

# Thames Vision 2035: Achieving safe and sustainable growth of river passenger transport

Spring 2020

Final report

ARUP



Populus



Image source: Arup

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All recommendations are aspirational and are not endorsed by TfL at this time.

**This report was written before the coronavirus outbreak and therefore does not take account of its impact on travel demand.**

## Our work

Arup and Populus were commissioned by the Port of London Authority (PLA) and Transport for London (TfL) to identify options to achieve safe and sustainable growth in passenger journeys on the Thames in London, Kent and Essex, from the 10m journeys in 2018, in the context of a previous Thames Vision target of achieving 20m annual journeys by 2035.

**This report was written before the coronavirus outbreak and therefore does not take account of its impact on travel demand.**

## Demand growth scenarios

We derived illustrative projections for three scenarios:

- Background growth from tourism and population. This could increase customer numbers to 11-13m (medium estimate 12m) per annum by 2035.
- Scenario 1: Background growth + planned interventions, which could increase customer numbers to 13-15m (medium estimate 14m) pa by 2035.
- Scenario 2: Marketing, customer service and improved peak services, which could deliver around 14-16m (medium estimate 15m) trips pa by 2035.
- Scenario 3a: Contactless capping, off peak demand growth and new piers, which could deliver demand of 18-20m (medium estimate 19m) trips pa by 2035.
- Scenario 3b which also includes lower fares on river bus services and could deliver demand of 19-22m (medium estimate 21m) trips pa by 2035.

## A challenging but achievable target

As such, the previous target of 20m annual trips is achievable by 2035, but continuing on the current trajectory of intervention is likely to lead to demand lower than that envisaged in the Thames Vision: only the more ambitious Scenarios 3a and 3b, which require PLA and TfL investment of £121m-£163m achieve the target.

This level of demand growth is likely to result in a step up in the number of central London river buses and tours movements in the busiest hour from 21 today up to between 26 and 42 in Scenarios 3a and 3b, which will require an increase of river capacity.

Likewise, if left unchecked, there is a risk of negative impacts on the environment from growth, including a potential 80% increase in CO2 and NOX emissions, a decrease in water quality and biodiversity, and higher noise levels. However, when coupled with the forthcoming PLA Net Zero strategy, and adoption of new tech by vessel owners, there is

an opportunity for future emissions to be 50% lower than today, and for water quality, biodiversity and noise levels to improve, even if demand meets the target.

# Executive summary

## Recommendations

- PLA, TfL, GLA and the key operators must set themselves up to deliver a shared set of strategic priorities for the river Thames, including new governance and possibly a River Task Force.
- The industry must focus relentlessly on getting the basics right, including improving awareness, making river buses part of TfL price capping and improving the reliability of the Woolwich Ferry.
- The industry should maximise the capacity of the river, initially through integrated timetable planning, pier extensions, new destination piers, better timetable planning and ultimately a real-time operations centre. We have suggested six new piers as part of this report.
- The industry should look to build up winter and off peak patronage in particular, through winter festivals, and more all-weather facilities at piers, in line with London's global competitors.
- PLA and TfL should secure the delivery of proposed new services, and new piers, (linked to developments where possible) and improve the realm around existing piers, in line with the TfL Pier Strategy.
- PLA and TfL should attract new entrants, encourage competition, enhance innovation and bringing fares down. These measures, along with extra capacity, could be delivered through incentives in river works licences and river services licences.
- PLA and TfL must place extra emphasis on delivering the forthcoming Net Zero strategy, and delivering supporting infrastructure for low emission vessels, and possible tolling of Woolwich Ferry to ensure sustainable growth
- PLA and TfL must monitor this strategy through improved collection of ridership data, regular customer satisfaction surveys, tourism trends and regular pier audit surveys.



Image source: Arup

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# Our approach: process and methodology



## 1. Policy review of vision & objectives

- Review of key policy and strategy documents from PLA, TfL, GLA and MCA
- Identification of key targets including those relating to the environment



## 2. Analysis of past demand, tourism, population trends, competition and market

- Historic demand for passenger services, including seasonality
- Tourism influence over demand for river services
- Changing tourism patterns
- Opportunities to stimulate competition and market growth



## 3. Audit survey of 29 piers and capacity assessment

- Pier operation
- Pier maintenance
- Ancillary uses
- Environmental concerns
- River and pier capacity review



## 4. 535 face to face interviews with the public

- Conducted at 6x selected pier points and nearby streets
- Mix of local residents, workers and tourists (50:50 users/non)
- Customer segmentation based on journey purpose or location
- Focus on drivers and barriers for using the services
- Investigation of new river services



## 6. Global benchmarking of 6 cities

- Workshop with experts from New York, Sydney, Auckland, Hong Kong, Dubai, San Francisco
- Comparison of industry structure and ownership, funding and financing, operations, pricing, transition to net zero, amenities



## 5. 16 interviews with operators, public authorities and other stakeholders

- PLA, TfL, GLA
- Riparian authorities and Environment Agency
- Operators
- Pier owners
- Developers
- Tourism agencies and river custodians



## 7. Demand projections and scenario development

- Identification of relevant interventions
- Development of scenarios for future growth
- Demand assessment of scenarios
- Capacity assessment of scenarios



## 8. Sustainability assessment

- Air quality, biodiversity, climate change, water quality, noise impacts
- Impact of going green



## 9. Compare to 2035 vision

- Identifying which scenario most closely aligns with vision, including 20 million passenger target



## 10. Action plan and recommendations

- Action Plan to 2035 for delivery of interventions
- Key recommendations

# Wider context for considering passenger growth

In assessing passenger growth scenarios, we have considered the wider current and future purpose of the river Thames.



## Thames Vision 2035: Summary of goals and priorities for passenger transport

- Target: Double the number of people travelling by river – reaching **20 million commuter and tourist trips every year.**
- Make more efficient use of piers and river space, including new timetabling to manage peaks in traffic.
- Innovate to achieve more passenger journeys at current low peak times.
- Develop and implement a long-term pier strategy.
- Convene a consultative forum to address issues of waves wash produced by vessels from growth in passenger transport.
- Secure the infrastructure required for growth in the transport of passengers and goods on the Thames.

# River services today

## Overview of river services

Passenger river services served 10.2 million customers in 2018/9. They include three types of services (which do not sum due to rounding):

- River bus (4.2m trips)
- River tours / charter (4.4m trips)
- Woolwich Ferry (1.8m trips)

River bus services are operated by Thames Clippers, serving both commuting and leisure trips. River tours and charter services are operated by a range of private operators including City Cruises, serving the tourism and leisure market. Woolwich Ferry provides a north to south link on the east side of the Thames and is most often used by pedestrians and lorries.

## Who uses river services

River services are used by both London residents and domestic and international tourists. London residents use the service both for commuting and leisure purposes.

## Demand growth over time

Since 2006/7, demand for London river access has grown (although some of this can be attributed to a change in counting method in 2013/14). Increases in river tours / charter and river buses have often outstripped growth in tourism,

employment and the population growth of riverside locations, although the long term upward trend has stalled recently due to the poor visitor year in 2017 and the reduction in reliability on the Woolwich ferry (see right). We suggest that the sector is well-placed to return to growth.

## Seasonality of demand

Much of the demand is concentrated in the peak holiday season, with summer afternoons, when tourist and commuter journeys coincide, being the busiest time of the year (see right). River demand decreases substantially (more so than hotel room occupancy, although it comparable to its counterpart in New York) during the winter months, especially on river tours and charter, which suggests that there is an opportunity for off-peak growth, with the right levels of investment and awareness.

## Key challenges for future growth

Achieving sustainable demand growth up to 2035 requires addressing key challenges including available investment, river capacity constraints, and environmental challenges, amongst others. These have informed the choice of interventions and future scenario development.

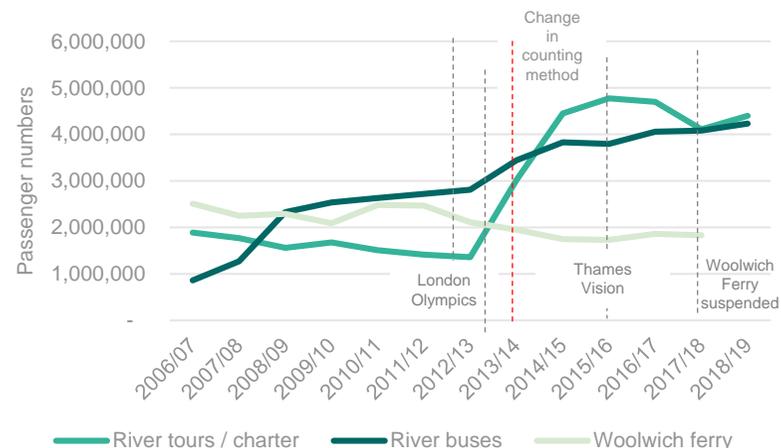


Figure: Annual demand for river services (Source: TfL)

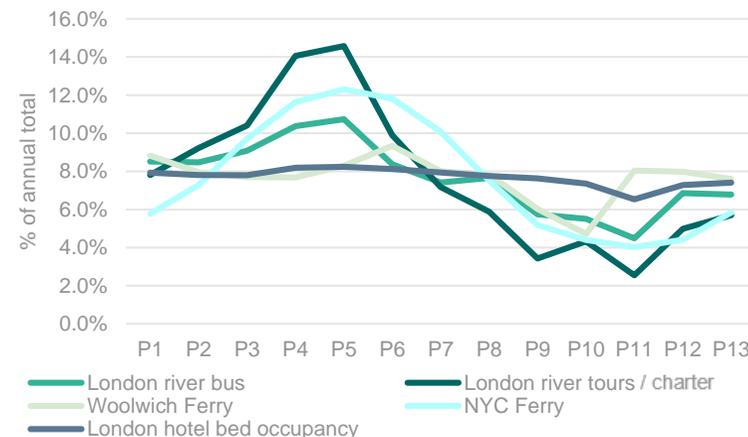


Figure: River Demand 2018/19 - Seasonal river and hotel demand 2018/9 (2017/8 for Woolwich ferry). (Source: TfL, MTA, London and Partners)

# Scenarios for future growth – Overview

The current Thames Vision ambition is to achieve **20 million annual passenger trips by 2035**.

We constructed one background growth scenario and **three further scenarios built incrementally** (with the final scenario separated into two sub-scenarios) to test the contribution of different interventions to assess how this goal may be achieved.

Interventions included in different scenarios can be mixed and combined as implementation plans are developed.

 **Annual trips by 2035 (central projection)**

 **Indicative total cost of interventions (estimated cost to PLA / TfL shown in brackets)**

 **13 – 15m**  
 **£64m (£48m)**

-  Woolwich Ferry reliability improvements
-  Planned services by Thames Clipper (east and others)
-  New Rotherhithe cross river ferry

 **11 – 13m**

- Tourism growth
- Population growth

**Background growth** ↑ **11-26%**  
2018-35 growth

**Scenario 1** ↑ **30-47%**  
2018-35 growth  
Background growth and planned services

**Scenario 2** ↑ **41-59%**  
2018-35 growth  
Improved customer experience and capacity on core services

**Scenarios 3a and 3b** ↑ **77-113%**  
2018-35 growth  
Fares integration & reduction, and new piers offering new routes

 **14 – 16m**  
 **£74 – 78m (£52 – 54m)**

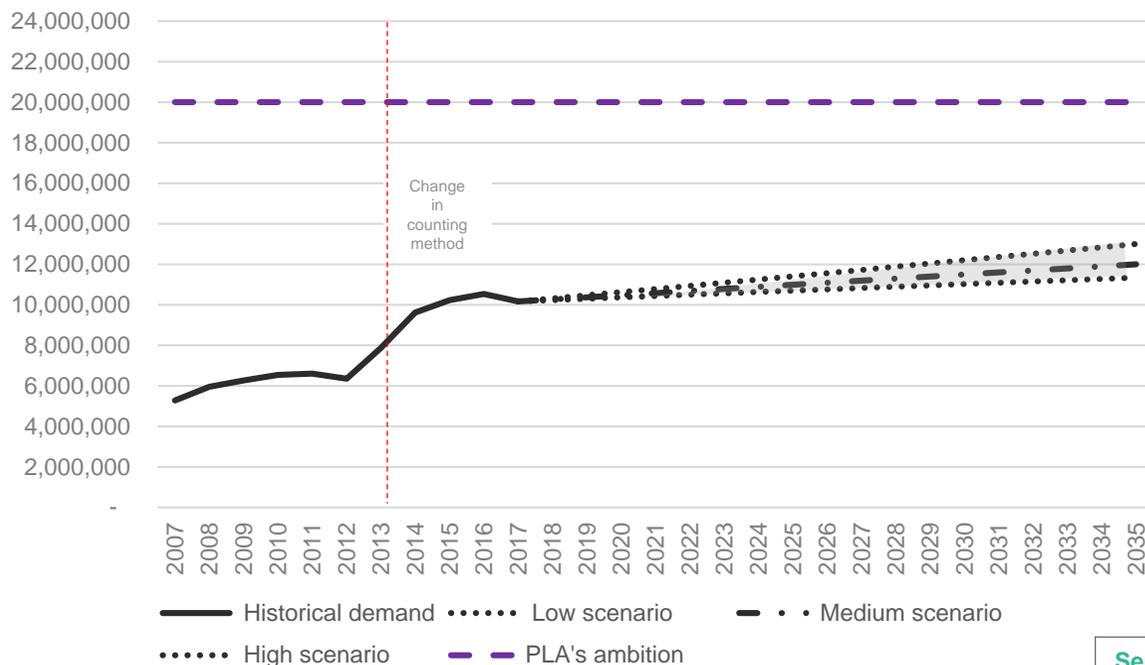
-  Improved peak hour frequencies
-  Flexible berth sharing
-  Vessel and pier quality
-  Accessibility to piers
-  Wayfinding
-  Marketing

 **18 – 22m**  
 **£437 – 606m (£133 – 166m)**

-  Woolwich regeneration
-  Destination piers and improved facilities at existing piers
-  Other cross river services
-  New routes from new and existing piers
-  Fares reduction
-  Contactless capping
-  Off-peak demand growth

# Background growth

Background growth projections\*



**In the absence of further interventions, demand is projected to be about 12 million trips (between 11- 13million trips) by 2035.**

## Summary

Our analysis shows that background growth could increase demand by 11 - 26%, reaching 12 million annual trips in the medium estimate by 2035 (equivalent to a compound annual growth rate, CAGR, of 0.6 - 1.3%). Background growth, without further interventions to increase capacity on the supply side, may be constrained by vessel and river capacity at peak times.

## Key assumptions

We have based our background growth on GLA population and tourism forecasts and previous growth in relation to these indices.

An elasticity of 0.5 has been applied to population growth in riverside boroughs to derive commuting demand for river bus.

An elasticity of 1 for river bus and 0.5 for river tours / charter applied to tourism has been used to derive leisure demand for river bus and river tours.

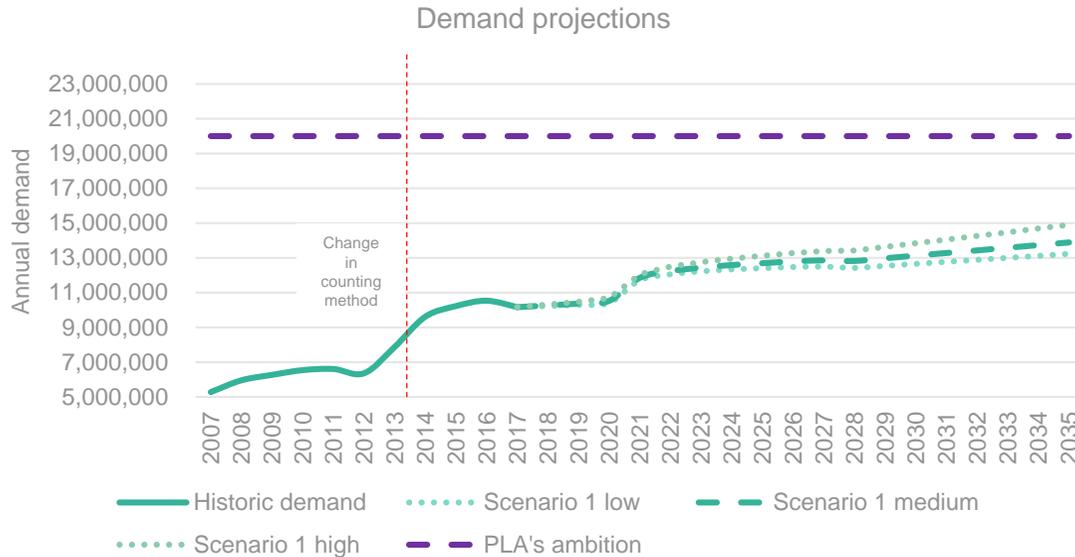
Service type	Annual passenger trips by 2035 (million)	Demand uplift (2018-2035)
River bus	5.1 (4.7 – 5.8)	26% (16 - 42%)
River tours/charters	5.0 (4.8 – 5.4)	18% (12 - 27%)
Woolwich ferry	1.8 (1.8 – 1.8)	0% (0 – 0 %)***
<b>TOTAL</b>	<b>12.0 (11.3 – 13.0)</b>	<b>18% (26 - 28%)</b>

\*Calculations undertaken in calendar years.

\*\*The lowest scenario assumes no population growth and the GLA tourism projections while the high scenario assumes double the population growth and tourism growth projected by the GLA. Information on forecasts and back casting is provided in an Appendix.

\*\*\*Demand accounting methods changed in 2013/14 and therefore previous demand is excluded from the analysis

# Scenario 1: 'Background growth + Planned interventions'



## Summary

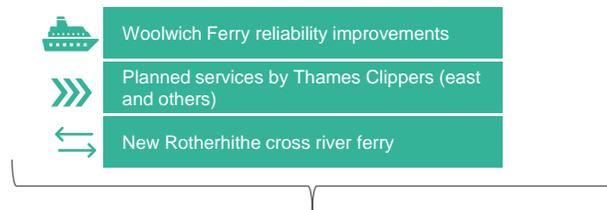
Background growth and planned interventions would be able to deliver approx. 14 million annual passenger trips by 2035.

## Key assumptions

In this scenario we have included Woolwich ferry reliability improvements, Thames Clippers' planned service expansion, and the new Rotherhithe cross river ferry, additional to the background growth.

We have included extensions to some central London piers, for which cases are being made and funding being secured. These will improve reliability at the margins, and pave the way for future growth in frequencies in further scenarios, but are not considered to have any material impact on demand.

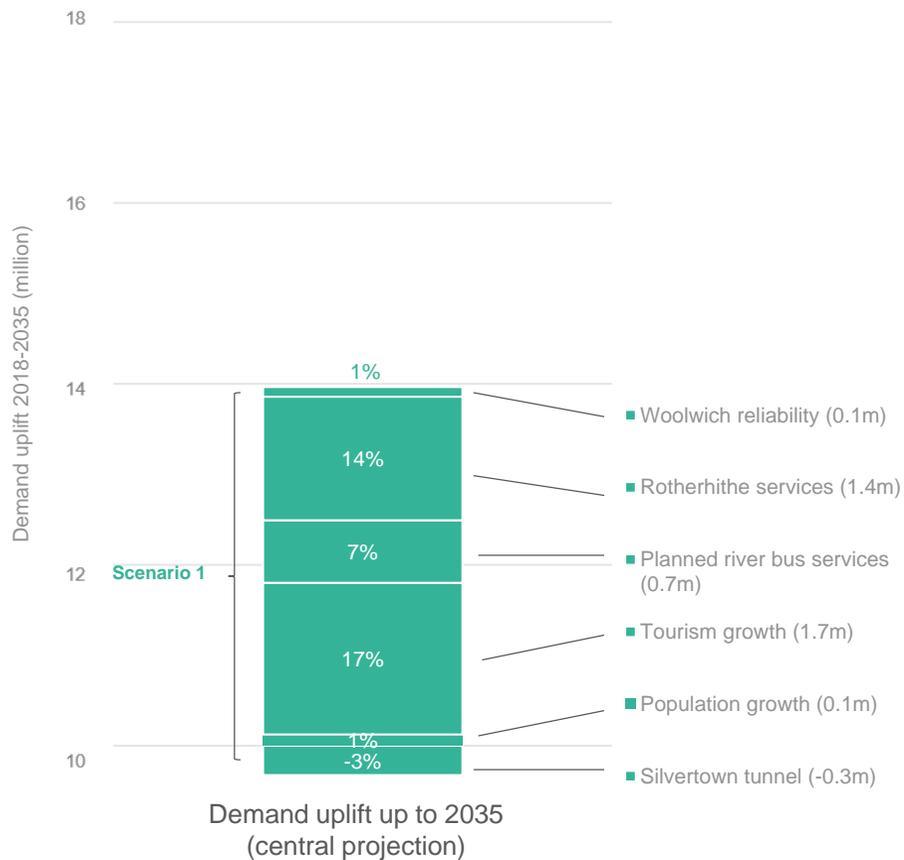
## Interventions\*



## Scenario 1

\*Intervention details in Appendix

# Scenario 1: 'Background growth + Planned interventions'



## Key demand drivers

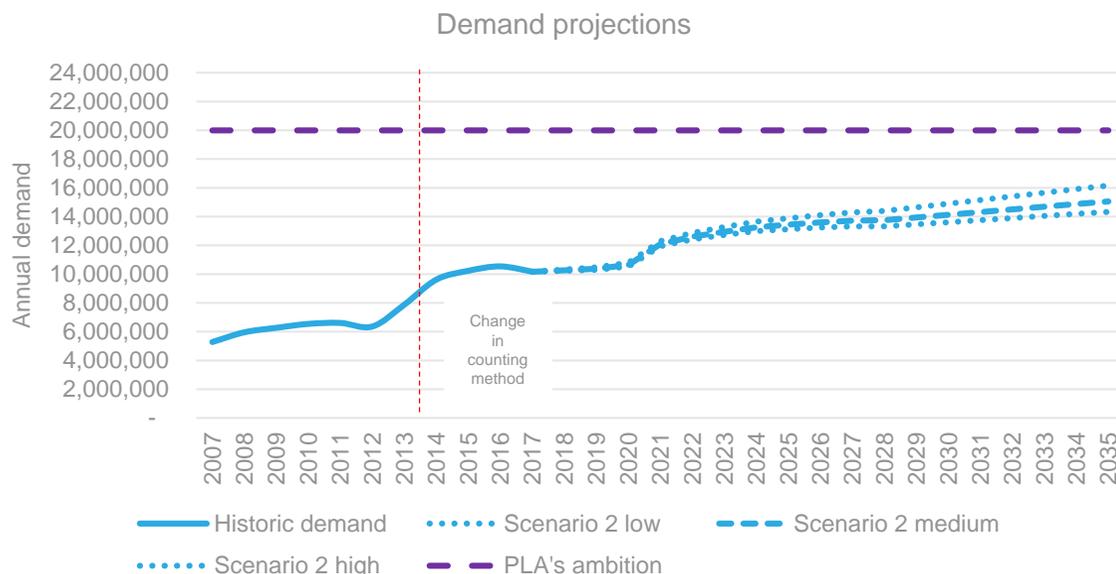
Demand is driven by background growth (mainly tourism growth), the planned new services, including the new Rotherhithe cross river ferry service. Other drivers, including population growth in riverside boroughs, have less of an impact.

Service type	Annual passenger trips by 2035 (million)	Demand uplift (2018-2035)
River bus	7.4 (6.9 – 7.8)	77% (69 - 91%)
River tours/charters	5.1 (4.8 – 5.4)	18% (13 - 27%)
Woolwich ferry	1.6 (1.5 – 1.7)	-14% (-18 - -8%)**
<b>TOTAL</b>	<b>14.1 (13.2 – 14.9)</b>	<b>36% (30 - 47%)</b>

\*Growth may be constrained by capacity. More detailed analysis of capacity and operational modelling would be required to establish this.

\*\*Due to the opening of the Silvertown Tunnel

## Scenario 2: 'Marketing, customer experience and improved peak services'



### Summary

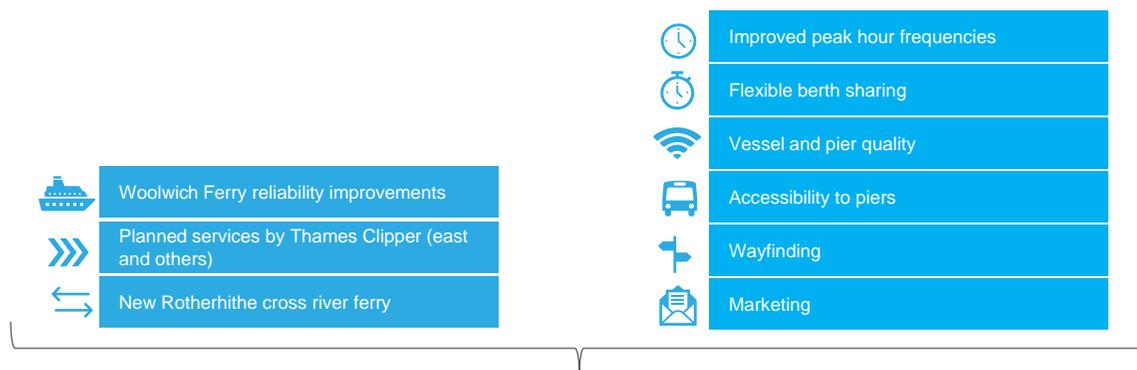
This scenario would deliver demand approx. 15 million annual passenger trips by 2035, enabled by increased capacity at peak times.

### Key assumptions

In addition to planned expansion, in this scenario we include a marketing campaign, wayfinding, better pier accessibility from other modes, and improved peak hour frequencies. These require flexible berth sharing and further pier extensions to implement (pier extensions are captured within the 'improved peak hour frequencies' interventions).

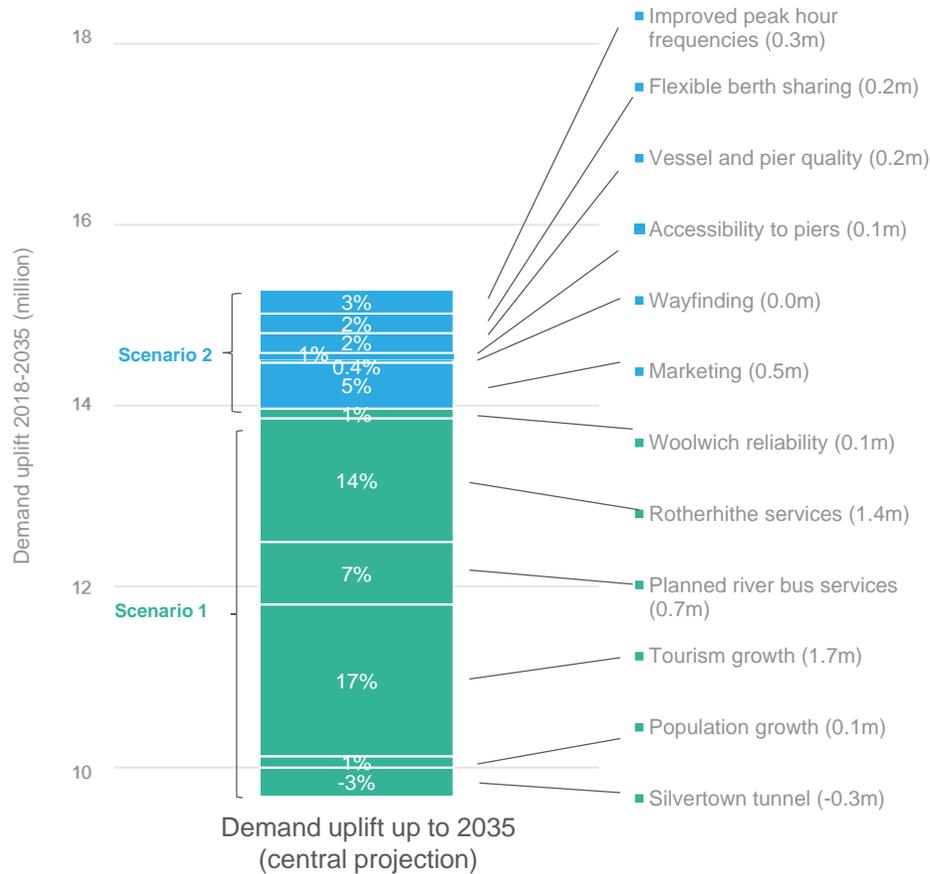
We also include vessel and pier quality improvements, which include providing WIFI and improved services onboard.

### Interventions\*



\*Intervention details in Appendix

# Scenario 2: 'Marketing, customer experience and improved peak services'



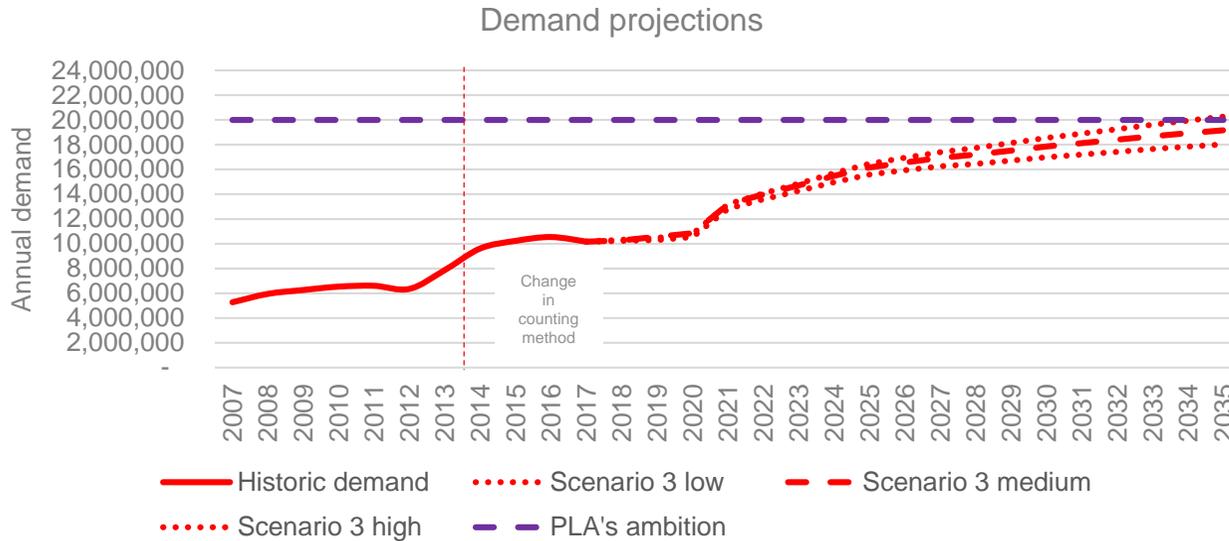
## Key demand drivers

Much of the growth in this scenario is driven by background growth and the planned new services such as Rotherhithe Ferry from Scenario 1. Marketing and improved customer experience, as well as peak capacity expansion also have an impact. Silvertown tunnel has a negative impact on Woolwich Ferry ridership.

Service type	Annual passenger trips by 2035 (million)*	Demand uplift (2018-2035)
River bus	8.3 (7.7 – 8.7)	98% (86 - 110%)
River tours/charters	5.4 (4.9 – 5.6)	24% (16 - 31%)
Woolwich ferry	1.8 (1.7 – 1.9)	1% (-5 - 7%)
<b>TOTAL</b>	<b>15.4 (14.3 – 16.1)</b>	<b>50% (41 - 59%)</b>

\*Figures may not add up due to rounding.

# Scenario 3a: 'Contactless capping, off-peak demand growth and new piers'



## Summary

Demand projections of approx. 19 million annual passenger trips by 2035, enabled by substantial increases in pier capacity.

## Key assumptions

In this scenario we introduce measures to increase winter off-peak demand (such as a large-scale winter river festival), contactless capping on river buses only, new routes and piers, existing pier upgrades, new cross river services further east, and regeneration of the Woolwich area.

Contactless capping is modelled as an average 20% reduction in fares for commuting trips on river buses only.

## Interventions\*

- Woolwich Ferry reliability improvements
- Planned services by Thames Clipper (east and others)
- New Rotherhithe cross river ferry

- Improved peak hour frequencies
- Flexible berth sharing
- Vessel and pier quality
- Accessibility to piers
- Wayfinding
- Marketing

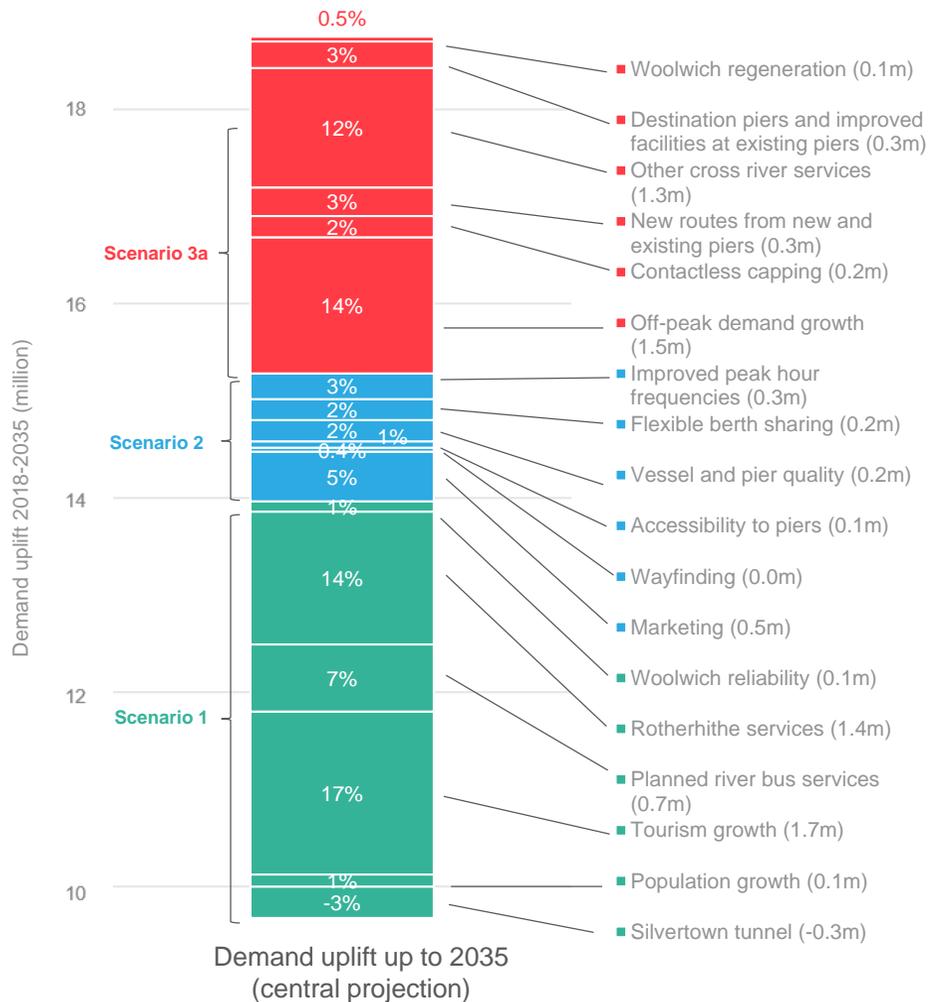
- Woolwich regeneration
- Destination piers and improved facilities at existing piers
- Other cross river services
- New routes from new and existing piers
- Fares reduction
- Contactless capping
- Off-peak demand growth

Not included in 3a

## Scenario 3a

\*Intervention details in Appendix

# Scenario 3a: 'Contactless capping, off-peak demand growth and new piers'



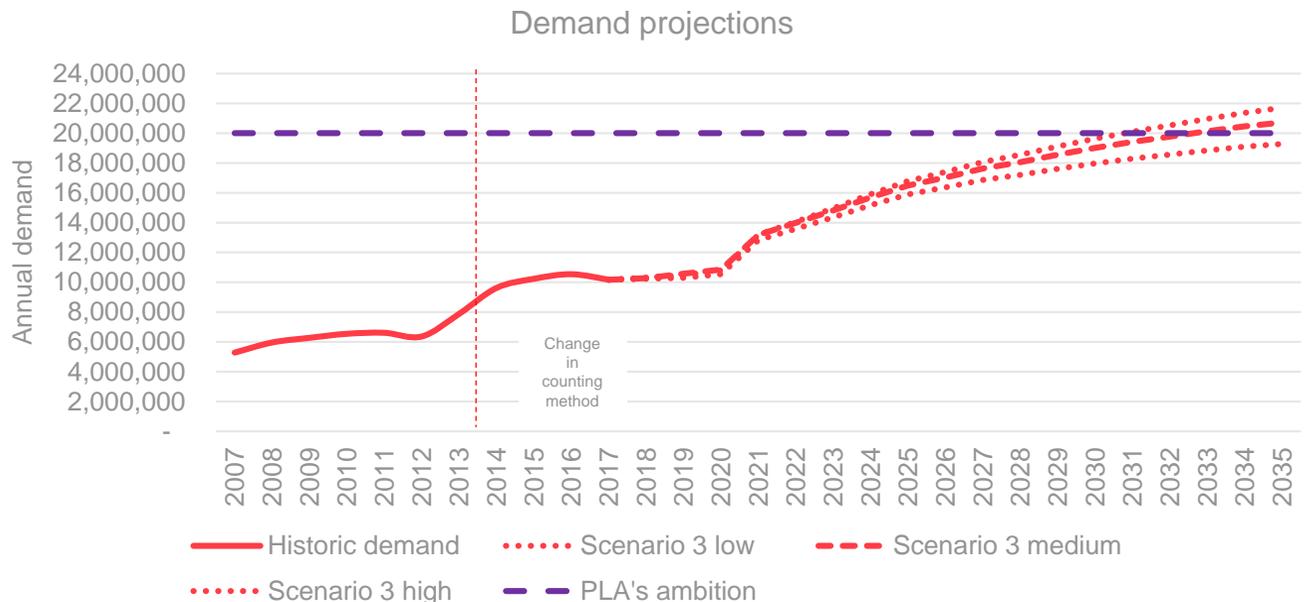
## Key demand drivers

Demand growth is primarily driven by background growth, Rotherhithe ferry and further cross-river services, and off-peak demand growth. Other significant contributors are marketing and customer experience, destination piers and improved pier facilities, new services from new and existing piers, more frequent and new services, and contactless capping.

Service type	Annual passenger trips by 2035 (million)*	Demand uplift (2018-2035)
River bus	10.5 (9.9 – 11.1)	151% (141 - 171%)
River tours/charters	6.6 (6.2 – 6.9)	52% (45 - 63%)
Woolwich ferry	2.1 (1.9 – 2.2)	13% (8 - 21%)
<b>TOTAL</b>	<b>19.2 (18.0 – 20.3)</b>	<b>85% (77 - 99%)</b>

\*Figures may not add up due to rounding.

# Scenario 3b: 'Fares reduction, off-peak demand growth and new piers'



## Summary

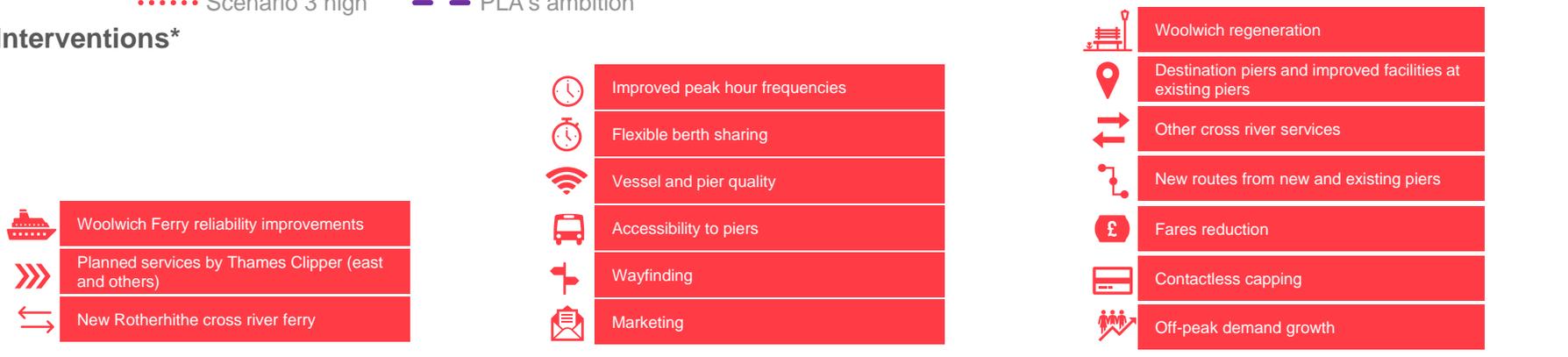
Demand projection of approximately 20 million annual passenger trips by 2035, enabled by substantial increases in pier capacity.

## Key assumptions

In addition to scenario 3a we have included a further 30% reduction in fares to all river bus users.

We have not assumed a change to river tours / charter fares, nor to the complimentary nature of the Woolwich ferry.

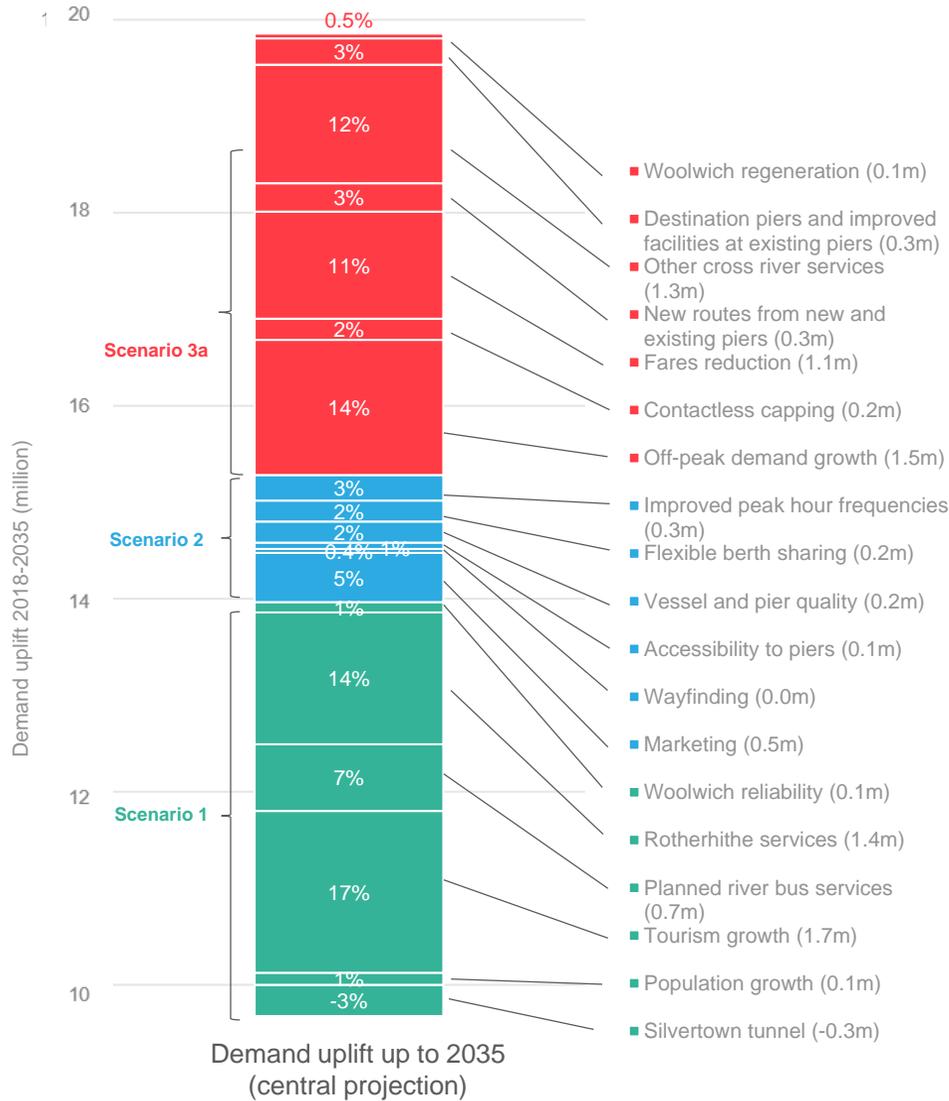
## Interventions\*



## Scenario 3b

\*Intervention details in Appendix

# Scenario 3b 'Fares reduction, off-peak demand growth and new piers'



## Key demand drivers

In addition to Scenario 3a, the fares reduction acts as a significant driver of river bus demand (a further c11%).

Service type	Annual passenger trips by 2035 (million)*	Demand uplift (2018-2035)
River bus	12.1 (11.3 – 12.7)	188% (173 - 208%)
River tours/charters	6.6 (6.1 – 6.9)	52% (44 - 62%)
Woolwich ferry	2.1 (1.9 – 2.2)	13% (7 - 20%)
<b>TOTAL</b>	<b>20.7 (19.3 - 21.7)</b>	<b>100% (90 - 113%)</b>

\*Figures may not add up due to rounding.

# The question of river capacity runs through all of this

There is little capacity for growth in frequency at peak times, although the off peak can absorb some of the growth for buses and a more substantial amount for tours, especially if strategies to grow ridership in the winter season are pursued.

There is also some capacity for peak demand growth through deploying larger vessels and undertaking measures such as flexible berth sharing. But achieving 20m passengers is likely to require a step up in the number of buses and tours movements in the busiest hour, from 21 today and in a business as usual scenario to between 23 and 36 services per hour in scenario 2, up to between 26 and 42 per hour in Scenario 3a and 3b. These estimates are based on the mid-point demand from each of the scenarios above, the range depends on the ability of operators to deploy larger boats, and the success of peak spreading. This potentially doubles the current frequencies in the worst case (see chart).

Increasing supply in the central London river services needs to be delivered within river capacity constraints.

We suggest that the PLA and operators can increase service capacity via more effective use of berths and river space. However under the current operating model there is little headroom to achieve this growth.

In order to facilitate increasing Central London movements beyond 22 per hour† (in both directions) the PLA should also consider the following core changes to river management:

- proactive berth management
- active operational controls (potentially extending the planned estuary control room to be river wide) including passage plan management, use of real-time data and real-time operational management and more active management of ad hoc movement.
- encouraging the modernisation of fleet that meet higher safety standards and manoeuvrability capabilities.

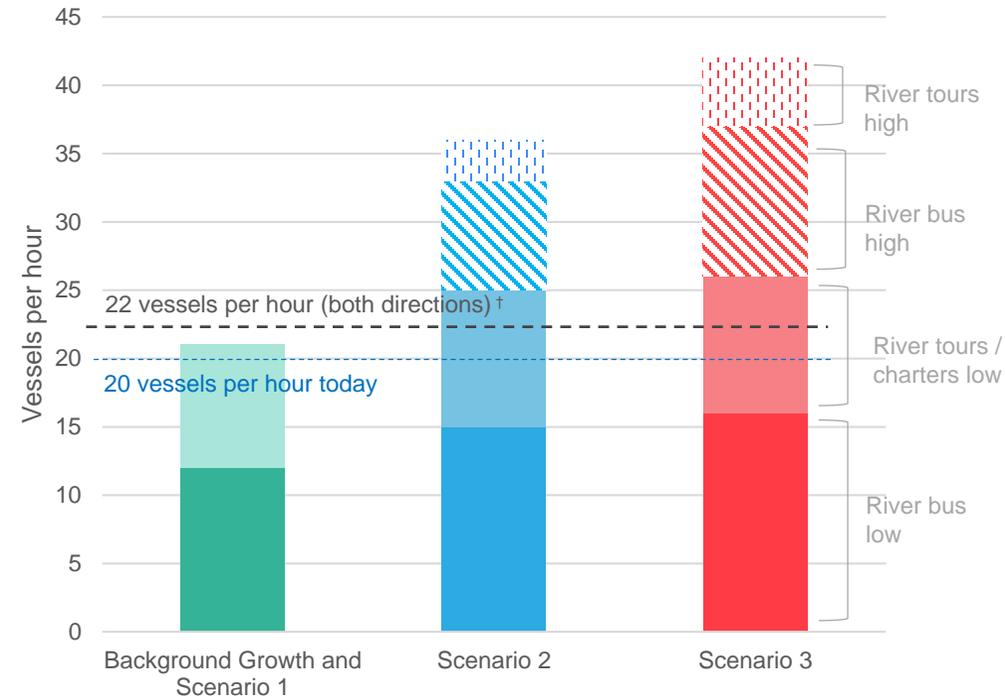


Figure: 2035 peak hour movements in central London (4-5pm)\*. Source: Arup analysis

† Based on discussions with Marico Marine, 22 vessels movements per hour in central London this is considered to be the practical limit based on current constraints

\*Note this only includes services operating in the central area between Tower Bridge and Westminster. The RB4 service is excluded.

# Our sustainability assessment

## Scope of our work

The environmental target in the Thames Vision 2035 is for the Thames to be “the cleanest since the industrial revolution”. We undertook a high-level sustainability assessment of the scenarios, through reviewing the impacts of each of the proposed scenarios on air quality, climate change (carbon), biodiversity, water quality and noise in 2035, against river service operations today.

The scenarios were assessed based on the combination of interventions and their total impact, and impact per passenger, across these measures based on targets set out in key policy documents. Two separate assessments were undertaken; one to understand the impact of interventions if ‘left unchecked’ and the other if ‘green’ measures to meet the targets were introduced. Examples of green measures are shown on pages 21 and 22.

We have used the following metrics in our assessment\*:

Policy / strategy area		Target	Source
	Air quality	<ul style="list-style-type: none"> <li>Reducing NOx and PM by 50% in 2041, with a 20% reduction by 2026 (<i>currently being revised to match the Clean Maritime and Maritime 2050 net zero goal</i>)</li> </ul>	<ul style="list-style-type: none"> <li>Air Quality Strategy for the Tidal Thames, PLA (2018)</li> <li>Five Year Action Plan, PLA (2018-2022)</li> </ul>
	Climate change (carbon)	<ul style="list-style-type: none"> <li>Zero carbon city by 2050</li> <li>Reduced flood risk and associated coastal squeeze via ‘soft’ flood defenses</li> </ul>	<ul style="list-style-type: none"> <li>London Environment Strategy, GLA (2018)</li> <li>Vision for the Tidal Thames 2035, PLA (2016)</li> </ul>
	Biodiversity	<ul style="list-style-type: none"> <li>Net gain in biodiversity, especially sites recognised for wildlife</li> <li>Achieve greater connectivity between habitats.</li> </ul>	<ul style="list-style-type: none"> <li>Vision for the Tidal Thames 2035, PLA (2016)</li> <li>Environment Report, PLA (2018)</li> <li>London Environment Strategy, GLA (2018)</li> </ul>
	Water quality	<ul style="list-style-type: none"> <li>Improved water quality</li> <li>Reduced plastics (including micro/nanoplastics) and other waste</li> </ul>	<ul style="list-style-type: none"> <li>London Environment Strategy, GLA (2018)</li> <li>Vision for the Tidal Thames 2035, PLA (2016)</li> </ul>
	Noise	<ul style="list-style-type: none"> <li>Minimise/ reduce impacts on marine life from underwater noise due to water activity</li> <li>Minimise human noise impacts</li> </ul>	<ul style="list-style-type: none"> <li>London Environment Strategy, GLA (2018)</li> <li>Maritime 2050, DfT, 2019</li> </ul>

\*We are aware PLA is currently undertaking the following throughout 2019/20: Net Zero Roadmap for Inland Vessels (E4Tech); Green PLA and Green Port Programme for the Thames

# Impacts of river services on the environment

The abundance of vessels and installation of piers on the River Thames has had a complex array of impacts on the aquatic environment over time. The environmental impacts include air, water and noise pollution, waste, bed scour and wildlife disturbance and collision. The biggest drivers of environmental impact have been from **vessel movement** and **pier installation**. There are also **local air quality** and **noise** impacts from town-centre lorry movements from the **Woolwich Ferry**. Note these impacts do not include the impact from actions currently being implemented as part of PLA's air quality strategy and forthcoming strategy for environment.



## Air quality and climate change



- **Vessel emissions:** the largest source of emissions on the Thames are from diesel-powered vessels. Emissions on the Thames from vessels have been projected by the PLA for 2020, 2025 and 2030. The emissions calculated are incorporated into the London Atmospheric Emissions Inventory (LAEI). The total emissions of oxides of nitrogen and fine particulate matter which are relevant to local air quality in the LAEI area in 2020 were 378 tonnes and 11 tonnes respectively. Total CO2 emissions in 2020 were 24,795 tonnes.
- **Lorry emissions:** many lorries currently progress through Woolwich town centre and cause local emissions. Woolwich Ferry is outside of the planned ULEZ expansion from Oct 2021.



## Biodiversity

- **Habitat loss from pier and pier installation:** this has been the major impact, with wildlife disturbance peaking around these structures. However, at a few piers in Central London, biodiversity habitat improvement measures have been implemented. For example, at Wandsworth Pier manila rope has been attached to the rear side of the pontoons to provide a perch for grey herons and other water birds. On the Greenwich Peninsula, reedbed habitats have been created on terraces around the piers that also support saltmarsh communities
- **Decline in biodiversity due to increase numbers of and larger motorised vessels:** creating an adverse impact on air, water and noise pollution, waste, bed scour, foreshore erosion and wildlife disturbance and collisions. Vessels on the River Thames have got larger, meaning larger and louder engines, broader and deeper hulls, and more people on board producing waste.



## Water quality

- **Vessel movement resulting in scour, sediment resuspension and erosion leading to habitat loss, water pollution and smothering of habitats:** A number of pier operators, generally to the West, have noted concerns with scour affecting guide piles and berthing pockets and sediment build up at bed level. Scour impacts the River Thames environment by disturbing and eroding riverbed sediments leading to habitat loss, pollution of the water column from nutrients released from suspended sediments, which get deposited upstream and downstream smothering other habitats.

## Noise



- **Vessel engine technologies and increasing numbers of people:** the increasing number of vessels and people on the River Thames can sometimes have a negative impact on people living close to the river.
- **Lorries:** many Woolwich Ferry lorries cause noise, vibration and severance in Woolwich town centre.

# Future impacts from increasing vessels and passenger numbers

If left unchecked\*, there are a range of impacts on the environment that are inevitable with an increase in vessels and overall passenger numbers, as well as increasing the size of some of the vessels. In adopting environmental measures in accordance with the key policy documents, the impacts can be avoided or reduced. Note that mitigation solutions are being implemented as part of the PLA's air quality strategy.



- **Air quality and climate change mitigation:** Work carried out by the PLA and TfL shows that whilst at present river vessels only contribute a very small proportion to overall emissions in London, it is expected that between 2016 and 2030 the percentage will significantly increase without action being taken (due to other sources reducing). The PLA is currently working to reduce these impacts. If left unchecked, increasing vessel numbers with no associated improvements in engine technology will have a detrimental impact on air quality due to an increase in emissions to air. Similarly, an increase in Woolwich Ferry use could lead to an increase in lorries and worsening air quality, in Woolwich town centre.



- **Biodiversity:** This will always result in greater levels of disturbance to wildlife, even with appropriate mitigation. However, wildlife has the ability to thrive alongside humans, even in the most densely populated parts of a city if it is given space to do so, in an environment with minimal pollutants, with as little disturbance as possible.



- **Water quality:** Vessel designs that only consider green fuels and ignore other design improvements, will still impact water quality. In particular, the move to larger vessel sizes will result in an amplification of bed scour and sediment resuspension. There is an opportunity, therefore, to develop alternative vessel designs that produce no emissions, pollution and bed scour. The PLA is exploring hull design for efficient vessels to mitigate this.



- **Noise:** Vessel engines are likely to get quieter in the future, therefore noise levels will probably decline when compared to current acoustic conditions. It should be noted, however, that noise will never be fully eradicated from the river environment as long as vessels continue to move through the water. Additional lorries may cause additional noise in Woolwich town centre.



## Mitigation

Example mitigation strategies included in the PLA's Air Quality Strategy:

- Appropriate standards for emissions
- New or retrofitted vessels with minimal drag, low-impact propulsion methods and low-emission fuel types (electric, hybrid, hydrogen or similar).
- Green tariffs
- Monitoring of river emissions

Further considerations:

- More efficient operations reducing unnecessary dwell time and km travelled.
- New service types that promote sustainable travel modes such as cross-river services promoting active travel.
- Digital ticketing to reduce paper waste.
- Offsetting measures such as wetland creation.
- Consider tolling Woolwich Ferry when Silvertown tunnel opens.

\* Note these impacts do not include the impact from actions currently being implemented as part of PLA's air quality strategy and forthcoming strategy for environment

# Future impacts from increasing and upgrading the pier network

If left unchecked\*, there are a range of impacts on the environment that are inevitable with an increase in and activity around piers. In adopting environmental measures in accordance with the key policy documents, these impacts can be avoided or reduced. Note that mitigation solutions are being implemented as part of the PLA's air quality strategy.



- **Air quality and climate change mitigation:** If vessels using the new piers are not low or zero emission they have the potential to affect local air quality. Adverse impacts on air quality could also arise if there is an increase in road transport in an area, due to a new pier and if combustion sources are used at piers. Pier location should take account of air quality in the vicinity. All impacts depend on technology choices and available technology.



- **Biodiversity:** Achieving biodiversity net gain when new piers are built, or enhancing existing structures to attract river wildlife, will be dependent on the quality of structure design. Biodiversity will be dependent on the extent to which these measures are implemented, and whether they are managed and maintained in the long-term. In particular, the future success of any new habitats or biodiversity enhancements will be dependent on their resilience to a changing climate.



- **Water quality:** Water quality is likely to deteriorate during pier construction, and also due to riverbed scour and bank erosion associated with the new routes. Water quality will be most affected prior to vessel greening.



- **Noise:** Increased noise disturbance is likely at new pier locations due to an increased number of people in close proximity the river. Significant increases in underwater noise disturbance are also likely from new and existing vessels associated with the new piers.



## Mitigation

Example mitigation strategies included in the PLA's Air Quality Strategy:

- Guidance for developers on the use of the river
- Installation of Green technology
- Shore-side power feasibility study

Further considerations:

- New piers should be built with passive provision for infrastructure that will be required to run electric or hydrogen vessels in future (a key point for TfL's revised Pier Design Guidelines for local authorities and developers).
- New piers should be built with passive provision for infrastructure that will be required to run electric or hydrogen vessels in future (a key point for TfL's revised Pier Design Guidelines for local authorities and developers).
- When the technology is mature, PLA and TfL should provide supportive infrastructure such as clean fuels, sewage, and charge points at their own piers, and update TfL's revised Pier Design Guidelines for local authorities and developers to ensure these facilities are provided at new piers.
- Private pier owners could be encouraged to invest in this infrastructure at their existing piers through using river works licences (discounts for pier owners that invest in clean fuels, sewage and charge points).
- Access to the piers needs careful planning consideration to minimise impacts of any road transport accessing the new piers.
- Micro-generation of solar, wind and tidal power from the Thames to power piers.
- Engineering design to enhance biodiversity, water quality, and flood defence.
- Waste / recycling / composting facilities to avoid litter.
- Transit-oriented developments, wayfinding and connections with sustainable transport.
- Avoid locating new piers near sensitive environmental habitats or communities.
- New piers could consider emissions from access to the piers; combustion sources at the pier as well as from vessels.

\* Note these impacts do not include the impact from actions currently being implemented as part of PLA's air quality strategy and forthcoming strategy for environment

## This will also require stakeholder involvement to drive change

A cleaner vessel fleet could be partly self-funded by operators through overall market growth, but is likely to require some funding by PLA / TfL, and/or offering discounts for greener operators calling at TfL-owned piers. River work and river services licences, or separate government funding schemes, could be used to incentivise environmentally friendly behaviour.

### This will require key stakeholders continuing to drive innovation and change. Initiatives could include:



#### New licencing, funding and finance streams

- Stronger environmental conditions and incentives as part of licencing arrangements
- Funding streams / grants to 'green piers'
- Promote sponsorship opportunities for new technology
- Apply to international innovation funds
- Customer option to "opt in" to financial contribution to offset trip



#### Investment in supporting infrastructure

- Clean fuels and offsetting
- Charge or refill points for vessels
- Sophisticated operations and berth modelling systems
- Wayfinding, active travel infrastructure and information around piers



#### Investment in best practice, education and awareness

- 'Green' design guide / modular "kit of parts" for new or refurbished piers, including innovation in production and maintenance techniques
- Creation of 'green' standard asset specifications with pre-planning approval
- Undertake pilot schemes
- Partner with international experts, innovators and promote River Group information-sharing
- Marketing, education and community programmes to drive consumer behaviour and awareness

# If left unchecked: air quality and climate change impacts



## Air quality predictions in a 'Do Nothing' background growth scenario

The London Atmospheric Emissions Inventory (LAEI) estimates the total emissions expected from passenger vessels on the Thames in 2020, 2025 and 2030. The predicted emissions in each year for CO<sub>2</sub>, NO<sub>x</sub> and PM are provided in the table below. The data is based on the current trends. The CO<sub>2</sub> increase is due to increases in vessel numbers, mitigated by a process of upgrading to newer ships and engines. Other factors are also included, such as the use of alternative fuel types, which affect CO<sub>2</sub>, NO<sub>x</sub> and PM differently. The figures do not fully account for the demand projections or sustainability actions described in this report, nor savings from the PLA's Air Quality Strategy, which is currently being implemented.

The 2020 estimate has been used as a baseline for today, in our assessment of the environmental impacts of the Strategy. The 2025 and 2030 projections have not been used and are included for illustration only.

Year	Total LAEI emissions from passenger vessels (tonnes/year)		
	CO <sub>2</sub>	NO <sub>x</sub>	PM
2020	24,800	380	10
2025	31,050	360	10
2030	36,790	340	10

Source: PLA Inventory

# Environmental impact of scenarios – If left unchecked

In a Do Nothing scenario, if environmental mitigation measures were not adopted the impact of river services will become more pronounced, at a time when other industries are ‘cleaning up’. The table below and the following slides present an illustrative assessment of the potential emissions if no measures are adopted. Note the PLA is currently working on a plan to reduce the future environmental impact of river services.

*If left unchecked\* the environmental impact per scenario in 2035 would result in:*

Policy / Strategy		Background growth	Scenario 1	Scenario 2	Scenario 3b
	Air quality (change in emissions)	No significant change	No significant change	--- Significant decrease in air quality (up to 50% increase in emissions)	--- Significant decrease in air quality (up to 80% increase in emissions)
	Climate change (change in emissions)	No significant change	No significant change	--- Significant increase in CO2 (up to 50% increase in emissions)	--- Significant increase in CO2 (up to 80% increase in emissions)
	Biodiversity	No significant change	No significant change	-- Moderate reduction in biodiversity	--- Significant reduction in biodiversity
	Water quality	No significant change	No significant change	-- Moderate decrease in water quality	--- Significant decrease in water quality
	Noise	No significant change	No significant change	-- Moderate increase in noise levels	--- Significant increase in noise levels

The environmental impact, compared to the baseline situation, worsens across all metrics from Scenario 1 to Scenario 3, as more vessels are used:

- **Vessels:** Additional fossil fuel powered vessels will increase local air quality pollutant concentrations and will add to total CO2 output of the fleet. These vessels also produce pollutants and waste that negatively impact biodiversity below water and reduce water quality. Additional lorries will progress through Woolwich town centre. Water quality will be particularly affected around pier structures and along new and existing service routes. Noise will increase above and below water due to greater vessel numbers and increased footfall. Noise will have a particularly significant impact along new service routes.
- **Infrastructure:** If not planned in a sustainable way the piers could encourage landside vehicle traffic. New piers and on-land development will have negative impacts on biodiversity, primarily due to habitat loss, disturbance and pollution. Water quality will be reduced due to pollutants and waste produced by construction activities and landside vehicle traffic. Noise level increases will be particularly high on and around piers and along key service routes, both new and existing.

Please note that the assessment has been undertaken on a **total impact basis. Only impacts from vessels have been modelled.**

\* Note these impacts do not include the impact from actions currently being implemented as part of PLA's air quality strategy and forthcoming strategy for environment

# Ensuring growth delivers environmental improvements

An opportunity exists to use growth as a catalyst for introducing new commitments that reduce the environmental impact of river operations. Achieving high levels of growth in Scenario 3b in a sustainable way is dependent on achieving the goals set out in PLA’s forthcoming Net Zero Strategy for Inland Vessels and Environmental Strategy.

*Adopting measures in accordance with environmental goals would result in the following by 2035:*

Policy / Strategy		Background growth	Scenario 1	Scenario 2	Scenario 3b
	Air quality (change in emissions)	No significant change	+ Small improvement in air quality	+ Small improvement in air quality	++ Significant improvement in air quality (up to 50% reduction in emissions)
	Climate change (change in emissions)	No significant change	+ Reduction in CO2	+ Reduction in CO2	++ Reduction in CO2 (up to 50% reduction in emissions)
	Biodiversity	No significant change	No significant change	+ Small increase in biodiversity	++ Moderate increase in biodiversity
	Water quality	No significant change	No significant change	+ Small improvement in water quality	++ Moderate improvement in water quality
	Noise	No significant change	No significant change	- Small increase in noise levels	-- Moderate increase in noise levels

As a general rule, the environmental impact, compared to the baseline situation, improves across all metrics from Scenario 1 to Scenario 3, for the following reasons:

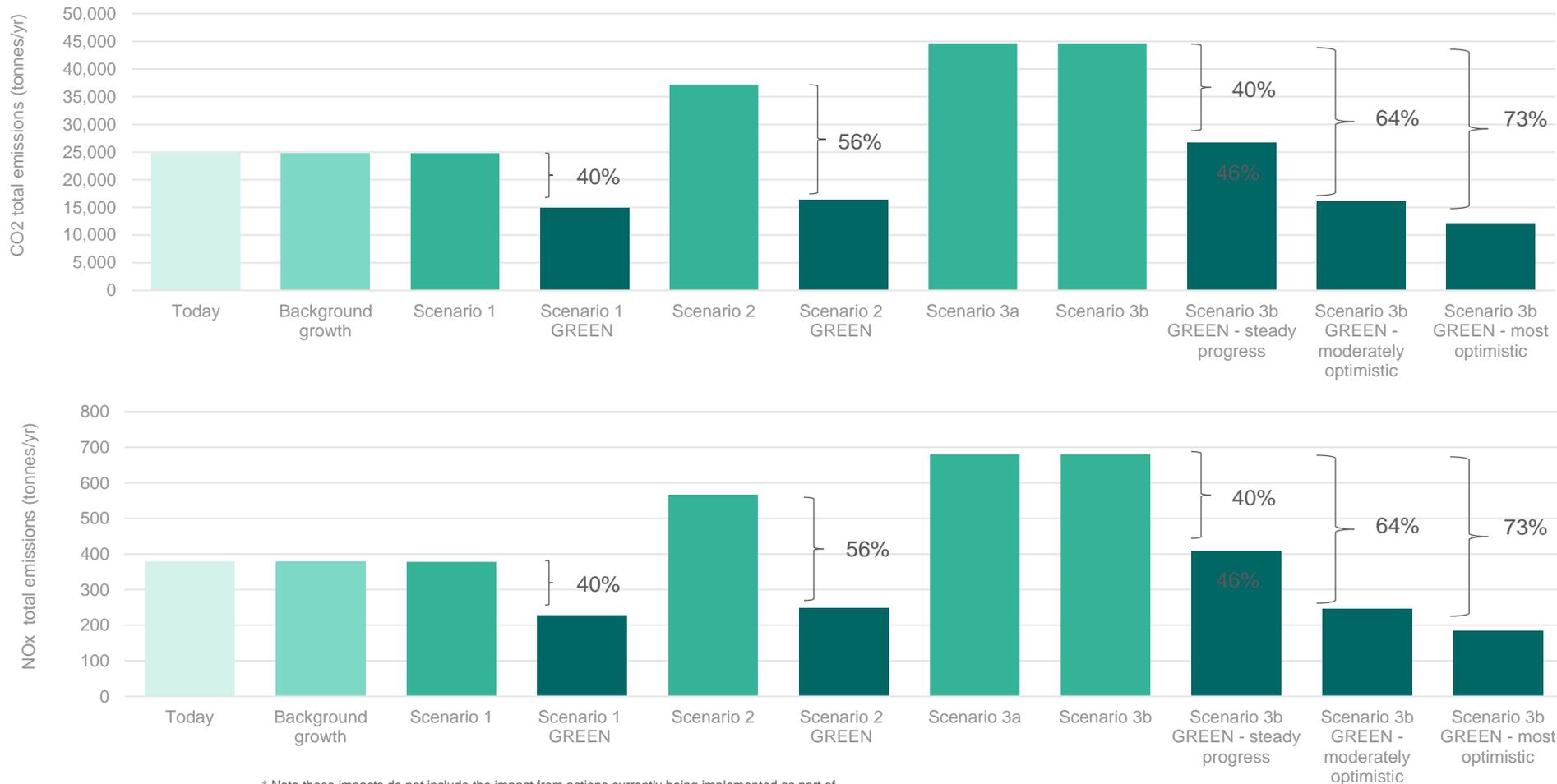
- **Vessels:** Zero or low emission vessels will form the majority of the fleet. These vessels will produce no pollutants or waste that are likely to impact biodiversity and water quality.
- **Infrastructure:** Some piers are likely to be equipped for vessels using alternative sources of energy. Facilities will encourage sustainable modes of transport being used to reach the piers. Biodiversity net gain will be applied across all pier and on-land development sites. New infrastructure will produce zero waste and pollutants. Ecological enhancements on in-river structures will enhance biodiversity and help improve water quality.

The exception to this is noise due to the fact that vessel movement and the presence of passengers on piers and river banks will always produce certain noise levels, both above and below water, that can never be mitigated.

Please note that the assessment has been undertaken on a **total impact basis**. **Only impacts from vessels have been modelled.**

# Future emissions by scenario

If left unchecked, future growth in passenger numbers could lead to an increase in overall emissions. Assuming a robust plan\* to achieving the environmental targets is implemented, the **total emissions** for CO2, NOx and PM10 in 2035 will be **less than today** in the **most optimistic maximum growth scenario (Scenario 3b)**.



(Source: Arup analysis) \* Note these impacts do not include the impact from actions currently being implemented as part of PLA's air quality strategy and forthcoming strategy for environment

# Even without 'going green', emissions are expected to decrease on a per passenger basis



Under each of our scenarios, the **total emissions per passenger** for CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> in 2035 will be **lower than today**. This is driven by higher occupancy rates, larger vessels and the new cross-river services being electrically powered.



Under a **robust plan\*** there is potential for a decrease in 2035 per passenger emissions against a 2020 baseline of between **46% and 76%**. These GREEN scenarios would achieve the PLA's Air Quality Strategy of achieving a 50% reduction in NO<sub>x</sub> by 2041.

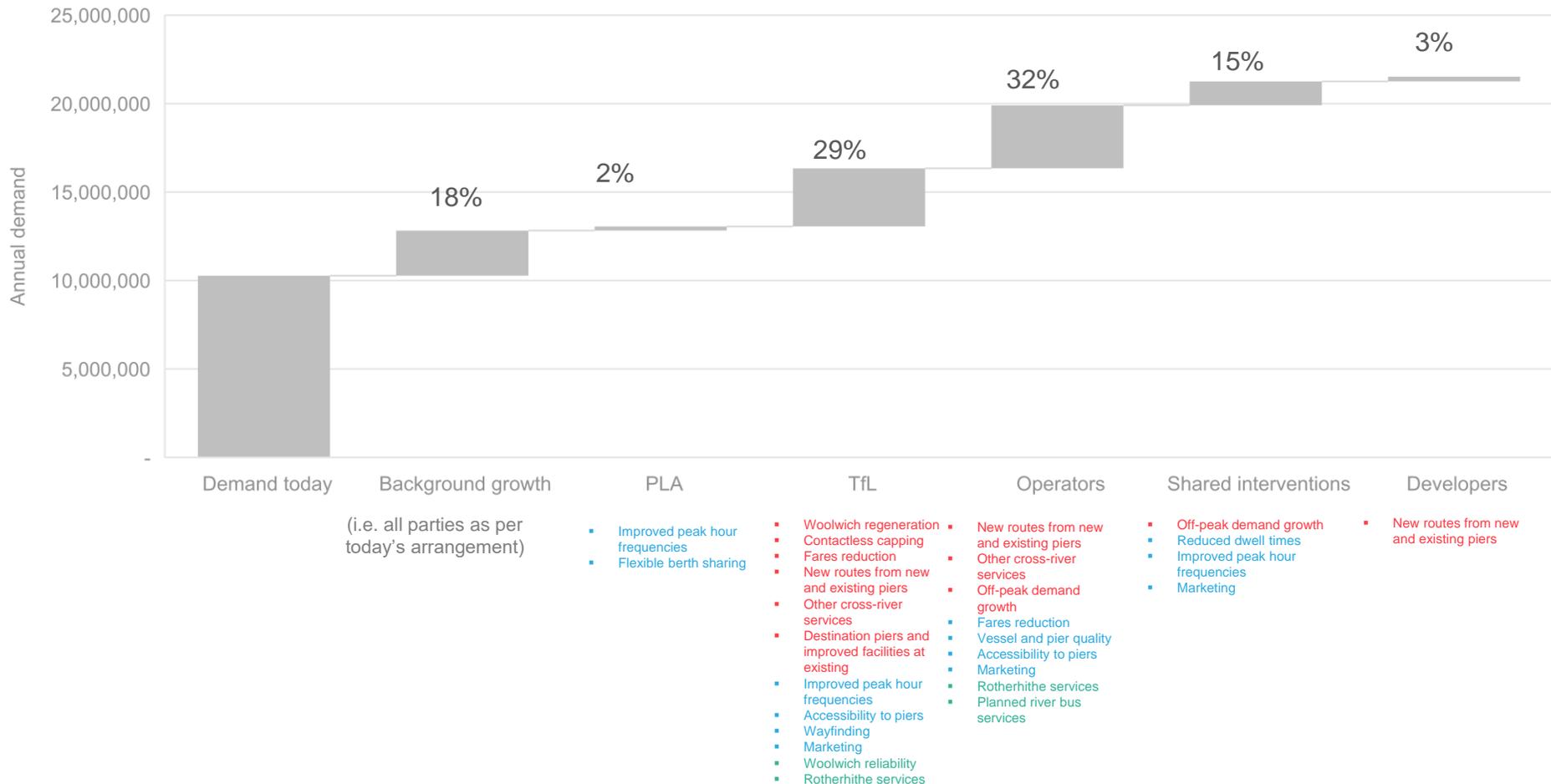


Source: Arup analysis

# No one party can deliver growth – an integrated approach is required

PLA can play a key role in catalysing change across the different organisations and stakeholders involved in providing passenger river services. Note that the business case to deliver the interventions would have to be developed before the partner organisations can commit to investing.

Demand increase potential by delivery partner



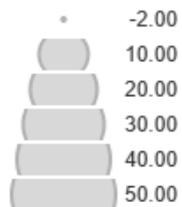
# Comparing the impact vs complexity of interventions

Analysing impact vs. complexity shows that increasing demand in the off-peak and delivering already planned services are easy wins that do not require complex infrastructure upgrades or investments.

At medium complexity, introducing Rotherhithe and additional cross river services could help drive significant demand.

Many other interventions have a lower impact and are high complexity.

## Circle size



## Cost to TfL / PLA (£m2019)



# Recommendations

Our recommendations correspond to a plan of action and the required interventions to achieve the 20m target in Scenario 3a and 3b.



## PLA, TfL, GLA and the key operators must set themselves up to deliver a shared set of strategic priorities for the river Thames

- The industry needs to re-focus on delivery, with clear leadership and governance. A significant rise in passengers per annum by 2035 requires a step change from the business as usual ways of working.
- This could be through a step up of current PLA / TfL industry wide groups to deliver quickly and return sector to growth, potentially the London 2020 River Thames Task Force, a new focused partnership of PLA and TfL to drive through changes, encourage competition, provide strategic direction, look after the interests of customers, and manage conflicts.
- Drive forward the upgrades to the strategic piers, making this a key business priority of the PLA, TfL and other pier owners.
- London River Services (LRS) could be given more prominence in TfL/GLA with a River Commissioner.



## The PLA and TfL must focus relentlessly on getting the basics right and tackling fare alignment

- Work with online journey planners to correctly reflect river services in apps, even if they are more expensive, or slower, in line with TfL's Pier Strategy.
- Include river services (Woolwich ferry and river buses) on the tube map.
- A marketing campaign to improve awareness.
- Better wayfinding, accessibility and integration, in line with TfL's Pier Strategy. Wayfinding from every station / major bus stop next to a pier. Relocate some bus stops to be closer to piers.
- Improvements to the ticketing experience, both at-pier and online.
- Deploy WIFI at piers (in line with TfL's Pier Strategy) and on board vessels.
- Recognise the unique role river bus services play as part of the public transport network in London and include river buses in a form of Oyster / contactless price capping.
- Ensure an improvement in Woolwich ferry reliability



## Maximise the capacity of the river

- Make greater use of integrated timetable planning, through TfL or PLA central resourcing.
- Consider short-term measures such as pier extensions and berth sharing, and a reduced dwell times for river tours to enhance capacity.
- Encourage new larger vessels, potentially through TfL River Services Licences. These would improve the capacity, emissions per customer, and would avoid the costs of works at piers.
- Medium term, encourage flexible berth sharing, potentially facilitated by lower dwell times for river tours, and pier extensions.
- Longer term, encourage greater segmentation of tours and buses through greater use of dedicated and destination piers by tours. Consider harmonisation of speeds and relocation of some central London moorings.
- In due course, implement a real-time operations centre for real-time timetabling, traffic control and delay recovery, controlled by PLA (potentially extending the planned estuary control room to be river-wide).
- Ensure that the availability of personnel, particularly qualified skippers, is not a constraint on growth, potentially through greater use of the Thames Skills Academy.



## Build up off-peak and winter patronage

- Use art and events to create a must-see river-based attraction or winter festival (e.g. Sydney Vivid, Christo's floating piers), in line with TfL's Pier Strategy.
- Consider using contractual mechanisms such as seasonal variation in pier call agreements to drive yield management.
- Provide more enclosed facilities to improve the waiting experience in all weather conditions, starting with the busiest four piers.



## Secure the delivery of proposed new services

- Rotherhithe crossing, the Isle of Dogs – Wood Wharf ferry, City Airport – Charlton ferry (in line with TfL's Pier Strategy), which can act as a showcase for new electric technology and potential new entrants.
- Additional services to the east.
- New services to consider skip-stop to improve journey times, such as Greenwich – Canary Wharf.
- In due course, implement more frequent peak time services in the central zone.



## Make the case for selected new piers, (linked to developments where possible) and improve the realm around existing piers

- Deliver the piers that are already in development.
- Investigate further the six additional piers suggested by us in this report: Fulham, Wapping / Limehouse, Greenwich West, Charlton, King Henry's Dock, Royal Docks areas, which will give almost full walkable coverage of Thames riverside within inner London.
- Further piers linked to major developments and towns further east and work with local authorities to help orientate these developments around the river.
- Work with Environment Agency and London boroughs to encourage new destination piers (note that this is likely to be restricted to a few areas).
- Work with London Borough of Newham to deliver improvements to the public realm and attractions such as cafés, markets etc near Woolwich Ferry Terminal north side.
- Consider the long term spatial influence and integration with planning, allowing greater sight of piers from areas nearby (such as in Sydney West Harbour Authority).



## Find means of attracting new entrants, encouraging competition, enhancing innovation and bringing fares down

- Encourage pier owners to consider holding non-exclusive agreements with individual operators, to allow other operators to help fill spare capacity.
- Encourage more on-river competition through softer side activities such as brochures, assistance and guidance to potential new entrants.
- Consider adopting the Civil Aviation Authority (CAA) approach to capacity created by new investments (50% to new entrants).
- Consider using PLA and TfL powers to remove harder barriers to entry, potentially through providing usage guarantees for new vessels.
- Encourage innovative offers on charters and new ideas for winter services, potentially including an initial period of reduced pier calling fees for new entrants.
- Alternatively, consider more direct intervention, through a London buses-style franchising model for river buses, allowing TfL to control service levels and fares directly.



## The PLA's Net Zero roadmap becomes more important with growing service levels

- A cleaner vessel fleet could be partly self-funded by operators through overall market growth, but is likely to require some funding by PLA / TfL, potentially through a scrappage scheme, and/or offering discounts for greener operators (in lien with TfL's Pier Strategy).
- In due course TfL may also consider stronger environmental conditions as part of River Services licencing arrangements.
- For now, new piers should be built with passive provision for infrastructure that will be required to run electric or hydrogen vessels in future (in line with TfL's Pier Strategy, and a key point in TfL's revised Pier Design Guidelines for local authorities and developers).
- In due course, PLA and TfL should provide supportive infrastructure such as clean fuels, sewage, and charge points at their own piers, and update TfL's revised Pier Design Guidelines for local authorities and developers to ensure these facilities are provided at new piers.
- Private pier owners could be encouraged to invest in this infrastructure at their existing piers through using river works licences (discounts for pier owners that invest in clean fuels, sewage and charge points).
- TfL could consider tolling the Woolwich ferry when Silvertown Tunnel opens, to reduce the environmental impacts of heavy goods vehicles in Woolwich town centre.



## Monitor the strategy

- Gather more data on ridership through the Thames AIS system, licencing arrangements, regular customer satisfaction surveys, tourism trends and regular pier audit surveys.

# Appendix

Intervention descriptions and owners

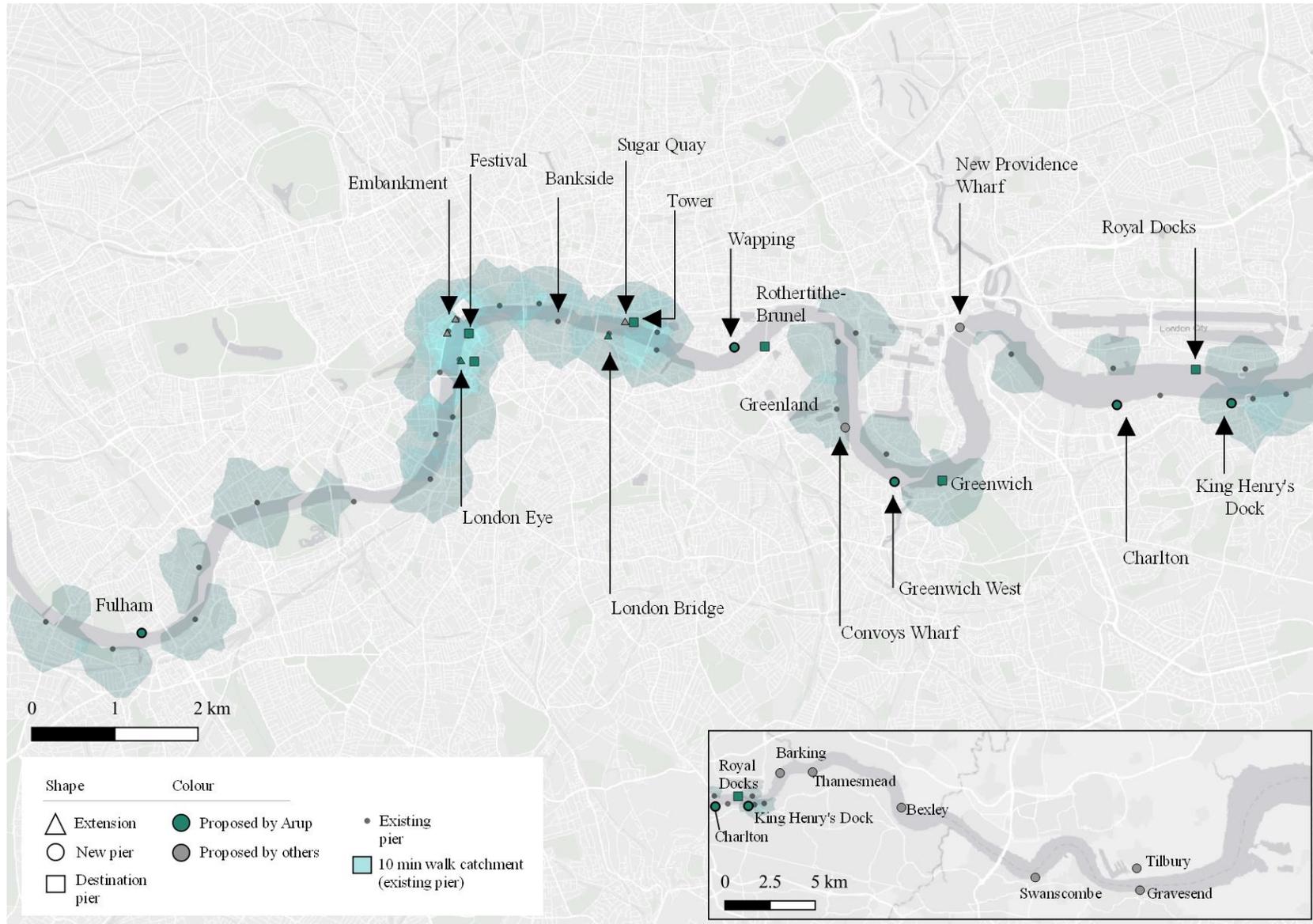
2035 Scenario 3 pier map

Constructing the environmental assumptions

# Intervention descriptions and owners

Intervention	Description	Timescales	Complexity	Key delivery partner
<b>Woolwich regeneration</b>	<ul style="list-style-type: none"> <li>Improvements in public realm around Woolwich piers</li> </ul>	10-15 years	Medium	<ul style="list-style-type: none"> <li>TfL and local authority</li> </ul>
<b>Destination piers and improved facilities at existing piers</b>	<ul style="list-style-type: none"> <li>See next slide</li> </ul>	10-15 years	High	<ul style="list-style-type: none"> <li>various</li> </ul>
<b>Other cross river services</b>	<ul style="list-style-type: none"> <li>Cross river services similar to Rotherhithe (likely East)</li> </ul>	<10 years	Medium	<ul style="list-style-type: none"> <li>River bus operators</li> </ul>
<b>New routes from new and existing piers</b>	<ul style="list-style-type: none"> <li>Weekend service on Putney and express service to Greenwich</li> <li>Service to Kew / Richmond off-peak (e.g. Christmas service to Kew Gardens)</li> <li>Increased services in the evenings</li> </ul>	<10 years	Medium	<ul style="list-style-type: none"> <li>River bus operators</li> </ul>
<b>Fares reduction</b>	<ul style="list-style-type: none"> <li>Off-peak (e.g. winter months) reduction in fares for river bus and river tours</li> </ul>	<5 years	High	<ul style="list-style-type: none"> <li>River bus operators</li> <li>TfL</li> <li>River tour operators</li> </ul>
<b>Contactless capping</b>	<ul style="list-style-type: none"> <li>Contactless capping to encourage commuters onboard</li> </ul>	<5 years	High	<ul style="list-style-type: none"> <li>River bus operators</li> <li>TfL</li> <li>River tour operators</li> </ul>
<b>Off-peak demand growth</b>	<ul style="list-style-type: none"> <li>Events (e.g. Illuminated River Project) and marketing campaigns to raise awareness of the river in the off-peak season</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>TfL/London and Partners</li> </ul>
<b>Improved peak hour frequencies</b>	<ul style="list-style-type: none"> <li>Pier extensions (see next slide) to increase capacity and timetabling technology through the following:               <ul style="list-style-type: none"> <li>active operational controls</li> <li>passage plan management</li> <li>berth management</li> <li>use of real-time data</li> </ul> </li> </ul>	<10 years	High	<ul style="list-style-type: none"> <li>PLA / TfL</li> </ul>
<b>Flexible berth sharing</b>	<ul style="list-style-type: none"> <li>Flexible berth sharing between river buses and river tours</li> </ul>	<10 years	High	<ul style="list-style-type: none"> <li>PLA / TfL / Operators</li> </ul>
<b>Vessel and pier quality</b>	<ul style="list-style-type: none"> <li>Shelter and catering facilities provided at piers</li> <li>WIFI is provided at piers and onboard to encourage commuters</li> <li>Additional experiences and offering on-board</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>Operators</li> <li>TfL</li> </ul>
<b>Accessibility to piers</b>	<ul style="list-style-type: none"> <li>Improved mode integration to increase accessibility to piers</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>TfL</li> </ul>
<b>Wayfinding</b>	<ul style="list-style-type: none"> <li>Extension of wayfinding measures implemented in Embankment and Westminster to other piers</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>TfL</li> </ul>
<b>Marketing</b>	<ul style="list-style-type: none"> <li>Marketing campaign targeted at non-UK visitors and domestic visitors, including services in journey planners more prominently, in collaboration with L&amp;P</li> <li>Improved information on apps like Citymapper and include river services on tube map</li> <li>Targeting of younger population groups, for events (e.g. O2)</li> </ul>	<5 years	Low	<ul style="list-style-type: none"> <li>Operators</li> <li>TfL</li> <li>London and Partners</li> <li>Other tourist organisations</li> </ul>
<b>Woolwich reliability</b>	<ul style="list-style-type: none"> <li>The reliability of Woolwich services is significantly improved</li> </ul>	<5 years	Low	<ul style="list-style-type: none"> <li>TfL</li> </ul>
<b>New Rotherhithe cross river ferry</b>	<ul style="list-style-type: none"> <li>Rotherhithe crossing</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>River bus operators</li> </ul>
<b>Planned services by Thames Clipper (to the east and others)</b>	<ul style="list-style-type: none"> <li>East Thames Clipper services planned</li> <li>Other river bus improvements planned by TC (RB1X and RB6)</li> </ul>	<5 years	Medium	<ul style="list-style-type: none"> <li>River bus operators</li> </ul>

# 2035 Scenario 3 Pier map



## Constructing the environmental assumptions

Assuming a robust plan to achieving the environmental targets is implemented, the **total emissions per passenger in 2035** for CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> will **be less than today**. But overall emissions are likely to rise unless green initiatives are pursued.

Due to uncertainty regarding future vessel improvements future scenarios have been determined on the following basis in order to provide an estimated range of the potential impact on local air quality and climate change.

- Emissions have been calculated using the PLA inventory emissions data for the all vessels on the Thames.
- Growth in emissions has been calculated against a 2020 emissions baseline.
- The following GREEN scenarios have been developed, each of which has two options for the existing fleet, these scenarios represent the following:
- Scenario 1 GREEN:
  - 50% of existing fleet being changed to low or zero emissions vessels. No new fleet added.
- Scenarios 2 and 3 GREEN steady progress:
  - 80% of existing fleet being changed to low or zero emissions vessels.
  - 50% of new fleet is low or zero emissions
- Scenario 3 GREEN moderately optimistic:
  - 100% of the existing fleet being changed to low or zero emissions vessels and 80% of any new vessels added are low or zero emissions; and
  - 50% of new fleet is low or zero emissions
- Scenario 3 GREEN most optimistic:
  - 100% of the existing fleet being changed to low or zero emissions vessels and 50% of any new vessels added are low or zero emissions; and
  - 80% of the existing fleet being changed to low or zero emissions vessels and 50% of any new vessels added are low or zero emissions.
- Emissions per passenger have been estimated using the scenario central demand projections.