ARUP

Port of London Authority and Thames Estuary Growth Board

The case for new zero-emission ferry crossings

Final report

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Executive summary

Arup was commissioned by the Port of London Authority (PLA) and the Thames Estuary Growth Board (TEGB) to undertake a study to understand the benefits of zero emission pedestrian and cyclist ferry river crossings on the Thames.

It should be noted that the demand, funding and fare revenue scenarios are based on indicative and high-level assumptions, and further rigorous modelling and interrogation of assumptions will be required based on robust patronage forecasting, as well as better estimates of capex and opex as the project stages progress.

Strategic case

New river crossings can:

Improve the connectivity of London's transport network

Mitigate severance issues

Support the growth of residential development, especially in east London

Relieve congestion and overcrowding on popular travel corridors

Increase the use of active travel or public transport

Reduce emissions

From a long list of sites, three crossing options, Isle of Dogs - North Greenwich, Royal Docks - Charlton and Barking Riverside - Thamesmead were shortlisted for their alignment with the project objectives to: support the community, enabling growth, addressing a network gap, integration with the broader network, congestion relief and reduction of carbon emissions.

Initial assessment suggests that sufficient energy supply exists at all shortlisted sites to enable delivery of a low emission ferry. The strategy for energy supply, vessel recharging and vessel technology need to be confirmed in a concept study, taking a holistic approach to energy and operations. An initial appraisal suggests that sufficient energy supply is likely to be available from local District Network Operators (DNOs) and that recharging of the vessels is not likely to be a significant barrier to the operational performance needs.

Figure 1: Crossing 1 – Isle of Dogs to North Greenwich site layout. The red squares indicatively show the proposed location for the new piers (subject to detailed viability assessment and consent).

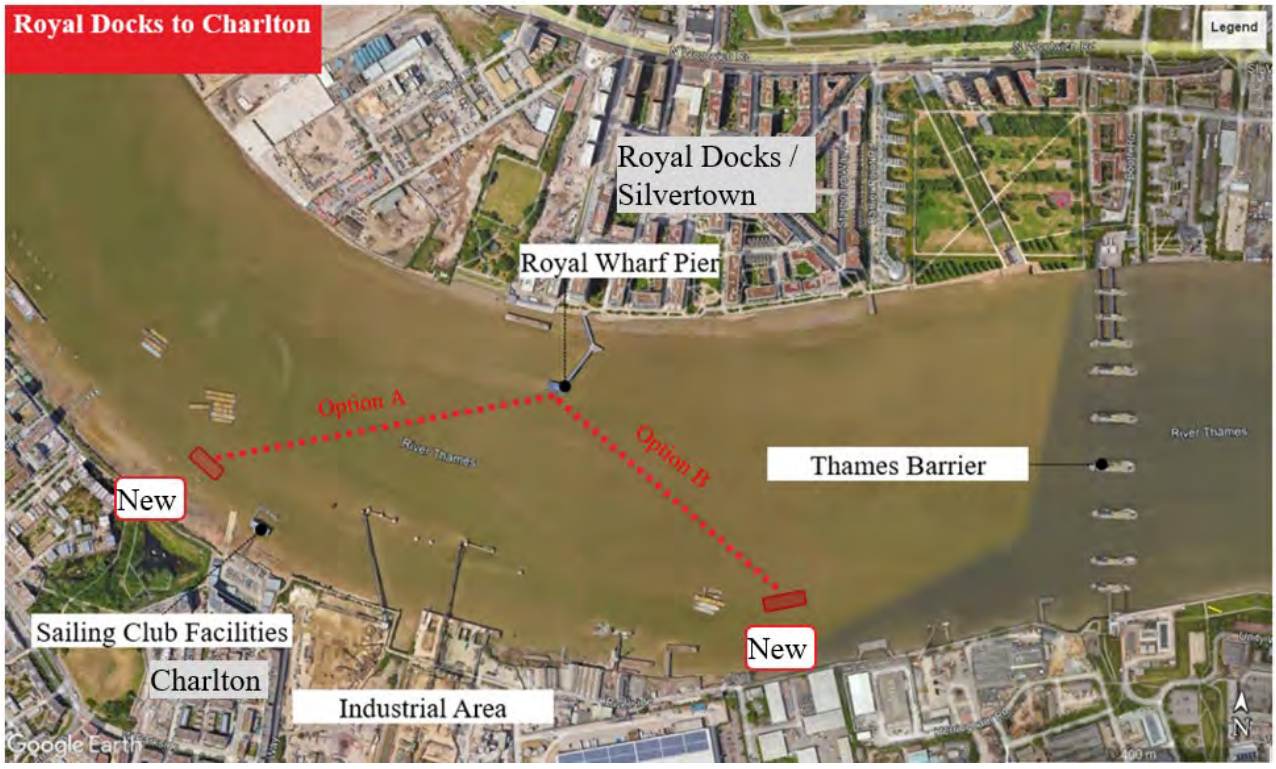


Figure 2: Crossing 2 – Royal Wharf to Charlton. The red squares indicatively show the proposed locations for the new pier (subject to detailed viability assessment and consent).

Figure 3: Crossing 3 – Barking Riverside to Thamesmead. The red squares indicatively show the proposed locations for the new pier (subject to detailed viability assessment and consent).

Economic case

Demand is higher for the Isle of Dogs to North Greenwich crossing, compared to more eastern sites (Royal Docks to Charlton and Barking Riverside to Thamesmead). This is largely driven by existing population and employment catchments, however in the future, major developments such as Silvertown, Charlton Riverside, Barking Riverside and Thamesmead will drive demand for additional river crossings in the east.

Table 3 provides the daily demand for the travel to work method and benchmark demand estimates. By comparison, daily demand for the RB4 service in 2015 was 535 passengers per day.

Table 1: Daily demand with £1 fare, costs, and benefit-cost ratio range

	Isle of Dogs - North Greenwich	Royal Docks - Charlton	Barking Riverside - Thamesmead
Demand range (daily, 2035)	**550 – 4,300**	**350 – 2,800**	**250 – 1,850**
	2 No. vessels 2 No. new piers	2 No. vessels 1 No. new pier (south side)	2 No. vessels 1 No. new pier (south side)
Capital costs	£38m	£25m	£25m
Operational costs (30 years)	£94m	£94m	£94m
Total costs	**£132m**	**£119m**	**£119m**
Benefit-cost ratio (BCR)	**0.2-2.3:1**	**0.1-1.5:1**	**0.2-1.7:1**

Whilst the lower end of the benefit-cost ratio results is below the level that is typically awarded government funding, the upper end represents good value for money. The results are heavily dependent on levels of demand and third party funding.

Financial case

A multi-source funding package is needed. The crossing can be delivered by a range of different funding sources, including fare revenue, sponsorships, Central and Local Government grants and diversion of funding from other sources.

Figure 17 and Figure 18 below provide a present value view on both project costs and funding, over the life of the project for Scenario 1. Figure 17: Free Fare, Scenario 1 assumes no fare revenue and Figure 18: £1 Fare, Scenario 1 assumes a £1 fare is charged for the average annual trips estimated for Royal Docks to Charlton, Option A.

Note that this assumes a Woolwich ferry charge is introduced, and that existing funds for cycling access to Silvertown tunnel are diverted to this new ferry service instead. We also looked at a case where Woolwich ferry was not tolled, and Silvertown funding was not diverted.

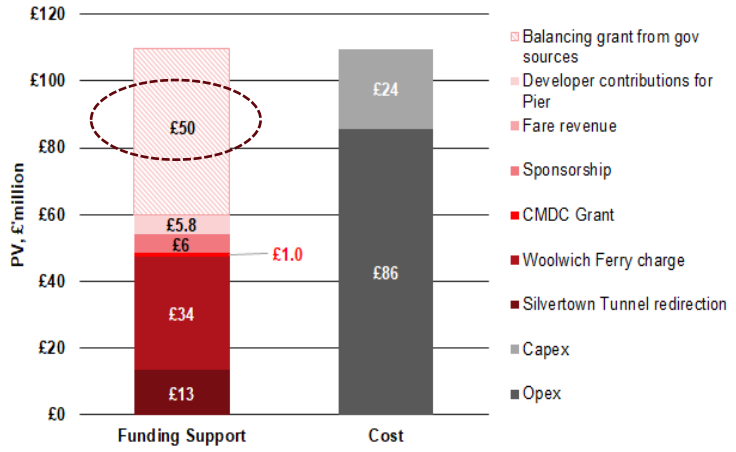


Figure 4: Free Fare, Scenario 1

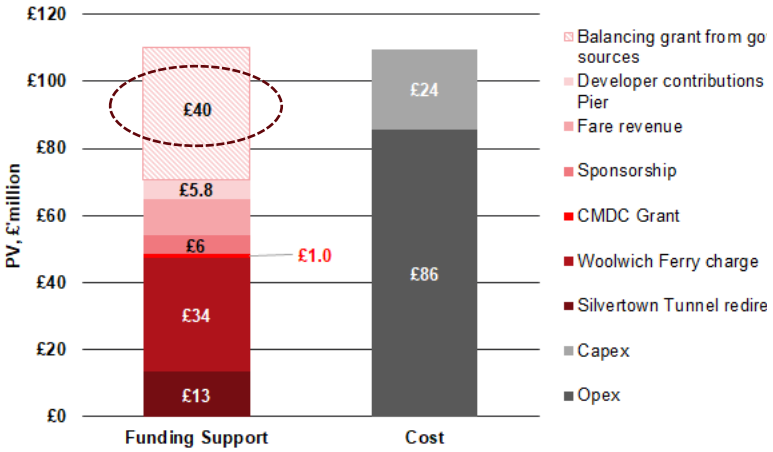


Figure 5: £1 Fare, Scenario 1

Table 2 below provides a further matrix of the estimated government funding support required based on different fare rates per trip, for Scenario 1, and adjusted for elasticities of demand on passenger numbers. The higher the fares, the lower the grant funding required. With a £3.50 fare, the grant required will be some £21m in 2024 prices.

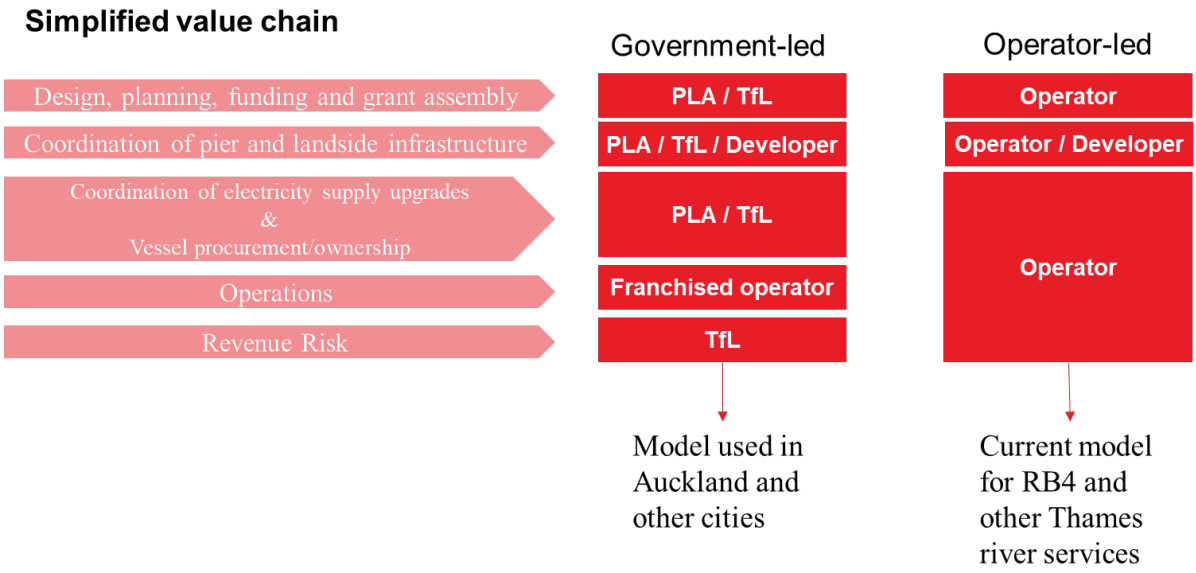
Table 2: High-level estimates of fare and gap funding scenarios to breakeven (2024 prices)

Approximate fare per trip	Approximate "balancing grant" from government required to cover the funding gap
£0	~ £50m
~ £1	~ £40m
~ £1.5	~ £35m
~ £2	~ £31m
~ £2.5	~ £27m
~ £3	~ £24m
~ £3.5	~ £21m

Commercial case

We have identified two potential delivery models, one led by a government entity such as TfL or PLA, and other led by an operator, such as Thames Clippers. These are outlined in Figure 6.

Figure 6: Delivery Model Overview



The first, government-led model, is based upon the one that is being implemented in Auckland, New Zealand, and is broadly similar to the TfL bus network. The second operator-led model, reflects that there is a large incumbent operator on the Thames which has previously been successful at bidding for government funding, and raising private capital, whilst offering services that are integrated within the broader London transport network. The high costs of the electrification infrastructure, the resulting natural monopoly (it would not be practical to have two ferry operators on the same crossing), and the reliance on public funding streams suggest a high level of government involvement, whichever model is chosen.

There are further commercial considerations that operators such as Thames Clippers currently hold exclusivity agreements at several piers, including but not limited to Royal Wharf and Barking Riverside. We recommend conducting a comprehensive audit of the existing exclusivity rights associated with the existing piers which are to be adapted for the proposed ferry crossing use. This audit will serve to illuminate the terms, conditions, and time limits associated with these agreements, allowing for a clearer understanding of their potential impact on the proposed ferry service.

Management case

Multiple vessels may be needed to deliver a ‘turn up and go’ service. Infrastructure and operational solutions exist that can reduce the berthing, mooring and passenger loading/unloading times, but these would need to be confirmed in a concept design that considers site-specific navigation constraints and opportunities. An initial appraisal of operational performance envelopes suggests that two vessels are likely to be required to deliver suitably short service intervals, except for Barking Riverside to Thamesmead, where there is a risk that service intervals could be longer or more vessels needed, which would add operational complexity and cost.

Broadly speaking, there is strong stakeholder support and a fit with wider stakeholder objectives. That said, further work is needed to overcome local concerns about wear and tear on existing infrastructure, and potential additional infrastructure on desire lines approaching the new pier sites.

Next steps

Further work will need to be undertaken to progress the scheme, including:

- **Work with Mayoral candidates, TfL and GLA towards a commitment in the next Mayor's Transport Strategy**.
- **Build consensus:** Each of the shortlisted sites identify the need to construct a new pier. The new piers could potentially serve other along-river services in addition to this scheme. Partnerships with other stakeholders, such as existing operators, Thames Clippers, could allow costs to be shared. Further work could be undertaken to identify opportunities to rationalise along-river services, including modifications such as reducing the number of stops on existing RB4 services for example. This could create a more integrated river transport scheme, providing a crossing at the shortlisted sites as explored through this study, whilst sharing costs accordingly.
- **Convene a Project Board**.
- **Work with potential funders**. Including DfT.
- **Outline business case, full business case and concept design development**: Concept designs need to be developed for the chosen selected site to inform detailed economic and financial analysis. This would need to take into consideration site-specific characteristics and constraints such as the need for dredging.
- **Undertake market testing**: Further engagement will be needed to test the appetite from the market for the scheme, including identification of potential private partners for vessel design and delivery. As outlined in the technology options review, we suggest that due to the constraints of operating on the Thames, free running vessels will be the more appropriate solution, with battery electric ferries being more appropriate than hydrogen, subject to sufficient power being supplied to the berths. Further engagement will need to be undertaken with DNOs to determine local electricity capacity at selected sites.
- **Review suitability of existing infrastructure**: Each of the shortlisted three options identify the use of at least one existing pier. A detailed assessment of asset condition and suitability for the proposed vessel will need to be undertaken.
- **Further demand modelling**: An initial assessment has been undertaken to determine demand at each of the short-listed sites using a range of different point estimates. Further detailed analysis will need to be undertaken.
- **Further analysis is needed to determine whether existing pier infrastructure can be used**: Using or adapting existing pier infrastructure presents an opportunity to reduce costs, risks and programme. Nonetheless, modifications to existing piers are likely to be required to safety accommodate both cross-river and along-river services, plus additional passenger throughput. Ownership and governance of existing pier infrastructure could create challenges for adopting infrastructure, particular if for multiple service providers.
- **Further consultation is needed to deliver a solution that works for all river-users**: The Thames is a busy waterway, with a diverse range of users and varying environmental conditions. The safe navigation of both cross-river and along-river traffic at the crossings will be a key driver for operations and supporting infrastructure. This will need further exploration in consultation with key stakeholders during subsequent stages.
- **Based on initial estimates, a service could be operational by 2026**: Based on a high-level programme – initial estimates on timeframes for consenting, procurement, design and construction indicate that the service could be operational by 2026.

1. Introduction

Arup were commissioned by the Port of London Authority (PLA) and the Thames Estuary Growth Board (TEGB) to undertake a study to understand the benefits of zero emission pedestrian and cyclist ferry river crossings on the Thames. The purpose of the study is to articulate the costs and benefits associated with a ferry crossing, providing an evidence base to support further analysis and feasibility studies.

This study is one of the key actions identified in the Thames Vision Action Plan (Port of London Authority, 2022), which is built around three interconnected themes centred on the role the river plays for people and the environment. These include *Trading Thames* – the No.1 Net Zero UK commercial hub, *Destination Thames* – a place to live, visit, play and enjoy and *Natural Thames* – clean air, water and land supporting diverse wildlife. The plan specifically references commissioning and publishing a study on the business and public benefit case for electric ferry river crossings, with the scheme contributing to the three interconnected themes, as a sustainable net zero transport option that supports the community and encourages active travel.

The core objective of this study is to advocate for zero emission ferry river crossings to be included in the plans of candidates for the 2024 Mayoral elections. In the context of this report, zero emission means zero emission at the point of use.

1.1 Important note

This report is being provided as part of an early-stage feasibility study and is not being delivered for investment purposes. As such, no reliance should be taken by the PLA and TEGB or any other party on any costing, demand, or revenue forecasts. Costs, demand, and revenue forecasts have been provided in this report for illustrative purposes only.

1.2 Structure of this report

The document is structured as follows:

- **Chapter 1 – Introduction**: An overview of the study and our approach.
- **Chapter 2 – Strategic case**: An overview of the strategic and policy context, including articulation of the strategic case for river crossings.
- **Chapter 3 – Economic case**: Cost and benefit analysis for the short-listed options.
- **Chapter 4** – **Financial case**: An outline of potential funding sources and packages to fund the proposed scheme.
- **Chapter 5** – **Commercial case**: An outcome of the commercial case and potential delivery models.
- **Chapter 6 – Management case**: Outline of next steps towards successful delivery including governance structure and programme.
- **Chapter 7** – **Summary and recommendations**: A summary of next steps and recommendations.

1.3 Strategic context

The historic role and function of Thames crossings

Crossing the Thames provided the foundation of London itself 2,000 years ago, and since then, the means of traversing the river have been central to the capital's development, initially as a major trading port, then opening up areas for industry, growth to be Europe's largest metropolis, and more recently in facilitating housing and redevelopment. The city owes its existence to the location of the first London Bridge, itself the only structure spanning the Thames until 1750, meaning that cross-river ferries played a significant part in London life until relatively recently. Records of the Woolwich ferry date back to 1308, and other ferries operated to the west and east of the centre, with routes between Isle of Dogs – Greenwich, Rotherhithe – Limehouse, and Millwall – Deptford in the Docklands area alone. The ferry crossing gradually fell away as more road bridges and cross-river railways were added in the 19th and 20th centuries. The Greenwich foot tunnel opened in 1902, and was joined by its Woolwich counterpart a decade later. Above the water line, the Woolwich free ferry converted from paddle steamer to motor ships in 1963.

Notwithstanding the pandemic, the last 30 years have seen a huge upturn in river use among pedestrians and cyclists. The Thames Path was stitched together from historic towing routes and tweaks to the built environment in central London, and was officially opened in 1996, broadly coincident with the regeneration of the waterfront on the South Bank, Greenwich and Docklands, the huge influx of employment and residential development around the Isle of Dogs, and an upturn in international tourism, leading to a significant boost in pedestrian river access and broader visibility of the river among Londoners.

Soon after, new crossings emerged with the DLR extensions to Lewisham and Woolwich, and the opening of the Jubilee line extension, which unlocked further new developments at Canary Wharf and the Excel arena, bringing more workers and leisure travellers to the area. The O2 arena, the Cable Car, and other east London riverside attractions increased the popularity of days out in east London in the late 2000s, cemented with riparian Olympic venues and the river's visible role in the London 2012 opening ceremony. More recently, east London riverside locations have been earmarked to provide for much of London's additional housing needs, with recently delivered developments around Royal Wharf and Barking Riverside being specifically integrated with new pier access, and significant housing developments underway or planned for Greenwich Peninsula, Barking Riverside, Silvertown, Royal Docks, Charlton, and Thamesmead, among others.

To service this, the Thames is now home to a thriving River Bus sector, operated by Uber Boat by Thames Clippers, on four other key routes operating between Putney Pier in the west and Barking Riverside Pier in the east, seven days a week. The Woolwich ferry is now operated by Transport for London, and is joined by the RB4 Rotherhithe – Canary Wharf service, and various lower capacity foot ferries in west London. There are a growing number of leisure operators.

As outlined in the 'Vision for the Tidal Thames' (Port of London Authority, 2016), the Thames plays a key role in both transporting people and goods, providing a space for sport and recreation, being a cultural hub, and has large potential given large developments alongside the river. Patronage of the River services sector is expected to return to pre-pandemic levels in 2023/24, and carry almost 10m customers.

East London river crossings are scarce

Despite this activity, the frequency of river crossings decreases substantially east of Tower Briadge, and again when east of Greenwich (shown in Figure 4). For pedestrian and cyclist crossings (blue), together with ferry services (Rotherhithe to Canary Wharf and Woolwich ferry (red)), and existing rail crossings (grey) providing existing transport links. There are up to 22 pedestrian crossings in the 15km west of North Greenwich, whereas there are only 6 in the 15 miles east of North Greenwich. In particular, the two stretches between the Cable car and Woolwich foot tunnel, and east of Woolwich ferry, are completely free of pedestrian and cycle crossings.

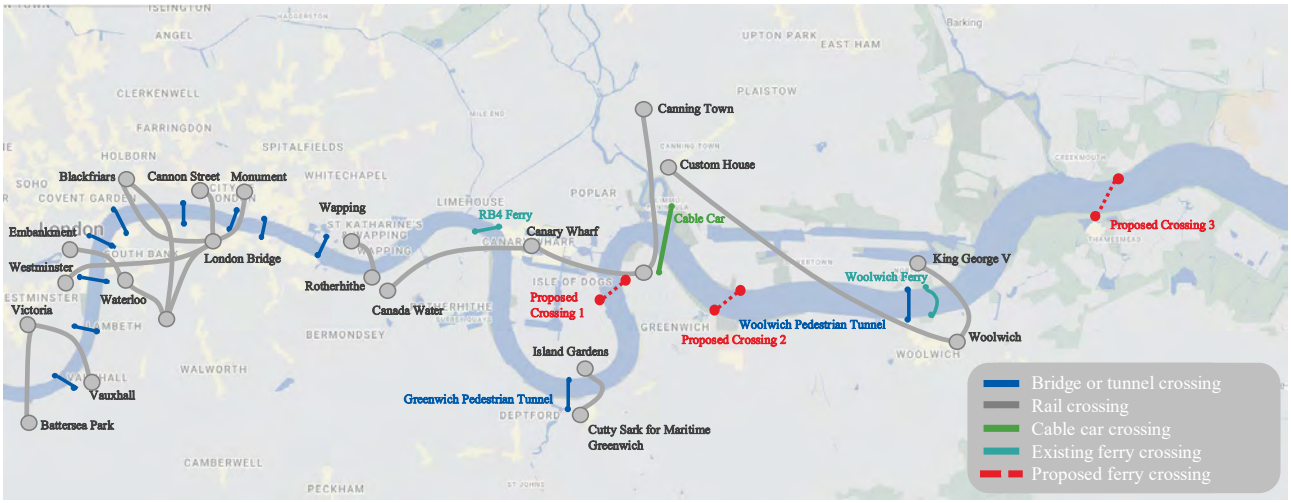


Figure 7: Existing River crossings

Given the interaction between regeneration and river crossings, various plans have been made for additional bridges east of Tower Bridge. Recent plans include new bridges or rail crossings at Silvertown (road tunnel, now under construction), Isle of Dogs – Canary Wharf (cycle bridge), Thamesmead (DLR extension) and Belvedere (road bridge). Ferry services offer a strategic complement to other crossing types: they tend to be faster and cheaper to install and operate, have lower capacity, and can be better integrated with the immediate riverside streetscape and leisure experience. As such, they should be seen as key components of plans to regenerate parts of London.

The river Thames has a significant role to play in the transport network. In support of the Mayor of London's goal for 80% of all trips in London to be on foot, cycle or using public transport by 2041, river transport has the ability to ease the pressure valve in certain bottlenecks in the public transport network, build in another layer of resilience in the face of climate change and security pressures, provide critical links for the city and reconnect locals and visitors alike to the rich cultural heritage of the river. However, as a mode it has its own unique challenges, having to deliver services within complex marine environments and operational and industry requirements which need to be considered.

1.3.1 The future outlook for growth is positive

London's population is expected to increase by 70,000 every year, reaching 10.1 million by 2041, a projection that has only eased slightly since the pandemic (GLA Economics, 2023). The Thames transects several opportunity areas (OAs) as outlined in the London Plan, which are locations with development opportunities to accommodate new homes, jobs and infrastructure of all types. These OAs are linked to existing or potential improvements to public transport and typically each have capacity for at least 5,000 new jobs or 2,500 new homes, or a combination of the two. As shown in Figure 5, OAs include areas such as Isle of Dogs, Greenwich Peninsula, Charlton Riverside, Royal Docks and Beckton Riverside, Thamesmead and Abbey Wood and London Riverside (Barking Riverside in Barking and Dagenham).

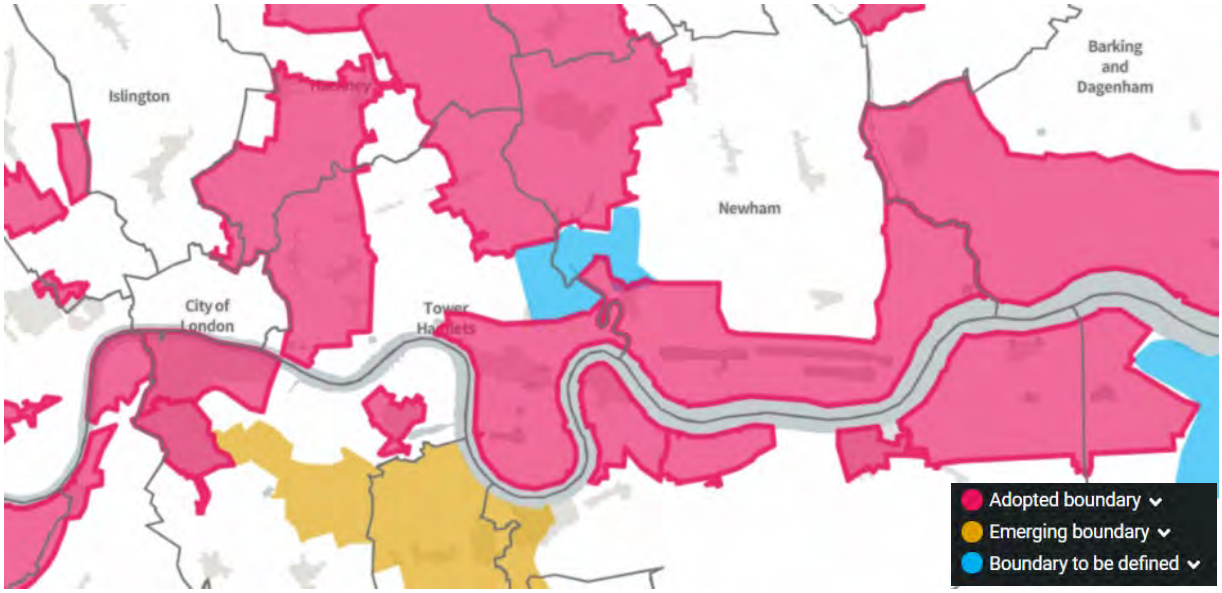


Figure 8: Opportunity Areas (Greater London Authority, 2021)

1.3.2 Existing technology, challenges and opportunities

Due to the concentration of many diesel-powered vessels in a relatively small area, the level of air pollution from river traffic in and around the riverbanks is notably high. In 2019, a sum of £500,000 from the Mayor of London's Air Quality Fund was allocated to initiatives aimed at reducing pollution generated by boats on the tidal Thames. These initiatives included modifications to commercial and passenger boats to lower emissions, particularly of particulates and nitrogen oxides.

Despite the high proportion of diesel-powered vessels on the Thames, new zero-emission technologies are gathering pace. In September 2023, London's largest river bus operator (Uber Boat by Thames Clippers) introduced Europe's first hybrid high-speed passenger ferry, along with the first of three new passenger ferries designed to operate with zero tailpipe emissions in Central London. These ferries emit 90% less pollution compared to traditional ferries that rely on marine diesel fuel. They are powered by batteries in the Central Zone, representing the current state of available technology, where zero-emission ferries are best suited for shorter river crossings.

Investment in decarbonisation continues in both the public and private sector. We understand that Thames Clippers has secured funding from the Department for Transport (DfT) to conduct research and development into environmentally friendly river transport, including the exploration of new power and propulsion technologies and other schemes aimed at reducing emissions. In 2023, the Department for Transport announced an allocation of £34 million in funding to support efforts to decarbonize the maritime sector, with a specific focus on advancing new technologies in the field.

1.3.3 Summary of context

River crossings continue to have an impact on London’s geographic and economic development. New ferry crossings are lower cost than bridges and can be quicker to develop and better integrated with the streetscape. As such, they can boost housing and commercial activity in London’s riparian Opportunity Areas, and zero emission ferries can provide an exemplar demonstration of new emerging technology. As such, potential funding for zero emission ferry services exists from developers and decarbonisation sources, as well as traditional sources of government funding.

2. Strategic case

2.1 The case for river crossings

The introduction of ferry services across the Thames aligns with policy objectives from a range of stakeholders including transport bodies, local planning authorities and national and regional government as reviewed in Section 2.2. It will improve connectivity of London's transport network, mitigate severance issues and support anticipated growth and development in London as outlined below:

Improve the connectivity of London's transport network

The Thames provides both an opportunity and a hinderance to achieving a connected London transport network. It currently acts as a barrier for those travelling in a northerly or southerly direction and a conduit for those travelling east to west. A ferry crossing could provide access where bridges or tunnels are sparce, connecting public transport and cycling routes north and south of the river, and can help to provide a fully integrated transport system. The Mayor and the GLA are committed to improving the connectivity of the London transport network particularly in areas where there the public transport offer is poor, such as east London (Mayor of London, 2018).

Mitigate severance issues

Severance in an urban context refers to the division or separation of communities due to the presence of large natural or manmade barriers such as highways, railway lines or rivers. Local residents can experience negative consequences including reduced access to services, jobs and amenities, and social isolation. The local economy can also suffer with businesses have limited customer accessibility. Shuttle ferry services can provide a link across the river that help address these issues for both existing and new developments. Both the London Plan and the Mayor's Transport Strategy include a commitment to dealing with severance issues (Mayor of London, 2018). An example of the significant effects of severance can be seen in a recent consultation by TfL looking at new river crossings, which found that resolving severance issues in East London can increase the access to jobs for residents by 148%, 231% and 211% in Thamesmead, Erith and Belvedere respectfully (Transport for London; Cabinet Member for Regeneration, 2014).

Support the growth of residential development, especially in east London

London is a growing city, with the population set to reach 10.1 million by 2044 (GLA Economics, 2023). To accommodate this, large residential developments are being brought forward, particularly in east London where the decline of the riparian industries provides opportunity. Developments such as Thamesmead and Silvertown are next to the river which currently severs these communities. TfL and the GLA have recognised this issue and support the creation of new ferry services that provide connectivity for riverside commercial and residential developments (Transport for London, 2019).

Relieve congestion and overcrowding on popular travel corridors

Growing population and commuting patterns and a lack of effective planning are jeopardising the ability of the river crossings to connect north and south effectively. As the closure of Hammersmith bridge showed, London's transport network is vulnerable to the closure of river crossings and lacks the resilience that would be provided by high capacity, multi-model, multi-location crossing infrastructure (Greater London Authority - Transport Committee, 2021). Some existing routes across the Thames are at capacity, for example both Canada Water and Canary Wharf stations are experiencing significant overcrowding issues. Ferry services offer an alternative transport option that both provides resilience and additional capacity to existing services.

Increase the use of active travel or public transport

The central focus of the Mayor's Transport Plan is to increase active and public transport trips, to achieve the target that 80% of all trips in London are made on foot, by cycle or using public transport by 2041. By being designed with walkers and cyclists in mind and integrating with the Thames Path, other routes, and key attractors, shuttle ferries can act as a catalyst to increase the use of active travel and public transport. The services will also providing a pleasant way to cross the river, benefitting from natural light and panorama, and provide active travel users with a natural

resting point on their journey. At the same time, additional cycling and walking traffic will help improve perceptions of safety for other waterfront users, especially women, and particularly after dark.

Reduce emissions

By providing an alternative mode of transport and reducing the number of vehicles on the road shuttle ferry services can help reduce emissions and improve air quality, especially in areas outside of central and inner London, that are dominated by private car use. River transport is currently exempt from ULEZ. Ferries, like other forms of public transportation, can move large numbers of people efficiently and produces lower emissions per passenger compared to private vehicles. The DfT Maritime Strategy includes an aspiration to have all domestic ferries zero emission by 2050 (Department for Transport, 2019), and newer electric or hybrid-electric ferries, being explored in this study, can operate with significantly lower emissions than traditional diesel-powered vehicles.

2.2 Vision for the ferry services

These objectives lead us to a vision for the new ferry services, in terms of how it would appear to the user. These characteristics have formed the basis of our benefit and cost modelling (in the Economic case) and operational model (in the Management case), later in the report.

- At least a 16-hour operating day (7.00 – 23.00 considered initially, but opportunity to extend these hours).
- A turn up and go, ~10 min frequency. We note that cyclists and pedestrians are sensitive to wait times, and also note the counter-point that a pause for a ferry can serve as a useful rest stop and point of interest on a meandering leisure journey. See Management case for more details on service operations.
- Integrated with local active networks. The piers should be visible from the local streetscape and where possible, integrated with new developments. Local feeder cycle and pedestrian networks, especially the Thames path, should include wayfinding. We have included an allowance for some landside infrastructure upgrades in our capital costs in the Economic case.
- Well-lit and safe access, especially at night. This includes feeder routes. We have allowed for the costs of the piers and vessels to be staffed during operational hours.
- Walk / roll on and roll off access for walkers / cyclists. This includes wide boarding areas, to reduce dwell time, as per the vessels operational in Amsterdam (see case studies in Table 17).
- Accessible service with low fares. It is important that the services are physically and financially accessible. Vessels and piers will offer level boarding. To make the services attractive to all users, it is important that fares remain relatively low, and we have modelled a range of fares scenarios to determine what the impact is on demand and on funding requirements.
- Integrated with existing systems. The new services will carry TfL's roundel logo and be integrated with other aspects of the London transport system, including appearing on maps and journey planners, being part of the Oyster / Contactless payments system, as well as Pay As You Go price capping (PAYG).
- A local landmark / attractor for wider river access. In some of the locations that we researched as part of this report, there are few reasons to visit the riverside, and if there are, there are few points to pause or socialise. The vision is for the piers and ferry services themselves to be a local attractor, and point of interest, such that they offer non-ferry users an opportunity to access the river, and in doing so, provide informal security to others.

2.3 Policy review

This section summarises key findings from a rapid review of reports and studies relevant to the introduction of ferry services across the Thames. A brief description of these and other documents and an explanation of their relevance to this study are included in Table 3.

Table 3: Policy Review

Document	Summary
National	
Maritime 2050: Navigating the Future **(Department for Transport, 2019)**	The DfT Maritime Strategy provides a long-term strategy for the maritime sector in the UK. It includes an aspiration to have all domestic ferries zero emission by 2050. It is also **supportive of the idea of river services** playing an increasing role as an alternative to road transport. If there is compelling evidence of the benefits of this, such as passengers avoiding traffic congestion or overcrowding on other types of public transport, then it will support industry proposals.
Clean Maritime Plan **(Department for Transport, 2019)**	This document outlines the pathway to achieving zero emissions shipping in the UK and is the environmental route map of Maritime 2050. This includes an **aim to have all domestic ferries zero emission by 2050**. The document is due to be updated in 2023.
Domestic maritime decarbonisation: the course to net zero emissions **(Department for Transport, 2022)**	This consultation was published by the Department for Transport to gather evidence on the proposed pathway to transport decarbonisation, the barriers preventing it, and the potential economic and regulatory interventions. It explored technical, operational and policy options available for government to accelerate decarbonisation in the transport sector. It outlines that the most common barriers preventing maritime decarbonisation are economic and structural. This includes inadequate access to capital investment which is required to decarbonise, either through retrofitting existing vessels or purchasing new, zero emission vessels. Additionally, there is a lack of private sector investment and limited collaboration between government departments with stakes in decarbonisation resulting in limited space for maritime industry input. **The suggested sub-sectors for which the emissions may be easier to abate included the ferry sector and workboats serving offshore wind, oil and gas installations. These are considered as having the most potential to act as first movers in decarbonisation**.
Regional	
Mayor's Transport Strategy **(Mayor of London, 2018)**	The Mayor's Transport Strategy sets out how the city can change the transport mix across London to **reduce the city's dependency on cars and encourage walking, cycling and green public transport**. The document sets out an intention to investigate the feasibility of new **cross-river ferry services**, including services between the Isle of Dogs and North Greenwich and an extension of river transport services to Barking Riverside to connect key growth areas with Canary Wharf and other new developments in east London. The strategy also makes a commitment to improving the energy efficiency of the river fleet and reducing air pollutants and CO2 emissions.
London's Environment Strategy **(Mayor of London, 2018)**	This strategy sets out the policies and actions that will **improve the quality of air in the capital, clean up the natural environment and decarbonise energy sources**. The increased use of waterways for passenger services is supported, including increasing leisure use. At the same time, the mayor plans to work with government and relevant groups to reduce emissions from activity on London's waterways.
London's Passenger Pier Strategy	The London Passenger Pier Strategy sets out the Mayoral and Port of London Authority's (PLA's) vision for the role of piers in supporting London's growth,

(Transport for London, 2019)	particularly in east London. This includes **encouraging the use of piers and river services for commuting, leisure and tourism and improving integration with other transport modes and the Thames Path**. It also commits to pursuing environmentally sustainable piers which generate their own energy and facilitate low emission vessels.
The Vision for the Tidal Thames **(Port of London Authority, 2016)**	This document sets out the vision for the Thames over the next 20 years (since publication). This includes **doubling the number of commuter and tourist trips every year from 10 million to 20 million**, encouraging the uptake of green technologies to reduce the port's environmental impact, and creating a riverside that is a centre of culture and a magnet for ramblers, historians, artists and others.
Thames Vision 2035: Achieving safe and sustainable growth of river passenger transport **(Arup, 2020)**	This report, written by Arup and Populus on behalf of PLA, identifies options to achieve safe and sustainable growth in passenger journeys on the Thames in London, Kent and Essex. **The goal of the PLA is to double passenger transport from 10 million in 2018 to 20 million in 2035**. This is to be achieved with climate change and the environment in mind to enable the Thames to become the cleanest since the industrial revolution.
Thames Vision 2050 (Port of London Authority 2022)	This document outlines the vision for Thames in 2050, specifically as the UK's leading port, central to the nation's economy, with net zero emissions. A clean river, free of pollution and rubbish, **supporting more sport, passengers, and freight**. A resilient Estuary, adapting to climate change and richer in wildlife. A more diverse Thames, providing jobs, learning and enjoyment to the whole community, and always, everyone, staying safe.
PLA Strategy **(Port of London Authority, 2017)**	The PLA strategy has been updated to reflect the Thames Vision. It includes a commitment to seek **investment opportunities to increase river use** and PLA revenues and an aim to ensure Local authorities are 'thinking Thames' when developing local plans.
Air Quality Strategy for the Tidal Thames **(Port of London Authority, 2018)**	This strategy aims to reduce river-based pollution and emissions on the tidal Thames whilst **facilitating growth in passenger and freight transport** in line with the Thames vision. Policies such as the green tariff aim to encourage voluntary reduction of emissions beyond what is legally prescribed. There is also an ambition to engage with planners, developers, the riparian boroughs, GLA, ECC & KCC to encourage the use of the river, while enabling best practice and improvements in air quality.
The London Plan **(Mayor of London, 2021)**	This strategic plan outlines the spatial development framework for London, encompassing economic, social, transport, and environmental aspects. It emphasises the **need for investment in river crossings, stating that the lack of such crossings is hindering growth and development**. Furthermore, it encourages policies which support mode shift from cars to public transport and active travel. The plan **encourages the prioritisation and inclusion of river crossings in development decisions and plans, recognising their significance as a tool to unlock growth areas.** As part of this study, several potential crossings listed in this plan have been evaluated. It also emphasises the importance of maximising the social, economic, and environmental benefits for London while considering the emerging Marine Spatial plans. **It recommends giving priority to the development of new river crossings in East London and notes the mayor's ambitions for Net Zero in London.**
London's ageing river crossings **(Mayor of London, 2021)**	Thames river crossings are identified as being crucial to the resilience of London's Road network. Whilst this report largely relates to bridges, it identifies the **need and role of river crossings as part of London's transport network.** This report includes recommendations such that: TfL, the Government and all impacted boroughs should consider formalising the Thames River Coordination Group to oversee maintenance of river crossings, and opt-in for a collective fund for maintenance.

Local	
Royal Borough of Greenwich Carbon Neutral Plan 2021 - 2030 **(Royal Borough of Greenwich, 2021)**	The Greenwich carbon neutral plan (2021-2030) outlines the borough's actions to achieve carbon neutrality by 2030, aligning with the 1.5°C global temperature rise limit. **In the Transport theme, their ambition is to promote walking and cycling within the borough and improve cycle access at vital river crossings**. Collaboration with the Greater London Authority and Transport for London is envisioned for these projects, suggesting potential joint ventures.
Royal Borough of Greenwich Transport Strategy, 2022-2032 **(Royal Borough of Greenwich, 2022)**	The Greenwich Transport Strategy presents the borough's vision and policies aimed at achieving net-zero emissions while creating an appealing, accessible, and sustainable transport network. Positioned under the broader corporate plan and carbon neutral plan, the strategy aligns with existing policies, including the borough's Local Development Framework. Noteworthy policies include enhancing north/south and orbital connections**, enhancing public transport in the waterfront zone**, introducing new river crossings, and promoting greater river utilisation.
Royal Greenwich Local Plan **(Royal Borough of Greenwich, 2014)**	This document details the local plans to sustainably grow and develop the built environment in the Royal Borough of Greenwich, outlining the vision for Greenwich, the spatial strategy, and detailed strategic policies. Under the Infrastructure and Movement chapter, the plan states that the borough will support transport schemes which are critical to development, including advocating and partnering with agencies to deliver new river crossings in East London. Specifically, improved transport infrastructure in Thamesmead, Charlton Riverside and Greenwich Peninsula, which mirrors the options considered as part of this study. Furthermore, the local plan outlines the borough's **support for active travel schemes and provision of enhanced walking and cycling routes which can improve accessibility.**
Newham Local Plan **(Newham London, 2018)**	The Newham Local plan sets out the overarching vision and detailed policies to be implemented in the borough up to 2033. It outlines its objectives to develop **the Royal Docks area into a high-quality waterfront mixed use urban quarter using new strategic infrastructure such as river crossings.**
Tower Hamlets Local Plan **(Tower Hamlets, 2019)**	The Tower Hamlets Local Plan sets out the borough's plans and policies related to infrastructure provision and spatial planning. It sets out the borough's vision for the future up to 2031, highlighting the need to generate benefits for all of its residents. The first key objective outlined in this document sets out the vision for managing growth in the borough and shaping change. Under this key objective, the borough **states its support of additional transport investments, including new river crossing opportunities, and active travel connections**. It outlines two potential river crossings as proposed schemes, including the Greenwich Peninsula to Isle of Dogs crossing, as well as the Rotherhithe to Limehouse.
Barking & Dagenham Local Plan (Barking & Dagenham, 2023)	The Barking & Dagenham local plan sets out the spatial and development vision for the borough up to 2035. It captures the character, opportunities, constraints, and broad principles for development of each sub-area, identifying the potential development sites for housing, employment, and other uses. Under the borough's 'Better integrated transport infrastructure' statement, the borough sets out its **commitment to the improvements of cycle and pedestrian facilities and the delivery of new services such as new river crossings.**

2.4 Project objectives

The review of local, regional, and national policies, strategies and plans has helped inform the development of six project objectives that inform sifting criteria for potential locations. These project objectives align with the Mayor's objectives to meet the challenges of economic and population growth, as an internationally competitive and successful city making the most of its rich heritage and cultural resources. This includes the Thames, London being a city that delights the senses, leveraging natural environments and waterways to realise the potential for improving Londoners' health, welfare and development and most importantly a city where it is easy, safe and convenient for everyone to access jobs, opportunities and facilities, encouraging active travel and making better use of the Thames (Mayor of London, 2016). The project objectives are as follows:

1. **Supports the community**: Services the existing community, including areas of higher deprivation, servicing an area with large population catchment with potential to drive high demand.
2. **Enables growth**: Potential to support developments/ opportunity areas**.**
3. **Addresses a network gap**: Addresses a gap in the existing public transport network, improves overall public transport accessibility and provides travel time savings.
4. **Integrates with the broader network**: Integrates with existing active and public transport infrastructure to provide users with seamless journeys.
5. **Provides congestion relief**: Connects key locations on an active travel desire line and provides congestion relief.
6. **Reduces carbon emissions**: Reduces carbon emissions through promotion of green mobility – active travel and low-carbon public transportation.

2.5 Sifting criteria

The sifting criteria was developed in line with the policy findings in Section 2.2, including the Mayoral objectives, such as net zero ambitions and sustainable transport targets. The sifting criteria was centred around four key categories:

1. **Technical viability**: The feasibility of the site given engineering constraints, tidal conditions, navigational considerations, crossing distances, wind, and wave conditions.
2. **Environment and consents**: The environmental and biodiversity impacts of the site, with consideration of permits and consents required to deliver it.
3. **Cost**: The relative construction and operating cost of the option, considering existing infrastructure.
4. **Strategic fit**: How strategically suitable is the option when considering its impact on the community and network. This includes the impact on disadvantaged communities, the size of the potential user base, the potential to support developments/opportunity areas, the existing gap in the local transport network, the options integration with active travel infrastructure, and the congestion relief it can potentially provide to the local transport network.

A baseline assessment was developed for each potential option. The assessment was conducted using a range of sources which included the 2021 ONS Census, TfL's PTAL accessibility score, Index of Multiple Deprivation, PLA hydrographic services: charts and surveys and tide tables, Defra MAGIC Map and the British Geological Survey (BGS) Geology Viewer. Each option was then given a rating on a three-point scale (1-low to 3-high) based on the baseline assessment.

2.6 Options generation and initial sift

A range of river crossing locations were explored to develop the initial long list of options. The long list of options focused on locations from in local plans, prior river crossing studies as well as locations identified by the consultancy team and PLA. The long list of options was narrowed down into a short-list of three options using four equally weighted sifting criteria.

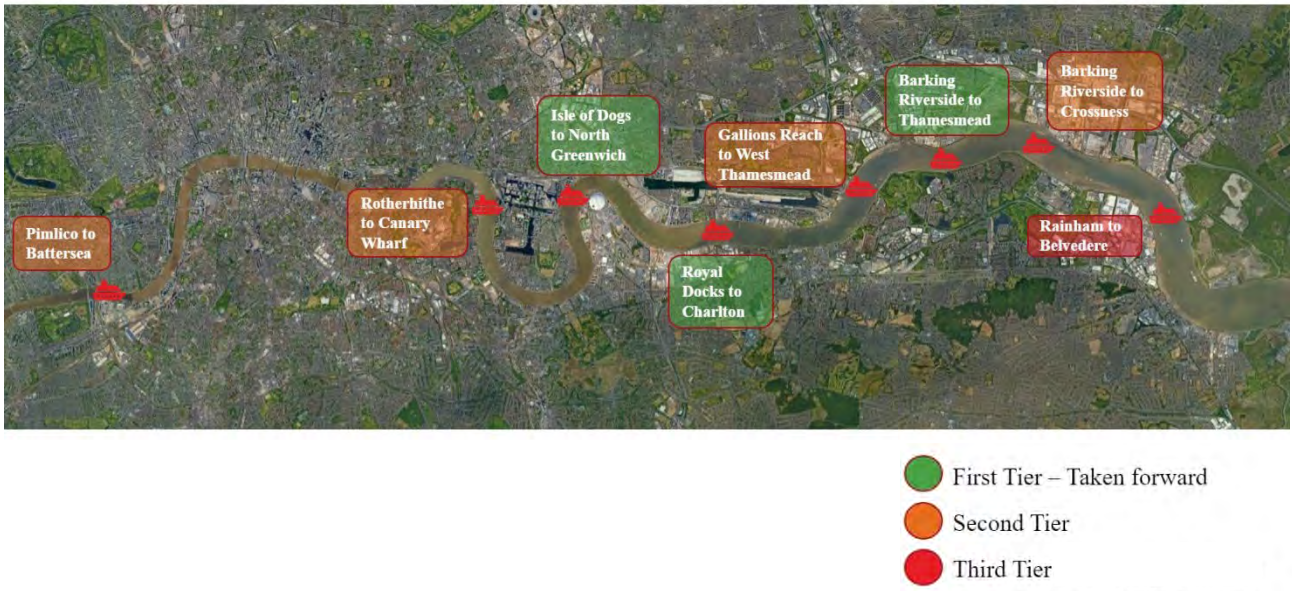


Figure 9 Sifting overview

The outcomes of this sifting process were taken forward in the economic analysis (Section 3). A detailed overview of the long-listed options review is available in Appendix A.1 including the scores provided for each location across the sifting criteria outlined in Section 2.4.

Table 4 Inital sift outcome summary

Crossing	Decision	Rationale summary
Pimlico - Battersea	Second tier Not taken forward	This crossing would not significantly improve cross-river journey times due to the proximity to existing crossings such as Chelsea Bridge. Additionally, this crossing is less technically viable as there is less space to accommodate accessible pier infrastructure, reduced distance to sufficient water depth and shorter crossing distance.
Rotherhithe - Canary Wharf	Second tier Not taken forward	The proposal in this location would be an upgrade to the existing RB4 service, with electrification and improved cycle access. There is no significant network gap at this location, and the existing crossing route takes approximately 6 min by the RB4 ferry link. Additionally, the existing service means that opportunities for growth are muted. Similarly to the Pimlico to Battersea option, this crossing is located at the narrow part of the river, creating challenges for accommodating accessible pier infrastructure.
Isle of Dogs - North Greenwich	Taken forward	See detailed overview in section 2.5
Royal Docks - Charlton	Taken forward	See detailed overview in section 2.5
Gallions Reach - West Thamesmead	Second tier Not taken forward	There are some issues with technical viability in this option, particularly with the location being within the Thames Barrier control zone, as well as the entrance to Royal Docks being used occasionally for access by large vessels. The relative cost of this option is high given the need for new landside approaches and structures. This option would provide minimal congestion relief on the RB1 Ferry route, Woolwich Ferry and Woolwich Tunnel.
Barking Riverside - Thamesmead	Taken forward	See detailed overview in section 2.5
Barking Riverside - Crossness	Second tier Not taken forward	There is a lack of existing public and active transport links for this option, meaning that integration with the existing network would be poor and this option would need extensive supporting infrastructure. Additionally, there is currently industrial land on both sides, and a low population catchment yielding low potential demand.
Rainham - Belvedere	Third tier Not taken forward	New piers are required on both sides, and both sides are industrial and would require landside approaches. Since the sites are mostly industrial, there is a low population catchment, and hence lower potential demand. There is a lack of existing public and active transport links, meaning that integration would be poor and this option would need extensive supporting infrastructure.

2.7 Shortlisted options

2.7.1 Isle of Dogs - North Greenwich

Ridership

Isle of Dogs - North Greenwich was shortlisted as it addresses a current network gap for pedestrians and cyclists. It is located along a desire line, particularly between key employment areas in Canary Wharf and the Greenwich peninsula. It also supports a leisure and tourist function through provision of an additional link to the O2 Arena. The proposed crossing is shown in Figure 7, with a new pier on the northern (Isle of Dogs) and southern (North Greenwich) side.

Figure 10: Crossing 1 – Isle of Dogs - North Greenwich site layout. The red squares indicatively show the possible locations for the new piers (subject to detailed viability assessment and consent).

Technical viability

The river at this location is wider (370m approximately) relative to the upstream sites, therefore providing more space to accommodate the infrastructure required for this crossing without affecting the existing navigational channel. On the south side, there are three existing piers – Delta Wharf Pier, Ordnance Wharf Pier and North Greenwich Pier. Using North Greenwich Pier was discounted as travel time would be excessive. Both Delta Wharf and Ordnance Wharf piers are piled structures and their level is fixed which made them accessible at certain tide levels only. It is assumed that the new pier needs to be accessible at all tide levels. Therefore, Delta Wharf and Ordnance Wharf are unlikely to be incorporated as part of the new facilities and were discounted. There are no existing assets that could be used for the crossing on the north side. Therefore, two new piers are required at this site.

The opportunity of modifying the existing piers (by adding a brow, brow landing and pontoon) is to be considered as part of the feasibility study. Based on an initial review, the location of the new piers is proposed as follows.

Between the South West India Docks and Blackwall Yard, the waterfront is privately owned, with some public access. The area between South West India Dock and Blackwall Entrance is a Conservation Area and

therefore, extensive planning applications controls would be required. The area upstream of South West India Dock presents better connectivity with the wider transport network and accessibility. The new pier concept would be subject to simulation and pilot involvement to assess visibility and navigational safety, as well as consultation with the South West India Dock.

On the south side, following discussion with PLA, Ordnance Wharf area was discounted due to restricted visibility by being located on the river bend. The area downstream of Delta Wharf pier is well connected with the wider transport network. For these reasons, it is assumed that the new pier will be located downstream of Delta Wharf pier.

It is assumed that the location of the new piers is such that adequate water depth (at least 2m) is available to access the pier at all tides (Figure 11).

Navigational constraints to be considered at this location include the turning circle at Southwest India Dock, interface with through traffic including larger ships and visibility at the river bend and at the Southwest India Dock Entrance. The assumed vessel trajectory is shown indicatively in Figure 11.

In addition to the new piers, new vessels and an upgraded power supply is required.

Initial preferred route

Based on the above, at this early stage our preferred route is from a position close to the car park and pumping station on the Isle of Dogs side, to a position just to the north of the existing Delta Wharf pier on the North Greenwich side. All locations are approximate and a further feasibility study is required to confirm the form and location of the new piers.

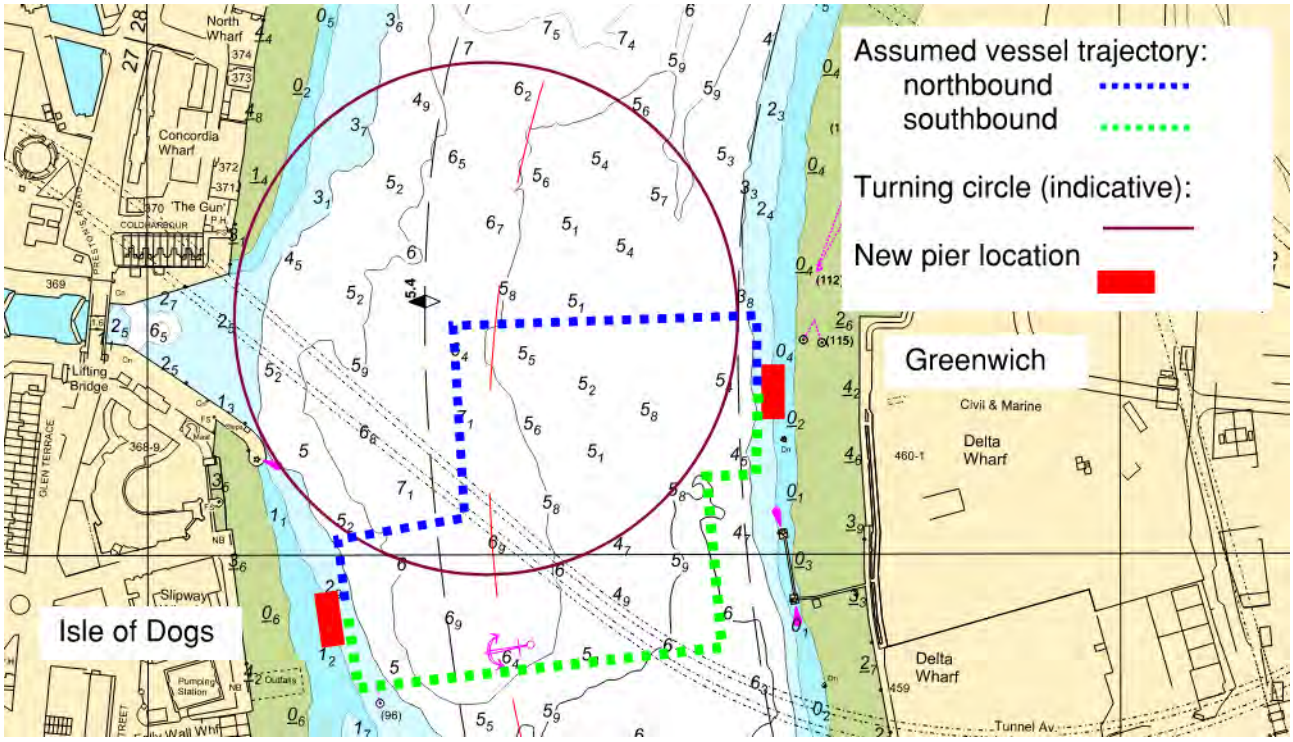


Figure 11: Crossing 1 - Isle of Dogs - North Greenwich – Water depth at proposed pier location (depth in metres and reduced to Chart Datum which is approximately the level of the Lowest Astronomical Tide), assumed vessel trajectory, navigational channel and turning circle [Base map extracted from: Port of London Authority navigation charts - Greenwich Reach to Blackwall Reach]

Environment and consenting

This option is expected to have moderate consenting risk due to relatively onerous visual planning context when compared to other options. Due to the proximity to Blackwall tunnel and Jubilee line tunnel, permits from Transport for London may be required. The proposed location for the new piers minimises the risks associated with the requirement of permits from Transport of London due to the distance between the proposed piers and the tunnels. In addition, the listed buildings between the Southwest India Dock Entrance

and Blackwall Basin Entrance (north side) and landownership risks will require consideration. Planning permission will be required for the construction of the new structures.

Strategic fit

This crossing provides strategic fit with the project objectives:

- **Policy alignment:** The location of the proposed crossing within the Royal Borough of Greenwich and the Borough of Tower Hamlets, aligns with each local authority's policy ambitions, enhancing public transport in the waterfront area and developing new river crossings to increase the use of the river.
- **Potential demand**: There is a large population catchment and high potential demand for this crossing on both sides of the river. This is driven from surrounding employment centres in Canary Wharf on the northern side and attractions in and around the popular O2 Arena on the south side which is likely to drive demand for the crossing.
- **Supports future growth:** This proposed crossing spans two opportunity areas, namely the Greenwich Peninsula opportunity area in the south and the Isle of Dogs opportunity area in the north (Figure 7). In addition to this, there are several large, planned and existing regeneration projects including the Canada Water redevelopment (British Land, 2023) and the Canary Wharf central business district, providing over 1.5 million square metres of office and retail space.
- **Supports deprived communities:** According to the Indices of Multiple Deprivation (IMD), this crossing is likely to yield benefits for deprived communities, with surrounding neighbourhoods on the south side being within the 20% most deprived neighbourhoods in the UK. The neighbourhoods on the North side are within the 40% most deprived neighbourhoods in the UK (MHCLG, 2019).
- **Addresses a network gap:** This crossing does not address a significant network gap for pedestrians, given existing links via the Jubilee line and the Cable Car. However, it would do so for cyclist. And it will provide users with additional options and reduce congestion on existing routes, reducing the expected pier to pier journey time for a pedestrian (via Greenwich Foot Tunnel that would not take the Jubilee line) by approximately 60 minutes. A ferry crossing at this site would improve overall accessibility as Isle of Dogs is currently relatively poorly connected when compared to the neighbouring Canary Wharf area. Additionally, on the southside, the North Greenwich area has very poor connectivity, with a PTAL score of 0 (Transport for London, 2023).
- **Integration with broader network:** This crossing will integrate well with existing public and active transport links – connecting the C3 cycle lane on the north bank to the Q14 route on the south bank (Transport for London, 2023). It would also link to the Thames Path walking route on the south bank, although there is no path on the north bank at this point on the river. There is a reasonably frequent bus service on both sides, and the north bank is very well connected to the tube and DLR network. The North Greenwich pier is close to a Jubilee line connection. This broad network integration would allow for interchange opportunities for users to range of destinations.

2.7.2 Royal Wharf - Charlton

Ridership

Royal Wharf - Charlton was shortlisted as it addresses a current network gap for pedestrians and cyclists, providing new links to future developments at Charlton Riverside and Silvertown, and onwards to the Royal Docks area to the north of Royal Wharf. The proposed crossing is shown in Figure 12, with use of existing Royal Wharf pier on the northern side, and a new pier in Charlton (southern side).

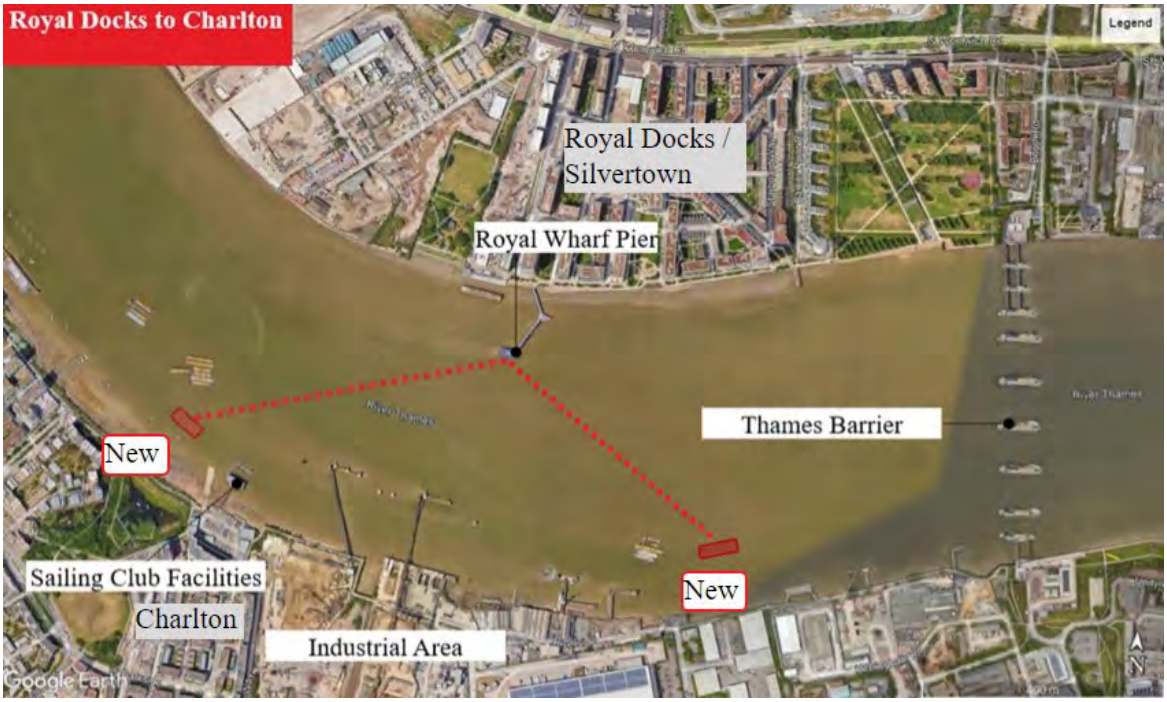


Figure 12: Crossing 2 – Royal Wharf - Charlton. The red squares indicatively show the potential locations for the new pier (subject to detailed viability assessment and consent).

Technical viability

The river at this location is wider than the upstream sites (475m approximately), meaning that there is more room to accommodate infrastructure without interfering with the navigational channel, but more onerous infrastructure is required when compared to upstream sites to reach suitable water depth. There is considerable navigational activity at this site due to the presence of two large aggregate berths, Greenwich Yacht Club and yacht moorings and Cory's barges. There is potential to use Royal Wharf pier on the north bank, though modifications may be required. A new pier is required on the south bank (Charlton Pier).

A feasibility study is required to confirm the form and location of the new pier and the viability of using or adapting Royal Wharf pier. An initial review was undertaken to determine the location of the new pier on the south side.

Upstream of the site there is North Greenwich Pier, the use of North Greenwich Pier for this crossing was discounted as travel time would be excessive. Using the existing facilities at Greenwich Yacht Club was considered, however, discounted as access to the river will need to be through the Yacht Club premises and would be tidally restricted. For accessibility reasons, it was decided that the new pier was to be located outside the industrial area (limiting interface with the industrial berths), upstream of the Greenwich Yacht Club. The proposed location is in close proximity to current developments such as Silvertown where connection with the wider transport network and accessibility is assumed to be adequate.

An alternative location for the new pier on the south side, downstream of the industrial areas, has also been considered. This alternative location is within the boundary of the Charlton Riverside development, but is in close proximity to the Thames Barrier. As such, consideration should be given to navigational constraints associated with vessels lining up for their assigned span within the barrier. The new pier concept would be subject to simulation and pilot involvement to assess visibility and navigational safety.

It is assumed that the location of the new piers is such that adequate water depth (at least 2m) is available to access the pier at all tides (Figure 13). The site poses some navigational constraints, including impact on the existing along-river traffic including large ships and interface with existing along-river ferry services.

In addition to a new pier, new landside approaches will be required to provide accessibility to the new pier, as well as new power supply and new vessels.

Initial preferred route

Based on the above, both new pier sites have merits as well as constraints. The eastern pier location is closer to the Charlton Riverside development, and if the operational constraints from proximity to the Thames barrier can be overcome, that would be our preferred option. However, at this early stage we have illustrated the route from the existing Royal Wharf pier on the north side, to a position close to Greenwich Peninsula Park and the Yacht Club on the south side. All locations are approximate, and a further feasibility study is required to confirm the form and location of the new piers.

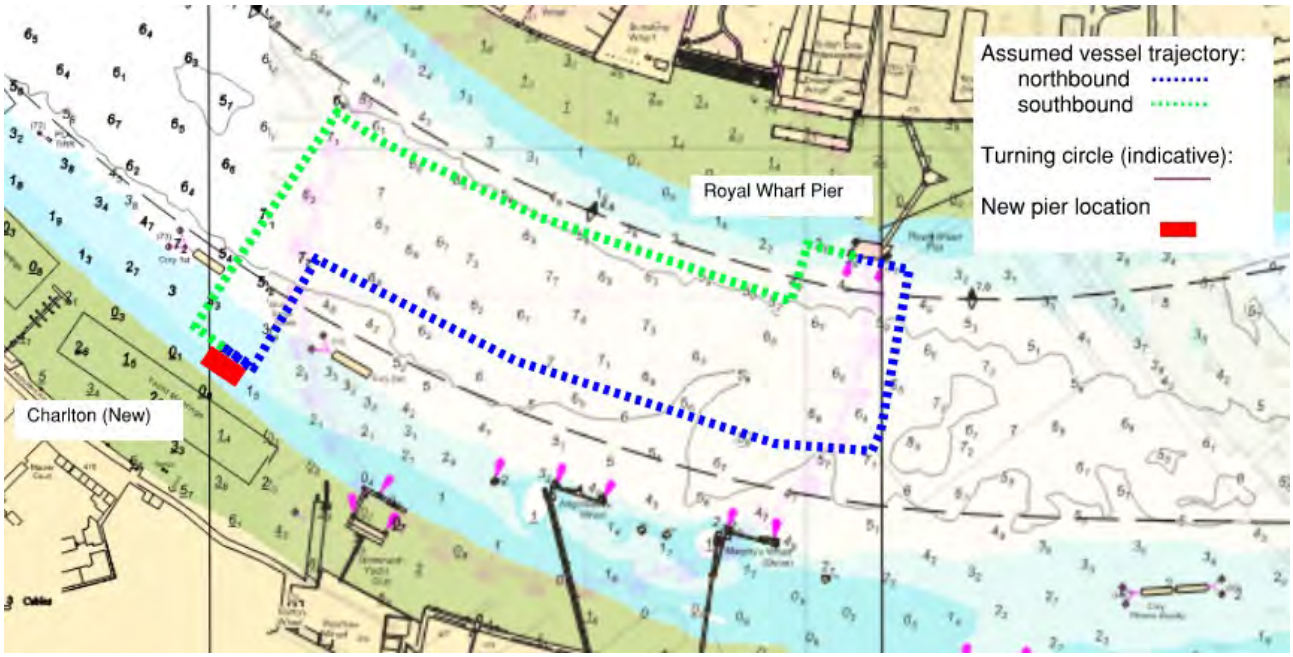


Figure 13: Crossing 2 – Royal Wharf - Charlton – Water depth at proposed pier location (depth in metres and reduced to Chart Datum which is approximately the level of the Lowest Astronomical Tide),, assumed vessel trajectory, and navigational channel [Base map extracted from: Port of London Authority navigation charts - Blackwall Reach to Bugsbys Reach and Woolwich Reach]

Environment and consenting

This crossing is expected to have low environmental impacts, it has less onerous visual planning requirements than upstream sites. Planning permission will be required to construct the new pier on the south side of the river, and potentially for modifications to Royal Wharf pier. Additionally, this site is within the Thames Barrier control zone, which means that it may require special permissions for construction and operational considerations from the PLA.

Strategic fit

This crossing provides strategic fit with the project objectives:

- **Policy alignment:** The location of the proposed crossing within the Royal Borough of Greenwich and the Borough of Newham, aligns with each local authority's policy ambitions, enhancing public transport in the waterfront area and developing new river crossings to increase the use of the river.
- **Potential demand**: This crossing is likely to yield a moderate population catchment and moderate potential demand. The area around Royal Wharf pier is medium-density residential. Royal Docks employment opportunities, and the Silvertown development are within walking distance. The western pier location on the south side is at the heart of the Charlton Riverside development. Retail / town centre facilities on the south side of the river in Charlton are a few minutes' walk inland, which may appeal to those accessing from the residential areas on north side.
- **Supports future growth:** According to the London Plan, both pier sites are within opportunity areas, namely the Royal Docks and Beckton Riverside opportunity area and the Charlton Riverside

opportunity area (Mayor of London, 2021). Both sites have several planned and recently completed developments, such as the Herringham Quarter (Buildington, 2023) on the south side, and Riverscape on the north side (Riverscape, 2023). The sites have several large industrial and professional employers and business parks, such as Tate & Lyle, London City Airport, and Ropery Business Park. The proposed crossing maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.

- **Supports deprived communities:** Royal Wharf is primarily residential and industrial, with social housing in developments near the riverside. On the south side, the land surrounding the proposed Charlton pier is primarily industrial and retail, with some housing located in Greenwich Peninsula. More broadly, Charlton falls within the 40% least deprived, and Royal Wharf in the 50% most deprived neighbourhoods in the UK (MHCLG, 2019).
- **Addresses a network gap:** The crossing is expected to address a moderate network gap, reducing the expected pier to pier journey time for a pedestrian by approximately 50 minutes, with the nearest existing crossing being either the Woolwich foot tunnel or Woolwich ferry. This would improve overall public transport accessibility on both sides of the river. Both Royal Wharf and Charlton have PTAL scores <2, indicating relatively poor connectivity (Transport for London, 2023).
- **Integration with broader network:** The proposed crossing is expected to integrate well with public and active transport links, including the Q14 cycle route (Transport for London, 2023) and Thames Path walking route (Transport for London, 2023). Since there is no major cycle route close by on the north bank nor a Thames Path route, this may encourage residents on the north side to use active travel. There is a reasonably frequent bus service on both sides, and the North bank is well connected to DLR network.

2.7.3 Barking Riverside - Thamesmead

Ridership

Barking Riverside - Thamesmead was shortlisted as it addresses a current network gap for pedestrians and cyclists, providing new links to future developments at Barking Riverside and Thamesmead. The proposed crossing is shown in Figure 7, with use of existing Barking Riverside Wharf and a new pier at Thamesmead (southern side).

Figure 14: Crossing 3 – Barking Riverside - Thamesmead. The red squares indicatively show the proposed locations for the new pier (subject to detailed viability assessment and consent).

Technical viability

The river is wider (580m approximately) at these proposed sites than upstream sites, with more space to accommodate infrastructure without interfering with the navigation channel. However, more onerous infrastructure is required to reach the required water depth when compared with upstream sites. There is considerable navigational activity at this site due to the presence of two large aggregate berths and Greenwich Yacht Club. There is potential to use Barking Riverside pier on the north bank, though modifications may be required. A new pier is required on the south bank (Thamesmead Pier).

A feasibility study is required to confirm the location and form of the new pier and the viability of using or adapting Barking Riverside pier. The new pier concept would be subject to simulation and pilot involvement to assess visibility and navigational safety. An initial review was undertaken to determine the location of the new pier on the south side.

There are no existing structures (on the south bank) that could be used for the crossing at this site. The proposed location for the new pier seeks to minimise any impacts on the current use of the Thameshaven Ship Tier by keeping it away from the vicinity of this asset. In addition, it considers future river accessibility and connection with the wider transport network provided as part of planned developments in the area e.g. Thamesmead masterplan. It is assumed that the new pier on the south bank will be located upstream of the pump station.

The proposed location of a new pier at the heart of the Thamesmead masterplan is such that adequate water depth (at least 2m) is available to access the pier at all tides. The site poses some navigational constraints, including impact on the existing along-river traffic including large ships, the cable tunnel upstream of Barking Riverside Pier, interface with existing along-river ferry services, Thameshaven Ship Tier, the new Cory barge moorings and increased traffic for the sites at Rippleway and Belvedere.

There is an alternative pier location on the south side, close to the Thamesmead cannons site, to the east of Thameshaven ship tier. This is closer to existing residential areas.

In addition to a new pier, new landside approaches will be required to provide accessibility to the new pier, as well as new power supply and new vessels.

Initial preferred route

The western pier location offers better integration with the Thamesmead development, although this may still be some years away. The eastern location pier location is closer to the existing residential development and offers a more direct route. At this early stage we have illustrated the route from the existing Barking Riverside pier on the north side, to a position at the heart of the proposed new Thamesmead development, and have used this as the basis for the remainder of the work in this report. However, our recommendation as that the eastern location is kept under consideration, and that a decision should be made based on timing of delivery of the Thamesmead development, among other factors. All locations are approximate and a further feasibility study is required to confirm the form and location of the new piers.

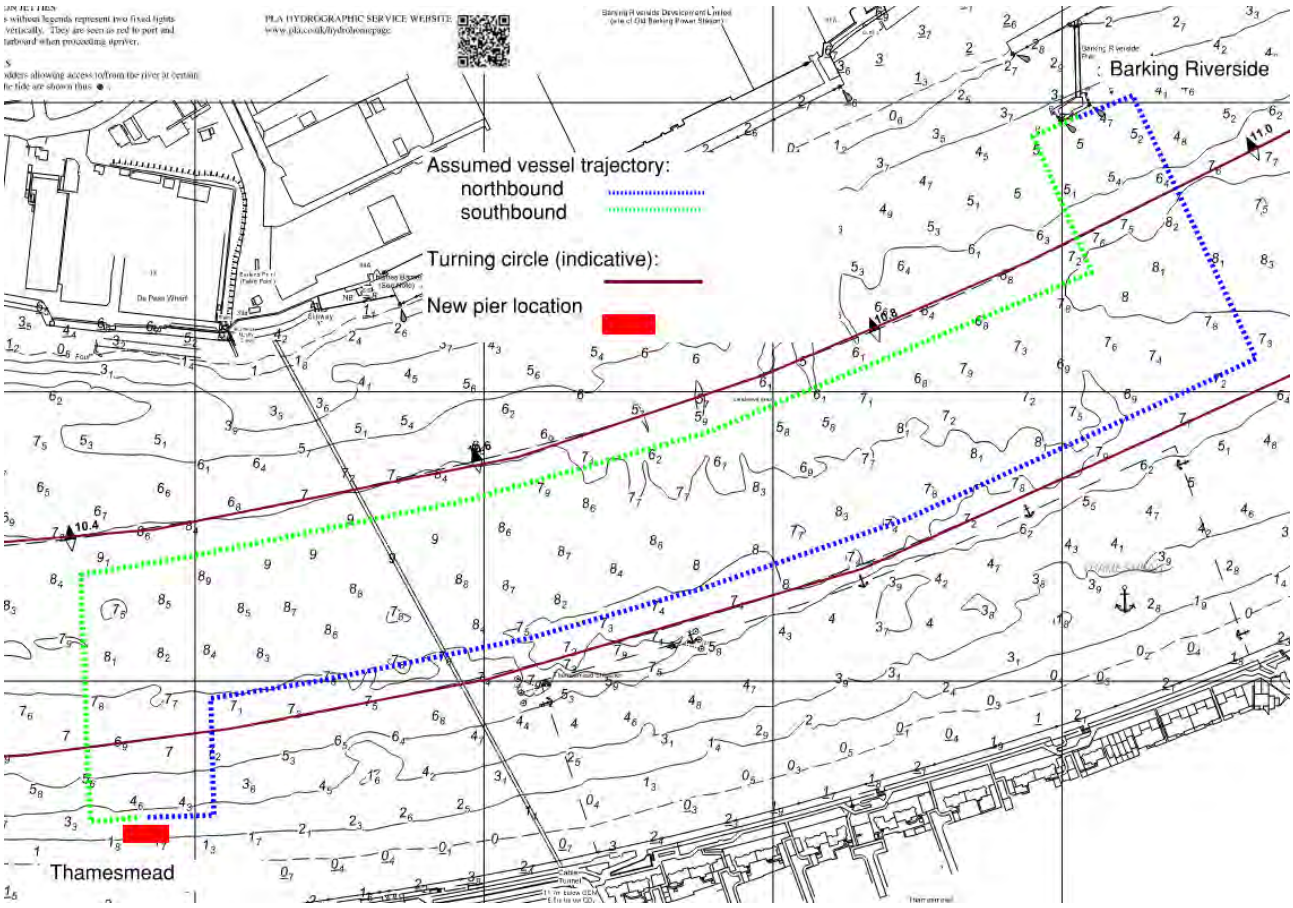


Figure 15: Crossing 3 – Barking Riverside - Thamesmead. – Water depth at proposed pier location (depth in metres and reduced to Chart Datum which is approximately the level of the Lowest Astronomical Tide), assumed vessel trajectory, and navigational channel [Base map extracted from: Port of London Authority navigation charts - Barking Reach]

Environment and consenting

This crossing is expected to have relatively low environmental and consenting requirements. Relative to upstream sites, this proposed option has less onerous visual planning requirements. There are some land-based designations including an SSI Impact Risk Zone. Additionally, planning permission is required for new structures on the south bank and potentially for modifications to Barking Riverside pier.

Strategic fit

This crossing provides strategic fit with the project objectives:

- **Policy alignment:** The location of the proposed crossing within the Royal Borough of Greenwich and the Borough of Barking & Dagenham, aligns with each local authority's policy ambitions, enhancing public transport in the waterfront area and developing new river crossings to increase the use of the river.
- **Potential demand**: This crossing is likely to yield a moderate population catchment and moderate potential demand as it links together two new developments with significant social housing: Thamesmead Riverside Development and Barking Riverside. Currently, there is a moderate existing population catchment and strong future demand given the planned development.
- **Supports future growth:** The crossing is likely to enable growth. According to the London plan, the sites are both within the Mayor of London's opportunity areas: London Riverside, and Thamesmead and Abbey Wood (Figure 1).
- **Supports deprived communities:** Both the north and south sites of this option are within the 30% most deprived neighbourhoods in England, suggesting that a new crossing is likely to be beneficial to these communities (MHCLG, 2019).
- **Addresses a network gap:** The crossing would reduce the expected pier to pier journey time for a pedestrian by approximately 60 minutes (via Woolwich ferry). A ferry crossing at this site would improve overall public transport accessibility, for both Barking Riverside (PTAL score of 0) and West Thamesmead (PTAL score of 2) suggesting relatively poor connectivity (Transport for London, 2023).
- **Integration with broader network:** The crossing could integrate well with public and active transport links, connecting the Q14 cycle route (south) and the C42 (north), providing more active travel options for residents on both sides (Transport for London, 2023). There is a reasonable bus service on both sides, and the Southbank connects to the proposed DLR extension.

2.7.4 Lower priority sites

Several sites were filtered out during the short-listing process for a range of reasons as outlined below. These sites could be further analysed and assessed in the future for their strategic fit and alignment to the project objectives.

Pimlico - Battersea
This crossing was considered a lower priority, given existing active travel crossings near the proposed crossing including Chelsea Bridge and Vauxhall Bridge, as well as constraints to infrastructure development and operations resulting from the location of existing piers. The crossing is situated at a narrow part of the river, with less space to accommodate accessible pier infrastructure which may impact navigation. There is also significant navigational risk with the interface between recreational users of the river and existing ferry services.

Rotherhithe - Canary Wharf
This option was considered a lower priority since it is not likely to generate opportunities for growth or address a current network gap. The river crossing between Rotherhithe and Canary Wharf is already served by an existing crossing via the RB4 ferry, operating at approximately 10-minute frequency. However, further work could be undertaken at this site to transition the existing service to a low-emission vessel and make it more accessible for the general public (including cyclists), as currently access to the pier is via the Hilton Hotel.

Gallions Reach - West Thamesmead
This crossing was considered a lower priority due to factors including low population catchment and constraints on technical viability which limit the feasibility of this option. This crossing would require new piers on both sides of the river, and related infrastructure needs such as power supply and landside approach will significantly impact costs. Additionally, the use of this site requires consideration of the entrance to Royal Docks which is used occasionally for access by large vessels requiring a turning area, as well as consideration for the Thames Barrier, given that this site is within its control zone (though not considered to be a limiting factor). The proposed pier sites are likely to experience low demand, given the low density industrial and retail environment on the north side, and the moderate population catchment on the south side.

Barking Riverside - Crossness
This crossing was considered a lower priority due a low existing population catchment, low potential demand, low technical viability, and high associated costs. This potential crossing is surrounded by industrial land/sewage treatment works on the south side of the river, making it unattractive to active travel users. Additionally, this crossing may require new piers on both sides of the river affecting cost (if existing Barking Riverside Pier deemed not suitable due to excessive travel time) . Management of the interface with along-river traffic including large ships is required.

Rainham - Belvedere
The lower prioritisation of this crossing was based on two primary factors: the low population catchment and potential demand, and the associated high cost due to more extensive infrastructure development. The location of the crossing was surrounded by industrial land on both sides of the river, indicating a limited residential population in the vicinity, hence a low potential demand for the crossing. Additionally, building a crossing at this location would have required substantial investment in new infrastructure, including the construction of new piers on both sides of the river. Management of the interface with along-river traffic including large ships is required.

3. Economic case

The aim of the economic case is articulate the benefits and costs of the shortlisted options and to carry out a value for money assessment. Our analysis follows HM Treasury Greenbook Guidance as well as DfT's Transport Analysis Guidance (TAG) principles appropriate at the Strategic Outline Business Case (SOBC) level.

Note that the project is at an early stage, and so the benefits and costs estimates are the result of simple analysis, are approximate and are subject to change. We have attempted to control for some of this by adding optimism bias and risk, as appropriate. However, the results in this section remain illustrative only and are not intended for reliance or for investment decisions by public or private sector entities.

3.1 Costs

A high-level cost estimate has been made for the capital and operational costs for the crossings to inform the cost and benefit analysis. We have not developed a concept design for each of the sites and therefore, the costs presented in this section are subject to a number of assumptions and benchmarks based on industry best practice and prior experience. The level of accuracy of this cost assessment is considered appropriate for the purpose of this exercise. However, the costs presented here should be used with caution.

3.1.1 Capital costs

Table 5 presents the different categories in which the capital costs have been grouped into for the assessment. The capital cost estimates assume that no dredging, scour protection or river wall works are required and that no additional foundations are required for the landside access structures. Land costs and the cost associated with integrating the new piers with the wider transport network beyond the immediate proximity are not included. The costs estimate does not include capital expenditure for any modifications that the existing piers may require beyond the power supply upgrades. A further allowance of between 20-30% of the pier capital costs should be included if any modifications of the existing piers are required. We have benchmarked the bottom-up costs against available information for other piers on the Thames and concluded that the estimated costs are in line with this.

Note that a further 55% optimism bias has been applied to these capital costs before their use in the economic case.

Table 5 Capital costs (2023 prices, 5% risk applied)

Item	Description
Battery-electric vessels	2No. vessels are required to meet the passenger demand with acceptable service intervals (see Management case).
Total vessel cost £3m per vessel	
Landside access	Provides step and ramp access over the river wall from the Thames path.
Piled bankseat	Provides connection between the landside access structure and the access brow. Supports the brow. Can be a significant structure, responding to brow loads and vessel impact risk.
Access brow	Provides connection between the bankseat and the pontoon, accounting for varying levels of the pontoon with tidal influence on water levels. Can be a significant structure, responding to loads and fatigue challenges imposed by waves.

Pontoon (including pontoon restraint) and pontoon superstructure	Floating pontoon, which provides an embarking and disembarking area, as well as waiting area. Pile restraints, which secure the pontoon and allow it to safely move with varying water levels. The pontoon superstructure includes fenders, mooring furniture, balustrades, waiting areas, canopy etc.
UKPN substation and cabling	Includes new local UKPN substation, cabling from main primary substation to the pier (assumed at 1km distance) and other MEICA.
Total pier cost £12.8m per pier	
Contractor's fees	Contractor's preliminaries, overheads, profit and risk
Total contractor costs £9.1m	
Employer's cost	During both preconstruction phase and construction phase (project management, procurement, planning, commercial and legal).
Total employer's costs £1.0m	
Professional services	During preconstruction phase: design, planning and consent support, and construction phase: technical support and site supervision.
Total professional services costs £2.7m	

3.1.2 Operational costs

While each of the sites has its own site-specific conditions, we have looked at key cost differentiators and concluded that for the level of accuracy inherent within this exercise, it was reasonable to apply the same assumptions across the different sites. Following from this report, A feasibility study and concept design development will be required to explore the cost differential across sites, taking account of the local constraints and opportunities. This may increase costs due to local risks or provide cost reduction opportunities.

Table 6: Costs included in the OPEX assessment

Operational expenditure (**OPEX**)	
Staffing **£1.7m per annum**	Includes salary + 50% illustrative overheads for full time equivalents (FTE)s for vessel crew, engineering team and back of house staff. It is assumed that each vessel has a two people crew. Assuming that 2No. vessels operate during 16h a day for 365 days, it is estimated that a total of 16 No. FTEs for vessel crew are required. 2No. FTEs for back of house staff and 0.5 FTEs for engineering team – assumes the organisation managing the crossings undertakes the management of other river services. If a crossing was to be manged by a dedicated organisation, the FTEs allowance could increase.
Vessel power supply **£0.3m per annum**	Includes outline estimate of standing and capacity charges, consumption charge and climate change levy. For the power calculations: vessel powering based on Thames Clipper Hunt Class vessel, conservatively assumed a service speed of 10 knots. It is assumed that power is available on both sides of the river.
Pier maintenance **£0.2m per pier per annum**	Includes yearly in-situ maintenance and offsite maintenance for pontoon (dry docking) every 15 years

Pier offsite maintenance – every 15 years £3.0m	
Vessel maintenance **£0.3m for two vessels per annum** **Battery replacement – every 10 years £0.6m**	Includes routine maintenance and battery replacement every 10 years
Operator profit **£0.2m per annum**	Allows for 5% of the yearly operational cost
Other **£0.1m per annum**	Nominal allowance for other miscellaneous operational costs, etc.

3.1.3 Total costs

A summary of the capital and operational costs for each site is presented in Table 7 below.

Table 7: Lifetime (30 years) costs for each location (2023 prices, undiscounted)

	Isle of Dogs - North Greenwich	Royal Wharf - Charlton	Barking Riverside - Thamesmead
	2 No. vessels 2 No. new piers	2 No. vessels 1 No. new pier (south side)	2 No. vessels 1 No. new pier (south side)
Capital costs	£38m	£25m	£25m
Operational costs (30 years)	£94m	£94m	£94m
Total	**£132m**	**£119m**	**£119m**

3.2 Demand analysis

The demand analysis sits at the core of both the economic and financial cases, providing the projected passenger numbers required for revenue calculations which features both in the financial and economic modelling.

3.2.1 Drivers of demand by site

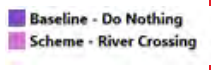
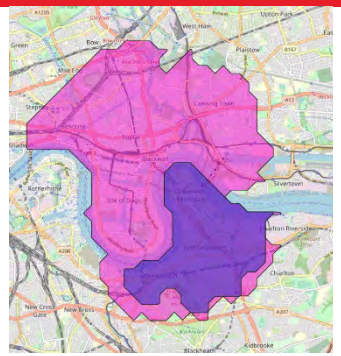
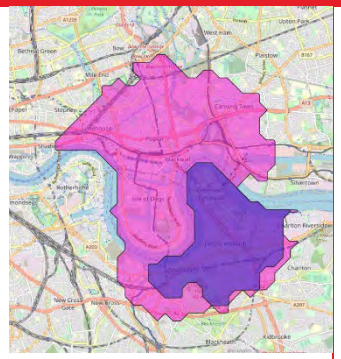
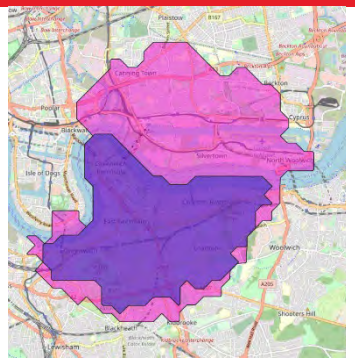
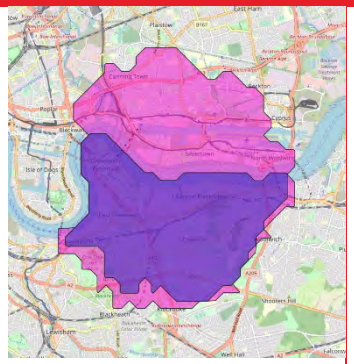
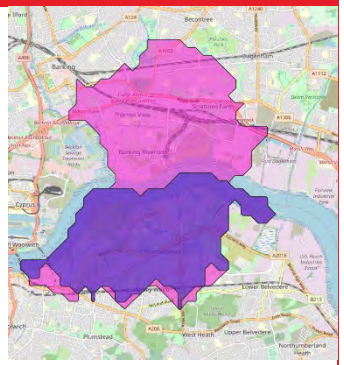
This section provides an overview for each of the short-listed sites based on outcomes from accessibility modelling. It summarises the drivers of localised demand and considers a broad range of attractors for different users using the ferry.

Accessibility modelling has been to measure the impact of proposed public transport connections. The complexity of a service schedule, spatial location of piers and behavioural aspects of travellers make it difficult to measure the impact and success of interventions. However, accessibility modelling provides a way to assess the level of integration of transport and land use by quantifying the destinations that can be reached within a certain travel time budget, such as homes or jobs.

As outlined in Table 4, there are at least 107,000 residents (2021) who can access the southern pier of any of the shortlisted crossings within a 15-minute cycling catchment in the AM peak. This is forecast to grow by at least 34% for all proposed crossings by 2035. These riverside sites are expected to grow at a greater rate than London and is forecast to increase by 16% during the same period (Greater London Authority, 2021). This

growth, concentrated along the Thames is largely driven by developments in the area, including Silvertown, Charlton Riverside, Barking Riverside and Thamesmead.

Table 8: 15-minute cycle time catchment, calculated from the southern piers in the AM peak (50th percentile traveller)

	Isle of Dogs to North Greenwich Option A	Isle of Dogs to North Greenwich Option B	Royal Docks to Charlton Option A	Royal Docks to Charlton Option B	Barking Riverside to Thamesmead
15-minute Cycling catchment 					
Population 2021 within catchment (rounded)	248,000	220,000	160,000	164,000	107,000
Population 2035 within catchment (rounded)	333,000	295,000	218,000	224,000	144,000
Population Change 2021 – 2035	+34%	+34%	+36%	+37%	+34%
Jobs 2021 (rounded)	214,000	205,000	70,000	73,000	31,000

	Isle of Dogs to North Greenwich Option A	Isle of Dogs to North Greenwich Option B	Royal Docks to Charlton Option A	Royal Docks to Charlton Option B	Barking Riverside to Thamesmead
Existing attractors by user type	**Residents**: Canary Wharf Shopping Centre, Elizabeth Line (Canary Wharf station) and DLR (Canary Wharf station) (north). **Residents**: Canary Wharf Shopping Centre, Elizabeth Line (Canary Wharf station) and DLR (Canary Wharf station) (north).		**Residents**: University of East London (north), DLR (north), Charlton retail park (south), Southeastern Railway (south – links to Cannon Street, Waterloo, and London Bridge). **Residents**: University of East London (north), DLR (north), Charlton retail park (south), Southeastern Railway (south – links to Cannon Street, Waterloo and London Bridge).		**Residents**: Gallions Reach Shopping Centre (north), Overground (north), Thames path, open space (south).
	Employment: Canary Wharf Employment Area (north). **Employment**: Canary Wharf Employment Area (north).		**Employment**: Royal Docks (north), Woolwich town centre (south) **Employment**: Royal Docks (north), Woolwich town centre (south)		**Employment:** Cannon Retail Park (South), Thamesmead town centre (south)
	Tourists: O2 Arena (south), Jubilee line (south), IFS Cloud Greenwich Peninsula Cable Car (south). **Tourists:** O2 Arena (south), Jubilee line (south), IFS Cloud Greenwich Peninsula Cable Car (south).		**Tourists:** London City Airport (north) **Tourists:** London City Airport (north)		**Tourists:** N/A
Future attractors	Canary Wharf developments including Park Place development, Westferry Printworks (north) Canada Water town centre (north) Canary Wharf developments including Park Place development, Westferry Printworks (north) Canada Water town centre (north)		Riverscape residential development (north) Herringham Quarter – Charlton Riverside (south) Riverscape residential development (north) Herringham Quarter – Charlton Riverside (south)		Barking Riverside development (north) Thamesmead Waterfront development (south)

3.2.2 Demand estimation approach

We used two methods to estimate demand, more details of which are provided in Appendix A.2:

- The first approach made use of Census (2011) travel to work data as a baseline for cross-river trips in London. We added in the new ferry links and calculated the impact on generalised journey times. We then applied factors for market capture from the ferry links. We then applied an uplift to account for non-work trips.
- The second approach used benchmarks of demand from existing river crossings, and applied adjustments based on accessibility modelling and an assessment of the catchment population in 2035 (when compared to the catchment population of the benchmark). Note that the choice of base year for this method was challenging, given the impacts of Covid-19 on demand and the recent reliability of the Woolwich ferry. We endeavoured to use a recent, relatively event free year for each benchmark, as shown in Table 9 below.

Table 9: Raw benchmark data from existing river crossings (source: Thames Clippers, TfL)

	RB4	Greenwich foot tunnel	Woolwich foot tunnel	Woolwich ferry	Jubilee line	Cable car
Demand	535	2,970	641	518	8,119	3,749
Year	2015	2016	2016	2016	2018	2022

This gave us a range of potential demand for the three shortlisted locations, Isle of Dogs North Greenwich, Royal Docks to Charlton and Barking Riverside to Thamesmead.

3.2.3 Demand for shortlisted ferry services

Table 3 provides the daily demand for the travel to work method and benchmark demand estimates from four benchmarks (RB4 ferry, the Woolwich tunnel, the Woolwich ferry and the Greenwich tunnel) and the forecast based on all for 2035. These are illustrated in Table 10.

Table 10: Daily demand from different methods for 2035, with £1 fare

	Isle of Dogs - North Greenwich	Royal Docks - Charlton	Barking Riverside - Thamesmead
Travel to work method	1,300	2,050	1,000
Benchmark method			
RB4	550	350	250
Greenwich foot tunnel	4,300	2,800	1,850
Woolwich foot tunnel	1,450	950	600
Woolwich ferry benchmark	1,150	750	500
Range	**550 – 4,300**	**350 – 2,800**	**250 – 1,850**

Note for comparison that the existing RB4 service carried some 535 passengers per day in our base year of 2015. We acknowledge that the foot tunnel benchmarks are more likely to be at the upper end of feasible demand, given that they operate without a wait time. We would also suggest that the two ferry benchmarks will be at the lower end, given that they are not well-marketed or integrated with the streetscape (and in the case of Woolwich ferry, have had on-off reliability issues for many years).

The largest demand is for the Isle of Dogs - North Greenwich option, given its large population, followed by Royal Docks to Charlton, and the lowest for Barking Riverside to Thamesmead. The Royal Docks to North Greenwich induced demand forecast is highest (242 per day) followed by Barking Riverside to Thamesmead (187).

The Barking Riverside to Thamesmead route may have relatively small route shift demand despite providing significant journey time savings due to a lack of existing travel to work demand across the river at a point this far east.

3.3 Benefits and cost-benefit analysis

The largest benefit is the generalised cost of travel savings, with other benefits from greenhouse gas emissions mitigated, accidents avoided and active travel benefits. The cost benefit analysis was carried out using inputs that correspond with the range of demand estimates in Table 3. As such, the lower bound of the range was used in Table 4 and the upper bound in Table 3 providing a low and high estimate of the BCRs in Table 12. The appraisal period used was 32 years (2 years build out plus 30 years of service), the appraisal year is 2024 and the price year 2010.

Table 11: Cost benefit analysis (£ms, 2010 prices, discounted to 2010, £1 fare)

	Isle of Dogs - North Greenwich	Royal Docks - Charlton	Barking Riverside - Thamesmead
Benefits			
Generalised cost of travel saving	13.1-102.6	6.8-53.1	7.4-58.0
Vehicle GHG emissions mitigation	0.2-1.9	0.4-3.4	1.1-8.8
Accident prevention	0.5-4.1	1.2-9.1	2.4-18.6
Active travel benefits	0.5-0.5	0.1-0.01	0.2-0.2
Costs			
Capital	43.4	28.6	28.6
Operating	43.0	43.0	43.0
Fares income	-(minus)2.2	-(minus)1.5	-(minus)1.5
Net present value (NPV)	**-(minus)69.8-40.2**	**-(minus)61.7-6.0**	**-(minus)61.7-21.6**
Benefit-cost ratio (BCR)	**0.2-1.6:1**	**0.1-1.1:1**	**0.2-1.3:1**

There are a wide range of results, reflecting the uncertainty over capital costs and demand at this early stage. The highest benefit-cost ratios are for the Isle of Dogs to North Greenwich option, despite having a significantly higher capital cost. This is driven by the significantly higher demand forecasts that this route enjoys.

The Barking Riverside to Thamesmead crossing also has reasonably BCRs. This is driven by the high potential for journey time savings resulting from its isolated location, and the potential for shifting people away from car use leading to higher emissions mitigations and active travel benefits.

3.3.1 Sensitivity test on developer contribution to capital costs

We carried out the cost benefit analysis with a test assuming that half of the capital costs would be borne by a developer, broadly in line with one of the scenarios in the financial case, and in line with previous experience at newly built piers. The result of this analysis is presented in Table 12.

Table 12: Benefit-cost ratio range assuming developer contribution to capital costs (£ms, 2010 prices, discounted to 2010, £1 fare)

	Isle of Dogs - North Greenwich	Royal Docks - Charlton	Barking Riverside - Thamesmead
Benefit-cost ratio (BCR)	**0.2-2.3:1**	**0.1-1.5:1**	**0.2-1.7:1**

Whilst the lower end of the results is below the level that is typically awarded government funding, the upper end represents good value for money. The results are heavily dependent on levels of demand and third party funding. We recommend further work to provide more accurate estimates.

4. Financial case

4.1 Funding sources

We are aware that conventional funding availability from the Department for Transport (DfT) and Transport for London (TfL) is currently extremely tight. Scheme promoters need to be much more creative and sophisticated in putting together a funding and financing strategy for their projects, looking at a much wider array of potential sources. As such, we have investigated a wider range of funding sources for this project. Figure 10 summarises the primary categories of funding sources (long-list) available in the UK.

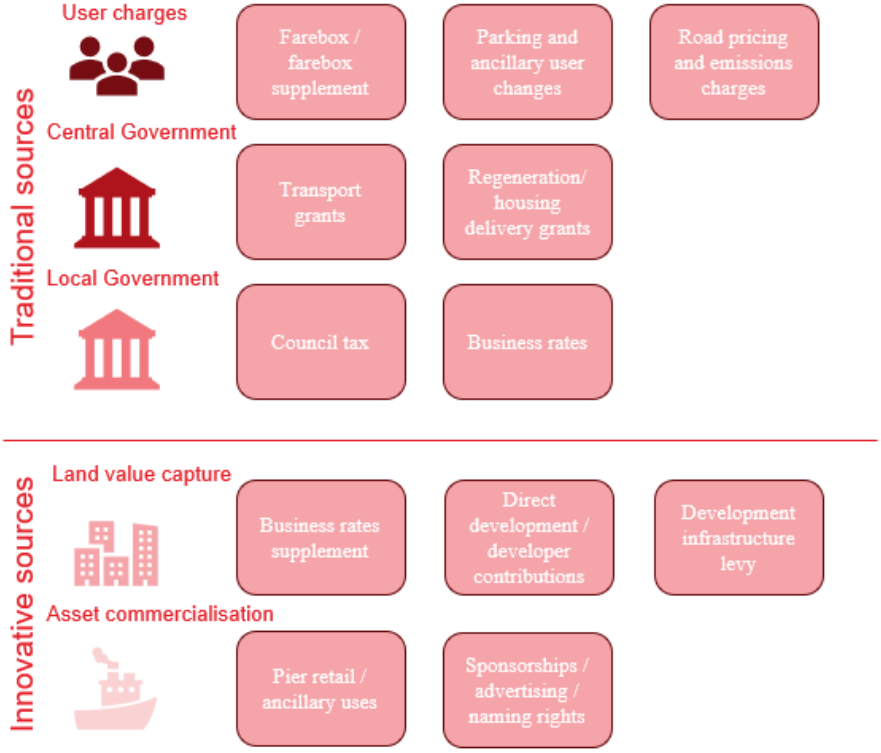


Figure 16: Funding source methods for transport schemes (Arup)

4.2 Fares

There is a large variety in charges for existing river crossings (see Table 13 below). Low fares are essential for attracting users from all income brackets and can help drive demand. The vision for the ferry services is that the fares will be integrated with Oyster / Contactless / PAYG systems.

Based on the benchmark fares, we modelled the impacts of £1 (used in the Economic case), £2 and £3 fares.

Table 13: Existing single fares for river crossings (2023)

	Fare
RB4 ferry	£3.80
Cable car	£6.00
Woolwich ferry	£Free
Woolwich and Greenwich foot tunnels	£Free
Peak Zone 1 Tube	£2.80

4.3 Funding packages

We evaluated the long list of funding options against a set of criteria to ensure desirability, suitability and viability of different mechanisms for different types of infrastructure, in different contexts. This would include consideration of:

- **Potential scale of income** – considers the relative magnitude of the funding as a lump sum or over the project lifecycle.
- **Certainty of funding** – considers the likelihood of the funding materialising.
- **Justification and rationale** – consider whether the funding source suggested is relevant and justified compared to the usage of the funds (considers correlation between source and use)
- **Ease of implementation** – considers the institutional effort required to generate the funding.
- **Appeal to stakeholders** – considers the viability with key stakeholders such as passengers and project sponsors.

The criteria were ranked between 1 and 3. 1 being worst, 3 being best.

As a result, and utilising the above criteria, Table 11 below provides a short-list of plausible funding sources at this stage of development.

We based funding and financing on the Royal Docks – Charlton option.

Case Study – Royal Wharf Pier

Image Source: DHA Designs

Royal Wharf Pier was open to the public at the end of 2019. The 130m long pier serves as a stopping point for MBNA Thames Clippers River Bus Services while providing a public space. The total gross floor area is approximately 1,030m^2 (both canting brows: 471.4m^2, bankseat 167 m^2 and pontoon 394m^2)
The contract duration was 12 months and the total cost was estimated as £5.5million (2019 price) prior construction.

Source: (Architects' Journal, 2019)

Figure 17: Royal Wharf Pier case study

Case Study – Barking Riverside Pier

Image Source: Beckett Rankine

The new Barking Riverside Pier (Barking Riverside, London), in service from spring 2022, is served by Uber Boat by Thames Clippers.

The pier comprises a floating pontoon with a 63m long canting brow. This new structure extends from the old and disused Barking power station coaling jetty. The pier was designed to accommodate simultaneous berthing of two ferries.

The total cost was estimated as £7.3million (2021 prices) prior to construction, and the project was funded by Barking Riverside Limited and the London Borough of Barking and Dagenham.

Source: (New Civil Engineer, 2021)

Figure 18: Barking Riverside Pier case study

Table 14: Potential funding package – Site 2: Royal Docks to Charlton, Option A

Funding source	Indicative amount (£)	Assumption	Certainty of income	Justification and rationale	Appeal to stakeholders	Ease of implementation	Potential scale of funds	Average score
DfT – Clean Maritime Demonstration Competition Round 4	£1,000,000 in 2024	Refers to a lower range of the project size – noting that the CMDC4 project total costs must be between £500,000 and £6 million.	2	2	3	3	2	2.4
TfL - Woolwich ferry cross-subsidisation	£1.17 million per year	Estimated based on 1.17 million annual passengers in 2019/2020 paying £1 fare to use the service which is currently subsidised – to be used to fund the new cross river service (Greater London Authority, 2021).	1	2	2	1	2	1.6
TfL – Redirection of Silvertown Tunnel – Cross River Cycling Service **(Greater London Authority, 2021)**	£14 million in total to 2025 (~£7 million per year in 2024 and 2025), note this figure is approximate	Money saved from alternative to cycle bus could be redirected to ferry services. 25% of the £70m 'saved' was assumed as a conservative estimate to account for the proposed bus service.	1	2	1	1	3	1.6
Contributions from developers – provision for funding of the pier	£6m (roughly half of the pier cost for RD-C A)	Based on the precedent set by the Royal Wharf Pier project where private developers fully paid for the pier's capital costs of £5.7m.	2	2	2	3	3	2.4
Private - Sponsorship	£210,000 per year	Based on 50% of IFS' Cable Car sponsorship, which pays TfL £420,000 a year over 5 years (£2.1m sponsorship) to have the cable car, rebranded with its name and corporate colours.	1	2	2	2	2	1.8
Users – Fare revenue	Between c.£900,000 and £2m in 2026	Based on a range of £1 to £2.50 per trip, multiplied by average annual trips for Royal Dock to Charlton (Option A)	2	3	3	3	3	2.8

4.4 Funding packages – Royal Docks to Charlton (Option A)

The total funding envelope for the Royal Docks - Charlton scheme is unlikely to be met by a single source. Most transport projects are delivered through a complex combination of different mechanisms. To understand how the funding sources could be packaged to fund the scheme, **we have outlined two illustrative examples (scenarios)** which provides an indication of the potential funding availability and magnitude, as well as reflecting on any funding gap:

1. **Scenario 1**: where all the funding sources presented in Table 14 above are sourced, along with fare revenue.
2. **Scenario 2**: where all the funding sources presented in Table 14, **except for Woolwich ferry and Silverton tunnel**, are applied, along with fare revenue.

This are presented in more detail below.

Scenario 1: All sources

Figure 19: Free Fare, Scenario 1 and Figure 20: £1 Fare, Scenario 1 below provide a present value view on both project costs and funding, over the life of the project for Scenario 1. Figure 19: Free Fare, Scenario 1 assumes no fare revenue and Figure 20: £1 Fare, Scenario 1 assumes a £1 fare is charged for the average annual trips estimated for Royal Docks to Charlton, Option A. This (£1) option suggests that the original funding gap ('Balancing grant from government sources') is reduced by around £10m (from £50m), over the life of the project to £40m.

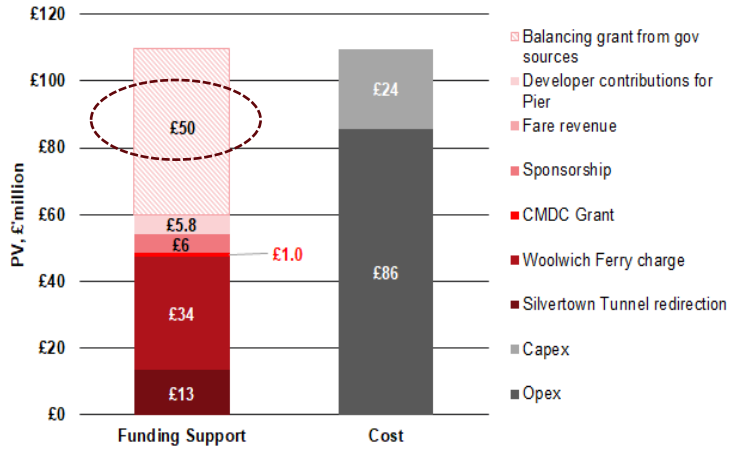


Figure 19: Free Fare, Scenario 1

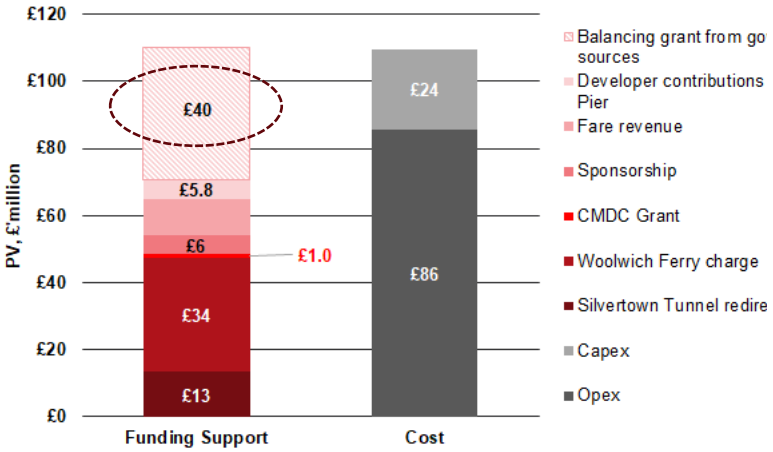


Figure 20: £1 Fare, Scenario 1

Table 15 below provides a further matrix of the estimated government funding support required based on different fare rates per trip, for Scenario 1, and adjusted for elasticities of demand on passenger numbers. The higher the fares, the lower the grant funding required. With a £3.50 fare, the grant required will be some £21m in 2024 prices.

Table 15: High-level estimates of fare and gap funding scenarios to breakeven (2024 prices)

Approximate fare per trip	Approximate "balancing grant" from government required to cover the funding gap
£0	~ £50m
~ £1	~ £40m
~ £1.5	~ £35m
~ £2	~ £31m

~ £2.5	~ £27m
~ £3	~ £24m
~ £3.5	~ £21m

Scenario 2: All sources, except Silvertown funding diversion and Woolwich ferry charge

Figure 21 and Figure 22 below provide a present value view on both project costs and funding, over the life of the project for Scenario 2. Figure 19 assumes no fare revenue and Figure 22 assumes a £1 fare is charged for the average annual trips estimated for Royal Docks to Charlton, Option A. Scenario 2 shows that the original funding gap ('Balancing grant from government sources') is significantly higher than in Scenario 1 (£97m vs £50m), as the Silverton tunnel redirection and Woolwich ferry cross-subsidisation are no longer included. Considering this, compared to a no fare option, the £1 fare option (Figure 22) suggests that the original funding gap is reduced by around £10m (from £97m), over the life of the project to £87m.

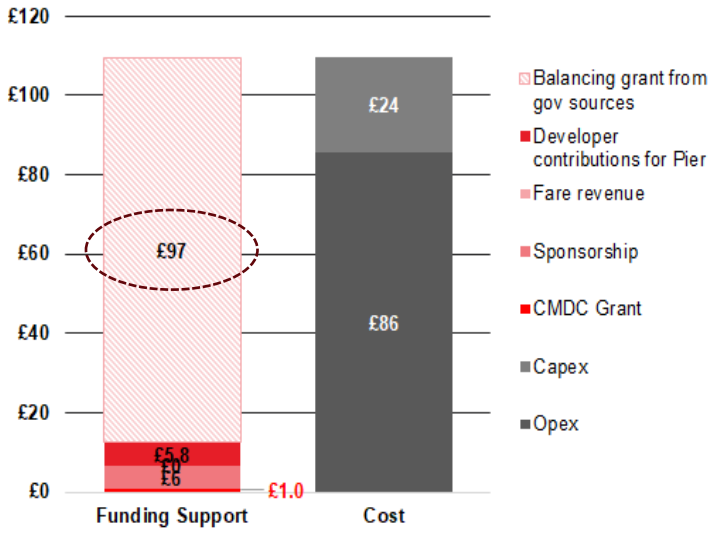


Figure 21: Free Fare, Scenario 2

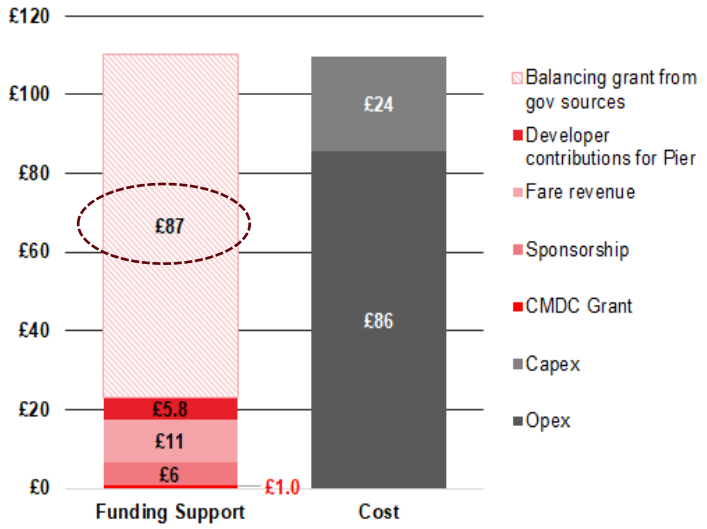


Figure 22: £1 Fare, Scenario 2

Table 16 below provides a further matrix of the estimated government funding support required based on different fare rates per trip, for Scenario 2, and adjusted for elasticities of demand on passenger numbers. The higher the fares, the lower the grant funding required.

Table 16: High-level estimates of fare and gap funding scenarios to breakeven

Approximate fare per trip*	Approximate "balancing grant" from government required to cover the funding gap*
£0	~ £97m
~ £1	~ £87m
~ £1.5	~ £83m
~ £2	~ £78m
~ £2.5	~ £75m
~ £3	~ £71m
~ £3.5	~ £69m

*£ value in 2024 terms

4.4.1 Conclusion

Scenario 1 provides for a fundable project based on several possible funding pots and options and suggests a manageable 'balancing grant' based on a relatively low and plausible fare levels. However, it is highly dependent on the success and quantum of government grant applications, as well as market and economic constraints (which could affect sponsorships, developer contributions and changes in passenger demand estimates and elasticities). Scenario 2 is less plausible as it suggests a large funding gap which is unlikely to be covered by government sources.

5. Commercial case

The purpose of the commercial case is to demonstrate the commercial viability of the zero emission ferry programme and the market's capability to deliver. It outlines potential delivery models that could be used, in future to engage with the supplier market (including the identification of key partners), a high-level programme outlining next steps and indicative timings, and key risks and opportunities that may impact the delivery of river crossings on the Thames. The commercial case is generic to all three crossing options. The range of potential funding sources for the Royal Wharf – Charlton option were identified in the financial case.

This section explores a range of viable business models to fund the cross river ferry service.

5.1 Delivery models

5.1.1 Principles

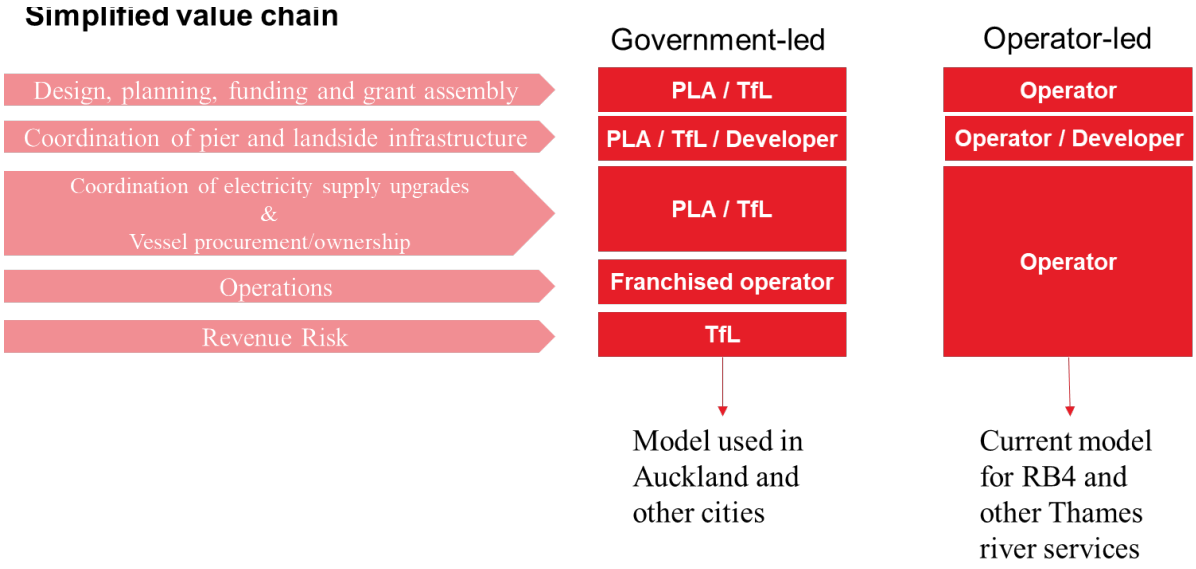
The commercial models suggested reflect a number of principles.

- **Mixed publicly funded/commercial**: Recognising the role of the public sector in funding, and the private sector's role in delivery of the London river and bus networks, a mix of public funding, supplemented by private, commercial models is preferred. This may include asset commercialisation, for example through the use of sponsorship.
- **Free or low cost at-the-point-of-use**: We would expect the fares system to be regulated so that low cost fares were guaranteed (as there are a key vehicle for delivering the strategic objectives). It is also important that this links in with Oyster / TfL contactless network.
- **Tried and tested:** We suggest commercial models that have been demonstrated to work, either for other transport modes in London, or for electric ferry services elsewhere.

5.1.2 Candidate models

We have identified two potential delivery models, these are outlined in Figure 23: Delivery Model Overview.

Figure 23: Delivery Model Overview



Government-ran delivery model

In this delivery model, Government (e.g. TfL) would own the piers (if these are not delivered through developers), and would potentially own the vessels and franchise operations for defined time period i.e. 2-5 years. In this model the Government agency would also take on the revenue risk and it would also allow the service to be branded to the agency. For example, if the service were to be run by TfL, they would be able to be brand the service as a TfL river service and integrate it with existing public transport in London as well as integrating payment systems i.e. through the Oyster System. TfL would act as a sponsor for the scheme and would gather funding including sponsorships to fund key infrastructure requirements such as grid connections, pier design and construction (or upgrades where required) as well as vessels.

The ultimate success of the ferry crossing in this delivery model will depend on strong collaboration and communication between key partners, including the PLA, GLA, local transport operators, supply industry and users as outlined in further detail below.

Case Study – Auckland Transport Ferry Service

Source: Auckland Transport

The recent Public Transport Operating Model has been in place in New Zealand since 2013. Through this model, regional councils including Auckland Transport contract/ tender public transport services to operators. In practice the operators own their fleet and deport to provide the service. The services are funded by regional councils, farebox revenue, advertising revenue among other sources.
Source: (Ministry of Transport; New Zealand Government, 2021)

Operator-led model

In this delivery model, an operator, such as Thames Clippers, or another, would act as the sponsor for the scheme. This model would comprise the operator owning the piers (if not delivered through developers) and potentially own the vessels. The operator would operate the service in perpetuity and take on the revenue risk. The service could be branded as a TfL river service as with the Government-ran delivery model and be integrated with the existing public transport network including payment systems. In this model the operator would be responsible for gathering funding including sponsorships. In this respect we note that Thames Clippers have previously applied and managed central government funding for decarbonisation of maritime operations. Note that we expect there to be some challenges with operator model if it receives subsidy.

Case Study – Existing business model
Rotherhithe to Canary Wharf

Source: Thames Clippers

The Rotherhithe to Canary Wharf Ferry provides a quick, frequent and easy transfer between Hilton's Doubletree Hotel from Doubletree Docklands Pier (also known as Nelson Dock Pier) to Canary Wharf. It is currently operated by Thames Clipper. Currently, the boats operates a roughly 10 minute frequency during weekday peak periods, and 15 minute off-peak frequency. It operates between 06:30 and 23:30 during the week, and between 08:30 and 23:30 on weekends.

An adult ticket is £3.80 one-way, with passengers able to touch in and out with an Oyster or contactless card or Uber apps.

The commercial viability of the scheme will be based on understanding the various infrastructure and service components required to deliver the scheme, including commercial business models, combined with an assessment of the risk profile.

In developing these commercials models, we have taken into account insights and lessons learned from existing electrified ferry operations and the existing shape of the river services market on the Thames. The first, government-led model, is based upon the one that is being implemented in Auckland, New Zealand, and is broadly similar to the TfL bus network. The second operator-led model, reflects that there is a large incumbent operator on the Thames which has previously been successful at bidding for government funding, and raising private capital, whilst offering services that are integrated within the broader London transport network. The high costs of the electrification infrastructure, the resulting natural monopoly (it would not be practical to have two ferry operators on the same crossing), and the reliance on public funding streams suggest a high level of government involvement, whichever model is chosen.

5.2 Commercial considerations

Operators such as Thames Clippers currently hold exclusivity agreements at several piers, including but not limited to Royal Wharf and Barking Riverside. We recommend conducting a comprehensive audit of the existing exclusivity rights associated with the existing piers which are to be adapted for the proposed ferry crossing use. This audit will serve to illuminate the terms, conditions, and time limits associated with these agreements, allowing for a clearer understanding of their potential impact on the proposed ferry service.

While exclusivity arrangements often serve as a means to secure essential services and developer funding, careful consideration should be given before extending such agreements to the new proposed piers. These agreements may inadvertently constrain the range of services and options available to stakeholders. Therefore, a thorough examination of their implications for the ferry service and the broader public interest is essential in the next stage of this project.

5.3 Market capability and future market testing

There are many potential suppliers of electric vessels (often alongside batteries and charging infrastructure supply), worldwide; however, a much smaller number of companies have proven delivery and a long service record. Most such vessels are built bespoke to individual needs. We suggest that the lead entity (depending on which commercial model is chosen) would be to actively engage suppliers to gauge the capability and interest in the market to deliver vessels appropriate to the needs of this river crossing. Through this engagement, potential suppliers should be given the opportunity to feedback and inform its development.

There are a number of companies that specialise in design and delivery of pier and landside infrastructure, some of them with a recent track record of delivery of infrastructure on the river Thames.

We understand that the grid connections and any power supply upgrades would be supplied by the Distribution Network Operator (DNO), UK Power Networks. The DNO is obligated to provide assistance to new grid connections in a timely manner, although we note that larger power connections may be subject to longer administration periods.

There are fewer options for servicing of electric vessels on the Thames. Existing options include Thamescraft Dry Docking Servies. There are plans to develop a boatyard on the Thames (e.g. the Albert Island Boatyard) but it is at present unclear if these plans will be realised and when. Existing vessels sometimes have to travel outside of the Thames Estuary for servicing.

We suggest that the next phase would include market testing with the potential suppliers, and sharing of the two commercial delivery models.

6. Management case

The Management Case includes detail on proposed service operations project planning and governance structures, and the measures in place to engage with external stakeholders and manage risks. Importantly, this includes a project plan and next steps.

6.1 Technology options

We considered three vessel technology aspects to consider for cross-river services on the Thames: vessel, mooring and propulsion options. A brief overview of the different options available is shown in Table 2. This review of technology options is location-agnostic and relates to applicability to the cross-river Thames context.

We have based the costs and operations on a free-running, battery operated ferry, with charging at either end. Due to the constraints of operating on the Thames around existing navigation, cable ferries are not expected to be a viable solution. The most suitable mooring arrangements will be dependent on the vessel characteristics, berth arrangement and service frequency. Battery electric ferries are well-proven technology, highly suited to short crossings, and more energy efficient overall than hydrogen fuel cell vessels. They are more appropriate for a zero emission Thames cross river service than hydrogen, as long as sufficient power can be supplied to the berths.

Table 17: Technology options overview – propulsion, mooring and energy storage Operational considerations

Option	Case Study	Advantages	Disadvantages
Vessel type			
Chain ferries are often deployed for river crossings. In these cases, an onboard winch pulls the vessel along a fixed cable or chain that is attached at each side of the river and normally lies on the seabed.	Floating Bridge No.6, River Medina, Isle of Wight, UK Udbyhøj Cable Ferry, Randers Fjord, Denmark	Chain ferries typically have simple designs that can be built, maintained and operated at a lower cost. They are simple to manoeuvre, which can be beneficial in narrow rivers with strong currents, and no additional mooring system is required since the chain holds the vessel in place. As the ferry is always attached to the cable, it is also possible to permanently connect to a shore power cable to enable zero emission electric operation without extended charging times (see example Udbyhøj Cable Ferry).	As the ferry moves, the chain is lifted off the seabed which causes a hazard for vessels passing in front or behind the ferry. Due to the significant vessel traffic on the Thames, this is likely to be unacceptable at all locations. The nature of chain ferries means that the vessels must berth perpendicular to the riverbank which may obstruct other vessels operating on the river, depending on location.
Free running vessels are fitted with propulsors, such as propellers or waterjets, that allow them to operate and manoeuvre freely.	GVB IJ river ferries, Amsterdam Thames Clippers Services, London	Free running vessels can be manoeuvred freely to give way to passing river traffic in a busy waterway. For multi-vessel services, they require only a single berth on either side of the river, rather than two for chain ferries.	More complex vessel designs that would typically be comparatively more expensive to build and maintain. Mooring arrangements at each berth may slow down high frequency services.
Mooring Options			
No mooring systems Vessels may "push" against a pontoon, linkspan or slipway to hold the vessel in place	Pre-2018 Woolwich Ferries, UK (now replaced) Rock-Padstow Ferry, UK	Allows for fast turnaround times with little or no time required to secure the vessel.	Consumes more power and hence increases emissions from conventionally fuelled vessels or reduces endurance of electric vessels. Potential safety issues may be encountered (e.g. in case of an engine failure) particularly in strong currents.

during loading/unloading.			
Rope moorings Securing the vessel with ropes or mooring cables.	Thames Clippers, UK	Conventional rope or cable moorings are a simple and low-cost solution.	Requires more crew to attach lines. Can take longer to secure the vessel than other solutions.
Vacuum or magnetic auto-mooring Automatic systems that hold the vessel in place through vacuum or magnetic pads.	New Woolwich Ferries, UK (Magnetic) Fjord1 Ferries, Norway (Vacuum)	Can quickly and accurately position the vessel for loading/unloading or connecting to charging provisions. Can be integrated with charging solution. Requires little or no human intervention.	Relatively expensive and complex solution. Can take up to 1 minute to fully connect.
Mechanical auto-mooring Mechanical systems that physically connect the vessel to the berth, e.g. with a hook or restraining bar.	ForSea Ferries, Denmark Rotherhithe Ferry Concept, UK	Can quickly secure the vessel with little or no human intervention. Simpler solution to other automooring. Accurate positioning allows for automatic charging connection.	Does not provide the same level of vessel position control as vacuum/magnetic systems.
Propulsion energy options			
Battery Electric Electrical energy stored in battery units onboard the vessel and recharged from a shore power	Dozens of examples operating commercially. Including: GVB North Sea Canal Ferries, Netherlands	Widely demonstrated solution with a range of experienced equipment suppliers available. Safety issues are well understood and hence relatively simple to manage. Electrical energy generally available at a significantly lower cost than low-carbon hydrogen.	Large battery units can contribute to high capital cost and will require replacement throughout the vessel's life. Low energy density means large battery units or frequent charging is required which could reduce vessel capacity.

connection while at berth.	Udbyhøj Cable Ferry, Randers Fjord, Denmark MV Ampere, Norway		Fast charging can be limited by local grid constraints, potentially limiting operating schedule. Grid electricity carbon intensity will be applicable.
Compressed Hydrogen Fuel (CH2) Hydrogen fuel stored at high pressure (350 to 700 bar) and converted to electrical energy in a fuel cell.	Sea Change, San Francisco, USA Hydrogenesis Passenger Ferry, Bristol, UK HySeas III (Ferry Concept), UK	Compressed or liquefied hydrogen can provide higher energy density than battery storage and hence greater range or endurance. Refilling fuel tanks can be faster than recharging batteries, hence having less impact on vessels schedule.	Fewer commercial examples and limited equipment supply chain, particularly for LH2. Fuel cells and hydrogen storage expected to represent significant capital cost and fuel cell stacks require replacement through life. Low-carbon hydrogen is more costly and harder to source than electrical energy. There are challenges in safely and efficiently bunkering hydrogen, particularly in populated areas. The process of generating hydrogen through electrolysis, storing it, and converting it back to electricity in a fuel cell is significantly less energy efficient than using stored electrical energy.
Liquid Hydrogen Fuel (LH2) Liquid hydrogen stored at cryogenic temperatures (−253°C) and converted to electrical energy in a fuel cell.	MF Hydra, Norway		

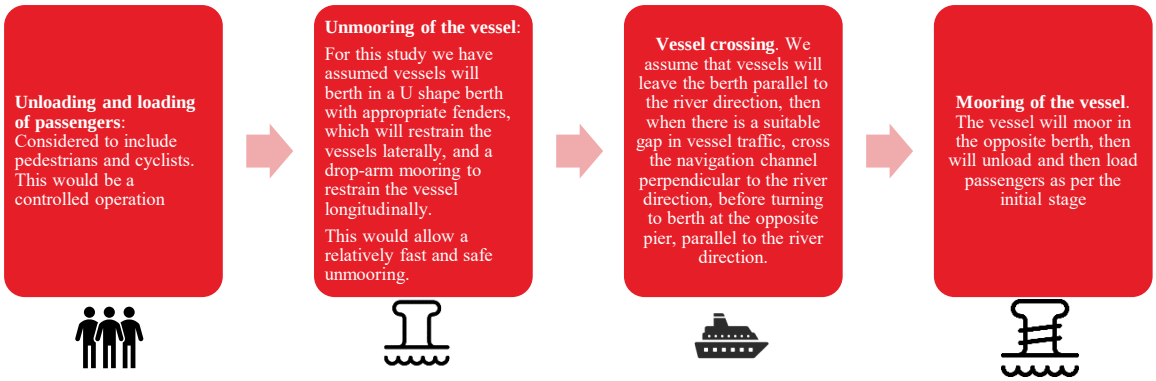
6.3 Service operations

6.3.1 Making use of existing river services

We briefly investigated the opportunity to use existing river services to serve the piers identified, through introducing additional stops in existing Uber Boat (Thames Clippers) services. Whilst this would provide an additional cross-river link at a lower cost, it is unlikely that this approach would achieve a turn-up-and-go frequency desired (most Thames Clipper services are half-hourly), or be zero emission (Thames Clippers services are diesel, or hybrid-diesel powered, and full hydrogen or electric power is more challenging given the larger vessels and longer routes).

6.3.2 Stages of operations

A typical crossing will involve:



Based on experience, mooring and unmooring time takes between 0.5 and 1 min for this type of operation, at each end. Loading and unloading of passengers is expected to take between 2.5 and 5 mins, at each end.

6.3.3 Crossing lengths, speeds and journey times

The crossing length at each of the shortlist crossings varies between 500m and 1400m, with the river getting wider as it gets further east. This, coupled with the lower traffic levels, allows for a higher average speed to be reached in the east, as shown in Table 3. Vessels will accelerate and deaccelerate to safety leave the berth, cross the navigation channel and berth at the opposite pier. The lower crossing speeds take account of the increased number of situations where vessels may need to slow down to allow along-river traffic to pass. We tested template operations for each of the three crossings, as shown in Table 7, for a smaller, 150 capacity single vessel and smaller, 75-capacity two-vessel operations. Note that the service internal for scenarios with two vessels assumes that operations are managed to synchronise crossings.

We recommend that two-vessel operations are taken forward and have used these to drive the costs in the earlier sections of this report. Two-vessel operations can achieve the 10-minute service frequency at North Greenwich – Isle of Dogs and Royal Wharf – Charlton, with some buffer. At Barking Riverside – Thamesmead, two-vessel operation can only achieve a service interval of between 11 and 18 minutes. The maximum throughputs from two-vessel operations vary between 245 and 668 passengers per hour, sufficient to meet the demand.

Table 18: Crossing times, service intervals, and max throughputs by vessel size and number

Crossing	Vessel option	Min. times			Max. times		
		Crossing time (mins)	Max throughput (pax/hr)	Service interval (mins)	Crossing time (mins)	Max throughput (pax/hr)	Service interval (mins)
Isle of Dogs - North Greenwich 500m Average speed 3-5 knots	1No. 150 Pax	3 min	668	13 min	5 min	363	25 min
	1No. 75 Pax	3 min	334	13 min	5 min	181	25 min
	2No. 75 Pax	3 min	668	7 min	5 min	363	12 min
Royal Wharf - Charlton 900m Average speed 4-6 knots	1No. 150 Pax	5 min	538	17 min	7 min	315	29 min
	1No. 75 Pax	5 min	269	17 min	7 min	157	29 min
	2No. 75 Pax	5 min	538	8 min	7 min	315	14 min
Barking Riverside – Thamesmead 1400m Average speed 4-6 knots	1No. 150 Pax	8 min	407	22 min	11 min	245	37 min
	1No. 75 Pax	8 min	203	22 min	11 min	123	37 min
	2No. 75 Pax	8 min	407	11 min	11 min	245	18 min

6.4 Stakeholder engagement

Successful delivery relies on building consensus amongst key stakeholders. As part of study, we have undertaken stakeholder engagement with the organisations shown in Figure 15 Stakeholder engagement. This engagement included the preparation and delivery of materials, conducting briefings, documenting outcomes, and executing necessary actions. This included tailored material for both individual stakeholder meetings and wider focus groups

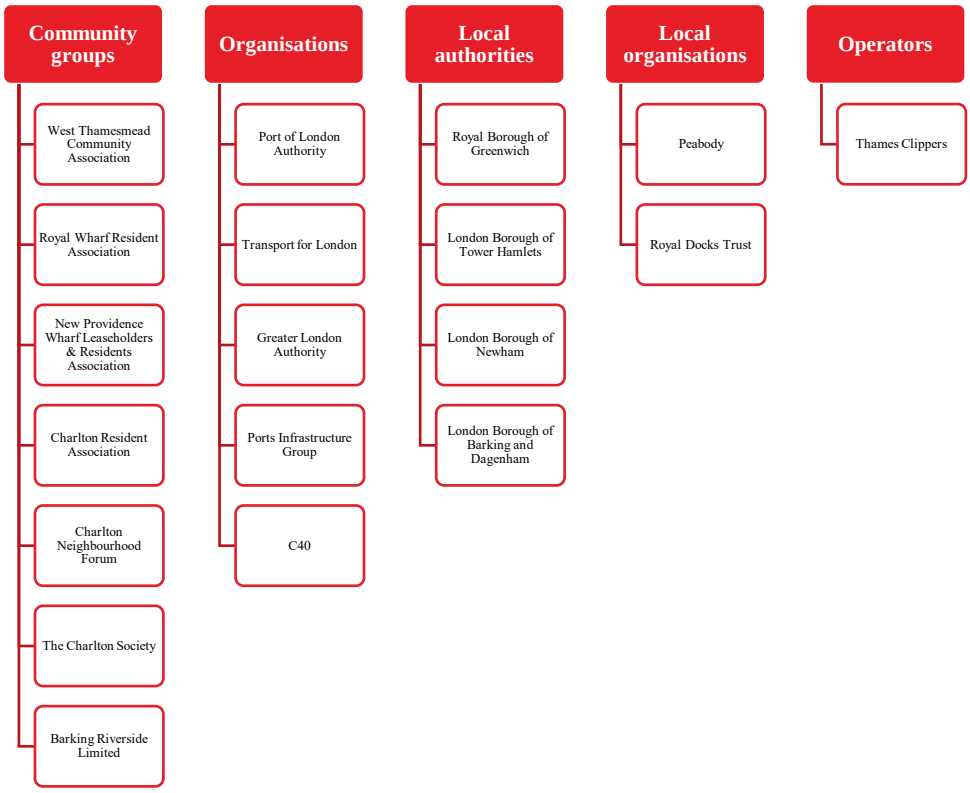


Figure 24: Stakeholder engagement

6.4.1 Positive feedback

All stakeholders have expressed their appreciation for the engagement efforts and have generally voiced strong support for the introduction of additional electric ferry crossings along the Thames. This initiative has found alignment with the broader housing and transportation priorities of several boroughs, as outlined in the Strategic Case. Stakeholder community groups have particularly welcomed this proposal, emphasising its potential to improve accessibility while maintaining a minimal environmental footprint. They believe it has the capacity to unlock new leisure and employment opportunities. Stakeholders have highlighted the importance of ensuring the permanence and affordability of these ferry crossings to encourage consistent usage.

Moreover, stakeholders have shown enthusiasm for integrating these ferry crossings with proposed developments such as the Charlton Riverside development and the Thamesmead Waterfront development. However, they have emphasised that the availability of such crossings should not be contingent on the progress of these development schemes. This is to prevent any unnecessary delays in providing new transport infrastructure for existing residents, especially in areas where existing transport infrastructure is poor. Notably, on the north side of the river, where cycling infrastructure is presently lacking, residents who rely on cycling have expressed strong support for the idea. Additionally, stakeholders have eagerly embraced the prospect of integrating these ferry crossings with other proposed projects, such as the DLR extension, recognising the potential for enhancing the overall transportation network.

6.4.2 Stakeholder concerns

Certain stakeholders voiced concerns regarding the current exclusivity agreements and private interests linked to the piers necessitating adjustments for the accommodation of the new ferry. Additionally, stakeholders emphasised concerns regarding the potential wave impact stemming from the ferry's operation on nearby structures, notably the Coldharbour wall. This impact could lead to increased maintenance costs, particularly impacting leaseholders and residents who typically bear the maintenance expenses for existing Thames Clipper piers and surrounding infrastructure.

Furthermore, stakeholders raised questions about the effects of enhancing cycling and walking infrastructure on the established road networks and the proposed pier locations, particularly in the case of Crossing 1. Other issues included heightened noise levels emanating from the ferries, as well as noise generated by

pedestrians and cyclists using the crossings. Concerns regarding increased foot traffic and potential antisocial behaviour were also recorded. These concerns highlighted the complexity of the proposal and the need to address such issues in the planning and delivery phase.

There will be further legitimate interests in zero emission ferry operations from a wide range of stakeholders. Any individual or group that has direct or indirect potential to influence the successful outcome of the programme is considered a stakeholder, and effective management and consultation with these stakeholders is fundamental to achieving the objectives of the programme. The next steps will include further engagement with the above, alongside the Environment Agency, and the Thames Estuary Partnership and its members, in order to develop a working partnership and consensus of willing partners.

6.5 Project board

The scale of investment, and multi-organisational nature of the new zero emission ferry proposal necessitates a strong governance structure.

We recommend forming a Project Board, a dedicated group overseeing the planning, development, and execution of zero emission ferry crossings on the Thames. The Board would oversee the development of the project through its next phases. Its remit and agenda would be to:

- Review project progress and discuss / sign-off key decisions.
- Act as a client for future project development carried out by third parties, including strategic outline business case, outline business case, scheme and / or pier design.
- Plan future actions and maintain momentum.
- Develop a comprehensive plan, building on the one in this document; drive forward the plan, monitor and mitigate risks.
- Coordinate stakeholder management and communications. Collaborate with communities, businesses, and authorities to integrate diverse perspectives and ensure project success.
- Navigate any legal or regulatory requirements, including planning, safety standards others.

The **lead organisation** will depend upon the commercial model chosen. This organisation will be responsible for the overall management of the programme. Given the dependence on public funding, even in an operator-led model, key commercial decisions may be subject to approval by TfL or central government (DfT). Regardless of delivery model, we suggest that the Project Board membership should include the following organisations:

- **Port of London Authority, Thames Estuary Growth Board (PLA):** the Port of London Authority is a key driver of the zero emission ferries programme. In addition, the PLA owns the riverbed and foreshore up to the mean high water mark, so will play a key role in any additional piers, and regulates Thames river traffic and operations.
- **Transport for London (TfL)**: TfL delivers the Mayor's transport strategy, coordinate London's transport network, and its ticketing system. TfL is likely to play a significant role in coordinating funding sources. The GLA Act (1999) also gives TfL the power to procure transport services.
- **Greater London Authority (GLA)**: GLA has an interest in river crossings to support delivery of the Mayor's transport strategy, and well as deliver on Mayoral housing and business aims.
- **River operators**: river operators will have a strong interest in any scheme that requires new operations and the reconfiguration of existing services, including Thames Clippers routes and pleasure boat services. An operator may lead the project, or have an interest in bidding for an operating contract, in which cases its membership of project board would be reconsidered.
- **Relevant developers (once a lead route is determined):** Lendlease at Silvertown and Peabody at Thamesmead at will deliver housing, any new piers will need to be integrated with developments, and developers may deliver some piers themselves.

- **Relevant community groups (once a lead route is determined):** Community groups will advise on integration with local plans.
- **The supply industry (designers, constructers, financiers, and others) (once contracted)**: to ensure effective delivery, market testing with suppliers is recommended in the next phase of this work. Membership of Project Board will vary according to importance and any procurements.
- **Users:** Represented by London Travelwatch or Transport Focus.

6.6 Complementary measures and interdependencies

A range of complementary measures are required to support the successful delivery of the zero emission ferry crossings includes. These may include:

- **Residential and community development**: delivery of homes and development in these areas will drive demand for the ferry service. Without residential development, the Royal Wharf – Charlton and Barking Riverside – Thamesmead options become much less viable.
- **Active transport investment**: investment in active transport, including pedestrian and cycling access and land side infrastructure is needed to support the ferry service. Some stakeholders highlighted to us the lack of pedestrian and cycling infrastructure on desire lines approaching the pier sites. This includes crossings of major roads on the Isle of Dogs, and improvements to the Thames Path around Greenwich, for example.
- **Marketing**: Closer to opening, a marketing campaign to publicise the new ferry service and build awareness for commuters, tourists and residents. A perception of permanence of the service will be needed in order for potential users to take up employment or education on the opposite side of the river.

6.7 Delivery programme

The following section provides an outline of an indicative delivery programme based on past precedents, and as such, is approximate at this stage. It includes next steps for the business case development process.

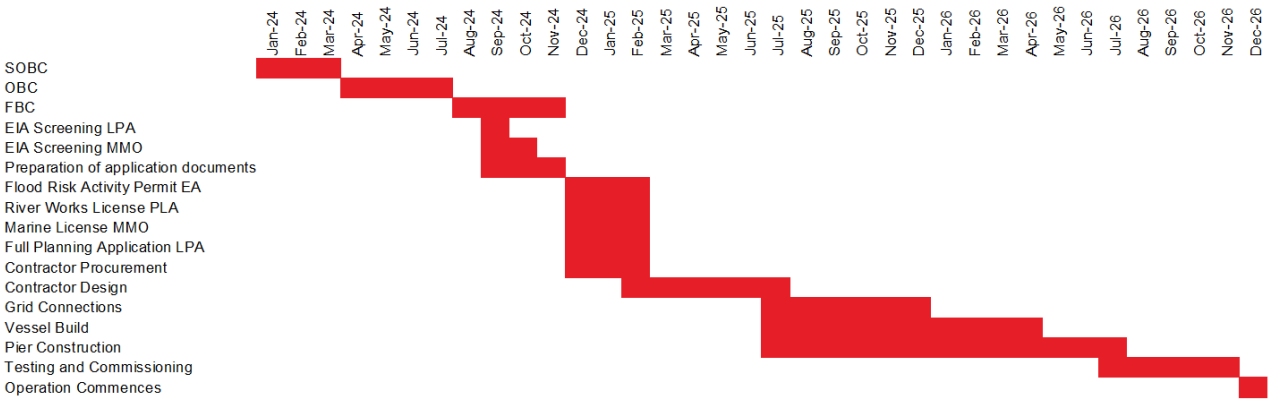


Figure 25 Outline Programme

6.8 Key risks and opportunities

An initial risk matrix outlining the risks and opportunities that may impact the delivery of the cross-river ferry service along the Thames is outlined in Table 3: Risks and opportunities.

Table 19: Risks and opportunities

Risk	Description	Impact	Mitigation	Post-Mitigation Impact	Owner
Construction costs overrun	Capital costs of the river crossing are more than anticipated, due to programme overruns or external factors such as inflation.	High likelihood Medium overall impact (cost, time)	Use of a wide range of cost benchmarks to determine cost estimates. Contingency and optimism bias added to the costs.	Medium likelihood Medium overall impact	PLA
Securing funding	Funding for scheme is challenging to secure, especially against backdrop of tightening of government finances.	High likelihood High overall impact (cost, time)	Further exploration of alternate funding sources and commercial models.	Medium likelihood Medium overall impact	PLA
Demand for ferry services	Low patronage due to low modal shift / induced demand.	Medium likelihood High overall impact (low patronage and revenue)	Monitor and secure benefits realisation.	Medium likelihood Medium overall impact	PLA
Delays	The opening date may be missed, due to delays in design, procurement, consenting or construction.	High likelihood Medium overall impact (cost, time)	Construction period timeline will be updated in the next phase. This will include identification of opportunities to reduce the construction period.	Medium likelihood Low overall impact	PLA
Technical deliverability	Aspects of the scheme are not technically deliverable (i.e. dredging, pier access, energy availability).	Medium likelihood Medium overall impact (cost, time, quality)	Work to date suggests that the scheme is broadly technically deliverable, with the systems proposed being operational in other metro systems.	Low likelihood Low overall impact	Contractors

6.9 Next steps

Further work will need to be undertaken to progress the scheme, including:

- **Work with Mayoral candidates, TfL and GLA towards a commitment in the next Mayor's Transport Strategy**.
- **Build consensus:** Each of the shortlisted sites identify the need to construct a new pier. The new piers could potentially serve other along-river services in addition to this scheme. Partnerships with other stakeholders, such as existing operators, Thames Clippers, could allow costs to be shared. Further work could be undertaken to identify opportunities to rationalise along-river services, including modifications such as reducing the number of stops on existing RB4 services for example. This could create a more integrated river transport scheme, providing a crossing at the shortlisted sites as explored through this study, whilst sharing costs accordingly.
- **Convene a Project Board**.
- **Work with potential funders**. Including DfT.
- **Outline business case, full business case and concept design development**: Concept designs need to be developed for the chosen selected site to inform detailed economic and financial analysis. This would need to take into consideration site-specific characteristics and constraints such as the need for dredging.
- **Undertake market testing**: Further engagement will be needed to test the appetite from the market for the scheme, including identification of potential private partners for vessel design and delivery. As outlined in the technology options review, we suggest that due to the constraints of operating on the Thames, free running vessels will be the more appropriate solution, with battery electric ferries being more appropriate than hydrogen, subject to sufficient power being supplied to the berths. Further engagement will need to be undertaken with DNOs to determine local electricity capacity at selected sites.
- **Review suitability of existing infrastructure**: Each of the shortlisted three options identify the use of at least one existing pier. A detailed assessment of asset condition and suitability for the proposed vessel will need to be undertaken.
- **Further demand modelling**: An initial assessment has been undertaken to determine demand at each of the short-listed sites using a range of different point estimates. Further detailed analysis will need to be undertaken.
- **Further analysis is needed to determine whether existing pier infrastructure can be used**: Using or adapting existing pier infrastructure presents an opportunity to reduce costs, risks and programme. Nonetheless, modifications to existing piers are likely to be required to safety accommodate both cross-river and along-river services, plus additional passenger throughput. Ownership and governance of existing pier infrastructure could create challenges for adopting infrastructure, particular if for multiple service providers.
- **Further consultation is needed to deliver a solution that works for all river-users**: The Thames is a busy waterway, with a diverse range of users and varying environmental conditions. The safe navigation of both cross-river and along-river traffic at the crossings will be a key driver for operations and supporting infrastructure. This will need further exploration in consultation with key stakeholders during subsequent stages.
- **Based on initial estimates, a service could be operational by 2026**: Based on a high-level programme – initial estimates on timeframes for consenting, procurement, design and construction indicate that the service could be operational by 2026.

7. Conclusions

This report has set out the strategic, economic, financial, commercial and management cases for new zero emission river crossings in east London. In conclusion:

- There are three good route options. Prioritisation will depend on timing of nearby developments, and further work on river operations. Whilst the Isle of Dogs – North Greenwich has the highest ridership, and the highest benefit-costs ratio, the Royal Wharf Charlton has a high induced travel and offers better integration with the Charlton Riverside development (if the eastern pier can be taken forward). The Barking – Thamesmead option may be some years behind. There is an opportunity to stage all three options over the next 5-15 years.
- There are significant opportunities to develop the new services with housing and redevelopment.
- Broadly speaking, the ferries can be accommodated within existing river movements, and achieve reasonable journey times and frequencies. But there are operational constraints to overcome.
- There are plenty of global precedents for electric ferries. Many other cities, including Amsterdam and Auckland, provide real-life case studies. There are now many manufacturers of equipment, and the supply market is capable of delivery.
- Broadly speaking, there is strong stakeholder support and a fit with wider stakeholder objectives. That said, further work is needed to overcome local concerns about wear and tear on existing infrastructure, and potential additional infrastructure on desire lines approaching the new pier sites.
- Funding is perhaps the largest challenge. In an environment with less traditional government funding available, even securing contributions from many different sources will require a government contribution and potentially “breaking some eggs.”

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A.1 Long-list options summary

Figure 26 Long list sifting outcomes

		Site 1	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*	*Site 8*
		Pimlico to Battersea	**Rotherhithe to Canary Wharf**	**Isle of Dogs to North Greenwich**	**Royal Docks to Charlton**	**Gallions Reach to West Thamesmead**	**Barking Riverside to Thamesmead**	**Barking Reach to Crossness**	**Rainham to Belvedere**
Location	Proposed use of piers	**North side**: New pier at Pimlico possibly between Lupus Street and Churchill Gardens Estate **South side**: Battersea Pier	**North side**: Canary Wharf Pier **South side**: Nelson Pier	**North side**: New pier - two possible options a) upstream of South West India Dock entrance or b) downstream of Blackwall entrance **South side**: North Greenwich Pier	**North side**: Royal Wharf Pier **South side**: New pier at Charlton - possibly between Lombard Wall and Anchor and Hope Lane	**North side**: New pier at Gallions Reach - possibly downstream of Gallions Point Marina **South side**: New pier at West Thamesmead - possibly upstream of Gallions Reach Park	**North side**: Barking Riverside Pier **South side**: New pier at Thamesmead possibly between Linton Mead and Thamesbank Place	**North side**: Barking Riverside Pier **South side**: Potential to use Crossness STW Jetty	**North side**: New pier at Rainham, possibly near Ferry lane **South side**: New pier at Belvedere, possibly near Corinthian Manorway
Technical viability	Constraints and opportunities for infrastructure and operations	1	2	2	2	1	2	1	1
		Narrow part of the river - less space to accommodate accessible pier infrastructure but also reduced distance to sufficient water depth and shorter crossing distance. New pier and new power supply required at Pimlico (north side). Existing Battersea Pier (south side) has the potential to be used/adapted. New vessels and upgraded power supply required. Interface with recreational users of the river and existing along river ferry services - significant navigation risk would need to be explored.	Narrow part of the river. This proposal is an upgrade of the existing Hilton Hotel - Canary Wharf service, with upgraded infrastructure for increased landside capacity, dedicated cycle access, and new vessels, whilst making use of existing infrastructure where possible. Canary Wharf Pier (north side) and Nelson Pier (south side) with potential to be used/adapted. Upgraded power supply required. Navigational constraints include existing along-river and cross-river ferry services and interface with along-river traffic including larger ships than upstream sites. Challenging accessible access, particularly on the south bank.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel particularly on the north side. New pier likely needed on Isle of Dogs (north side). Two potential locations have been considered a) upstream of South West India Dock Entrance or b) downstream of Blackwall Entrance. North Greenwich pier (south side) can potentially be used. However, crossing distance may exceed desirable service time. Alternatively, a new pier could be considered in the vicinity of Delta Wharf (south side). New vessels and upgraded power supply required. Navigational constraints/risks include turning circle at Southwest India Dock entrance and interface with along-river traffic including larger ships than upstream sites.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel vs. more onerous infrastructure required (when compared with upstream sites) constrained south bank. Potential to adapt Royal Wharf Pier (north side). Likely that new pier is required on the south side in Charlton. New landside approaches may be required at Charlton (south side). New vessels and upgraded power supply required. Navigational constraints/ risks include existing along-river ferry services, interface with along-river traffic including large ships. The site is within Thames Barrier control zone.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel vs more onerous infrastructure required (when compared with upstream sites). Entrance to Royal Docks is used occasionally for access by large vessels and turning area is required in that area of the river. New piers may be required on both sides of the river, but note that a new pier is a possibility within Thamesmead redevelopment. Potential pier location for the north side is downstream of Gallions Point Marina Entrance and upstream of Gallions Reach Park on the north side. New landside approaches may be required at both sides. New vessels and upgraded power supply required. Navigational constraints/ risks include interface with along-river traffic including large ships. The site is within Thames Barrier control zone.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel vs more onerous infrastructure required (when compared with upstream sites). Potential for Barking Riverside Pier (north side) to be adapted. New structure pier and landside approaches may be required on south side of the river but note that a new pier is a possibility within Thamesmead redevelopment. New vessels and upgraded power supply required. Navigational constraints/ risks include existing along-river ferry services, cable tunnel upstream of Barking Riverside Pier and interface with along-river traffic including large ships.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel vs more onerous infrastructure required (when compared with upstream sites). Potential for Barking Riverside Pier (north side) to be adapted. However, crossing distance may exceed desirable service time. Alternatively, a new pier and landside approaches may be required on the north side. Crossness STW Jetty (south side) may be used/adapted. New landside approaches may be required. New vessels and upgraded power supply required. Navigational constraints/ risks include interface with along-river traffic including large ships.	River wider than upstream sites – more space to accommodate infrastructure without interfering with the navigation channel vs more onerous infrastructure required (when compared with upstream sites). Extensive new piers are required on both sides. Both sides of the river are industrial and would require landside approaches. New vessels and upgraded power supply required. Navigational constraints/ risks include interface with along-river traffic including large ships.
Environment and consenting	Environmental or consenting sensitivity	2	2	2	3	3	3	2	2
		Heritage structures in vicinity including Pimlico listed pier wall. More onerous visual planning context than downstream sites. Presence of a number of land-base designations, including safeguarded wharf. Planning permission required for new structures.	More onerous visual planning context than downstream sites. Nelson Docks - listed grade II Planning permission will be required for challenging land access routes.	More onerous visual planning context than downstream sites. Physical constraints given Blackwall Tunnel and Jubilee line tunnel - TfL permits may be required. Listed buildings between Southwest India Dock Entrance and Blackwall Basin Entrance (north side). Planning permission required for new structures.	Less onerous visual planning requirements than upstream sites. Planning permission required for new structures.	Less onerous visual planning requirements than upstream sites. Land-based designations include: SSI Impact Risk Zone. Planning permission required for new structures.	Less onerous visual planning requirements than upstream sites. Land-based designations include: SSI Impact Risk Zone. Planning permission required for new structures.	Less onerous visual planning requirements than upstream sites. Land-based designations include: SSI Impact Risk Zone and Local Nature Reserves. Priority Habitat inventory - Coastal Saltmarsh.	Less onerous visual planning requirements than upstream sites. Land-based designations include: SSI Impact Risk Zone, Local Nature Reserves, Site of Special Scientific Interest Unit – Unfavourable Declining (north side) Nitrate Vulnerable Zones 2017 Designations (England) Priority Habitat inventory - Coastal Saltmarsh. Planning permission required for new structures.
Cost	Relative Cost	2	3	2	2	1	2	3	1
		Moderate	Lower	Moderate	Moderate	Higher	Moderate	Lower	Higher

		Site 1	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*	*Site 8*
		Pimlico to Battersea	**Rotherhithe to Canary Wharf**	**Isle of Dogs to North Greenwich**	**Royal Docks to Charlton**	**Gallions Reach to West Thamesmead**	**Barking Riverside to Thamesmead**	**Barking Reach to Crossness**	**Rainham to Belvedere**
Strategic Fit	Supports the community	1	1	2	2	3	3	1	1
		Less deprived than many comparators, but close to Churchill Gardens estate on Pimlico side and some social housing in Nine Elms. Pimlico is in the 30% least deprived neighbourhoods in the UK; Battersea falls in the 30% most deprived neighbourhoods. Census 2021 suggests that there is high density of residents deprived in at least one dimension living in proximity to the proposed Pimlico site, and a moderate density in the Battersea site.	Less deprived areas, and few larger social housing estates within walking catchment. Rotherhithe falls within the 50% most deprived and Canary wharf being within the 20% least deprived neighbourhoods in the UK. There is moderate density of residents deprived in at least one dimension living in proximity to the proposed Rotherhithe site, and a low density in the Canary Wharf site.	Some social housing within North Greenwich and Isle of Dogs developments. Serves deprived neighbourhoods, with Greenwich in the 20% most deprived neighbourhoods and Isle of Dogs in the 40% most deprived in the UK. There is a moderate density of residents deprived in at least one dimension living in proximity to the proposed Isle of Dogs site, but a low density in the North Greenwich site.	Royal Wharf has some residential nearby, with some social housing in developments near the riverside, whereas Charlton is mostly retail and industrial uses. More broadly, Charlton falls in the 40% least deprived neighbourhoods and Royal Wharf in the 50% most deprived in the UK. There is a moderate density of residents deprived in at least one dimension living in proximity to the proposed Royal Docks site, but a low density in the Charlton site.	Serves Thamesmead estate. Gallions Reach in the 20% most deprived in the country, and West Thamesmead within the 40% most deprived neighbourhoods. There is a moderate density of residents deprived in at least one dimension living in proximity to the proposed sites.	Serves Thamesmead estate and the significant affordable housing in Barking Riverside development. Both north and south sites in the 30% most deprived neighbourhoods in the UK. There is a low density of residents deprived in at least one dimension living in proximity to the proposed Barking Riverside site, but a high density in the Thamesmead site.	Little local residential at present, but wider Barking is in the 30% most deprived neighbourhoods, and wider Crossness within the 40% most deprived neighbourhoods in the UK. There is a low density of residents deprived in at least one dimension living in proximity to both sites, reflecting the low population density overall.	Mostly industrial uses, with little residential on both sites of the river. Within broader catchment, serves somewhat deprived neighbourhoods, with Belvedere in the 40% most deprived, and Rainham within the 50% most deprived in the UK. There is a low density of residents deprived in at least one dimension living in proximity to both sites, reflecting the low population density overall.
	Catchment of potential users / transport demand	3	3	3	2	1	2	1	1
		Large population catchment and high potential demand. Large numbers of tourist attractions and employers. Battersea pier is destination in its own right.	Large population catchment and high potential demand. Link between offices and leisure activities at Canary Wharf, and housing on Rotherhithe side.	O2, Canary Wharf offices and other docklands attractions, as well as reasonable residential density offer a mix of demand. Large population catchment and high potential demand	Moderate population catchment and moderate potential demand. Retail facilities on Charlton side a few minutes walk inland (although river frontage is currently industrial) may appeal to those accessing from the residential areas on north side. Attractions of Royal Docks on north side are approx. 10-15 minute walk from Royal Wharf pier.	Lower density industrial / retail environment on north side. Moderate population catchment and moderate potential demand on south side.	Links together two new developments with significant social housing. Moderate existing population catchment and good future demand on both sides, with proposed developments at Barking Riverside and Thamesmead.	Industrial land on both sides. Currently low population catchment and low potential demand.	Industrial land on both sides. Low population catchment and low potential demand
	Enables growth	2	2	3	3	3	3	3	2
		The Battersea site is within the Vauxhall, Nine Elms, Battersea Opportunity Area Planning Framework (OAPF) and is in close proximity to the site of the Battersea Power Station redevelopment, a £9bn project transforming 42-acres (over 8 million sq. ft) of former industrial brownfield site into homes, shops, bars, restaurants, cafes, offices and over 19 acres of public space. The proposed crossing therefore maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	Existing service means that opportunities for growth are muted. The sites are within the Canada Water opportunity area and the Isle of Dogs opportunity area. There are a number of large, planned and existing regeneration projects including the Canada Water redevelopment and the Canary wharf central business district, providing over 1.5 million square metres of office and retail space.	Both sites are within Opportunity areas, namely the Isle of Dogs opportunity area and the Greenwich Peninsula opportunity area. The Greenwich site is within the Greenwich Peninsula masterplan site, with 17,500 new homes created as part of the plan. Both sites are surrounded by major employers, with Canary Wharf on the East and the O2 centre on the West. The proposed crossing therefore maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	Both sites are within opportunity areas, namely the Royal Docks and Beckton Riverside OA and the Charlton Riverside OA. Both sites have a number of planned and recently completed developments, such as the Herringham quarter, and Riverscape. The sites have a number of large industrial and professional employers and business parks, such as Tate & Lyle, London City Airport, and Ropery business park. The proposed crossing therefore maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	Both piers are within opportunity areas (Thamesmead and Abbey Wood, Royal Docks and Beckton Riverside) and have a number of large planned residential and commercial developments including Thamesmead waterfront (1,500+ new homes & 100 hectares), Royal Eden Docks, and Royal Albert Dock. The proposed crossing therefore maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	The sites are both within the Mayor of London's opportunity areas: London Riverside, and Thamesmead and Abbey Wood. There are a number of planned commercial and residential developments including Thamesmead Waterfront (100 hectares) and Barking Riverside (65,000m2). The proposed crossing maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	Both sites are within opportunity areas, with the Crossness site being within the Bexley Riverside OA, and the Barking site within the London Riverside opportunity area. There are a number of planned commercial and residential developments including Thamesmead Waterfront (100 hectares), Southmere (1,600 homes), and Barking Riverside (65,000m2). Maximises opportunities for growth through GLA opportunity areas and large regeneration schemes.	Enables some growth through GLA opportunity areas, namely the Bexley Riverside OA and the London Riverside OA.

		Site 1	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*	*Site 8*
		Pimlico to Battersea	**Rotherhithe to Canary Wharf**	**Isle of Dogs to North Greenwich**	**Royal Docks to Charlton**	**Gallions Reach to West Thamesmead**	**Barking Riverside to Thamesmead**	**Barking Reach to Crossness**	**Rainham to Belvedere**
	Addresses a network gap	1	1	1	2	2	2	3	3
		The ferry crossing would reduce the expected pier to pier journey time marginally for a pedestrian by approximately 10-15 minutes (via Chelsea bridge). A ferry crossing at this site would improve overall public transport accessibility as Battersea and Pimlico have PTAL scores of between 2-3 which is relatively poor compared to surrounding areas.	An upgraded ferry crossing at this site would primarily improve cycling accessibility, which currently has to access the service through the Hilton Doubletree Hotel on the south side. Currently from a public transport perspective, the south near Doubletree Docklands Pier (PTAL of 1a-1b - lowest scores), compared to Canary Wharf which is relatively well connected (PTAL score of 5). The current crossing route takes approximately 6 min by the existing ferry link, and over an hour by foot through the Rotherhithe tunnel, which is not recommended for pedestrians due to the exhaust fumes.	Significant overlap with existing Jubilee line service The ferry crossing would reduce the expected pier to pier journey time for a pedestrian (via Greenwich Foot Tunnel that would not take the Jubilee line) by approximately 60 minutes. A ferry crossing at this site would improve overall accessibility as Isle of Dogs is currently relatively poorly connected when compared to the neighbouring Canary Wharf area. Additionally, on the southside, the North Greenwich area has very poor connectivity (PTAL score of 0).	The ferry crossing would reduce the expected pier to pier journey time for a pedestrian by approximately 50 minutes. Woolwich foot tunnel / ferry is nearest river crossing option. A ferry crossing at this site would improve overall public transport accessibility on both sides of the river. Both Royal Wharf and Charlton have PTAL scores <2.	The ferry crossing would reduce the expected pier to pier journey time for a pedestrian (via Woolwich ferry) by approximately 60 minutes. A ferry crossing at this site would improve overall public transport accessibility on both sides of the river, as currently Gallions Reach and West Thamesmead have PTAL scores of 1a and 1b, suggesting poor connectivity.	The ferry crossing would reduce the expected pier to pier journey time for a pedestrian by approximately 60 minutes (via Woolwich ferry). A ferry crossing at this site would improve overall public transport accessibility, for both Barking Riverside (PTAL score of 0) and West Thamesmead (PTAL score of 2) suggesting relatively poor connectivity.	The ferry crossing would reduce the expected pier to pier journey time for a pedestrian (via Woolwich ferry) significantly by approximately 4 hours. A ferry crossing at this site would improve overall public transport accessibility, on both sides of the river. Currently, Crossness has a PTAL of 0, and Barking has a PTAL of 1a, suggesting poor connectivity.	The ferry crossing would reduce the expected pier to pier journey time for a pedestrian significantly by approximately 5 hours (via Woolwich ferry). A ferry crossing at this site would improve overall public transport accessibility, on both sides of the river. Currently, Rainham has a PTAL score of 0, and Belvedere has a PTAL of 1a, suggesting poor connectivity.
	Network integration (active and public transport)	3	3	3	2	2	3	1	1
		Could integrate well with public and active transport links. The site is well-placed for integration with the existing cycle network (Cycleway 8 on the North side), as well as Thames Path walking routes on both sides of the river. Both piers are adjacent to bus stops and within 600m metres of a tube station.	The river crossing could integrate well with public and active transport links. The Ferry would connect the C3 cycle lane on the north bank to the C14 route on the south bank , and both the Thames Path walking routes on the north bank and south bank. There is a reasonably frequent bus service on both sides, and the Canary Wharf is close to Jubilee and DLR stations. However, the Rotherhithe pier is quite far from the nearest tube station.	The river crossing could integrate well with public and active transport links. The Ferry would connect the C3 cycle lane on the north bank to the Q14 route on the south bank. It would link to the Thames Path walking route on the south bank, although there is no path on the north bank at this point on the river. There is a reasonably frequent bus service on both sides, and the North bank is very well connected to the tube and DLR network. The North Greenwich pier is close to a Jubilee Line connection.	The river crossing could integrate well with public and active transport links. The Ferry would connect to the Q14 cycle route on the south bank (although this is slightly further away) and the Thames Path walking route on the south bank, although there is no major cycle route close by on the north bank nor a Thames Path route. There is a reasonably frequent bus service on both sides, and the North bank is well connected to DLR network. The south side is reasonably close to Charlton train station.	The river crossing could integrate reasonably well with public and active transport links. The Ferry would connect to the Q14 cycle route on south bank although there is no major cycle route close by on the north bank. There is a reasonable bus service on both sides, and the North bank is fairly close to DLR connections and would link to the proposed DLR extension on the southside.	The river crossing could integrate reasonably well with public and active transport links. The Ferry would connect up the Q14 cycle route on the south bank and the C42 on the North bank. There is a reasonable bus service on both sides, and the Southbank connects to the proposed DLR extension. The north bank pier wouldn't be close to any rail, DLR or tube connections.	The river crossing would not integrate well with public and active transport links and would need extensive supporting infrastructure. The Ferry would connect up the Q14 cycle route on the south bank. There is a reasonable bus service on both sides The North bank pier would be within 1 km of Dagenham Dock train station and the southside pier would be close to the proposed DLR extension.	The river crossing would not integrate well with public and active transport links and would need extensive supporting infrastructure. The Ferry would connect up the Q14 cycle route on the south bank. There is a reasonable bus service on both sides.
	Congestion relief	2	2	3	2	2	2	2	1
		Provides minimal congestion relief on existing transport routes, such as Vauxhall Bridge and Chelsea Bridge.	Provides minimal congestion relief on existing transport routes, such as the RB4 Ferry route.	Provides some (minor) congestion relief on the existing Jubilee line transport route, and potentially Blackwall tunnel.	Provides minimal congestion relief on the existing RB1 Ferry route.	Provides minimal congestion relief on the RB1 Ferry route, Woolwich Ferry and Woolwich Tunnel.	Provides minimal congestion relief on the Overground and RB1 Ferry route.	Provides minimal congestion relief on the transport network (Elizabeth line, C2C).	May provide minor congestion relief on Dartford Crossing.

		Site 1	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*	*Site 8*
		Pimlico to Battersea	**Rotherhithe to Canary Wharf**	**Isle of Dogs to North Greenwich**	**Royal Docks to Charlton**	**Gallions Reach to West Thamesmead**	**Barking Riverside to Thamesmead**	**Barking Reach to Crossness**	**Rainham to Belvedere**
Outcome	Total Score	**17**	**19**	**21**	**20**	**18**	**22**	**17**	**13**
	Rank	6	4	2	3	5	1	6	8
	Shortlist	Second tier	Second tier	**First tier - taken forward**	**First tier - taken forward**	Second tier	**First tier - taken forward**	Second tier	Third tier

A.2 Demand analysis methods

Modelling route shift demand using origin destination journey data

This method made use of Podaris, a transport accessibility software tool, and travel to work (TtW) data from the 2011 Census. Podaris provided estimates of the journey time (JT) and generalised cost of travel (GCT) between all Middle Super Output Area (MSOA) pairs in Greater London. This was carried out for the existing transport network and for the transport network plus each of the shortlisted crossings. From these outputs, for each of the three crossings, a GCT saving was calculated for every MSOA origin-destination pair, most of which were zero. It was assumed that if the MSOA pair experienced a GCT saving then a percentage of the people travelling between that pair (taken from the 2011 Census TtW data) would shift to using a route that included using the new ferry crossing. These percentage shifts range from 10 – 100% depending on the size of GCT saving. The total demand was calculated by summing of all route shifts from the TtW pairs.

It is important to note that this method only estimates demand resulting from passengers travelling to work and changing routes as a consequence of the new ferry crossing. It does not include new generated demand - new journeys that would not have occurred without the new crossing.

From the 2011 baseline year, demand for other years was estimated by fusing historical trip data for London produced and provided by the Strategic Analysis team in TfL. Working age population forecasts for Greater London (published by the Office for National Statistics (ONS) were then used to forecast demand up to 2043. All assumptions and sources are set out in subsequent sections.

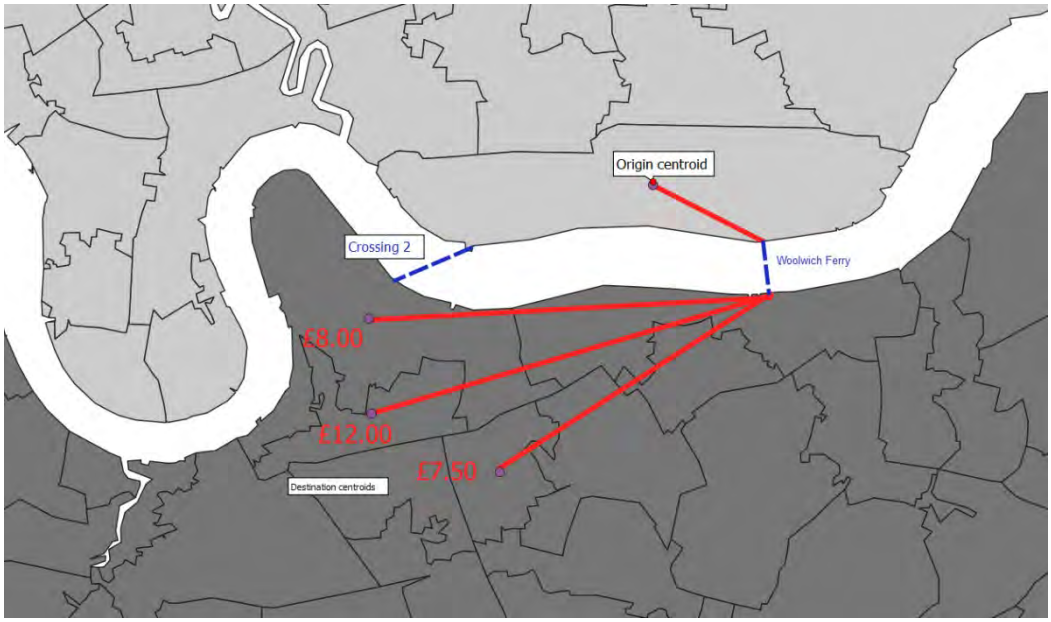

Figure 27: Method 1, High GCT before crossing is implemented.

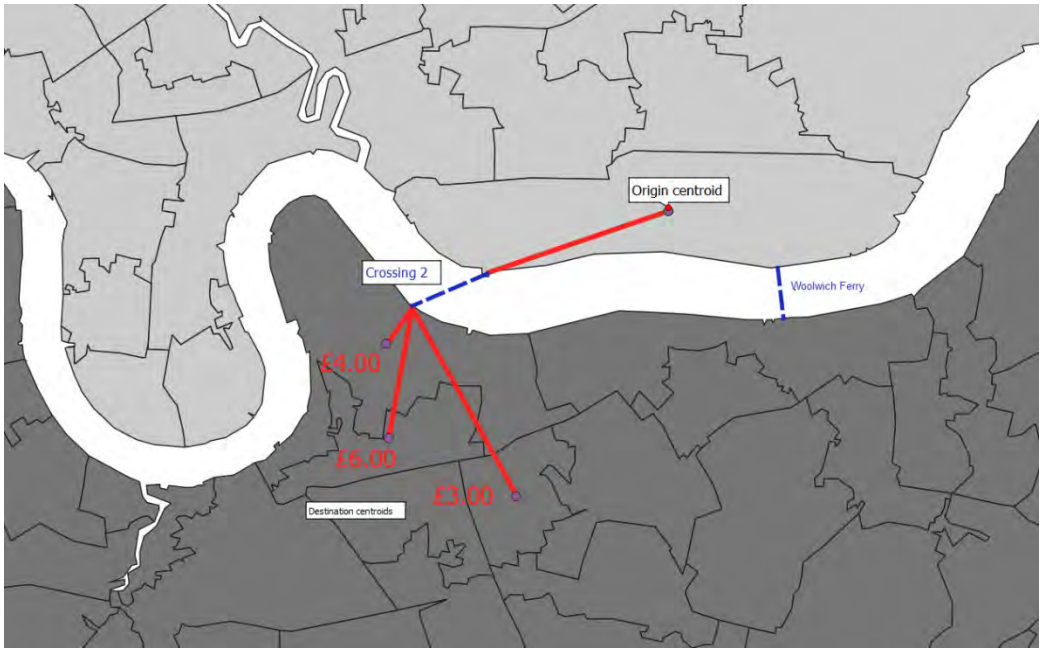

Figure 28: Low GCT after crossing is implemented

Modelling localised route shift demand using river crossings data

Passenger, pedestrian and cyclists counts were used for all relevant crossings across the Thames including the Greenwich Tunnel, Woolwich Tunnel, Woolwich Ferry, RB4 Ferry (from Rotherhithe to Canary Wharf), the London Cable Car, and passengers using the Jubilee Line by entering at Canary Wharf station and exiting at North Greenwich, or vice versa. Demand estimates were calculated using an assumption for the percentage of passengers shifting from existing routes.

The percentage shift depended on the proximity of the new crossing to the existing crossing. The total demand was calculated by summing the route shift demand from all of the existing routes. this method estimates demand for all types of passenger including commuters and leisure passengers. As with the previous method, this method estimates the demand resulting from passengers changing routes and does not include induced demand.

To account for the varying base years within the input data, and to forecast for future years, adjustments were made for pedestrian and cycle trip growth, population growth around origin piers, and employment growth around destination piers (all data used and assumptions made are contained in Appendix A.2).

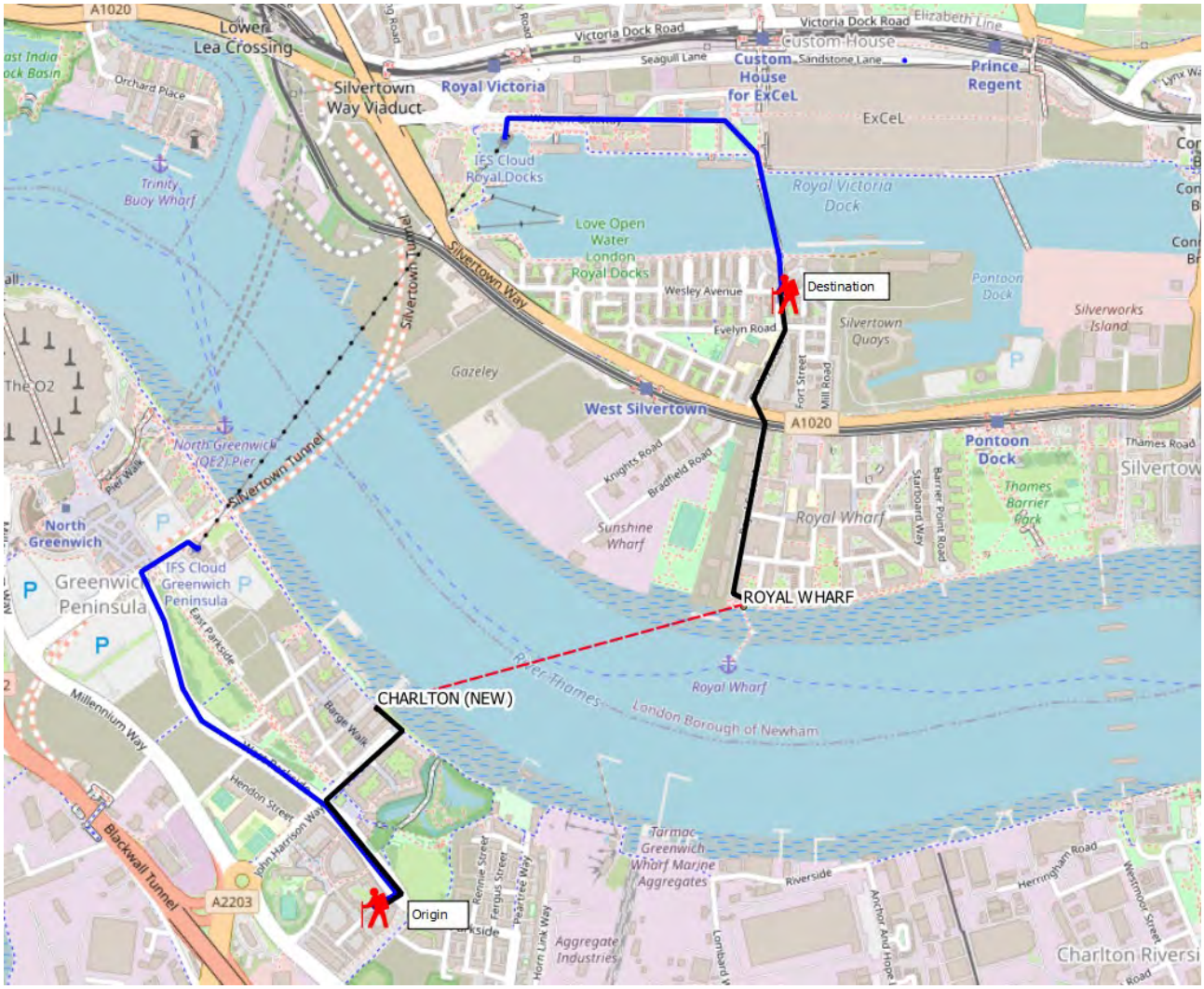

Figure 29: Example journey with route shift from cable car (in blue) to Crossing 2 (in black)

Modelling total demand using benchmarking approach

For this method, passenger data for both the RB4 Ferry route and the Greenwich Foot Tunnel was used as a benchmark. This was scaled up or down using catchment analysis carried out in Podaris. This journey-time catchment analysis estimated the total number of residents within a 15-minute cycle ride of either pier of the proposed ferry route and produced a scaling factor depending on the relative size of these catchments. All assumptions including scaling factors are detailed in subsequent sections. This method, by design, estimates total demand, including route shift and new generated demand.

To account for the various base years within input data, and to forecast for future years, adjustments were made for pedestrian and cycle trip growth, population growth around origin piers, and employment growth around destination piers. Population growth data was amended to include planned developments. Further information on assumptions and data are outlined in further detail below.

The RB4 is a small passenger ferry that connects Rotherhithe to Canary Wharf. The Rotherhithe pier is located within the grounds of the DoubleTree by Hilton hotel which part-funds the service. The service is free for guests but not for non-guests. This was chosen as a benchmark because it is the only other pedestrian and cycle shuttle ferry in the area. It is believed this may provide an underestimate of demand because of the limited access to the Rotherhithe pier, the lack of awareness of the service, and the fact it is not specifically designed for cycles.

The Greenwich Foot Tunnel is a small tunnel that connects Greenwich centre to the southern most point on the Isle of Dogs. There are 87 steps between the surface and the tunnel and a lift. The route is popular for cyclists, however the lift has had extended periods of being out of service (London News Online, 2021). This is considered to be the most appropriate benchmark because it provides an 'arrive and go' service at a location relatively close to the proposed routes.

Modelling induced demand

This method captures newly generated demand, which is the number of passengers using the new crossing that would have otherwise not made this journey. The method assumes that the river acts a barrier between housing on one side and jobs on the other, causing severance. Census 2011 JtW data was analysed to estimate the size of this severance effect for each of these three crossings by comparing JtW demand between MSOAs on the same side of the river with MSOAs on opposite banks. It was assumed that the introduction of the new route would reduce the severance effect and stimulate new generated demand.

A.3 Benefits and cost analysis

Benefits analysis

The core economic benefits resulting from the introduction of ferry crossings include:

- User benefits namely journey time savings.
- The benefit of fare generation to the provider.
- Emissions mitigation.
- Accident avoidance.

There will also be health benefits associated with a shift towards cycling and walking. An overview of benefits and their impact type are outlined in Table 20. Descriptions of the benefits associated with the ferry crossings are provided in Table 20.

Table 20: Benefit mapping overview

Impact type and beneficiary	Impacts	Description	Appraisal method
User benefits	Generalised Cost of Travel saving	Reduction in Generalised Cost of Travel (GCT) which is a combination of journey time savings and monetised preferences relating to mode, wait times and interchanges.	Monetised
Provider benefits	Revenue	The revenue expected from passenger fares	Monetised
Wider economic impacts	Vehicle GHG emissions reduction	Reductions in emissions associated with reduced vehicle trips.	Monetised
	Active travel benefits	Physical and mental health benefits of increased cycling, both to the user and to wider society from reduced absenteeism and reduced risk of premature death associated with improved health	Monetised
	Accident prevention	Benefits to user and wider society of reduced vehicle accidents.	Monetised
Social impact	Community severance and social connectedness	Benefits derived from expected changes that people have with others, such as the potential effects of severance because of the scheme.	Qualitative in sifting
	Accessibility	Benefits derived from changes to key barriers, impacting accessibility.	Qualitative in sifting
	Deprivation	Improves in social vulnerability/deprivation levels due to	Qualitative in sifting

		better accessibility to jobs, education and healthcare.	
Other impacts	Tourism	Increase in tourism due to better connectivity/accessibility.	Qualitative in sifting

The forecast economic benefits draw heavily on the demand analysis with expected demand the key factor in determining the scale of benefits expected. The economic analysis provides a range of Benefit Cost Ratios (BCRs) for each option based on the range of demands provided in the previous analysis. The analysis follows the Department for Transport's TAG appraisal guidance using the following core assumptions:

- An appraisal period of 30 years
- The infrastructure is assumed to take two years to build starting in 2024 with service commencing in 2026.
- Future benefits are discounted at 3.5% for the first 30 years.
- The appraisal year is 2023
- A price base of 2010

A.4 Potential funding sources

Table 21: Long list of funding sources

Category	Description	Funding Source	Fund	Additional information	Generalised scale £	Timeframe
User charges	Revenue from charges towards the use of the service (i.e. Fares)	Fares	N/A	Farebox and farebox supplement for users of the ferry service.	£	N/A
Central Government Grants and Loans	Direct funding / loans towards specific projects or programmes	Department of Transport	CMDC Round 4 – Feasibility Studies and Pre-Deployment Trails	Innovate UK, part of UK Research and Innovation, will work with The Department for Transport to invest up to £34 million in innovation projects to reduce emissions from shipping. These will be to develop and deploy real world operational demonstrations of clean maritime solutions as well as carry out innovative feasibility studies and pre-deployment trials. The Clean Maritime Demonstration Competition (CMDC) Round 4 is part of a suite of interventions launched by the UK Shipping Office for Reducing Emissions (UK SHORE). UK SHORE aims to transform the UK into a global leader in the design and manufacturing of clean maritime technology. The aim of this competition is to fund real world demonstrations, pre-deployment trials and feasibility studies into clean maritime technologies that reduce emissions.	£	Opens: Wednesday 2 August 2023 Closes: Wednesday 27 September 2023, 11am
			Transport Research and Innovation Grants (TRIG)* *DfT in partnership with Connected Places Catapult	The TRIG Programme aims to; foster innovation to improve UK transport, generate growth in the transport sector and build links between policy teams in DfT and innovators. While the competition encourages applications with innovative ideas across all areas of transport as part of our traditional open call, some grant funding gets ringfenced for projects addressing areas like COVID-19 Recovery and Resilient Transport Systems, Maritime Decarbonisation and Future of Freight challenges (as per the TRIG 2021 call).	£	2023 grants awarded. Future dates not yet announced.
		UK Emissions Trading Scheme Authority (UK ETS) – joint body comprising of the UK Government, Scottish Government, Welsh Government and the Department of Agriculture, Environment and Rural Affairs in Northern Ireland	UK ETS	The UK ETS was launched in 2021 to replace the UK's participation in the EU ETS. The scheme incentivises decarbonisation through a process of buying and selling emissions allowances, which companies must obtain for every tonne of emissions they produce each year. Companies that are successful in reducing their emissions can sell unused allowances to other firms.	£	N/A
Regional & Local Government	Use of local transport budgets or use of new revenue raising powers	Local authorities / Mayor of London	Community Infrastructure Levy (CIL), Mayoral CIL and S106	The CIL is a charge which can be levied by local authorities on new development in their area. This only applies in areas where local authorities have consulted on and approved, a charging schedule which sets out its levy rates and has published the schedule on its website. This applies to developments greater than 100 square metres. CIL, Mayoral CIL and S106 payments could potion revenue to be ringfenced to support the scheme. It could be applied to both directly unlocked sites as well as a wider area based on the identified economic impacts of the project. There is likely to be a stronger case for ringfencing a higher proportion of revenues from directly unlocked sites. S106 and CIL are relied upon to fund a wide range of infrastructure that is needed to accommodate growth.	££	N/A
Land value capture	Private contributions from developers	Direct developer contributions	N/A	Private sector contributions- including ad hoc private sector contributions to specific projects. The private sector can provide gap funding for specific projects, reducing the burden on the public sector. However, this funding source is unpredictable and potentially vulnerable to economic downturns.	££	N/A

Category	Description	Funding Source	Fund	Additional information	Generalised scale £	Timeframe
		Transport premium charge (residential)	N/A	A betterment levy on residential property around major transport projects. This provides a more targeted and proportionate way of capturing uplift in residential values than council tax or stamp duty supplements. To note, the Mayor does not have existing powers to implement this, so would need primary legislation (e.g. by amendment to the GLA Act 1999).	£	N/A
Asset commercialisation	Generating revenue from commercialising non-transport assets created from / associated with transport infrastructure	Commercial sponsorships	N/A	Advertising and naming rights on vessels and associated transport infrastructure, including piers.	£	N/A

Funding assumptions

Item	Assumption
Capex and Opex - Royal Docks to Charlton	As per Appendix A4
Funding sources	**All funding materialises as per Table 11 above**
Build out period	2 years (2024 – 2026)
Operational period	28 years (2026 to 2053)
Appraisal period	30 years
Capital spend	60% in year 1, 40% in year 2
Passenger demand figures	Adjusted for elasticities of demand, as per Economic Case
Concessionary fares	50% fare discount for children, over 60's and persons with disabilities has been assumed and incorporated, accounting for around 22.5% of all trips.
Inflation	3% (long-run average, ONS)