s proposed 24tph timetable put into operation at this time. Train frequency can be increased as required after ETCS implementation. The deployment of ETCS in the early 2040s happens on the remainder of the corridor as currently planned.

It is expected that additional platforms would be required at London Fenchurch Street in the late 2030s/early 2040s in order to provide the platforming capacity needed in the late 2040s. If it was preferred to provide these platforms at West Ham, then it is recommended they are provided alongside a pedestrian capacity improvement. Pedestrian capacity schemes would be required at Barking by 2025, West Ham by 2027 and London Fenchurch Street between 2025 and 2035, depending on pedestrian modelling assumptions.

depending on pessimistic modelling assumptions:

2025		2030		2035		2050	
Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity	Indicative train service	Approx. total capacity
2021 TT + 7x 4-car sets	26,000	ETCS 24tph TT	27,100	2030 + 2 12-car	29,500	2035 + 2 12-car	32,000
Key Advantages <ul style="list-style-type: none">Assumed to be lower cost relative to ETCS in short-term.No signalling changes needed (although some signals may need to be moved due to platform extensions).No timetable changes required in the short-term.Capacity is increased on the single line.Maintains high percentage of seating capacity (over 60 %).All platforms would be 12-car length (except Upminster 1A).				Key Disadvantages <ul style="list-style-type: none">Potential performance issues, identified by c2c research, including slower running times and increased likelihood of delay.Platform extensions required at Grays and Shoeburyness. The complexities and costs of both require further investigation.DOO equipment not present at multiple stations.Infrastructure investment in 2025, followed by ETCS investment in 2030, combined with station improvements results in high spend throughout the 2020s/early 2030s. The costs of all these interventions at once could be prohibitive.Deferral to early 2030s may clash with other lines of route currently proposed to be deployed with ETCS at this time.			
Indicative investment timeline (date works are required to be delivered by)							
2025 <ul style="list-style-type: none">Additional rolling stockGrays platform 3 extensionShoeburyness platform 3 extensionBarking station gatelineFenchurch Street station capacity		2030 <ul style="list-style-type: none">ETCSWest Ham station capacity (2027)		2035 <ul style="list-style-type: none">Additional rolling stockBarking station capacity		2050 <ul style="list-style-type: none">Additional rolling stockNew platforms at Fenchurch Street or West HamDynamic Loop on Single Line	

Table 16 – Summary of potential strategy and investment timeline if train lengthening was chosen as the preferred short-term intervention.

Tables 15 and 16 above outline the two strategy options proposed to be developed further. Figure 37 below shows the staged total capacity provided by Strategies A and B respectively.

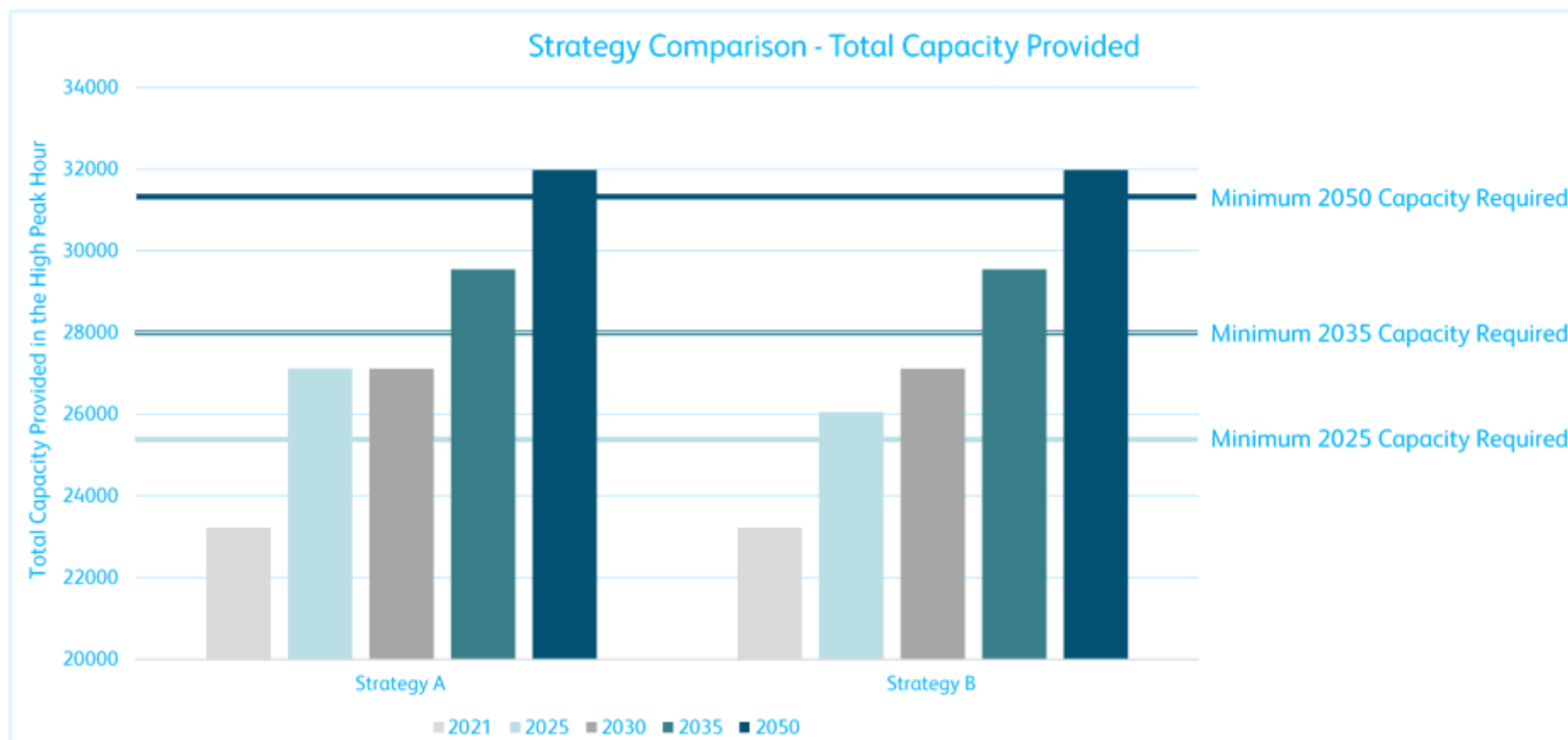


Figure 37 – Comparison of overall (seating and standing) capacity provided in the high peak hour under Strategies A and B.

7.2.3 ALTERNATIVE PHASING OPTIONS

Longer-term deployment of strategy options could differ from that set out above, however, the low number of options available severely limits these choices. Figure 38 below shows the potential directions that strategies could go in following the initial first steps of either implementing ETCS or lengthening trains. As noted previously, the option of reconfiguring all Class 357 rolling stock alone could provide total capacity of around 28,000 in the high peak hour.

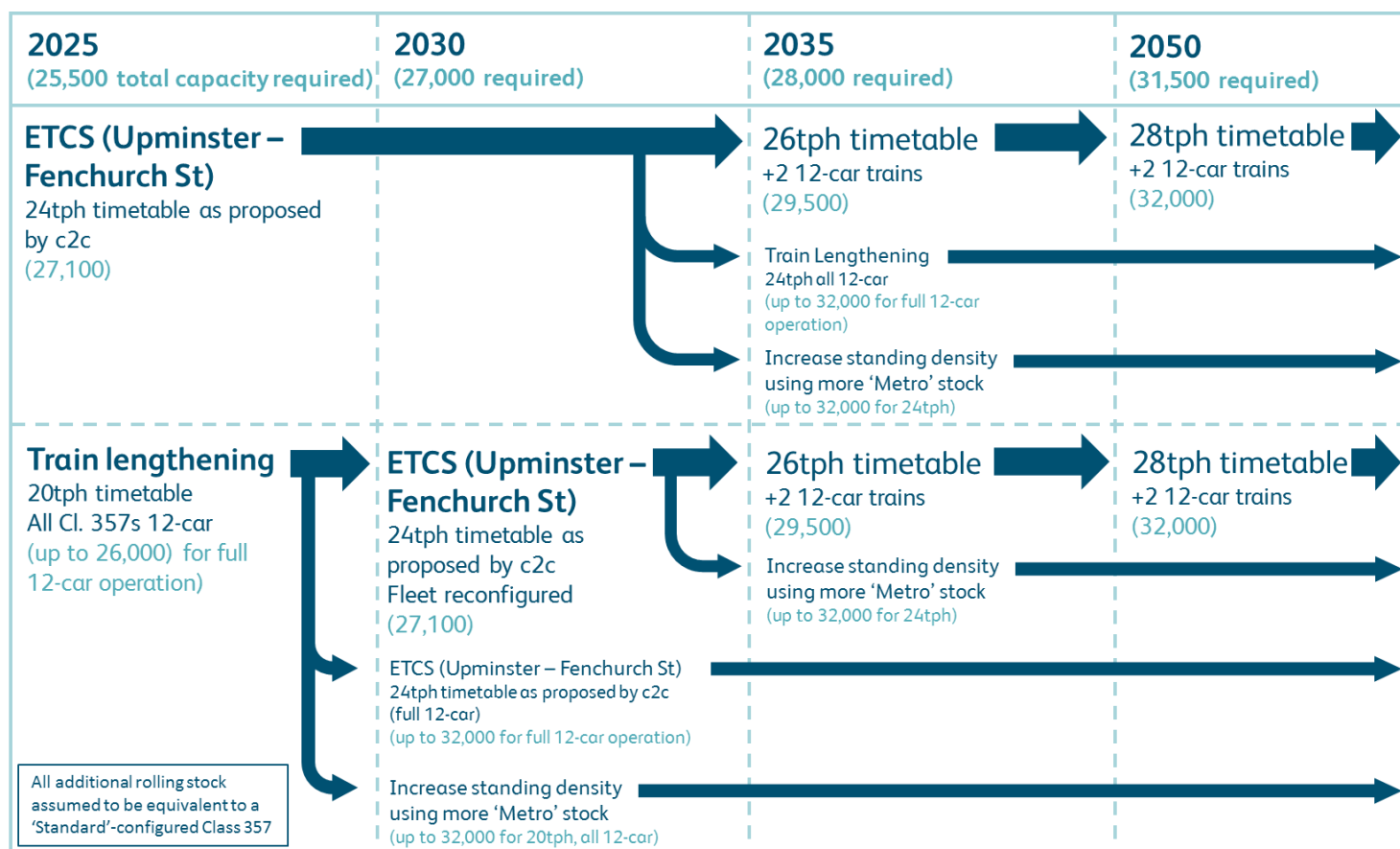


Figure 38 – Indicative alternative phasing options.

Unless changes to the rolling stock configuration is considered, it is clear that investment in enhancing the signalling on the corridor through ETCS is required to provide the necessary level of train service in the medium- and long-term. The required capacity cannot be delivered using any train lengthening strategy alone. Train lengthening could be implemented in the short-term but its suitability for this part of the network is questionable and its longevity is limited to around five years.

Both strategies are able to accommodate the forecasted requirements for freight in the off-peak.

It is recommended that further consideration is given to the options identified in this study by development of business cases and progression through the Department for Transport's Rail Network Enhancements Pipeline (RNEP) process, as shown by the flow diagram below in Figure 39. The signalling enhancement (ETCS) led option has already been developed by c2c. This study recommends further consideration of this option alongside other options in this study. It is recommended that this progresses as soon as possible, due to the level of demand growth forecasted in the short-term.

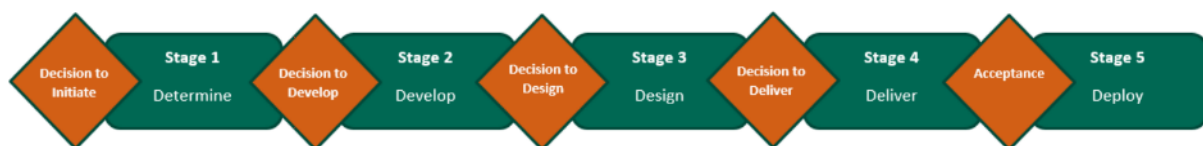


Figure 39 – Rail Network Enhancements Pipeline

7.3 HIGHER GROWTH

This study has used a standard passenger forecasting model to estimate levels of future growth across the corridor. As discussed above, the South Essex region has strong housing growth potential beyond that which is assumed in passenger forecasting model used for this study. Stakeholders have identified that certain areas, such as Barking, Dagenham and Thurrock have the opportunity to accommodate further additional housing not yet identified in Local Plans.

A high level sensitivity test was carried out to illustrate the potential impact of a 10 % increase in passenger demand. The results of this show that the interventions recommended for 2035 would need to

be implemented in around 2028-2030 and the 2050 interventions would need to occur in the late 2030s. It is important to highlight that this basic test does not account for aspects observed to occur in high density situations, such as people adjusting their travel times or choosing not to travel by train at all.

Similarly freight growth has the potential to exceed the central case used by this study. Analysis indicates that up to eight freight train paths (two more than the central case forecast) could be achievable alongside passenger services in the off-peak hours on with the current infrastructure. This would be subject to the capacity and capability of connecting lines.

7.4 RECOMMENDATIONS FOR FURTHER STUDY

The core of this study's remit has been to assess capacity across the existing service patterns on the Essex Thameside corridor. It has not been possible to assess more system-wide interventions within this study. Further study is

required to assess freight requirements beyond the Essex Thameside corridor and whether there are other passenger service opportunities beyond its boundaries, for example.

7.4.1 CROSS-LONDON FREIGHT

As noted earlier, the Essex Thameside corridor is a critical freight artery, primarily for intermodal container traffic and construction materials. While it has been established that the current infrastructure is able to accommodate freight demand on the Essex Thameside corridor for the next 30 years, this capacity potential cannot be fully exploited without other freight interventions across the London orbital routes, over which all freight services to and from Essex Thameside must

traverse. It is expected that the LRFS will establish a series of cross-London recommendations for enabling more freight on Essex Thameside, and is due to be published in autumn 2020. Following the publication of the LRFS it is recommended that any options to enable greater cross-London freight capacity are reviewed and developed within the framework of the RNEP to ensure that long-term freight growth potential on Essex Thameside can be realised.

7.4.2 JOINT STATIONS STRATEGY

It is also recommended that Network Rail, c2c and TfL develop a joint stations strategy for the three critical stations on the corridor (London Fenchurch Street,

West Ham and Barking) to decide where and when to focus investment and begin to develop and cost complementary options across all three stations.

7.4.3 LONDON LIVERPOOL STREET

Due to the requirement to increase service level frequency to provide long-term capacity on the Essex Thameside corridor and the challenge to locate additional platforms at London Fenchurch Street, it may be necessary to seek capacity elsewhere. One option is the West Ham-focussed solution, outlined above, however there is potentially also an opportunity to seek

this capacity at London Liverpool Street. It is suggested, therefore, that a review to jointly assess capacity and capability across the London ends of the Essex Thameside corridor and the Great Eastern Main Line (GEML) is recommended to identify whether it is strategically and operationally possible to use London Liverpool Street in

addition to London Fenchurch Street as the Essex Thameside terminus.

It is recommended that the implications for multi-modal passenger demand are assessed in detail, along with what infrastructure interventions may be necessary to accommodate Essex Thameside services on the GEML in the peak hours. Careful consideration would need to be taken with regards to platform and station capacity at London Liverpool Street and Stratford stations, the capacity and capability of Forest Gate Junction (near Stratford) as well as capacity for further services on the GEML to its core markets in north and east

Essex, Suffolk and Norfolk. It is noted that this may be operationally challenging to achieve due to the high frequency Elizabeth Line service on the GEML.

London Liverpool Street is also the terminus for the West Anglia Main Line, and any proposed operational changes would also need to account for future requirements on this line.

This could be considered further as part of the long-term strategy for the long-term development of London Liverpool Street station.

7.4.4 LEVEL CROSSINGS AND POWER SUPPLY

It is expected that before an increase in frequency of passenger and/or freight services on the corridor could be permitted, some of the current 41 level crossings would need to be upgraded or closed. The indicative concept train plans established by this study should be used to assess each level crossing in detail to understand the scale of works which would be required to operate these

higher frequency timetables in both the peak and off-peak periods.

Similarly, a detailed assessment will be required of any proposal which adds more carriages or locomotives drawing power from the overhead lines to determine whether an enhancement to the power supply is needed.