Thames Freight Infrastructure

Design Guidelines for Piers

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Contents

EXECUTIVE SUMMARY

Introduction & Context

This document provides guidance on the infrastructure required for light freight services on the tidal River Thames. This guidance assumes the use of existing pier infrastructure to reduce traffic in central London while providing a sustainable and financially viable delivery solution. The use of electric vehicles such as e-cargo bikes will also contribute to improving air quality in line with CRP and Defra's [Clean Air Logistics for London programme] (CALL). However, the interconnection between marine and landside infrastructure poses challenges for a river freight solution. To address this, Beckett Rankine, in conjunction with the Port of London Authority and Cross River Partnership, have developed guidance for pier owners and e-cargo bike operators to ensure safe and efficient transfer of light freight between river and shore. This document offers guidance for the e-cargo transport and light freight industries, which are experiencing rapid growth and development, and does not mandate solutions. While the document has been written based on the current market, the principles contained within can be carried forward into the future. E-cargo bikes have been tested at a number of piers across London and the findings recorded to inform this guidance.

Why E-Cargo Bikes?

Pier infrastructure is typically designed for pedestrians and is therefore spatially constrained such that large vehicles cannot be accommodated. E-cargo bikes (electrically assisted bicycles design to transport varying sizes and weights of cargo) are an appropriate solution for delivering freight in the area. This is due to their size being suitable for accessing the pier infrastructure, while carrying heavy loads and needing less physical fitness from the rider. There is a range of different types of e-cargo bikes available, including two-wheeled bikes, trikes, and four-wheeled van replacements each with their own strengths and limitations.

EXECUTIVE SUMMARY

Pier Suitability Guidance

The success of a light freight operation depends significantly on the suitability of the pier from which it operates. Piers are typically designed for pedestrian use only, and therefore require modification to allow use for use by a light freight service. The criteria to be considered when selecting a pier include:

- ◊ Pier location;
- ◊ Hinterland Connection;
- ◊ Landside Access;
- ◊ Operational Space;
- ◊ Provision of buildings and ancillary facilities;
- ◊ Security and safety provided.

In addition, the pier must be flexible enough to accommodate the future growth of traffic volume, and the size and number of e-cargo bikes serving it. While there are numerous piers located throughout London that could potentially support a light freight service, some may not offer the necessary flexibility. More human aspects, such as suitable rider training and etiquette are also important for a successful light freight operation.

Recommendations & Next Steps

Recommendations are provided to aid in the development of a light freight service on the river and to allow a safe and efficient light freight transfer facility. Size requirements for pier geometry are suggested to allow for e-cargo bikes to manoeuvre, as well as guidance of the supporting facilities which may be required. Safety and Security are both key concerns as these both impact operator welfare and satisfaction, while allowing them to operate in pedestrianised areas.

As the industry is rapidly evolving, the next steps which an operator should take are a moving target. This document considers the ongoing actions for the successful implementation of a light freight operation, including:

- ◊ Acceptance and sharing of this guidance document to ensure shared governing principles.
- ◊ Agreement between suppliers, cargo operators and pier owners to allow a service to be implemented.
- ◊ Rider training standardisation to include additional risks associated with river infrastructure.

GLOSSARY

(Canting) Brow A (canting) brow is a walkway structure connecting the shore to the pontoon.

E-Cargo Bike An electric bike specifically designed to carry goods or cargo for last-mile deliveries. It is powered by an electric motor and has a large cargo capacity, making it a sustainable and efficient alternative to traditional delivery vehicles.

Gradient A term used to describe the steepness of a slope or the rate at which something changes.

Hinterland The inland region that is connected to a coastal gateway or port by rail, road, or waterways and supports the flow of goods and services to and from the port.

Light Freight Transportation of relatively small and lightweight goods, typically weighing less than 1,000 kg, using modes of transportation such as vans, trucks, or e-cargo bikes.

Micro-consolidation The process of combining multiple smaller shipments into a larger shipment for transportation and is specific to smaller and lightweight goodswhich are often delivered by courier. Typically occurs close to the end delivery point.

MLWS Mean Low Water Springs is the average height obtained by the two successive low waters during the 24hrs (approx. once a fortnight) when the range of tides is greatest.

MHWS Mean High Water Springs is the average height obtained by the two successive high waters during the 24hrs (approx. once a fortnight) when the range of tides is greatest.

Pier A structure built out into the water from the shore, used for loading and unloading ships.

Tidal Action The movements of the tides, which are caused by the gravitational forces of the moon and the sun. It includes the rise and fall of water levels and the associated currents, waves, and other phenomena that are influenced by the tides.

Turning Radius The minimum amount of space required for a vehicle or any other moving object to make a U-turn or turn around in a circular path without hitting any obstacles.

Vessel Wash Waves and currents created by ships or boats passing through the water.

Walk Assist A feature of some e-cargo bikes where the bike provides a specific amount of support power to help you manoeuvre it. Useful for gradients and heavy loads.

1. BACKGROUND

1.1 Introduction

The tidal Thames has great potential for handling large scale light freight operations due to the large number of existing piers strategically distributed along the river in close proximity to existing businesses and communities. By making use of this existing infrastructure the introduction of light freight services on the tidal Thames could potentially benefit numerous consumers and be a financially viable and sustainable method to reduce traffic in central London. This freight model lends itself toward a ultra-low emission delivery service as compared to HGV's such that only electric vehicles, such as e-cargo bikes, are used for deliveries. This aligns with CRP and Defra's Clean Air Logistics Programme for London.

However, the interconnection between the marine infrastructure and the associated landside infrastructure, and how light cargo operations can navigate this interface is not fully understood, even though it presents some of the key limiting factors for a viable river freight solution. Having identified this, Beckett Rankine, in conjunction with the Port of London Authority (PLA) and Cross River Partnership (CRP) have developed this guidance for both pier owners and e-cargo bike operators to consider when developing a light freight operation.

This guidance document considers the issues associated with a light freight service on the river and explores solutions for a safe and efficient light freight transfer facility between river and shore.

Using e-cargo bikes to form a light freight service is a growth sector and is developing rapidly. This guidance document represents the first formal guidance provided for the sector, but it is hoped that it will be built upon in the future. This document is intended to provide recommendations only.

This document is produced through discussion with TfL and should be read in conjunction with "A Constructors' Guide to Cargo Bikes & Construction Logistics" which is forthcoming.

This document was developed as part of CRP's Clean Air Logistics for London (CALL) project, a Department for Environment, Food and Rural Affairs (Defra) funded project led by Westminster City Council.

Further publications which may also be relevant include:

- ◊ London Cycle Design Standards (2014)
- ◊ Cycle Infrastructure Design – Local Transport Note 2/08 (2008)
- ◊ Sustrans: Parapet Heights on Cycle Routes – Technical Note No. 30
- ◊ Sustrans Design Manual; Handbook for Cycle Friendly Design (2014)
- ◊ PLA, A Safer Riverside; Guidance for Development Alongside and on the Tidal River Thames
- ◊ Clean Air Logistics for London Programme

Figure 1. Typical Pier - Battersea Power Station Pier, London

1.2 Scope of Guidance

The interface between marine infrastructure and the London transport network, and how a light freight service could operate is a wide topic. This guidance focuses on the general technical & spatial requirements for a light freight service to operate from a typical pier, including:

◊ E-Cargo Bike Types;
◊ E-Cargo Bike Swept Paths;
◊ Recommended Access Spacings;
◊ Gradient Considerations;
◊ Interaction With Pedestrians;
◊ Water Edge Safety Implications.

This guidance also provides advice on the operation side of the light freight service and some key elements which should be considered including:

◊ Rider Training and Etiquette;
◊ Safety and Security;
◊ Operational Systems;
◊ Integration Into the Wider Network.

Figure 2. E-Cargo Bike Trial

2. E-CARGO BIKE TYPES & TRAINING

2.1 Why E-Cargo Bikes?

Cargo bikes are bicycles which are designed to transport cargo of varying dimensions and weight. These cargo bikes are typically Electrically Assisted Pedal Cycles (EAPCs), known as E-Cargo bikes, and are often used by cycle freight riders as they are easier to ride on challenging terrain and can carry heavier loads than a bicycle without electrical assistance. From an operator's standpoint, E-Cargo bikes also help to widen the pool of employees, by lowering the required fitness level to be a qualified rider.

Riverfront infrastructure is typically constrained and therefore any vehicles serving a freight service in the area must be manoeuvrable and space efficient such that e-cargo bikes are very appropriate.

It is important to note that an e-cargo bike must have a power rating of no more than 250W, and a maximum assisted speed of 15.5mph. If a vehicle is in excess of this, it will be deemed as an L-category vehicle which means it must be registered, insured, and taxed as a motor vehicle. L-category vehicles are outside the scope of this guidance document.

2.2 E-Cargo Bike Types

There are a variety of E-cargo bikes available in the market today, ranging from utility e-cargo bikes (modified push bikes), the typical 2 wheeled e-cargo bikes, e-cargo trikes and four-wheeled pedal quadricycles.

Further information of the use of E-Cargo bikes can be found in the following documents:

- Business Cargo Bike Guide
- Cargo Bike Case Studies
- TfL Cargo Bike Action Plan

E-CARGO BIKE TYPES

Figure 3. E-Cargo Bike Types

E-Cargo bikes are a similar width to a standard bike, so they can use most cycle lanes and can move easily around in traffic. Unlike a regular bike, E-cargo bikes vary in length (2m – 3.34m long), and some can be made longer by attaching trailers.

Cargo trikes can carry greater loads than an e-cargo bike but are less manoeuvrable. They have a wider body (approximately 0.8 – 1.1m) and thus requires wider turning circles and access routes.

Typically, the most common and widely used e-cargo bike is the 2-wheeled e-cargo bike but as the light freight industry expands, there is a trend towards 4-wheeled bikes due to the increased load capacity, versatility and practicality.

For the purpose of this document, a variety of e-cargo bikes currently being used in London have been considered and trialled at a selection of piers across London. The four bikes considered are shown in Table 1.

In comparison to the dimensions of a typical bicycle, which is approximately 1800mm long and 650mm wide, it is clear that additional allowances to commonly available guidance are required to account for the differing bike types and sizes.

E-Cargo Bike	Overall Dimensions (L x W x H)	Turning Radius*	Max. Payload
Urban Arrow XL Two Wheeled E-Cargo Bike	294cm x 70cm x 110cm	~4.40m	125kg
Urban Arrow Tender Three Wheeled E-Cargo Bike	271cm x 95cm x 110cm	~4.75m	300kg
EAV 2CUBED 4 Wheel Van Replacement	277.5cm x 100cm x 193.5cm	~3.15m	150kg
Citkar Delivery Max 4 Wheel Van Replacement	301cm x 100cm x 179cm	~3.9m	215kg

Table 1: E-Cargo Bikes Tested and Specified

**Measured as tightest turn possible under controlled conditions*

2.3 Swept Paths

The turning radii for each of the bikes was measured in controlled conditions, on flat ground, with each operator travelling as slowly as they were able to achieve the tightest turn – this was by being walked along for the 2 and 3 wheeled e-cargo bikes, while the 4 wheeled pedalled as slowly as possible. While it is noted that with lighter loads some of the bikes can be moved by hand to achieve a tighter turn, this is not practical for a repeat operation standpoint.

Using these turning radii as a starting point, the swept paths for each of the e-cargo bikes tested is demonstrated below in Table 2. These consider the clearance required due to the size of the bikes when turning and represent the absolute minimum turning possible.

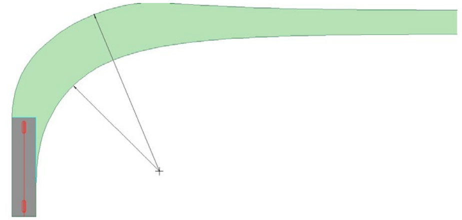
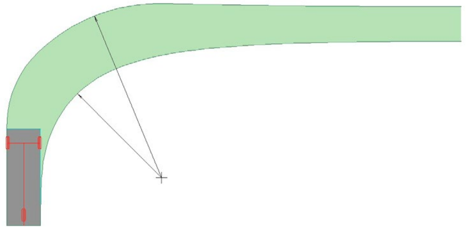
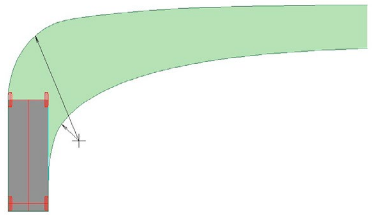
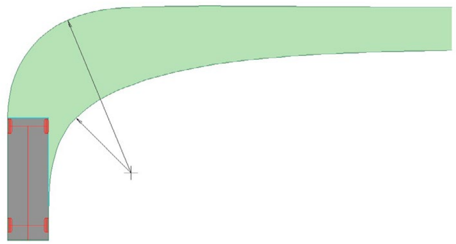
Urban Arrow XL	Outer Body Radius: Inner Body Radius: Swept Path Width: Movement	5.0 m 3.6 m 1.4 m Walked	
Urban Arrow Tender	Outer Body Radius: Inner Body Radius: Swept Path Width: Movement:	4.9 m 3.3 m 1.6 m Walked	
EAV 2CUBED	Outer Body Radius: Inner Body Radius: Swept Path Width: Movement:	2.9 m 0.6 m 2.3 m Pedalled	
Citkar Delivery Max	Outer Body Radius: Inner Body Radius: Swept Path Width: Movement:	4.0 m 1.9 m 2.1 m Pedalled	

Table 2: Swept Paths for Tested E-Cargo Bikes

2.4 E-Cargo Bike Rider Training

Adequate rider training is essential for the successful facilitation of e-cargo bikes into riverside infrastructure. Neither the pier, nor the surrounding area is exclusive to the e-cargo bike operators, and a light freight service will require extensive interaction with pedestrians, who will be the main source of traffic within these areas. As riders will be taking on a lot of responsibility, they should therefore have a professional and assured training. Only with proper training will the implementation of light freight via piers be integrated safely with current services and gain the confidence of the public.

Finding the right operator and ensuring that the provided rider training programmes are suitable is just as, if not more, important than the type of e-cargo bike to be used. Careful selection of a e-cargo bike operator is integral to the successful implementation of light freight delivery via the tidal Thames.

There are several organisations that supply training to cargo operators but there is not an industry agreed standard for the training of an e-cargo bike rider.

Currently some operators use sections 1-5 of the Cycling National Standard (Bike ability 3) to train their riders, while others supply more bespoke training which is assured by City & Guilds. Additional to this is any additional training associated with specific activities such as how to manage and manoeuvre a connected trailer, transporting hazardous goods or handling conflict, for example. It is recommended that riders have completed standard cycle training before undertaking E-cargo bike training.

Figure 4. E-Cargo Bike Training ©Pedal Me

While this document does not consider the relative advantages and disadvantages to each of the training standards, it is recommended that any light freight operator on the tidal Thames should operate a suitable training scheme as per the above. TfL are actively liaising with providers to check for consistency and to advise on the many related considerations to produce a more uniform training approach with further information available in their forthcoming guidance document (ref: “A Constructors’ Guide to Cargo Bikes & Construction Logistics”).

Prior to operating on a pier riders should have additional training to familiarise themselves with the steep brow gradients that can be present at low tide, the limited space available, especially on tight turns, and the extra care required to operate in close proximity to pedestrians. Smaller piers may also be quite lively under the effects of tidal action and vessel traffic, where riders must be made aware of when to expect wash movement following the passing of a vessel.

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3. TYPICAL PIER GUIDANCE

3.1 What is a Typical Pier

To understand the challenges associated with operating a light freight operation, and how an existing pier could support this, we must first understand the basic structure of a typical pier and its key components as shown in Figure 5.

Most Piers on the tidal Thames have been designed for passengers and therefore their use for e-cargo bikes requires adaptations to allow them to be safely and efficiently used. There have been a number of trials and investigations considering their use, which have informed this guidance document.

As well as the trials undertaken to inform this document, see Appendix A, additional trials undertaken by others include:

◊ London Light Freight River Trial Press Release

◊ River Freight Pilot Case Study

◊ DHL Express River Freight Service

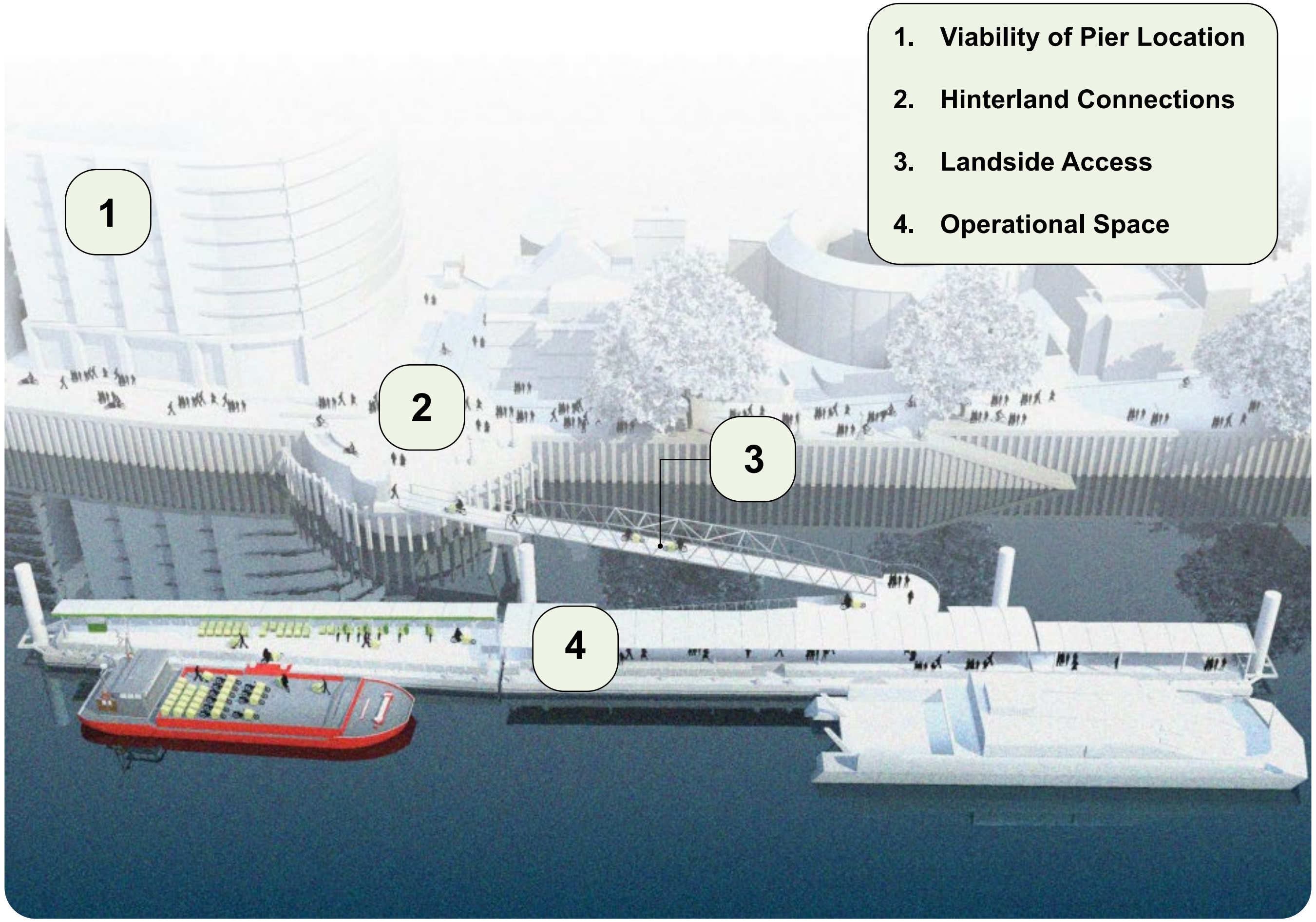

Figure 5. Typical Pier and its Key Components

3.2 Viability of Pier Location

When assessing a pier's suitability for light freight, it is necessary to anticipate how the use will evolve. This is not always straightforward as the location must enable the future development of the traffic volume and the operation of the pier needs to be as flexible as possible with regards to the size and number of cargo bikes serving it.

The following criteria should, as a minimum, be considered in the selection of a e-cargo pier:

◊ Space availability to allow for a light freight service to successfully operate. This should account for the necessary storage area, space for micro-consolidation (if required), buildings and ancillary facilities, connections to the hinterland, security etc.

◊ The availability of good inland transport links (road, rails, cycle lanes or cycle highways) to allow the light freight service to effectively distribute goods.

◊ The adjacent land uses, including existing structures and facilities, and the extent of urbanisation and zoning criteria.

There are numerous piers located throughout London potentially representing opportunities for a light freight service, however some of these may not be able to offer sufficient flexibility to allow a light freight service to successfully operate. A selection of the larger piers is shown within Figure 6 below, but this by no means represents all pier structures on the tidal Thames and excludes those with heavy passenger usage, or those used exclusively for residential purposes.

1. **Putney Pier**
2. **WRQ Pier**
3. **Plantation Wharf Pier**
4. **Chelsea Harbour Pier**
5. **Cadogan Pier Extension**
6. **BPS Pier**
7. **St Georges Wharf Pier**
8. **Millbank Millenium Pier**
9. **Festival Pier**
10. **Woods Quay**
11. **Temple Pier**
12. **Crown Pier**
13. **Blackfriars Pier**
14. **Bankside Pier**
15. **London Bridge City Pier**
16. **Tower Millenium Pier**
17. **Tower Bridge Quay Pier**
18. **Butlers Wharf Pier**
19. **Wapping Pier**
20. **Canary Wharf Pier**
21. **Greenland Pier**
22. **Masthouse Terrace Pier**
23. **Greenwich Pier**
24. **North Greenwich Pier**
25. **Royal Wharf Pier**
26. **Woolwich Royal Arsenal Pier**
27. **Barking Riverside Pier**

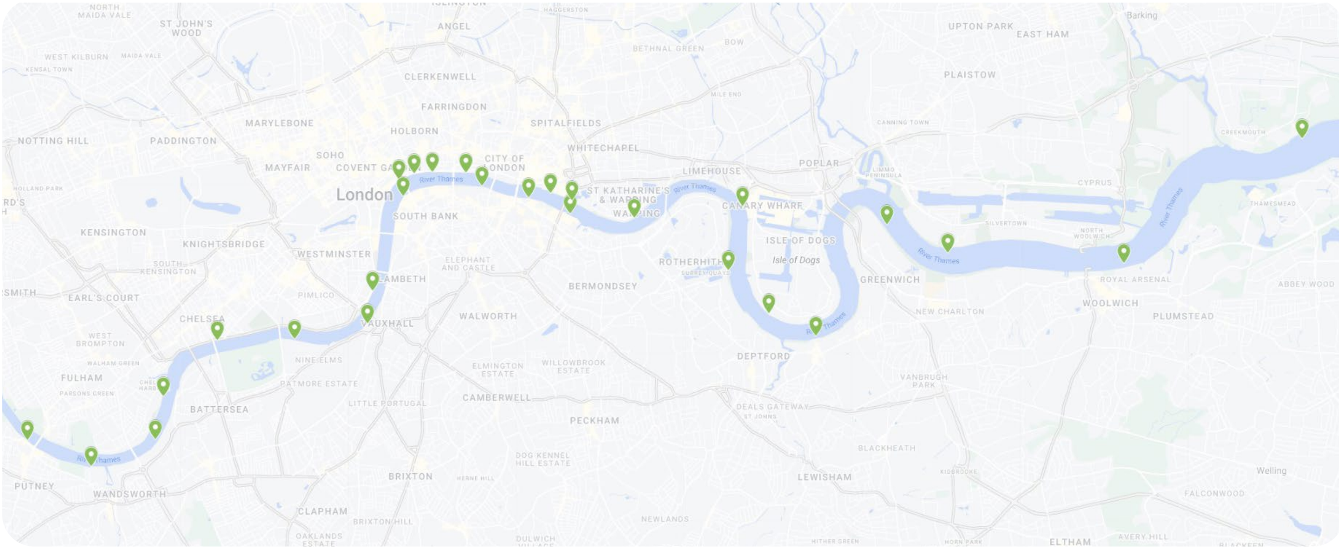

Figure 6. Piers on the River Thames - Numbered from West to East

When the freight service requirement cannot be satisfied by an existing pier, the development of a new facility may be required. This could require either:

◊ The development of a new pier – the ideal location for a new pier is a study in and of itself, however to reduce the space requirements over water, it is recommended that it should have a landside connection to a site where there is space for associated activities, such as a loading bay or parcel pickup lockers.

◊ An extension or repurposing of an existing pier.

An example of a typical pier with a brief assessment of its typical features and characteristics is shown for demonstrative purposes (Figure 7):

Figure 7. Typical Pier Characteristics - Bankside Pier ©GoogleEarth

3.3 Hinterland Connections

Hinterland is defined as the area behind the pier which acts as a conduit for the movement of goods. For a pier to support a successful light freight service it needs to have sufficient hinterland access to distribute goods for last mile delivery effectively. This depends on the inland transport network and its proximity to the pier landing. An additional consideration could be the potential for river-to-rail e-cargo bike linkages, for example CRP's recent report On Track for Sustainable Logistics highlights the potential of Waterloo Station, which is located in close proximity to the London Eye Waterloo Pier.

Additionally, the nature of the hinterland can influence the nature of the light freight service. Residential properties in close proximity would be advantageous for a light freight service focusing of the delivery of packages, while offices may favour express documents and office supplies, and catering establishments would favour fresh food deliveries.

There is also a logistical aspect to the understanding of the hinterland transport connections. Traffic forecasting to ascertain the extent of potential e-cargo shipments and the potential impact on the road and cycle networks must be considered.

This will allow a projected long-term outlook on potential future traffic in the area. For piers where light freight and commuter passengers are handled then the freight deliveries may need to be timed outside peak commuting hours.

The design factors which should be considered for the hinterland connections are:

- Accessibility for riders;
- Adjacent transport network characteristics;
- Work schedules on the pier;
- Buildings and Ancillary facilities (if possible).

An example of a typical pier, in this case Blackfriars Pier, with an assessment of its hinterland characteristics is shown below for demonstrative purposes (Figure 8). In this instance there is no straightforward access from the pier to the road network, instead all e-cargo vehicles would be routed 250m along the river walk, where they are not able to cycle, to continue their journey. In this particular situation, a potential solution could be to undertake landside works to provide access through the wall to allow a more direct access. This would change the risk profile of the area by increasing the risk to pedestrians on the narrow riverside walk and may not be desirable. A full assessment of the hinterland and the feasibility of any enabling works should be carried out to support a piers adoption of a light freight service.

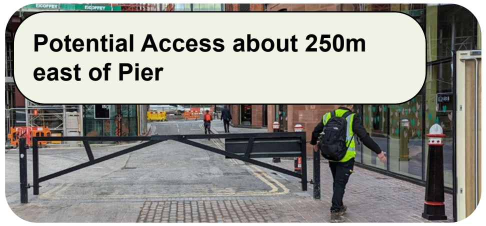

Figure 8. Typical Pier Characteristics - Blackfriars Pier Examples ©GoogleEarth

CASE STUDY - PUTNEY PIER

Putney Bridge Pier has recently been granted planning permission and is one of the first piers on the tidal Thames to consider the use of e-cargo bikes within its design. The pier, the primary purpose of which is to serve a passenger ferry service, has been specifically designed to also facilitate light freight distribution. This has been done in a number of ways, discussed briefly below:

- ◊ A storage space has been provided below the access ramp to allow for the storage of goods and to aid the transfer between vessel and e-cargo bike. This will also allow for a degree of backloading and micro consolidation. The space has the potential to be expanded in the future by incorporating parts of the pontoon hull if required.
- ◊ To allow this storage space to be accessed via e-cargo bike operators, the access route has been designed to be wider around corners to give e-cargo bikes more room to manoeuvre. The critical areas here are the 90° turn at the foot of the access brow, and the hairpin bend which forms part of the on-deck pontoon ramp.
- ◊ To further optimise the potential for a light freight service, a dedicated light freight berth has been provided on the rear face of the pontoon. The use of this berth is tidally dependent, but is envisaged that the service could use the front berth during the lowest tides and could be timed around the passenger ferry service.

Figure 9 demonstrates the arrangements and sets out how such a cargo operation could function.

While this has been considered from concept within the design for Putney Pier, a similar model could be incorporated into other piers with relatively minor structural modification works.

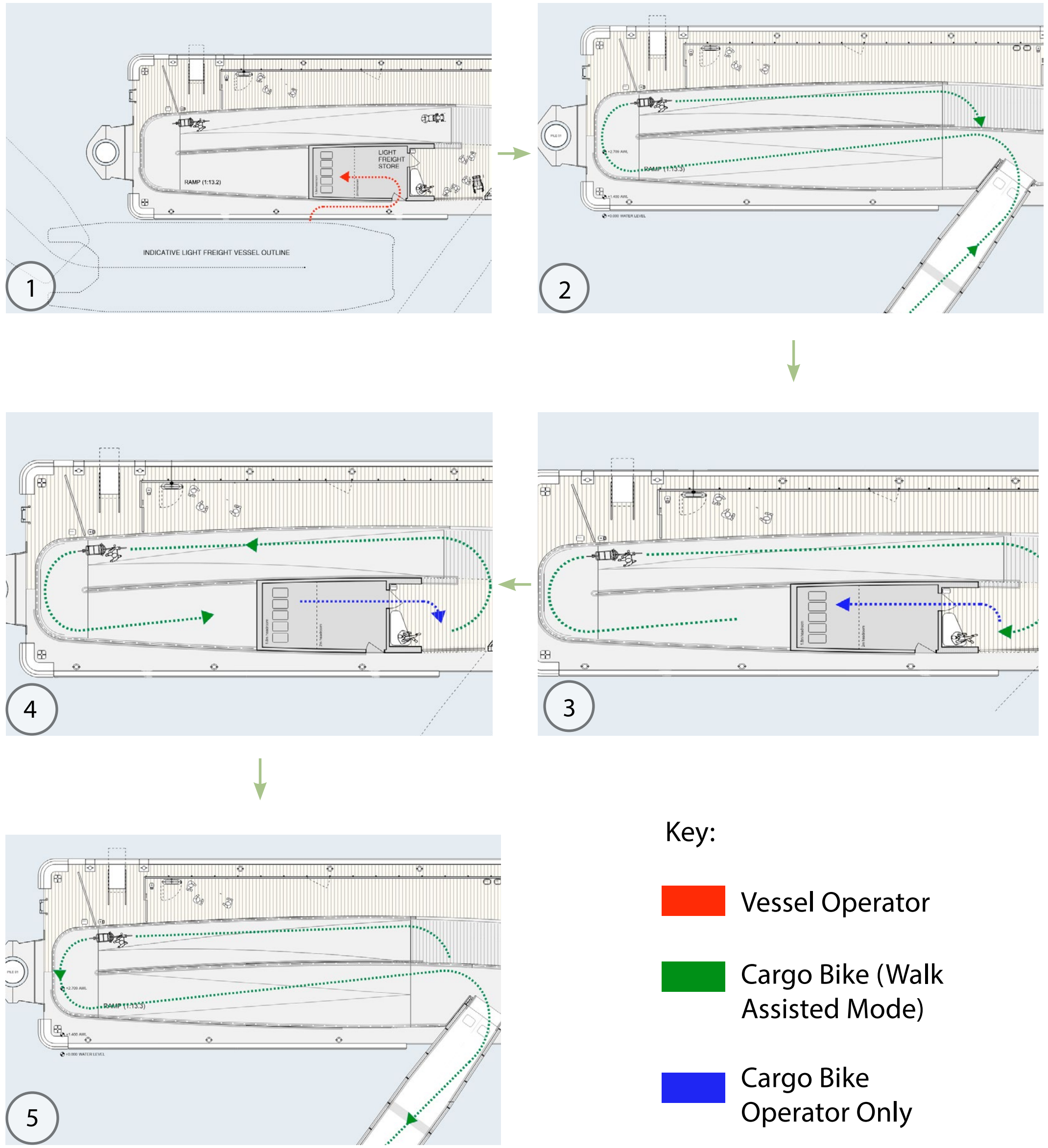

Figure 9. Indicative Light Freight Operation Flowpath

3.4 Landside Access

Good access from the landside to the pier for wheeled vehicles is necessary with adequate width to avoid conflict with pedestrians. There are many factors that affect the safe and efficient access of e-cargo bikes to a pier.

These include:

◊ Approach speed
◊ Access width limitations
◊ Visibility
◊ Access gradients

A pier is a dynamic structure and moves with the tide, such that the associated risks with accessing a pier change throughout the tidal cycle. While it may be safe to cycle onto a pier at high tide, that same pier may require an e-cargo bike to be walked onto the structure at low tide.

APPROACH SPEED

While the e-cargo bikes have the potential to travel at a maximum assisted speed of 15.5mph, where there is likely to be significant interaction with pedestrians, bike speed should be no more than walking pace.

Speed must be sufficient to maintain control while allowing a minimal stopping time if required (see further information on minimal stopping time and speed restrictions under Visibility).

Generally, it is recommended that riders dismount and walk their e-cargo bike when going onto a pier, unless it is not practicably safe to do so, particularly if they have not ridden on the pier before. Some 2 & 3 wheeled E-cargo bikes have a built in walk-assist function to aid with movement, this is very beneficial when ascending a steep gradient. However, other bikes and 4 wheeled equivalents must be pedalled to activate electrical assistance and in these cases the slope should only be attempted when there is an absence of pedestrians upon it.

At walking speeds, the risk to pedestrians, the rider and their bike is minimised. Part of the rider training should include allowing riders to identify suitable speeds for a variety of scenarios and environments.

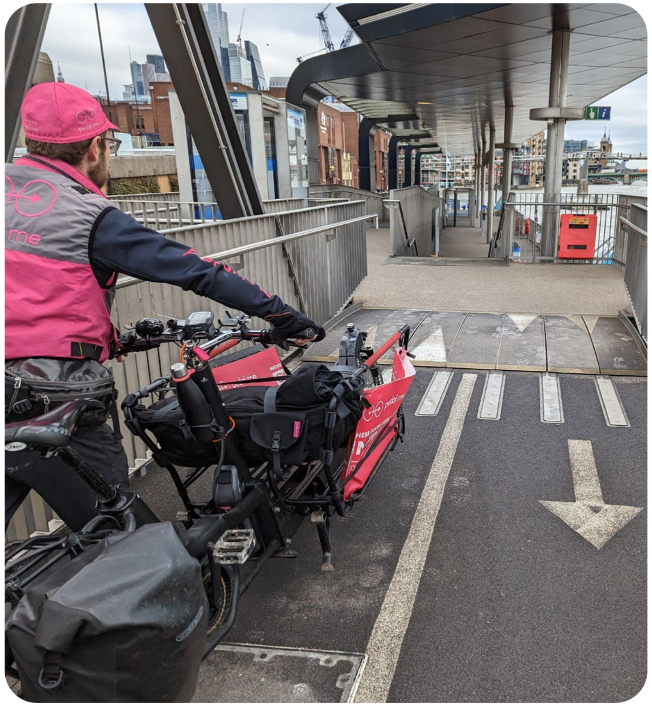

Figure 10. Rider Walking his bike on pier

ACCESS WIDTH REQUIREMENTS

A clear access width is required by the e-cargo bikes to safely navigate a pier without causing undue risk of harm to the user and general public, or of damage to the bike or the pier. The width required by the riders and pedestrians in motion needs to consider (depending on path segregation):

◊ The dynamic width of the bike and its cargo;
◊ Distance from other e-cargo bikes;
◊ Clearance from access edge constraints;
◊ Deviation/Safety Factor.

To allow for a segregation between freight cargo and pedestrians a suitable width of access is required. Existing guidance for the width of cycle lanes in available through TfL's London Cycle Design Standards (LCDS) which should be adhered to as far as possible. However, this guidance has not been written with respect to an operation such as a light freight service on a space limited pier in the river.

A conventional push bike, of width 65cm, with rider will have a "static width" of 75cm but extra width is needed to account for movement. A "dynamic width" of approximately 100cm is reasonable to allow for the bike not travelling perfectly linearly.

In the case of the e-cargo bikes considered, alternative "dynamic widths" are suggested as below:

E-Cargo Bike Type	Static Width	Dynamic Width
Two Wheeled E-Cargo Bike	750 mm	1150 mm
Three Wheeled E-Cargo Bike	950 mm	1300 mm
4 Wheel Van Replacement	1000 mm	1350 mm

Table 3. Suggested Static and Dynamic Widths

The access width is dependent not only on whether the route is segregated, but also whether two-way traffic is considered. The table below sets out minimum access widths for two-way traffic assuming very low to high cycle flow, as defined by LCDS. An additional width of 500mm is recommended to account for a handrail making up an edge condition, such that a minimum width for a brow for use by pedestrians and e-cargo bikes with low cycle flow and shared access would be 3.55m.

Flow	Partially Separated Access*	Shared Access**
Very low/low cycle flow	3.35 m	2.55 m
Medium/high cycle flow	4.85 m	3.35 m

Table 4. Recommended minimum access widths(based on LCDS)

Note: An additional 500mm is recommended per access way edge constrained by a handrail taller than 600mm.

**Partially Separated Access: A access divided by painted markings or a low, raised indicator.*
***Shared Access: An access fully shared without any form of separation.*

These widths assume that the cyclist is pedalling and a narrower accessway could be acceptable should the e-cargo bike be walked onto the pier.

On most piers, the access brow will be the narrowest part of the structure, however several piers will also have ramps on the piers themselves which may be narrower than the brow. Unless specific operational measures are put in place to prevent e-cargo bikes using the structure at the same time as pedestrians, shared access should be assumed.

The trials, see Appendix A, demonstrated that each of the trial vehicles were able to enter piers where access was limited to a clear width of only 1.35m (distance between outer handrails) as shown in Figure 11. However, this was carried out under controlled conditions, with no pedestrians and only a single bike. All operators agreed that this was narrower that they would be comfortable with under "real-world" conditions. It is not appropriate for a regular service made up of multiple bikes and interaction with pedestrians.

Where width is more limited such that shared access is not possible, it is recommended that a traffic light system be implemented for shared access routes. This operational control can be easily put in place such that the route is no longer shared between users. In which case more narrow widths such as the below could be used for very low through medium cycle flow (as defined by LCDS):

Figure 11. Tight Access at Blackfriars Pier. Showing the risk of contact with the handrail

E-Cargo Bikes Only	2-Way	1-Way
Very low/low cycle flow	2.35 m	1.85 m
Medium/high cycle flow	3.35 m	2.55 m

Table 5. Recommended minimum access widths for cycle traffic only (based on LCDS)

Note. An additional 500mm is recommended per access way edge constrained by a handrail taller than 600mm.

In cases where the minimum recommended width as shown above are unable to be met, the cargo operator should dismount and walk the e-cargo bikes. For e-cargo bikes where this is not possible the operator should demonstrate via comprehensive risk assessment the controls in place to justify access through a more narrow width.

ACCESS GRADIENTS

Access gradients are of particular note when operating on a pier because, unlike on a land-based cycle route, they change. The gradient along a pier is dictated by the tide such that a rider can experience a very different experience when accessing a pier at different tidal states.

The challenge is that a steep gradient can make it difficult for riders to move up or down the brow/access. Based on the BS6349 guidelines appropriate longitudinal gradients should be 1:10 in extreme conditions and 1:12 between design low and high-water levels, however actual gradients on some piers in the tidal Thames can be steeper around low tides, which usually occur twice per day.

During the trials all of the e-cargo bikes tested were able to traverse gradients ranging from 1:5 – 1:12. All bikes considered were able to do this due to the electric-assist. For E-Cargo bikes without electric assist it would not be possible for a rider to safely manoeuvre up a brow with this gradient. Electric assist is therefore a critical requirement for any e-cargo vehicle operating on pier infrastructure.

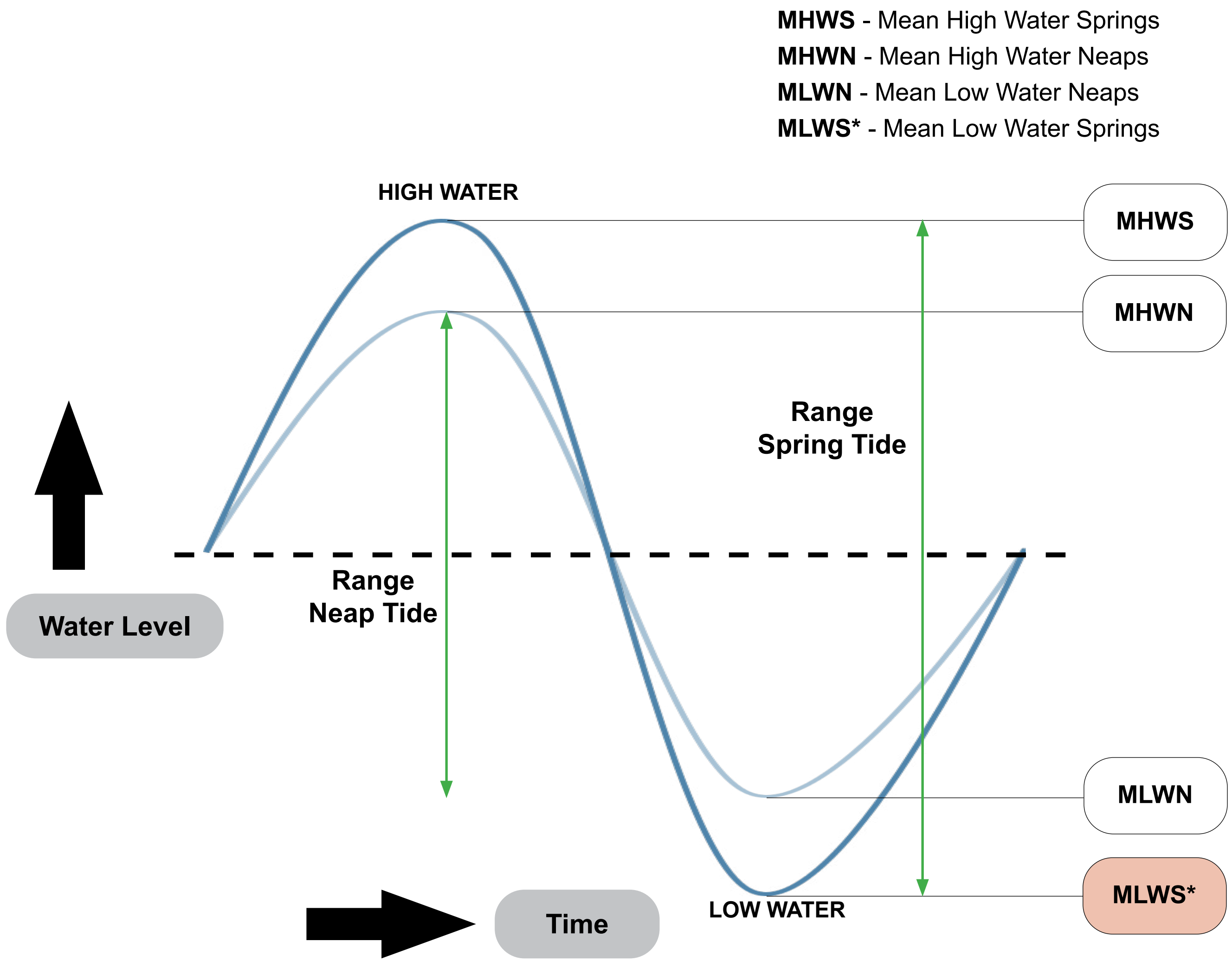

Figure 12. Typical Tide Ranges

** Tidal levels less than MLWS should be avoided if possible*

However, with a full payload the steeper gradients would become a risk in adverse conditions. If conditions were particularly windy, or if it were raining or snowing negotiating a gradient steeper than 1:12 would be challenging, especially if descending the slope with a full load. It is recommended that all access brows should have a high friction surface to help to ensure sufficient grip for the e-cargo bikes. Any service should be timed to avoid low springs tides as far as practicable (Figure 12), and trials carried out to better understand the operation at these gradients if the pier is to be used at these tidal levels. In central London, a Spring Low Tide occurs around either midday or midnight twice a month.

During testing at Masthouse Terrace Pier on a MLWS tide, the gradient of the brow ranged between 1:5 to 1:6 (Figure 13). The riders had no significant problems coming down the access brow, and were able to control their speed effectively. They had more difficulty moving up the gradient yet all e-cargo bikes were able to ascend the brow successfully. It was, however, more difficult for the riders and demanded higher levels of physical fitness and vehicle control, particularly given the different styles of electric assist across the bikes.

To get a more accurate representation of manhandling the loaded e-cargo bike up the brow, a test load of 1 person (~75kg) was considered. This load was below the maximum capacity of the bikes but neither the two nor the four wheeled bikes could be efficient climbing the 1:5 gradient.

Trials on less steep brows were accomplished with no difficulty.

Figure 13. Left: Rider unable to safely climb brow
Right: 4-Wheel Van replacement not able to hill start

Table 6 below shows the comparison of gradient tested during trials to accommodate e-cargo bikes on riverside infrastructure.

Gradient Recommendations		
Gradients between 1:5 and 1:8	Gradients between 1:10 and 1:8	Gradients less than 1:10
Not Recommended* Difficult to walk and hill start e-cargo bike on these gradients with and without loads.	**Minimum allowable gradient** Only minor difficulties when walking e-cargo bikes up these gradients.	**Recommended gradients** Easy to stop and manoeuvre e-cargo bikes on these gradients.

Table 6. Gradient Recommendations

**Subject to further trials and operational mitigations.*

Figure 14. Gradient Tested During Trials

An additional concern on the piers is when there is a sharp change in gradient, for example on a transition ramp at the end of a brow. Due to the additional length of an e-cargo bike, when compared to a conventional bicycle there is an increased risk of grounding. This is exacerbated as e-cargo bikes typically have a low frame to reduce their centre of gravity. Whether an e-cargo bike will ground is purely geometrical and will vary based on the exact e-cargo bike used – its variability is such that a general gradient solution has not been developed based on the vehicles considered during the trial. During the trial no instances of grounding occurred, however there was one location at the base of the brow at Tower Bridge Quay where the rider highlighted this risk in traversing the transition ramp between the brow and the pontoon (See Figure 14). With a full bike load, and the lower suspension, this could be an issue for an operational service.

It is recommended that any area of gradient change on a pier structure be assessed for this risk and a structural solution be considered i.e., a longer transition ramp at the base of a brow. Where this is not practicable, suitable signage should be put in place to inform users.

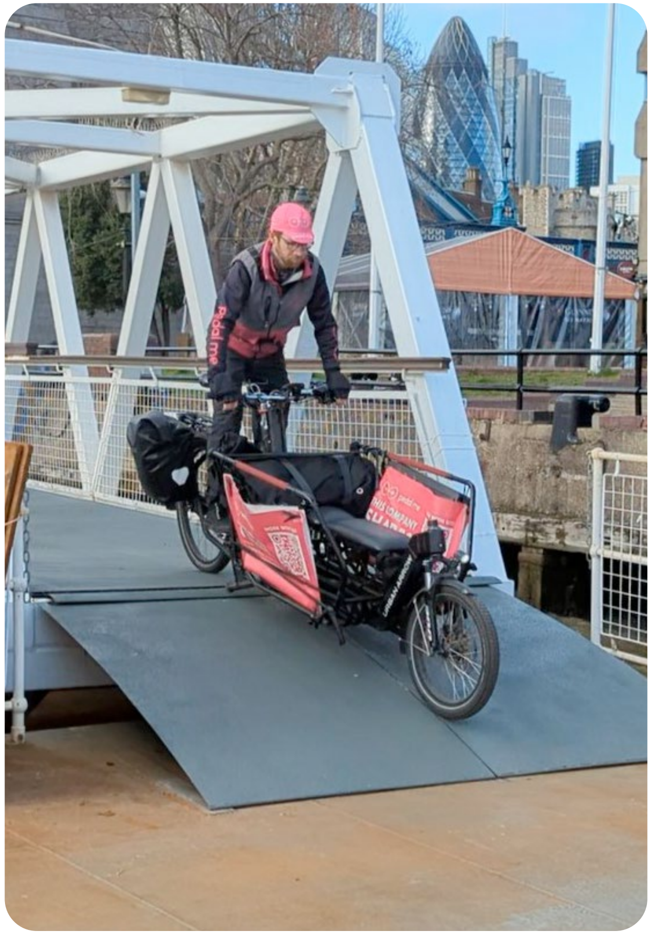

Figure 15. Steep Gradient Change During Testing

For this reason, it is recommended that vertical deflections, such as speed bumps, are avoided for e-cargo bike infrastructure. LCDS states that non-standard cycles can be disturbed by upstands of 10mm such that a continuous access is required, this is not thought to apply as strictly to e-cargo bikes which are more robust that the typical non-standard cycle considered by LDCS. The intent to keep a continuous access however remains valid.

VISIBILITY

A key risk associated with cargo transit on a pier structure is that the change in gradient common on brows and piers can limit rider visibility.

This is also true with sets of steps. [Cycle Infrastructure Design (Local Transport Note 2/08)] states that a minimum stopping sight distance of 15m should dictate the minimum sightlines available for a cyclist.

It is suggested that in the case of an e-cargo bike, which is heavier and requires more effort to be brought to a standstill, that this minimum does not provide sufficient distance to safely brake, without an associated risk of locking up the front wheel. It is recommended that ABS (anti-lock braking), which is standard for many e-cargo bikes, is mandated for those operating on piers.

While it is recommended bikes are walked are far as possible, where they are required to be cycled it is strongly recommended a local speed restriction be imposed. A 5mph limit is appropriate for most piers with 8mph possibly being safe on piers with wider brows.

Signage should be provided to advise cyclists of the correct route through the pier and of any hidden hazards, such as a sharp turn, low level bollard, sharp change in gradient, steps, etc. Markings and signs should be provided to make clear the need for cyclists to slow down and give way. For areas with 90-degree bends and limited visibility, safety convex mirrors should be placed to give riders the vision to see around blind corners where required.

3.5 Operational Space

In addition to adequate access for e-cargo bikes a pier requires a sufficient clear area on deck to facilitate handling the freight and loading the bikes together with ancillary facilities for the operatives and possibly also charging points for the bikes.

Depending on the scope and scale of the light freight service in question, this operational space may need to allow for:

STORAGE & SORTING

A storage and sorting place may be required for the Light Freight service as goods are not always able to be directly loaded to vehicles. Ideally, the storage space required should be approximately equal to at least the carrying capacity of the vessel and should include an allowance for transportation equipment such as roll cages. This approximation allows for a small degree of backload (packaging/containers/returns sent back to the distribution centre), however should the light freight service merit high backload volumes, then a larger storage area would be required. The storage area should be covered and protected from the elements. For more information, please refer to Micro Logistic Hubs.

E-CARGO BIKE STORAGE

In some examples of a light freight service, it may be that the e-cargo bikes used to form the service are stored and maintained on the pier itself. This has significant implication for the operational area required for the pier. In the case of e-cargo bikes being stored overnight security arrangements are required. together with an adequate power supply (see Charging Stations).

SHARED USAGE

Should the operational space be cleared when not required, this would allow shared usage, for example with pedestrians who may wish to use the pier. However, it can be difficult to ensure that this is the case and that the operational space is in fit condition to accommodate the various uses. Most of the piers on the tidal Thames have been designed to facilitate the free movement of people so ideally the freight handling space should be able to be cordoned off so as to limit the shared use to the pier access route only.

FUTURE USAGE

The requirement to provide dedicated operational space for a light freight scheme makes the shared use of an existing pier challenging, unless the pier is large and not intensively used; efficient operation may be more readily achieved by the provision of a new pier or a pier extension. It may be advantageous to compromise with a smaller operational space, and a reduced operational capacity, such that an existing pier could be utilised, at least in the short term. A critical advantage to the provision of a larger space, however, is that it offers the service greater flexibility toward the future as the Light Freight service expands.

Figure 16. Operational Width on a Typical Pier - Tower Bridge Quay

©GoogleEarth

MINIMUM WIDTH REQUIREMENTS

As the operational space will serve the e-cargo bikes in some capacity, it must be of sufficient size to allow manoeuvrability of e-cargo bikes. The minimum width of this operational space should therefore be at least the turning radius of the e-cargo bike which, depending upon type, can range from 3m to 5m – as per Table 1. The operational space required will be affected by the following:

- ◊ Access for personnel and pedestrians
- ◊ Access for cargo loading and unloading (With/Without Mechanical Assistance)
- ◊ Waiting and turning space for the e-cargo bike
- ◊ Cargo storage area
- ◊ Facilities for operatives (e.g. WC, changing facilities and lockers)

4. BUILDINGS & ANCILLARY FACILITIES

For a successful light freight service, additional buildings and ancillary facilities may be required. These facilities could be a roofed area to provide weather protection for cargo handling and may include a fully enclosed area for secure storage. While it is preferable to use permanent structures, it may be appropriate to use temporary/portable facilities in the short term, for example to facilitate a rapid start-up, to minimise initial cost or to provide flexibility for future pier restructuring or reorganisation.

The design of buildings and ancillary facilities is outside the scope of this guidance.

Depending on the needs of its customers, the availability of land and the commercial aspects, the light freight facility may also consider providing some or all of the following ancillary facilities, these have been previously listed as elements for consideration in determining Operational Space.

MAINTENANCE WORKSHOP

The maintenance facilities required will include a well-equipped workshop with sufficient space to work on a number of e-cargo bikes at a time. They should be located landside of the pier and either close to or on the perimeter of the pier.

SHELTERED & SECURE PARKING

Sheltered and secure parking may be required to store the e-cargo bikes safely overnight and the riders' own bikes during the day, if they have cycled to work.

CHARGING STATIONS

Where available e-cargo bikes should have the option to be charged on or near piers. This can be easily implemented together with the maintenance workshops or sheltered parking. The nature of the charging station is dependent on the e-cargo bike itself, as all have different batteries and therefore different charging requirements.

In general, battery capacity for 2 and 3 wheeled e-cargo bikes tends to vary from 500 to 800 Watt-Hours, with some variance for those with more than 1 battery. A four wheeled e-cargo bikes can vary from 800 to 1600 Watt-Hours. For most e-cargo bikes a 12V system is required. The batteries must be removed from the e-cargo bikes prior to charging, although for some four wheeled bikes, they can be charged in-situ.

WELFARE FACILITIES

Depending on the nature of the freight operation, welfare facilities may need to be provided for riders who would be using the river infrastructure. Currently several passenger piers include public restrooms, but this is not common. Welfare is not limited to restrooms only; showers, changing rooms, storage lockers, first aid facilities, etc. should all be considered. For sites with supporting infrastructure on the landside, this could also be used to help provide the necessary welfare facilities.

5. SECURITY & SAFETY

5.1 Security

By implementing a light freight service, the operator is increasing the number of users of the marine infrastructure and is therefore introducing a new set of risks not previously considered as part of the structure's design. The operator should also be conscious of risks to the riders given the proximity to the general public and the potential value of the goods they will be transporting.

As a minimum, a CCTV system should be provided as it ensures continuous monitoring of the entrances and key areas. This should be integrated within the access control and gate management systems (if any). The system should also include the following features:

- View live cameras;
- Continuous recording or scheduled recording;
- Alarm or event-initiated warning systems;
- Camera pre-sets and pop-ups on alarm monitors for live view and recording;
- A backup system to ensure continuous monitoring and recording during system faults, and emergencies.

Security lighting should be provided to detect and deter anti-social behaviour as well as to provide light for CCTV cameras present on the pier.

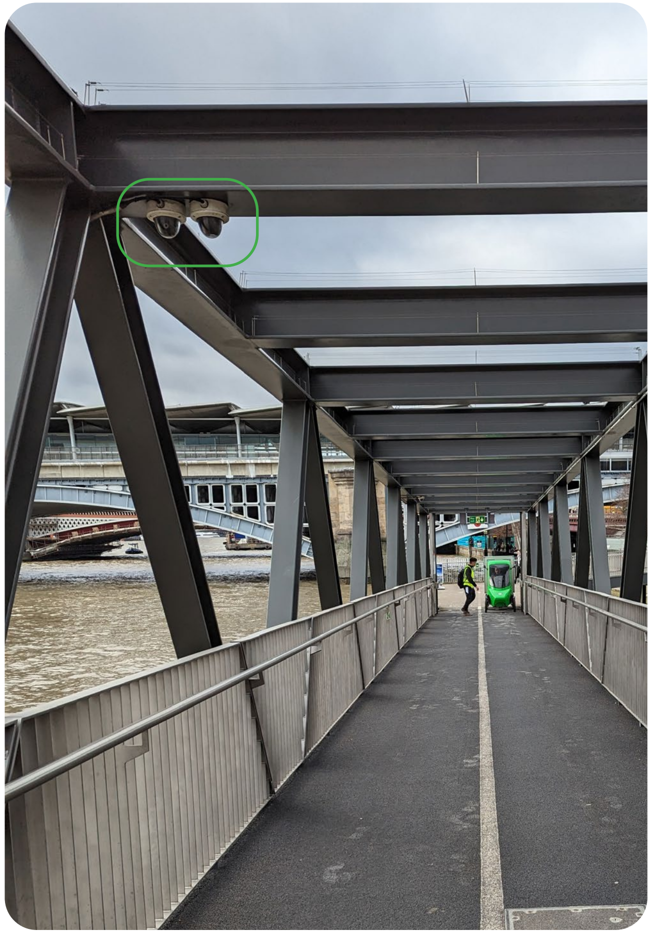

Figure 17. CCTV Cameras at Blackfriars Pier

5.2 Safety

Most piers are already designed to accommodate pedestrians and cyclists, albeit with the cyclists dismounted. However, in most cases e-cargo bikes fall outside of the original pier design considerations, and for the interaction between the riders and the general public. Adoption of the measures set out below will enable the two types of activity to take place with the minimum of conflict.

SCHEDULING

Arranging for cargo handling to take place outside peak passenger movement times will minimise the scope for interaction of passengers and e-cargo bikes. Where this degree of separation is not possible e-cargo bikes should not be permitted to traverse the access brow and ramps while a passenger vessel is loading or discharging passengers or for the 2-3 minutes before or after when passengers may be rushing to or from the vessel. This measure will confine e-cargo bike movements to times when passenger numbers are fewer, and they will have time to wait for a bike to pass.

MARKINGS & SIGNAGE

Arrangements should be made to ensure that personnel and pedestrians who need to enter the operational areas are able to do so safely. This should be achieved by the provision of clearly marked walkways and potentially by path segregation (either through markings only, or through physical barriers).

Signage should be put up to keep members of the public and riders aware of potential hazards.

Signage must provide clear, reliable information and at the same time must be appropriate and sensitive to their environment. Putting up new posts may often cause visual clutter and new maintenance liabilities. Surface markings are a preferred alternative to post mounted signs.

Figure 18. Surface Markings at Blackfriars Pier

TRAFFIC LIGHT SYSTEMS

On riverside infrastructures, interaction between riders and pedestrians will be critical, unless the pier is designated for light freight only use. Hence, where widths are insufficient to allow shared access, that a traffic light system be implemented to prevent conflict between the two parties for narrower access points (Figure 19 & 20).

This traffic light system could be automated or operated by an onsite warden such that it can best meet the requirements of the pier users.

Figure 19. Narrow Access Point

Figure 20. Cycle Traffic Light System

WATER EDGE SAFETY

Most piers will already have existing edge protection. They vary depending on site specific circumstances, but most will be standard hand railing of 1.1m height. Edge protection on piers is designed to prevent people from accessing the river and not for e-cargo bikes safety. The integration of e-cargo bikes onto piers introduces a new set of water edge safety criteria for the riders. During testing the riders did not identify any concerns regarding the existing water edge safety on the piers, however the maritime environment is outside of their normal experience.

It is recommended in the Sustrans Handbook for Cycle-friendly design that a parapet height of 1.4m is provided for cyclists. A pier is not held within this guidance but, subject to a risk assessment, it can be taken as applicable for these purposes, and a 1.4m parapet provided where appropriate. Generally, e-cargo bikes will be operating at very slow speeds so existing edge protection may be sufficient but in some locations, such as at the bottom of a steep ramp or brow, additional protection may be required in the event of brake failure.

Guidance on consideration of this risk is available in *"[Parapet heights on cycle routes: Technical information note no. 30 (2012)]"* by Sustrans.

Figure 21. Steep Gradient down to a Parapet Directly infront

6. RECOMMENDATIONS

This document provides guidelines to help provide a light freight service which is both efficient and safe for users. While the recommendations made within should be followed where practicably possible, it is recognised that this is not possible in all situations. Furthermore, the exact nature of the freight service considered will also impact the recommendations. Where the advice cannot be implemented a targeted risk assessment should be carried out in line with the principles of this document to establish if there are alternative solutions which could be implemented, further advice is available from CRP/PLA/BR (see Contact Information). A summary of the minimum requirements and recommendations made throughout this document can be found within Table 7, while full recommendations and context can be found within this document.

Factor	Minimum	Recommended
Pier Geometry		
Access Width	1.85m (one-way)	> 2.55m (one-way)
Access Gradients	Gradients between 1:10 & 1:8	Gradients less than 1:10
Operational Width	Turning Radius of E-cargo Bike	-

Factor	Minimum	Recommended
Building & Ancillary Facilities		
Admin Facilities	-	✓
Maintenance Workshop	-	✓
Sheltered & Secure Parking	-	✓
Charging Stations	✓	✓
Welfare Facilities	-	✓

Factor	Minimum	Recommended
Security & Safety		
CCTV System	✓	✓
Security Lighting	✓	✓
Scheduling	✓	✓
Markings & Signage	✓	✓
Rider Training	✓	✓
Traffic Light Systems	-	✓
Water Edge Safety	✓	✓

Table 7. Summary of Recommendations

7. NEXT STEPS

There have been a number of trials for light freight operations on the river carried out to date, including those undertaken to inform this guidance document, and it is envisaged that over the coming years, further trials will be carried out considering different goods, locations and vehicles. This will likely be in conjunction with light freight operations being officially launched. An important next step will be for the guidance document to accepted and shared by the industry, such that future piers are designed or modified in way that follows a shared set of governing principles.

Light freight operations using the river and e-cargo bikes is very much a growth industry, full details of what the end supply chain will look like is not yet fully understood. Cargo operators and suppliers will need to enter into partnership agreements with pier owners, to develop these supply and transit chains. Potentially, incentives could be offered for businesses to use sustainable methods of freight delivery such as e-cargo bikes, instead of traditional delivery methods. None of these light freight operations are able to begin in earnest, however, without the modification to the existing river infrastructure, or the creation of new infrastructure, suitable to support the operation.

Rider training is a critical component of the successful implementation of a light freight service. While there are existing training courses, an important step moving forward is to ensure an agreed level of training is provided to cover the additional risks of operation on river infrastructure.

This document represents guidance based on the market at the time of writing. Light freight and e-cargo markets are rapidly evolving and therefore new information and findings will become available as the operating environment changes, it may be necessary to revise and update this as the industry develops.

Figure 22. Trials Undertaken on Blackfriars Pier

8. CONTACT INFORMATION

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BIBLIOGRAPHY

PLA
A Safer Riverside; Guidance for Development alongside and on the tidal River Thames
(2020)

Department for Transport
Local Transport Note 02/08 – Cycle Infrastructure Design
(2008)

SUSTRANS
SUSTRANS Design Manual - -Handbook for Cycle-Friendly Design
(2014)

SUSTRANS
Parapet Height on Cycle Routes – Technical Information Note No.30
(2012)

Transport for London
London Cycling Design Standards
(2014)

Transport for London
London Cycling Design Standards 3 – Streets and Spaces
(2016)

Transport for London
London Cycling Design Standards 4 – Cycle Lanes and Tracks
(2016)

Transport for London
London Cycling Design Standards 7 – Construction, including Surfacing
(2016)

Transport for London
Cargo Bike Action Plan
(2023)

Cross River Partnership
On track for sustainable logistics: Integrating Rail Freight into London's deliveries
(2023)

Cross River Partnership
Clean Air Logistics for London
(2022)

Cross River Partnership
The London Light Freight River Trial: Making the case for deliveries using the Thames
(2023)

Cross River Partnership
River Freight Pilot Case Study: Summer 2022
(2022)

Cross River Partnership
Do I have the Right Space for a Micro Logistics Hub
(2022)

Department for Environment Food & Rural Affairs
Business Cargo Bike Guide
(Ongoing)

Department for Environment Food & Rural Affairs
Cargo Bike Case Studies
(2022)

DHL
DHL Express Delivers On The River With New Thames Service
(2022)

APPENDIX A: E-CARGO TRIALS

To inform this guidance document, Beckett Rankine carried out a set of e-cargo bike trials and testing on the 20th and 27th February 2023. These trials were performed on a variety of piers across London; these piers were Tower Bridge Quay, Blackfriars Pier, and Masthouse Terrace Pier and were chosen in conjunction with the PLA as a representative sample of the majority of London piers. Each location was noted to feature a specific challenge which contributed towards the trials and their outputs, allowing for more applicable feedback.

- **Tower Bridge Quay** – Multiple approach brows meaning a more complex pedestrian interactions, relatively narrow pontoon.
- **Blackfriars Pier** – Spatially constrained landside and limited access width for the access route
- **Masthouse Terrace Pier** – Multiple gradients and changes of gradients due to on deck ramp and brow

To allow these to be considered fully, Tower Bridge Quay and Blackfriars Pier were accessed during a high tide such that the adverse gradients did not impact the wider considerations. The trials at Masthouse Terrace Pier were then carried out at low springs tide to exacerbate the already steep gradients at the site.

In addition to multiple pier locations, a variety of e-cargo bikes were also utilised to best represent the full range of options available on the market. We contacted Pedal Me, Absolutely and Delivery Mates who provided a range of 2, 3 and 4 wheeled e-cargo bikes.

For each of the piers, the trials included the entire extent of the passenger pier pontoons, access brows and adjacent landside connections (such as landside access ramps). Trials were not carried out on any public property, including any adjacent footpaths.

The key test carried out as part of the trials involved the simulation of a package collection for the e-cargo bikes. This test began with a walkover of the routes with each rider to highlight any key risks and hazards. Following this, the rider then accessed the pier via bike by the main access brow or ramp. Once the rider has reached the main pontoon where package transfer would occur in a real freight operation, the rider would be required to turn the e-cargo bike and exit the pier along the same route.

The method of the turning (manhandling, 3-point turn, single turn) was left to the discretion of the riders based on available space and bike manoeuvrability.

To maximise the useful output of the trials, multiple feedback discussions were held with each rider at multiple stages throughout the process. Key aspects of this were the perceived difficulty prior to accessing the pier based on the walkover, followed by additional views after having cycled as well as a commentary and their initial perceptions.

The speed of the riders was initially determined by the riders based on the walkover and their views of what was safe for the location. Where safe to do so, areas of the route were re-trialled with riders considering different approach speeds to understand the impact this has on safe and controlled navigation. The varying of speeds was particularly important given the different gradients. Where possible and safe to do so, trials were repeated with an 80kg loading to develop an understanding of the impact of a loaded e-cargo bike, which is inherently harder to control than an unloaded e-cargo bike.

The trials considered only a single e-cargo bike on a pier at any given time unless safe to do otherwise, and were timed to minimise the impact on the general public, such that they may not fully represent how occupied a pier may be if in use by the general public and multiple e-cargo bikes at as single time.