Urban waterborne public transport systems: An overview of existing operations in world cities

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SUMMARY

This report aims to collate information on existing waterborne public transport systems in order to provide a resource for cities that may be considering implementing a water transit network. Stockholm County Council has recently expressed interest in expanding its existing inland waterway network to facilitate increased passenger transport capacity within the city and surrounding districts. This report introduces waterway public transportation systems currently operating in 23 cities around the world to provide an overview of the current state of urban water transit globally. Key operational metrics have been identified and described which have been chosen in order to be most relevant in assessing water transport options for cities. Information regarding system organization, route structure, schedules, and vessels have been compiled. In addition, operational factors contributing to the success of existing water transit systems have also been highlighted as per existing literature. Such characteristics introduced in the report overview include transport integration within the wider public transport network, public perception and feasibility of implementation, land use implications, and the role of water transport in tourism and leisure travel. Efforts toward incorporating environmental sustainability are also briefly addressed. Cities have been divided into three broad categories based on the geographic size and passenger carrying capacity of each water transit system. There were 13 cities identified as large scale, 6 as medium scale and 4 as small scale, or in nascent stages of development. Facilities on board vessels and also terminal infrastructure are compared, as well as any unique features or operating characteristics, which are highlighted. Finally, the systems are mapped a scale in order to compare route structures and scope of operation.

OVERVIEW OF URBAN FERRY SERVICES

Cities are increasingly looking at new ways to expand their public transport offering. Development of transport networks on urban waterways is one method that is being considered. Stockholm is one such city with an interest to further develop its water transport links to islands within the inner city and the more distant archipelago areas. This report details the efforts of cities which have developed urban water transport networks for passenger transport. Building on the work of previous studies in urban water transport, this report seeks to further shed light on contemporary water transit systems; what they look like, what they add to a city's infrastructure and transport network and how they are being used. It is the hope that this report will be a useful resource to cities that are looking to implement new waterborne transport service, or expand existing small scale water transport networks to a larger scale. In order to define the scope of investigation and inform the selection of the cases that have been chosen, it is first necessary to explore the key characteristics of water transit systems.

Route and service type

The first key characteristic is route type. While traditional ferry services have usually operated in a cross-river only configuration, contemporary ferry systems have evolved to incorporate a range of route designs. This report identified ferries in urban waters that can be seen to operate in three different route types:

Type A refers to routes where boat services traverse along a river or water body stopping at multiple destinations connecting points of interest along a waterfront. Such services have been referred to also as *linear* ferry systems (Thompson et al. 2006; Soltani et al. 2015; Tanko & Burke 2015). The Älvsnabben service (Line 285) in Gothenburg can be seen operating in this type of configuration (Figure 1). As will be shown, this is increasingly becoming the favoured route type of contemporary water transit services which seek to maximise efficiencies and stimulate waterfront development by providing waterfront transit stops. Among the cities identified in this report that can be seen operating this route type, some have focused predominantly on one side of the waterway, while others incorporate a more cross river zig zag pattern, depending on the land use context of each respective city.

While this operating model results in increased passenger capture capacity and frequent stops, there are obvious issues in terms of increased journey times. This is especially the case with water transit often being subject to longer terminal stopping times. Some cities have implemented split route configurations, where some services run express and bypass terminals in order to minimise stopping times such as in Brisbane (Figure 2).

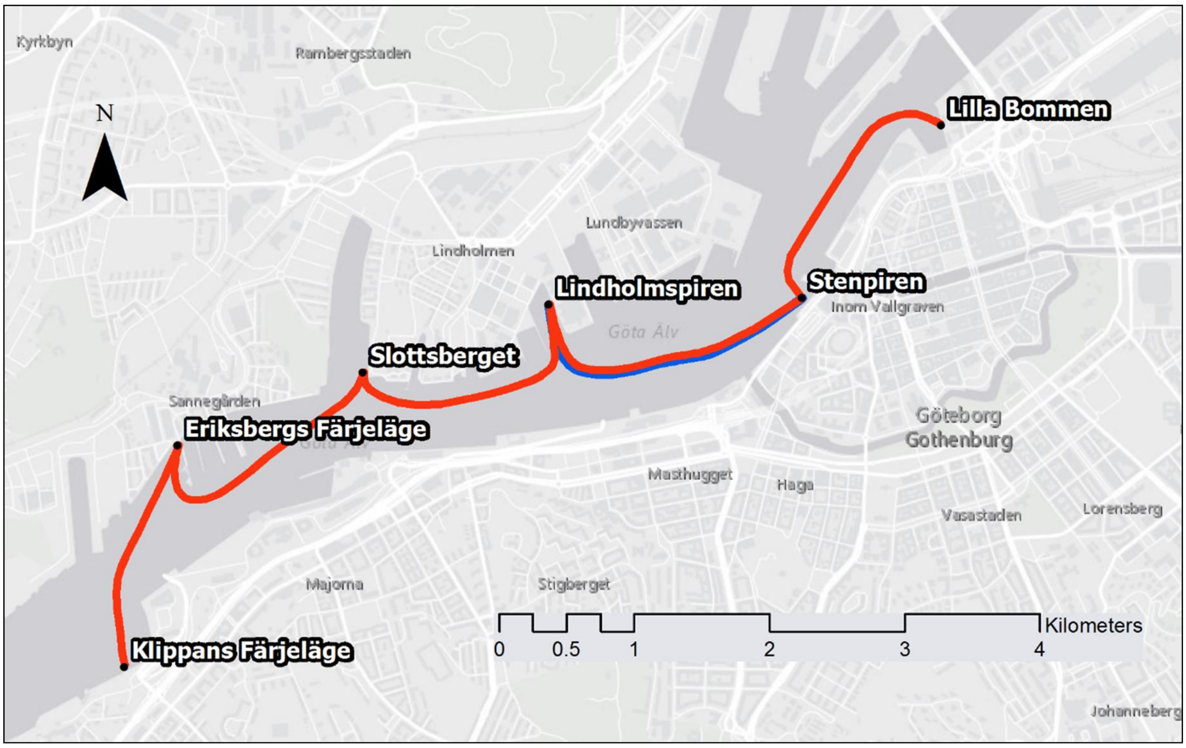


Figure 1 Route A type in Gothenburg, Sweden

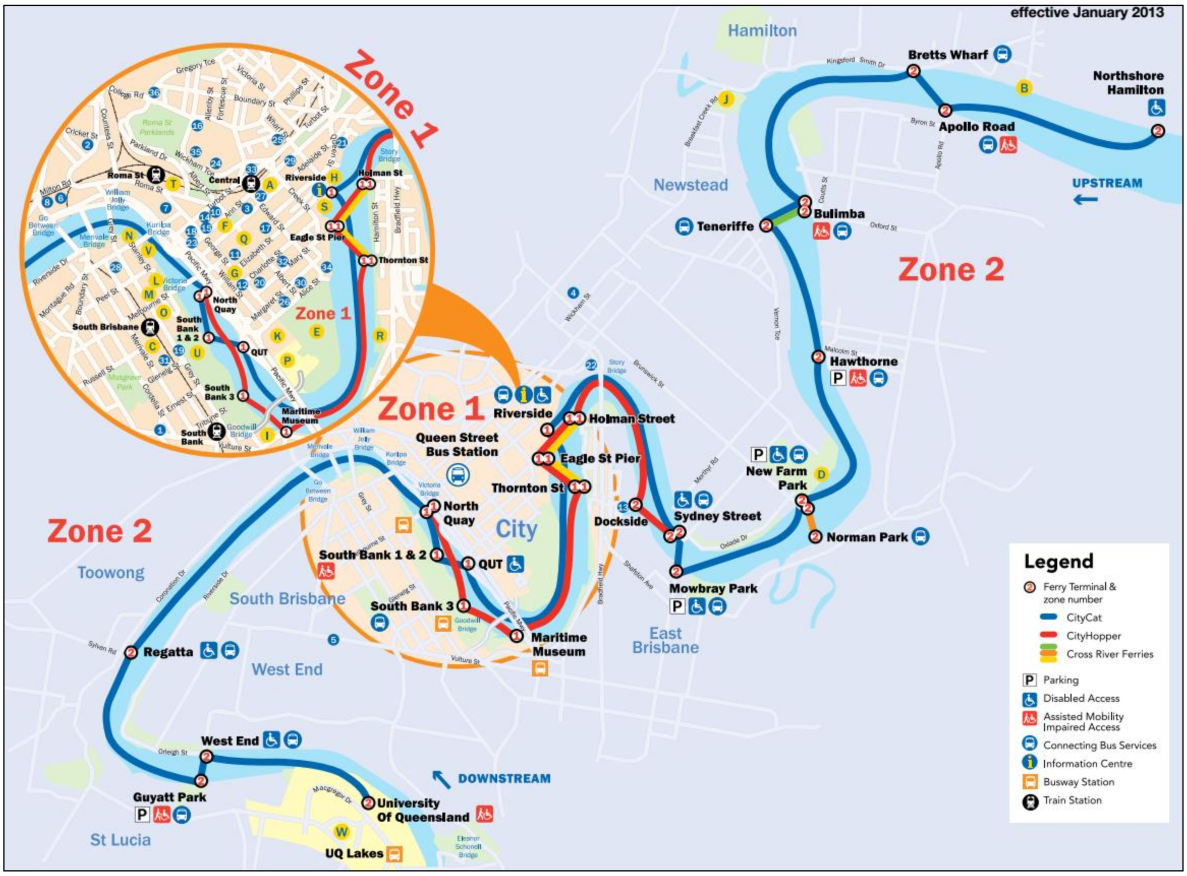


Figure 2 Full route (blue) and inner city express route (red) in Brisbane. Source: Translink (2017)

In other cases the cities have divided the one primary linear route into a more complex set of coordinated, complimentary routes that require transfer between vessels to reach destinations, such as in Hamburg (Figure 3).

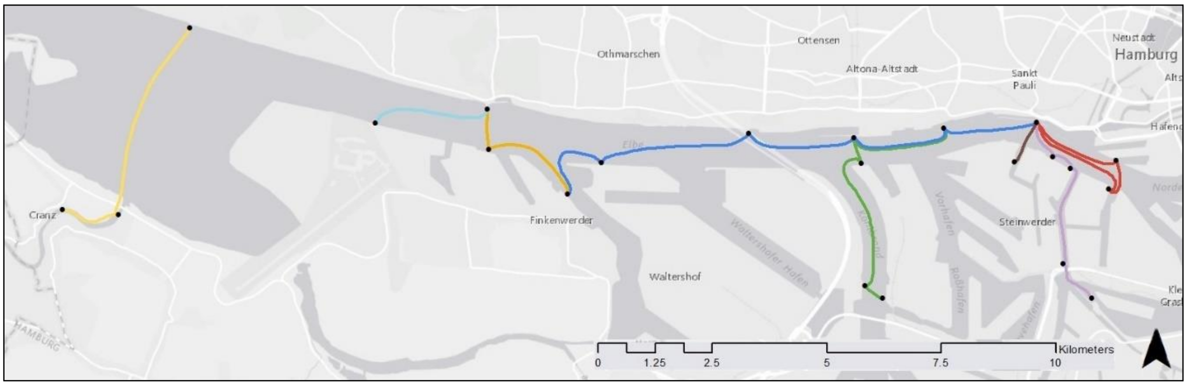


Figure 3 Coordinated water transit routes in Hamburg

Routes of Type A can also run parallel to land based transit avoiding congestion and often deliver comparable travel times, especially during peak periods (Tanko et al. forthcoming). Regarding the land use planning implications, this style of route also has been shown to facilitate Transit Oriented Development (TOD), where terminal nodes on the route serve to stimulate economic development and increase land values around terminals, as was shown in Brisbane (Tsai et al. 2015) and New York (Camay et al 2012; New York City Economic Development Corporation 2013).

Type B refers to shorter routes with two or three stops either in a simple river crossing or triangular three-point stop configuration. This was previously the most common form of ferry that was developed primarily in the absence of land based transport connection. A good example is Copenhagen, which operates high frequency cross river services in the inner-city area between popular destinations (Figure 4). In some cases these routes form part of an essential transport connection, where they are subsidised and used for free such as in Gothenburg and Brisbane. Due to the short travel times the design of vessels themselves usually cater for a quick turnaround and capacity rather than on board amenities. In Gothenburg, the Älvsnabbare service between Stenpiren and Lindholmspiren features wide open spaces to maximize on board accommodation of commuters and cyclists on a particularly busy cross river route with a departure frequency of every 7 minutes and travel time of 5 minutes. Since the travel time is short the time at the terminal plays an important part in the overall journey time. In order to reduce this terminal time this route has implemented double ended vessels (Figure 5). For this route type the speed of vessels is not as critical if considering the alternate land based option could take much longer to commute via the road network (Stenius et al. 2014)

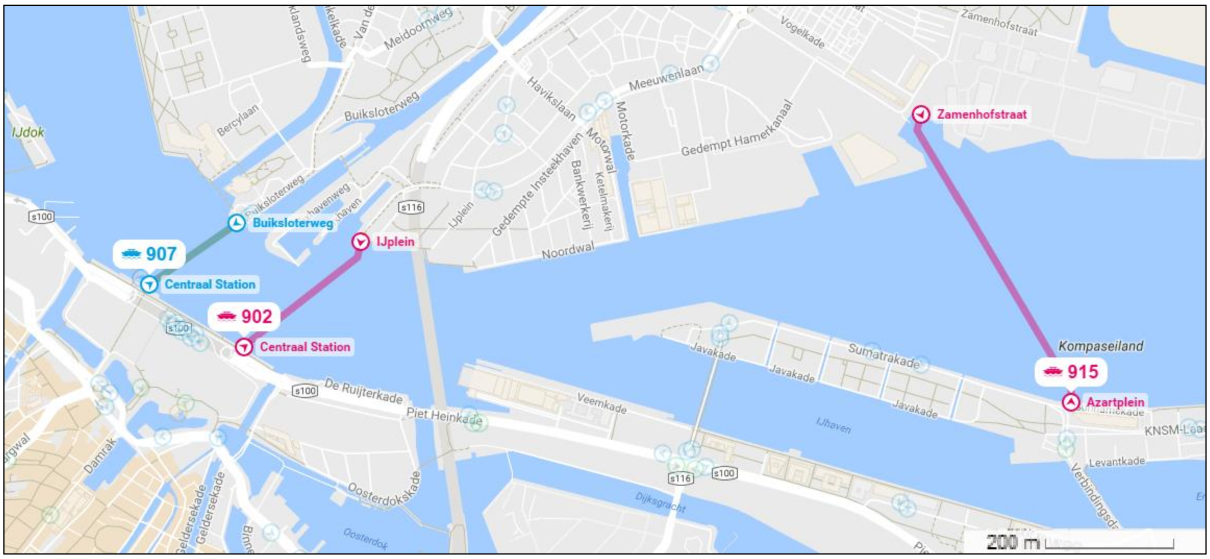


Figure 4 Example of Type B cross river routes in Amsterdam Source: GVB/Google Maps

Figure 5 Älveli and Älvfrida vessels in Gothenburg. Source: Styrsöbolaget (2015)

Finally, an important performance driver for such routes is a high frequency service. In Brisbane, Hong Kong, New York, Stavanger and Venice, services of this route type have a frequency of less than 10 min in peak periods. In cities with high night traffic like in Amsterdam, there are also late services on popular routes.

Type C routes are those which link suburbs with the inner-city area. An example of this is Line 89 in Stockholm which connects the suburban Ekerö area 25km outside the city centre (Figure 6). These ferries don't usually operate at high frequencies since the journeys are typically long. In contrast with B type routes the design focus on such routes tends towards service amenity and providing facilities like comfortable seating, tables, toilet and having food available on board. An issue with these routes is achieving a constant demand outside peak commuting periods to sustain all day operation as a regularly scheduled public transport service. In some cases, services only operate in the morning and afternoon peak periods leaving a non-service gap in between, such as in Auckland and San Francisco. These routes may face greater scrutiny for running vessels at less than capacity, with greater challenges in creating a long term economically viable service.

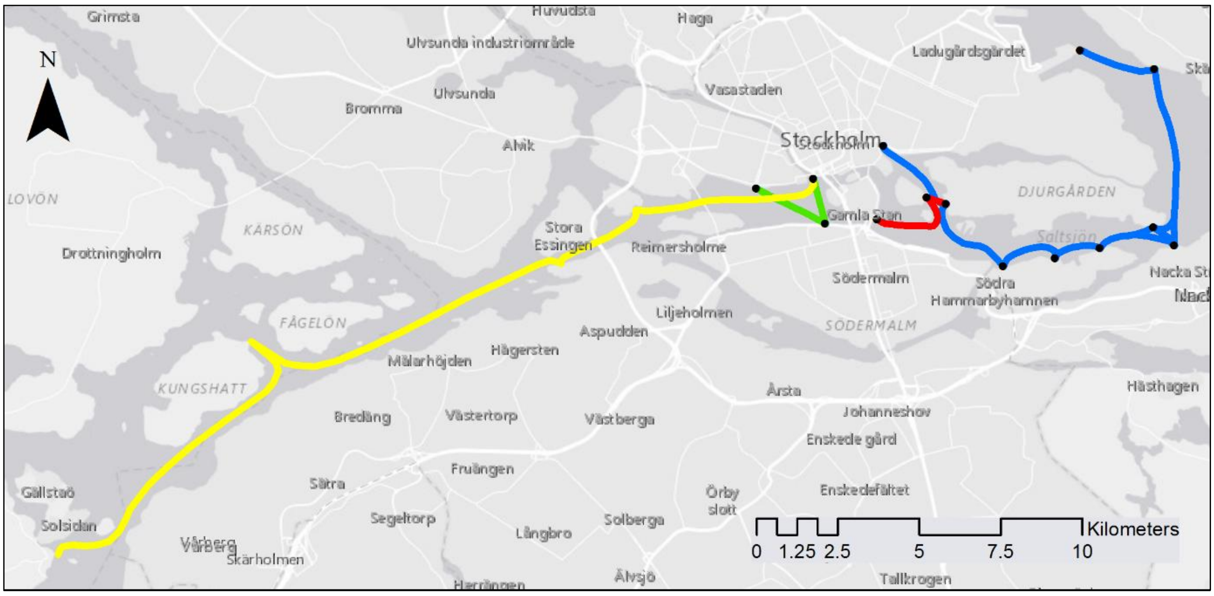


Figure 6 Route comparison: Type C (Yellow), Type A (Blue), Type B (Red) in Stockholm

Type C routes can be found in many cities and there have been some interesting strategies to counteract the lack of passenger demand outside peak hours. In Wellington, for example, ferries operate on different routes based on the time of day and season. In Hamburg, ferries transform into lecture halls during off peak hours to cater for a different purpose and clientele. In this report, we focus on ferry service connecting suburban areas within the city limits, and therefore intercity (or intercountry) travel is outside the scope of this analysis.

We now look toward other factors worth considering in the development of urban water transport systems. The first of these, which has already been briefly mentioned is scheduling of services, and how the network is planned

Scheduling

A particular challenger facing planners of water transit is balancing the demand for services and coordinating an appropriate schedule. Ferry services that are not frequent enough will create problems to offering a convenient transport alternative for passengers. Route type and length, as well as population density, will largely determine the frequencies of service that can be economically offered. As noted, Type B routes linking inner city areas may be able to run at headways of as little as 5 minutes. Other routes that are part of a wider network may require more considered planning. In Sydney, for example, there is a significant challenge in scheduling the ferry network and facilitating the changing of passengers between routes in a complicated network characterised by one key transfer hub. Sandell (2015) has suggested that by implementing a pulse timetable where ferry services meet at timed intervals at this central hub, it could greatly increase origin-destination pairings, with only little increase in cost (Figure 7). In the Water365 project in Stockholm it has been suggested that suburban shuttles (of the Type C route) could feasibly operate with twice the capacity of inner city routes while having a departure frequency of 20 minutes (Stenius et al. 2014).

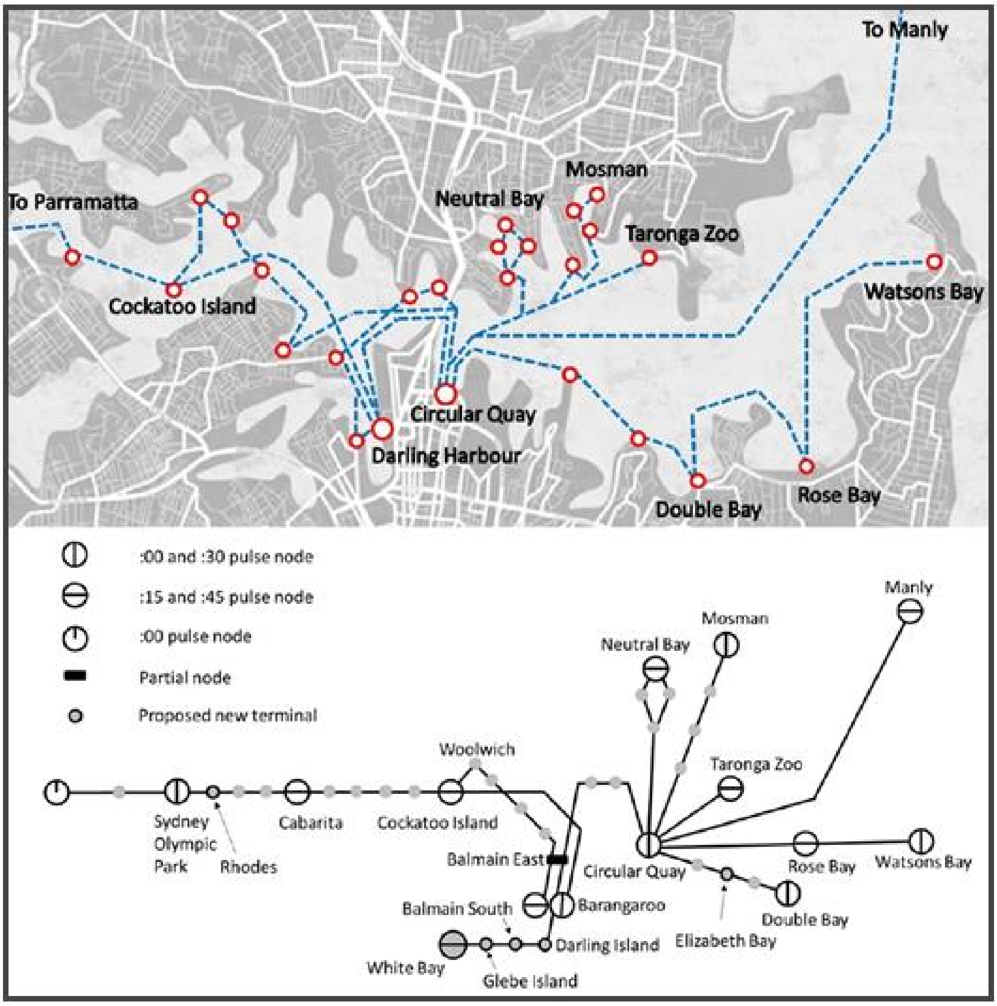


Figure 7 Pulse timetable ferry network design. Source: Sandell (2015)

Transit network integration

One of the key aspects that has been identified in the success of contemporary water transport services is the connection with existing public transport networks (Soltani et al. 2015). It was found in this report that water transport services vary from fully integrated into the existing public transport network with terminals facilitating interchange between services (Brisbane, Gothenburg), to separate ferry services operated by private companies outside of the public transport network and on a non-scheduled basis (Hong Kong). Considering the public transport ticketing system, one can find integration in Stockholm, Gothenburg, Vancouver and Rio de Janeiro. While it is perceived convenient for a passenger to have a combined ticket pass, the viability of intermodal integration needs to be investigated from an economic point of view for running the vessels, especially for Type C routes.

Terminal design

Closely linked with the need for water transit to be linked with the wider public transport network is the importance of terminal location, design and infrastructure. A key factor is the conscious planning of ferry terminals with other transit options, with ease of transfer between modes being facilitated. The design of the terminals is also important for other reasons. In coordination with vessel design, terminals should be designed in order to reduce the time taken to load and unload passengers. Some further performance factors of terminals are availability of facilities like seating and shelter, ticket machine availability, real-time information systems and disability access. Despite these ideal specifications, terminals may be limited to more pragmatic designs in accordance with their route type they support. For example, longer distance routes might require more seating spaces with food kiosks and toilet facilities, while route types A and B would likely require more focus on reducing the time spent at terminals. In routes relying on short turnaround times, as noted, there is move toward double ended vessels. However, for the most part, docks facilitating side loading are common and have been effectively implemented. For reference, a 1.5 minute estimated embankment time at full capacity has been recommended for future service design in Stockholm (Stenius el al. 2014).

In terms of the structure itself, while most cities have fixed wharfs, Rotterdam and Hamburg have floating wharfs which might be suitable for making docks more integrated with other transport as they can be easily towed to a new location. However, there is an ongoing debate about whether temporary terminal facilities will encourage supportive land use development as much as fixed terminals (Thompsons et al. 2006). Tidal considerations are also relevant in cities such as Hamburg where careful planning needs to be made for not only terminal infrastructure but also logistical operation to account for tidal variation. Seasonal variation in some cities may not dictate terminal type as greatly as other cities, for example, where Stockholm's water level sees an annual fluctuation of about 10 cm in its water levels. Finally, the effects of flooding need to be considered in any structural design according to the local weather conditions.

Accessibility, comfort and public perception

One of the identified motivations towards developing water borne transport services is that research has shown that comfort of journey is an increasingly important factor for commuters. Assessment of water transport has shown that commuters are often more satisfied with the comfort of services compared to other modes (Queensland Government, 2015), and empirical studies have suggested that there is a premium value attached to water transport services, where commuters will prefer boat transport despite a longer travel time compared to a bus (Tanko et al. forthcoming). However, even in cities with extensive public transportation networks, the actual mode share of waterborne transport is usually low. For example, in Sydney the mode share of ferry transport is only 3% of all public transport journeys despite having a total of 14.8 million trips a year (Sydney Ferries 2012). To increase ridership and make waterways more popular, cities have adopted different strategies, with some promoting high speed express services (Sydney) or additional on board facilities and Wi-Fi (Rotterdam). Auckland has a focus on providing infrastructure catering for the needs of the physically challenged where there are separate access points and seating to make the travel experience easy and comfortable. Gothenburg caters to the needs of cyclists where ferries have a wide-open space for accommodating bicycles. On board food and drinks and premium seating on London's Thames Clippers river transit service has proven popular with commuters seeking respite from overcrowding on London Underground rail services.

However, such efforts to bolster the appeal of water transit are still being debated, with some arguing that such facilities detract from the focus of providing a useful and efficient service. As water transport usually entails longer travel times this poses practical challenge to balance acceptable travel times while providing better service amenities. Efforts to identify the specific factors valued by water transport passengers and how to weigh these benefits against travel time is the focus of ongoing research of the authors. If suitable design changes are implemented and attractive facilities provided, the longer travel time can potentially be seen as an opportunity to facilitate *positive utility of travel*, which is an emerging transport concept that studies how passengers derive benefits from their travel.

From a ferry terminal facility point of view, a passenger can reasonably expect sheltered seating areas, information centres, toilets, and perhaps food kiosks. Many modern piers include these facilities as part of the design. Branding of these piers with a uniform design language consistent with the wider public transport network is also important for increasing awareness of services and legibility. For instance, the addition of river services to the London Underground map was part of a plan to increase awareness of water transit options (Figure 8). Finally, an important aspect regarding public perception is the perceived safety of water transit compared to other modes. Cities like Hamburg are seen to emphasize this and ferries are equipped with life boats, life jackets and modern radar and Automatic Identification Systems (AIS) systems.

Figure 8 River transfer points highlighted on London Underground map. Source: TfL (2017)

Vessel design

Vessel design depends on several factors such as operating route, traffic volume and climate. Ideally a vessel should be stable during loading operations and during motion against all wave headings, have low resistance, and be accessible for all passengers. Around the world, vessels are a mix of monohulls (Copenhagen, Gothenburg and Hamburg) and catamarans (Brisbane, Amsterdam, London and Auckland. Those in Rotterdam and Brisbane have slender hulls designed to generate minimal wake, which is beneficial where wake wash and erosion is a potential limitation to operation in urban waterways. The hull material is also an important factor and needs special attention based on local conditions. While a lighter hull entails having a larger capacity, lower fuel costs and cheaper construction, on the other hand it suffers from poor stability as the draught becomes dependent on the payload. Given present technology, heavier hulls are the material of choice recommended for year-round ice operations, while light hulls are favoured for efficiency gains in non-ice conditions. As such, materials vary from hardened steel in Stavanger, to a combination of an aluminium hull and fibre superstructure in Sydney and Brisbane. Furthermore, for a vessel that operates year-round in ice conditions, service operation would need to be more robust in the absence of appendages such as open water propellers and rudder stocks which are susceptible to damage. Such implementations can be seen in new vessels at Gothenburg that use azimuthal shrouded propellers.

As part of the Waterway365 (Stenius et al 2014) project in Stockholm a number of potential designs have been investigated for suitability. One concept, the *CityBoat* design for inner city transport, favoured a monohull design. The form of the hull, with focus on stem angle, rake angle and flare angle are important considerations in terms of achieving a low resistance profile, particularly in ice conditions. New innovative designs are also continuingly being developed and refined. For example, the BB Green electric vessel design currently under trial in Stockholm has a hull that uses an air cushion to reduce drag and wake formation (BBGreen

2016). But there is further scope for investigation regarding the choice of hull as there are other factors that need to be considered. This is part of ongoing research within the Waterway365 project at KTH.

Another important consideration in vessel design is the internal passenger spaces. General arrangements including places for seated and standing passengers, areas for bicycles, safety box, driver compartment, luggage stowage and toilet are potential factors to consider. While the number of passengers and bicycles for each trip are variable, it is important to maintain a high cabin ratio for sustainable operations. In Stockholm, the public transport authority SLL states requirements of 150 passengers, 40 bikes and room for 50 additional standing passengers, which would form the basis for computing minimum dimensions of a suitable vessel. Such specification could aid in the development of modular design concepts for different internal arrangements for different route types and dictate customized design details such as foldable seats or collapsible cycle racks.

Operating costs

The operating costs and manpower used is also an area with a potential for improvement in water transport. Due to regulations, typically a ferry in Stockholm needs two or more operators and, in general, the salary of a sea operator is higher than his land based counterpart. It therefore may be possible to lower operational costs if the manpower on board vessels could be reduced. There have been some efforts in reducing the crew size in other cities and can be seen in Gothenburg where ferries are designed to work with a crew size of two. Hamburg currently operates vessels by the captain alone who also operates the hydraulic gangway for passenger loading and unloading. Amsterdam is currently testing and developing self-driving boats, although the practical application in passenger vessels is still a future prospect.

In terms of propulsion technologies there is also scope for improvement, and there are a number of positive initiatives within water transport. In Hamburg and Stockholm older vessels have been modified to run on hybrid electric power. Hybrid vessels in Sydney and San Francisco have been seen to use solar power in addition to conventional power. In Stavanger, new hybrid electric boats added to the fleet are being designed such that their power systems have a DC grid that adds flexibility in terms of later conversion to hybrid or purely electric power. In Hamburg, a hydrogen fuel cell based ferry has been introduced. However, while some ferries now run with low or zero emissions, it is nevertheless important to consider the entire life cycle from battery production to disposal and its impact on the environment.

In addition to environmental considerations, economic sustainability is a practical factor that needs to be considered. A proposal has been to replace existing diesel fuel with (Hydrogenated Vegetable Oil) HVO, similar to the buses in Stockholm. But the shift of fuel source is set to raise costs by 60%. Similarly, in terms of adopting alternatives like fuel cells and electric power, the associated costs of supporting infrastructure and fuel sourcing might make the changes economically unviable. Furthermore, the low payload-equipment ratio is a particular limitation in electric power for water transport applications. The current limitations on technology make the batteries considerably heavy and often they weigh as much as 160% of the payload. While it can be argued that the loss in weight due to the battery can be counteracted by taking a higher payload, it is important to consider that area plays as much an important role as displacement does. Theoretically, it would be possible to increase the displacement to maintain a high payload despite the battery but with possible associated increased resistance and higher fuel consumption.

Study examples and methodology

In the report's main section that follows, a selection of waterborne transit systems in cities across the world are described. In total, 23 cities were chosen as part of this compilation which represent the breadth of experience in planning and operating water transport currently available. The contents of this report consist of data collected from various sources, including transit operator's official websites, as well as transport planning and technical reports and relevant academic publications. This report also builds on previous studies at KTH investigating the use of inland waterways in an expanded transport function. In summer 2014, a study by students of KTH and Konstfack University of arts, craft and design, in collaboration with Vattenbussen AB was conducted. The purpose of the study was to test the feasibility of concepts introduced in the previous Waterway 365 study, Stenius et al. 2014. As part of this work some existing waterborne transportation systems were investigated and data on their operations complied. Furthermore, in November 2015, Stockholm County Council carried out an internal study to explore the feasibility of new experimental water transport lines and the possibility of developing next generation ferries. As part of the current joint research between KTH, Vattenbussen and Stockholm County Council, this report has been aided by data from the above-mentioned reports and referenced accordingly.

The cities chosen for this report were broadly categorized into three major categories: large scale, medium scale and small scale operations, based on the number of routes, passengers served and the overall scale of the water transport system. The demarcation of cases is as follows:

Large scale (13 cases) (>7 lines, high number of stops)

- Amsterdam
- Auckland
- Brisbane
- Hong Kong
- Istanbul
- Izmir
- London
- New York
- San Francisco

- Seattle
- Stavanger
- Sydney
- Venice

Medium scale (6 cases) (4 – 6 lines, medium number of stops)

- Copenhagen
- Gothenburg
- Hamburg
- Rio de Janeiro
- Stockholm
- Vancouver

Small scale (4 cases) (1-3 lines, limited number of stops)

- Boston
- Oslo
- Rotterdam
- Wellington

The references to data and pictures used in the presentation of the different cases are summarized under the headings *CASE REFERENCES* and *IMAGE REFERENCES* in the end of the report. There they follow under the heading of the cities respectively.

LARGE SCALE WATER TRANSIT NETWORKS

AMSTERDAM

NETHERLANDS

Population	842,343
Area (urban)	350 km^2
Density	4,908 per km^2
Route type	A,B
Ferry routes	9
Terminals	15
Passengers	-

Public transport network overview

The public transport network is managed by GVB in Amsterdam which includes metro rail, tram, bus and ferry services. Fare collection is by rechargeable smart card, single ticket or day pass. The ticket system is integrated with other public transportation and the same ticket can be used for transfer between other public transport modes without cost penalty.

Ferry system overview

The vessels in Amsterdam are catamarans that are equipped to carry people, mopeds and bicycles with full disability access. There is a total of 15 vessels in service which are all catamarans.

Features	
Vessel capacity	150 (inside/outside)
Vessel facilities	Toilet, tables, priority seating, bicycle area
Terminal facilities	Static signage, digital signage, real time signage, ticket machine, disability access, luggage storage

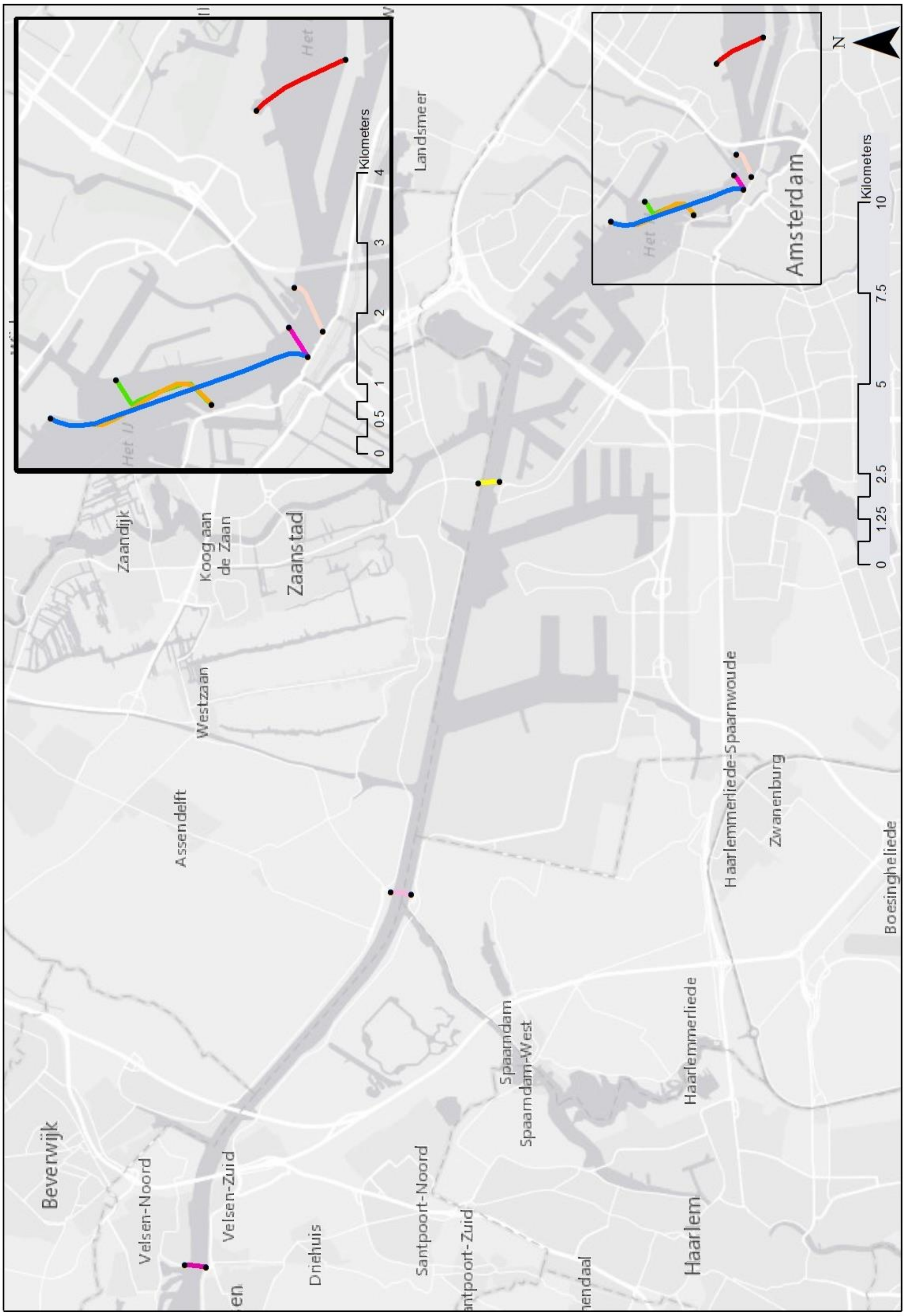
Operational characteristics	
Operating time	6am – 10pm
Peak periods	6am-9am 4pm-7pm
Frequency	10 – 20 mins peak 45 mins off peak
Fare	$4 USD

Additional information

The city of Amsterdam has numerous canals traversed by canal tour boats and pleasure crafts. The water is viewed as an economic resource and there is high drive towards waterfront development. There is also active research with respect to autonomous crafts that is set to debut in 2017.

AMSTERDAM

NETHERLANDS



AUCKLAND

NEW ZEALAND

Population	1,454,300
Area (urban)	559.2 km²
Density	2,600 per km^2
Route type	A,B
Ferry routes	10
Terminals	20
Passengers	5,500,000

Public transport network overview

The public transportation network in Auckland is run by AT, a government organisation. However, the ferries are managed by Fullers and other private companies. Other available transit options include metro rail and bus. Fare collection is by rechargeable smart card, single ticket or day pass. The ticket system is integrated with other public transportation and the same ticket can be used for transfer to and from ferries between other public transport modes without cost penalty.

Ferry and terminal overview

There are several types of ferries operating in Auckland. They are all catamaran type vessels equipped to carry passengers, bicycles, and have disability access.

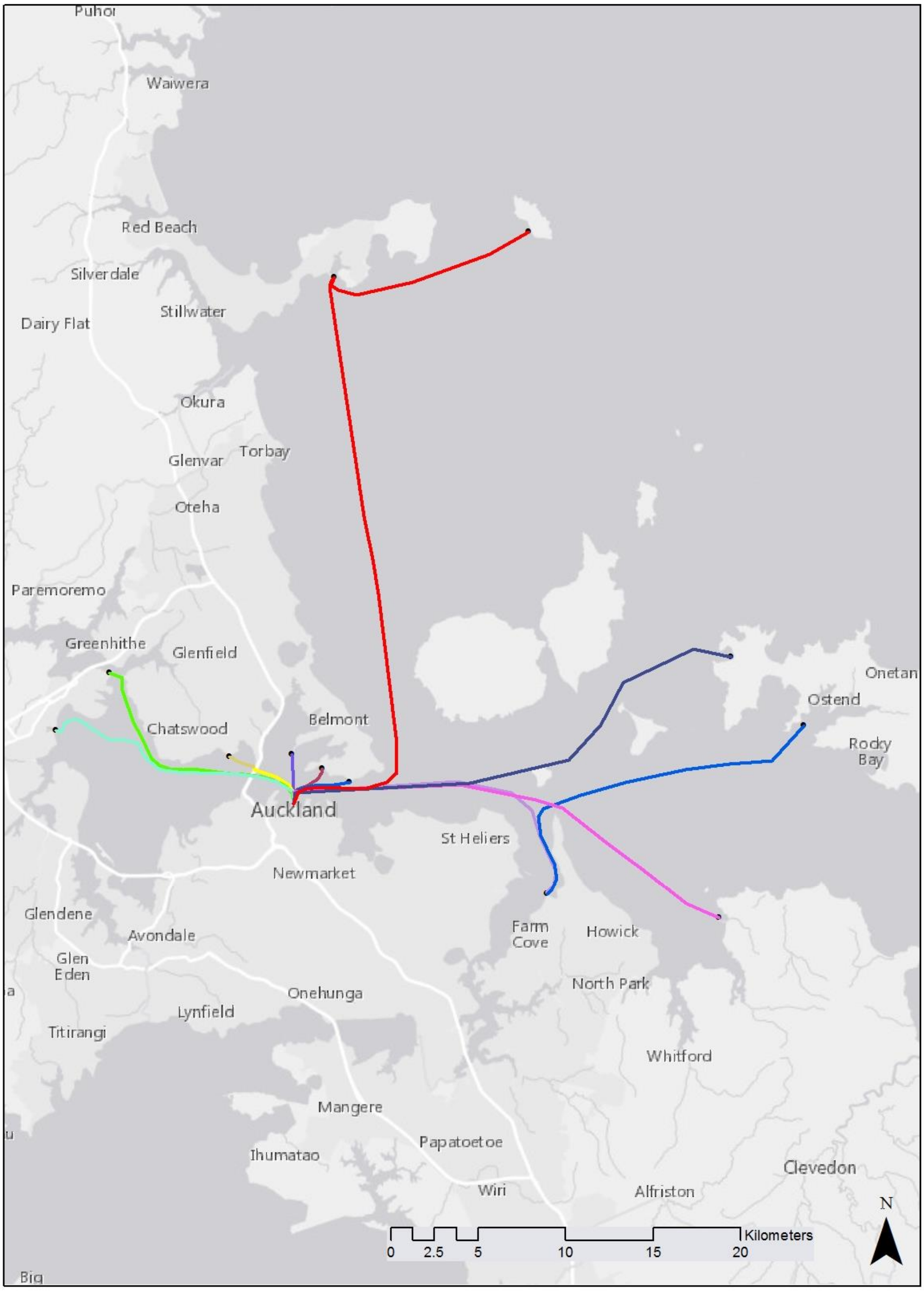
Features	
Vessel capacity	401 (331 seated) 14 bicycles
Vessel facilities	Tables, priority seating
Terminal facilities	Static signage, ticket machine, disability access,

Operational characteristics	
Operating time	6am – 10pm
Peak periods	6am-10am 4pm-8pm
Frequency	30 mins peak 60 mins off peak 150 mins off peak weekend
Fare	$4 USD

Additional information

The city of Auckland develops a strategic plan for ferry system development every 10 years. Under the current plan, there is a focus to prioritize high frequency public transport, transform and elevate customer focus and experience, build network optimisation and resilience and ensure a sustainable funding model. The newer high speed catamaran ferries are equipped with a large café and four toilets catering to the needs for handicapped commuters and other commuters.

AUCKLAND
NEW ZEALAND



BRISBANE

AUSTRALIA

Population	2,308,700
Area (urban)	15,826 km^2
Density	2,600 per km^2
Route type	A,B
Ferry routes	5
Terminals	24
Passengers	6,250,000

Public transport network overview

The public transportation in Brisbane is run by TransLink which includes a network of bus, metro rail and ferry services. Transdev Brisbane Ferries manage the ferry services. Different modes are integrated together and there is no penalty for transfer between modes. Ticketing is done by smartcard (86%) or single paper tickets and prices are the same for each mode.

Ferry and terminal overview

There are three types of vessels operating in Brisbane. First, the CityCats are high speed catamarans covering the whole river (top). Second, the CityFerries are slower monohull vessels used in the inner city route (bottom). Finally, CityHoppers are similar vessels to CityFerries which are used on cross river services. The fast City Cats are designed to compete with other means of transportation in terms of travel time. They have an aluminum hull with a fiber superstructure for lighter weight.

Facility features	
Vessel capacity	Catamarans 149-162 Monohull: 53-78 Seating in/out
Vessel facilities	Disability access and space for six wheelchairs, priority seating, WiFi
Terminal facilities	Static signage, ticket machine, disability access at most terminals

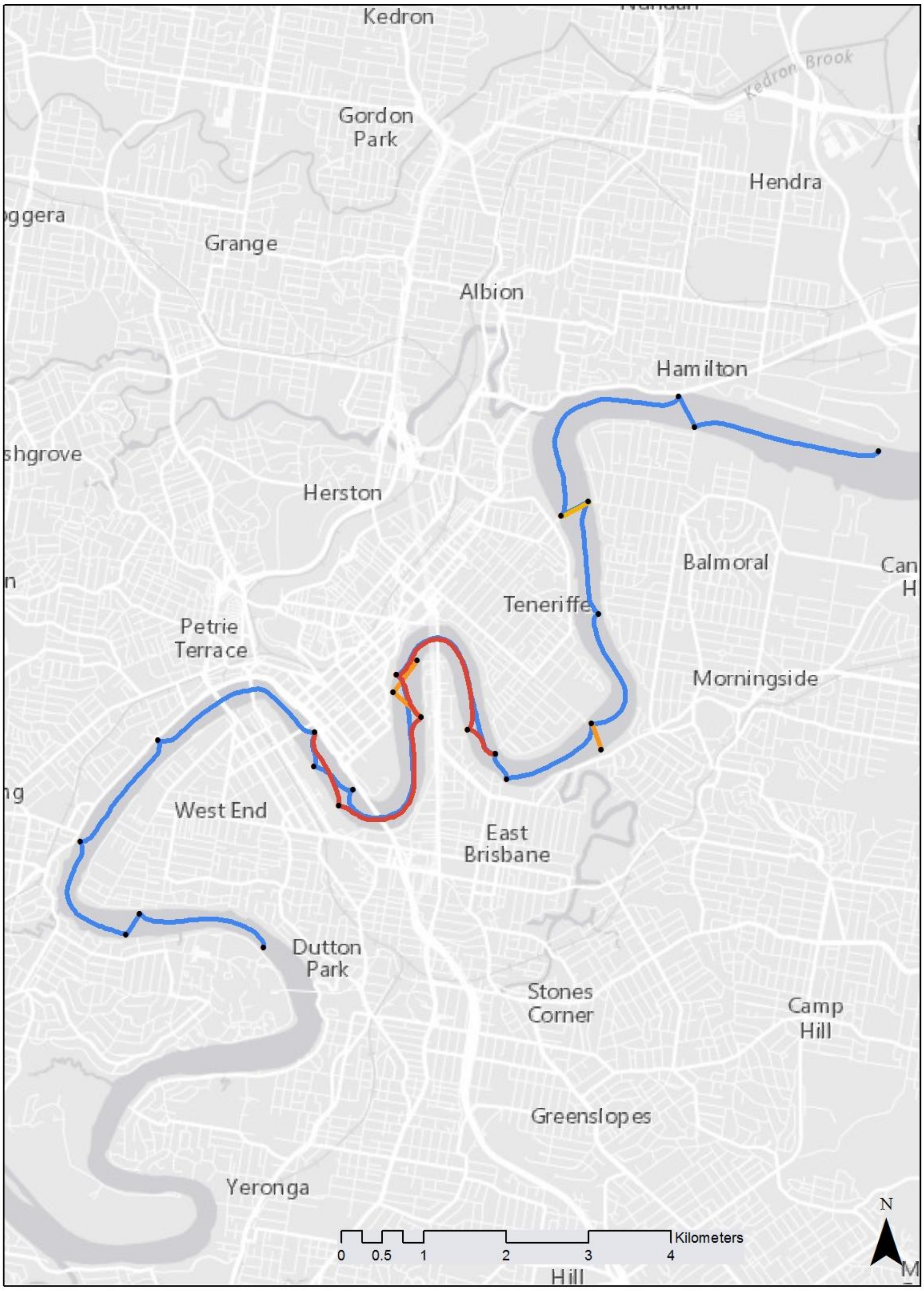
Operational characteristics	
Operating time	5am-12am (until 1am Friday/Saturday)
Peak periods	6am-9am 4pm-7pm
Frequency	5-15 mins peak 30 mins off peak
Fare	\$2.60 - \$3.00 USD zone based (prepaid/paper); Free inner city “CityHopper” service)

Additional information

Vessels are often branded in local sporting team livery which strengthens the iconic nature of the service in Brisbane. Tourism and leisure use are popular demonstrated by strong use outside peak periods and weekends.

BRISBANE

AUSTRALIA



HONG KONG

CHINA

Population	7,234,800
Area (urban)	2,755 km^2
Density	6,544 per km^2
Route type	A,B,C
Ferry routes	6
Terminals	7
Passengers	29,900,000

Public transport network overview

Public transport is run by the Transport Department, Hong Kong Government. Other available transport includes an extensive metro, rail and bus network. Ferries now mainly serve a supplementary role and as a lifeline to outlying islands with no other transport options. Tickets can be purchased at terminals or through an integrated electronic portal available via the internet.

Ferry and terminal overview

There are now 11 ferry operators providing 18 licensed passenger ferry services to outlying islands and across the harbour. There remains two franchised ferry services operated by "Star Ferry" between Central and Tsim Sha Tsui as well as between Wan Chai and Tsim Sha Tsui. The ticket system is not integrated with other public transportation means. Separate tickets need to be purchased for the use of ferry services.

Facility features	
Vessel capacity	288 - 762
Vessel facilities	Disability access, toilets, café, bicycle racks (only some ferries at specific times)
Terminal facilities	Static signage, ticket machine, food kiosks

Operational characteristics	
Operating time	0730 - 2220
Peak periods	7.30am – 9.30am 4pm – 6pm
Frequency	8 mins (peak) 20 mins (off peak)
Fare	$0.30 – 0.50 USD $1.60 USD for bicycle

Additional information

Most recent focus on transport development has been on land based modes, with little investment in vessel or terminal infrastructure to modernise services. In addition, widespread land reclamation has hindered access to waterfront and ferry services. Ferry services amount to 5% of total transportation.

HONG KONG
CHINA

ISTANBUL

TURKEY

Population	14,025,646
Area (urban)	1,539 km2
Density	2,691/km2
Route type	A,B, C
Ferry routes	7
Terminals	14
Passengers	~40,000,000

Public transport network overview

The public transportation in Istanbul comprises of metro rail, trams, buses and ferries. The ferries are operated by Sehir Hatları which is a private company. In total there are 7 ferry lines operating in the city. The public transportation is run by the government. The ticket system is not integrated with other public transportation means and separate tickets need to be purchased for use of ferry services.

Ferry and terminal overview

The ferry vessels operating in Istanbul are monohulls and have large capacities. Some of the old vessels have now been replaced by fast catamarans.

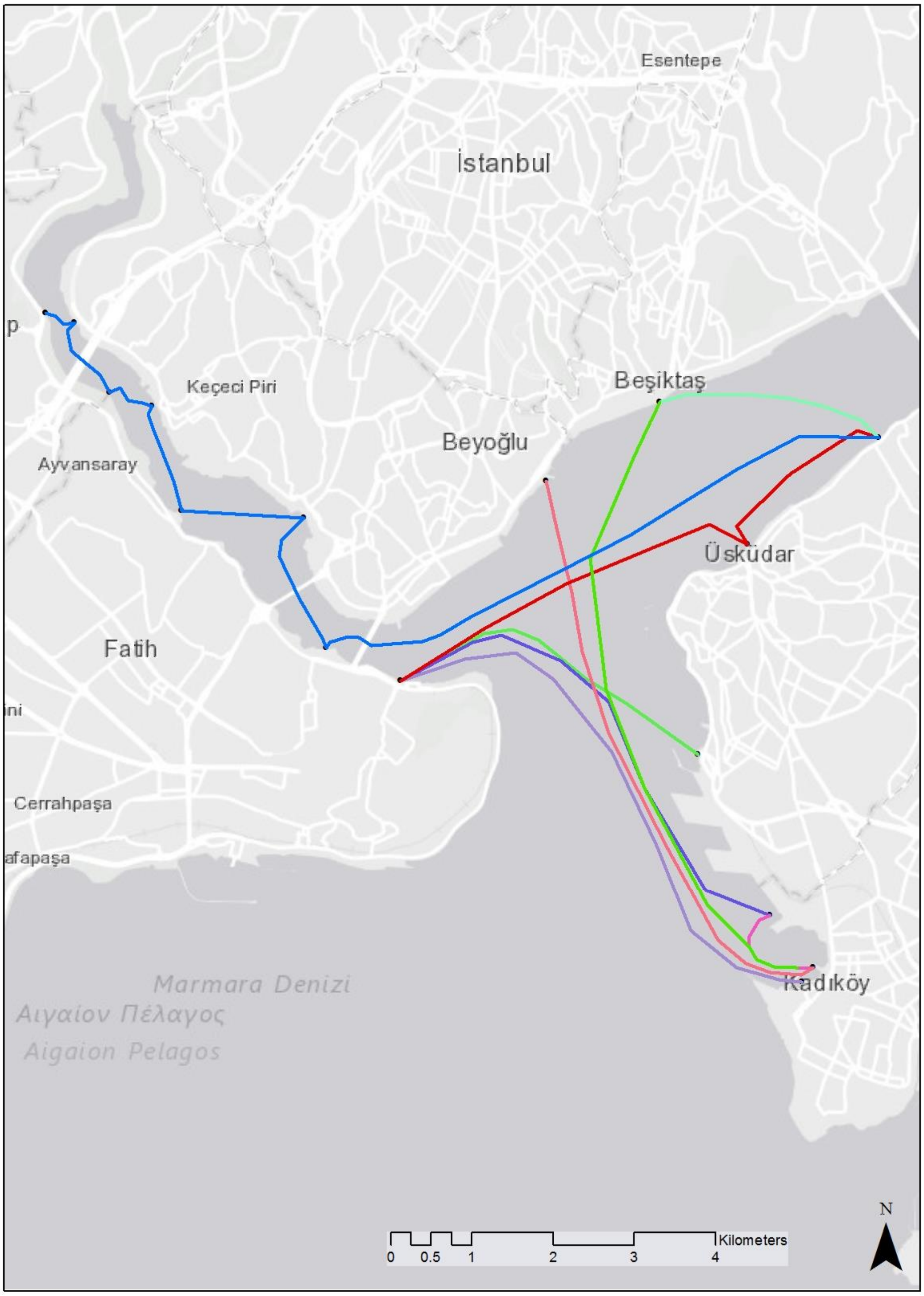
Facility features	
Vessel capacity	600 - 2100
Vessel facilities	-
Terminal facilities	Static signage, ticket machine

Operational characteristics	
Operating time	7am – 11pm
Peak periods	6am-9am 4pm-7pm
Frequency	20 mins all day short distance 45 – 90 mins long distance services
Fare	$2.80 – $4.00 USD

Additional information

The city has a long history of water transport in the Bosphorus. While the existing fleet runs on fossil fuels, Sehir Hatları has started working on a new program to add new lines and procure new cleaner fuel vessels, and covert existing vessels to run on green energy.

ISTANBUL
TURKEY



IZMIR

TURKEY

Population	2,847,691
Area (urban)	7,340 km^2
Density	390 per km^2
Route type	A, B, C
Ferry routes	11 (A, B) 3 (C)
Terminals	8
Passengers	600,000

Public transport network overview

Public transport ferries are managed by Ideniz in Izmir. Fare collection is by a rechargeable smart card system called Kentkart. There are also single ticket or day passes. There is also an option to pay using a mobile application. The ticket system is integrated with other public transportation and Kentkard holders get discount rates compared to paper ticket holders. There are 14 ferry routes serviced by 18 vessels.

Ferry and terminal overview

The ferries operating in Izmir are a mix of old and modern vessels. The new vessels are large capacity catamarans and medium capacity monohulls while the older vessels have a traditional monohull design.

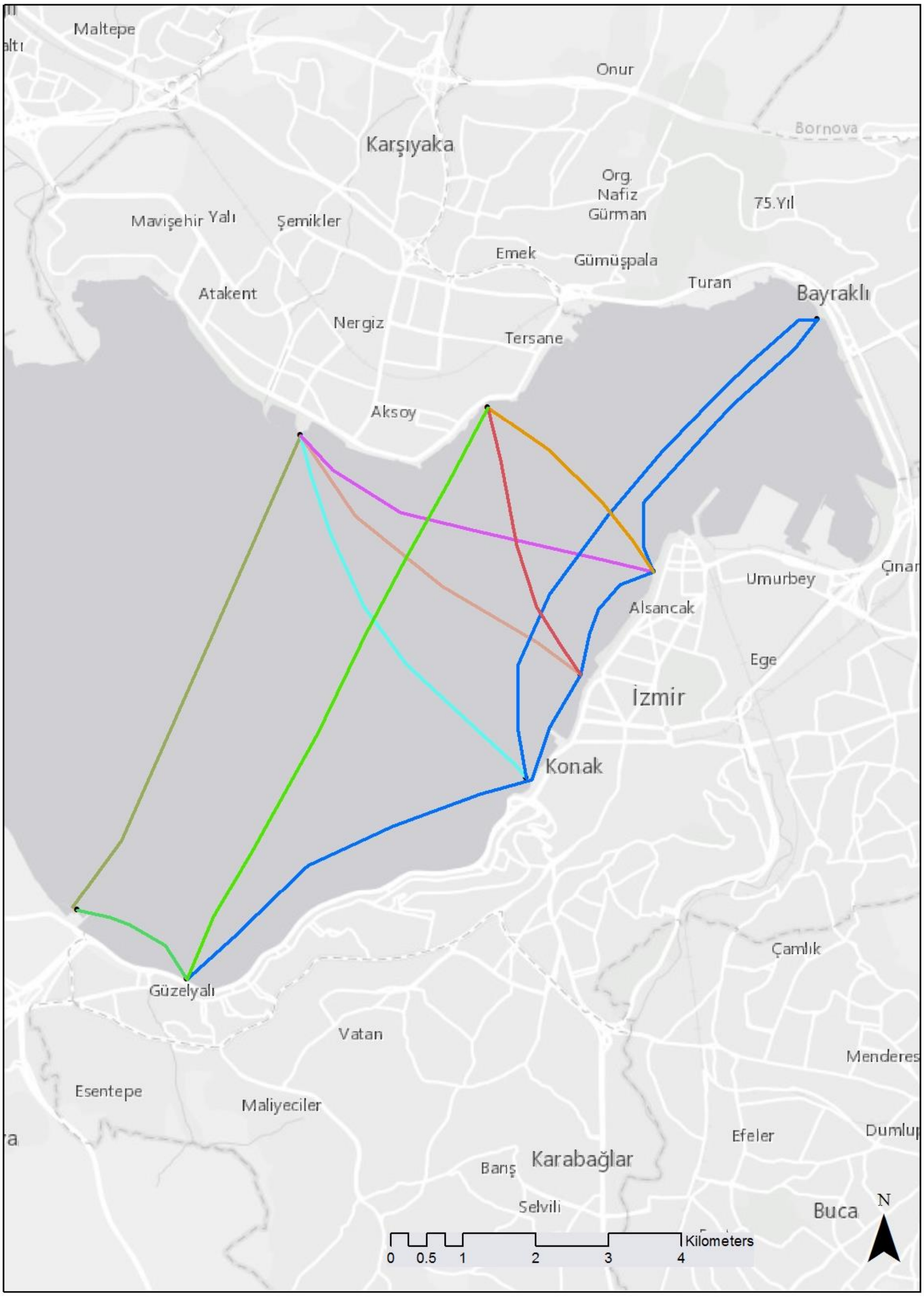
Facility features	
Vessel capacity	140 – 426 (inside/outside)
Vessel facilities	Toilets, priority seating, bicycle area
Terminal facilities	Static signage, ticket machines

Operational characteristics	
Operating time	7 am – 12 am
Peak periods	8 am – 10 am 4 pm – 7 pm
Frequency (mins)	15 mins peak 25-30 off peak
Fare	$0.80 – 1.30 USD

Additional information

Integration of the public transport system occurred in 1999. The city has set new transport network goals for 2030, including setting up new terminals and making industrial and tourist sites more accessible.

IZMIR
TURKEY



LONDON

ENGLAND

Population	8,673,713
Area (urban)	1,572 km^2
Density	5,518 per km^2
Route type	A, B
Ferry routes	6 (A) 1 (B)
Terminals	28
Passengers	4,300,000

Public transport network overview

The public transport boat network in London is managed by Transport for London (TfL). Ferries themselves are operated b a private company MBNA Thames Clippers. Fare collection is by rechargeable smart card, single ticket or day pass. There is also an option to purchase tickets via a mobile app. The ticket system is partially integrated with other public transportation means, with efforts ongoing to achieve full integration. There are 7 ferry routes serviced by 15 vessels.

Ferry and terminal overview

Boats operating in London are slender, low wake catamaran vessels. The vessels lack a sun deck but there is some outdoor seating at the rear of the vessel. The seating capacity is limited by the number of seats as it is local regulation to have all passengers seated during operation.

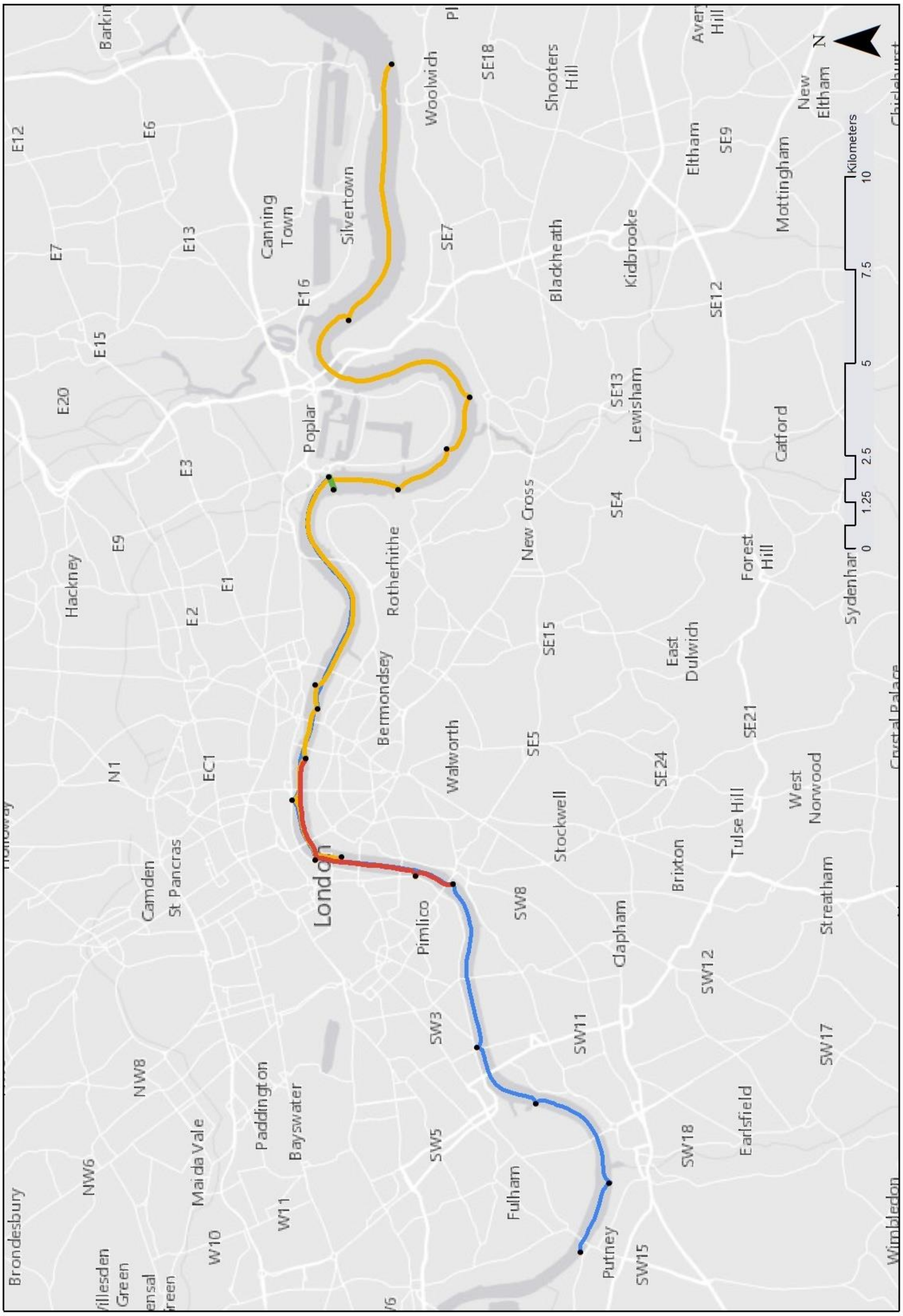
Facility features	
Vessel capacity	150 (inside)
Vessel facilities	Priority seating, bicycle area, on board shop selling food and drinks including alcohol, airline style seating
Terminal facilities	Digital signage, ticket machines, staffed information kiosk

Operational characteristics	
Operating time	6 am – 10 pm (wd) 11 am – 8 pm (sun)
Peak periods	7 am – 10 am 4 pm – 7 pm
Frequency	20 mins peak 30 -60 mins peak
Fare	\$5.50 – \$10.30 USD

Additional information

The Thames Clippers ferry system has an extensive marketing strategy to promote its “premium” service including converting ferries into movie/football club themed vessels for special occasions and other charter options. Additional services are provided for events at the O2 stadium.

LONDON
ENGLAND



NEW YORK

USA

Population	8,550,405
Area (urban)	1,213.37 km^2
Density	416 per km^2
Route type	A, B
Ferry routes	2
Terminals	8
Passengers	1,200,000

Public transport network overview

The East River public water transit network is managed by NY Waterway which is a private company. Fare collection is by pre-purchased single or seasonal tickets that can be bought online, or paper tickers via ticket machines at piers. The ticket system is not currently integrated with other public transportation. There are 4 routes planned with 2 currently operating and another set to open in August 2017 (Astoria route).

Ferry and terminal overview

The ferries initially operating on the new East River route were re-purposed monohull vessels. They have enclosed space as well as a sun deck. Purpose built vessels have been designed and constructed and are due to go into operation in 2017.

Facility features	
Vessel capacity	150 (inside)
Vessel facilities	Priority seating, bicycle area, sun deck, WiFi (new vessels)
Terminal facilities	Digital signage, ticket machines, bus connection

Operational characteristics	
Operating time	6 am – 9 pm
Peak periods	6 am – 10 am 2 pm – 7 pm
Frequency	20-30 mins peak 30 mins off peak
Fare	$9 - $21.50

Additional information

There are currently ongoing talks with respect to integrating the services with other public transportation for a citywide common ticketing system.

NEW YORK
USA

boken
Hudson River Tributary
Hudson River NEW JERSEY NEW YORK
Greenwich Village
Greenpoint
Chinatown
New York
MANHATTAN ISLAND
Hudson River
NEW JERSEY Hudson River NEW YORK
East River
Brooklyn Heights
Brooklyn
Fort Greene
Fort Jay
GOVERNORS ISLAND
South Brooklyn
Adelphi
Bed
Red Hook
Park Slope
0 0.5 1 2 3 4 Kilometers
N

SAN FRANCISCO
USA

Population	864,816
Area (urban)	600.6 km^2
Density	7,124 per km^2
Route type	A, B, C
Ferry routes	8 routes operated by 6 companies
Terminals	11
Passengers	2,772,500 (Blue & Gold) 2,545,122 (Golden Gate)

Public transport network overview

Ferries in San Francisco are operated by several private companies, of which Blue and Gold Fleet and Golden Gate Fleet are the largest. Fare collection is by single ticket or day pass. The ticket system is not integrated with other public transportation. There are 11 ferry routes serviced by 8 vessels by Golden Gate while Blue and Gold comprises 20 vessels operating on tourist and commuter routes.

Ferry and terminal overview

The ferries operating under the Golden Gate Fleet are a mix of refurbished monohulls and newly acquired catamarans, whilst the Blue and Gold Fleet are a mix of new monohulls and catamarans.

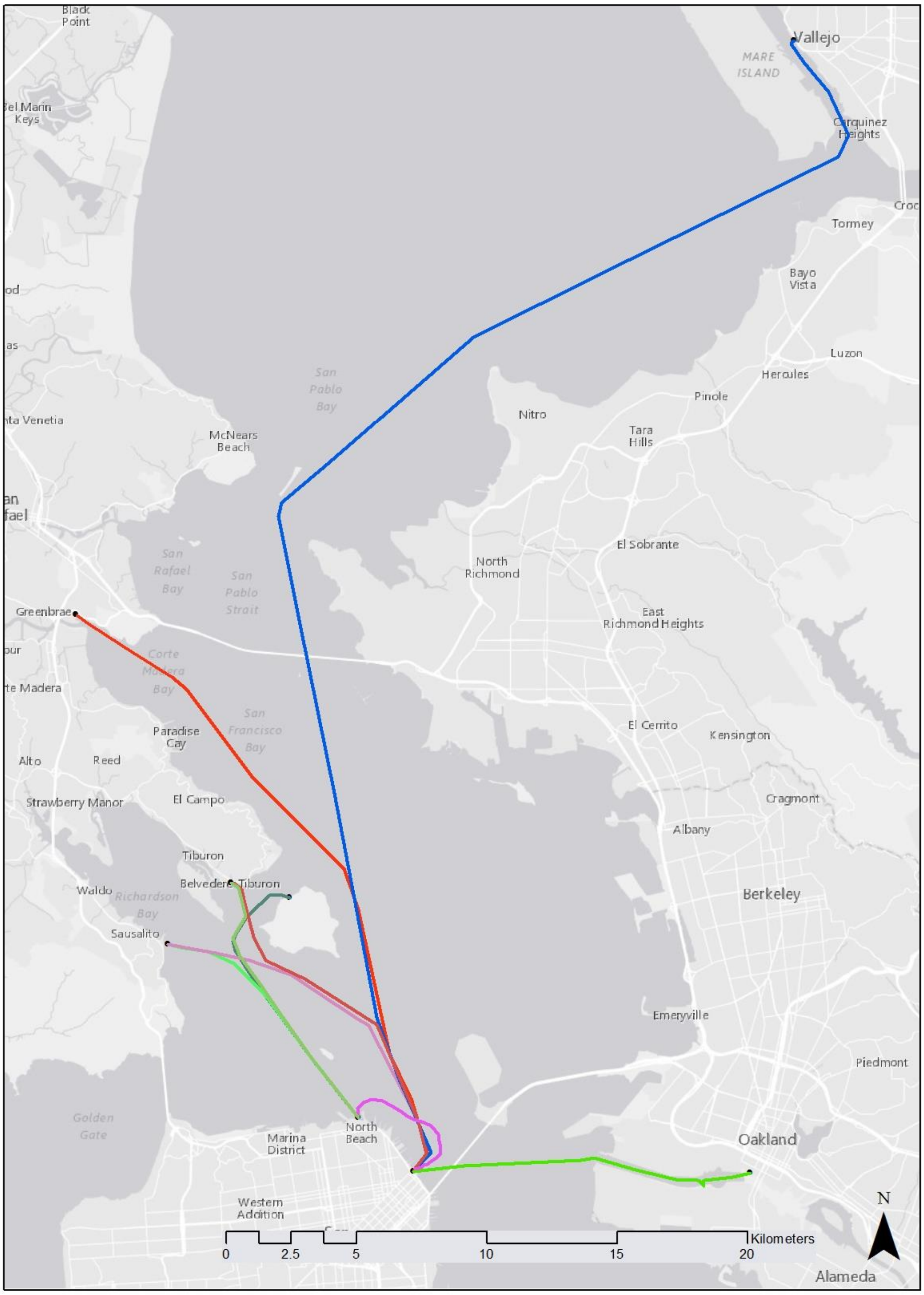
Facility features	
Vessel capacity	400-750 (inside and outside) 72 bicyccles 149-788 (inside and outside) (Blue & Gold)
Vessel facilities	Interior and exterior seating, toilets, refreshment stand, security cameras, bicycle racks, modern accessibility lift
Terminal facilities	Static signage, ticket machines

Operational characteristics	
Operating time	6 am – 9 pm
Peak periods	6 am – 10 am 4.30pm – 6.30pm
Frequency (mins)	20-35 mins peak and off peak
Fare	$7.00 – $11.00 USD

Additional information

There are plans towards expanding the ferry system by increasing the frequency and number of serviced routes due to increasing congestion on land based transportation. However, a corresponding challenge is with respect to congestion owing to the large number of craft currently operating in the bay area. Simulation studies show different scenarios and respective congestion and is still under investigation.

SAN FRANCISCO
USA



SEATTLE

USA

Population	684,451
Area (urban)	369.2 km^2
Density	3,151 per km^2
Route type	B, C
Ferry routes	8
Terminals	20
Passengers	23,000,000

Public transport network overview

Seattle ferries are managed by 'Washington State Ferries'. Fare collection is by single ticket or a long-term pass. The ticket system is not integrated with other public transportation. There are 20 ferry routes serviced by 24 vessels.

Ferry and terminal overview

The ferries operating under the Washington State Ferries are large capacity monohulls with some ferries having space for carrying cars as well.

Facility features	
Vessel capacity	199 – 2500 (inside and outside) 34 – 202 cars
Vessel facilities	Interior and exterior seating, toilets, refreshment stand, modern accessibility lift
Terminal facilities	Static signage, ticket machines

Operational characteristics	
Operating time	4 am – 9 pm
Peak periods	6 am – 11 am 4.30pm – 10pm
Frequency (mins)	40 – 80 mins peak Limited service off peak
Fare	\$3.30 - \$19.45 USD

Additional information

Recent studies have indicated the importance of ferries in the area's mobility and access, with the economic importance to the mainland industry also identified. New research is currently being conducted to design measures to expand the ferry system to further these objectives.

SEATTLE
USA


Four Corners
Breidablick
Kingston
Edmonds
Shoreline
Indianola
Poulsbo
Suquamish
Foy
Agate Point
Keyport
Port Madison
Manzanita
Rollingbay
Interbay
Fletcher Bay
Queen Anne
Bainbridge Island
Tracyton
Creosote
Seattle
South Beach
Bremerton
West Seattle
Manchester
Lowman Beach Park
East Port Orchard
Vashon Heights
Bethel
Banner
0
2.5
5
10
15
20
Kilometers
N

STAVANGER
NORWAY

Population	130,426
Area (urban)	71 km^2
Density	1,800 per km^2
Route type	B, C
Ferry routes	9
Terminals	46
Passengers	4,200,000

Public transport network overview

The public transportation using ferries in Stavanger is operated by Kolombus. However, the ferries are owned by Norled who own over 80 vessels operating all over Norway. Fare collection is by single ticket or a long-term pass through a mobile application or a smart card. The ticket system is integrated with other public transportation.

Ferry and terminal overview

The ferries operating in Stavanger are a mix of monohull car carriers and fast catamarans. There are 46 ferry routes serviced by 24 vessels.

Facility features	
Vessel capacity	180 – 296 (catamarans) 398 (car carriers) 106 cars
Vessel facilities	Interior and exterior seating, toilets
Terminal facilities	Static signage, ticket machines

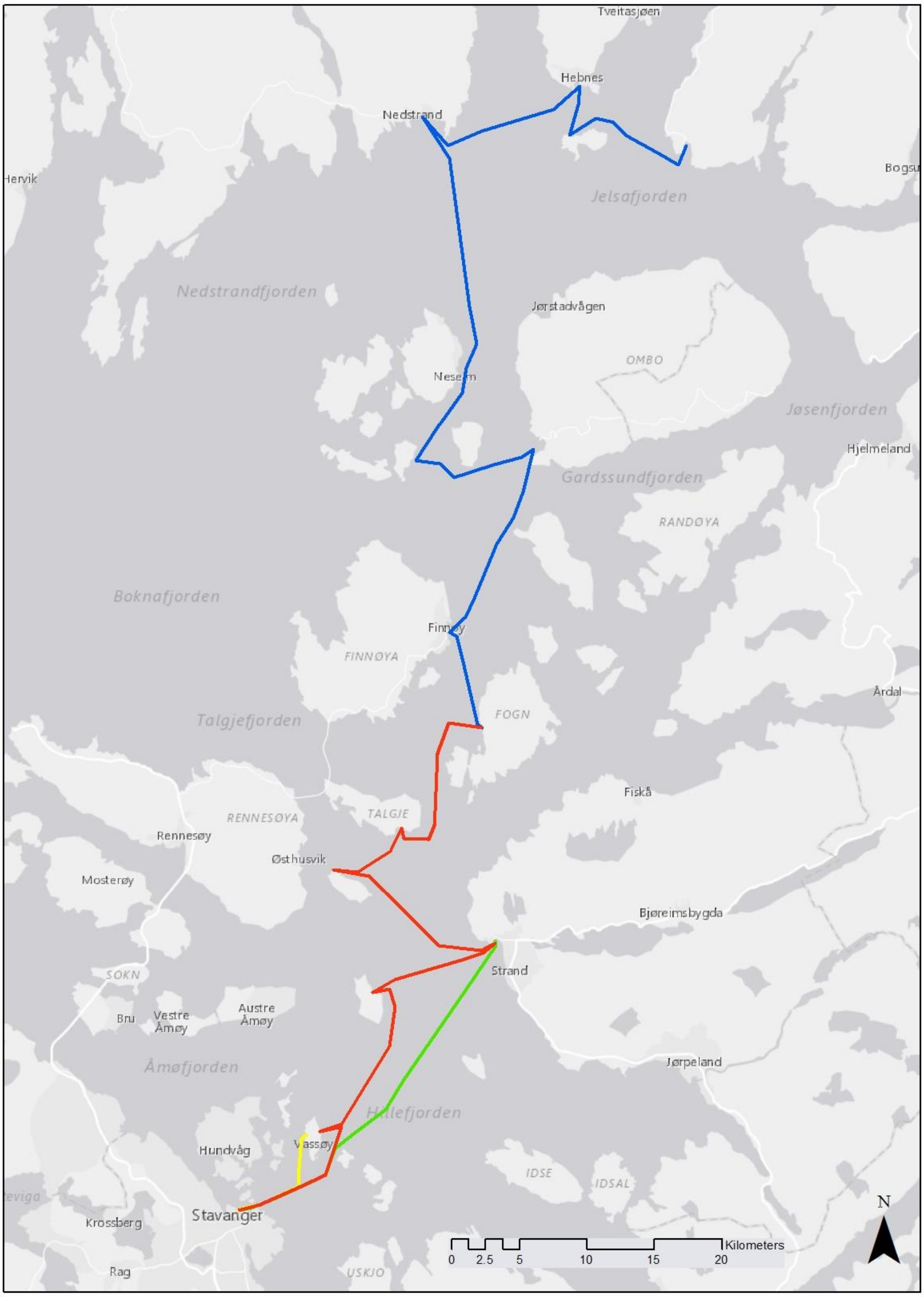
Operational characteristics	
Operating time	5 am – 11 pm
Peak periods	5 am – 7 am 4 pm – 8 pm
Frequency (mins)	5-15 mins peak 60-90 off peak
Fare	$7 USD

Additional information

There is great emphasis on the deteriorating ecosystem in the fjords and efforts to modernize the existing fleet and convert them to green energy vessels. Norled has designed several such craft which can be found serving in the fleet.

STAVANGER

NORWAY



SYDNEY
AUSTRALIA

Population	4,921,000
Area (urban)	12,367 km^2
Density	372 per km^2
Route type	B, C
Ferry routes	8
Terminals	39
Passengers	14,700,000

Public transport network overview

The ferry network in Sydney is operated by Harbour City Ferries which is a private consortium contracted by Trasnport NSW, a government authority. Transport NSW also runs rail and bus services. Fare collection is by single ticket or a long-term pass through a mobile application or smart card. The ticket system is integrated with other public transportation means. There are 39 ferry routes serviced by 28 vessels. Further, 6 more ferries are currently being procured.

Ferry and terminal overview

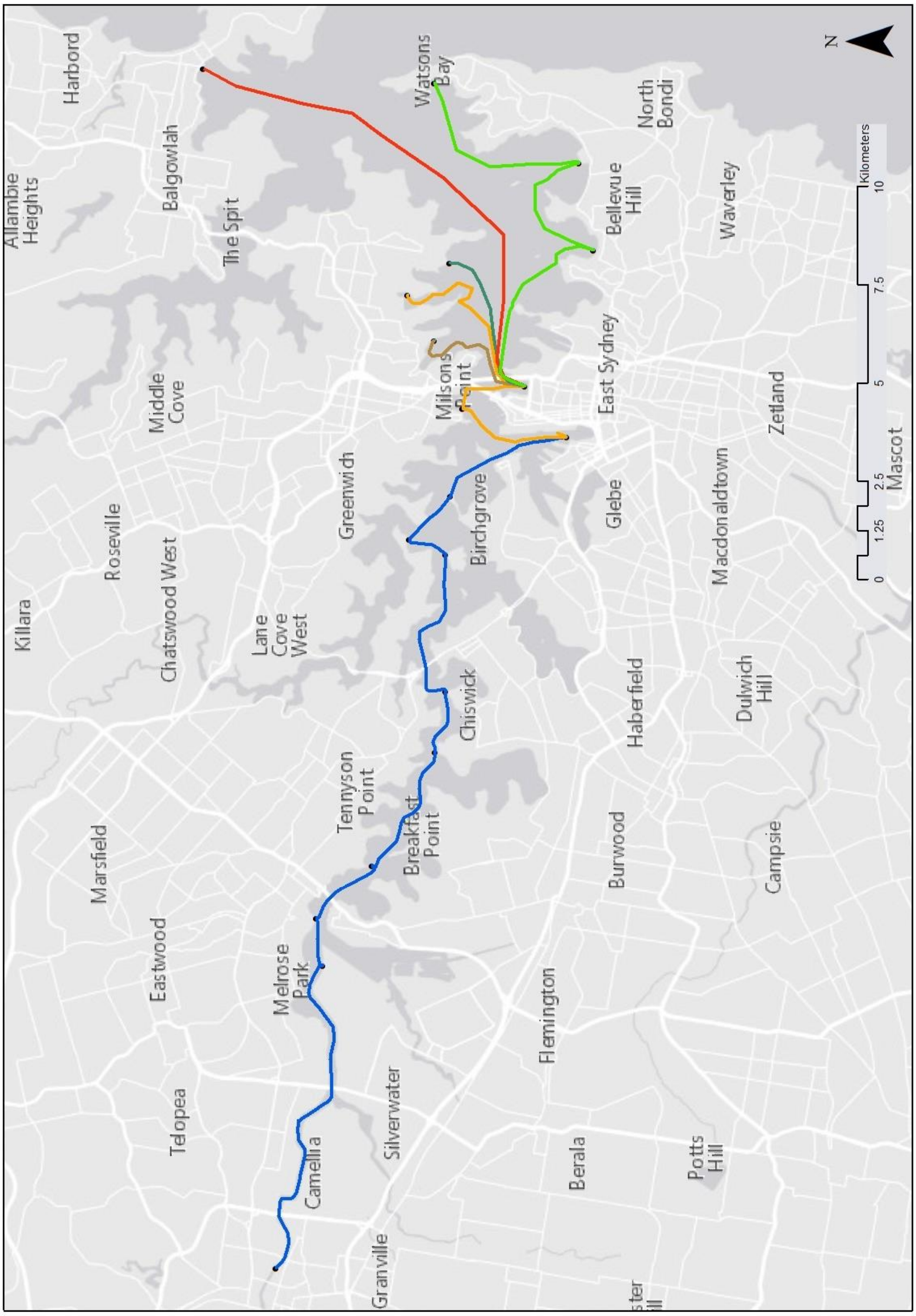
The ferries operating in Sydney are older style monohulls with multiple enclosed decks and a sun deck. The new ferries that are under procurement will be faster catamarans to cater for the increased demand for better travel times.

Facility features	
Vessel capacity	300 (old ferries) 400 (new ferries)
Vessel facilities	spacious interior with comfortable inside seating, outdoor viewing areas, a large walk around deck and additional features for passengers; including Wi-Fi access and real-time journey information, and charging stations for electronic devices.
Terminal facilities	Digital signage, ticket machine, staffed information kiosk

Operational characteristics	
Operating time	5 am – 11 pm
Peak periods	5 am – 7 am 4 pm – 8 pm
Frequency (mins)	15 mins peak 30 - 90 mins off peak
Fare	$4.30 – $6.50 USD

Additional information
Ferry customers report the highest level of customer satisfaction of any public transport mode in Sydney. Travel time, systems and efficiency and comfort were marked as important towards customer satisfaction. Ferry demand peaks at areas where job and recreational activities are concentrated. There are some private fast ferry services that charge a premium price that are also popular.

SYDNEY
AUSTRALIA



VENICE
ITALY

Population	264,579
Area (urban)	414.57 km^2
Density	640 per km^2
Route type	A
Ferry routes	24
Terminals	67
Passengers	55,000,000

Public transport network overview

The vaporetto public transport ferry service is operated by ACTV, a public company. Fare collection is by single ticket or a seasonal pass. The ticket system is integrated with other public transportation. There are 67 ferry routes serviced by 99 vessels.

Ferry system overview

The ferries operating in Venice are monohulls built between 1955 and 2004 with some of the older ferries no longer in service. Through the years they have maintained a similar design with a slender hull and no sun deck.

Facility features	
Vessel capacity	210 (inside)
Vessel facilities	Inside seating, outdoor viewing areas
Terminal facilities	Static signage

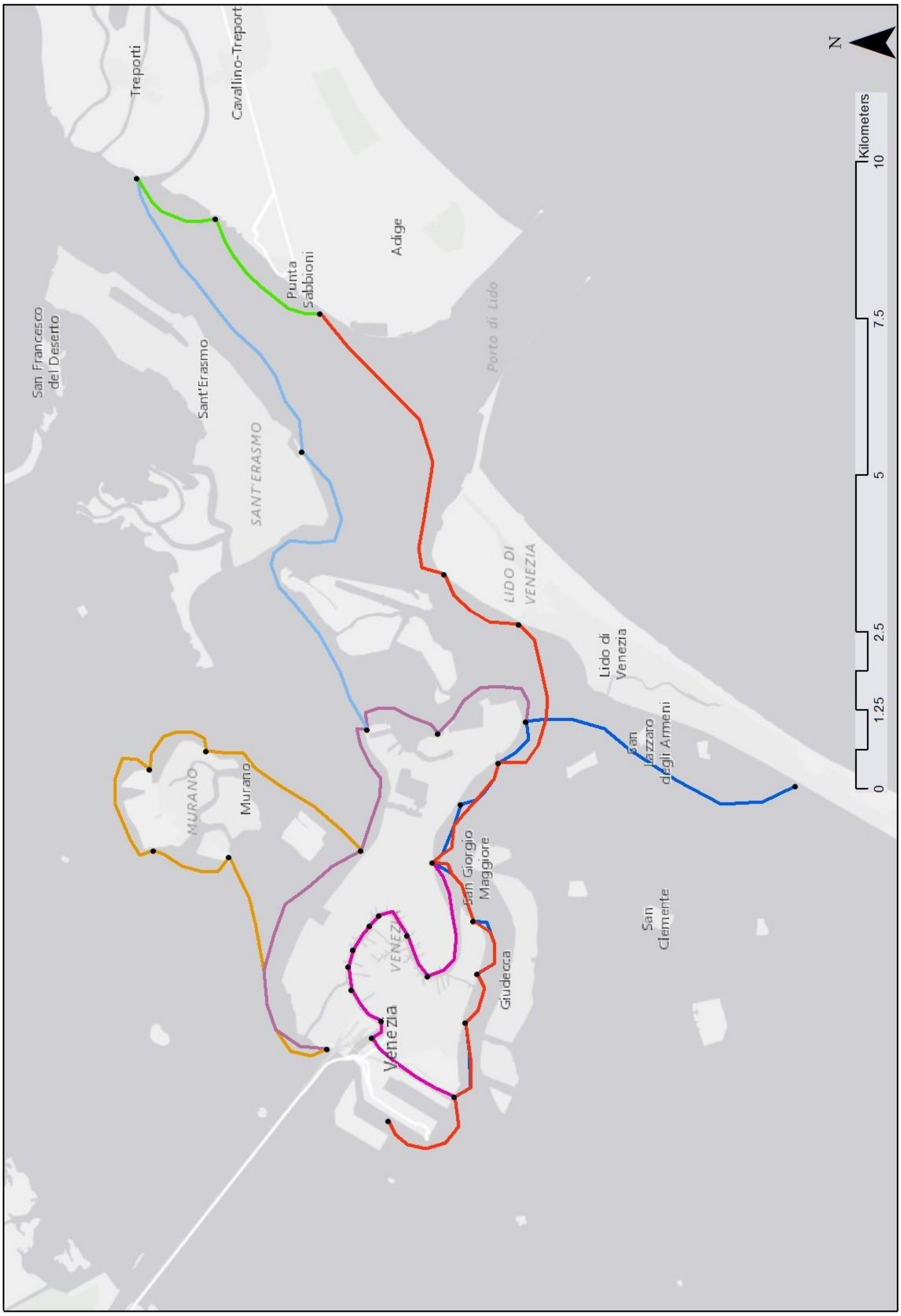
Operational characteristics	
Operating time	5 am – 11 pm
Peak periods	5 am – 7 am 4 pm – 8 pm
Frequency (mins)	5-15 (Peak) 60-90 (Off Peak)
Fare	$7.80 USD

Additional information

A simplified version of the network is supplied to aid in scale comparison only. A more detailed transit route map is also provided.

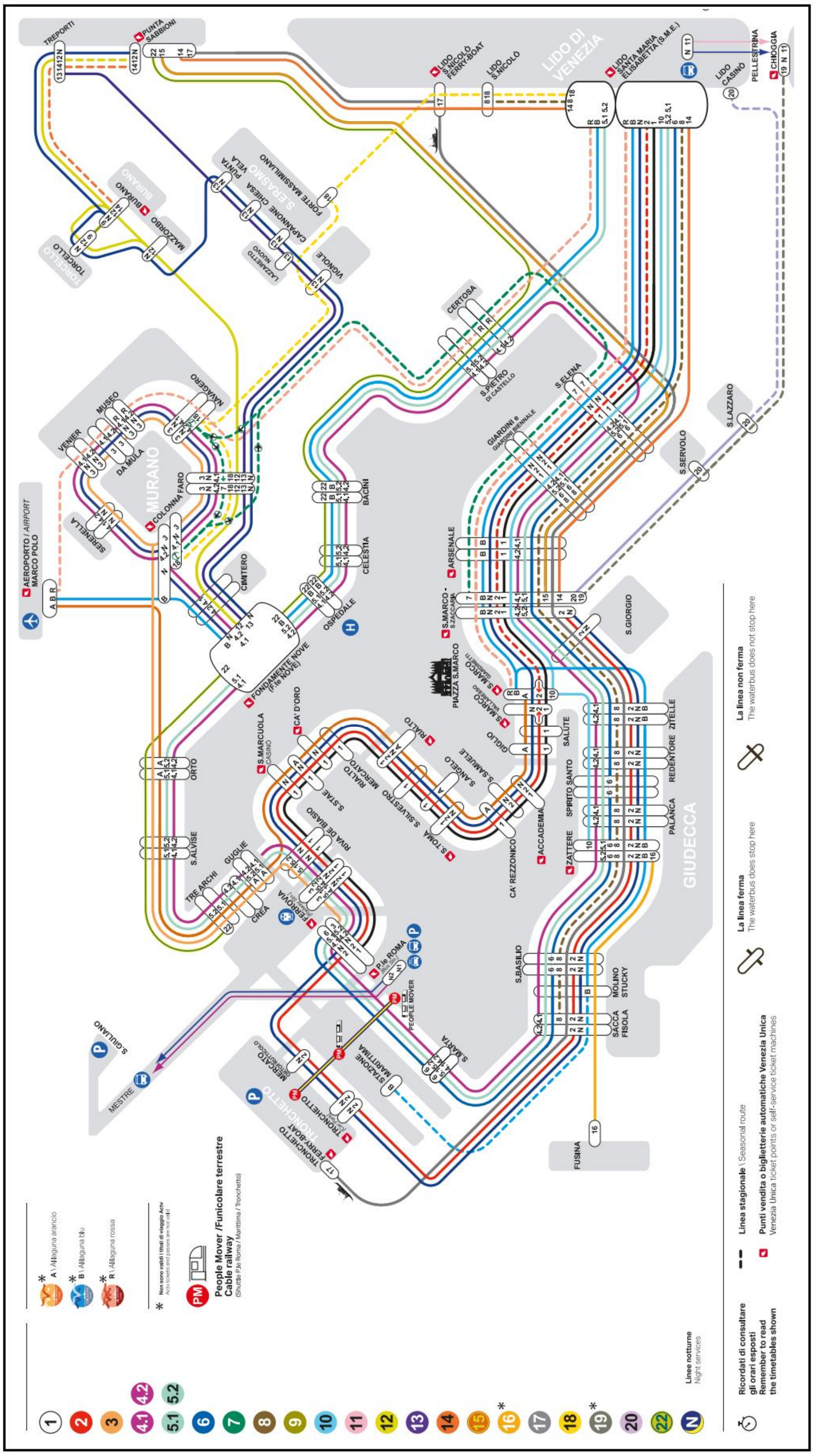
VENICE

ITALY



VENICE

ITALY



MEDIUM SCALE WATER TRANSIT NETWORKS

COPENHAGEN

DENMARK

Population	562,379
Area (urban)	615.7 km^2
Density	6,800 per km^2
Route type	A,B
Ferry routes	3
Terminals	10
Passengers	500,000

Public transport network overview

Movia operates harbour buses which are part of the public transportation network. They are contracted by the local department of transport, which is also responsible for metro rail and bus services. The ticket system is integrated with other public transportation means with no penalty for transfer between modes.

Ferry and terminal overview

There are 3 lines and 10 destinations operated by 4 vessels. The three boats are becoming more popular each year with together over half a million passengers annually, most of which use the boats in summer. The last three years the number of passengers in the three summer months increased by approximately 10,000 per month. Up to 3,500 passengers use the harbor buses on Saturdays during the summer months.

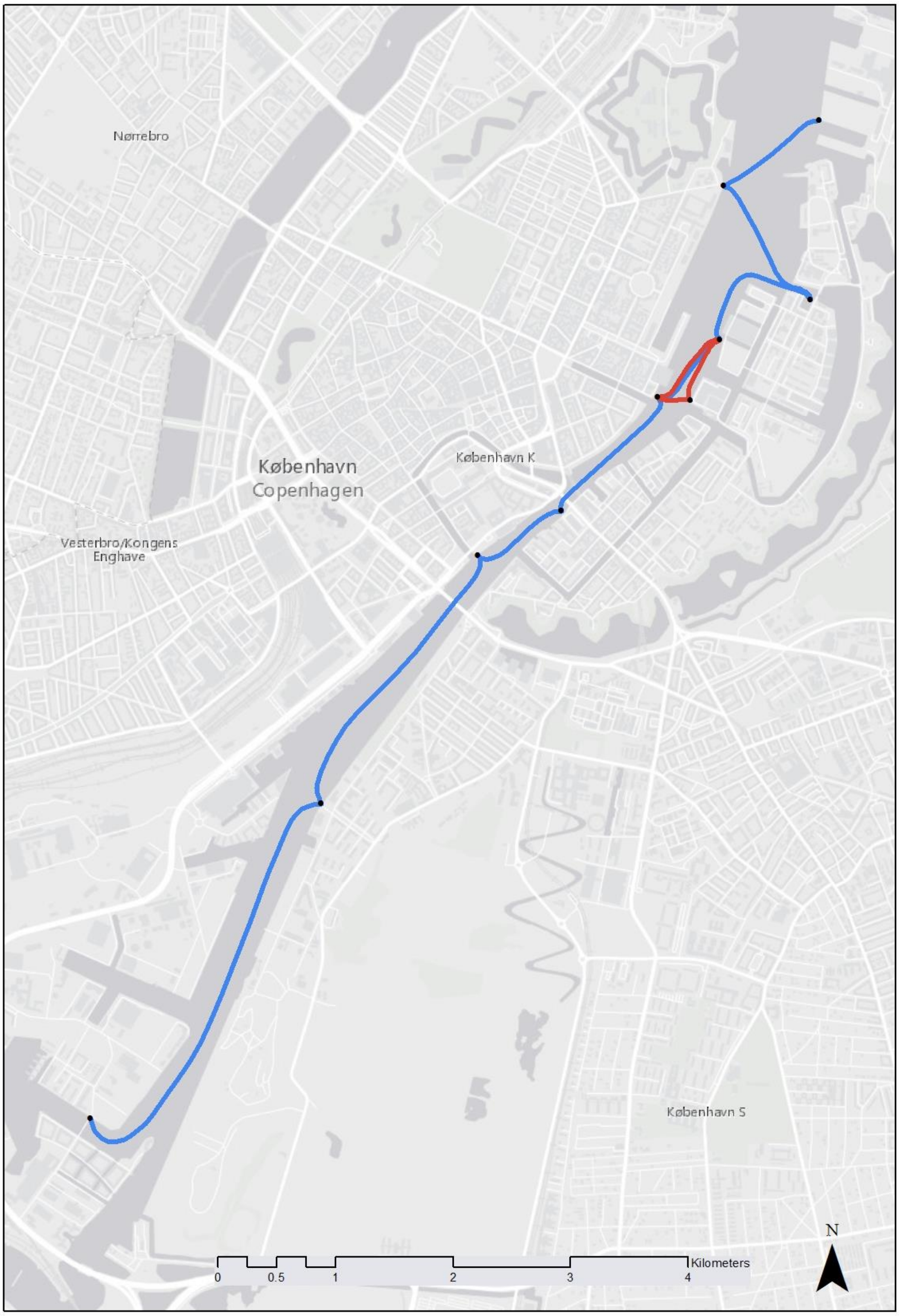
Facility features	
Vessel capacity	64-80 20 bicycle spaces
Vessel facilities	Full disability access on all vessels
Terminal facilities	Static signage, full disability access at all terminals

Operational characteristics	
Operating time	7am-11pm
Peak periods	No differentiated peak schedule
Frequency	40 mins all day
Fare (USD)	$3.65 USD fixed entire route

Additional information

One cross river line runs on an as needed basis for patrons of the waterfront opera house. There is an emphasis on land development linked to the areas served by the boats. Tourist use is also popular.

COPENHAGEN
DENMARK



GOTHENBURG

SWEDEN

Population	549,789
Area (urban)	447.76 km^2
Density	1,200 per km^2
Route type	A,B,C
Ferry routes	A,B
Terminals	6
Passengers	800,000

Public transport network overview

The ferry network in Gothenburg is operated by Västtrafik which is a public company. Fare collection is by single ticket seasonal ticket via smart card. The ticket system is integrated with other public transport including bus and tram services. Of the existing lines, one line is operated free of charge as it acts as a bridge between two key destination Stenpiren and Lindholmspiren.

Ferry and terminal overview

The fleet is a mix of old and new vessels with the newer catamaranscapable of withstanding ice loads. The ferries on Route Type B are double ended. Recently they have tested the use of HVO as a fuel on the ferry Buro with success. All ferries have a sun deck as part of the design.

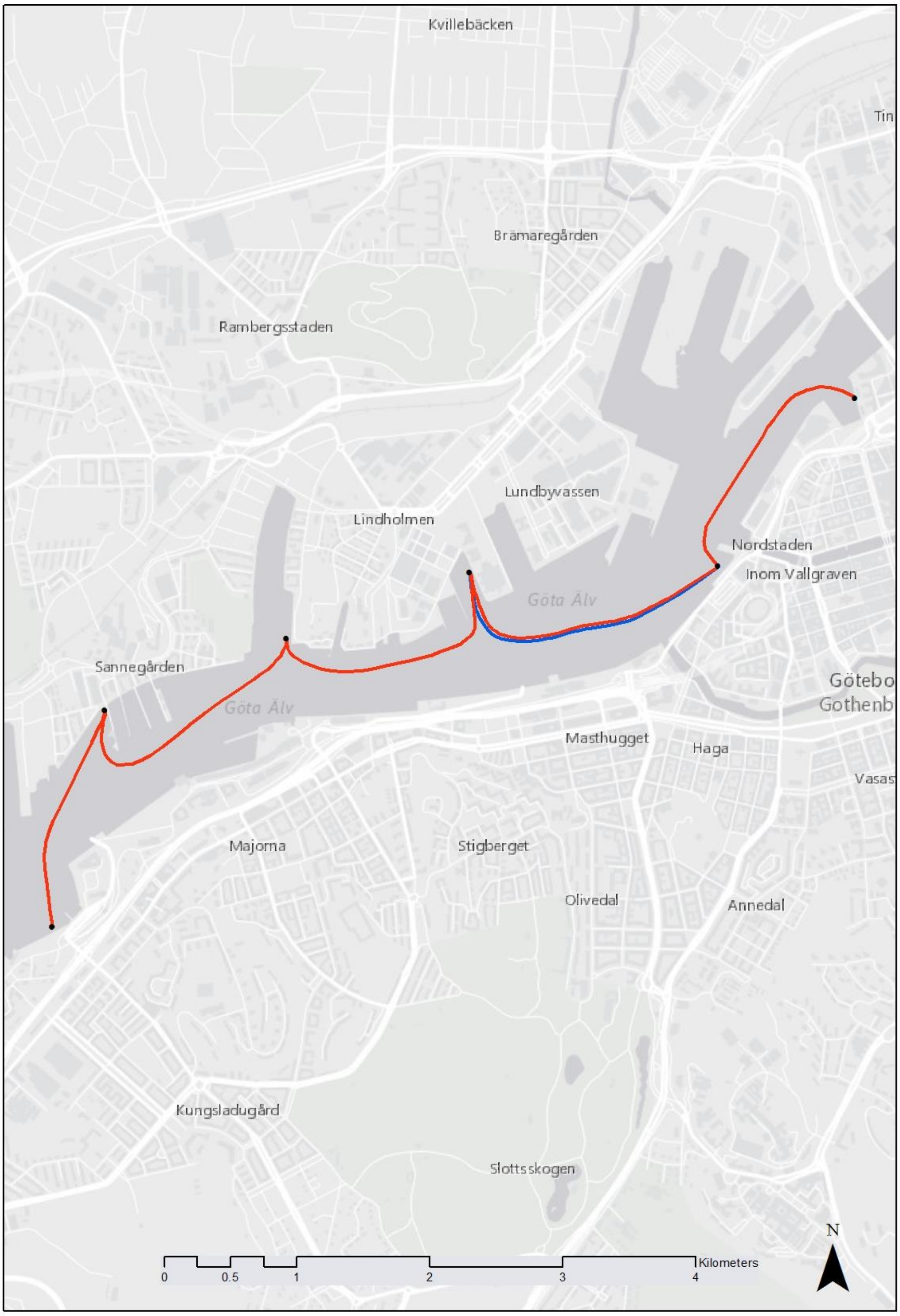
Facility features	
Vessel capacity	298 80 bikes
Vessel facilities	spacious interior with comfortable inside seating, outdoor viewing areas, a large walk around deck and additional features for passengers; including real-time journey information and priority seating designations.
Terminal facilities	Digital signage

Operational characteristics	
Operating time	6 am – 10 pm
Peak periods	5 am – 10 am 3 pm – 6 pm
Frequency (mins)	15 – 20 (Peak) 30 (Off Peak)
Fare	$4 USD

Additional information

In 2012, a city development plan– 'River City Gothenburg' was centred around the concept of developing infrastructure around the River Göta along with adding new service routes and facilitating land development.

GOTHENBURG
SWEDEN



HAMBURG
GERMANY

Population	1,774,242
Area (urban)	755 km^2
Density	2,300 per km^2
Route type	A,B
Ferry routes	3 (B) 4 (A)
Terminals	22
Passengers	8,000,000

Public transport network overview

The public transportation ferries in Hamburg are operated by HVV which is a public company. However, the ferries are owned by HADAG. Fare collection is by single ticket or seasonal pass. The ticket system is integrated with other public transportation. There are 7 ferry routes serviced by 24 vessels.

Ferry and terminal overview

The fleet is a mix of old and new monohull vessels. However, the old vessels underwent refurbishment and were retrofitted with new superstructures. All ferries had side docking arrangements with new ferries having forward and aft thrusters.

Facility features	
Vessel capacity	200-400 (inside and outside) 20 cycles
Vessel facilities	Inside and outside seating, top outdoor deck with cafeteria style seating. One man ferry operation
Terminal facilities	Static signage, ticket machines

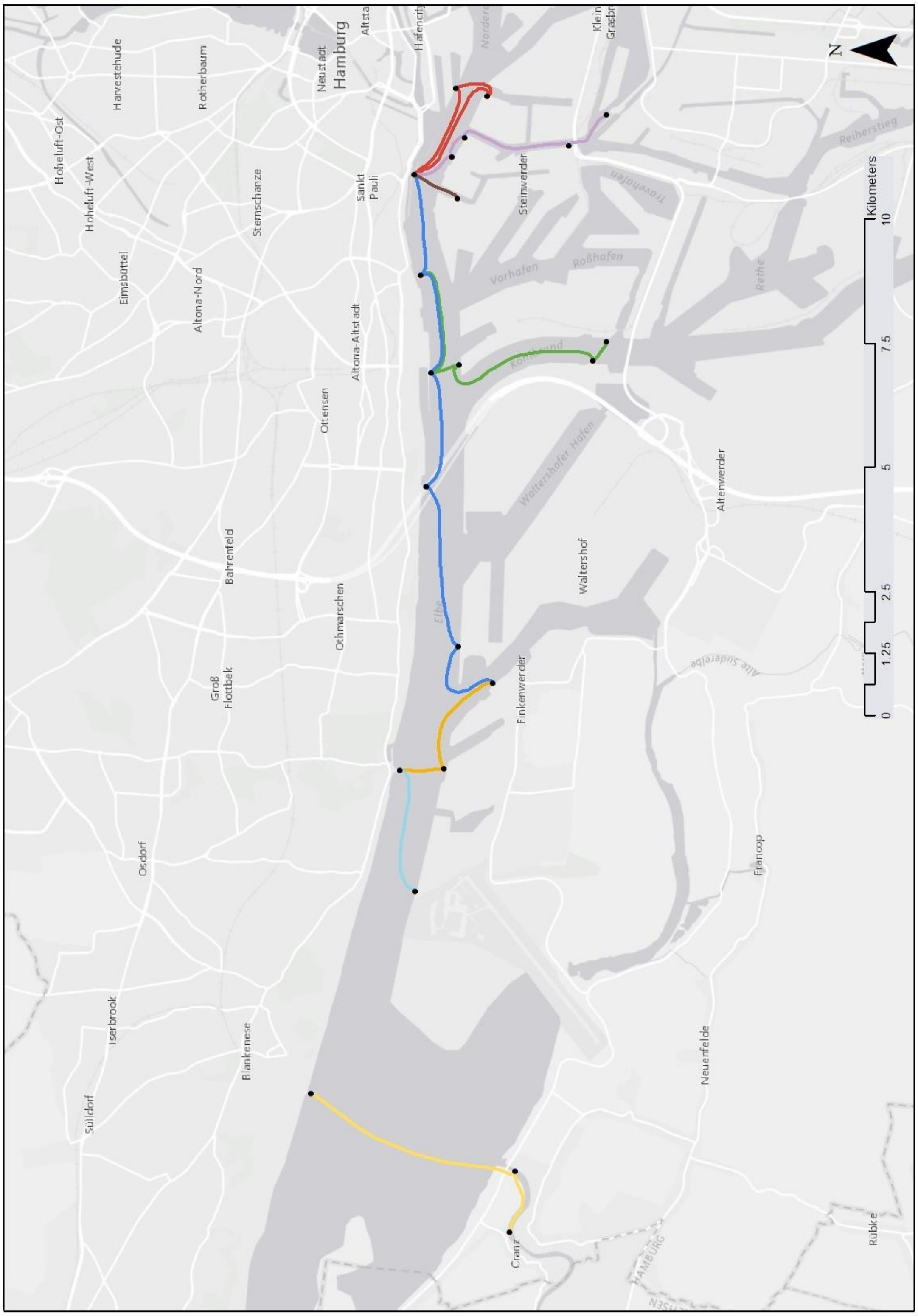
Operational characteristics	
Operating time	5 am – 10 pm
Peak periods	5 am – 8 am 3 pm – 6 pm
Frequency (mins)	15 mins peak 30 mins off peak
Fare	$3 USD

Additional information

Hamburg operates a network of ferry routes that link together and require transfers for some journeys. Ferries linking the employment hub of Airbus on the waterfront is popular. Hamburg is currently looking at fleet modernization and are exploring usage of zero emission ships including hydrogen fuel cell technology.

HAMBURG

GERMANY



RIO DE JANIERO

BRAZIL

Population	12,280,702
Area (urban)	1,221 km^2
Density	2,705 per km^2
Route type	B
Ferry routes	6
Terminals	5
Passengers	-

Public transport network overview

Ferries in Rio de Janeiro are operated by CCR Barcas which is a private company but under contract from the government body Rio Trillhos. Fare collection is by single ticket or seasonal pass. The ticket system is not integrated with other public transportation. There are 6 ferry routes serviced by 19 vessels.

Ferry and terminal overview

The ferries operating in the city are a mix of small and larger catamarans that were newly acquired. Old vessels are monohulls with large capacity and multiple decks.

Facility features	
Vessel capacity	237 – 645 (Small catamarans and monohulls) 1300 – 2000 (Large Catamarans and monohulls)
Vessel facilities	Spacious interior with comfortable inside seating, outdoor viewing areas
Terminal facilities	Static signage, ticket machines

Operational characteristics	
Operating time	5 am – 12 pm
Peak periods	6 am – 10 am 5 pm – 8 pm
Frequency (mins)	10 mins peak 20 – 60 mins off peak
Fare	$5 USD

Additional information

The city is looking at expanding its ferry network and have ordered 7 new high speed vessels from China.

RIO DE JANIERO
BRAZIL

STOCKHOLM
SWEDEN

Population	925,934
Area (urban)	188 km^2
Density	4,900 per km^2
Route type	A, B, C
Ferry routes	4 regular 2 trial
Terminals	21
Passengers (2014)	3,200,000

Public transport network overview

Stockholm boat transport is operated by SL 'which is a public company. Fare collection is by single ticket or a seasonal smart card fare. The ticket system is integrated with most other public transportation. There are 4 ferry routes serviced by 11 vessels. Out of the vessels, 4 are owned by SL and 7 are owned by different service providers.

Ferry and terminal overview

The ferries operating in the city are older monohulls. The ferries have sun decks and designated place for bikes. One ferry is built to operate in light ice while others still rely on ice free waters for operation.

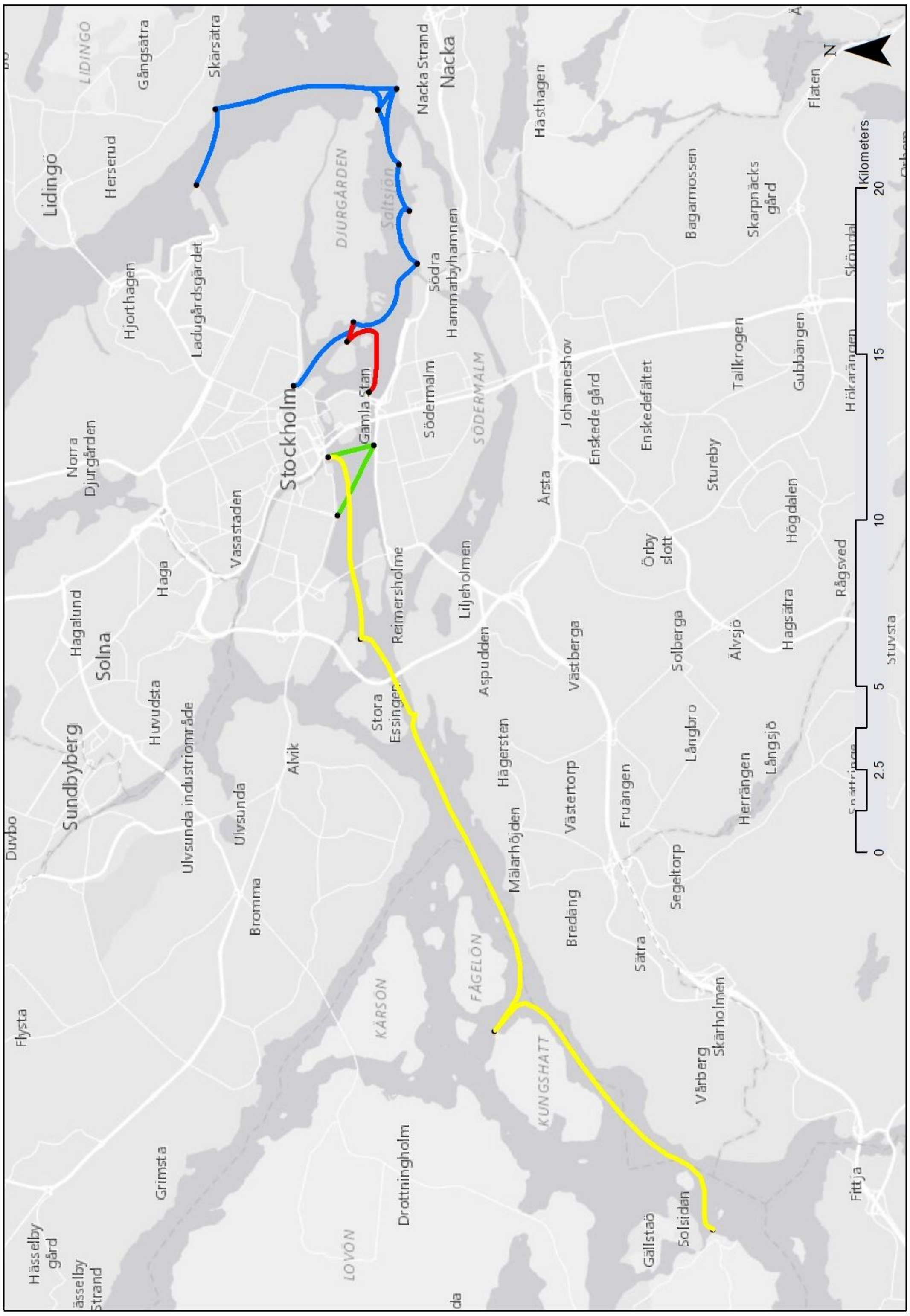
Facility features	
Vessel capacity	225 – 300 40 bikes
Vessel facilities	spacious interior with comfortable inside seating, outdoor viewing areas, a large walk around deck and additional features for passengers; including real-time journey information.
Terminal facilities	Digital signage, ticket machines

Operational characteristics	
Operating time	6 am – 7 pm
Peak periods	9 am – 12 am 2 pm – 5 pm
Frequency (mins)	15 mins peak 20 – 20 mins off peak
Fare	$5 USD

Additional information

The waters in the city freeze during winter months and ferry operations usually halt during the season. The city is currently looking at tackling this problem an also d expanding the ferry network with new routes and future vessels which are currently being investigated.

STOCKHOLM
SWEDEN



VANVOUVER

CANADA

Population	369,075
Area (urban)	2,078 km^2
Density	1,146.7 per km^2
Route type	A,B
Ferry routes	2
Terminals	4
Passengers (2013)	6.000.000

Public transport network overview

Translink operates the public transport network in in Vancouver. SeaBus is a passenger only ferry that crosses the Burrard Inlet, connecting downtown Vancouver with the North Shore. Each ferry can seat up to 400 passengers at a time, and departs every 15 minutes during the day and every 30 minutes in the evening. There is only one line at present. The ticket system is integrated with other public transportation means.

Ferry and terminal overview

There are two terminals: Waterfront in downtown Vancouver, which connects with buses, SkyTrain and West Coast Express; and Lonsdale Quay in North Vancouver, which connects with North Shore buses. Crossing time is 12 minutes. The ferries are low speed catamarans with a cruise speed of 12 knots that carry passengers, cycles and are equipped for disabled passengers.

Facility features	
Vessel capacity	385
Vessel facilities	Disability access, information System
Terminal facilities	Static signage, ticker machines

Operational characteristics	
Operating time	6am – 1am (Mon - Sat) 8am – 11:30pm (Sunday/Holiday)
Peak periods	6am – 7pm
Frequency	15 mins peak 30 mins off peak
Fare (USD)	$2.75 - $5 USD

Additional information

Though the vessel is capable of higher speeds, the wake created disturbs other users of the Burrard Inlet. The vessel makes 50 crossings in a day and has a 12-minute turnaround time between piers.

VANCOUVER
CANADA

SMALL SCALE WATER TRANSIT NETWORKS

BOSTON

USA

Population	645,966
Area (urban)	4,600 km^2
Density	5,344 per km^2
Route type	A,B
Ferry routes	3
Terminals	7
Passengers	1,250,000

Public transport network overview

The public transportation company MBTA runs three ferry lines (F1, F2H, F4). There are metro rail, bus and ferry services in Boston. The ticket system is integrated with other public transportation using the Charliecard smart card called.. The routes are serviced by 2 MBTA owned vessels and 11 Boston Harbor Cruises (BHC) owned vessels.

Ferry and terminal overview

The ferries are a mix of old and new vessels. The newer vessels have a catamaran hull and are fitted with advanced radar technology.

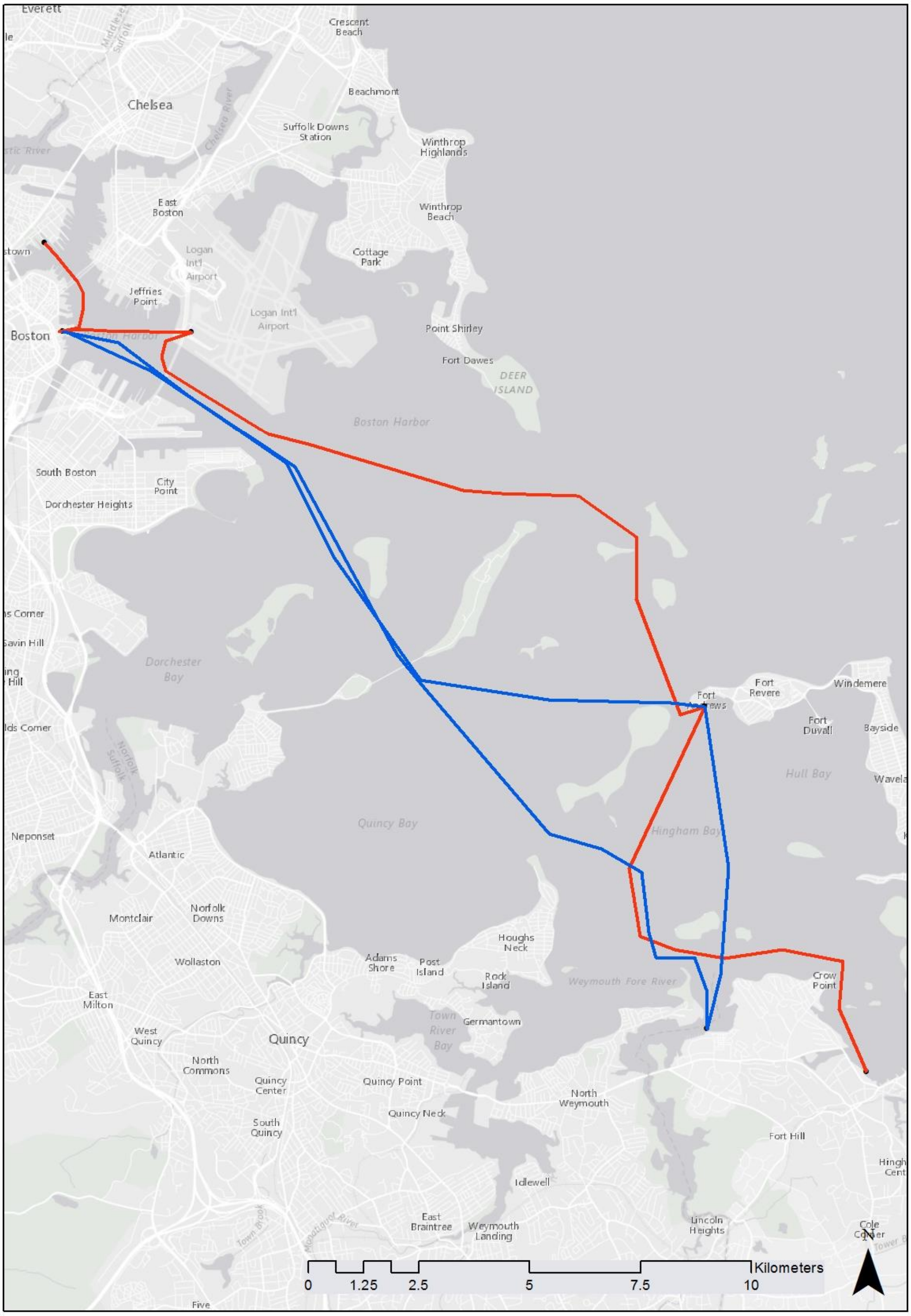
Facility features	
Vessel capacity	Monohull vessels
Vessel facilities	Heating and air-conditioning, café, free Wifi, table seating, toilets
Terminal facilities	Static signage, ticket machine

Operational characteristics	
Operating time	6am – 8pm
Peak periods	6am - 9am 4pm - 7pm
Frequency	15-30 mins peak 2 single services in between peak periods
Fare	\$3.50 - \$9.25 USD \$18.5 (airport ferry)

Additional information

A study done by MBTA revealed that, despite ferries carrying the least number of passengers per capacity, their fare box recovery was the highest. A project called Focus 40 has been initiated that will consider how a range of factors – including technological innovation, demographic shifts, and climate change – will require the MBTA to adapt to meet future demand.

BOSTON
USA


Everett
Chelsea
Crescent Beach
Beachmont
Suffolk Downs Station
Winthrop Highlands
East Boston
Logan Int'l Airport
Winthrop Beach
Cottage Park
Jeffries Point
Boston
Point Shirley
Fort Dawes
DEER ISLAND
Boston Harbor
South Boston
City Point
Dorchester Heights
Dorchester Bay
Fort Revere
Windemere
Fort Duvall
Bayside
Hull Bay
Hingham Bay
Quincy Bay
Neponset
Atlantic
Montclair
Norfolk Downs
Wollaston
Houghs Neck
Adams Shore
Post Island
Rock Island
Weymouth Fore River
Crow Point
East Milton
West Quincy
Quincy
Germantown
North Commons
Quincy Center
Quincy Point
North Weymouth
Quincy Neck
South Quincy
Fort Hill
Idlewell
East Braintree
Weymouth Landing
Lincoln Heights
0
1.25
2.5
5
7.5
10
Kilometers
N

OSLO

NORWAY

Population	658,390
Area (urban)	480.76 km^2
Density	1,400 per km^2
Route type	A,B,C
Ferry routes	6
Terminals	4
Passengers	2,700,000

Public transport network overview

Osloferries are run by three private operators: Tide Sjo AS, Oslo-Fergene AS, and Skibs Bygdofaergerne. These companies also operate a combination of buses, leisure cruises, freight and oil tankers. The ferry system is managed and planned by public authority Ruter for Oslo and the county of Akershus. The ticket system is integrated with other public transportation.

Ferry and terminal overview

There are 6 lines running in the city but at a time only 3-4 lines are operational. B1, B4, B9 are operational in winter while B2 and B3 operate in place of B1 during summer. Two lines operate on longer suburban routes.

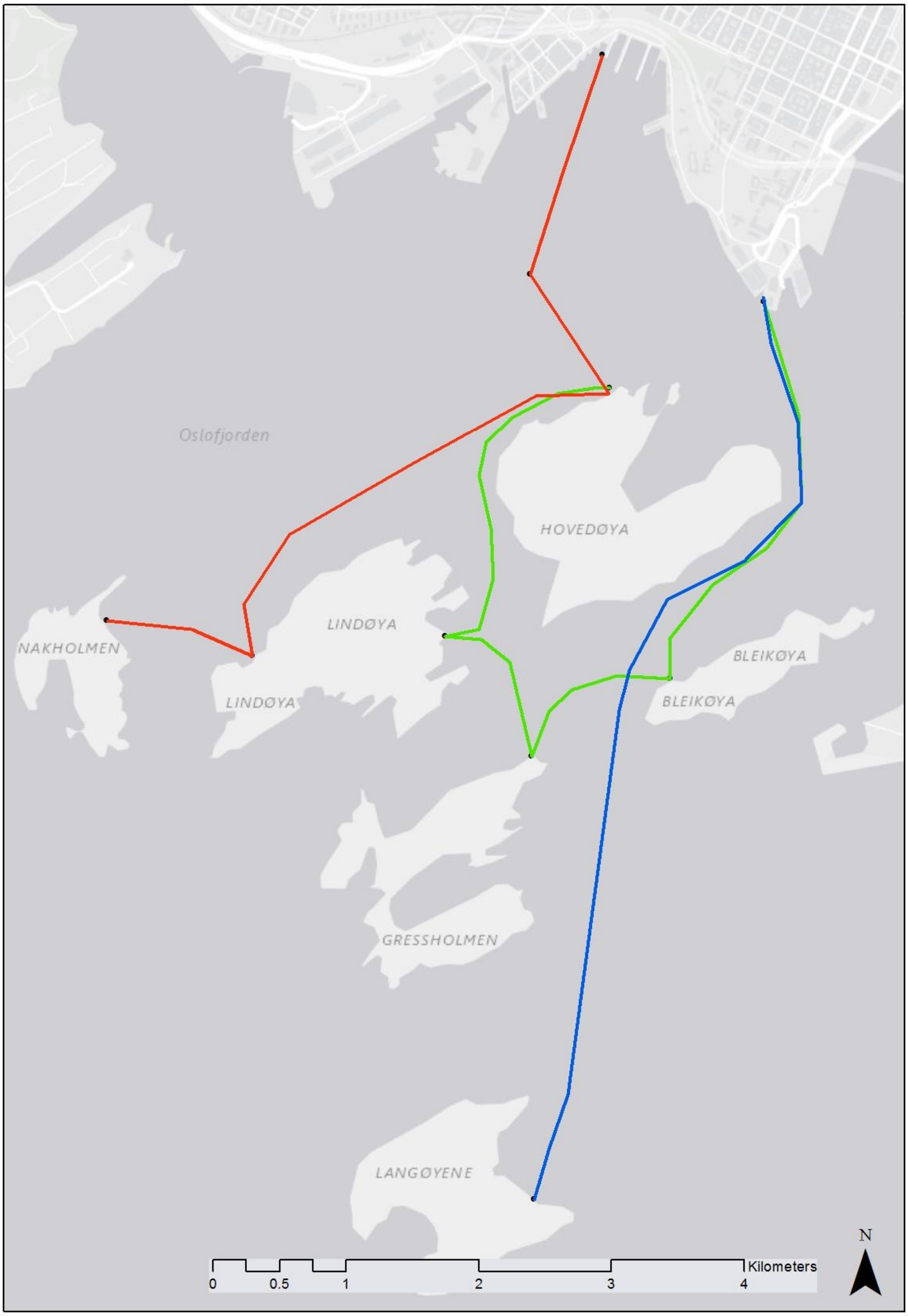
Facility features	
Vessel capacity	236
Vessel facilities	Indoor seating and outdoor viewing areas.
Terminal facilities	Static signage

Operational characteristics	
Operating time	5am – 12 pm
Peak periods	7am – 9 am
Frequency	20 mins peak 60 mins off peak
Fare	$4.50 USD

Additional information

The ferries run on conventional fuel currently, however hybrid natural gas vessels are utilsed on the main route between Akkerbryge and Nesoddtangen

OLSO
NORWAY


Oslofjorden
HOVEDØYA
LINDØYA
NAKHOLMEN
LINDØYA
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BLEIKØYA
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LANGØYENE
0
0.5
1
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Kilometers
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ROTTERDAM
NETHERLANDS

Population	1,015,215
Area (urban)	325.79 km^2
Density	2,969 per km^2
Route type	A,B
Ferry routes	2
Terminals	4
Passengers	2,000,000

Public transport network overview

Public transport in Rotterdam include bus, metro rail and ferry and is operated by RET. The ticket system is integrated with other public transportation so ferry journeys have no penalty for transfer.

Ferry and terminal overview

There is one fast ferry operated by RET: a high-speed catamaran vessel with an aluminium hull and a fiber superstructure. The slender hull design produce minimal wake. The docks used in the city are floating type which adds flexibility in terms of water level and dock location. Boat can dock undock on both of the terminal sides.

Facility features	
Vessel capacity	150
Vessel facilities	GPS tracking fed to terminals for real time location of vessels
Terminal facilities	Real time GPS based signage

Operational characteristics	
Operating time	6am – 7pm
Peak periods	None
Frequency	60 mins all day
Fare (USD)	$3.80 USD

Additional information

The vessels are fitted with an electrical and loud- speaker system and Dynamic Passenger Information (DPI) displays. Terminals are also equipped with a camera system for public safety and real-time vessel location information via a wireless internet connection.

ROTTERDAM
NETHERLANDS

WELLINGTON
NEW ZEALAND

Population	369,075
Area (urban)	2,078 km^2
Density	1,146.7 per km^2
Route type	A,B
Ferry routes	2
Terminals	4
Passengers	-

Public transport network overview

The public transportation in Wellington is run by Metlink. Other transport includes train and bus service. There are two boat lines that are serviced by two small capacity catamarans. The ticket system is integrated with other public transportation.

Ferry and terminal overview

The ferries running in the city are all high-speed catamarans. The routes operating in Wellington have a flexible nature. Due to selective transportation demand at different times, the vessels operate on different routes based on the time of the year.

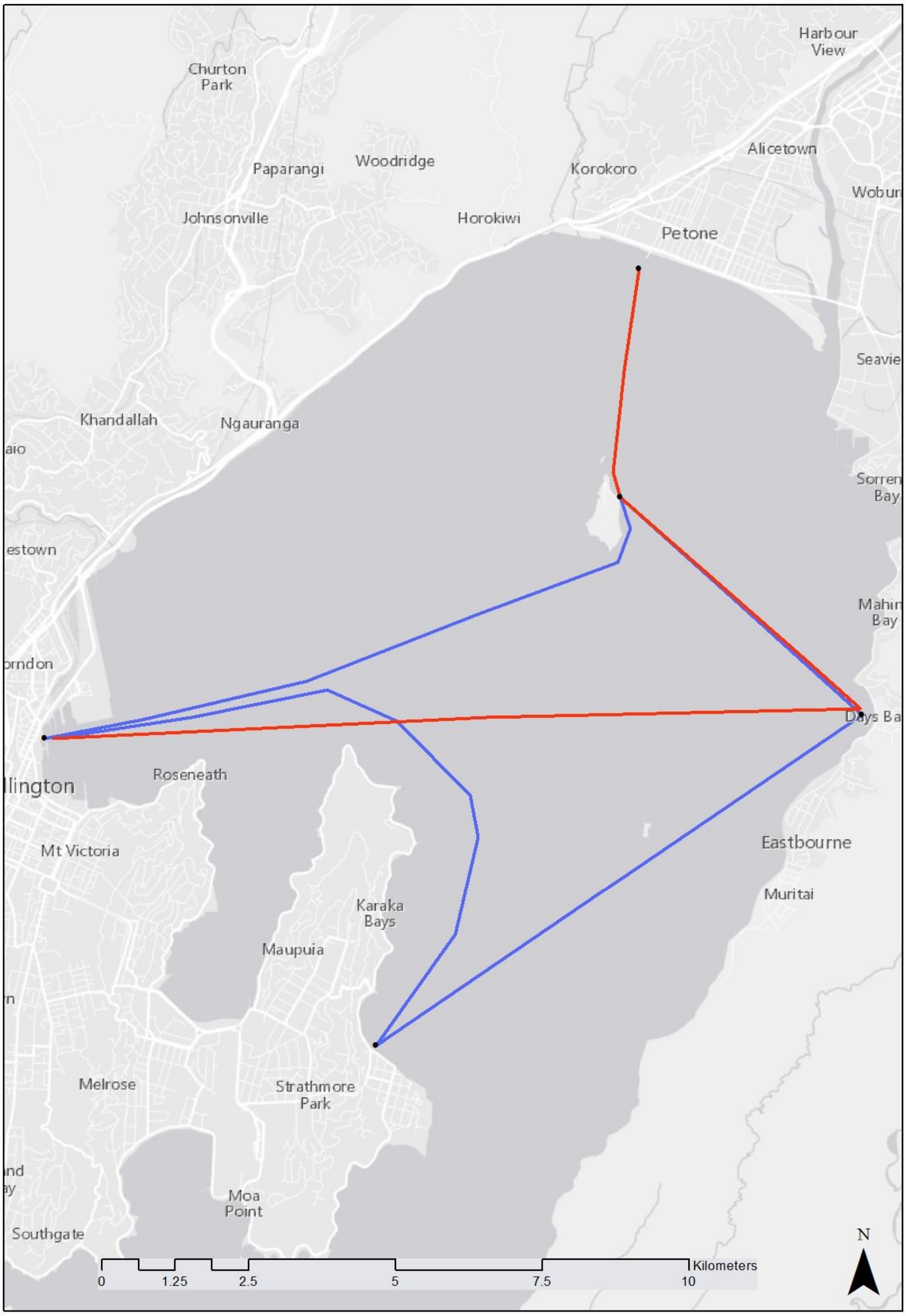
Facility features	
Vessel capacity	99
Vessel facilities	Indoor and outdoor seating.
Terminal facilities	Static signage, ticket machines

Operational characteristics	
Operating time	6am – 1am
Peak periods	6am – 9am 4pm – 7pm
Frequency	25 - 35 mins peak 100 – 120 mins off peak
Fare (USD)	$6.50 - $8.00 USD

Additional information

There is also a private ferry company Fullers that provides ferry and bus services to neighboring islands.

WELLINGTON
NEW ZEALAND



CONCLUSION AND FUTURE RESEARCH

This report has highlighted key characteristics for currently operating urban water transit systems in a number of cities globally. One of the first factors raised was that of route service design and operating models. As shown, cities have designed their networks in a number of different configurations to meet local needs. This may depend on population density, surrounding land development and topographical constraints. However, one of the common themes is integration with other transport. The most successful cities have sought to include the planning of water transport early in transport and land use planning policies, something also concluded in the Swedish studies, *Waterway 365* (Stenius et al. 2014) and *Koll på vatten* (Trafikverket 2015). The presence of a central publicly owned transport authority that is able to manage and plan a city-wide network is beneficial for facilitating this connection and the consideration of water transport as a key transport mode. However, such planning and management may prove to be more difficult to implement in some contexts than others. For example, in cities with complex land ownership rights and difficulties in coordinating fragmented transport agency and private operator responsibilities, it's possible that boat operators may be excluded from discussions on development of multimodal transit systems. Such circumstances are present in the case of Bangkok, where water transport has not been included in the future transport planning dialogue of the city moving forward, with instead an overemphasis and reliance on land based transit solutions. If successful water transit systems are to be realised, commitment must be demonstrated to meaningfully include and integrate water transport within the future transport plans of the respective city.

The design of vessels and supporting terminal infrastructure is also a key consideration in finding the right balance for each city. While systems were show to vary between locations, many cities have predominantly continued operating older vessels on primary boat routes. However, with the concurrent modernization of other public transport modes in terms of the use of more environmentally friendly fuel systems and inclusion of modern amenity features, there are question to the degree this progress has occurred in waterborne transit. Many cities have been hesitant in large scale investment in water based modes due in large part to the low economic return value when compared to the carrying capacity of other transit modes. Cities that have pursued modernization have either been led by private sector entrepreneurship, or strong political leadership focused on making longer term transformative change in the use of urban waterways for transport. In the former case, the Thames Clippers system, while initially receiving government support, now operates largely on its own. The latest generation custom built catamarans in London cost around $3M USD with modern convenience on board. This is catered largely toward a cost insensitive market that is willing to pay for a "premium" service. In the latter case, other cities such as New York have decided to keep water transport in line with the fares of other transit services, a symbolic vote of confidence by subsidizing more modest vessels in order to facilitate passenger demand. In either case though, this requires belief that a system is viable in a specific context and the required investment to make it possible.

In this regard, empirical evidence has suggested that boat users value the transit experience differently when compared to other land based modes, raising questions as to what exactly constitutes passenger experience in water transit. It was shown that passengers travel more when compared to equivalent bus journeys and this suggests either aesthetic or productivity benefits that accrue to water transit users. Unpacking this distinction and understanding such attributes is needed in order to meet the demands of commuters when designing such systems. Furthermore, including such factors in expanded forms of Cost Benefit Analysis may also facilitate better decision making processes. Research has begun in this regard around the passenger experience in Stockholm, with future planned comparative studies in Brisbane and London to follow.

The specifics of route design and managing operations of vessels and terminal infrastructure can be also be a key difference in determining whether a system is successful or not. While there are acceptable and widely used best practice guidelines for planning land transit networks, there is little empirical evidence that has looked at water transit specifically due to its recent development as a public transport mode. However, there are key differences that can potentially affect service viability, such as challenges in loading and unloading passengers quickly without increasing terminal times, and additional safety and vessel crew regulations that are unique to waterborne transport. Further research is therefore needed on incorporating these additional factors in developing best practices for transit route designs and timetabling that reflect the specifics needs of water transport. Work in currently ongoing at KTH to further address such issues in order to ensure vessel designs are congruent with such findings.

Land use around terminals also needs to be careful considered when planning new stops and designing routes. Along with the need for cooperation between transport modes as previously mentioned, connection between transport and land use planning departments needs to be emphasised. Transit Orientated Development (TOD) is a land use planning strategy that promotes a model of high density residential and commercial development centred on transit stops along a route to encourage public transport use and decrease urban sprawl. An equivalent system is Ferry Oriented Development (FOD), which encourages the development of waterfront areas located around a ferry terminals on a linear ferry route line. Some cities have leveraged water transit networks to encourage waterfront rejuvenation programs. Such coordinated efforts would make sense to increase density and business around terminals and create new key city precincts to further increase the viability of water transport services. However, while developing land around ferry terminals should be facilitated, there is little research specifically suggesting how TOD and FOD differ and how FOD can be best implemented. This may be especially important in differing contexts where there may be restrictions in the ability to development waterfront areas and this may impact on the viability of water transport systems. Such effects therefore need to be considered carefully in each context. However, as highlighted in the introduction, if done well such waterfront development plans can prove successful in facilitating the use of inland waterways for transit by creating economic benefits for land users around such redeveloped areas.

Finally, the environmental benefits of water transit may prove to be an important consideration for cities who wish to measure success by other metrics in addition to passengers numbers and economic benefits. Many inland waterways are currently underutilised, and by shifting transport to these waterways, benefits can be achieved in reducing not only vehicle pollution and congestion, but travel times. Another potential avenue is shifting freight movements from urban streets to waterways to increase delivery reliability and remove trucks and other delivery vehicles from congested streets. Such metrics could prove to be key indicators in the development of water transit in cities looking to achieve these environmental goals.

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