OPERATIONAL FEASIBILITY STUDY FOR REGIONAL FERRY SERVICE, PORTLAND, OREGON

2020

Operational Feasibility Study for Regional Ferry Service

Portland, Oregon

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FRIENDS OF FROG FERRY

MARITIME CONSULTING PARTNERS

Flowing solutions

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Section 1 Executive Summary

This Operational Feasibility Study of a ferry service on the Columbia and Willamette rivers provides an objective review of all major functional requirements of a successful ferry service. After defining the vision and goals established by the Friends of Frog Ferry, the study team sought to collect all relevant data and information concerning the intended ferry service, perform its analysis and identify potential challenges and opportunities. Where challenges or barriers exist, the team provides potential solutions or mitigating strategies.

Operational Feasibility

Strictly speaking, operational feasibility asks the simple question of whether a ferry system can be implemented and, if so, how. Answering this question is more complex than a simple ‘Yes’ or ‘No’ but ultimately, that is the goal. To accomplish this, the team investigated all relevant aspects of operational feasibility; shoreside infrastructure, vessels, the route, scheduling, labor, regulatory requirements, etc. If the study identifies a single barrier to entry that cannot be overcome through the application of innovative solutions, technologies or statutory and regulatory changes, then the answer to the operational feasibility question is ‘No’. In this case, however, the team was able to identify workable solutions to all challenges that were discovered.

The simple answer to the question of operational feasibility is a confident *Yes*.

Summary of Identified Challenges and Proposed Solutions

The Route

The envisioned route, from Vancouver, WA to Oregon City, OR spans 21.6 nautical miles (nm) on the Columbia and Willamette rivers. From a navigational standpoint, the route changes drastically from north to south and poses numerous challenges. Starting in Vancouver, the initial portion of the route on the Columbia River is unconstrained and generally represents a low level of risk. Favorable conditions persist proceeding upriver from the confluence of the Columbia and Willamette rivers, throughout the lower portions of the Willamette until reaching the Steel Vertical Lift Bridge (Steel Bridge).

The next portion of the route starting from the Steel Bridge and continuing to Ross Island (the downtown Portland core) takes on a very different identity. The river becomes more constrained, more heavily trafficked by small, recreational craft and contains numerous blind spots created by the frequent bridge tower foundations. From Ross Island to Oregon City, the challenges of the Willamette intensify as you proceed south. The river continues to become more constrained, and recreational traffic continues to increase. Bends in the river create blind spots for vessels traveling at a medium speed (20 – 25 kts), and shoreside structures (floating homes, private docks and marinas) become increasingly more prevalent.

Key considerations regarding navigational challenges on the proposed route include:

- Wake energy is a cause for concern along the entire route, whether it is creating an adverse effect for other vessel traffic or shoreside structures. If a ferry is going to be able to transit at speed, the design must minimize wake energy.
- Vertical clearance restrictions at the Steel Bridge require that the vessels do not exceed a maximum height of 14 feet above the design waterline.
- Debris in the river will present a challenge to operational reliability and must be addressed through vessel design and operational procedures.
- The upper Willamette River (south of Ross Island to Oregon City) is far more constrained and challenging.

Vessels

Passenger vessel design is a balance of competing factors. You must start with a clear understanding of the operational mission and then balance factors such as capacity, speed and regulatory restrictions to develop something that is cost efficient and effective. Because of this, passenger vessels are typically tailored to the service they provide and the route they run. This case was no different. As the team completed the route assessment, the impacts on the vessel requirements became clear.

As the requirements of the route varied drastically from north to south, it became apparent that it would become increasingly difficult to achieve an effective balance of some key vessel parameters. In order to address this, the team pivoted to a new approach defining two classes of vessels as opposed to trying to identify a single class of vessels that would compromise capacity and other important factors in order to meet the more stringent requirements imposed by only a portion of the route. The two classes of vessels proposed are generally described as:

- Upper River Class – smaller, more maneuverable vessels with a single passenger deck (approximately 70 passengers) and a catamaran hull designed to minimize wake energy.
- Lower River Class – larger vessels with a single passenger deck (approximately 100 passengers) and a catamaran hull designed to minimize wake energy.

Both classes would be designed to meet the 14-foot vertical clearance restriction.

Schedule

As a direct result of the decision to utilize two different classes of vessels, the route itself was divided into two divergent routes emanating from the downtown Portland core, one transiting north to Vancouver (the Lower River Route) and one transiting south to Lake Oswego (the Upper River Route). In doing so, the team was able to devise a theoretical schedule that meets the primary objective of reliably not exceeding thirty-minute headways (time between departures from any given point on the route) while still accounting for the many factors on the rivers that will affect transit times on a daily, but inconsistent basis. These include river debris, currents, traffic and wake sensitive areas.

To meet this schedule serving a bifurcated route, a total of seven single-deck catamarans with a hull design optimized to minimize wake energy while at a service speed of 22 knots will be required. Six vessels (4 Lower River Class and 2 Upper River Class) will be in operation each day, requiring a seventh vessel (1 Upper River Class) to rotate through the schedule as vessels undergo extended maintenance periods or if short-term vessel downtime is experienced. This ensures reliability, a crucial component to any successful commuter ferry service.

Staffing

Delivery of a ferry service of this magnitude is not overly complicated, but it does require numerous behind-the-scenes resources to ensure reliable service, effective communications with its ridership and a system that can adapt to the changing needs of the markets it serves.

There are two key groups that comprise the team: (a) staff support functions such as information technology, administration, and marketing and sales and (b) line operations.

It is critical that the staff functions understand the local business climate, key influencer concerns (political, economic and social aspects) and local practices and policies to ensure the system is in synch with local priorities in order to perform at the highest level. Because of this, it is critical that these resources be accessed locally.

It is equally important that the operations resources are experienced in the delivery of ferry service, in particular a commuter ferry service. These resources are less likely to be identified locally in the Portland region and therefore the team recommends that marine operations be outsourced to a qualified vessel manager through a competitive process.

Terminals and Docks

For many ferry systems, particularly those that span numerous jurisdictions, the terminals and docks are owned by landowners, developers or local municipalities and used by the ferry service under a lease agreement or other terms. Identifying suitable terminals and docks is usually the greatest challenge for a new ferry service. The Columbia and Willamette service is no exception. While the locations were all deemed to be appropriate for the intended markets and accessible to multiple transit links at most sites, there is little in the way of existing infrastructure. While the landside infrastructure for this type of ferry service is minimal, suitable docks that meet accessibility guidelines are critical. Of the existing docks on the core route, most of them are not suitable for commercial passenger ferry service (with the possible exception of Foothills Park in Lake Oswego) as they were designed for recreational use. As a result, the team provides alternative dock arrangements at a concept level for consideration. It will be necessary to work with the local landowners and municipalities to plan, fund and implement suitable dock solutions.

Of critical importance to the long-term success of the ferry service is the identification of a homeport. A homeport is a centralized location for the overnight moorage, staging and maintenance of the fleet. It can also serve as a base of operations, administration, fueling and reprovisioning. While not all ferry services have a homeport, it is viewed as a distinct advantage by those that do as it amplifies the operational efficiencies of the entire system and fosters cohesive communication across the entire organization. It is highly recommended by the study team that a suitable homeport for the ferry system be identified.

Financial Viability

Financial viability of a ferry service depends on the organization's ability to raise the necessary capital needed to procure the assets (terminals, vessels, support equipment) and then generate enough ongoing income over a sustained period to maintain sufficient cash flow to support operations and future capital needs.

In order to establish the financial viability of a ferry service, it must first be defined with a high level of technical confidence in its feasibility. As the primary objective of this study, this has been accomplished. The companion Finance Plan outlines federal, regional, and local public funding sources for public passenger ferry service infrastructure costs; funding for a ferry is new to the Portland region and it should be noted that there are several federal grant programs specific to ferries, with most offering an 80%:20% federal to state match. Federal ferry funding focuses on funding capital infrastructure, with the intention of the local community funding the local operational subsidy.

Recommendations and Next Steps

⇒ As the upper Willamette presents very different challenges, two classes of vessels are recommended.
⇒ Similarly, two separate routes, diverging to the north and to the south from the downtown core are recommended.
⇒ A standard schedule that focuses on typically peak morning and afternoon/evening commute times is used for modeling purposes. It is recommended that further demand modeling that focuses on market surveys and utilizes geolocation technology be performed to optimize this schedule.
⇒ A successful ferry service requires specific skillsets and management systems. It is recommended that a vessel management company with these particular qualifications be utilized to manage the vessel operations.
⇒ It will be imperative that planners work closely with local communities to implement suitable terminal and dock solutions.
⇒ Further work to identify and design a homeport will be required.

⇒ It is recommended that a Ridership Demand Study with Passenger Profile findings be conducted to assess passenger demand, how passengers will likely transit to/from the terminals, and pricing.

⇒ It is recommended that a Triple Bottom Line Study be conducted to assess the Social, Economic and Environment impacts of the ferry service.

Section 2 Service Objectives

Prior to conducting an operational feasibility study, the ferry system must be defined as to what end-user service it is intended to provide. This can best be accomplished by establishing service objectives, a mission statement and guiding principles. Once established, a system to achieve them can be defined at the concept level. This is an iterative process whereby an initial architecture is established within the confines of numerous assumptions. As these assumptions are either verified or disproven through the feasibility process, the architecture is refined, and the system becomes more clearly defined to a greater level of detail.

Service Objectives

For a Columbia/Willamette River ferry service, Friends of Frog Ferry (FFF) has established the following Mission Statement:

The objective of the proposed ferry service is to initiate safe, reliable and efficient ferry service on Columbia/Willamette.

Mission

The Friends of Frog Ferry (FFF) has established the following Mission Statement:

Mission: "Create a safe and sustainable river-friendly public passenger ferry service to better connect people to their river and help build community livability."

This Mission Statement is supported by the following goals:

- Enhance resiliency planning / emergency response
- Provide equity benefit: jobs, connect low-income communities to central economic core
- Low operational subsidy
- Educate about Native past
- Create an iconic presence on the water
- Promote economic vitality; access
- Reduce greenhouse gas emissions
- Benefit tourism industry
- Efficient: Public-Private Partnership
- Tap into federal funding for infrastructure costs
- Foster stewardship of rivers

Guiding Principles

The fundamental principles that encompass the values of the proposed ferry system are:

1. Safety
2. Customer Experience
3. Reliability
4. Community Benefit – Triple Bottom Line

Service Description

Introduction

For purposes of a feasibility study, it is important to clearly define the scope of the system envisioned. This includes identifying the targeted market segment, locations served, the type of service to be provided and the assets needed to deliver that service. The service description provides a concept-level depiction of the system.

Target Market Segment

The ferry system shall serve the following primary markets:

1. Commuters: These are motorists willing to leave their cars at home, or to park near the shore by their home, and commute via watercraft as well as compatible modes of transportation such as MAX light rail, bicycle, walking, or bus.
2. First Responders and Citizens in Distress: Provide an emergency response option in case of a catastrophic event such as a Cascadia Subduction Zone earthquake or a major bridge failure. Provide emergency response support to any events on the rivers.
3. Locals: "Circulators," which are pedestrians in the downtown core who are transiting during the day across or up or down the river for lunch, meetings, or errands (non-home destination on either end; office to restaurant or appointment).
4. Visitors: Sightseeing during non-commuter hours via an iconic, fuel-efficient mode of transportation for locals and tourists to see the city from a new point of view that builds the "City of Bridges" and "River City" brand of being located along two mighty rivers. This service would connect most riverfront amenities as well as provide a link to other mass transit options.

Locations Served

Preliminary demand modeling focused on the following areas for regular ferry service:

- Downtown Vancouver, WA
- St. Johns / Cathedral Park
- Downtown Portland
- South Waterfront
- Lake Oswego

Figure 2:a Route Overview

Other areas considered for secondary on-demand or future ferry service include:

- *Swan Island*
- *Pearl District*
- *Moda Center / Oregon Convention Center*
- *OMSI (Hosford-Abernethy)*
- *Sellwood*
- *Milwaukie*
- *Oregon City*

Type of Service

The type of service envisioned is a passenger-only commuter service during peak commute hours with the ability to provide on-demand service (to Moda Center for Blazer games or Saturday trips to OMSI) at other times of the day. As with most ferry system start-ups, a core commuter-based service is envisioned that can grow to other service areas and hours as demand increases.

Route

The route of the core service is from Vancouver, WA, at the northernmost point on the Columbia River to Lake Oswego, OR, at the southernmost point on the Willamette River. In between, stops could include Cathedral Park, Salmon Street (Downtown Portland) and OHSU (South Waterfront). This core service could be modeled as a linear point-to-point route, a hub and spoke route with a central hub, or a hybrid of the two. It is the intention of this feasibility study to provide a recommendation as to the optimum model to follow.

Schedule

The schedule for the core commuter service is envisioned as a year-round service, Monday through Friday (except major holidays), during morning and afternoon peak commute hours. The goal would be to establish maximum headways for commuters of 30 minutes or less.

Additional on-demand departures would be scheduled during high season, outside the peak commute hours, and on the weekends.

Vessels

The feasibility study will identify the ideal vessel needed, based on the route assessment and an optimized schedule. In concept it is believed that small, medium-speed (20 - 25 knots) vessels that produce a low wake energy are most appropriate for the service. The vessels will need to be capable of safely and comfortably carrying between 50 and 150 passengers, bicycles and wheelchairs while complying with the accessibility guidelines for passenger vessels. The vessels should have amenities typical of commuter ferries on comparable routes, such as an ADA-compliant restroom, a means to serve concessions, provide Wi-Fi access and highly efficient particulate absorbing (HEPA) equipped HVAC.

Service Capability

Characteristics that will measure service capability reflect the goals of the project sponsor. The results are meant to serve as a benefit to all stakeholders and, when possible, should be evaluated by comparing the data collected to the desired outcome.

- Reliability - The proportion of completed trips to scheduled trips - minimum 98% excluding:
  - ✓ Inclement weather: inclement weather, such as sustained winds in excess of 34 knots, restricted visibility less than 200 yards.
  - ✓ Dangerous river conditions: river debris making transit difficult, dangerous, or destructive.
  - ✓ Planned overhaul maintenance – average 7 days per vessel per calendar year.
- On Time Departures - Minimum 95% on time departures - within three minutes of the scheduled departure

Operational Efficiency

- Transit times shall balance fuel efficiency with appropriate dwell times.
- Minimizing fuel consumption and environmental impact should be considered in the vessel design.

Section 3 Terminal Location, Accessibility and Infrastructure

Terminals are a key element of any transportation system where passengers either originate, terminate or pass through during their day's journey. They can either be points of interchange between different modes of transportation and their respective networks or they can be solely dedicated to one mode of transportation.

In contrast to the historical perception of transit terminals, modern passenger ferry terminals are relatively simple in their design, requiring little hard infrastructure and facilities. The primary reason for this is the focus on individual passenger mobility between transportation modes. Advances of technology in almost all terminal functions (information, ticketing and security) have improved the passenger experience from the point of origination to point of destination.

The objective of this section is to determine the feasibility of potential terminals identified to serve specific markets by the ferry system and make recommendations for necessary modifications or upgrades.

Feasibility of Terminal Locations

Key attributes were investigated at each terminal site to determine feasibility. These included:

- Location – does the physical location provide access to the river, does the location serve a large enough community/demand and what type of market is served? Vetting a location is more a question of what market the terminal is serving than where it is physically located. The type of market translates to the accessibility and infrastructure needed to support it. These needs differ by market.
- Accessibility – what are the primary modes of transportation linked to the terminal site? Do the modes support the market demands? The assessment varies by site, but generally includes the following modes/links:
    - Pedestrians – whether linking from other modes or from their points of origin, pedestrian traffic is key to a passenger ferry terminal and access should be uninhibited. A general rule of thumb for pedestrian links is the half-mile rule, where under the right circumstances, commuters are willing to walk up to 0.5 miles to make a link between modes. This distance must take into account the terrain, a mostly direct route, minimal traffic crossings and assumes a well-maintained walking surface.
    - Bicycles – the Portland area is considered to be one of the most bicycle friendly urban regions in the country and bicycle access to the ferry terminals at both ends (origin and destination) will be of critical importance. Bicycle access includes multi-use and dedicated trails as well as surface street routes.
    - Bicycle/Scooter Share – share programs are becoming more popular in urban settings. Some of these programs use bike hubs to store and locate

bikes/scooters while others use application-based locating to identify available units. These share programs effectively extend the range between links or between terminals and ultimate destinations/points of origin.
    - Car/Ride Share – similar to bicycle/scooter share, car share programs (such as Zipcar) and ride share programs (such as Uber) effectively extend the range between links and provide added flexibility to commuters.
    - Kiss & Ride Zones – typically refers to areas designated for drivers to drop or pick up riders without parking. Kiss & Ride is still a common practice for some commuters.
    - Car Parking – refers to parking lots or garages within 0.5 miles (see Pedestrians above) of the terminal. Car parking is of higher value at origination terminals where commuters can drive to their first transit link and store their vehicle until their return trip.
    - Bike parking – while the vessel will be capable of carrying a limited number of bikes, not all commuters require a bike at both their origin and destination. Secure bike parking in close proximity to the terminal is essential to limiting the number of bikes carried on board the vessel, critical to minimizing dwell times, and ensuring there is adequate capacity.
    - Transit – includes bus, train, circulator shuttles and light rail connections. While the half-mile rule provides a general guide for the proximity-value of these links, other forms of connecting make greater distances still feasible.
- Infrastructure – determined by the market served, infrastructure may vary by site. While there may be some existing infrastructure that can be utilized, most of the sites will require community outreach, coordination with local neighborhood supporters for the service, meetings with key transit leaders, strategic planning, careful design and build-out. Typical infrastructure for passenger ferry terminals includes:
    - Vessel interface – this includes landings, access ramps and docks (see Section 4 Dock Requirements)
    - Traffic management – including queuing areas, barriers and signage. A well-designed terminal space provides effective traffic management with minimal labor.
    - Personal security – optimizing lighting, secure fencing, surveillance and secure bike parking. See Section 9 – Personal and Public Safety for further details.
    - Customer experience – featuring electronic ticket kiosks, digital signage to provide real-time information, restroom facilities, and concessions. For inclement weather, a covered queuing area is necessary to provide passengers with shelter while they wait.

Of the nine sites included in this feasibility study, five are considered to be part of the core ferry route while four are considered primarily for discretionary service and/or future service.

This report will summarize the assessment of each core route terminal site based on the key attributes identified above. As the needs for each terminal site vary based on their intended use, they will be assessed accordingly. The needs for terminals outside of the core route differ greatly for discretionary use and will be considered in future planning. Further details supporting the assessment of each site, including those not on the core route, can be found in Appendix A – Reconnaissance Report.

Terminal Assessments

Vancouver Terminal 1 - Core Route

Figure 3:a Vancouver Terminal 1

The Port of Vancouver's Terminal 1 is currently undergoing a major renovation project as a part of the Port's waterfront development[1]. Vancouver is considered a key terminus stop on the ferry route. The Port's development plans of the waterfront present a good foundation for a public ferry terminal. This analysis is based on those plans.

[1] https://www.discoverterminal1.com

Location

The Port of Vancouver's Terminal 1 is located on the Columbia River, within close proximity of the downtown core of Vancouver, WA. Interstate 5 crosses the Columbia River immediately adjacent to the terminal, with multiple offramps to local streets.

The Terminal 1 ferry terminal will primarily serve residents of Vancouver and those living in the surrounding suburbs who commute to Portland on a daily basis, as well as Portland area residents who may commute to Vancouver on the backhaul. As a secondary market, residents or visitors to either city can use the ferry during normal hours or off-hours/weekends for discretionary trips to enjoy the river and sights offered by each urban core. These specific markets emphasize the need for car parking, pedestrian-friendly access and enhanced wayfinding.

The ferry terminal will only require a small footprint, close to the access gangway of the dock.

Accessibility

Based on the Port's development plan, accessibility to the terminal will be excellent for the intended market. Access for pedestrian and bicycle links to other modes are already well established and safe. As it is expected that this particular market will include a high percentage of riders originating from further afield, many will arrive by car and parking will be available. Three new parking projects are currently being planned within 0.3 miles of the terminal.

Figure 3:b Existing links within one half mile of terminal site at Vancouver Terminal 1

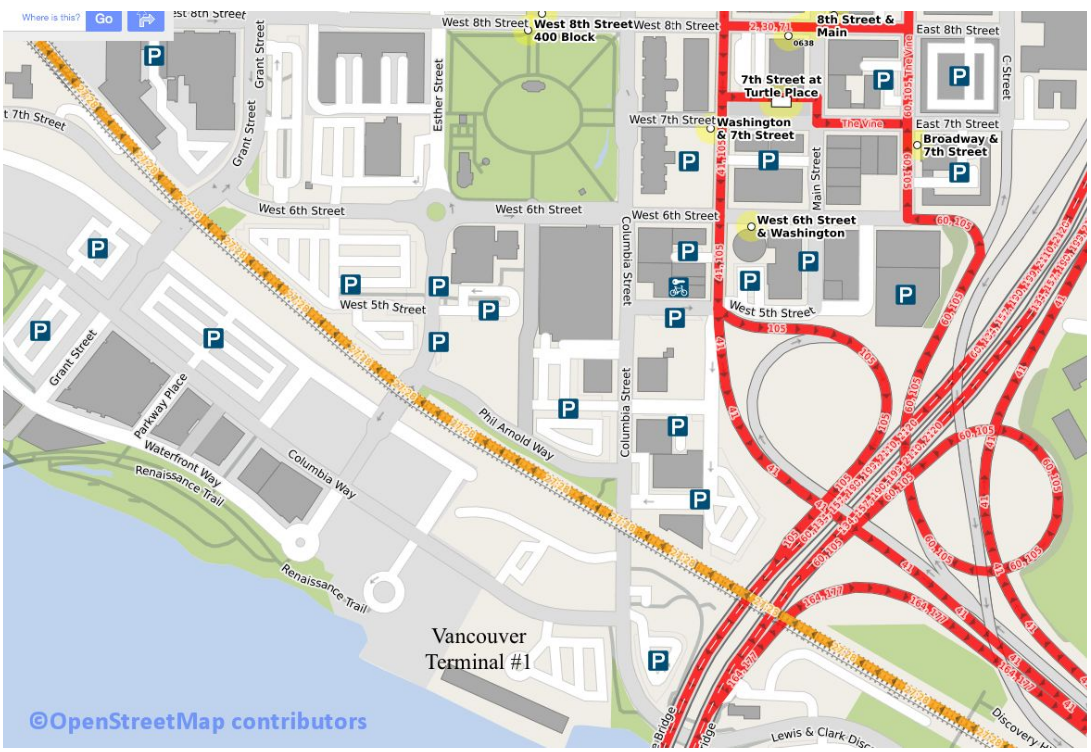

Table 3:1 Vancouver Terminal 1 accessibility

MODE	DETAILS
Pedestrian (Half Mile)	Under the development plan, highly accessible for pedestrians, clear walkways from most directions.
Bicycles	Under the development plan, highly accessible for bicycles, clear pathways from most directions.
Bicycle/Scooter Share	Not currently available in Vancouver, but there may be plans to implement.
Car/Ride Share	Uber and Lyft both operate in Vancouver.
Kiss & Ride Zones	Esther Street and Waterfront Way roundabout, approx. 350 feet from the terminal.
Car Parking	Numerous reserve and public parking spaces within a half mile or less. Development plans currently call for additional parking close to the terminal.
Bike Parking	Currently, there is no secure bike parking within a short distance from the terminal.
Transit	There are several C-TRAN stops within a half mile: • Vine and 30 routes from the east • 2, 71, and 105 routes from the north • 60 route from the south (Jantzen Beach)

Accessibility Recommendations

- Vancouver should push forward with plans for a bike/scooter share program.
- The roundabout at Esther Street and Waterfront Way provides an excellent opportunity for a Kiss & Ride location and should be designated as such for use by ferry passengers.
- Secure bike parking should be considered as part of the Port's development plan, located in close proximity to the ferry queuing area.
- Vancouver should consider adding a shuttle or circulator service between the downtown core and developing waterfront areas, including the ferry terminal.

Infrastructure

There is currently little to no specific infrastructure in place to support the ferry. It is envisioned that the following elements will be incorporated into the Port of Vancouver's development plan:

- Vessel Interface – the existing dock will require some major modifications. See Section 4 – Dock Requirements for details.
- Traffic Management – using the public dock complicates passenger traffic management issues. Adding an extension to the dock to accommodate the ferry will require the access control point (gate) to be at the end of the public dock where it meets the extension. While queuing for the ferry will naturally occur on the public dock, passengers will be encouraged to wait at the top of the dock access ramp under a covered queuing area (`Figure *4*:*e*). Because the ferry

terminal will comprise a very small part of Terminal 1, the ferry terminal will require carefully designed wayfinding from downtown and along the waterfront, guiding passengers through the expanse of the developed terminal.

- Personal Security – as part of the Port's development plan, it is recommended that adequate lighting, surveillance and a secure bike parking facility be incorporated in close proximity to the covered queuing area. The dock extension should also be secured with fencing and an access gate.
- Customer Experience – in the ferry terminal area, the Port's development plan should consider public restrooms and concessions for use by the general public as well as the ferry passengers. Specific to the ferry passengers, an electronic ticket kiosk, digital signage and a covered queuing area will be necessary.

Cathedral Park – Core Route

Figure 3:c Cathedral Park

Cathedral Park is a 22-acre City of Portland park situated at the base of the St. Johns Bridge. The park has a large parking lot and boat launch ramp, several trails, greenspace, wooded areas and a plaza.

Location

Cathedral Park is located on the east bank of the Willamette River, in the Portland neighborhood of Cathedral Park. The residential neighborhoods of St. Johns, University Park and Portsmouth are all within a two-mile radius of the park, to the north and east.

The Cathedral Park ferry terminal will primarily serve residents of those neighborhoods on their daily commute to downtown Portland destinations. As a secondary market, residents may use the ferry during normal hours or off-hours/weekends for discretionary trips to enjoy the river and gain convenient access to either the Portland or Vancouver downtown areas. These specific markets emphasize the need for some car parking, pedestrian-friendly access and enhanced wayfinding.

The ferry terminal will only require a small footprint, with a minimal queuing area close to the access gangway of the dock. (See Section 5 – Dock, Terminal and Uplands Configurations.)

Accessibility

Currently, accessibility to the terminal area is a challenge for the intended market. Access for pedestrian and bicycle links to other modes are available, but must cross an active train track and contend with some steep hills. As it is expected that this particular market will include a moderate percentage of riders originating from local neighborhoods, some may require car parking.

Figure 3:d Existing links within one half-mile radius of Cathedral Park

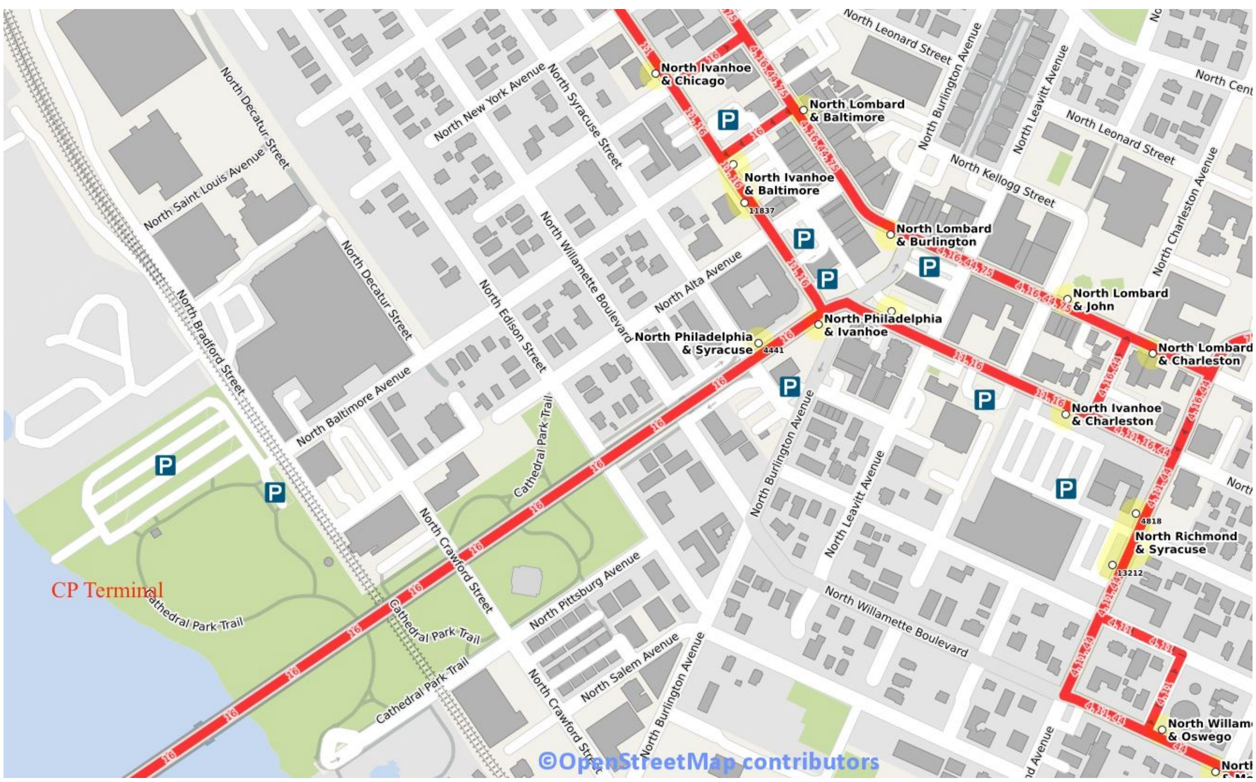

Table 3:2 Cathedral Park terminal accessibility

MODE	DETAILS
Pedestrian (Half Mile)	Access for pedestrians from the north and east, through the park on stable trails. At some point, pedestrians must cross train tracks. The area is at the base of a steep hill.
Bicycles	Access for bicycles from the north and east. A shared roadway bicycle route extends down N. Burlington Avenue linking cyclists to the park via the Cathedral Park Trail.
Bicycle/Scooter Share	Cathedral Park and St. Johns are currently outside the boundary of the local Portland bike share program (BikeTown).
Car/Ride Share	Uber and Lyft both operate in the area.
Kiss & Ride Zones	Either the small parking lot or the larger boat launch parking lot provides good opportunities.
Car Parking	Parking at the small lot is very limited. The large lot is currently striped for vehicles with boat trailers to support the boat launch. Paid parking lots are available up the hill, about a half-mile walk from the terminal site.
Bike Parking	Currently, there is no secure bike parking within a short distance from the terminal.
Transit	There are several TriMet stops within a half mile: • 4 and 75 routes from the east, N. Lombard Transit Center • 16 route from the west • 44 route from the southeast

Accessibility Recommendations

- Install a pedestrian/bicycle crossing/bridge for the train tracks.
- Designate ferry parking in the large lot.
- Designate a Kiss & Ride for use by ferry passengers.
- Secure bike parking should be considered, located in close proximity to the ferry queuing area.
- Consider adding a dedicated shuttle service between the Cathedral Park core and the ferry terminal, scheduled to synch with ferry arrivals and departures.

Infrastructure

There is currently little specific infrastructure in place to support the ferry. The following additions or modifications will be necessary to properly support a ferry service:

- Vessel Interface – the existing docks are not suitable for this type of service. See Section 4 – Dock Requirements for details.
- Traffic Management – there would be the tendency for queuing for the ferry on the public dock, but passengers will be encouraged to wait at the top of the dock access ramp under a covered queuing area (`Figure *4*:*e*). The ferry terminal

space will require carefully designed wayfinding from outside the park and along the park trails, guiding passengers through the park to the terminal space to minimize interface with the boat launch.

- Personal Security – it is essential that adequate lighting, surveillance and a secure bike parking facility be incorporated in close proximity to the covered queuing area.
- Customer Experience – in the ferry terminal area, public restrooms currently exist. Specific to the ferry service, an electronic ticket kiosk, digital signage and a covered queuing area will be necessary.

Salmon Street – Core Route

Figure 3:e Salmon Street

The Salmon Street site is an open promenade with the Salmon Street Springs Fountain as a centerpiece. Situated where Salmon Street ends at the Tom McCall Waterfront Park, at the intersection of Salmon Street and SW Naito Parkway. The site is an ideal centralized site to provide ferry access to the downtown core, where dense employment districts exist.

The Waterfront Park Trail runs along the seawall and provides an open, paved space for an unconfined terminal site.

Location

The Salmon Street site is located on the west bank of the Willamette River, in the downtown core of Portland. The commercial areas of downtown Portland, Goose Hollow and Old Town China Town are all within a one-mile radius of the site, to the west of the river.

The Salmon Street ferry terminal will primarily serve commuters who work in the downtown core. As a secondary market, inbound passengers may use the ferry during normal hours or off-hours/weekends for discretionary trips to enjoy the river and gain convenient access to Portland's downtown for shopping, dining or events. Similarly, the terminal is a convenient departure point for passengers from Portland, whether tourists or locals, to access the ferry for a trip to downtown Vancouver or to Lake Oswego. These specific markets have little need for parking, but pedestrian and bicycle-friendly access and transit links are critical.

The ferry terminal will only require a small footprint, with a minimal queuing area close to the access gangway of the dock. (See Section 5 – Dock, Terminal and Uplands Configurations.)

Accessibility

Accessibility to the terminal area is excellent for the intended market. Access for pedestrian and bicycle links to other modes or directly into the downtown core are numerous from the south, west and north. Cyclists can access Salmon Street via the Waterfront Trail, a multi-use trail that extends a little over a mile along the river between Hawthorne Bridge to the south and Steel Bridge to the north, or via designated bike lanes along Naito Parkway and numerous cross streets into the downtown core.

Portland launched a bike share program, sponsored by Nike (BikeTown), several years ago and the brightly colored orange bicycles can be found throughout the city, within a designated zone.

The City of Portland has prioritized roadways for bicycle use throughout the city by designating multi-use paths, shared roadways and designated bike lanes. An interactive map designating these can be found at:

https://pdx.maps.arcgis.com/apps/webappviewer/index.html?id=b51534aa6e1f4dd4ad4d83c4a084d9a6.

Figure 3:f Existing links within one half-mile radius of Salmon Street

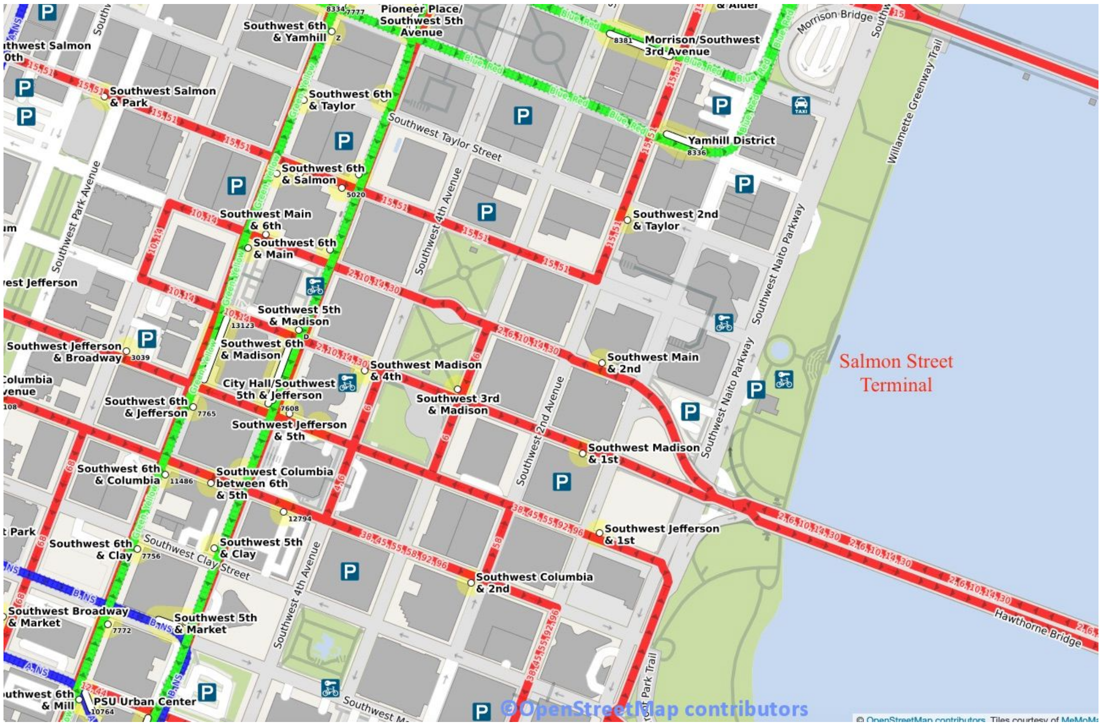

Table 3:3 Salmon Street terminal accessibility

MODE	DETAILS
Pedestrian (Half Mile)	Access for pedestrians from the north, south and west, through the park on paved trails to city streets and sidewalks. The ground is mostly flat.
Bicycles	Access for bicycles from the north, south and west. There are numerous dedicated bike lanes and routes.
Bicycle/Scooter Share	There is currently a BikeTown hub located at SW Salmon Street, 250 feet from the terminal site.
Car/Ride Share	Uber and Lyft both operate in the area.
Kiss & Ride Zones	While there are no designated Kiss & Ride spots, there is a pull-out located on the northbound lanes of SW Naito Parkway.
Car Parking	Parking is not considered a high priority for this market segment, but with close proximity to the downtown core, there are numerous paid parking locations.
Bike Parking	Currently, there is no secure bike parking within a short distance from the terminal.
Transit	There are numerous transit links within a half mile: • Five lines of the MAX light rail • Numerous TriMet routes • Several C-TRAN routes

Accessibility Recommendations

- Designate a Kiss & Ride for use by ferry passengers.
- Secure bike parking should be considered, located in close proximity to the ferry queuing area.

Infrastructure

There is currently little infrastructure in place specifically to support the ferry. The following additions or modifications will be necessary to properly support a ferry service:

- Vessel Interface – the existing dock is not suitable for this type of service and is privately owned. See Section 4 – Dock Requirements for details.
- Traffic Management – queuing for the ferry will be in an open public space around the top of the access ramp to the dock or under a covered waiting area (`Figure *4*:*e*). The ferry terminal space will require carefully designed wayfinding from outside the park, on the main thoroughfare and along the Waterfront Trail both north and south.
- Personal Security – it is essential that adequate lighting, surveillance and a secure bike parking facility be included in close proximity to the covered queuing area and on the dock.
- Customer Experience – in the ferry terminal area, public restrooms do not currently exist and should be added. Specific to the ferry service, an electronic ticket kiosk, digital signage and a covered queuing area will be necessary.

South Waterfront Greenway – Core Route

Figure 3:g South Waterfront Greenway

The South Waterfront Greenway is a City of Portland park that stretches along the west bank of the Willamette River at South Curry Street south of Ross Island Bridge.

Location

The South Waterfront Greenway is located on the west bank of the Willamette River, amongst numerous properties of the Oregon Health and Science University (OHSU) campus and other health and medical businesses.

The South Waterfront Greenway ferry terminal could primarily serve commuters who work on the OHSU campus or other nearby hospitals (connected via the tram to the VA and Shriner's), residents, and related support businesses. Commuters will be coming from the areas served by the ferry in and around Vancouver, St. Johns, Cathedral Park and Lake Oswego. As a secondary market, employees of OHSU and the surrounding businesses may use the ferry as a quick link for discretionary trips to downtown Portland. These specific markets have little need for parking, but pedestrian and bicycle-friendly access and transit links are critical.

The ferry terminal itself, consistent with other terminal sites, will only require a small footprint, with a minimal queuing area close to the access gangway of the dock. (See Section 5 – Dock, Terminal and Uplands Configurations.)

Accessibility

Accessibility to the terminal area is excellent for the intended market. Access for pedestrian and bicycle links to other modes or directly to business destinations are numerous from the south, west and north. The South Waterfront Greenway is a multi-use trail that extends a quarter mile along the river or via designated bike lanes along local streets.

Figure 3:h Existing links within one half-mile radius of the South Waterfront Greenway

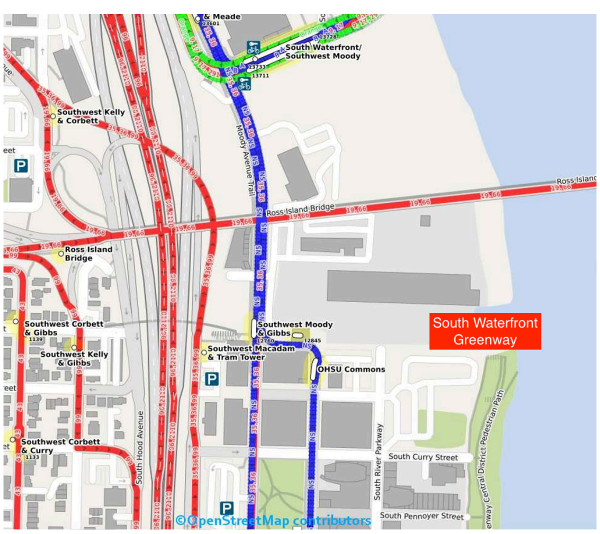

Table 3:4 South Waterfront Greenway terminal accessibility

MODE	DETAILS
Pedestrian (Half Mile)	Access for pedestrians from the north, south and west, along city streets with sidewalks. The ground is mostly flat.
Bicycles	Access for bicycles from the north, south and west. There are numerous dedicated bike routes.
Bicycle/Scooter Share	There is currently a BikeTown hub located at the base of the OHSU Aerial Tram, 1,000 feet from the greenway.
Car/Ride Share	Uber and Lyft both operate in the area.
Kiss & Ride Zones	While there are no designated Kiss & Ride spots, there are numerous potential sites in the immediate vicinity. For the intended market segment, this is not considered a high priority.
Car Parking	Parking is not considered a high priority for this market segment, but there are a few paid parking locations within close proximity.
Bike Parking	There is a large secured bike parking area at the base of the Tram.
Transit	There are numerous transit links within a half mile: • Two lines of the MAX light rail • Nine TriMet bus routes • One C-TRAN route • Portland Streetcar • Aerial Tram

Accessibility Recommendations

- Expand the secure bike parking area or add more bike parking closer to the terminal site to accommodate added ferry commuters with bikes.

Infrastructure

There is currently no infrastructure in place specific to the support of a ferry, but the site has high potential. The following additions or modifications will be necessary to properly support a ferry service with a ferry terminal:

- Vessel Interface – there are currently no existing docks.
- Traffic Management – queuing for the ferry will be in an open public space around the top of an access ramp to the dock or under a covered waiting area
- Personal Security – it is essential that adequate lighting, surveillance and a secure bike parking facility be included in close proximity to the covered queuing area.
- Customer Experience –An electronic ticket kiosk and digital signage with waiting area.

Foothills Park – Core Route

Figure 3:i Foothills Park

Foothills Park is a nine-acre City of Lake Oswego park situated at the former site of a Georgia Pacific wood chip loading facility. The park has a small parking lot, several paved walkways, greenspace, wooded areas, amphitheater, picnic pavilion, viewing platform and a public dock.

Location

Foothills Park is located on the west bank of the Willamette River, in the City of Lake Oswego. The residential neighborhoods of Old Town, Birdshill, Forest Hills, Evergreen, Lakewood and Hallinan are all within a one-mile radius of the park, to the north, west and south.

The Foothills Park ferry terminal will primarily serve residents of Lake Oswego neighborhoods and surrounding areas on their daily commute to downtown Portland destinations. As a secondary market, residents may use the ferry during normal hours or off-hours/weekends for discretionary trips to enjoy the river and gain convenient access to either the Portland or Vancouver downtown areas. Additionally, residents of Vancouver or Portland may use the ferry during normal hours or off-hours or on weekends for discretionary trips to enjoy the river and gain access to the small downtown area of Lake Oswego. These specific markets emphasize the need for some car parking, pedestrian and bicycle-friendly access and transit links.

The ferry terminal will only require a small footprint, with a minimal queuing area close to the access gangway of the dock. (See Section 5 – Dock, Terminal and Uplands Configurations.)

Accessibility

Currently, accessibility to the terminal area is good for the intended market. Access for pedestrian and bicycle links to other modes are available, but must contend with some hills. As it is expected that this particular market will include a moderate percentage of riders originating from local neighborhoods, some may require car parking.

Figure 3:j Existing links within one half-mile radius of Foothills Park

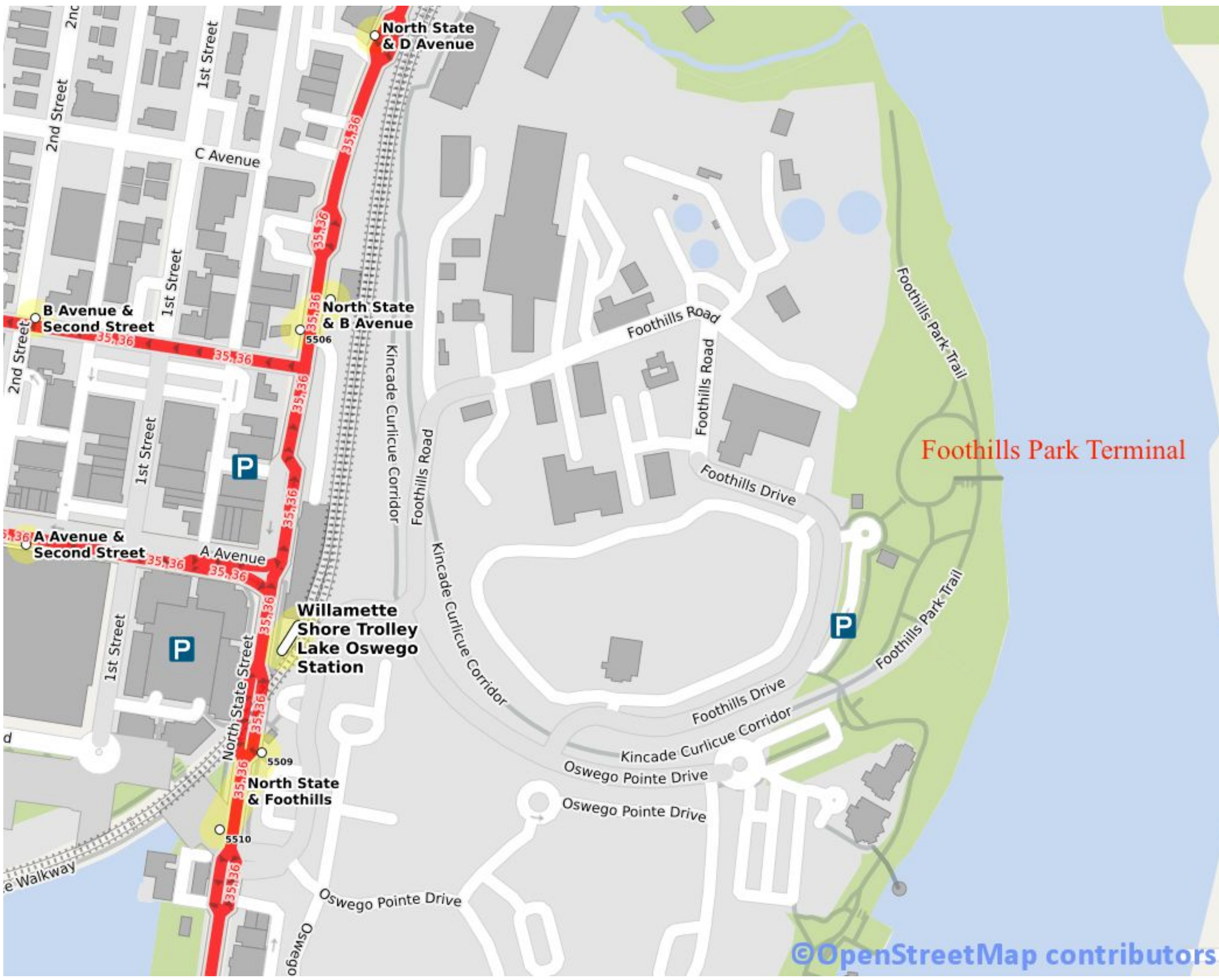

Table 3:5 Foothills Park terminal accessibility

MODE	DETAILS
Pedestrian (Half Mile)	Access for pedestrians from the north, west and south, through the Foothills neighborhood on roadways and paved trails.
Bicycles	Access for bicycles from the north, west and south following the same routes as pedestrians.
Bicycle/Scooter Share	Lake Oswego is currently outside the boundary of the local Portland bike share program (BikeTown).
Car/Ride Share	Uber and Lyft both operate in the area.
Kiss & Ride Zones	The roundabout provides good opportunities.
Car Parking	Parking at the small lot is very limited. Paid parking lots are available up the hill, about a half-mile walk.
Bike Parking	Currently, there is no secure bike parking within a short distance from the terminal.
Transit	There are limited TriMet links within a half mile: • 35 route runs north and south • 36 route runs along the south shore of Lake Oswego The Lake Oswego Transit Center is 0.75 miles from the terminal and has four additional TriMet routes.

Accessibility Recommendations

- Identify parking within a half-mile radius.
- Secure bike parking is recommended, located in close proximity to the ferry queuing area.
- Consider adding a dedicated shuttle service between the Lake Oswego Transit Center, parking lot and the ferry terminal synched with the ferry arrivals.

Infrastructure

There is currently some infrastructure in place to support the ferry. The following additions or modifications will be necessary to properly support a ferry service:

- Vessel Interface – the existing dock is suitable for this type of service. See Section 4 – Dock Requirements for details.
- Traffic Management – queuing for the ferry will naturally occur on the public dock, but passengers will be encouraged to wait at the top of the access ramp. The ferry terminal space will require carefully designed wayfinding from outside the park and along the park trails, guiding passengers through the park to the terminal space.
- Personal Security – it is essential that adequate lighting, surveillance and a secure bike parking facility be incorporated in close proximity to the covered queuing area.

- Customer Experience – in the ferry terminal area, public restrooms currently exist. Specific to the ferry service, an electronic ticket kiosk and digital signage will be necessary.

Section 4 Dock Requirements

Docks represent a critical element in the ferry system. As the interface between the vessels and shoreside, docks must be adequately designed and constructed to accommodate the vessel and safely transfer passengers to and from shore terminals and queuing areas.

The objective of this section is to determine the feasibility of existing docks identified for potential use by the ferry system and make recommendations for necessary modifications and upgrades. It is in the interest of the ferry system to utilize existing infrastructure wherever possible, but when requirements aren't met, the FFF team will provide recommendations for alternative dock arrangements.

Feasibility of Existing Docks

Several key factors were investigated at each dock to determine feasibility. These include:

- Water depths – there must be sufficient water depth for the vessels to access the dock at all river levels. With a safety margin of 30%, docks are considered to be not feasible without at least 8 feet of water at 0.0 feet Columbia River Datum (CRD). Shoaling risk and past dredging at the site could also impact feasibility due to cost and permit challenges.
- Exposure – docks exposed to prevailing weather (winds and wind-generated waves), excessive current or excessive vessel wakes that would compromise the safety of the vessel or passengers are considered to be not feasible.
- Dimensions and Construction – the physical size of the dock and type and quality of construction must be sufficient to support the intended vessels. An overall available unobstructed dock face of 100 feet is ideal, but under certain circumstances, as little as 60 feet can be utilized. Dock width should provide a clear walkway and stable platform for passengers to safely transit. A minimum clear width of eight feet is considered feasible. The available freeboard of the deck above the water should be adequate to remain dry in the prevailing conditions, but not too high to impede access from a vessel with under three feet of freeboard. Docks should be designed to support loads placed on them by vessels of sufficient displacement (75,000 - 125,000 lbs).
- Access / ADA – type of access from shoreside to the dock and overall compliance with ADA requirements is assessed. ADA parameters are reviewed in detail in Appendix A – Reconnaissance Report. Critical items include ramp slope and cross slope, surfaces, clear widths, landings and handrails. Initial feasibility is determined by full compliance with ADA access guidelines as they apply, or whether minor modifications would make it feasible.
- General Passenger Safety – passenger safety is paramount as docks inherently pose a high risk of injury or even drowning. Assessment includes tripping

hazards, stability of walking surfaces, slip and fall hazards, availability of barriers between passengers and the water, lighting, as well as available safety equipment (life rings, swim ladders, etc.). Initial feasibility is determined by full compliance, but minor modifications may be possible to make it feasible.

- Dock Hardware/Fendering – hardware should be of sufficient design and construction to support commercial vessels of the size envisioned. Dock hardware includes numerous types of potential means of securing the vessel, fendering to protect both vessel and dock from damage as well as the safety of crew. Initial feasibility is determined by full compliance, but minor modifications may be possible to make it feasible.
- Use Agreements – depending on the original dock construction funding, some of the facilities may have special use limitations. These limitations may be beyond the sole control of the current owner/manager. Use of core service docks is considered to be more critical than that of non-core service docks where use may not be scheduled and more flexible regarding dock access.

Of the nine sites included in this feasibility study, five are considered to be part of the core ferry route while four are considered primarily for discretionary service or future service. Also, of the nine sites, six locations currently have existing docks while three do not.

The following existing docks were assessed for feasibility against the factors identified above:

- Port of Vancouver's Terminal 1 Public Dock
- Cathedral Park Public Boat Launch
- Kevin J. Duckworth Memorial Dock
- Salmon Street Dock (private)
- Oregon Museum of Science and Industry (OMSI) Dock
- Foothills Park Dock (Lake Oswego)

See Appendix A – Reconnaissance Report for specific details and findings on each dock. *Table 4:1 Feasibility Assessment of Existing Docks* provides a summary of those assessments. The conclusions are as follows:

- With some minor modifications to dock hardware and, in some cases ADA compliance, three of the existing docks (Duckworth, OMSI and Foothills Park) are feasible for use with the ferry system.
- Of these three, two (Duckworth, OMSI) are feasible in part because their intended use is for discretionary service, not regular ferry service.
- The remaining three docks (Vancouver Terminal 1, Cathedral Park and Salmon Street) are considered to be not feasible without major modifications. Details of these major modifications are discussed further in this section.

Table 4:1 Feasibility Assessment of Existing Docks

Existing Docks / Assessment Factors	Vancouver T1	Cathedral Park	Duckworth	Salmon Street	OMSI	Foothills Park
Core Service	Y	Y	N	Y	N	Y
Water Depth	F	F	F	F	F	F
Exposure	F	F	F	F	F	F
Dimensions	F	NF	F	NF	F	F
Construction	F	NF	F	NF	F	F
Access / ADA	NF*	NF*	F	NF*	F	F
Dock Hardware / Fendering	NF*	NF*	NF*	NF*	NF*	NF*
Use Agreements	NF	NF	F	NF[2]	F	F
Feasible with minor modifications	NF	NF	F	NF	F	F
Feasible with major modifications	F	F	-	F	-	-

Table Key: Y=Yes, N=No, F=Feasible, NF=Not Feasible, *=modifications can likely be made to make the dock feasible for use.

Feasibility of Future Docks

The following sites were assessed for feasibility of a dock potentially being installed to support the ferry against a limited set of factors (water depth, exposure and potential access):

- OHSU/South Waterfront
- Milwaukie
- Oregon City

See Appendix A – Reconnaissance Report for specific details and findings on each potential dock site. Table *4:2* Feasibility Assessment of Sites without Existing Docks provides a summary of those assessments. The conclusions are as follows:

- All three sites are feasible for installation of docks to support the ferry.

[2] The dock at Salmon Street is privately owned and maintained by American Waterways, Inc (*Portland Spirit*). While the details of the *Portland Spirit's* use agreement are unknown, it is assumed that regular ferry operations at the dock would conflict with operation of the *Portland Spirit*.

Table 4:2 Feasibility Assessment of Sites without Existing Docks

No Existing Docks / Assessment Factors	OHSU	Milwaukie	Oregon City
Core Service	Y	N	N
Water Depth	F	F	F
Exposure	F	F	F
Potential Access	F	F	F

Table Key: Y=Yes, N=No, F=Feasible, NF=Not Feasible

Modifications and Alternatives

Minor modifications

Some of the docks (Foothills Park, Duckworth and OMSI) would be feasible for use by the ferry with only minor modifications for the safety and security of the passengers, interface between the vessel and the dock itself and meeting customer experience requirements.

For passenger safety and security, including ADA requirements, some examples of minor modifications include the elimination of trip hazards, applying non-skid surfaces, adding lighting and surveillance cameras, providing handrails and installing gates for access control where possible.

All of the docks evaluated were primarily designed to accommodate smaller recreational craft with lower freeboard and temporary fenders. The dock hardware used at most of the docks for tying vessels up are continuous bull rails (Figure *4*:*a*). While bull rails are very functional for the recreational boating community, they are insufficient for commercial vessels of this size and generally not expedient. For commercial vessels performing repetitive and frequent landings, cast cleats (Figure *4*:*b*) or bollards (Figure *4*:*c*) are preferred.

Figure 4:a Bull Rail

Figure 4:b Cast Cleat

Figure 4:c Bollard

Additionally, permanent fendering should be added. With such a low freeboard (approximately 15”) the unprotected dock face will not match well with the higher freeboard and rub rails of the vessels (at 30 – 45” of freeboard). Where possible, the docks should be equipped with fender knees (Figure *4:d*). As a commuter ferry of this kind makes frequent landings at all of the stops and dwell time is crucial, the support infrastructure should be robust and convenient to use.

Figure 4:d Fender knees

With the low freeboard of the existing docks, it will be necessary to design and fabricate gangways that can bridge the horizontal and vertical gap between vessel and dock interface. With a vertical gap between the deck of the dock and main deck of the vessel of approximately 15 – 30”, a ramp meeting ADA requirements (minimum 12:1 slope, clear width of 36”, equipped with handrails) will be required. Most likely these ramps will run parallel to the vessel and require a landing at the top to then transition through a 90 degree turn to a gangway that spans the horizontal gap.

In order to meet customer experience expectations, the existing docks will all require informational and safety signage. Due to the local climate in Portland, it is also recommended that all new access ramps be covered (`Figure *4*:*e*).

`Figure 4:e Covered access ramp

Major modifications and alternatives

For Vancouver's Terminal 1, Cathedral Park and Salmon Street the existing docks will still be considered to be infeasible for a commercial ferry service, even with some of the minor modifications described above. In order to be considered feasible, major modifications and/or alternative arrangements are necessary.

In Vancouver, the use agreement for the dock excludes a ferry service from operating in such a way that may impede public use of any part of the dock. This prohibits the ferry from having a designated berthing location, staging infrastructure and gaining uninhibited access to the dock; all critical components of a successful ferry service. To address this, it is recommended that FFF and the Port of Vancouver investigate extending the existing dock to allow for a designated berth for the ferry service (see Section 5 – Dock, Terminals and Uplands Configurations for details of this recommendation).

At Cathedral Park, the existing boat launch docks have reached the end of their service life and were not designed to support commercial vessels of this size. The docks and access for passengers along the floating boarding docks that are being used simultaneously by recreational boaters presents an elevated risk factor. It is recommended that FFF and the City of Portland consider design and construction of a designated floating dock immediately to the south of the existing launch ramp (see Section 5 – Dock, Terminals and Uplands Configurations for details of this recommendation).

The existing dock at Salmon Street, aside from use agreement issues, is not of suitable construction for use by a commercial ferry operation. It is recommended that FFF and the City of Portland consider design and construction of a designated floating dock immediately to the south of the existing dock (see Section 5 – Dock, Terminals and Uplands Configurations for details of this recommendation).

Section 5 Dock, Terminal and Uplands Configurations

An assessment of Terminal sites and existing docks was performed by the Friends of Frog Ferry (FFF) team to determine feasibility and establish recommendations for improvements. It was determined that, with perhaps some minor improvements to terminals and uplands, most of the terminal sites on the core route are feasible for use in support of the ferry system. Those recommendations can be found in Section 3 – Terminal Location, Accessibility and Infrastructure.

In Section 4 – Dock Requirements, it was determined that all of the docks require minor modifications and most of them require major modifications in order to be feasible for ferry service. Recommendations for each dock are found in that section. This section shall expand on the major modifications required for the primary docks in the core route.

Vancouver Terminal 1 Modifications

The current development plan provides for excellent accessibility and all of the needs for a successful terminal site can be incorporated into the plan. However, the existing dock is not feasible for use by a commercial ferry as currently configured. Some of the issues identified with the dock can be addressed through minor modifications, but the use agreement will still restrict use by the ferry. In light of this, a modified dock is recommended.

Recommended Dock Modifications

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to the dock (Table *5*:*1* Estimated Capital Expenses Vancouver Terminal 1):

- Add a 100-foot dock extension to the existing public dock. New dock extension has a designated ferry-only landing zone, handrails and access gate.
- Replace existing access ramp to the dock with a new, eighty-foot covered ramp that meets ADA requirements.
- Remove existing multi-pile dolphin as mitigation for new pile.

Estimated Capital Expenses

Table 5:1 Estimated Capital Expenses Vancouver Terminal 1

Item	Cost
Dock	$187,500.00
Gangway	$0.00
Piling	$165,000.00
Ground Improvements	$0.00
Mitigation	$40,000.00
Soft Costs	$127,500.00
Mobilization	$60,000.00
Contingency	$145,000.00
Total:	$725,000.00

Cathedral Park Modifications

Current accessibility to the terminal site is a challenge for several reasons. Recommendations to improve accessibility have been made in this report (see Section 3 – Terminal Location, Accessibility and Infrastructure). The existing docks that support the boat launch are not feasible for use by a commercial ferry as currently configured. The issues identified with the dock cannot be addressed through minor modifications and the location of the existing docks creates a high degree of risk for pedestrians accessing the ferry. In light of this, a new dock located to the south of the existing launch ramp is recommended.

Recommended Dock Modifications

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to the dock (Table *5*:*2* Estimated Capital Expenses Cathedral Park):

- Construct and install a new 100-foot dock in deep water. New dock to have a designated ferry-only landing zone, public landing zone on the opposite side, a waiting area with handrails and access gate.
- A new, covered access ramp to the dock from an access point in the park.
- Remove old abandoned piles as mitigation for new piles.

Estimated Capital Expenses

Table 5:2 Estimated Capital Expenses Cathedral Park

Item	Cost
Dock	$187,500.00
Gangway	$218,500.00
Piling	$165,000.00
Ground Improvements	$15,000.00
Mitigation	$39,800.00
Soft Costs	$132,500.00
Mobilization	$77,500.00
Contingency	$208,950.00
Total:	$1,044,750.00

Salmon Street Modifications

Current accessibility to the terminal site at Salmon Street is excellent due to the location, links to local transit and generally flat, improved terrain. Some minor recommendations to improve accessibility have been made in this report (see Section 3 – Terminal Location, Accessibility and Infrastructure). The existing dock at Salmon Street is deemed to be not feasible for use by a commercial ferry. The issues identified with the existing dock could possibly be addressed through minor modifications but, as it is privately owned, there are likely to be barriers to use that would make it infeasible. In light of this, a new dock located to the south of the existing dock is recommended.

Recommended Dock Modifications

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to the dock (Table *5*:*3* Estimated Capital Expenses Salmon Street):

- Construct and install a new 100-foot dock along the seawall. New dock to have a designated ferry-only landing zone, a waiting area with handrails and access gate.
- A new, covered access ramp to the dock from the seawall overlook.
- New dock would use pile supports and not interact with the seawall.

Estimated Capital Expenses

Table 5:3 Estimated Capital Expenses Salmon Street

Item	Cost
Dock	$187,500.00
Gangway	$122,500.00
Piling	$165,000.00
Ground Improvements	$10,000.00
Mitigation	$25,000.00
Soft Costs	$132,500.00
Mobilization	$77,500.00
Contingency	$180,000.00
Total:	$900,000.00

South Waterfront Greenway

Current accessibility to the South Waterfront Greenway is excellent due to the location, links to local transit and generally flat terrain. Some minor recommendations to improve accessibility have been made in this report (see Section 3 – Terminal Location, Accessibility and Infrastructure).

Recommended Dock Concept

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to a dock:

- Identify a suitable location along the South Waterfront Greenway to install a dedicated ferry dock with access ramp. The proposed concept would be similar in construction, arrangement and cost to the proposed concept for Cathedral Park.

Lake Oswego Foothills Park Modifications

Current accessibility to the terminal site at Foothills Park is good for the intended market, but could be improved by implementing some of the transit link recommendations made in this report (see Section 3 – Terminal Location, Accessibility and Infrastructure). The existing dock at Foothills Park is deemed to be feasible for use by a commercial ferry with some modifications and probable resolution of use restrictions. The issues identified with the existing dock could probably be addressed through minor modifications. The use restrictions will require a collective resolution between FFF, the City of Lake Oswego and the Oregon State Marine Board. In light of this, a new dock located to the south of the existing dock is provided as an alternative if a resolution cannot be reached.

Recommended Dock Modifications (Preferred Option)

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to the dock (Table *5*:*4* Estimated Capital Expenses Foothills Park):

- Approximately 100 linear feet of the existing dock would be designated for exclusive use by the ferry.

Estimated Capital Expenses

Table 5:4 Estimated Capital Expenses Foothills Park

Item	Cost
Dock	$0.00
Gangway	$0.00
Piling	$0.00
Ground Improvements	$0.00
Mitigation	$120,000.00
Soft Costs	$0.00
Mobilization	$0.00
Contingency	$0.00
Total:	$120,000.00

Recommended Dock Modifications (Alternate)

From Section 3 – Terminal Location, Accessibility and Infrastructure and Section 4 – Dock Requirements, the following recommendations are made in regard to the dock (Table *5*:*5* Estimated Capital Expenses Foothills Park (Alternate Option):

- Construct and install a new 100-foot dock. New dock to have a designated ferry-only landing zone, a waiting area with handrails and access gate.
- A new, covered access ramp to the dock from the existing overlook.
- Remove old low-level dock to mitigate for new piles.

Estimated Capital Expenses

Table 5:5 Estimated Capital Expenses Foothills Park (Alternate Option)

Item	Cost
Dock	$187,500.00
Gangway	$197,500.00
Piling	$165,000.00
Ground Improvements	$20,000.00
Mitigation	$45,000.00
Soft Costs	$132,500.00
Mobilization	$75,000.00
Contingency	$205,625.00
Total:	$1,028,125.00

Section 6 Permits

Facility Regulatory Context

Docking facilities on the Willamette and Columbia rivers suitable for Friends of Frog Ferry (FFF) vary in suitability and age. It is likely that a combination of upgrades to existing facilities and the addition of new facilities would need to take place in order to meet the operational and service requirements. All proposed operations are located within navigable waters of the U.S. and changes or improvements to docks and piers would be subject to multiple regulatory reviews. This section explores general thresholds where permits may be required and provides a framework of the current regulatory environment.

Permit Requirements

Any work below ordinary high water (16-18 feet) or above the water surface, requires permits. This threshold is clearly met with new dock and pier work, piling, modification of existing structures, dredging, riverbank stabilization, and any work that could create a discharge to the water column of any type. Therefore, most of the conceptual plans outlined in this report will require permitting and the associated cost and schedule implications.

Some limited facility improvements may be possible without additional state or federal permit effort, but this work would generally be limited to cosmetic, safety and maintenance that does not change the size of the previously authorized structure. An example could include painting a section of dock to mark it for FFF use, installation of a handrail along an existing dock, replacement of slippery gangway deck with a modern grated deck that meets light transmission requirements, or signage. Typical facility improvements that would likely require permits include adding a small section of dock to better accommodate fendering of the vessel, adding new pile to better meet mooring loads, or replacing a gangway with a longer system to reduce slope. It is recommended that the state and federal agencies be coordinated with prior to planning work to ensure permit coverage is in place, if needed.

State/Local Process

The federal permit process is uniform for the states of Oregon and Washington, however, permit administration is through two separate districts of the Corps of Engineers (COE). Washington projects on the Columbia River are permitted through the Vancouver Field office of the Seattle District. Willamette River projects are authorized through the Portland District. Both districts rely on the same regulations and adhere to the same standards and general approval schedule.

In addition to the permits previously mentioned, local approvals are also typically required for project maintenance and new projects. These can include greenway review, shoreline master program, State Environmental Policy Act (SEPA), and grading cut/fill requirements. As docks and piling have the potential to impact flood flows, the local city or county must review the flood impacts under the local National Flood Insurance Program (NFIP). This typically includes a no-rise certification and documentation required by the Federal Emergency Management Administration (FEMA).

Finally, structures and piling supporting docks and piers must receive local building permits and associated review. This would include structural review as well as fire/life safety. Many of the dock facilities reviewed were originally designed for public use and likely designed to meet code current at the time of construction. Changes of use and operations, however, may trigger the need for additional local agency building department coordination and approval, depending on proposed site-specific changes.

Federal Process

Endangered Species (ESA) are present in the rivers, and thus a permit from the COE and Department of State Lands (DSL) in Oregon, and Washington State Fish & Wildlife (WDFW) in Washington will be required for work either below or over Ordinary High Water (OHW). Depending on the proposed improvements and impacts, work will likely require additional consultation with National Marine Fisheries Service (NMFS) for potential impacts to ESA multiple listed salmonids and other species. United States Fish & Wildlife (USF&W) also has authority over several listed species that vary based on river location.

Timing

Timing and schedule are a factor that must be considered for all prospective work in, and near, the river. Each agency, municipality, and permit has specific timelines. The process, however, can typically be completed within a year, unless more site-specific issues are encountered around land use and sediment contaminants. The local process can be completed before or after the State/Federal process or concurrently. There are advantages and disadvantages to each approach.

Besides allocating at least a year for permitting, the other factor to consider is in-water work windows. As significant work such as piling and new docks are below OHW and have the potential to negatively impact ESA species, time limitations are applied that restrict these actions to when species are least likely to be present. In-water work permits have many other special conditions, but the limitation of work to specific ‘work windows’ based on expected fish runs can significantly impact the planning schedule. The in-water work timeframes vary by location and water body. Integrating these fixed time limits into the overall schedule is critical in project planning for any dock improvement along the river.

Recently, some agencies and municipalities have been requiring some form of mitigation for docks, piers and other impacts. The goal of this mitigation is for a result of no net loss of habitat and function due to a new project. This could include removal of abandoned pile nearby to offset proposed pile, removal of an abandoned dock to offset a new dock area, upgrading the solid surface deck of an existing dock to a grated deck allowing better light penetration, or replanting a riparian area with limited native canopy. Any proposed improvements should include consideration to avoid and minimize impacts.

There are other regulatory changes under discussion that could impact permitting. Cities and agencies are developing new requirements that will likely restrict some uses in response to a FEMA/NMFS legal action brought about by an outside conservation coalition. These restrictions generally apply to commercial and development facilities, and encourage riparian protection while providing some limited public access. Specifics are being worked out, but this issue is commonly referred to as the NMFS/FEMA BiOP.

Planning Process

The State and Federal permit process starts with the submittal of a joint COE/DSL or COE/WDFW permit application.

The process after application is transparent to the applicant, (after an application is deemed complete) until public comments are received. The applicant has the opportunity to address specific comments and make appropriate changes. The process includes:

Federal – Corps of Engineers (COE) which coordinates the following additional Federal level reviews:

- National Marine Fisheries Services (NMFS)
- U.S. Fish and Wildlife (USF&W)
- EPA
- Tribes
- U.S. Coast Guard
- DEQ – 401 certification
- and Others

State – Department of State Lands (DSL) which coordinates the following State level reviews:

- Oregon Department of Fish and Wildlife
- Oregon State Marine Board
- and Others

Local – The local county or city reviews the project for land use and building code requirements. In some municipalities, the local approval is required before a state permit will be issued.

Oregon State – Department of State Lands (DSL) Proprietary Section issues approval for projects located below the bed and banks of the State of Oregon and projects may require a lease, registration, or license.

Washington State – Department of Natural Resources (DNR) issues approval for use of the bed and banks of the State of Washington through an official approval process and agreement.

Each agency looks for specific issues and provides comments related to fulfilling their specific mission. For example, the NMFS goals are focused on salmon and fish recovery, and are less concerned with the economic benefit of docks, dredging, moorage or other non-fish issues. DEQ is concerned about short-term and long-term impacts of a project to water quality, such as sediment and other chemicals. DSL/DNR is interested in protecting the public's access to the water surface among other priorities. Each agency has a responsibility to protect the goals and objectives of their agency's charter.

Section 7 Support Services

Objective
Determine and report the necessary vessel support services such as fuel, water, electrical utilities, rubbish, waste-oil, bilge-water, maintenance contractors, and haul-out facilities.

Introduction
Portland is a major U.S. port and ship repair center on the Pacific Coast with a wide variety of marine suppliers, vessel repair facilities, fabrication facilities, moorage and fueling options. Comprehensive haul-out and drydock services for large and small vessels are available throughout Portland and Vancouver, including travel lifts for vessels up to 70 tons and dry dock facilities for ships up to 80,000 tons.

Many commercial facilities with electricity, diesel fuel, water, pump out facilities and marine supplies exist in and near the proposed area of operation, which include the Willamette River, the Columbia River near Vancouver and the Multnomah Channel. Access to rail, truck and barge loading is also available throughout the area.

Homeport
Introduction
Future operating plans will inform the development of the ferry system’s maintenance and storage strategies including defining the location and configuration of the ferry system’s permanent moorage facility or “homeport.”

The importance of establishing a homeport cannot be overstated. Ferry vessels require a wide variety of routine inspections, maintenance, light repairs, reprovisioning, staffing and training activities. Centralizing these activities in a homeport with the right infrastructure is highly advantageous to any ferry system as opposed to fragmented facilities and services.

Description
Successful ferry systems require suitable infrastructure to support operations and ensure that they can be performed efficiently.

- The operator should strive to identify a homeport that is close to the area of operation and provides as many services as possible with few restrictions.
- Operating costs should consider non-revenue vessel movements to and from vessels’ homeport. An ideal situation would be to create a homeport at or near the main hub or terminus of the route. This ensures all levels of the organization are centralized, maintaining good communication and common processes.
- Sufficient dock space for the entire fleet (as planned), with the ability to expand, providing a safe and secure environment.

- All logistics and services should be supported, such as fueling, potable water, sewage, provisioning and shore power.
- A maintenance facility to house specialty tools, spare parts and workshop spaces.
- Administrative offices would be onsite to foster a strong corporate culture and maintain consistent communications throughout the organization.
- A facility to house consumables such as tools, fuel filters, used oil drums, cleaning supplies, paper towels and toilet paper.
- The homeport should be accessible and be able to reasonably accommodate access by employees, regulators (USCG) and contractors.
- Restrictions regarding hours of operations, maintenance, hot work, noise levels, and diving operations should be evaluated.

Logistics

Fuel

The operator will be responsible for all fueling requirements associated with the ferry service. The endurance of small passenger vessels proposed for this service will be extremely limited and fueling each vessel will be required on a daily basis. Fueling services of every variety exist throughout the area of operation. Depending on which services are available at the selected homeport, one of the following options will apply, in order of preference:

- Homeport fueling facility: establish a fueling operation at the homeport that complies with applicable laws and regulations. This would include storage tanks, transfer pumps and associated piping to the dock, and proper containment.

- Fuel delivery by truck: utilize a fuel truck to deliver fuel directly to the vessels at the homeport or other designated area.

- Third-party fuel dock: utilize commercial or recreational fuel docks. These are outside the direct control of the operator and would require non-revenue transits to and from the fuel dock.

Clipper Oil Marine Fuels near Swan Island Basin and Vigor Shipyard is an example of a full service fuel supplier providing ultra-low sulfur diesel by truck or at the dock.

Clipper Oil Marine Fuels
2040 Harbor Island Drive
Suite 203
San Diego, CA 92101
Ph: 619-692 -9701
Fuel Dock Location: Willamette River 45°33'54.4"N 122°44'02.3"W

Carson Oil is an example of a fuel provider providing ultra-low sulfur diesel by truck to the destination of choice.

Carson Oil
3125 NW 35th Ave.
Portland, OR. 97210
Ph: 503-224-8500

Fueling the vessels is a critical and labor-intensive support activity that could pose a high level of risk to the operation. It is vital that an efficient, convenient and low risk solution be developed.

Potable Water

Potable water will be sourced from treated city water and supplied to the vessel's water tank at the vessel's homeport.

Sewage

As discussed in Section 8 – Regulatory Assessment, an adequately sized holding tank is required. A calculation of the average and peak capacity of the device must include, the flow rate, volume (or number of persons that the device is capable of serving) and the period of time the device is rated to operate at peak capacity.

The operator will be responsible for maintaining a plan to properly transfer sewage to an approved facility in accordance with applicable regulations. The most efficient method would be to install a pump-out station on the maintenance dock that discharges to city sewer for treatment.

Waste Oil

The Operator will be responsible for properly removing, storing and recycling waste-oil from the vessel and maintenance facility in accordance with applicable regulations.

Garbage

The Operator will be responsible for establishing a procedure for properly removing and disposing of operational and maintenance rubbish that meets all applicable regulations.

Bilge-water

The Operator will be responsible for properly removing, storing and recycling bilge-water from the vessel and maintenance facility in accordance with applicable regulations.

Maintenance contractors

The majority of maintenance and repair for the vessels will be accomplished dockside. Ideally, this will not require vessel movements and vessels will remain at the homeport.

Contractors will perform the necessary maintenance onboard. For hull and underwater propulsion equipment inspection, repair and maintenance, the vessels will need to be hauled out of the water. This work will be completed at a shipyard by the shipyard's staff or third-party contractors.

Periodic haul-outs are required for regulatory inspection every five years[3] for vessels on freshwater routes (See Section 8 – Regulatory Assessment). From a practical maintenance standpoint, this is not frequent enough to ensure reliability of small passenger vessels. It is recommended that the operator consider performing hull examinations and repairs on a more frequent basis, at a minimum of every two years.

Haul Out Facilities

There are several haul-out facilities within a 30-mile radius of the operating region capable of hauling the vessel for this service. The operator will select a haul-out facility for any repair based on the vessel's size, shipyard availability, and type of project to be completed. A list of local haul-out facilities is provided below:

Table 7:1 Local Haul Out Facilities

Shipyard	Location	Type	Tonnage	Dimensions
Vigor	Swan Island	Drydock	10,000	329' x 140'
JT Marine	Vancouver	Drydock	1200	200' x 40'
Diversified Marine	Portland	Drydock #1	100	60' x 30'
		Drydock #2	700	101' x 62'
Schooner Creek	Hayden Island	Travel Lift #1	35	-
		Travel Lift #2	70	

It will be important for the operator to become familiar with the capabilities of each shipyard and develop communications protocols and repair contracts in advance that will ensure immediate response in conditions requiring haul-outs for emergency repairs.

Recommendations

It is rare to identify a site that can accommodate all of the requirements of a homeport. Typically, waterfront property in close proximity to the route is in high demand or has restrictions. But if the opportunity to design and build a homeport can be identified, it is invaluable to the success of a ferry system.

As a part of the reconnaissance, an initial scan of potential homeports or permanent moorage facilities was conducted. The Port of Portland provided some potential

Section 1 [3] *46 CFR 176.600 - Drydock and internal structural examination intervals.*

locations, and other sites with existing tenants (typically other marine operations that might sublet space) were investigated.

As indicated in the Reconnaissance Report (Appendix A) permanent moorage is available at several sites with at least the potential for some supporting infrastructure.

Section 8 Regulatory Assessment

Introduction

Purpose

The objective of this section is to provide an assessment of relevant regulatory issues, including vessel and port security requirements that pertain to the operation of the proposed ferry service and outline steps for compliance.

Scope

A broad review of relevant regulatory issues was performed by narrowing the focus to the most likely categories of vessels as determined by the Service Objectives outlined in Section 1 of this paper. This resulting outline summarizes these requirements to aid strategic planning efforts. Provisions listed here will inform several sections of this study.

Passenger Vessel Services Act of 1886

Overview

The Passenger Vessel Services Act (PVSA) requires vessels that transport passengers between ports in the United States be built, owned and operated in the U.S.

46 USC 55103
In General - Except as otherwise provided in this chapter or Chapter 121 of this title, a vessel may not transport passengers between ports or places in the United States to which the coastwise laws apply, either directly or via a foreign port, unless the vessel—

1. Is wholly owned by citizens of the United States for purposes of engaging in the coastwise trade; and
2. Has been issued a certificate of documentation with a coastwise endorsement under chapter 121 or is exempt from documentation but would otherwise be eligible for such a certificate and endorsement.

Application

The Passenger Vessel Services Act applies to all vessels operated on waters subject to the jurisdiction of the United States, which includes the area of operation on the Columbia and Willamette rivers.

The rule is important to the proposed ferry system because it limits essential elements of ownership, operation and construction. Understanding these limits allows stakeholders to rule out less expensive foreign-owned service providers and builders and more accurately estimate capital and operating costs.

Recommendation

Vessels must be built, flagged and owned in the United States.

Passenger Vessel Safety Act of 1993

Overview

The Passenger Vessel Safety Act of 1993 (Section 2101 of title 46, United States Code) clarifies certain marine safety laws by providing gross tonnage thresholds to distinguish "Passenger Vessels" from "Small Passenger Vessels".

- A passenger vessel is a vessel of at least 100 gross tons carrying more than 12 passengers, including at least one passenger for hire.

- A small passenger vessel is less than 100 gross tons carrying more than 6 passengers including at least one passenger for hire.

Application

The Passenger Vessel Safety Act applies to all vessels operated on waters subject to the jurisdiction of the United States which includes the area of operation on the Columbia and Willamette rivers.

The rule is important to the proposed ferry system because the tonnage category of a vessel defines standards of construction, required safety appliances, manning requirements and other important factors affecting capital and operating costs.

Recommendation

Select the category of vessel (greater than or less than 100 tons) to meet the mission requirements and, as defined by the Passenger Vessel Safety Act, ensure the applicable standard (Passenger Vessel or Small Passenger Vessel) is applied when establishing vessel design criteria.

The United States Code

Overview

As stated earlier, this section outlines a broad survey of relevant regulatory issues and was performed by narrowing the application to the most likely categories of vessels as determined by Friends of Frog Ferry (FFF) in Section 1 Service Objectives. The resulting outline below summarizes these obligations, making it easier for FFF stakeholders to recalibrate their strategies. Specific provisions listed here will also inform relevant sections of this study.

Title 46

Title 46, Chapter I, Subchapter T Vessels that carry 150 passengers or less, and are less than 100 gross tons are classified under CFR, Title 46, Chapter I, Subchapter T, Part 175 to 185 (commonly referred to as 'T-boats'). Based on FFF's service objectives, this is the most likely category of vessel for consideration. Vessels in this category require a Master holding a U.S. Coast Guard Master's license of the correct tonnage/area and the vessel must meet the Subchapter-T requirements.

Routes Permitted

"Oceans", "Coastwise", "Lakes Bays and Sounds" and "Rivers" are terms associated with a vessel's Certificate of Inspection. Each area of operation is referred to as a "route." Further limitations may be imposed by referencing bodies of water, geographical points, and distance to points, etc.[4]

When designating a route or imposing operational limits, the United States Coast Guard Officer in Charge of Marine Inspection (USCG OCMI) will consider, among other factors, the Subchapter-T requirements for the selected vessel as well as performance capabilities, operating modes, maneuverability, and the stability criteria that is listed below.

For example, a vessel operating on a "Rivers" route does not require the same lifesaving equipment and arrangements as a vessel operating "Coastwise" or on open water. A vessel on a "Rivers" route may not be required to have life jacket lights or distress flares because they are operating in close proximity to land. The section of the Columbia and Willamette rivers considered for the ferry is considered a "Rivers" route.

Stability Criteria

A Stability Letter issued to a vessel describes the conditions of operations and lists information such as allowable weight, number of passengers permitted on each deck, deepest waterline drafts, location of watertight bulkheads, location of subdivision bulkheads, and location of watertight doors. The terms "Protected Waters" and "Partially Protected Waters" are terms associated with the stability letter that should not be confused with the term "route" defined on a vessel's Certificate of Inspection (COI).

Protected Waters vs. Partially Protected Waters

The terms "Protected Waters" and "Partially Protected Waters" are terms used in connection with stability criteria and the vessel's stability letter. These are important considerations as they will affect the overall cost of the vessel and operating limitations as determined by the OCMI. The OCMI may impose further limitations to bodies of water, geographical points, distance to geographical points, distance from land, seasonal limitations, and/or similar factors based on the stability of a vessel. Protected waters are defined in CFR 170.050 as sheltered waters presenting no special hazards such as most rivers, harbors and lakes.

Partially protected waters are defined in CFR 170.050 as waters within 20 nautical miles of the mouth of a harbor of safe refuge, unless determined by the OCMI to be exposed

[4] 46 CFR 176.110

waters and those portions of rivers, harbors, lakes, etc., which the OCMI determines not to be sheltered.

Manning Requirements

The manning requirements for a vessel are determined by the OCMI after consideration of the applicable laws and regulations. The size and type of vessel, installed equipment, proposed routes and frequency of port calls are examples of consideration of the OCMI.[5]

Vessels with a single passenger deck, carrying 150 passengers or less in protected areas often operate with 1 Master and 1 Deckhand per deck.

Certificate of Inspection (COI)

Subchapter-T Passenger vessels must be inspected by the United States Coast Guard for issuance of a Certificate of Inspection (COI) every five years and pass an annual inspection each year the COI is valid. Periodic inspections must occur within three months of the second or third anniversary of the date the COI was issued.[6] Upon inspection and certification these vessels must have the current and valid COI posted where it is clearly visible to passengers.

A COI issued to a vessel describes the vessel, the route(s), the minimum manning requirements, survival and rescue equipment, fire extinguishing equipment, maximum number of passengers and total number of persons that may be carried.

Upon new construction, the builder applies for an inspection for original COI before construction has started.[7] Acceptance is based on information, specifications, drawings, calculations and on the successful completion of the initial inspection.[8]

Application

Selecting a vessel design ultimately determines its operational limits. For example, when designating a permitted route or imposing any operational limits on a vessel, the OCMI will consider the performance capabilities of the vessel based on design, stability, propulsion, speed, operating modes, maneuverability and other characteristics relevant to the mission. The area of operation for each vessel and any necessary operational limits are determined by the OCMI and recorded on the vessel's Certificate of Inspection (COI) and Stability Letter.

The size of the vessel in terms of length and capacity has numerous stipulations in 46 CFR Subchapter-T that affect construction and operating costs. Rules for intact stability,

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[5] 46 CFR 15.501
[6] 46 CFR 169.226
[7] 46 CFR 107.211
[8] 46 CFR 115.105

damage stability, watertight integrity, subdivision, means of escape, and safety appliances vary according to these thresholds.

The OCMI determines the total number of persons permitted to be carried on a vessel by considering the total weight of passengers, crew and variable loads; stability restrictions and subdivision requirements of the vessel; the vessel's route, general arrangement, means of escape, and lifesaving equipment; minimum manning requirements; and the maximum number of passengers permitted in accordance with 46 CFR 176.113. For a vessel operating on short runs in protected waters, the OCMI may give special considerations for increased passenger allowances.[9]

Vessels carrying 49 passengers or less, that are under 65 ft in length, represent a regulatory threshold that is also important. For example, in some cases, vessels carrying 49 passengers or less may be eligible to undergo a Simplified Stability Proof Test (SST), whereas variable loads (deck loads, bunkers and passenger weights) are simulated and measured on a simplified scale as opposed to being demonstrated by design calculations, deadweight surveys and incline experiments.

While vessels carrying 150 passengers or less fall under the rules laid out in 46 CFR Subchapter-T, vessels with a capacity over 150 passengers fall under a separate regulatory regime (Subchapter-K) which triggers additional construction and operating requirements.

Recommendation

Refer to Section 13 - Vessel Requirements to define the minimum requirements of the base vessel necessary to accomplish the mission requirements. *Table 13:2 Vessel Requirements - Regulatory Elements* incorporates these regulatory elements and defines the base vessel.

Washington Utilities and Transportation Commission

Overview

The Washington State Utilities and Transportation Commission (UTC) is tasked with reviewing applications for commercial ferries and granting permits in accordance with Washington State laws. This includes any commercial ferry navigating over and upon the waters of the state of Washington, which includes portions of the Columbia River. The UTC requires annual reporting, approval of all fares and schedules as well as approval of suspension of service.

Application

The proposed ferry operation must apply for a permit with the UTC to operate in and out of the City of Vancouver, WA. As the proposed route is not within ten miles of an

[9] 46 CFR 176.113d

existing commercial ferry route there should not be any barriers to the granting of a permit, however there are ongoing reporting and compliance requirements.

Recommendation

A detailed legal review of Washington State UTC requirements and any similar State of Oregon requirements should be performed. Immediately following this review, the operator should start the application process in order to firmly establish fares and any imposed restrictions.

The Clean Water Act of 1972

Overview

Section 312 of the Clean Water Act (CWA) sets out the principle framework for regulating sewage (blackwater) discharges from vessels into the U.S. navigable waters and is implemented jointly by the U.S. Environmental Protection Agency (EPA) and the U.S. Coast Guard. Section 301(a) of the CWA provides that "the discharge of any pollutant by any person shall be unlawful" unless the discharge is in compliance with certain other sections of the Act. 33 U.S.C. 1311(a).

This section requires the use of operable, U.S. Coast Guard-certified Marine Sanitation Devices (MSDs) onboard vessels that are 1) equipped with installed toilets, and 2) operating on U.S. navigable waters.

Application

The proposed ferry vessel must be equipped with an MSD per section 312 of the CWA. An MSD includes any equipment for installation on board a vessel that is designed to receive, retain, treat, or discharge sewage, and any process to treat such sewage. A holding tank is classified as a Type III MSD.

Recommendation

Rather than installing a Type II MSD, maintaining it and discharging treated water into the river, the authors of this paper recommend the installation of Type III MSD, which is a holding tank with sufficient capacity to endure average and peak capacities, and to routinely discharge the tank to a certified shore-based facility.

The Clean Air Act of 1970

Overview

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

Section 177 of the CAA grants the ability for states to adopt California emission standards instead of federal ones. As of August 2019, 13 states have adopted the California standards, including Oregon and Washington (2009).

Engines

Under the CAA, the EPA has adopted the International Maritime Organization's (IMO) exhaust emission standards for marine diesel engines. These rules also apply to domestic emission standards and to diesel engines installed on U.S. vessels. The EPA categorizes the use of diesel engines in a marine environment as "off road diesel engines."

The standard for off-road diesel engines (including marine) are established in Tiers. Tiers 1-4 are designed to be implemented over time in order for the technology to be developed and industry to adjust. The Tiers are also implemented at different times and levels for different engine displacements and power outputs.[10]

Tier 1-3 - Advanced Engine Design

Tier 1 standards for equipment under 37 kW (50 hp) is the least stringent and progressively Tier 2 and Tier 3 standards have higher standards. The Tier 1-3 standards are met through advanced engine design. Tier 3 standards for Nitrogen Oxides and Hydrocarbons are similar to the 2004 standards for highway engines.

Tier 4 - Control Technologies

The Tier 4 standards require that emissions of PM and NOx be further reduced by about 90%. Such emission reductions can be achieved through the use of control technologies—including advanced exhaust gas aftertreatment—similar to those required by the 2007-2010 standards for highway engines. As noted above, in 2009, Oregon and Washington adopted the California standard.

Fuel

Ultra-Low Sulfur Diesel

The EPA mandated the use of ULSD fuel in highway diesel fuel engines equipped with advanced emission control systems built after 2007. These advanced emission control technologies were required for marine diesel engines in 2014.

Recommendation

For a used vessel, these regulations would not apply unless a major rebuild or repower is considered. Therefore, the emissions from the existing engines, depending on year of manufacture, could conform to Tier 0 through Tier 3.

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[10] Title 40 CFR Part 89

For newly constructed vessels, the vessel must be powered with engines certified as compliant with the applicable USA EPA requirements at the time the keel is laid. For the class/size of vessel considered and anticipated power requirements (under 800 hp per engine), it is expected that the engines will have to comply with Tier 3.

Marine Transportation Security Act (MTSA)

Overview

On November 25, 2002, Congress passed the Maritime Transportation Security Act of 2002 (MTSA), giving the Department of Homeland Security (DHS), and specifically the U.S. Coast Guard (USCG), the authority to regulate facilities and vessels located on or adjacent to waterways under U.S. jurisdiction.

Maritime Security

MARSEC (Maritime Security) is the three-tiered United States Coast Guard Maritime Security system (alert state) designed to easily communicate to the Coast Guard and the maritime industry pre-planned scalable responses for credible threats. The objective is to provide an assessment of possible terrorist activity within the maritime sectors of transportation, including threats to nautical facilities and vessels falling within the jurisdiction of the United States that could be targets of attack.

The three-tiered system is as follows and closely follows the Homeland Security Advisory System (HSAS):

Level 1 – Corresponds with HSAS code Green, Blue or Yellow - no threat.
Level 2 – Corresponds with HSAS code Orange - elevated threat.
Level 3 – Corresponds with HSAS code Red - imminent threat.

Facility Security Plans

A vessel carrying no more than 150 passengers for hire on domestic voyages is exempt from the requirements of the MTSA (33 CFR 104.105). Shore facilities accepting vessels carrying more than 150 passengers are required to have a Security Plan.

Alternative Security Programs (ASP) give groups of similar facilities an alternative way to comply with the Maritime Transportation Security Act (MTSA). An ASP is provided by the Passenger Vessel Association (PVA) for use by its members. Prior to implementing an ASP, members must demonstrate they are a "member in good standing" of the sponsoring organization and must complete a vulnerability assessment.

Recommendation

Due to cost considerations and associated liabilities, it is not recommended to ‘voluntarily’ comply with MTSA requirements. Additional recommendations can be found in Section 9 Personal and Public Safety to effectively address security concerns.

Americans with Disabilities Act (ADA)

Overview

The Americans with Disabilities Act (ADA) of 1990

The Americans with Disabilities Act (ADA) of 1990 is a comprehensive civil rights law that prohibits discrimination on the basis of disability. Title III of the ADA establishes requirements for the purchase and lease of vehicles operated by private entities, who are primarily engaged in the business of transporting people.

The United States Access Board

The United States Access Board is an independent federal agency that is structured to function as the coordinating body among federal agencies. The board is the leading source for information on accessibility and design.

In 1998, the Access Board established a 21-member advisory committee to provide recommendations to assist the Board in developing passenger vessel accessibility guidelines. The committee included disability organizations, industry trade groups, state and local government agencies, and passenger vessel operators. The result was a final report referred to as the Passenger Vessels Accessibility Guidelines (PVAG) which supplements the Board's ADA Accessibility Guidelines for Transportation Vehicles.

Passenger Vessels Accessibility Guidelines (PVAG)

The PVAG primarily focuses on access on board large passenger vessels such as cruise ships and large vehicle ferries. As stated earlier in this section, the Passenger Vessel Safety Act of 1993 establishes gross tonnage thresholds to distinguish a "Passenger Vessel" from "Small Passenger Vessels." As a result, provisions for small passenger vessels were proposed in December 2000 by the Passenger Vessel Access Advisory Committee (PVAAC) in Chapter 12 of their final report entitled, *Recommendations for Accessibility Guidelines for Passenger Vessels*.

These provisions generally address vessel embarkation and debarkation points, clear deck spaces and transfer seats, restrooms, accessible routes, transfer systems, and means of escape. These small vessel provisions were based on language similar to what is found in the Board's draft guidelines that address larger vessels, but were extensively modified to be compatible with smaller passenger vessels.

Passenger Vessel Association (PVA)

The Passenger Vessel Association, "the Voice of the Passenger Vessel Industry," is an organization dedicated to promoting the interests and economic well-being of U.S. passenger vessel owners and operators.

According to the PVA, as stated in their letter to members dated October 3, 2011, entitled "The Application of ADA to Service by Certain Commercial Passenger Vessels," vessel owners and operators have some degree of discretion to decide the most appropriate means of compliance. Furthermore, the letter states, "It is possible that a customer or a government official may not be satisfied with an operator's 'good faith' effort to interpret the rule and comply with it."

Applicability

The operator has identified customer experience as a top priority for the proposed passenger ferry and is convening a Passenger Experience Committee comprised of individuals who are disabled to help guide the design process.

Recommendations

It is recommended that the Passenger Experience Committee create a hierarchy of priorities (with safety as the first priority) to guide the design specifications process before creating a detailed rendering of the vessel. The guidelines proposed by the United States Access Board for small passenger vessels (Chapter 12 of the final report) should be evaluated and adopted to the extent that they are structurally and operationally feasible.

These priorities should be communicated frequently between the committee, the design staff and the operator (and other stakeholders) to ensure that ADA provisions are adequately understood.

Newly designed and constructed vessels should be evaluated separately from existing vessels. Alterations to existing vessels shall provide accessibility to an extent it is technically feasible.

Examples of technical infeasibility would include the existence of structural conditions that would require removing or altering a structural member, or because other existing constraints prohibit the modification or addition of elements, spaces or features.

Other exceptions include

- A re-admeasured tonnage that changes the regulatory classification;
- Changes in the stability of the vessel not meeting the applicable regulatory standards;
- Modifications that reduce the integrity (e.g., strength, and fire resistance) of a Class A or B bulkhead or deck; and
- An increase in power load in excess of the existing power supply.

For newly constructed vessels a design review is recommended. Some examples from the PVAAC's final report have been extracted in the table below to illustrate the necessary level of architectural and design planning.

Table 8:1 Sample ADA Vessel Design Requirements

Element	Example
Embark/Debark	At least one entry/departure point with a minimum clear width of 32 inches and an onboard maneuvering space of 60" x 60" or 42" x 80"
Clear Deck Space	For a vessel of 101 to 149 passengers 6x clear deck spaces 30" x 48" with wheelchair tie downs OR: 1. Not more than fifty percent of the requirement may be met with approved transfer seats. 2. If providing a clear deck space is not structurally or operationally feasible, a transfer platform and transfer seat instead of each clear deck space.
Restrooms	At least 1x restroom meeting the following provisions: 1. The entry door shall have a clear width of 32 inches (815 mm). The door shall be capable of being opened and closed by the occupant. 2. A maneuvering space 48 inches (1,220 mm) minimum in depth and 80 inches (2,030 mm) minimum in width shall be provided outside the entry door.
Accessible Route	Each element (Clear deck space or transfer seat) and space (restroom) must be accessible by the embark/debark point.

Section 9 Public Safety

Objective

This section will focus on the physical safety of passengers, the security of property and emerging infectious disease practices

Background

In 2020, the COVID-19 pandemic, combined with months of protests that have often erupted into riots, looting and the destruction of downtown properties have eroded public trust. The context of a violent incident involving TriMet transit passengers in 2017, has also had a profound impact on Portland region transit users.

Applicability

Personal and Public Safety

An examination of personal and public safety is important to the proposed ferry system because today's transit users experience a greater range of fear and anxiety for their own personal safety. Most Portland transit research in 2020 is focused on removing police from transit and evaluating how to de-escalate mental-health-related behaviors. The change in attitude is tied to bias, questions of equity, and frequent uncomfortable situations for passengers rather than significant events such as the fatal MAX stabbing.

The applicability of federal regulations regarding maritime security (MARSEC) as it relates to the Maritime Transportation Safety Act (MTSA) can be found in Section 8 – Regulatory Assessment of this paper. Of note, regulatory discussions regarding the MTSA refer to scalable responses to credible threats as they relate to terrorist activity within the maritime sectors and are not relevant to a discussion of non-terrorist activity.

Coronavirus

The Coronavirus pandemic of 2020, as a public health emergency, has been clearly identified as a personal and public safety issue and a top priority at every level. Today, any review of a ferry service must include an examination of the subject.

For the purposes of this feasibility study, the authors of this paper will provide an overview of the subject along with the current status of emerging protocols and mitigation strategies as they are being considered today.

Public Safety at the Terminal

Overview

A typical passenger experience starts with departing passengers being escorted up the access ramp, the crewmember unlocking the gate, releasing departing passengers and greeting awaiting passengers. Queued passengers gather at the primary access point or staging area until access to the vessel is granted; this is called a “store and forward model.” An assigned crewmember confirms boarding passes, grants access, and secures the gate when all passengers are loaded.

How long queued passengers experience a “wait” plays an important role in real and perceived safety and passenger comfort.

Today, contactless smart cards and mobile applications for transit fare payment reduce or eliminate passenger waiting times. Posted schedules and on time arrivals and departures also keep passenger waiting times at a minimum.

Responsibility

Vessel and facility owners and operators are ultimately responsible for the safety and security of their patrons and passengers. It is essential that a community outreach team comprised of residents, local “dock” communities, key employers, public safety officials and public transit agencies partner with the transit community and urban planners to seek a balance between passenger perceptions of safety and the actual operational safety precautions put into place to optimize customer safety.

Target Hardening

“Target hardening” is a term used when referring to the strengthening of the security at a particular location in order to reduce risk of criminal activity. Reinforcing areas of concern with a suite of protective measures can be very effective.

Examples of this approach include:

- Locks, gates and controlled entry
- Additional guards and added patrols
- K-9 units
- Closed circuit television with central monitoring
- Barrier to entry

Environmental Design

A proven method to enhance public safety is the use of environmental design strategies to deter crime and maintain a sense of community ownership.

Examples of environmental design strategies include:

- Maintaining a high freedom of movement for waiting passengers

- Keeping passenger loitering areas clean and well maintained
- Maximizing natural surveillance (foot traffic, passing traffic, overlooking windows, surrounding homes and businesses)
- Intelligent use of lighting
- Utilizing natural barriers or installing transparent weather barriers to reduce visual obstructions.

Emergency Communications and Mass Notification (Terminal)

Transit systems, colleges and universities, public parking lots and other public use spaces utilize call boxes and blue light stations with emergency telephones serve as a deterrent and help improve perceptions of safety and security. Solar powered options exist for use in remote locations and where power sources are available area platforms can be equipped with cameras and area lighting.

Figure 9:a Emergency call stations

Emergency Call Station

Solar Powered Platforms

Area Lighted Platforms

Recommendations

Develop objective criteria for judging levels of public safety (e.g., a simplified risk scorecard or list recommended safeguards). Then, in coordination with operational needs, create a Public Safety Plan for each terminal location that includes a blend of “target hardening” elements and environmental design strategies that balance each community’s sense of ownership and inclusion with safety precautions that optimize customer safety.

Given the Portland region’s recent concerns regarding personal and public safety, enhance the plan to include a security review for each proposed site that examines the cost and benefits of establishing a means of emergency communications and mass notification (emergency call tower or blue light station) at each terminal site.

Public Safety Protocols on the River

Overview

Staffing Levels and Security Sweeps

Unlike other modes of public transit, commercial passenger vessels have a required higher qualification for staffing levels. For example, whereas the legally minimum required staffing level for a bus may include only one operator, the minimum required staffing levels for the types of vessels and routes proposed in this report range from two to four crew members.

Protocols for the frequency of security sweeps on board the vessel can be addressed at the operational level. The main advantage to having additional crew is increased presence in passenger areas as well as improved emergency response capabilities

Proximity to Emergency Services

Ferry routes in the proposed area of operation are never far from land. If shoreside assistance is deemed necessary, the vessel Master, after making a determination, can quickly direct the vessel to a location with the most appropriate emergency resources.

Authority and Jurisdiction

The Multnomah County Sheriff’s Office

The Multnomah County Sheriff's Office River Patrol Unit partners with the Oregon State Marine Board, the Port of Portland and the United States Coast Guard to provide safe commercial and recreational access and passage in the area of operation.

The United States Coast Guard (USCG)

The USCG has federal responsibility under the Department of Homeland Security (DHS) for ensuring the safety, security and stewardship of the nation’s waters.

Emergency Communications and Mass Notification (Vessel)

Passenger vessels are normally equipped with redundant and multiple means to communicate and report threats that include alarms, radiotelephony and cellular communications. Protocols to coordinate response activities are often outlined in a response plan that includes procedures for notifying the appropriate authorities. The plan should include descriptions of the primary and secondary communication methods and which notifications will be made.

Recommendations

Identify public safety concerns on board the vessel while underway and compile a list of standards and policies that address them. Develop a security program that addresses preparation, prevention and response activities that will occur when a threat is present along with the stakeholders and personnel who are responsible for carrying out those activities.

Establish employee training criteria for each job title with curricula designed to meet public safety and concerns in the region. These criteria should include knowledge of current security threats and patterns and recognition of characteristic or behavior patterns of persons who are likely to threaten security.

Coronavirus

Overview

The world continues to address the challenges regarding COVID-19. Governments, health authorities and public transit organizations have been working hard to coordinate efforts to stop its spread. The situation is dynamic and changing and continued coordination with local, state and federal officials is necessary moving forward.

Interim Guidance

The Centers for Disease Control and Prevention (CDC) has provided Interim Guidance for Businesses and Employers Responding to Coronavirus Disease[11] as well as Employer Information for Bus Transit Operators.[12]

In Oregon, Governor Kate Brown has published Executive Order No. 20-27, ORS 443.441, ORS 433.443, ORS 431A.010 that provides guidance that applies to public transit agencies and providers. Frequently asked questions regarding public transit can be found at the Oregon Department of Transportation website.[13]

Recommendations

Develop, implement and operationalize plans to prevent, mitigate and respond to the spread of COVID-19 on board the ferry vessel. Incorporate preventive measures, including hand hygiene, physical distancing, wearing facemasks (or cloth face coverings) as well as cleaning and disinfection protocols into the plan.

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[11] *National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases. "Interim Guidance for Business and Employers." CDC, U.S. Department of Health & Human Services, 5 Aug. 2020, www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html.*

[12] *National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases. "COVID-19 Employer Information for Bus Transit Operators." CDC, U.S. Department of Health & Human Services, 5 Aug. 2020, www.cdc.gov/coronavirus/2019-ncov/community/organizations/bus-transit-operator.html.*

[13] *COVID-19 FAQs for Transit Providers." Oregon Department of Transportation, U.S. Department of Health & Human Services, www.oregon.gov/odot/RPTD/Pages/Coronavirus.aspx. Accessed 24 June 2020.*

Continuously monitor and evaluate emerging preventative measures geared toward transit operators. The American Public Transportation Association (APTA) has published a whitepaper entitled “Cleaning and Disinfecting Transit Vehicles and Facilities During a Contagious Virus Pandemic” that discusses a wide range of industry practices.

Nebulizers, misters and foggers are examples of disinfectant technologies being used on board transit vehicles as well as a variety of HVAC engineering controls addressing airflow, air pressure, filtration and UV treatment.

Ensure an assessment of the HVAC system is included in a tracking system or database of design requirements for the proposed ferry vessel.

Section 10 Route Assessment

Operational feasibility of a ferry service necessitates a detailed assessment of the route to identify potential risks or barriers and to verify distances and navigational restrictions in order to accurately determine transit speeds and calculate transit times. This information further informs dock and vessel requirements as well as schedule optimization.

A detailed route assessment can be found in Appendix A: Reconnaissance Report. This section highlights the most pertinent points as they apply to the feasibility of the route.

Core Route

As identified in Section 1 – Service Objectives and Description, the core route for the ferry service is from Vancouver, WA (Terminal 1) at its northernmost terminus to Lake Oswego, OR (Foothills Park) at its southernmost terminus. This route transits a short distance along the lower Columbia River and a majority of the lower Willamette River over a total distance of 21.6 nautical miles (nm).[14]

Figure 10:a Route Overview

Outside of the core route, the project team also assessed the route leg continuing up the Willamette from Lake Oswego to Oregon City for feasibility of running a ferry to Oregon City in the future, to parallel proposed plans for the Oregon City waterfront near Willamette Falls.

[14] All distances and speeds in this feasibility report utilize standard nautical measurements (nautical miles and knots, respectively) for consistency and ease of translation.

River Conditions

Introduction

Understanding the conditions on the rivers is critical to establishing feasibility of the route and identifying what is necessary to make a ferry service successful. This includes vessel features that will mitigate certain challenges, dock requirements and factors that will affect the optimization of the schedule. River routes are unique, with very different challenges than those typically encountered by ferry operations on bays, sounds or open waters. The following criteria were investigated in detail in Appendix A: Reconnaissance Report. The key points or influences of each on the route are described below.

Current

In this region, the Columbia and Willamette rivers are influenced by the tide, and the Willamette is also influenced by Columbia River discharge. During high flow in the Columbia, flow in the Willamette is backwatered and depending on Columbia elevations, flow can approach zero feet per second at times. As snowpack and rainfall are collected from a distant and large basin, flows in each river are highly independent. Flows in the Columbia are also set by water allocation, power demands, treaties, and fishery management, which are among some of the constraints. The predominant trend in river heights and current is that they tend to be lowest in September and October and highest in the Spring. Currents can vary significantly on the route throughout the course of the year.

Peak flows on the rivers can reach four to six knots, at extremes. The significance of current velocity on a ferry system is apparent in two primary areas. First, current affects the schedule by slowing the vessels when transiting upriver and provides a push going downriver. But this effect is not always equal on all vessels. This will create less reliable arrival times at all stops throughout the day. The best way to mitigate this effect is to design the vessel with additional power that is not normally required, but available to the operator when necessary to maintain a prescribed speed over the ground to maintain the schedule.

The second impact of excessive current is on the maneuvering ability of the vessel when arriving or departing a dock. Current, particularly when running perpendicular to the dock face, can increase the amount of time required to maneuver in and out of the dock. The best way to mitigate this effect is to avoid utilizing docks that are positioned perpendicular to the flow of current and to ensure the vessel is designed with adequate maneuverability at slow speeds.

River Debris

Debris on the rivers presents a considerable challenge to maintaining consistent and reliable ferry service. The amount of debris varies throughout the year, typically reaching a peak due to heavy rains and snow runoff during the early spring on the Willamette and on the Columbia in May.

The types of debris vary as well. Large deadheads[15] and sinkers[16] are an ever-present danger to small, higher speed vessels that are best suited for this type of ferry service. This larger class of debris can cause serious damage to a vessel's hull and propulsion or any other appendages below the waterline (rudders, foils, props, etc.). Smaller debris, including tree branches, twigs and garbage present a different challenge in their potential to cause damage to the vessel propulsion over time and clog seawater intakes and waterjet intakes. This smaller debris is more prevalent at high water and times of high runoff.

Regardless of the type of debris encountered, there are several procedural and equipment measures that can be taken to mitigate the risk. First and foremost, Rule 5 of the Inland Navigational Rules of the Road requires that "every vessel shall at all times maintain a proper lookout…so as to make a full appraisal of the situation and of the risk of collision." "Collision" should be interpreted to include risk of collision with other vessels, stranding or grounding, and other hazards to navigation. The duties of a look-out also include the detection of ships or aircraft in distress, shipwrecked persons, wrecks and debris.[17] Ensuring that look-outs are available (see Section 15 – Staffing Levels), properly trained and a standard Bridge Resource Management watch condition system is in place to ensure they are properly utilized, are critical mitigation measures to detect and avoid all types of debris. In addition, the Master must be experienced with the maneuvering characteristics of the vessel, the prevailing currents of the rivers under varying circumstances, and should always be well informed as to the current conditions on the rivers.

Several mitigation measures can be designed and built into the vessels. This includes reinforced hull plating and framing, particularly at the bows, equipping the vessels with night vision/low-light imaging cameras and using propulsion equipment that will be the least affected by debris (see Section 13 – Vessel Requirements).

Vertical Clearances

The limiting vertical clearance on the route (Steel Vertical Lift Bridge) is 26 feet at Columbia River Datum (CRD). At a river level of 0.0 feet CRD, there is 26 feet of vertical clearance for a vessel passing under the lower span of the Steel Bridge without a lift. A lift of the lower span (a railroad span used by Union Pacific and Amtrak and a pedestrian/bicycle walkway) requires advance notification and coordination with the railroad. When the river is at its highest of 16 feet, there is only 10 ft of vertical clearance. In these situations of high water, a bridge lift of the lower deck (rail bridge)

[15] A deadhead is a log or heavy timber floating nearly vertical, with little of its bulk showing above the surface.

[16] A sinker is a log that was resting on the bottom for years and may attain enough buoyancy to float just below the surface.

[17] International Maritime Organization (IMO) Recommendations on Navigational Watchkeeping

will be required. Note, with only the lower deck raised, the vertical clearance is 71 feet at CRD. It will never be necessary to raise the upper deck of the bridge.

An analysis of river height data collected by the US Geological Survey National Water Information System[18] for a 10-year period indicates that river levels can vary as much as 20 feet, with multiple peaks throughout the year at various times. Levels also vary drastically from year to year, with some years experiencing heavy rains and/or snow melt-off while others are not as extreme. *Table 10:1* is a summary of the total number of days per year, averaged over 10 years (2010 – 2019), that the river exceeded the indicated height.

Table 10:1 10-Year Average of Willamette River Heights

RIVER HT (CRD)	VERT. CL. (STEEL BR)	10-YR AVERAGE	
		DAYS/YR	%
10	16	45.5	12%
11	15	32.1	9%
12	14	23	6%
13	13	18.6	5%
14	12	11.2	3%

Based on this analysis, the maximum recommended overall vertical height (excluding retractable masts,[19] etc.) of the proposed vessel should be no greater than 14 ft above the design waterline (to accommodate river heights up to +12 ft CRD without a bridge lift). By doing so, approximately 6% of transits, on average, will require a bridge lift.

While limiting the vertical height of the vessels another 1 - 2 feet could reduce the average lifts to 3 - 5% of the transits, the impact on vessel design would be significant and is deemed to be infeasible. A maximum vertical height of 14 feet above the design waterline is considered to be achievable for vessels of the size and capacities proposed but will definitely limit any proposed design to a single passenger deck.

The height range of the rivers also impacts the design, construction and maintenance of docks on the rivers. Due to the nearly 20-foot vertical range in river heights throughout a given year, docks and gangways must be designed to accommodate the variation. This makes floating docks more feasible than hard piers but requires that they be designed

[18] https://waterdata.usgs.gov/usa/nwis/uv?site_no=14211720
[19] Requirements for the vertical positioning of masthead lights are described in detail in Annex 1 Part 2 of the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS).

and built to withstand the forces of a larger vessel alongside. Floating docks must also accommodate relatively long access ramps in order to maintain a reasonable slope at low water conditions. (See Section 8 – Regulatory Assessment for details on ADA requirements.)

Depth

The navigable waterways of the Columbia and Willamette rivers are maintained by the U.S. Army Corps of Engineers to ensure large ocean-going commercial vessels can safely navigate them. As such, depths in the main river channels exceed 40+ feet CRD. This is consistent as far up on the Willamette River as the Steel Vertical Lift Bridge. Beyond that, the river maintains depths greater than 20 ft all the way up to Oregon City, aside from some shoaling areas along the riverbanks. Vessels typical to this type of ferry service have drafts of 3 - 6 feet, so river depth is not a concern.

Vessel Traffic

Vessel traffic on the Columbia and Willamette rivers varies greatly. Both rivers are used by everything from non-motorized recreational craft to large ocean-going commercial vessels. Both rivers are popular among recreational users: stand-up paddleboarders, crew teams, kayakers, sailing vessels, wakeboarders/surfers, cruisers and fishermen. Recreational use varies depending on the season and the location. Commercial vessel traffic is more consistent throughout the year and more prevalent on the Columbia, but large ships are still present on the Willamette as far up as the Broadway Bascule Bridge.

The risks associated with vessel traffic vary greatly when considering several factors such as types of vessels and their maneuvering characteristics, relative experience of operators, volume of traffic and congestion, constraints of the navigational channel, environmental conditions, means of communication, and speed of advance. In the assessment of vessel traffic conditions on the rivers, a subjective Traffic Risk Rating (TRR) was assigned to each leg of the route. Table *10:2* Provides a summary of these relative risk ratings.

Table 10:2 Traffic Risk Ratings by Route Leg

ROUTE LEG	TRR[20]	KEY RISK FACTORS
Vancouver to Cathedral Park	3.5	Small craft, recreational fishermen
Cathedral Park to Convention Center	3.0	
Convention Center to Salmon Street	3.5	Small craft, high density, constrained channel
Salmon Street to OMSI	4.0	Small craft, high density, constrained channel, obstructions
OMSI to OHSU	4.0	Small craft, high density, non-motorized, constrained channel
OHSU to Milwaukie	3.5	Small craft, high density, cross traffic
Milwaukie to Lake Oswego	3.5	Small craft, blind corners/obstructions, constrained channel
Lake Oswego to Oregon City	4.0	Small craft, recreational fishermen, blind corners/obstructions, constrained channel

Operators of small passenger vessels such as those being contemplated for this ferry service are expected to follow the International and Inland Rules of the Road for navigation as they apply. They should also be aware of local conditions, practices and customs in order to act prudently and practice safe navigation. On the lower Columbia and Willamette rivers this includes navigating outside the federally maintained channel when water levels safely allow in order to mitigate close quarters situations with deep draft vessels that cannot react as quickly or safely navigate outside the channel themselves. It also includes taking extra precautions when navigating in restricted visibility, in particular when transiting designated Critical Maneuvering Areas (CMAs) or making way for deep draft vessels in narrow channels (in accordance with Rule 9, Narrow Channels).

The Harbor Safety Plan, published by the Lower Columbia Region Harbor Safety Committee,[21] provides further guidance on local navigation practices and customs.

Speed/Wake Restrictions

Speed limits and wake restrictions exist in designated areas on the rivers per local regulations. These regulations can be accessed via an interactive map at the following website:

https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=841da68081294bb2a6b50f93b1a12f05

[20] On a scale of 1 - 5 where (1) = relatively low risk and (5) = a very high risk.
[21] www.lcrhsc.org

Current Oregon State regulations establish rules for 'Slow-No Wake' zones on the waters within the state. The Oregon State Marine Board (OSMB) defines these zones.

> 250-010-0025
> Basic Rule for "Slow-No Wake"
> (1) No person shall operate a boat on the waters of this state in excess of a "slow-no wake" speed within 200 feet of a boat launch ramp, marina with a capacity for six or more moored vessels, floating home/boathouse moorage with six or more contiguous structures, and locations where persons are working at water level on floats, logs or waterway construction.
> (2) Section (1) of this rule does not apply to commercial vessels or vessels engaged in navigation on rivers where a speed in excess of "slow-no wake" is needed to ensure safe passage.
>
> Where, "Slow-No Wake" means operating a boat at the slowest speed necessary to maintain steerage and that reduces or eliminates waves that appear as white water behind the boat.

Section (2) of this rule cannot be interpreted as an exemption from the rule for commercial vessels as it only allows for speeds in excess of 'slow-no wake' when needed to ensure safe passage.

Regardless of local regulations, Rule 6 of the Inland Navigational Rules, requires that all vessels maintain a safe speed for the conditions. Similarly, Rule 2 of the Inland Navigational Rules, requires that all vessels be responsible for their own wake and the damage it could cause at all times. This applies to commercial and recreational vessels.

This report takes a close look at the impacts of speed and wake restrictions on the route, whether imposed by local regulation or deemed to be prudent operational practices. Generally speaking, the entire route is considered to be 'wake sensitive' due to current conditions or in anticipation of future uses and development along the rivers. It is recommended that the ferry operation utilize a vessel design that minimizes the wake energy produced, commonly referred to as Ultra Low Wake. This general condition is addressed in Section 13 – Vessel Requirements.

The areas of greatest concern for wake energy are as follows:

- Immediately north of Steel Bridge – a private moorage dock for small vessels on the west bank will require 'a slow bell'[22] to minimize wake.

[22] The act of slowing a vessel to a speed necessary to minimize its wake appropriately for the given circumstances is commonly referred to as 'a slow bell.'

Figure 10:b Low wake north of Steel Bridge

Figure 10:c Westbank seawall between Steel Bridge and Hawthorne Bridge

- Steel Bridge south to Hawthorne Bridge – sea wall on the west bank will not absorb wake and vessel traffic will require frequent slow bells. The relatively short distances between stops in this region will not allow a vessel to come up to full speed.

Figure 10:d Marinas and floating homes Stevens Point to Sellwood Bridge

- Stevens Point to Sellwood Bridge – a number of marinas and floating homes along this stretch will require a slow bell.

Hazards to Navigation

Generally speaking, the rivers are relatively free of major hazards to navigation beyond what is already discussed in this section, debris and traffic. There is shoaling in some areas, but they are not on the normal route and easily avoidable with prudent navigational practices and care.

Vessel operators should take caution in navigating the rivers, particularly at times of restricted visibility. Even without major hazards, there are still risks inherent to any ferry operation that require heightened situational awareness, training and established operational procedures to properly mitigate. These conditions are amplified on the Willamette River, particularly upstream of Ross Island where the river becomes increasingly constrained, has numerous blind spots, and the shorelines are heavily populated by homes with private docks.

Localized Weather

The weather in the Portland region is generally considered to be mild. Winters can be wet, with mild temperatures only occasionally dropping below freezing. Snow is not common and rarely results in much accumulation. Summer is also generally mild except when hotter, dry air from the interior of Oregon pushes in. Winds are generally light to moderate in strength with the occasional winter storm bringing high winds. Prevailing winds are from the southeast in Fall/Winter and the northwest in Spring/Summer. Ground fog (convection) is common in Fall and Spring as temperatures transition and represents the most consistent weather challenge to vessel operations.

Route Profile

A route profile incorporates distances between stops and calculates time underway at an average speed (accounting for maneuvering) and dwell time[23] at each stop.

For the core route, from Vancouver to Lake Oswego, Table *10:3* indicates the route profile before being corrected for slowdowns.

Table 10:3 Core Route without Slowdowns

LEG	DETAIL TIME	DEPART FROM	ARRIVE AT	DIST (nm)	SPD (kts)	TIME (hrs)	TIME (mins)
S1	23.1	Vancouver T1		8.85	24.0	0.369	22.1
			Cathedral Park			Dwell Time	3.0
S2	18.4	Cathedral Park		6.30	24.0	0.263	15.8
			Salmon Street			Dwell Time	3.0
S3	4.5	Salmon Street		1.05	24.0	0.044	2.6
			OHSU			Dwell Time	3.0
S4	18.9	OHSU		5.45	24.0	0.227	13.6
			Lake Oswego			Dwell Time	3.0
				0	0.0	0.000	0.0
				21.7		0.902	54.1
						Total Dwell Time	12.0
						Total Time	66.1

Total transit time, from departure at Vancouver to departure from Lake Oswego for the return (representing a full one-way trip), is approximately **66 minutes**.

Slowdowns for slow-no wake zones, vessel traffic, congestion, bridge transits and other anticipated conditions add time to each leg. The route profile in Table *10:4* accounts for these slowdowns in real-world conditions.

[23] Dwell time refers to the time a vessel spends at a scheduled stop without moving. Dwell time starts at "last line," meaning the last line used to secure the vessel to the dock is secure, and ends at "first line." Dwell time is calculated according to the passenger traffic expected to disembark and embark at each stop.

Table 10:4 Core Route with Slowdowns Due to Anticipated Conditions

LEG	DETAIL TIME	DEPART FROM	ARRIVE AT	DIST (nm)	SPD (kts)	TIME (hrs)	TIME (mins)
S1	23.1	Vancouver T1		8.85	23.0	0.385	23.1
			Cathedral Park			Dwell Time	3.0
S2	18.4	Cathedral Park		6.30	20.5	0.307	18.4
			Salmon Street			Dwell Time	3.0
S3	4.5	Salmon Street		1.05	14.0	0.075	4.5
			OHSU			Dwell Time	3.0
S4	18.9	OHSU		5.45	17.5	0.311	18.7
			Lake Oswego			Dwell Time	3.0
				0	0.0	0.000	0.0
				21.7		1.079	64.7
						Total Dwell Time	12.0
						Total Time	76.7

Total transit time, from departure at Vancouver to departure from Lake Oswego for the return (representing a full one-way trip), is approximately **77 minutes**. This transit time is achieved using a catamaran with an ultra low wake hull design. By contrast, a traditional hull design that was not optimized to drastically reduce the wake energy would require considerably more transit time.

In addition to the core route, recreational/discretionary routes can be served when other passenger needs are considered. These include destinations along the core route, such as the Moda Center/Oregon Convention Center, OMSI and Milwaukie. Outside the core route, Oregon City is classified as a potential discretionary route for future consideration. Details of the assessment of the Lake Oswego to Oregon City route leg can be found in Appendix A – Reconnaissance Report. Of particular note is that this section of the Willamette continues to become more constrained and contains several blind spots. It can contain considerable traffic from recreational users and private docks along the shoreline are prevalent.

Route Considerations

The route assessment identifies some key points that are salient to further discussion in other sections of this report.

Vessel Requirements (See also Section 13)

Currents on the rivers will require that the vessels have a fairly high maneuverability at low speeds. While some propulsion systems provide a higher degree of maneuverability than others, thrusters can also be used to supplement some systems.

Also due to currents, the vessels will need to have a service speed that utilizes only 80-85% of the maximum continuously rated power. The remaining reserve power will be necessary to make up for current effects.

Debris in the water presents a real risk to the vessels and passengers as well as to the reliability of the service. The vessels should be designed with mitigating factors, such as thicker hull plating and frames, and thermal imaging cameras.

The maximum vertical height of the vessels should not exceed 14 feet from the design waterline to minimize the number of required bridge lifts.

The vessel should use a hull shape optimized to produce minimal wake energy. Although slowdowns will not be entirely avoidable, lower wake energy produced at service speed will drastically reduce the time lost due to slowdowns.

Schedule Optimization (See also Section 11)

The conditions on the rivers vary greatly as you navigate further upstream. While the Columbia and lower Willamette rivers are relatively wide and straight, the upper Willamette becomes far more constrained and challenging. South of Ross Island to Oregon City, the river has numerous areas that are sensitive to wake, bends in the river that create blind spots and shallows to be avoided. These challenges create less confidence in the ability to maintain the schedule. One way to mitigate these challenges is to utilize a smaller vessel, producing less wake energy while being more maneuverable and responsive and less intrusive. To optimize a southern route, from Salmon Street to Lake Oswego, consider utilizing a class of smaller vessels.

Section 4 – Dock Requirements

Where possible, docks should be designed to lay parallel to the flow of the river. This will reduce maneuvering time in and out of the dock as well as minimize debris trapped against the face of the dock.

All docks should be assessed, modified or designed to ensure they meet applicable ADA requirements throughout the transfer of passengers from shore to the vessels.

Section 11 Schedule Optimization

Introduction

Trade-offs when optimizing ferry system schedules are complex, especially asymmetric[24] multi-destination routes that may not follow the same pattern throughout the day. The factors affecting these tradeoffs were examined closely in the route assessment and include vertical clearances, river debris, water depth, river current, vessel traffic, slowdown areas and more.

A goal of 30-minute headways was established in Section 1 Service Objectives. Further conclusions from Section 10 Route Assessment indicate challenging river conditions south of Ross Island resulting in a decreased level of confidence that predictable schedules can be maintained in that area. As such, the concept of using a second class of smaller vessels on the upper Willamette River was introduced as a solution. Splitting the route into two sections also keeps transit times under one hour.

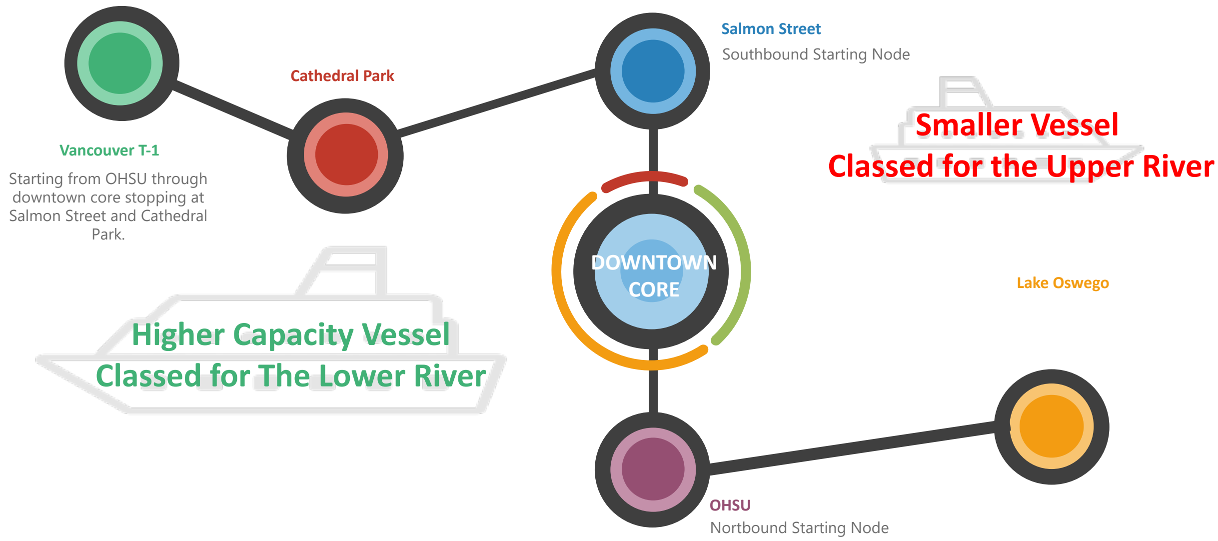
As a result, maximizing the benefits derived from modeling a simplified two-route hub and spoke model utilizing two classes of vessels are examined in this section:

- A lower river route, from OHSU to Vancouver, utilizing one class of vessel.
- An upper river route, from Salmon Street to Lake Oswego, utilizing a second class of vessel that is smaller and designed with the challenges of the route in mind.

A short overlap of both routes between OHSU and Salmon Street increases direct access to both destinations.

[24] Asymmetric routes are routes that vary by the number of stops, distance between each stop and the conditions encountered on each route. Asymmetric routes have different requirements and are not interchangeable.

Figure 11:a Simple hub and spoke model with two downtown starting nodes and two vessel classes



Schedule Optimization

Back-Up Vessel

Reliability is a key performance metric for any commuter-based ferry system. Having a back-up vessel in the system supports the reliability metric, as expressed in Section 1 - Service Objectives. Optimal intervals for planned and proactive maintenance onboard will be determined after the final vessel design has been established. These routines combined with unplanned maintenance, inspection requirements and haul-outs will ultimately divide the vessels' availability into discreet elements. Flexibility and capacity to meet overflow during peak demand periods, holidays and special events also support this need.

Transit Time

Transit time, defined as the elapsed time from when the vessel departs the dock of origination to when it departs the dock of destination for its return trip, is a critical measure for any ferry system. Transit times are weighed against competing modes of transit and are perceived by the target market as a key decision criterion. For FFF, a target transit time not to exceed 60 minutes has been established as a goal. A simple calculation of transit times using a service speed of 22 knots results in 58.3-minute transit times on the Lower River route and 30-minute transit times on the Upper River route. Table *11:2* and Table *11:3* below illustrate the route profile for each, respectively, to achieve these transit times.

As stated in the introduction to this section, trade-offs when optimizing ferry system schedules can be complex. The objective is to balance the "costs" of additional speed with the benefits gained in schedule. In this case, an analysis of the route profile at various service speeds indicates that the target goals for transit times can be met with 22 knots. The additional time that a 22 knot vessel requires to transit each route, when compared to a 24 knot vessel is 1.0 minutes for the Upper River Route and 3.2 minutes for the Lower River Route (Table *11:1* Transit Times).

Table 11:1 Transit Times

SERVICE SPEED	TRANSIT TIMES	
	UPPER RIVER	LOWER RIVER
22.0 kts	27.0 minutes	58.3 minutes
23.0 kts	26.4 minutes	56.7 minutes
24.0 kts	26.0 minutes	55.1 minutes
Transit Time Gained	**1.0 minute**	**3.2 minutes**

It is important to understand the costs associated with additional speed. In summary, they are as follows:

- As speed on a vessel increases, the power required for that speed increases exponentially. That increase in power triggers several cost factors:
    - Fuel consumption will increase exponentially
    - Emissions will increase exponentially
- Larger engines may be required, adding to the capital costs of the vessel, maintenance costs and further increasing the power required to move the (heavier) vessel through the water
- As hull speed increases, wake energy increases as well

A general rule of thumb in the ferry industry is to avoid designing for speed that you don't need. This is consistent with the analysis performed on this route and the optimization of the schedule. Therefore, a service speed of 22 knots is recommended.

Headway

Headway is defined as the interval between departures from any given terminal. Another way of interpreting the term is the maximum expected wait time for a passenger who may have missed a ferry.

When it takes approximately 60 minutes on the lower river route to transit from OHSU/ to Vancouver (Table *11:2*) then the maximum expected wait time for a passenger at OHSU is 120 minutes when only one vessel is in service, or the time it takes for the ferry to get to Vancouver and back (60 minutes each way = 120 minutes). If a second vessel is added, the maximum expected wait time is reduced to 60 minutes. Then, in order to maintain symmetric service schedules, two additional vessels must be added in order to reduce headways to 30 minutes. This increases the flexibility for commuters to integrate the ferry schedule into their commute.

Table 11:2 OHSU to Vancouver with Slowdowns Due to Anticipated Conditions

LEG	DETAIL TIME	DEPART FROM	ARRIVE AT	DIST (nm)	SPD (kts)	TIME (hrs)	TIME (mins)
S1		OHSU		1.05	14	.075	4.5
			Salmon Street			Dwell Time	3.0
S2		Salmon Street		6.3	19.3	.326	19.6
			Cathedral Park			Dwell Time	3.0
S3		Cathedral Park		8.85	21.1	.419	25.2
			Vancouver T-1			Dwell Time	3.0
				16.2		.82	49.3
						Total Dwell Time	9
						Total Time	58.3

For the Upper River route, it takes 30 minutes to transit from Salmon Street to Lake Oswego (Table *11:3*). Therefore, the maximum expected wait time for a passenger at Salmon Street is 60 minutes, or the time it takes for the ferry to get to Lake Oswego and back (30 minutes x 2). If a second vessel is added, the maximum expected wait time is reduced to 30 minutes, achieving the goal.

Table 11:3 Salmon Street to Lake Oswego with Slowdowns due to Anticipated Conditions

LEG	DETAIL TIME	DEPART FROM	ARRIVE AT	DIST (nm)	SPD (kts)	TIME (hrs)	TIME (mins)
S1		Salmon Street		1.04	14	.075	4.5
			OHSU			Dwell Time	3.0
S2		OHSU		5.45	16.8	.324	19.5
			Lake Oswego			Dwell Time	3.0
				6.5		.399	24.0
						Total Dwell Time	6
						Total Time	30.0

Recommendations

A detailed route assessment that identified challenging river conditions on the upper Willamette River combined with a goal of reducing transit times to less than one hour prompted an examination of splitting the route into two sections: an Upper River route and a Lower River route.

Unlike the common practice of using identical vessels on symmetric routes, operational considerations compel the use of smaller, more maneuverable vessels suitable for operating on the upper Willamette River.

In order to achieve the desired transit times, headways and reliability while supporting a 99% service capability, maintenance intervals and overflow a fleet size of seven vessels with the following assignments is recommended:

Table 11:4 Vessel Assignments

Class of Vessel	Quantity	Route
Lower River Class	4	OHSU to Vancouver
Upper River Class	2	Salmon Street to Lake Oswego
Upper River Class	1	Unspecified Back-Up Vessel

A phased approach to implementation is possible and may require additional schedule modeling.

Based on the schedule optimization identified in this section, a standard schedule that focuses on typically peak morning and afternoon/evening commute times can be used for modeling purposes. It is recommended that further demand modeling that focuses on market surveys and utilizes geolocation technology be performed to further align this schedule with market demand.

Section 12 Multimodal Ticket Integration

Overview

Multimodality, the use of more than one mode of transportation during a specified time period, is an important mechanism to reduce automobile dependence, assist with traffic mitigation, reduce greenhouse gas emissions, and reduce parking demand. Modes of transportation include ferries, buses, trains, light rail, on-demand rideshare such as Uber, subways, trollies as well as non-motorized transport such as walking, scooters and bicycling.

An important means of creating a seamless experience between transportation modes which incur a user fee or fare is through an integrated ticketing system. An integrated fare collection system across a multimodal transport network begins with fare collection at the customer interface and concludes with revenue distribution on the back end via a software platform.

Ticket integration refers to a fare collection and payment technology that is used across the various transportation modes and revenue distribution refers to flexible account management architectures that allow for multiple identifiers of fare payment. Ultimately this allows multiple types of fare collection systems to access the same customer account. For the customer it means one-stop shopping. A passenger may take a bus to a ferry stop, use one app for payment and have the perception of a cohesive and unified transit experience.

The proposed FFF service would provide multiple direct connections at each of its stops with transit links to TriMet bus and LRT routes, CTRAN bus routes and the Portland Streetcar routes.

Capabilities

The convergence of payment systems has been made easier due to the global trend of cloud-based processing, and the capability of multimodal ticket integration continues to grow with increased health and safety concerns. Contactless smart cards and mobile applications for transit fare payment are scalable with current technologies and advance fare collection is faster and can significantly reduce dwell times.

For example, a passenger may purchase a reloadable contactless smart card from a self-serve kiosk that is recognizable to a card reader on a bus, ferry, or train. The smart card can be reloaded using a mobile software application and read during a ticket inspection process using handheld card readers or card reader kiosks. For added convenience, card readers can be integrated to accept real time fare collection using contactless bank cards. After fare revenue is collected, an open and flexible central processing system manages revenue distribution through multiple identifiers.

Concerns regarding equity and accessibility to passengers who do have bank accounts or smartphones are legitimate. Any process of converting from cash and/or a legacy system to automated fare collection should include policy considerations for the passengers. For example, systems that allow users to load their smart cards with cash are helpful. In the end, a system architecture that allows for multiple identifiers does not distinguish between a government program, an employee program or a retail program.

Challenges to Establishing an Integrated Fare and Ticketing System

The financial arrangements that are used between transit providers to provide fare integration vary greatly. Some allow entry by riders of other systems at no additional charge and others charge a per passenger rate. Others are part of much larger and more complex service agreements. Some systems may be operated by different technology companies which do not use open platform interfaces and may not allow for fare integration.

Each system has its own policies and objectives for their fare schedules which may be incompatible with systems that may or may not provide direct connections with each other. For example, one transit provider may provide discounted fares for senior citizens and/or students, while another does not. Some systems, such as TriMet and CTRAN, may be able to rely on a greater number of operating funding opportunities to drive down fare prices, while others may be heavily reliant on the price of fares to make their systems viable.

In general, integrated fare systems are about cost and revenue sharing agreements, which are complicated by the cost of services provided and the revenues generated by each entity. These agreements define who receives what portion of the fare revenues that is necessary for integrating the fares. Integration requires a level of trust and cooperation to help transit agencies recoup their share of revenue from riders using their services.

In addition to the revenue transactions, each agency and their vendors (such as those who provide equipment, collect revenues, distribute funds, etc.) is bound by consumer privacy and trade secret laws which are essential considerations during integration efforts. Agencies collect significant volumes of fare data, particularly through electronic fare payment systems, and implement data management protocols to safeguard rider data and remove user IDs. Multiagency integration efforts require coordinating privacy policies among all partner organizations and ensuring sufficient privacy protection measures in the hardware and software used.

Further, fare payment options – which can include single or multiride tickets, stored value, period passes, card, or cash – are set by agencies pursuant to their fare policy. Fare collection methods (such as pay-on-board, proof-of-payment, or conductor validation) vary by mode, as some methods are more appropriate in particular circumstances. These collection methods both influence and are influenced by the specific payment technologies and fare media an agency adopts.

Finally, the choice of fare media accepted (e.g., cash, paper tickets, magnetic stripe cards, electronic smart cards, bankcards, and mobile ticketing) often requires balancing accessibility, interoperability with other transit services, equity (such as the ability for unbanked riders to purchase farecards and take transit), and the cost of producing fare media and any necessary technology like card readers.

Recommendations

For the purposes of this Operational Feasibility Study, the team has not prescribed a ticketing integration program with TriMet (or CTRAN or the City of Portland Streetcar program) because discussions have not yet taken place with those organizations about an integration program. Moreover, this report does not estimate the capital and operating costs essential to those discussions because the proposed service has yet to identify its fare policies, projected revenues, and/or experienced real-time costs.

If such a fare and ticket integration process is desired by the FFF and regional transit providers, the following summary guidance is suggested for initiating and completing that process.

Prioritize project goals. Each agency should identify and prioritize the goals they have for integration and reach a mutual agreement on them. There should also be mutual agreeing to the commitment of time and expense to do so.

Design adaptable fare systems. Ensure that the systems being integrated are adaptable and flexible with regard to how technologies evolve. Using different technologies can require many updates and changes to software and mainframe equipment, with resulting high cost.

Coordinate early and often with the agency staff who are responsible for fare collection and media. While fare collection at transit agencies constantly evolves each agency's fare payment system and structure provides different opportunities for integration. Achieving fare integration is more likely and feasible with a full and early understanding of the opportunities and limitations of both existing and future fare payment systems, as well as robust collaboration within the agency.

Recognize the utility of fare payment data. Fare payment systems are sometimes used to assist in modeling, assessing, or evaluating elements of a transportation network. Being able to access fare data is immensely useful for agencies to assess whether a service is useful to passengers, and whether or not to continue the service in the future.

Allow for multiple payment methods to increase equity in access. A true integrated system should ensure that standard fare media is able to be re-filled in various locations with cash and card and allow for additional methods of payment on-board such as pre-paid or credit cards. Doing so helps provide access to transportation services for un-or under-banked populations, or people who do not typically travel to locations where fare media are loaded with value.

Examples

Tri-County Metropolitan Transportation District of Oregon (TriMet), the Portland region's transit operator, has simplified their fare system with an open architecture to allow for greater flexibility and multiple vendors. This provides revenue tracking and distribution for bus transit, light rail and the Portland Streetcar, which all use the single HOP program.

Many prepaid commuter pass programs include ferries. Two of the most expansive and successful programs exist in Seattle and San Francisco and both have historically included marine transportation in their multimodal approach. Other successful programs include the Massachusetts Bay Transportation Authority's (MBTA) Charlie Card, Jackson Transit Authority's (JTA) My JTA Mobile Application, Long Beach Transit's Tap Card and London's Oyster Card.

Table 12:1 Integrated Commuter Pass Program Examples

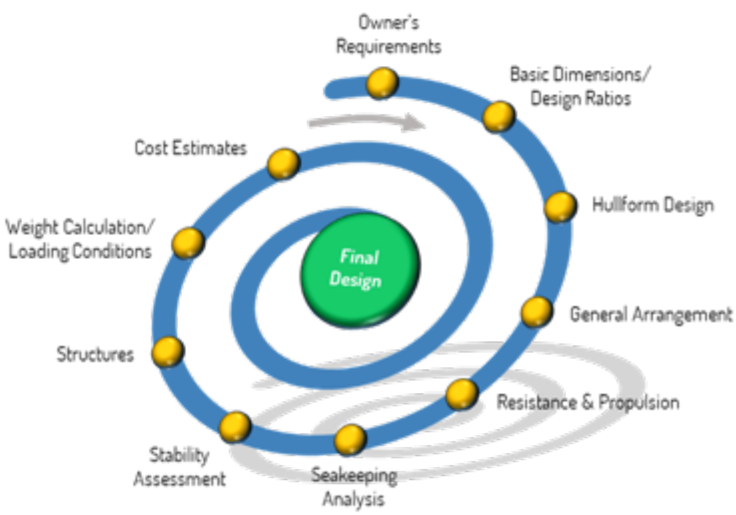
Location	Agency	Program	Includes Ferry Option
Portland, OR	Tri-County Metropolitan Transportation District of Oregon (TriMet)	HOP Card	No
Seattle, WA	Central Puget Sound Regional Fare Coordination Project (+10 Transit Agencies)	ORCA Card	Yes
San Francisco, CA	Metropolitans Transportation Commission (MTC +22 Transit Agencies)	Clipper Card	Yes
Long Beach, CA	Long Beach Transit	Tap Card	Yes
Jacksonville, FL	Jacksonville Transit Authority (JTA)	My JTA App	Yes
Boston, MA	Massachusetts Bay Transportation Authority (MBTA)	Charlie Card	Yes
London, England	Transport for London (TfL)	Oyster Card	Yes

Section 13 Vessel Requirements

The objective of this section is to define the minimum requirements of the base vessel necessary to accomplish the mission requirements as well as outline opportunities to further enhance or optimize the vessel.

The process by which vessel requirements and subsequent optimization is established is similar to the ship design spiral used by naval architects. In this approach, numerous variables that impact the design are considered simultaneously, at increasing levels of detail through each consecutive pass around the design spiral (Figure *13*:*a*). As further information is learned through the feasibility study, each variable becomes clearer in increasing detail. Subsequent trips around the design spiral capture new details that eventually become identified as ‘requirements.

Figure 13:a Standard ship design spiral



For this feasibility study, the primary categories that are analyzed through this process are:

- General Vessel Configuration
- Regulatory Requirements
- Principle Dimensions
- Performance
- Capacities
- Amenities

Information gleaned through the feasibility process directly impacts each of the primary categories. The sections of the feasibility study that most directly affect this process include service objectives and definition, dock interface, and the regulatory and route assessments. These sections define the base parameters that the vessel must comply with. Additional preferences are then defined by the service objectives (desires of the client and quality of service) and collective recommendations.

Defining the vessel is an evolving process. As additional information is collected, affected characteristics of the vessel are further defined and narrowed. This provides an ever-decreasing range for each parameter. Ultimately this range is pinpointed to specific parameters as capital considerations and technical limitations are applied.

Base Vessel Definition

General Vessel Configuration

The general vessel configuration establishes the primary parameters within which the vessel design and regulatory regime will fall. This is driven/limited primarily by the vessel mission, regulatory requirements and estimated capital expense.

At a minimum, to meet the FFF mission requirements (see Section 1 – Service Objectives and Definition) and regulatory requirements (see Section 8 – Regulatory Assessment), an aluminum-hulled catamaran, single-deck, diesel-driven small passenger vessel is required.

There are some key points that drive this base vessel configuration. These include:

- The need to provide point-to-point service on a schedule and with headways that come close to those of competing modes of transportation. This requires vessels that can achieve a service speed of 22 – 24 knots (considered a medium speed vessel[25]) consistently while still maintaining a low wake. Doing so requires a catamaran hull form (as opposed to a monohull), constructed of a light material such as aluminum or composite.
- Low wake wash energy at service speed is paramount. Section 10 – Route Assessment demonstrates the critical nature of maintaining a very low wake at all times on the river in order to maintain a schedule that meets the service objectives of 60-minute transits and 30-minute headways. Not all catamaran hull shapes are created equal. The design of the hull has a significant impact on the shape and energy of its wake. While many vessel designers will use terms such as ‘low wake’ and ‘ultra low wake’ to describe the wake properties of a particular hull form, these terms are not subject to a standard quantifier. Wake signature must be measured (energy created in joules and wake height in inches) during sea trials to quantify and accurately describe a vessel’s wake characteristics. The most common approach to minimizing the wake of a catamaran hull form is by spreading the displacement of the vessel over long, narrow hulls.
- Debris in the rivers (see Section 10 – Route Assessment) presents a significant risk to the ferry operation. This is a significant factor in the selection of propulsor and control for the vessel. A detailed analysis of three propulsor options (standard propellors, waterjets, and IPS azimuth drives) was undertaken in an

[25] Medium speed vessel – a general classification for vessels with service speed between 12 and 30 knots.

effort to identify the best option for this application (see Appendix B – Vessel Propulsor Alternatives).
- Vertical clearance limitations are very restrictive on the overall configuration of the vessel. The limiting height of 14 feet to reliably pass under the Steel Vertical Lift Bridge (see Section 10 – Route Assessment) without requiring a bridge lift essentially rules out a second passenger deck.

A vessel meeting these basic requirements could be constructed new or possibly sourced on the sale and lease market. The primary configuration requirement that will prove most challenging to meet with used vessels will be accommodating the vertical clearance restriction.

Balancing the capital expense of a new or used vessel meeting the minimum configuration requirements against potential operating efficiencies, amenity preferences and optimization factors introduces a range of options in hull shape, construction materials and propulsion. In particular, when taking into consideration critical characteristics such as seakeeping, vessel maneuverability and environmental impacts, the vessel definition process aids in identifying primary vessel characteristics that should exceed the minimum requirements.

The following table identifies the primary vessel configuration characteristics to consider in this application. For each, the minimum recommended requirement is identified as well as potential enhancements or optimizations influenced by the process.

Table 13:1 General Vessel Configuration

PARAMETER	DETAILS	MINIMUM	ENHANCED
Build Year	Suitable used vessel or new construction	2000 (~20 years), if available	New construction
Hull shape	Medium speed and low wake requirements make hull shape critical	Catamaran	Catamaran with narrow hulls, long waterline
Hull material	Medium speed and low wake requirements make hull materials critical	Aluminum or composite	
Builder	Must be built in the U.S.		
Designer	Experienced with similar designs and USCG Subchapter-T rules and required submissions		
Inspection	USCG Subchapter-T		
Flag	USA flag required on domestic routes		
Propulsion	Total power requirements (1000 – 1400 hp), simple and efficient, reliable	Twin diesel prime movers	Hybrid or all-electric
Drive and Control	Medium power requirements, simple and efficient, high maneuverability, reliable	Twin propellers with standard rudders	
Embarkation	Existing docks are all configured for side loading	Side loading	Bow and side loading for ultimate flexibility

Regulatory

In order to meet the minimum vessel requirements, the regulatory regime (as inspected and enforced by the U.S. Coast Guard) is well established and clear. This is fully described in Section 8 – Regulatory Assessment. The relevant regulatory elements have been summarized in the table below, with potential enhancements provided as well.

Key points that drive these parameters include:

- Meeting ADA guidelines for a passenger vessel (PVAG). These remain guidelines due to the inherent conflicts created with existing regulations. For example, door sill heights that impact the watertight integrity of the vessel create a barrier to access. While a vessel designed to a higher route and stability standard may have more inherent value, this must be balanced against the more stringent access issues it presents.
- Meeting USEPA emissions standards for marine diesel engines. With a proposed twin-diesel configuration, the vessel will require between 1,000 and 1,400 total horsepower to achieve the required service speeds (500 – 700 horsepower per engine). Engines of this size[26] are classified as a category C1 commercial engine and therefore must comply with Tier 3 standards for emissions.

Table 13:2 Vessel Requirements - Regulatory Elements

PARAMETER	DETAILS	MINIMUM	ENHANCED
Class	Non-class, USCG Subchapter T		
Route	Vessel designed and equipped according to anticipated operating route	River	
Stability	Vessel designed to meet specific intact and damage stability requirements	Protected	
Safe Manning	Certificate for operational crew	2	3
Gross Tonnage	Registered Gross Tonnage	< 100 GRT	
Accessibility	ADA Access	PVAG	Full ADA
Emissions	Propulsion and auxiliary engines (Used Vessel)	Tier 0	Tier 4
Emissions	Propulsion and auxiliary engines (New)	Tier 3	Tier 4

[26] There are several subcategories based on power density.

Principle Dimensions

The principle dimensions of the vessel include critical physical measurements; these are influenced by required capacities, speed requirements to reliably meet the intended schedule, physical restrictions such as water depth, vertical clearance, and interface with the docks. In this case, both minimum dimensions and maximum dimensions are provided in order to establish a range. The minimum dimensions are driven primarily by the intended mission of the vessel, for instance passenger capacity. By contrast, the maximum dimensions are restricted by physical characteristics and regulatory thresholds.

Key points that drive these parameters include:

- Maximum draft as limited by water depths. As relatively light draft vessels, there are no water depths along the route that present a concern or restriction.
- Vertical clearance of the Steel Vertical Lift Bridge, as identified above.
- Maximum size of the vessel to operate effectively (producing low wake energy) and safely on constrained waterways.

Table 13:3 Vessel Requirements – Principle Dimensions

PARAMETER	DETAILS	MINIMUM	MAXIMUM
Length Overall (LOA)	Controlling parameters are passenger capacity (minimum) and facilities (maximum).	60 ft.	100[27] ft.
Beam (Molded)	No restrictions, excessive beam could restrict some haul-out facilities.	20 ft.	30 ft.
Vertical Height	Design Load Water Line (DLWL) to top of highest fixed appendage.	N/A	14 ft.
Design Draft (Hull)	Keel to Design Load Water Line (DLWL)	2.5 ft.	4.5 ft.
Max Draft (with appendages)	Props, rudders or thrusters. On small vessels these appendages commonly extend below the keel and therefore add to the overall draft.	2.5 ft.	6.0 ft.
Freeboard	DLWL to main deck	2 ft.	4 ft.
Bow deck Freeboard	DLWL to bow deck	2 ft.	5 ft.
Loaded Displacement	Weight of the vessel in a fully loaded condition.	75,000 lbs	125,000 lbs

Performance

Vessel performance focuses on service speed[28] (as opposed to maximum speed), efficiency (fuel consumption per nautical mile) and environmental characteristics such as noise emissions and wake generation. Again, minimum requirements are driven by the base vessel mission. In the case of performance characteristics, maximum requirements are limited by either regulation, efficiency or recommended best practices.

Key points that drive these parameters include:

- Service speed provides additional margin to make up lost time and maintain the schedule when delays occur due to river current, traffic, debris, etc.

[27] Maximum LOA, Beam and Loaded Displacement are for the Columbia River and the lower Willamette River as far south as Ross Island. It is recommended that the upper Willamette River require lower maximums in these parameters.

[28] Service speed represents sustained speed under fully loaded conditions, typically at a reduced engine load profile such as 85% of the max continuous rating (MCR) for the engine.

- Interior and exterior noise levels are crucial to passenger comfort and health, the safety of the vessel, health of the crew and relations with the public impacted landside along the route.

Table 13:4 Vessel Requirements - Performance

PARAMETER	DETAILS	MINIMUM	MAXIMUM
Service speed	Loaded displacement @ 85% MCR	22 kts	24 kts
Fuel consumption	@ service speed	2.27 g/nm	2.92 g/nm
Noise levels	Pilothouse	-	65 dBA
@ service speed	Main deck passenger spaces	-	75 dBA
	Exterior decks	-	80 dBA
	External @ 100 meters	-	75 dBA
Wake wash	Wake energy @ service speed @ 100m	-	900 j/m
	Wake height @ service speed @ 100m	< 10 cm	20 – 25 cm

Capacities

Vessel capacities focus primarily on passengers, but also must consider additional subcategories of special passenger accommodations. In this case it is anticipated that some passengers in wheelchairs or with special needs will require specialized needs for space, storage and embarkation arrangements. Additional space for the storage of bicycles will also be required.

Capacity requirements also include the tankages necessary to support the vessel mission, in this case fuel, potable water and grey/black water. Each of these must be supported by the necessary logistics to load and off-load, the convenience of which influences endurance targets.

Key points that drive these parameters include:

- Passenger capacity as influenced by ridership demand and maximum headways.[29] These two factors must be balanced to determine the necessary passenger capacity of the vessels. See Section 11 – Schedule Optimization for detailed discussion on this topic. The upper limit of passenger capacity is established first by the regulatory threshold for 46 CFR Subchapter-T small passenger vessels of 150 passengers. Second, the passenger capacity is limited by the general vessel configuration and principle dimensions already established. The fact that the vessels will be limited to a length overall of 100 feet and a single deck will further limit the passenger capacity.
- Capacity to carry wheelchairs and bicycles. Both wheelchairs and bicycles require designated space, due to securing methods, that take away from space that otherwise could be designated for passengers.
- Sufficient tank capacity to achieve enough endurance while limiting weight carried onboard. Fuel, potable water and grey/black water storage should all be sized to allow the vessel to operate with a minimum number of required transfers.

Table 13:5 Vessel Requirements - Capacities

PARAMETER	DETAILS	MINIMUM	MAXIMUM
Passengers	Capacity for peak commute times	60	100
Bicycles	Capacity for bicycles (~10% of passengers)	6	10
Wheelchairs	Capacity for designated wheelchairs with tie-downs	1	2
Fuel	Endurance for a full day of operation	1 days	2 days
Potable Water	Sufficient for full day of operation	1 day	2 days
Grey/Black Water	Sufficient for full day of operation	1 day	2 days

Amenities

While vessel amenities may include a long list of important items, our focus begins with those items that have a material impact on the vessel configuration, general arrangement or power requirements. It is recommended that a secondary list of amenities that, while important, do not have a direct impact on any of these factors is generated separately.

[29] Headway is the time that elapses between departures from a single point.

Key points that drive these parameters include:

- Certain amenities are necessary to meet the service objectives. These amenities usually require a compromise or trade-off with other items due to weight control, space limitations or power requirements. HVAC is a prime example that includes all of those items, but in recent times during a pandemic, all forms of transit must consider a robust system to properly distribute and filter air.

Table 13:6 Vessel Requirements – Amenities

PARAMETER	DETAILS	MINIMUM	MAXIMUM
Cabin Environment	As appropriate for the local conditions	HVAC	HVAC
Restroom(s)	Restroom facilities (ADA accessible) recommended	1	2
Open Deck Space	Accessible to passengers	None	On main deck only
Concessions	Concessions include sales of food and beverages	None	Limited
Wi-Fi	As available for the local conditions	None	Complimentary

Optimization of Vessel

The first part of this section focused on establishing the base vessel requirements necessary to provide the service described in Section 1 – Service Objectives and Description. This, along with regulatory requirements, drives the primary requirements for the base vessel. Such drivers include maintaining low operating costs, attaining a schedule with no more than 60-minute transits and 30-minute headways, reducing emissions and improving community access. These base requirements are summarized in Table *13:7* below.

Table 13:7 Vessel Requirements – Base Vessel Summary

PARAMETER	SERVICE OBJECTIVE DRIVERS	REQUIREMENTS
Hull Shape	Schedule – 30-minute headways	Catamaran, ULW
Country of Origin	Regulatory	Built in the USA
Hull Material	Schedule – 30-minute headways	Aluminum or Composite
Passenger Decks	Vertical clearance limit – 14 feet	Single Deck
Propulsion	Regulatory, reduce emissions	Tier 3 Diesel
Drive and Control	Low operating expenses, reliability	Twin Props & Rudders
Service Speed	Schedule, low operating expenses	22 kts
Accessibility	Regulatory, community equity and access	PVAG
Passenger Capacity	Schedule – 30-minute headways	60 – 100
Bicycle Capacity	Community access	6 – 10
Restrooms	Community access	1 ADA

The only parameter above that has not yet been fully defined is passenger capacity, which is a function of the physical size of the vessel and public spaces required. As an operation adds more passengers, bicycle capacity, restrooms, concession spaces or other amenities, the physical size of the vessel grows. While the capacity is constrained by the vertical clearance requirement, it is still possible to fit everything that is desired in a vessel that doesn't exceed a vertical height of 14 feet above the design waterline. However, a vessel maximizing that and other parameters (Length Overall, Beam, Loaded Displacement) is too big to operate safely, effectively and efficiently on the upper region of the Willamette River. In light of these parameters, it is recommended that two separate classes of vessels be considered. The first class would be designed to maximize the capacities necessary for the Columbia and lower Willamette rivers while the second class would be smaller, designed to operate in the more constrained waters of the Willamette River above Ross Island. Table *13:8* summarizes these two vessel classes.

Table 13:8 Summary of Vessel Classes

PARAMETER	LOWER RIVER CLASS	UPPER RIVER CLASS
Length Overall	90 feet	65 feet
Beam	25 feet	20 feet
Vertical Height	14.0 feet	14.0 feet
Max Draft	4.5 feet	4.0 feet
Freeboard	3.0 feet	2.75 feet
Propulsion	1200 hp	1050 hp
Fuel Consumption	2.92 g/nm	2.27 g/nm
Passengers	100	70
Bicycles	10	7
Wheelchairs	2	2
Restrooms	2	1

Optimization Factors

There may be several areas where the vessels can be optimized to further attain or exceed the mission. These optimizations may require additional capital, add weight, conflict with other vessel features or require extensive engineering to implement. At this point these are recommendations and should be thoroughly vetted to ensure that they achieve the proposed benefits and do not create other conflicts.

Reduction of Emissions

Recent advances in technology have made it far more feasible to reduce carbon and nitrous oxide emissions, as well as particulate matter from marine diesel engines. With recent mandates to produce lower emissions in the maritime industry, engine manufacturers have already made considerable improvements in this regard by adhering to the phase-in, by tier, of EPA emission regulations. Currently, the diesel engines in the displacement and horsepower range that will most likely be used in these classes of vessels meet USEPA Tier 3 standards. Table *13:9* indicates the relative improvement of these diesel engines through this tiered program.

Table 13:9 EPA Exhaust Emission Standards for Category C1 Commercial Marine Engines

Tier	Model Year	Nitrous Oxide (g/kw-hr)	Hydrocarbons (g/kw-hr)	HC+NOx (g/kw-hr)	Particulate Matter (g/kw-hr)	Carbon Monoxide (g/kw-hr)
1	2004	9.8	-	-	-	-
2	2007	-	-	7.2	0.20	5.0
3	2018	-	-	5.6	0.11	5.0
4*	2017	1.8	0.19	-	0.04	5.0

*Tier 4 does not apply to engines under 600 kW (800 hp) total power. The Tier 4 standard in this table applies to the category of engines closest to what will be used in the vessels.

In addition to these improvements in emission standards, additional technologies are currently under development that, in the right application, further reduce emissions and reduce overall fuel consumption. But these technologies will not work under all conditions or in all applications. Following are some recommendations for consideration.

All Electric Propulsion: Electric drives are being developed to provide marine vessels with an alternative to diesel-only propulsion. An all-electric propulsion system could, in theory, result in a zero-emission vessel (depending on the source of electricity used for charging). In such a system, there are no diesel engines onboard the vessel (unless required by USCG for emergency back-up). Electric propulsion motors are powered by battery banks with sufficient amperage and charge to produce the necessary power for the duration of the transit, until sufficient time is allowed in the operating schedule to fully or partially recharge the batteries from a shoreside terminal. The challenge for these systems is the significant amount of battery storage required, particularly in smaller, high-speed vessels, to meet the demand. As battery technology improves at a rapid pace, this solution is becoming increasingly feasible.

Hybrid Propulsion: Hybrid drives utilize an onboard diesel engine to charge batteries and run electric motors for propulsion. These systems can be programmed to manage the power usage in order to maximize the output of the diesel engine, storing power in the batteries and only using direct power from the engine when necessary for higher speed operation. A plug-in hybrid system has the added benefit of charging batteries from shoreside terminals, further reducing the use of charging from the diesel engine. With more components, these systems can be heavier than a standard diesel-driven system, thereby requiring more power to propel the vessel at the same speed.

All-electric and hybrid systems can be designed as a custom installation to match the specific needs of a vessel and its route. Alternatively, several engine, electric motor, battery and controls manufacturers have teamed up to develop standardized systems that have output ranges for common applications. If one of these systems matches the demands of the ferry operation, it may be an easier and more effective solution. It is recommended that a feasibility study be performed to determine the applicability of either of these systems.

Renewables: Renewable fuel alternatives also provide potential reductions in emissions. Renewable fuels are produced from domestic feedstocks such as plant or animal products or wastes (i.e. soy, sunflower, algae or waste oils). The primary difference between 'biodiesel' and 'renewable diesel' begins with the processing method.

Biodiesel is referred to as a Fatty Acid Methyl Ester (FAME) and is produced by processing raw vegetable oil or animal fats through a chemical process called transesterification. As FAME is chemically distinct from petroleum diesel it has a separate ASTM standard.

Renewable diesel is also derived from similar biomass feed stocks, but processed by a method known as hydrotreating where hydrogen replaces sulfur, oxygen and nitrogen. This process yields several advantages over biodiesel, including fewer byproducts and waste, higher energy density and improved cold flow properties.

The primary benefit of using renewable fuels is the reduction of hydrocarbons, carbon monoxide and particulate matter. Depending on the production process and blend, renewable fuels can reduce carbon dioxide emissions by 20 - 60% over petroleum diesel.

While biodiesel may create additional fuel system maintenance or even void an engine manufacturer's warranty provisions, most renewable diesel products meet the same ASTM D975 standard as petroleum diesel and should not create the same problems.

Renewable diesel may provide a good opportunity for the ferry system to further reduce emissions without jeopardizing maintenance or reliability. It is recommended that this be investigated further by contacting other marine operators using renewable diesel products (not biodiesel) and identifying a local reliable source.

Customer Experience

While reliability is the primary factor that leads commuters to choose waterborne transit over other modes, the experience is a close second. A ferry ride on a properly designed vessel is more comfortable and enjoyable than most other forms of transportation. The views are generally good, there is room and freedom to get up and move around, and passengers can even go outside for fresh air. But there are other benefits that an optimized vessel can leverage to further attract and retain ridership.

Open deck space is a frequently undervalued amenity. While weather or conditions don't always allow for it, the ability for passengers to step outside and get fresh air and see the views even more clearly is a huge benefit. While these vessels are relatively small, and will be limited to a single deck, consideration to providing access to exterior decks should be considered.

Another amenity that adds value to both the passenger and the operator is concessions. With a minimum of twenty minutes on board, passengers will enjoy having the opportunity to purchase pre-packaged food items, beverages or other sundries. On a ferry system with high throughput and low fares, a concession can prove to be a significant revenue source.

While expensive, internal environmental control is an often-overlooked amenity. In recent times with airborne pathogens becoming a major concern of all modes of transportation, properly designed heating, ventilation and air conditioning (HVAC) systems are a necessity. Typically, the local climate dictates the HVAC needs for a ferry vessel. In the Portland region, heating and ventilation would be a necessity, but air conditioning may be optional if cooler marine air can be readily circulated through the ventilation system. With the very real potential for airborne pathogens being spread through transit modes, a properly engineered HVAC system with robust HEPA filtering is a new prerequisite.

Section 14 Capital Asset Procurement

Any ferry system can be highly capital intensive, usually consisting of shoreside facilities, real estate, vessels and other tangible assets. Developing a clear procurement strategy for these assets at the outset is critical to achieving value, forecasting capital requirements and establishing a realistic project schedule. This section will provide a general overview of what can be expected in development of a procurement strategy.

For the Friends of Frog Ferry (FFF) there are two primary categories of capital assets to be concerned with: shoreside assets (terminals and docks) and vessels.

Shoreside Assets

This study has assessed the condition and feasibility of several terminal sites and docks (existing and conceptual). In doing so, a wide range of recommendations has been made, from minor modifications to docks to terminal site preparation and new dock construction.

Due to ownership structures and user agreements, it is highly unlikely that FFF will own or procure any of these sites or structures. As is typical with ferry systems, whether publicly owned and operated, privately owned and operated or through a public-private partnership, these shoreside assets are rarely owned by the ferry operator or owner. Rather, individual assets are owned and developed by private or public entities and leased in part or exclusively to the ferry system. It is recommended that FFF utilize this standard strategy, remain engaged with site owners in the development of the sites and negotiate long-term lease agreements for their use.

Vessels

For vessel assets, there are essentially three options for ownership and two primary procurement strategies to consider. Any one of these (ownership and procurement) options will be largely influenced by the manner of financing utilized or the source of financing (i.e. institutional financing, grants), but for now we'll proceed under the assumption that those influences will apply equally to all.

Discussion of Ownership

Regarding the FFF ferry service, there are three fundamental ways for FFF to control the vessels for ferry operations: direct ownership, capital lease or vessel charter.

Direct Ownership

In this scenario, FFF would procure and own the vessels for the service. The vessels could be new construction or sourced on the sale and lease market (used vessels).

In the case of direct ownership, owners seek financing for the vessels and may hold the title outright or have a preferred ship mortgage and be considered the "operating owner."

Lease or Charter

If an entity had reason to not immediately own a vessel, but still wished to control its activities, it could lease or charter. While these terms (lease and charter) are frequently used interchangeably, for this discussion they are differentiated.

Lease

For this discussion, lease means a Capital Lease where the asset is leased from an institution, carried on the lessee's balance sheet, and is depreciated by the lessee. Generally, a Capital Lease decision is driven by particular needs and financial strategy.

Maritime Charter

When an entity wishes to utilize or control a vessel, but doesn't want, or can't immediately afford to own it, the entity can Charter a vessel.[30] Charter Hire is an expensed transaction and therefore the asset is not carried on the entity's balance sheet. There are two basic forms of charter: Bareboat and Time.

Bareboat (or Demise) Charter – which transfers the entire vessel, as well as the duties and risks of ownership to the Charterer balance sheet. In this scenario, the Charterer takes on full control of the vessel and its operation and navigation, including crew, insurance, consumables, technical management, regulatory compliance and others.

Time Charter – constitutes a contract to utilize the cargo capacity of a fully functioning vessel operated and managed by its owner. A time charterer enjoys the use of the vessel for a given time and under specific conditions as defined in the Charter Agreement.

Vessel Procurement

While it is always possible to source used vessels on the S&L market, the very specific parameters of these vessels (see Section 13 – Vessel Requirements) make it highly unlikely that a suitable used vessel could be identified on the domestic market, let alone several. This makes new construction the obvious choice.

For new construction there are typically two primary procurement methods: design-build and design-bid-build. Each has their advantages, depending on the nature of the vessels and preferences of the owner.

[30] The terms Lease and Charter are sometimes confused as being the same thing. In the cases of an Operating Lease and a Bareboat Charter they are similar. The key difference being an Operating Lease is normally structured as a financing vehicle (with a financial institution) for a relatively long term. On the other hand, a Bareboat Charter is more of a rental agreement established business to business, and generally for a shorter period.

Design-build

Under a standard design-build procurement the owner specifies the vessel mission, primary parameters that are critical (capacities, speed, regulatory) and requires bidders to propose a design solution that meets those requirements. Typically, for small passenger vessels, builders will team with a designer that they have experience with and propose a design that has already been completed, is near completion or will require little redesign effort to meet the requirements of the procurement. This approach transfers much of the design risk to the bidder.

Design-bid-build

A design-bid-build is a two-stage process where the owner first engages a designer (or designers) through a competitive procurement. The owner then works closely with the designer to design the vessel that meets their exact specifications and needs. For small passenger vessels this process typically starts with an existing design that is then customized to meet those needs, but sometimes it can be a new design from the keel up. This is all driven by the uniqueness of the design requirements. The second stage of this process is a competitive procurement of builders to bid on the design provided and provide some level of detail design and construction. This process places much of the design risk on the designer and owner.

Section 15 Staffing Levels

Staffing levels for a ferry service vary upon regulatory requirements, the mission of the service and the unique operating environment. Typically, it can be assumed that some basic functions are necessary, such as vessel operations, finance and administration, and human resources. But the needs for other functions, such as legal services, information technology and marketing and sales may vary greatly depending on the nature of the service and needs of the end-users. This section will investigate these functions and make recommendations on staffing levels, whether functions should be addressed in-house or subcontracted, and identify an organizational structure to fit the needs of the service.

Primary Functions in a Typical Ferry Service

The primary functional areas of roles and responsibilities for a typical ferry service such as that which is envisioned by Friends of Frog Ferry (FFF) include:

Leadership

Leadership includes the highest levels of management in the organization, commonly including a governing board. The leadership determines strategic direction for the organization and provides direction to the remaining functions to achieve those objectives. This function typically requires a high level of community and stakeholder interaction.

Operations

Operations includes vessel operations and maintenance. It can also include terminal operations and maintenance. Operation's primary mandate is the day-to-day execution of the service's mission.

Human Resources

Human resources provide staffing, employee development, employee relations and is instrumental in establishing, reinforcing and maintaining the organizational culture.

Legal

Any organization, regardless of size or services provided, requires some level of legal counsel. These requirements can cover a broad spectrum of the law, including all three major categories of common law: civil, criminal and administrative.

Marketing and Sales

Marketing and sales work in tandem to communicate the advantages of the service to the targeted market segments and then capture their business. This process requires market research, community outreach, multiple forms of communication and identifying and defining service changes.

Customer Experience

In any service industry, the customer experience is paramount. As a function, customer experience integrates closely with the marketing function to define the service and respond to customer needs, then ensures this translates effectively to the execution by operations.

Finance

Finance and accounting are a critical support function of any ferry service. Beyond managing accounts payable and receivable, this function also provides valuable reporting to the leadership, supports valuable grant applications and manages cash flows and taxes.

Information Technology

As technology has become such an important part of daily life and how any business is run, the IT function supports the entire organization with development of tools to better deliver the service, reach the customers and provide up to the minute updates.

Safety, Quality and Environmental (SQE)

SQE management is critical to the success of any ferry service. The SQE function develops, implements and actively manages systems that ensure compliance and constantly work to reduce risks.

In-house Staffing vs Contract

Staffing levels begin with establishing the demand and then developing a strategy for meeting that demand based on the resources the organization has. Typically, this comes down to a question of effectiveness and efficiency, which are not necessarily mutually exclusive. Is it more effective to meet a staffing demand by hiring an employee to address it, or would it be more effective to contract the effort to an outside firm? This section will establish the needs, based on the vision of the ferry service, and make recommendations as to staffing levels necessary to meet the needs and the most effective approach.

Service Demands

In order to provide the level of service as described in Section 1 – Service Objectives and Description, the organization will require approximately 270 vessel operating hours per week, at a minimum. In order to meet this demand, the organization will require sufficient resources to support all of the functions listed above.

Staffing Levels (FTEs)

Staffing levels for an organization designed to provide the service intended are best shown in Full Time Equivalent (FTE) units where one FTE is equal to one 8-hour day or 2,080 hours per year. Most of the operational positions will be hourly and will require flexible schedules with some days requiring up to 12 hours and some days being as short as 4 hours, as needed to meet the demands of the schedule and other activities necessary to ensure delivery of the service.

Table 15:1 Full Time Employees

FUNCTION	JOB CATEGORY	FTEs REQUIRED
Leadership	Executive Director	1.0
	Executive Assistant	1.0
Operations	Director of Operations	1.0
	Port Captain	1.0
	Captains	6.25
	Senior Deckhands	6.25
	Deckhands	6.25
	Port Engineer	1.0
	Senior Mechanics	2.0
	Maintenance Technicians	4.0
Legal	Counsel	0.25 – 0.5
Human Resources	Human Resources Manager	1.0
	Human Resources Generalist	0.5
Marketing & Sales	Director of Marketing, Sales & Customer Experience	1.0
	Web Design and Social Media Manager	1.0
	Public and Government Relations	0.25 – 0.5
	Customer Experience Representatives	3.5
Finance & Admin	Director of Finance & Admin	1.0
	Accounting Manager	1.0
Information Technology	IT Manager	1.0
Safety, Quality & Environment	SQE Director	1.0
	Total FTEs	**41.5**

Staffing Notes

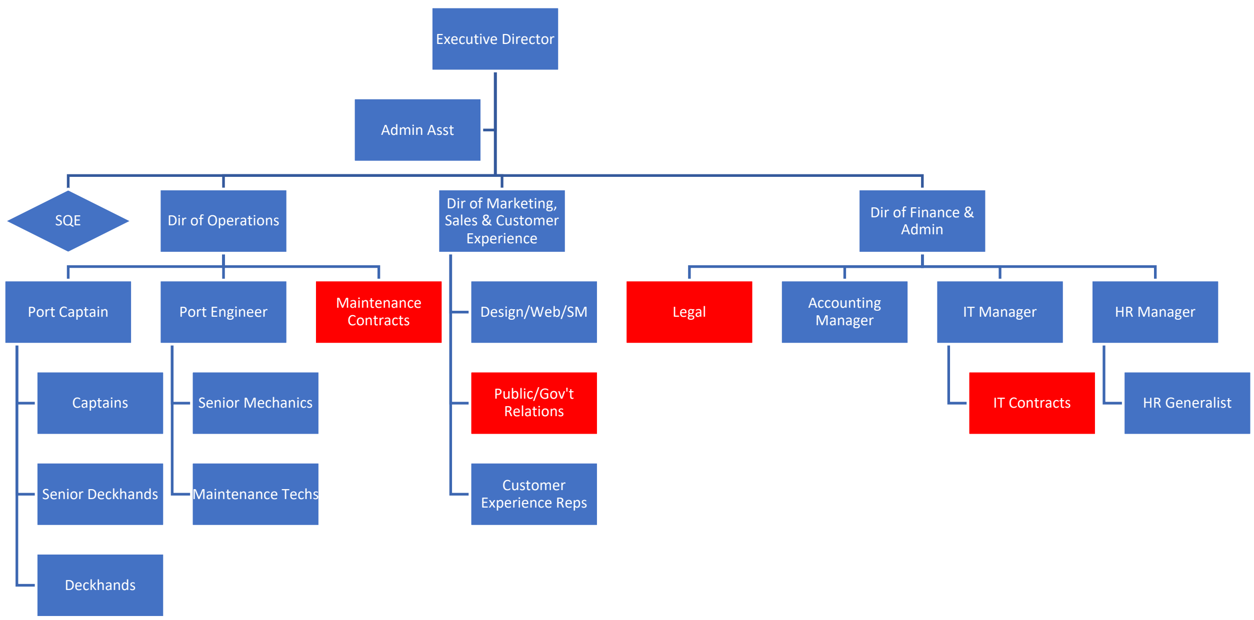
1. A key alternative to this staffing strategy would be to outsource all vessel operations to a third-party vessel manager with experience operating and managing ferries. This alternative is explored further in Section 16 – Management Options.
2. The Director of Operations is responsible for any terminal maintenance required. Maintenance staff will be allocated as needed, but most terminal maintenance will be outsourced through maintenance contracts, managed by the Director of Operations.

3. Senior Deckhands, as per Navigation and Vessel Inspection Circular (NVIC) 1-91, typically would not be required on the proposed vessels (but that decision is ultimately left to the discretion of the OCMI). It is expected that the vessels will only be required to have a crew of (1) licensed Captain and (1) Deckhand. However, due to the operating conditions it is recommended that an additional crew member be carried and trained to the standard established by NVIC 1-91.
4. The Port Engineer is typically a day worker while Senior Mechanics and Maintenance Technicians are scheduled as teams to work day, night and weekend shifts to meet the maintenance needs and availability of the fleet. The Port Engineer or a Senior Mechanic should be on call at any time a vessel is underway to provide emergency troubleshooting support.
5. Legal needs will vary in amount and type of support required. While the ferry service is not large enough to support or need full time counsel, representation by a business (corporate) law firm that can then delegate to specialties (such as admiralty law) is recommended.
6. Customer Experience Representatives (CERs) will spend a majority of their time at the terminals to provide direct customer interface. Although the terminals are managed by the Director of Operations, the CERs should report to the Director of Sales, Marketing and Customer Experience.
7. Public and Government Relations require the depth and experience of a marketing firm, but the need probably doesn't warrant a full-time employee.
8. The IT Manager will be responsible for managing IT contractors for routine support and specific IT projects.
9. The SQE position is unique in responsibility and reporting. As a full-time employee, SQE will report functionally to the Director of Operations, but requires a direct line of reporting to the Executive Director as well.

Organizational Structure

Figure 15:a illustrates a standard organizational chart for the intended ferry service. There are numerous possible alternatives to this that may be more vertically oriented or may shift secondary responsibilities around. Ultimately, careful consideration should be given to the final organizational structure to ensure all functions properly served and clear lines of reporting are established.

Figure 15:a Organization Chart



Section 16 Management Options

Management of the ferry service is a strategic decision that will greatly impact the effectiveness of the system to function, meet its mission and achieve long-term sustainability.

Introduction

Management of the ferry operations is a highly specialized discipline, requiring extensive knowledge of vessel operations and maintenance, regulatory compliance and service delivery. Regardless of whether the vessels are owned, leased or chartered, there are two fundamental ways to manage and operate them: in-house or outsourced.

In-House Management

Provided an owner has the requisite knowledge and resources, in-house operation is likely the most cost-effective approach. It also carries the highest risk in that the ramifications of any mistakes or failures fall to the owner. For seasoned ferry operators, this risk is normal and acceptable.

Outsourced Management

There are two primary approaches to outsourcing marine operations: vessel management and marine transportation services.

Vessel Management Services

Under a Vessel Management agreement, a third-party contractor manages and operates a vessel owned or leased by the owner. Vessel management agreements can be structured so all duties, responsibilities and operational risks are borne by the third-party operator. To achieve an effective transfer of responsibility and risk to the third-party operator the agreement will generally be structured as all inclusive. That said, the most problematic risk to transfer to the operator is the risk of mechanical failures or latent defects (residing within the owners' vessel).

Marine Transportation Services

Marine Transportation services are truly "turn-key" in that the vessel operator is hired and provides all service aspects necessary to transport the cargo as agreed. Under this type of agreement FFF would be hiring turn-key movement of its passengers, with minimal responsibility outside of providing the terminals. The primary difference between a Marine Transportation agreement and a full-service Vessel Management agreement is the third-party operator provides its own vessels (under the Marine Transportation agreement) as opposed to using the owner-provided vessel under a Vessel Management agreement.

In the case of FFF, the preferred financial strategy and governance probably wouldn't support the vessel charter costs under a Marine Transportation agreement and therefore it will not be considered for further analysis in this section.

Comparison of Management Options

For FFF, a comparison of feasible management options (in-house operations vs vessel management) should first establish the scope of those services. In this case, the services being considered include:

- Operation of the vessels
- Managing vessel maintenance
- Managing facility maintenance
- Human resources (specific to the marine operations staff, vessel crews and maintenance staff)
- Safety, quality and environmental programs

Embedding a vessel manager into the organization also impacts the structure. By way of comparison, Figure 16:a Organizational Structure with In-House Operations and Figure *16*:*b* illustrate these differences.

Figure 16:a Organizational Structure with In-House Operations

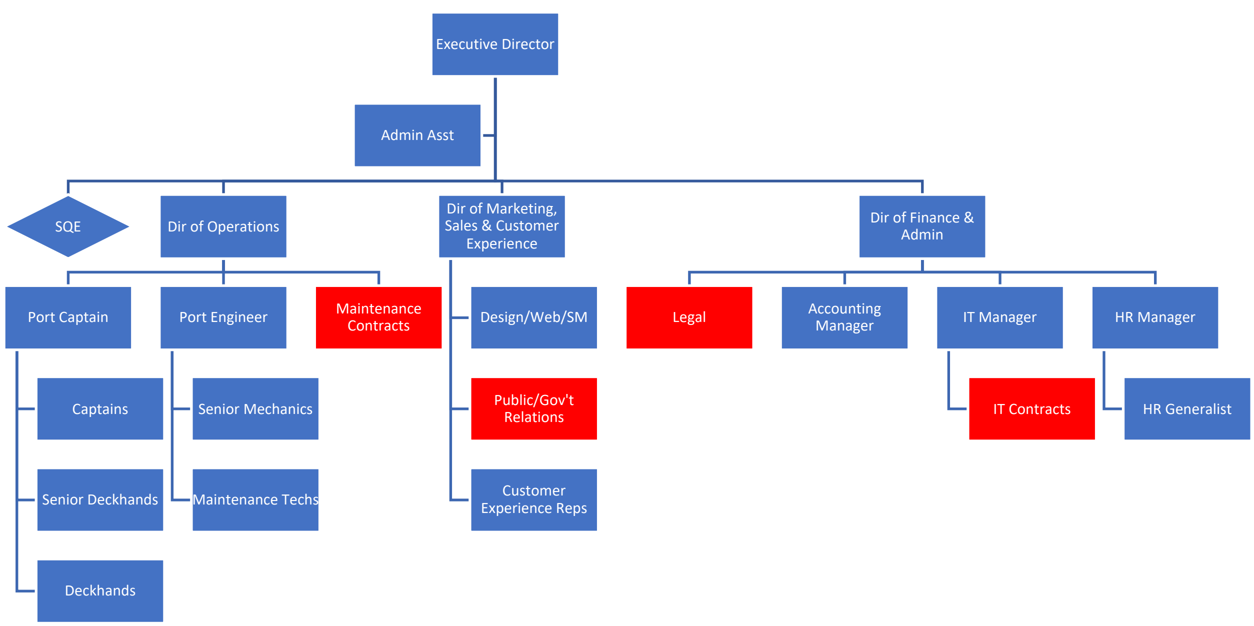
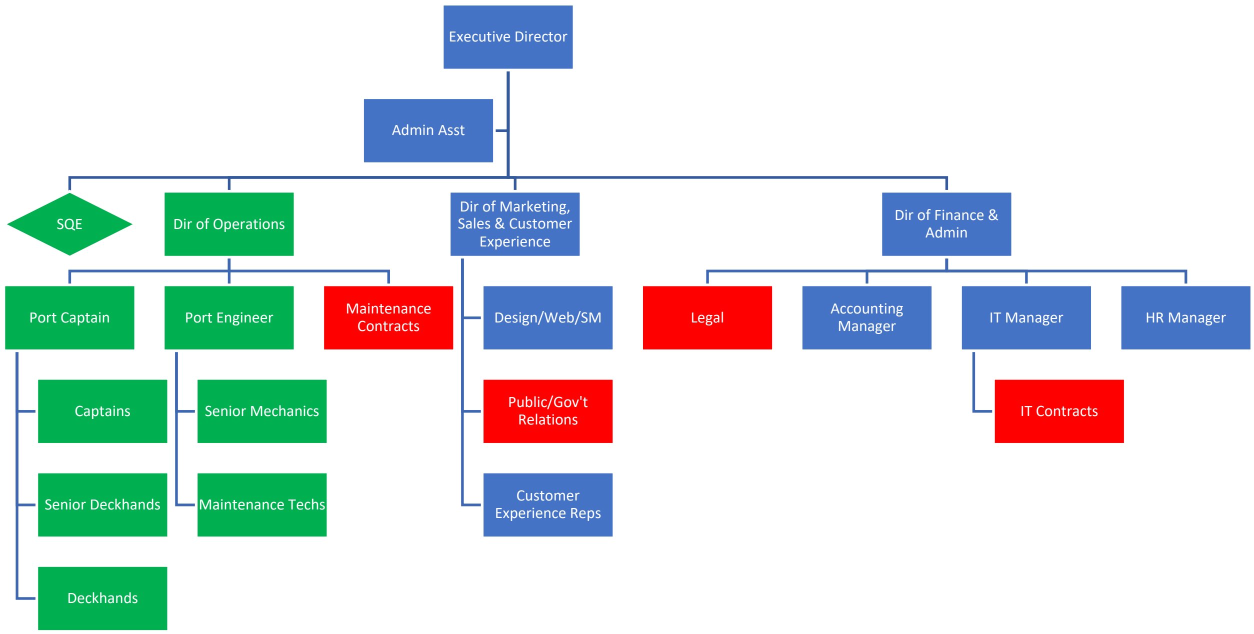


Figure 16:b Organizational Structure with Vessel Management Services



In comparing these two structures, the green positions in Figure *16:b* indicates employees of the vessel manager. There would likely be little to no difference in the total FTEs of those positions. However, this change would result in less human resource efforts for the owner as the majority of FTEs would become employees of the vessel manager.

When conducting a comparison of the two options, the primary focus is on three factors: relative cost, quality and risk.

Relative Cost

Most vessel management agreements are based on a cost-plus structure where the owner pays all of the operating costs plus an agreed-upon 'management fee' that includes all of the manager's overhead costs associated with the project and their profit. Incentives for reducing operating expenses can be built into the agreement, but regardless, all operating costs are transparent.

Some other operating expenses and overhead can be reduced through the use of a vessel manager. These include insurance, maintenance and safety management.

Quality

Due to the vessel manager's experience, one could expect that the quality of service and management would be higher from the beginning. This is simply due to the fact that the vessel manager has the experience and has built management systems that streamline their efforts while ensuring quality. In-house management would require a steep learning curve to attain the same level of quality.

Risk

For an experienced vessel manager, the operational risk is known and acceptable. For an owner who's new to vessel operations, to ferry operations in particular, the risk is largely unknown and will remain considerably higher until institutional knowledge and management systems can be built and implemented. This also applies to hiring risk, where an in-house operation is not as well equipped as a seasoned vessel manager to properly vet maritime employees.

Recommendation

Although a vessel management agreement would result in some increased costs, the benefit of reduced risk, higher reliability and quality of service far outweighs the expense. That being said, it is crucial that FFF utilize a competitive process in selecting a vessel manager that properly vets the bidders. Experience in ferry operations, not just any maritime operations, is critical. FFF should take care to structure a vessel management agreement that protects their interests while incentivizing their vessel manager to strive for high quality.

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Appendix A – Reconnaissance Report

RECONNAISSANCE REPORT

Operational Feasibility Study: Task 2

FRIENDS OF FROG FERRY

MARITIME CONSULTING PARTNERS

I. INTRODUCTION

The first phase of the Operational and Financial Feasibility Study is to collect relevant data and make observations pertaining to the ferry route, potential stops and necessary support services. The initial planning phase, prior to the reconnaissance is purely data based, relying on previous reports, published data and internet sources. This data is invaluable but needs to be verified under real-world conditions. The project team accomplished this by performing a reconnaissance of the route over the course of two days; one day on the river via boat and the one day by land. This Reconnaissance Report is a summary of the data collected by the project team through research performed in the planning phase that was subsequently verified, modified or updated as a result of real-world observations.

A. PURPOSE

The primary purpose of the Reconnaissance Report is to collect the observations made by the project team, organize them and summarize the team's findings and recommendations. A secondary purpose is to identify any critical barriers to implementation or changes in the direction of the study.

The Reconnaissance Report provides a guide to the team as it moves into the next phases of the feasibility study, ensuring all assumptions made are based on the same vision of the ferry system that is based on its technical feasibility.

II. METHODOLOGY

The methodology utilized for the reconnaissance consists of three basic phases; planning, conducting reconnaissance and merging data. Each phase is critical to the success and thoroughness of the reconnaissance, adding value to the feasibility study.

A. PLANNING

Prior to the actual reconnaissance, considerable planning was conducted to ensure that the most effective use of the team's time and efforts. This included extensive data investigation and review and development of a reconnaissance plan. The reconnaissance plan outlined the way by which the activities would be conducted, what general information would be collected, observed and verified and the key evaluation characteristics for terminal sites and docks.

B. CONDUCT OF RECONNAISSANCE

Conduct of the reconnaissance was established in the plan and shared with the project team. This plan communicated how the river runs would be conducted, specifying speeds and stops, in both directions (southbound and northbound). It also stipulated the data that would be gathered while underway and at each stop. Below is an excerpt from the reconnaissance plan:

The recon will be conducted over two days. One day will be on the water and will include a round-trip run up the Willamette and back, from Vancouver to Oregon City. For this run we will want to try to maintain 24 kts over the ground average speed during the run to Oregon City, not including approaches/departures and maneuvering at sites or slow bells for traffic or wake zones. On the return trip we will match RPM's to the upriver trip to give us a sense of the current impact.

For the second run we'll head back to Oregon City (speed won't matter) and stop at each site to gather info; pictures, soundings, confirm boundaries, inspect facilities, etc. I expect each stop will range from 10 – 15 minutes. We will not need to make any stops on the return unless we missed anything or want to investigate alternatives.

The second day will be land side. We'll drive to each site, checking transportation links, access and upland facilities / layout.

Like all plans, it is just a plan and changes can be made as circumstances allow or dictate. In the course of the actual reconnaissance, the project team elected to alter the approach and make one run on the river as opposed to two. This was made possible by utilizing two vessels simultaneously and shifting more of the dock observations to the second day by land. While the primary vessel focused on route timing and assessment, the second vessel was able to loiter longer at each terminal sight to collect water depth and dock data.

C. MERGING DATA

Members of the project team collected specific data throughout the course of the reconnaissance. This included photos, videos, research during planning, observations and notes. This data has been collated and merged into this report. This report and the data contained within is considered preliminary and unvetted. Over the course of the feasibility study the project team will use this report to identify gaps in available data, verify information and determine reasonable assumptions where possible.

III. OBSERVATIONS

A. ROUTE ASSESSMENT

A route assessment verifies distances between stops against those calculated on a nautical chart and the time needed to transit those distances at specific speeds. It also allows for simulated maneuvering and docking times as well as fluctuations in river current.

A route assessment also affords the project team a detailed look at the river conditions along the route. These include river heights and currents, traffic density and make-up, and hazards to the safe navigation of the river.

1. ROUTE DESCRIPTION

The general ferry route, as currently envisioned, is best described as a varying combination of route segments or legs that will be phased in over time through different stages and for different uses. Some legs will be a regular part of the commuter route, on a regular schedule, while others may only be utilized on an 'on demand' basis. This approach also lends itself to a flexible system that can grow and adjust with demand and changing ridership demographics and conditions. The table below identifies the route legs currently being considered as a part of the full route.

SOUTHBOUND

LEG	FROM	TO	DIST (nm)
S1	Vancouver	Cathedral Park	8.85
S2	Cathedral Park	Convention Center	5.6
S3	Convention Center	Salmon Street	0.75
S4	Salmon Street	OMSI	0.5
S5	OMSI	OHSU	0.55
S6	OHSU	Milwaukee	3.75
S7	Milwaukee	Lake Oswego	1.65
S8	Lake Oswego	Oregon City	4.85
Total Distance			**26.5**

NORTHBOUND

LEG	FROM	TO	DIST (nm)
N1	Oregon City	Lake Oswego	4.85
N2	Lake Oswego	Milwaukee	1.65
N3	Milwaukee	OHSU	3.75
N4	OHSU	OMSI	0.55
N5	OMSI	Salmon Street	0.5
N6	Salmon Street	Convention Center	0.75
N7	Convention Center	Cathedral Park	5.6
N8	Cathedral Park	Vancouver	8.85
Total Distance			**26.5**

2. GENERAL

Some general areas of observation that affect the whole route include the following:

a. Weather Conditions

The US Coast Pilot[1] describes general weather conditions in the Vancouver/Portland area as being influenced heavily by the surrounding mountain ranges as follows:

> *The coast range provides limited shielding from the maritime influence of the Pacific Ocean. The Cascade Range provides a steep high slope for the lifting moisture-laden westerly winds, which produces heavy rainfall in the western Cascade piedmont region. They also form the barrier for the Columbia River basin region and dry continental air masses. Airflow is usually northwest in Portland in spring and summer and southeast in fall and winter, interrupted occasionally by outbreaks of dry continental air east through Cascade passes and across ridge tops. When such an outbreak occurs, extreme high or low temperatures are usually experienced in the Portland area.*

Seasonal conditions are described as:

> *Portland has a very definite winter rainfall climate. About 88 percent of the annual total occurs in October through May, nine percent in June and September, while only 3 percent comes in July and August.*

For precipitation, the region experiences mostly rain, with only 17 days per year on average having snow and that snowfall being only a few inches at most.

Seasonal weather is clearly defined in the region, for the most part.

> *Winter is mild, cloudy and wet with southeast surface winds predominating. Summer is marked by mild temperature, with prevailing northwest winds and very little precipitation. Fall and spring are transitional in nature, with frequent periods of ground fog.*
>
> *In summer the hot, dry, continental air brings the highest temperatures. Extreme temperatures below zero are very infrequent.*

As for extreme weather, the region is relatively inactive:

> *Destructive storms are infrequent in the Portland area. Surface winds seldom exceed gale force. Thunderstorms are infrequent, occurring, on average, only seven days each year. Tornadoes with the funnel cloud reaching the ground are rare and there are rare occurrences of heavy*

[1] U.S Coast Pilot 10, Chapter 5

rain even though winter rains may persist for days at a time.

Weather conditions during the reconnaissance were consistent with prevailing patterns for July. The day was mostly sunny with good visibility on the water. Air temperatures were in the low to mid 80's Fahrenheit while the water was a cool 61 – 62 degrees on the Columbia River and 62 – 64 degrees on the Willamette River. Winds started out fairly light in the morning, but increased to 10 – 15 kts in certain areas on the river, mostly out of the northwest. Waves were typical for the wind conditions, ranging from flat calm to 1 ft in some parts of the Columbia.

b. River Conditions (Depths and Current)

The Columbia River and Willamette River use mean lower low water (mllw) during the lowest river stages for **Columbia River Datum** (CRD) from Harrington Point to Bonneville Dam on the Columbia and up to the Willamette Falls Locks on the Willamette for river depths. This datum applies to the entire route contemplated for the ferry system and explored during the reconnaissance.

According to data from the USGS Water Resources website, river levels fluctuate throughout the year on both rivers. High water tends to be in Spring and early Summer. River levels during this period often reach 15 feet above datum on the Columbia and 16 feet or higher on the Willamette. Extreme low waters on both rivers generally occur in the Fall (September to November) with mean low levels of 2 feet on both rivers and negative levels of -0.5 to -1.0 feet occurring for short periods, sporadically.

The significance of river heights is implicated in two primary aspects of the ferry system; the vertical clearance of bridges and the design and construction of docks. While river heights are somewhat predictable on an annual basis, the severity and daily fluctuations are not as reliable. Some years see moderate high levels while others bring extreme levels.

Water depth along the route, even at times of low water, is not a restrictive factor for the size of vessels intended for the system. At a conceptual maximum draft of 3 – 6 feet, the entire route can be easily run with plenty of water under the keel.

The limiting vertical clearance on the route (Steel Vertical Lift Bridge) is 26 feet at Columbia River Datum. This means that in the best scenario there is 26 feet of vertical clearance under this bridge. On the day of the reconnaissance, the Willamette river was at 7.5 feet, giving us 18.5 feet of vertical clearance (this was verified by the clearance gauge painted on the vertical bridge supports). When the river is at its highest of 16 feet, there is only 10 feet of vertical clearance. In these situations, a bridge lift will be required.

Due to the nearly 20-foot vertical range in river heights throughout a given year, docks and gangways must be designed to accommodate this variation. This makes floating docks more feasible than hard piers but requires that they be designed and built to withstand the forces of a larger vessel alongside. Floating docks must also accommodate relatively long access ramps in order to maintain a reasonable slope at low water conditions. (See Americans with Disabilities Act of 1990, ADA).

Various elevation baselines are used on the local rivers including Columbia River Datum (CRD), NGVD 29, City of Portland and local Gauge at a specific station. Conversions vary based on location, type and use. Some survey data reflects actual contour elevation and nautical charts typically reflect depth from a low water condition, thus the reader is cautioned against using data in this report for navigation or design. One of the more common datums used on the local rivers is CRD, which is a sloping datum that varies by river mile, with 0 typically being low water during low flow.

The river current over the course of the day varied by location and time. Both the Columbia and Willamette are influenced by the tide, and the Willamette is also influenced by Columbia River discharge. During high flow in the Columbia, flow in the Willamette is backwatered and depending on Columbia elevations, flow can approach 0 ft/sec at times. As snowpack and rainfall are collected from a distant and large basin, flows in each river are highly independent. Flows in the Columbia are also set by water allocation, power demands, treaties, and fishery management, as some of the constraints. The most general rule is the rivers and current will be lowest in September-October. All other times currents can vary significantly over the route.

Peak flows can reach 4 to 6 knots, at extremes. The significance of current velocity on a ferry system is apparent in two primary areas. First, current affects the schedule by slowing the vessels when transiting upriver and provides a push going downriver. But this effect is not always equal on all vessels. This will create less reliable arrival times at all stops throughout the day. The best way to mitigate this effect is to design the vessel with additional speed, not normally required, but available to the operator when needed.

The second effect of excessive current is on the maneuvering ability of the vessel when arriving or departing a dock. Current, particularly when running perpendicular to the dock face can increase the amount of time required to maneuver in and out of the dock. The best way to mitigate this effect is to avoid utilizing docks that are positioned perpendicular to the flow of current and to ensure the vessel is designed with considerable maneuverability at slow speeds.

c. Vessel Traffic

Vessel Traffic on the Columbia and Willamette rivers varies greatly. Both rivers experience everything from non-motorized recreational craft to large ocean-going commercial vessels. Both rivers are popular amongst recreational users; stand-up paddleboards, kayaks, sailing vessels, wakeboarders, cruisers and fishermen. The use of the rivers varies for recreational use depending on the season and the location. Commercial vessel traffic is more consistent throughout the year and more prevalent on the Columbia, but large ships are present on the Willamette as far up as the Broadway Bascule Bridge.

Operators of small passenger vessels such as those being contemplated for this ferry service are expected to follow the International and Inland Rules of the Road for navigation. They should also be aware of local conditions, practices and customs in order to act prudently and practice safe navigation. On the lower Columbia and Willamette rivers this includes navigating outside the federally maintained channel when water levels safely allow it in order to mitigate close quarters situations with deep draft vessels that cannot react as quickly or safely navigate outside the channel themselves. It also includes taking extra precautions when navigating in restricted visibility, in particular when transiting designated Critical Maneuvering Areas (CMAs) or making way for deep draft vessels in narrow channels (in accordance with Rule 9, Narrow Channels).

The Harbor Safety Plan, published by the Lower Columbia Region Harbor Safety Committee, provides further guidance on local navigation practices and customs. The latest revision can be found at www.lcrhsc.org *d. Speed/Wake*

Speed limits and wake restrictions exist in designated areas on the rivers as per local regulations. These regulations can be accessed via an interactive map at the following website:
https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=841da68081294bb2a6b50f93b1a12f05

Regardless of local regulations, Rule 6 of the Inland Navigational Rules, require that all vessels maintain a safe speed for the conditions. Similarly, Rule 2 of the Inland Navigational Rules, requires that all vessels be responsible for their own wake and the damage it could cause at all times. This applies to commercial and recreational vessels.

This report will look at the impacts of speed and wake restrictions on the route by each leg.

e. River Debris

At times throughout the year considerable debris can be found in the rivers. According to the US Coast Pilot:

> *Since logging is one of the main industries of the region, free floating logs and submerged deadheads or sinkers are a constant source of danger in the Columbia and Willamette Rivers. The danger is increased during spring freshets.*

Freshets, the flood of a river from heavy rain or melted snow, typically occur on the Columbia River in May but on the Willamette they begin earlier in the year. This results in a 'backwater' scenario when the Columbia reaches a peak rate of flow whereby considerable amounts of debris get 'trapped' in the lower Willamette where the currents meet.

This debris can be anywhere in size from a small stick (or large clumps of small sticks) to full-sized tree trunks. Either of these, and anything in between, can be hazardous to the safe navigation of the waterway. Small sticks can clog waterjets, jam rudders or damage props. Larger debris can damage any underwater appurtenances or cause severe hull damage.

3. BY ROUTE LEG

The following details are specific to each leg of the southbound route.

- **Transit Times** compare actual (including maneuvering/docking) times and averaged speeds versus those calculated during planning, which do not include slow-downs. All maneuvering/docking times consistently ranged between 30 – 60 seconds for arrivals and departures. All sites being considered have fairly straightforward, direct approaches without any lengthy slowdowns or maneuvering required. Reasons for any variations in transit times are noted.
- **Speed/Wake Zones** may be specifically regulated for an area or simply occur by necessity.
- **Vessel Traffic** summarizes typical traffic encountered on each leg. This will vary by season. A subjective **Traffic Risk Rating** (TRR) has been assigned to each leg, taking into account the traffic volume (at its peak), types of traffic and navigational restrictions. The TRR is assigned as a number from 1 – 5, with 5 representing the highest risk.
- **Current** also varies by leg, at different times of the year.

Items of concern or that present an unmitigated risk are in **red**.

a. *S1: Vancouver Terminal 1 to Cathedral Park*

Transit	**Distance**	**Speed**	**Time**
Calculated	8.85 nm	24.0	22 mins
Actual	8.85 nm	24.5	21 mins
Variations	Average speed was slightly higher than calculated due to weaker currents on the lower Willamette.		
Speed/Wake Zones	No restricted zones as per local regulations aside from within 200 ft of Cathedral Point. Typically, wouldn't expect speed reductions under normal circumstances other than for traffic.		
Vessel Traffic	Typically encounter ocean-going vessels underway or at anchor on the Columbia, some recreational traffic around Hayden Island, tug and barge traffic throughout the leg, large vessels transiting to terminals or shipyard on the Willamette and small craft fishing near Multnomah Channel and Cathedral Park. **TRR: 3.5**		
Hazards to Navigation	Debris can be found in both rivers. Severe shoaling at Kelley Point on Hayden Island (well-marked) and shoaling and obstructions near the mouth of Multnomah Channel (well outside the main channel).		
Current	The current in the Columbia around Vancouver varies between 0.5 and 2.0 kts, flowing west providing a slight push on this leg. At Kelley Pt the opposing current of the Willamette (gradual) begins to take effect.		

b. *S2: Cathedral Park to Convention Center*

Transit	Distance	Speed	Time
Calculated	5.6 nm	24.0	14 mins
Actual	5.6 nm	20.0	17 mins
Variations	Transit took longer than calculated due to a longer slowdown being required from just north of Steel Bridge to the dock.		
Speed/Wake Zones	No restricted zones as per local regulations aside from within 200 ft off Duckworth Dock, but the small boat pier on the west bank just north of Steel Bridge prudently requires a low wake.		
Vessel Traffic	Some commercial traffic transiting from/to Swan Island or terminals up the Willamette as far as the Steel Bridge. This includes ocean going vessels and tugs with barges in tow. Moving further up the river more and smaller recreational traffic is encountered, including non-motorized craft (paddleboards, kayaks). **TRR: 3.0**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. The only other hazard is the Steel Bridge which has a vertical clearance of 26 feet above datum (CRD).		
Current	The current in the Willamette varies depending on discharge rates and water level but is generally fairly moderate on this leg. The current flows northerly to the Columbia.		

c. S3: Convention Center to Salmon Street

Transit	Distance	Speed	Time
Calculated	0.75 nm	20.0	2 mins
Actual	0.75 nm	12.0	4 mins
Variations	Transit took longer than calculated due to longer slowdown departing Duckworth Dock and small boat traffic en route.		
Speed/Wake Zones	No restricted zones as per local regulations aside from within 200 ft of Duckworth Dock.		
Vessel Traffic	Commercial traffic above Steel Bridge is limited to passenger vessels and small tugs and construction barges. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft. There are also swimmers near several downtown beaches. **TRR: 3.5**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. The Burnside Bascule Bridge has a horizontal clearance of 205 feet between spans and the Morrison Bridge 209 feet between spans, requiring a prudent vessel operator to slow down in cases of traffic or low visibility.		
Current	The current in the Willamette varies depending on discharge rates and water level but is generally fairly moderate on this leg.		

d. S4: Salmon Street to OMSI

Transit	Distance	Speed	Time
Calculated	0.5 nm	18.0	2 mins
Actual	0.5 nm	6.0	5 mins
Variations	Transit took longer than calculated due to small boat traffic and an extended slow down past the swim dock and Riverplace Marina.		
Speed/Wake Zones	Local regulations require a slow-no wake zone within 200 feet of Riverplace Marina.		
Vessel Traffic	Commercial traffic above Steel Bridge is limited to passenger vessels and small tugs and construction barges. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft. **TRR: 4.0**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. Shoaling occurs on the west bank of the Willamette upriver from Riverplace Marina.		
Current	The current in the Willamette varies depending on discharge rates and water level but is generally fairly moderate on this leg.		

e. S5: OMSI to OHSU

Transit	Distance	Speed	Time
Calculated	0.55 nm	18.0	2 mins
Actual	0.55 nm	11.0	3 mins
Variations	Transit took longer than calculated due to a longer maneuvering time required in departing the OMSI dock.		
Speed/Wake Zones	There are no regulated wake or speed zones on this leg.		
Vessel Traffic	Commercial traffic above Steel Bridge is limited to passenger vessels and small tugs and construction barges. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft. There is a jet ski rental business on the east bank. **TRR: 4.0**		
Hazards to Navigation	Debris can be found in most parts of the Willamette.		
Current	The current in the Willamette varies depending on discharge rates and water level but is generally fairly moderate on this leg.		

f. S6: OHSU to Milwaukee

Transit	Distance	Speed	Time
Calculated	3.75 nm	24.0	10 mins
Actual	3.75 nm	12.0	19 mins
Variations	Transit took significantly longer than calculated due to several slowdowns, vessel traffic and a longer maneuvering time required in arriving at the Milwaukee dock.		
Speed/Wake Zones	There are several regulated wake or speed zones on this leg: • 5 mph speed limit within 100 feet of the Landing Boat Club (west bank near Toe Island) • 5 mph speed limit within 100 feet of Willamette Park & Sailing Club (west bank at Stevens Pt) • 5 mph speed limit within 100 feet of Oregon Yacht Club (east bank across from Stevens Pt) • No wake within 200 feet of the Macadam Bay Club Marina (west bank) • No wake within 200 feet of Sellwood Riverfront Park (east bank) • No wake within 200 feet of Waverly Marina (east bank) • No wake within 200 feet of Milwaukee Riverfront Park		
Vessel Traffic	Commercial traffic above OHSU is limited to sporadic passenger vessels and small tugs and construction barges. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft. **TRR: 3.5**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. More shoaling occurs on both banks of the river as you go further up. Most are well marked however there have been numerous groundings in the area known locally as the "Milwaukee Rock Garden".		
Current	The current in the Willamette varies depending on discharge rates and water level but is still fairly moderate on this leg.		

g. S7: Milwaukee to Lake Oswego

Transit	Distance	Speed	Time
Calculated	1.65 nm	22.0	5 mins
Actual	1.65 nm	16.5	6 mins
Variations	Transit took slightly longer than calculated due to some vessel traffic and a narrowing channel with blind spots around bends.		
Speed/Wake Zones	There are no regulated wake or speed zones on this leg other than no wake within 200 feet of Foothills Park (Lake Oswego). Note: while not specifically regulated, as the river narrows there are numerous private small boat docks along both banks that could be damaged by excessive wake energy.		
Vessel Traffic	Commercial traffic above Milwaukee is very limited. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft and fishermen either at anchor or underway or drifting. **TRR: 3.5**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. More shoaling occurs on both banks of the river as you go further up. Most are well marked, including a large submerged rock adjacent to George Rogers Park. (Marked by a white beacon, shown on chart 18528).		
Current	The current in the Willamette varies depending on discharge rates and water level and begins to increase noticeably on this leg.		

h. S8: Lake Oswego to Oregon City

Transit	**Distance**	**Speed**	**Time**
Calculated	4.85 nm	24.0	12 mins
Actual	4.85 nm	10.0	30 mins
Variations	Transit took considerably longer than calculated due to numerous slowdowns and a narrowing channel with blind spots around bends.		
Speed/Wake Zones	Note: while not specifically regulated, as the river narrows there are numerous private small boat docks along both banks that could be damaged by excessive wake energy.		
Vessel Traffic	Commercial traffic above Milwaukee is very limited. Continuing further up the river more and smaller recreational traffic is encountered, including non-motorized craft and fishermen either at anchor or underway or drifting. **TRR: 4.0**		
Hazards to Navigation	Debris can be found in most parts of the Willamette. More shoaling occurs on both banks of the river as you go further up. Most are well marked.		
Current	The current in the Willamette varies depending on discharge rates and water level and continues to increase noticeably on this leg.		

B. DOCKS / TERMINAL SITES

For each of the nine sites contemplated as a part of the ferry system, whether as a regular commuter stop or an on demand stop, an assessment was made of what currently exists, what changes or upgrades are needed, or what alternatives could be utilized.

For each site, the team evaluated both the terminal/uplands and the dock. Wherever a terminal or dock does not currently exist, the team attempted to identify what would be the most effective solution considering the information at hand.

1. VANCOUVER TERMINAL 1

a. Terminal 1

Terminal 1 Aerial during renovations

Terminal 1 rendering of planned redevelopment

General Description

The Port of Vancouver's Terminal 1 is currently undergoing a major renovation project as a part of the Port's waterfront development. https://www.discoverterminal1.com Vancouver is considered a key terminus stop on the ferry route in phase 2. The development plans of the waterfront present a good foundation for a public ferry terminal. This analysis is based on those plans.

Access/Egress

Under the current redevelopment plan, access/egress for the general vicinity of the dock will be good for pedestrians coming from multiple directions (parking structures, transit stops, bike paths, kiss and ride). The renovated amphitheater and surrounding area provide ample waiting space although without any protection from the weather.

Transportation Links (First and Last-mile Connections)

LINK	DETAILS

Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain. Columbia River Renaissance Trail to the east.
Bicycle / Scooter Share	None yet. Potential in near future.
Local Transit	C-TRAN stops within 0.5 miles
Car / Ride Share	Uber and Lyft
Kiss and Ride	Esther Street and Waterfront Way roundabout

Parking (Auto and Bike)

The current redevelopment plan includes some parking. Additional parking development is being considered by private entities.

Facilities

There do not appear to be any facilities specific to a ferry service in the redevelopment plan. That being said, the only need for a ferry system of this scope is an electronic ticket kiosk, signage and a covered waiting area.

Ownership

Terminal 1 is currently all property owned and operated by the Port of Vancouver USA.

Capital Improvements

The only necessary capital improvements to the current redevelopment plans include:

- covered waiting area
- electronic kiosk
- lighting
- signage (wayfinding)
- secure bicycle parking

b. Terminal 1 Floating Dock

Dock Description

Currently, an existing floating dock directly to the west of Terminal 1 is being considered for use by the ferry. However, there are some barriers to its use. In particular, it is designated as a public dock and would require some alterations to be safely utilized for the ferry service. The Port has indicated that it would work to resolve these issues.

As an alternative or perhaps preferred option, the inclusion of a ferry-specific dock in the waterfront development plan should be considered. For the time being however, this analysis addresses the existing dock.

Water Depths

The Terminal 1 dock is located in 30+ feet of water at CRD.

Exposure

The current floating dock lies in a west to east orientation, parallel to the north shore of the river. Its face is flush with the Terminal 1 hard pier and unprotected to the East, South and West. The greatest wind and wind wave exposure is from the east and west where the fetch is considerable.

Dimensions and Construction

The floating dock consists of a modular concrete/foam system with structural timber whalers. The dock is of high-quality construction, with internal piles alternating on either side. The general dimensions are as follows:

- linear dock face available for moorage – 180 feet
- clear width of pedestrian surface – 14 feet
- freeboard to deck – 1.75 feet

Access Ramps

The existing dock has one welded aluminum access ramp from the top of Terminal 1 hard pier (the amphitheater). The ramp has aluminum bulkheads with handrails on each side and is uncovered.

ADA

The Americans with Disabilities Act provides guidelines for passenger vessels (including gangways) to best accommodate individuals with disabilities. The ADA also mandates certain access requirements specific to docks and access ramps. The project team looked at each dock in relation to the major requirements (not fully inclusive of all requirements and guidelines) but until detailed design drawings can be attained compliance cannot be fully ascertained.

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Doubtful, need design to confirm

Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Compliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Compliant
Clear Width	The clear width of ramps shall be 36 inches minimum.	Non-compliant @ X inches clear
Landings	Level landings are required at doors and where ramps change direction.	Compliant
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Compliant

General Passenger Safety

Due to the dock's construction and overall width it provides a stable platform for ferry passengers to transit. There are no apparent tripping hazards. As it is a public dock, there are no railings on the outboard edges. There is no lighting or safety equipment (i.e. life-ring, swim ladder).

Dock Hardware

The dock has 6x6 timber bull-rails. This is sufficient for a commercial passenger vessel of the intended size.

Fendering

The current floating dock has no fendering.

Use Agreements

Aquatic Lands Enhancement Account (ALEA) grant?

Capital Improvements

Recommended capital improvements to the existing dock include:

- covered access ramp
- lighting
- safety equipment
- install sufficient fendering

As an alternative, it is recommended that the addition of a purpose-built ferry dock be considered in the redevelopment plan.

2. CATHEDRAL PARK

a. Cathedral Park Boat Launch

General Description

The Cathedral Park Boat Launch is a part of the City of Portland's Parks and Recreation department. The boat launch is located at the northwest end of the park, with a large parking lot for vehicles and boat trailers and two docks (west and east) situated on either side of the boat ramp.

Cathedral Park Boat Launch Property Lines

Access/Egress

Access/egress for the west dock is through the parking lot. Access/egress for the east dock is adjacent to the parking lot, following a paved sidewalk from the north and the Cathedral Park path to the east. Access/egress should be designed as to avoid pedestrian traffic crossing the active boat ramp.

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Urban streets, some with sidewalks. Terrain is hilly and active train tracks lay to the north. A shared roadway bicycle route extends down N. Burlington Avenue linking cyclists to the park via the Cathedral Park Trail.
Bicycle / Scooter Share	Cathedral Park is currently outside the boundary of the bike share program in Portland (BikeTown).
Local Transit	5 TriMet bus routes
Car / Ride Share	Uber and Lyft
Kiss and Ride	Either parking lot provides good opportunities

Parking (Auto and Bike)

There are currently two parking lots within Cathedral Park, a small lot (approximately 20 spaces) within a short walk to the boat launch, and a large lot (78 long pull-through spaces designed to accommodate vehicles with boat trailers) directly adjacent to the boat ramp. Some of these pull-through spaces could be reconfigured to accommodate standard vehicles, with each current space accommodating two vehicles. There is ample space for secure bike parking.

Facilities

There are public restrooms immediately adjacent to the boat launch parking lot. There is space for an electronic kiosk, covered waiting area, signage and bike parking.

Ownership

Cathedral Park is a part of the City of Portland Parks and Recreation Department.

Capital Improvements

The Cathedral Park terminal site will require the following capital improvements:

- electronic ticket kiosk
- signage (wayfinding)
- covered waiting area
- secure bicycle parking
- lighting
- designated parking/restriping

b. Floating Docks (Existing)

Dock Description

Currently, two floating docks are located on either side of the boat ramp. Both are floating docks, made of segments to provide for flexibility as they adjust to the level of the river. The docks are secured to a single row of pilings on the outboard side (away from the ramp). The west dock has a section (approximately 60 feet) at the end that is angled outward at about a 45-degree angle.

These docks are currently used by small recreational craft launching and staging at Cathedral Park.

Water Depths

The docks are built to access water depths between the 6 -foot and 30-foot curves at CRD.

Exposure

The current floating docks lie perpendicular to the flow of the river (except for the angled portion of the west dock). They are exposed primarily to wind and weather from the southwest to southeast with the southeast having the most wind fetch.

Dimensions and Construction

The general dimensions are as follows:

<u>West Dock</u>

- linear dock face available for moorage – varies based on water level
- clear width of pedestrian surface – 6 feet
- freeboard to deck – 1.25 feet

<u>East Dock</u>

- linear dock face available for moorage – varies based on water level
- clear width of pedestrian surface – 6 feet
- freeboard to deck – 1.25 feet

Access Ramps

There are no access ramps for either dock.

ADA

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Possible, need design to confirm
Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Noncompliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Compliant
Clear Width	The clear width of ramps shall be 36 inches minimum.	Not applicable
Landings	Level landings are required at doors and where ramps change direction.	Not applicable
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Not applicable

General Passenger Safety

Due to the docks' intended use as temporary mooring and staging for recreational fishermen, they are designed to flex with the slope of the riverbank as the height of the river varies. This necessitates several 'joints' between dock sections that are bridged by steel plates, which could pose tripping hazards. The docks are not very wide or stable and therefore not suitable for ferry passengers to transit as designed and constructed. There is not lighting or safety equipment. As they are public docks, there are no railings on the outboard edges.

Dock Hardware

The docks are equipped with bull-rails of 4x4 treated timber. This is insufficient for a commercial passenger vessel of the intended size.

Fendering

The current floating docks have no fendering.

Use Agreements

Oregon State Marine Board (OSMB) Grant

Capital Improvements

Recommended capital improvements to the existing dock include replacement with a wider, more substantial floating dock with a designated section for the ferry to land at the end of the east dock in deeper water. It is recommended that this section be turned perpendicular to the main dock, parallel to the flow of the river. The ferry landing should be equipped with the following:

- lighting
- safety equipment
- cast cleats or bollards
- fendering

Alternatively, a new dock designed and designated exclusively for ferry use could be built to the northwest of the existing docks.

3. CONVENTION CENTER

a. Convention Center

General Description

The Convention Center is a central hub for events. It is not so much a terminal site as it is a destination for activities. The Duckworth Dock is a .5-mile walk from the Convention Center, Moda Center and the rest of the Rose Quarter. As such, the actual terminal site is better identified as the Vera Katz Eastbank Esplanade as an ‘open’ terminal in concept.

It is not the intent of the system to utilize the Convention Center as a regular commuter stop or as a part of the regular ferry schedule, but rather as on-demand service specific to scheduled events. Therefore, the demands on the terminal differ from those of a standard transit terminal.

Access/Egress

Access/egress for the dock (Duckworth Dock) is along the Eastbank Esplanade which runs north and south along the east bank of the river. A short walk to the north leads you to a pedestrian overpass that will take you over the train tracks to access the Rose Quarter. A longer walk or bike ride to the south along the esplanade will take you to Tilikum Crossing and OMSI.

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Eastbank Esplanade is a non-motorized, multi-use path that runs in a north-south direction along the east bank for 1.5 miles.
Bicycle / Scooter Share	Several BikeTown hubs can be located to the north.
Local Transit	Four lines of the light rail (MAX) and six TriMet bus lines
Car / Ride Share	Uber and Lyft. Three Zipcar stations within 1 mile.
Kiss and Ride	Nothing within close proximity

Parking (Auto and Bike)

There are several reserved parking areas in the vicinity of the Oregon Convention Center. There are no identified secure bicycle parking facilities.

Facilities

While there is no designated terminal site close to the dock, the intent to use the Oregon Convention Center stop for on demand use negates the need for standard terminal facilities.

Ownership

Metro

Capital Improvements

The only capital improvement needed for the Convention Center site is wayfinding for the ferry landing and various local attractions (some currently exists along the esplanade).

b. Duckworth Dock

Dock Description

The Kevin J. Duckworth Memorial Dock, better known as the "Duckworth Dock", is a floating dock off the Eastbank Esplanade just north of the Burnside Bridge. Named after beloved Portland Trail Blazer Kevin J. Duckworth, the facility was developed with a grant from the Oregon Marine Board in cooperation with the City of Portland Bureau of Transportation (PBOT) and is operated by PBOT.

The dock is currently used by small recreational craft on a first-come-first-served basis. The first 100 feet of dock face on the outboard and upstream side has been set aside for commercial use only (designated by sign and yellow paint). As per city code, commercial vessels must obtain a permit through the Portland Parks and Recreation Reservation Center for use of the dock[2].

Water Depths

The outboard face of the Duckworth Duck is in 30 feet of water at CRD.

Exposure

The dock lies parallel to the flow of the river, along the east bank. It is exposed primarily to wind and weather from the south to northwest with the south exposure having the most wind fetch.

Dimensions and Construction

The floating dock consists of a modular concrete/foam system with structural timber walers. A single line of internal piles on the inboard side provide stability. The general dimensions are as follows:

- linear dock face available for moorage – 100 feet on the outboard side designated for commercial use
- clear width of pedestrian surface – 8 feet
- freeboard to deck – 1.25 feet

Access Ramps

The single access ramp runs from the Eastbank Esplanade and is perpendicular to the dock and the river. The aluminum access ramp has structural bulwarks with railings on either side.

[2] City of Portland Charter, Code and Policies 19.16.500

ADA

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Compliant
Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Compliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Compliant
Clear Width	The clear width of ramps shall be 36 inches minimum.	Compliant
Landings	Level landings are required at doors and where ramps change direction.	Compliant
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Compliant

General Passenger Safety

Due to the dock's construction and overall width, it provides a stable platform for ferry passengers to transit. There are no apparent tripping hazards. As it is a public dock, there are no railings on the outboard edges. There is low level lighting but no apparent safety equipment (i.e. life-ring, swim ladder).

Dock Hardware

The docks are equipped with cast cleats spaced at approximately 10 feet. The existing cleats are insufficient for a commercial passenger vessel of the intended size.

Fendering

The current floating dock has no fendering.

Use Agreements

Built with an OSMB grant.

Capital Improvements

Recommended capital improvements to the existing dock include:

- safety equipment
- replace some existing cleats with appropriately sized cast cleats or bollards
- install sufficient fendering

4. SALMON STREET

a. Salmon Street

General Description

Salmon Street or Salmon Street Springs (referring to the water feature within the park), is located at the eastern terminus of SW Salmon Street in downtown Portland. It is located in Tom McCall Waterfront Park along the Willamette River's western bank. Waterfront Park and Salmon Street Springs provide an open space with public access that could function as an 'open' terminal.

Access/Egress

Access/egress for the general vicinity is good for pedestrians coming from multiple directions and modes (parking structures, transit stops, bike paths). Cyclists can access Salmon Street via the Waterfront Trail, a multi-use trail that extends a little over a mile along the river between Hawthorne Bridge to the south and Steel Bridge to the north or via designated bike lanes along Naito Parkway (immediately parallel to Waterfront Park) and numerous cross streets into the downtown core.

Transportation Links (First and Last-mile Connections)

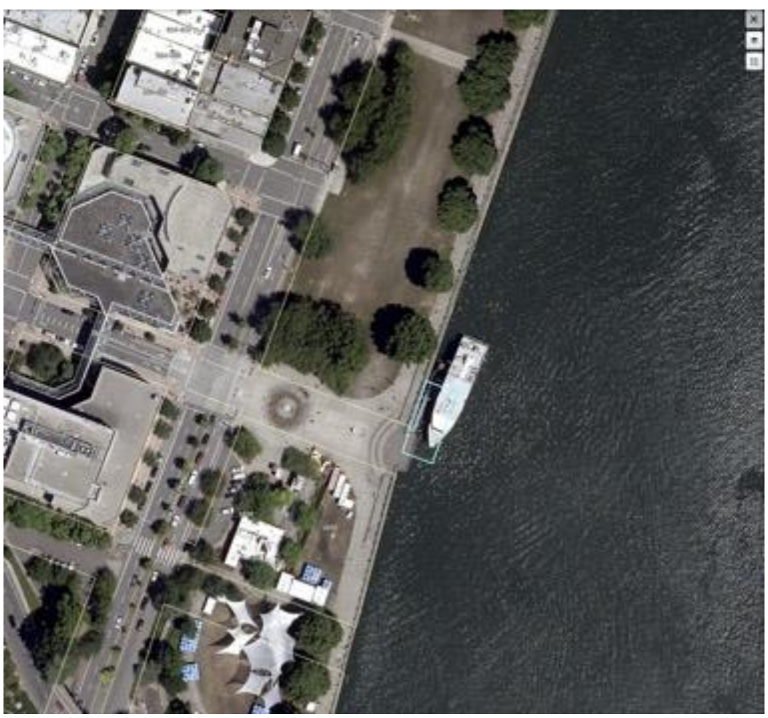
LINK	DETAILS
Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain. The Waterfront Park Trail runs north and south along the west bank and connects with a vast network of bike lanes.
Bicycle / Scooter Share	BikeTown hub located at SW Salmon Street and Waterfront Park.
Local Transit	Five lines of the light rail (MAX) and numerous TriMet bus routes. Five C-TRAN routes traverse the downtown corridor.
Car / Ride Share	Uber and Lyft. Zipcar stations (2) within 5 blocks.
Kiss and Ride	No designated spots nearby.

Parking (Auto and Bike)

There are currently numerous parking facilities close by. There is no apparent secure bike parking.

Facilities

There does not appear to be any facilities specific to a ferry service in the immediate area. There is space in Waterfront Park for a covered waiting area, electronic kiosk and secure bicycle parking.



Ownership

The Tom McCall Waterfront Park is owned and operated by City of Portland Parks and Recreation.

Capital Improvements

The Salmon Street terminal site will require the following capital improvements:

- electronic ticket kiosk
- signage (wayfinding)
- covered waiting area
- secure bicycle parking

b. Salmon Street Dock

Dock Description

The Salmon Street Dock is a privately owned and operated dock accessed via a gangway from

Waterfront Park at the Salmon Street Springs Fountain. The dock is a floating dock that runs parallel to the seawall. The dock was designed and built as a landing platform to accommodate the 150-foot Portland Spirit, a dinner cruise vessel.

Water Depths

The Salmon Street dock is in 30+ feet of water at CRD.

Exposure

The dock lies parallel to the flow of the river, along the west bank. It is exposed primarily to wind and weather from the south to northeast with the south exposure having the most wind fetch.

Dimensions and Construction

The dock at Salmon Street is a monolithic concrete dock with cosmetic walers and was not intended to support moorage of a commercial vessel. The dock is used as a landing platform for the access ramp. The dock is secured by two external pilings. The general dimensions are as follows:

- linear dock face available for moorage – XX feet
- clear width of pedestrian surface – X feet
- freeboard to deck – XX feet

Access Ramps

The single access ramp runs from the Waterfront Park and is parallel to the dock and the river.

ADA

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Possible, need design to confirm
Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Compliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Unconfirmed
Clear Width	The clear width of ramps shall be 36 inches minimum.	Unconfirmed
Landings	Level landings are required at doors and where ramps change direction.	Compliant
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Compliant

General Passenger Safety

As this is a private dock, the project team was unable to gain full access and perform an evaluation of passenger safety features.

Dock Hardware

As the dock is not used as a mooring platform, there is no existing hardware that would be suitable for securing a commercial passenger vessel of the size intended.

Fendering

There is no fendering on the dock. A log camel is used to distribute the loads bearing directly on it and protect the concrete from impact.

Use Agreements

The dock was privately built and is owned and operated by Portland Spirit under a use agreement with the City of Portland.

Capital Improvements

Recommended capital improvements to the existing dock are unknown at this time due to the lack of information available regarding the privately-owned dock.

As an alternative, it is recommended that the addition of a purpose-built ferry dock be considered directly to the south of the existing dock.

5. OMSI

a. OMSI

General Description

OMSI (Oregon Museum of Science and Industry) is envisioned as an on-demand destination for the ferry and not a part of the regular ferry schedule. The facility lies on the east bank of the river along the Eastbank Esplanade.

Access/Egress

Access/egress for the general vicinity of the dock is good for pedestrians and cyclists coming to/from OMSI or nearby destinations such as the Opera Center, via the Esplanade or city streets.

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain. The Eastbank Esplanade runs north to the Steel Bridge.
Bicycle / Scooter Share	BikeTown hub at the Opera Center
Local Transit	One line of the light rail (MAX) and a Portland Streetcar stop.
Car / Ride Share	Uber and Lyft
Kiss and Ride	At the OMSI parking lot

Parking (Auto and Bike)

There is ample parking at the OMSI lot but no secure bike parking

Facilities

While there is no designated terminal site close to the dock, the intent to use the OMSI stop for on demand use negates the need for standard terminal facilities.

Ownership

The uplands and dock are owned by the OMSI organization.

Capital Improvements

The only capital improvements needed for the OMSI site is signage.

b. OMSI Dock

Dock Description

The OMSI dock was designed and built as a multi-use facility and accommodates a submarine exhibit (USS Blueback), a commercial jetboat excursion operator as well as public access.

Water Depths

The OMSI dock is in between the 6-foot and 30-foot contours at CRD.

Exposure

The public access portion of the dock lies at an angle to the flow of the river, along the east bank. It is exposed primarily to wind and weather from the south to northwest with the south exposure having the most wind fetch.

Dimensions and Construction

The floating dock consists of a modular concrete/foam system but without structural walers. A single line of external piles on the inboard side provide stability. The general dimensions are as follows:

- linear dock face available for moorage – 65 feet on the outboard side of the angled section
- clear width of pedestrian surface – 8 feet
- freeboard to deck – 1.25 feet

Access Ramps

The single access ramp runs from the Eastbank Esplanade at an angle to the river bank and is extensive in both size and construction. With three switchbacks and landing platforms between each section, the ramp is wide and very accessible for multi-direction travel. The access ramp has structural bulwarks with railings on either side.

ADA

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Compliant
Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Compliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Compliant
Clear Width	The clear width of ramps shall be 36 inches minimum.	Compliant
Landings	Level landings are required at doors and where ramps change direction.	Compliant
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Compliant

General Passenger Safety

Due to the dock's construction and overall width it provides a stable platform for ferry passengers to transit. There are no apparent tripping hazards. As it is a public dock, there are no railings on the outboard edges. There is low-level lighting but no apparent safety equipment (i.e. life-ring, swim ladder).

Dock Hardware

The dock has 4x4 timber bull-rails. This is insufficient for a commercial passenger vessel of the intended size.

Fendering

The current floating dock has no fendering, but a log camel has been secured along the outboard face to distribute the load and protect the concrete face.

Use Agreements

Private facility, use agreements are unknown.

Capital Improvements

Recommended capital improvements to the existing dock include:

- safety equipment
- replace bull-rails with appropriately sized cast cleats or bollards
- install sufficient fendering

6. OHSU/ZIDELL

a. Zidell Property

General Description

The Zidell property is an extensive facility that stretches along the west bank of the Willamette River from Tilikum Crossing to just south of the Ross Island Bridge. The site includes the former facilities of the Zidell shipyard.

Access/Egress

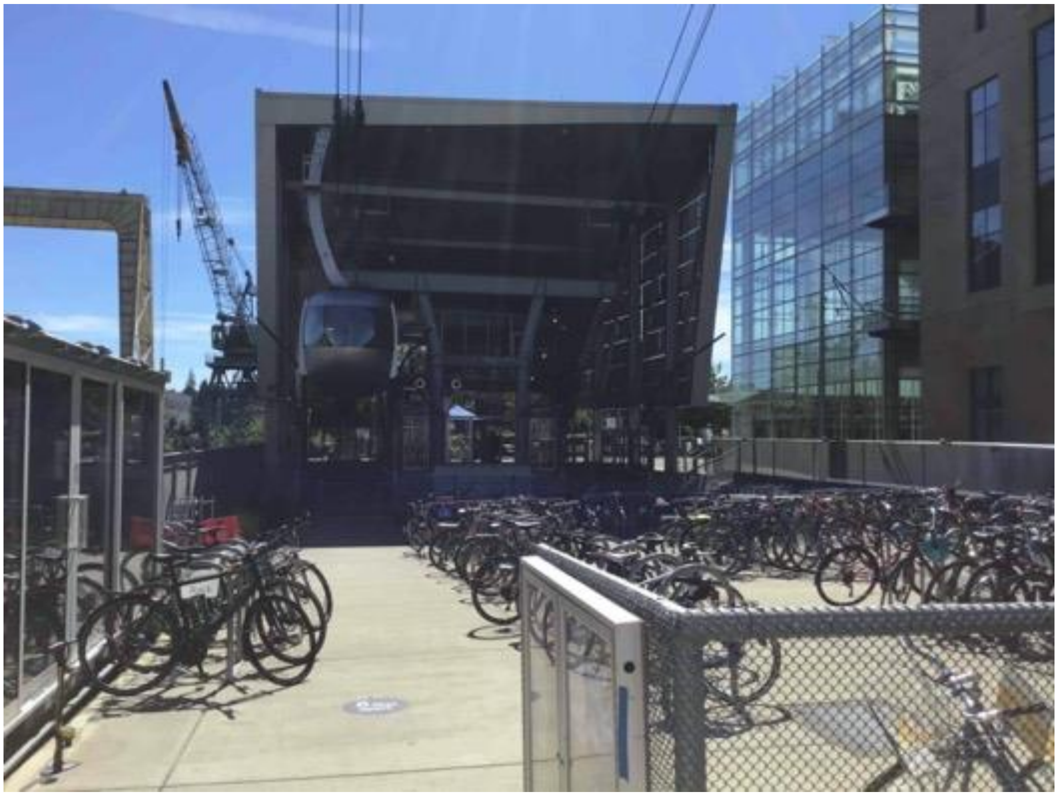
Access/egress for the general vicinity of the Zidell property is excellent for pedestrians coming from multiple directions (parking structures, transit stops, bike paths, kiss and ride). Cyclists also have excellent access via numerous multi-use paths and designated bike lanes on city streets.

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain surrounding the property. Most of the Zidell property is undeveloped.
Bicycle / Scooter Share	BikeTown hub immediately adjacent to the Zidell marine property and the OHSU Aerial Tram.
Local Transit	Two lines of the light rail (MAX), nine TriMet bus routes, one C-TRAN route, Portland Streetcar stop and the OHSU Aerial Tram.
Car / Ride Share	Uber and Lyft. One Zipcar station within 5 blocks.
Kiss and Ride	Numerous potential locations.

Parking (Auto and Bike)

There are numerous parking facilities in the vicinity. Additional parking development may be possible depending on land use. A lot for bike parking is located at the base of the OHSU Aerial Tram.



Facilities

While there are currently no facilities at the site, the Zidell Property presents extensive opportunities. It is recommended that the site be considered as both a ferry terminal and a maintenance hub for overnight moorage of the vessels and maintenance activities.

Ownership

ZRZ Realty.

Capital Improvements

While there currently are no ferry facilities, the Zidell property presents promising opportunities for a main ferry hub, terminal and maintenance facility as a part of the redevelopment plan.

b. No Existing Dock

There is currently no existing dock at the Zidell property to evaluate.

7. MILWAUKEE

a. Milwaukee Bay Park

General Description

Milwaukee Bay Park, in Milwaukee presents a future opportunity for a ferry terminal. The park is located on an 8.5-acre site nestled between the Willamette River to the west, Kellogg Creek to the south and Johnson Creek to the north. The park is also conveniently accessed from Milwaukie's downtown, just off McLoughlin Boulevard.

The park currently includes a boat launch with a dock, public restrooms and a parking lot. While the existing dock is not suitable for ferry service due to its light construction, opportunities exist for the addition of a ferry dock in the immediate vicinity.

Access/Egress

Access/egress for the general vicinity of the park is good for pedestrians coming from multiple directions (transit stops, bike paths, kiss and ride).

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain. Access to downtown Milwaukee includes crossing Highway 99 via crosswalks at a traffic light.
Bicycle / Scooter Share	None yet, Milwaukee is outside BikeTown's zone.
Local Transit	One line of the light rail (MAX) and a TriMet bus stop (4 routes).
Car / Ride Share	Uber and Lyft
Kiss and Ride	Potential at parking lot.

Parking (Auto and Bike)

There are currently no designated parking lots in the immediate vicinity.

Facilities

While there are currently no facilities specific to a ferry service other than public restrooms, there is potential for development with a modest footprint in the vicinity of the park.

Ownership

Milwaukee Bay Park is owned and operated by the City of Milwaukee.

Capital Improvements

The only necessary capital improvements to the current infrastructure include a covered waiting area, electronic kiosk and signage.

b. No Existing Dock

There is currently no suitable dock at the site to evaluate.

8. LAKE OSWEGO

a. Foothills Park

General Description

Foothills Park in Lake Oswego is nine acres on the Willamette River waterfront, just north of Roehr Park and the Oswego Pointe area. It features sweeping views of the river from a covered platform, pathways, a reflecting pond, and a grass amphitheater.

Access/Egress

Access/egress for the general vicinity of the dock is good for pedestrians coming from multiple directions (transit stops, bike paths, kiss and ride).

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Paved paths, mostly flat terrain. A short uphill walk via path to the main part of the City of Lake Oswego.
Bicycle / Scooter Share	None

Local Transit	One TriMet bus route within 0.5-mile, Lake Oswego Transit Center (four TriMet bus routes) within 0.75 mile.
Car / Ride Share	Uber and Lyft
Kiss and Ride	Foothills Park roundabout

Parking (Auto and Bike)

There is limited parking in Foothills Park. The nearest existing parking is a half mile away. There may be potential for development of additional parking on Foothills Road. There is no apparent secure bike parking in the park.

Facilities

While not intended for ferry use, the facilities at Foothills Park include public restrooms and a covered area adjacent to the roundabout.

Ownership

Foothills Park is owned by the City of Lake Oswego.

Capital Improvements

The Salmon Street terminal site will require the following capital improvements:

- electronic ticket kiosk
- signage (wayfinding)
- secure bicycle parking

b. Foothills Park Dock

Dock Description

The Foothills Park Dock is a floating dock on the west bank of the Willamette River. The dock runs parallel to the shore and is accessed by a single ramp. There is a sign on the dock that states it is not designed to support vessels over 40 feet. While length overall is not a typical metric used as dock design criteria, it is most likely intended as a guideline and warrants investigation.

Water Depths

The Foothills Park dock is in 30+ feet of water at CRD.

Exposure

The dock lies parallel to the flow of the river, along the west bank. It is exposed primarily to wind and weather from the north and the south, with both exposures having the moderate fetch.

Dimensions and Construction

The floating dock consists of a modular concrete/foam system with structural timber walers. A single line of internal piles on the inboard side provide stability. The general dimensions are as follows:

- linear dock face available for moorage – 270 feet on the outboard side
- clear width of pedestrian surface – 8 feet
- freeboard to deck – 1.25 feet

Access Ramps

The single access ramp runs from the Foothills Park pedestrian path and is perpendicular to the dock and the river. The access ramp has structural bulwarks with railings on either side.

ADA

Characteristic	Requirement	Condition
Ramp Slope	Ramp runs shall have a running slope not steeper than 1:12	Possible, need design to confirm
Cross Slope	Cross slope of ramp runs shall not be steeper than 1:48 (Ramp and dock)	Compliant
Surfaces	Deck surfaces shall be stable, firm and slip resistant. (Ramp and dock)	Compliant
Clear Width	The clear width of ramps shall be 36 inches minimum.	Compliant
Landings	Level landings are required at doors and where ramps change direction.	Compliant
Handrails	Ramp runs with a rise of greater than 6 inches shall have handrails.	Compliant

General Passenger Safety

Due to the dock's construction and overall width it provides a stable platform for ferry passengers to transit. There are no apparent tripping hazards. As it is a public dock, there are no railings on the outboard edges. There is no lighting and no apparent safety equipment (i.e. life-ring, swim ladder).

Dock Hardware

The dock is equipped with galvanized metal bull-rails. These are insufficient for a commercial passenger vessel of the size intended.

Fendering

The current floating dock has no fendering.

Use Agreements

The Foothills Park dock was funded by a Boating Infrastructure Grant (BIG). Commercial use and public access should be investigated.

Capital Improvements

Recommended capital improvements to the existing dock include:

- covered access ramp
- lighting
- safety equipment
- replace bull rails with cast cleats or bollards
- install sufficient fendering

As an alternative, it is recommended that the addition of a purpose-built ferry dock be considered. To the immediate south of the existing dock are several dolphins left over from a previous barge loading operation. If determined to be structurally sound, these dolphins could be used to support a new floating dock and access gangway similar to the existing dock. All access/egress would remain the same.

9. OREGON CITY

a. *Oregon City*

General Description

While there currently isn't a ferry terminal or dock in Oregon City, an extensive redevelopment of the 22-acre Blue Heron Paper Mill site is planned. As part of this plan, there is potential for a suitable ferry terminal, either as an on-demand destination or eventually for regularly scheduled transit. The site is in the downtown corridor and directly adjacent to the scenic Willamette Falls.

Partial rendering of Blue Heron Mill redevelopment

Access/Egress

Under the redevelopment plan, access/egress for the general vicinity of the development site will be good for pedestrians coming from multiple directions (parking structures, transit stops, bike paths, kiss and ride).

Transportation Links (First and Last-mile Connections)

LINK	DETAILS
Pedestrians and Cyclists	Urban streets and sidewalks, mostly flat terrain.

Bicycle / Scooter Share	None.
Local Transit	One TriMet route within 0.1 mile and the Oregon City Transit Center (8 TriMet routes) within 0.4 miles.
Car / Ride Share	Uber and Lyft
Kiss and Ride	Potential to incorporate into redevelopment plan.

Parking (Auto and Bike)

The current development plan does not specifically call out parking.

Facilities

The development plan currently identifies a location suitable for a floating dock with direct access to the site along the east bank of the river. Other facilities are not specifically called out in the plan.

Ownership

Unknown, however, the Blue Heron Mill site is owned by the Confederated Tribes of the Grand Ronde.

Capital Improvements

The redevelopment plan should consider shoreside aspects necessary to support a ferry in addition to a dock.

b. No Existing Dock

There is currently no suitable dock at the site to evaluate.

C. PERMANENT MOORAGE / MAINTENANCE FACILITY

The importance of establishing permanent moorage and a facility with the proper capabilities to perform light maintenance (daily planned maintenance activities, most things short of heavy maintenance requiring a drydock) for the ferry system cannot be overstated. It goes beyond just a dock to moor the vessels for the night. Successful ferry systems require suitable infrastructure to support operations and ensure that they can be performed efficiently.

An ideal situation would be to create a home port at or near the main hub or terminus of the route. This proximity eliminates or minimizes the need for deadheading the vessels and reduces operating costs. It also ensures all levels of the organization are centralized, maintaining good communication and common processes.

A home port would incorporate sufficient dock space for the entire fleet (as planned), with the ability to expand, providing a safe and secure environment. All logistics could be supported, such as fueling, potable water, sewage, provisioning and shore power. Light maintenance would be supported from shoreside facilities (parts storage, workshops, tools, etc.) located at the home port. Administrative offices would be onsite to foster a strong corporate culture and maintain consistent communications throughout the organization.

It is rare to identify a site that can accommodate all of these requirements. Typically, waterfront property in close proximity to the route is in high demand or has restrictions. But if the opportunity to build a home port from a clean slate can be identified it is invaluable to the success of a ferry system.

As a part of the reconnaissance, an initial scan of potential home ports or permanent moorage locations at the very least was conducted. Port of Portland staff provided some potential locations and other sites with existing tenants (typically other marine operations) that might sublet space were investigated in order to get an initial sense of the potential. Without drawing any conclusions based on the limited amount of information, it appears that permanent moorage is available at several sites and at least the potential for some supporting infrastructure.

Of all of the sites investigated, the most promise for establishing a full home port exists at the Zidell property. As a clean slate, this site could be developed into a permanent home port in phases, beginning with temporary floats and facilities until eventually building out into a purpose-built facility capable of supporting all of the system's needs, including vessel haul outs and major overhauls.

IV. SUMMARY

As stated earlier in the report, the purpose of the Reconnaissance Report is to collect the observations made by the project team and summarize the team's findings and recommendations based on the preliminary information gathered. This information is then used to inform the direction of the feasibility study by identifying any critical barriers that must be overcome or necessary changes in the direction of the study.

A. ROUTE ASSESSMENT

Preliminary conclusions from the route assessment suggest that the route contemplated for the ferry is absolutely technically feasible. The primary challenges include the following:

- Periods of high current in the rivers will affect accurate schedule-keeping and safe navigation.
    - Mitigation – vessel design criteria to include requirements for additional speed capability (above design service speed) and maneuverability.
- Vertical clearance restrictions along the route (26 feet at Steel Bridge at CRD), particularly at extreme high-water levels.
    - Mitigation – it won't be possible to design a vessel that will achieve 100% non-lift clearance (of the bridge), the project team must determine an acceptable percentage based on historical data that can be achieved without negatively impacting vessel design.
- Vessel traffic density and complexity on the rivers registered as a moderate to high risk along the entire route.
    - Mitigation – includes elements of vessel design, vessel operators with well-established policies and procedures and comprehensive training programs, and close coordination with other user-groups.
- Speed/wake restrictions on the rivers whether imposed by local regulation or prudent seamanship.
    - Mitigation – ultra low wake (ULW) vessel design (designed and verified through testing), sound operating procedures and public outreach.
- Debris in the river presents a high risk to reliable ferry service and potential safety of passengers.
    - Mitigation – vessel design elements (impact resistance, minimize underwater appurtenances, propulsor selection, night vision cameras), vessel operators with well-established policies and procedures and comprehensive training programs.

B. DOCKS/TERMINAL SITES

Evaluation of the nine potential terminals/stops for the ferry leaves additional research to be conducted but provided the project team with a clear vision for future strategy at each site. For each site, further investigation into property ownership and use agreements is necessary. The following table summarizes the recommended strategy for each site:

SITE	INTENDED USE	TERMINAL FEASIBILITY	DOCK FEASIBILITY	DOCK ALTERNATIVE
Vancouver Terminal #1	Regularly - scheduled Ferry	Feasible under development plan	Feasible assuming use agreement and capital improvements	Design and build ferry-specific dock

Cathedral Park	Regularly - scheduled Ferry	Feasible with some capital improvements	Existing dock is not feasible as configured without major changes	Design and build ferry-specific dock
Convention Center	On Demand Service	Feasible with some capital improvements	Feasible for intended purpose with capital improvements	
Salmon Street	Regularly - scheduled Ferry	Feasible with some capital improvements	Feasible assuming use agreement and capital improvements	Design and build ferry-specific dock
OMSI	On Demand Service	Feasible with some capital improvements	Feasible for intended purpose with capital improvements	
OHSU / Zidell	Regularly - scheduled Ferry	Feasible with major capital improvements	No existing dock. Design and build ferry-specific dock	
Milwaukee	Regularly - scheduled Ferry	Feasible with some capital improvements	Existing dock is not feasible	Design and build ferry-specific dock
Lake Oswego	Regularly - scheduled Ferry	Feasible with some capital improvements	Feasible assuming use agreement and capital improvements	Design and build ferry-specific dock
Oregon City	On Demand Service	Feasible under development plan	No existing dock. Design and build ferry-specific dock	

Appendix B – Propulsion Memorandum

MARITIME CONSULTING PARTNERS

Memorandum

Vessel Propulsion Alternatives

Date: Updated: 2 September 2020 Project: Frog Ferry Feasibility Research

Introduction

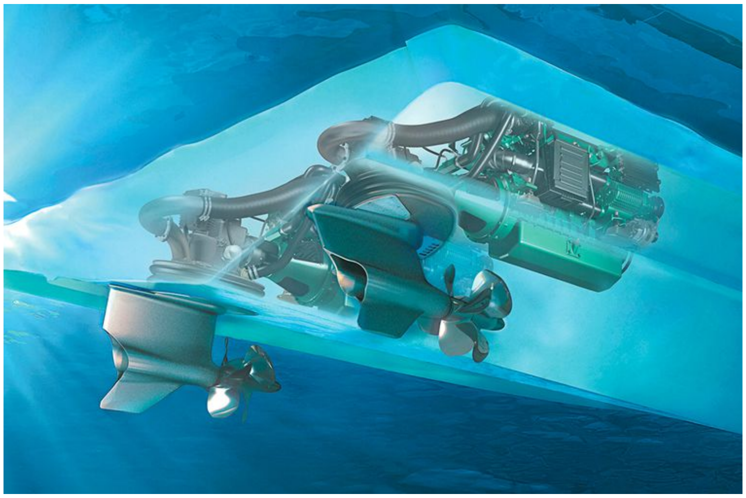
There are typically two or three alternatives for the propulsor[1] element of the propulsion system on small passenger vessels. In selecting the most appropriate, several variables need to be considered. For the operational feasibility of a passenger ferry on the Columbia and Willamette Rivers, three alternatives are under consideration:

- Propellers – the most common and conventional means of powering a vessel, props are designed to match the power and speed requirements. On a small catamaran, the most common configuration is a twin prop arrangement where each is powered by a single diesel engine turning a shaft through a reduction gear.

- Waterjets – a common propulsor on light, high-speed craft. Waterjets in a small catamaran hull can be configured as either a twin or quadruple (quad jet) arrangement with each waterjet being driven by a single diesel engine through a shaft, with or without a reduction gear or transmission.

[1] Propulsor is the mechanical devise that provides propulsion to the vessel when driven by the prime mover.

- Integrated Propulsion System[2] - a relatively new system approach where the propulsor is a steerable pod system, in this case two counter-rotating props that 'pull' water rather than 'push' it as conventional props and waterjets do. As an integrated system, the pods are each driven by a single diesel engine through a reduction gear and lower unit that extends below the bottom of the hull.



Criteria
The following criteria are considered in this analysis as those which have the greatest impact on the application being considered. The impact and importance of each criteria is given a rating from 1 – 10 (**Impact Rating**), where 10 represents the criteria is of paramount importance and will have a considerable impact on the feasibility of the ferry system.

1. Maneuverability – a key aspect of the maneuverability of a vessel is determined by the propulsor. Due to currents on the rivers and the significance of minimizing the time required in maneuvering, this is an important variable when selecting the best propulsor. Maneuverability can also be a significant safety consideration, particularly when avoiding hazards. **Impact Rating: 6**

2. Efficiency – all propulsion systems suffer from efficiency losses. But the amount of loss is dependent on the design of the vessel, speeds travelled and the environment it operates in. The route profile for the ferries requires efficiency at a service speed between 22 – 24 knots as well as

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[2] *IPS – Integrated Propulsion System is a proprietary propulsion system developed by Volvo Penta Marine*

at low speed (7 – 10 knots). Lower efficiency creates higher fuel consumption which translates to higher operating costs and air pollution emissions. **Impact Rating: 6**

3. Lifecycle Costs – the lifecycle costs of the alternatives can vary greatly. Lifecycle costs begin with the initial capital expense of the propulsor (as well as associated costs of the propulsion system as a whole), and then consider the ongoing routine maintenance and major overhaul expenses. **Impact Rating: 5**

4. Debris Risk – of great significance on the rivers, debris poses a risk to the propulsor and therefore the reliability of the service. Debris comes in many forms and the risks associated with the different alternatives depend greatly on the type of debris and associated mitigation strategies that are possible.
    a. Large debris – large debris (deadheads, sinkers) can cause serious damage to the hull if struck between frames at high speed. Of greater risk is the damage large debris can do to the propulsor. Operational procedures can mitigate the risk of striking large debris **Impact Rating: 5**
    b. Small debris – small debris (small sticks, branches, trash) will not cause damage to the hull but will cause varying degrees of damage to the propulsor. Small debris can also cause delays in the schedule. **Impact Rating: 8**

5. Reliability – crucial to the success of a waterborne transit system, reliability of any critical system on the vessels must be considered. The alternatives are subject to different failure risks as well as varying repair options that must be considered. **Impact Rating: 8**

Note – restrictions in vessel draft due to shallow areas on a given route is a common factor that can influence the selection of a propulsor (favoring waterjets). This is not a factor on the route being contemplated and therefore was not included in the analysis. Weight of the systems also can be a factor to include, particularly when a quad waterjet configuration is being considered. In this case the variance between the weight of the three systems is negligible and therefore not considered a factor.

Table – Summary of Criteria Factors, Weighted by Impact Rating

Criteria	IR	Propellers		Waterjets		IPS	
Maneuverability	6	Less maneuverable, longer stopping distance	12	Highly maneuverable, shortest stopping distance	18	Highly maneuverable, longest stopping distance	12
Efficiency	6	Less efficient than IPS by 10 – 15%	12	Less efficient than IPS by 30 – 40%	6	Most efficient at all speeds	18
Lifecycle Costs	5	Lowest capital expense, lowest scheduled maintenance expense. Lifecycle = baseline	15	Higher capital expense, higher scheduled maintenance expense. Lifecycle = +30%	10	Higher capital expense, highest scheduled maintenance expense. Lifecycle = +30%	10
Large Debris Risk	5	High risk – potential for impact damage	5	Low risk – not exposed to impacts	15	High risk – highly exposed to impacts	5
Small Debris Risk	8	Low risk – change props periodically	24	Medium risk – flush jets regularly	16	High risk – frequent prop damage	8
Reliability	8	High	24	High	24	Medium	16
			92		**89**		**69**

Recommendation
While an evaluation of different propulsors can be very subjective, the table above provides an approximate quantification of the varying elements of evaluation weighted by the **Impact Ratings** as they apply to the application intended. The table indicated that the benefits of standard props and waterjets far outweigh those of IPS, for this application. While the primary strengths of the IPS (efficiency at all speeds and maneuverability) are advantageous, they do not impact the scoring as heavily as debris risk and reliability which are not considered strengths of IPS.

Waterjets and standard props both have their relative strengths and weaknesses. Where they differ the most are in efficiency, maneuverability, lifecycle costs and debris risk. The primary difference between the two are that the weaknesses of props can be mitigated through operational procedures (maneuverability and large debris risk) while the weaknesses of waterjets cannot be easily mitigated (efficiency and small debris risk).

In light of this, it is the recommendation of MCP that standard props provide the greatest level of overall benefit through reliability, lower lifecycle costs and greater efficiency. It is important to ensure that proper risk mitigation measures are employed. This includes qualified operators who are experienced in operating vessels at these speeds in areas of debris, who understand how to read the river currents for debris flows, utilize a structured watch condition to properly employ lookouts when needed and are proficient at maneuvering prop-driven vessels. The vessels should be designed with reinforced structural frames in the bows to absorb potential impacts with large debris and low light / night vision cameras to assist in the avoidance of large debris.

Appendix C – Preliminary Demand Modeling

FRAMEWORK *and* APPROACH TO FERRY DEMAND MODELING IN THE PORTLAND METRO

ECONorthwest
ECONOMICS · FINANCE · PLANNING

Study commissioned by
FRIENDS OF FROG FERRY

FRIENDS OF
FROG FERRY

Friends of Frog Ferry Demand Modeling: Summary of Technical Report

March 2020

Goal: Estimate ridership for key stops as designated by PBOT, TriMet and Metro along the proposed transit route.

Methodology: TriMet required the use of Metro's Travel Demand Model (TDM) which is frequently used to determine demand for planned transit investments with the Portland-Vancouver metropolitan region. The TDM generally is comprised of trip generation, trip distribution, mode choice, and trip assignment. It should be noted that the Portland regional TDM was not built for ferry operations, as water transit has specific characterics that are difficult to characterize in a model built for land-based transportation modes. A traveler's mode choice is a function of four key variables: travel time, travel cost, household characteristics and the physical urban environment.

1. We ran the initial model in Summer 2019 and the results were inconclusive, due to the model not taking into consideration the differences a ferry service presents.
2. In Fall 2019, Friends of Frog Ferry hired ECONorthwest to reach out to other West Coast ferry services to bring their best practices and approaches to the Portland's regional TDM. ECONorthwest brought what they learned and applied them to the assumptions, working with Metro, PBOT and TriMet, to get a more optimistic set of results. **This report reflects this work.
3. To Be Determined: In 2020 or 2021, we will need to contract with a Passenger Ferry Demand Agency consultancy to help assess rider profiles, pricing, and drivers determining mode choice to get a better assessment for the benefit-cost analysis.

Ferry Service Passenger Characteristics: Studies have identified that users of ferry services valued safety, reduced stress, and vessel comfort as relevant characteristics for choosing that mode[1,2]. Additionally, researchers have found that travelers are willing to trade longer travel times for increased amenities on water transit services, resulting in different perceptions of how travelers weigh the benefits and costs associated with that mode choice. Passengers value on-time reliability, the highest use of their time/commute experience, time and cost.

San Francisco Bay Ferry/WETA: Determining ridership for new routes was analytically challenging. Their initial attempts to use travel-demand models to estimate ridership were inconclusive. As a result, they launched an extensive market study to determine appropriate strategies for route selection and understand which characteristics of ferry travel were relevant for measuring traveler preferences for service across various segments.[3]

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1 Outwater, M., et al. 2003. "Attitudinal market segmentation approach to mode choice and ridership forecasting: Structural equation modeling." *Journal of the Transportation Research Board*: 32-42.

2 Camay, S., Ellen Zeilinski, Adam Zaranko. 2012. "New York City's East River Ferry: Expanding Passenger Ferry Service and Stimulating Economic Development in the New York City Region." *Journal of the Transportation Research Board*: 192-200.

3 Outwater, M. (2003)

Kitsap County/Seattle: Like San Francisco Bay Ferry, an analytic approach using a TDM was eventually used for sensitivity testing but was a result of an extensive data collection process, rather than the foundation of further analysis. This approach was a success for the county. The surveys and community engagement helped identify key strategies that would yield the desired outcomes for a pedestrian ferry service. A key outcome of resulting from this effort was that connectivity to the ferry service was a critical component of the service.

Like San Francisco Bay Ferry, Kitsap County also found that demand for the service extended beyond commuters. During peak summer months, non-peak weekday service can include up to 30 non-commuter trips (~25 percent of capacity) and weekend service to Seattle can often be at capacity during that time. Since launching the service, Kitsap County has continued refine its scheduling and reservation system to work out inefficiencies but has generally found that demand was in-line with their early ridership estimates.

Friends of Frog Ferry Model Outputs and Estimated Ridership Summary: Based on the parameter changes described above, ridership estimates across all the Express routes increased from the initial Demand Modeling attempt. Across all three segments, park-and-ride users accounted for a large portion of the increased ridership. Using park-and-ride as a proxy for access to the terminal suggests that access is a critical feature to increasing ridership. This generally aligns with feedback from ferry planners that increasing the catchment area for connectivity to the terminal is a key feature of successful ferry service. However, some caution should be used in interpreting these results. We do not have a complete set of comparisons across all parameter changes and interactions in the model, making the marginal effect of each parameter change difficult to describe without further information.

Recommendation: In effect, this analysis attempts to build a “best case” scenario of ridership demand within the existing specifications of Metro’s regional transportation model. As Metro notes within their own description of the results, these ridership estimates are intended to be exploratory and are not official forecasts of ridership. In order to demonstrate the viability of ferry service, a financial feasibility study should be completed to ensure revenues can be generated to cover the cost of providing that service. Within that context, the revised demand estimates may be sufficient to sustain a financially feasible initial phase of operations proposed by Frog Ferry. Therefore, we recommend using this analysis as a foundation to further investigate the range of potential benefits associated with Frog Ferry’s proposed service.

Action: Based on these findings TriMet agreed to move the ODOT Statewide Transit Improvement Fund grant award of $200,000 forward (as the grant sponsor since FFF is not a designated direct recipient as a nonprofit agency), which triggers a $40,000 match from PBOT to fund the Operational Feasibility Study and Finance Plan, which will be conducted in Q1 and Q2 2020. Both plans will be created by Friends of Frog Ferry with support from sub-contracting ferry operations and dock engineering experts.

OVERVIEW

The Oregon Department of Transportation (ODOT) awarded a Statewide Transportation Improvement Fund (STIF) grant to investigate the feasibility of a pedestrian ferry service in the Portland Metro. Tri-Met agreed to be the partner public agency to administer the grant. As part of that process, Metro conducted an initial demand study in collaboration with Friends of Frog Ferry (FFF), the Portland Bureau of Transportation (PBOT), and Tri-Met. The initial ridership estimates, resulting from the demand modeling, demonstrated low ridership across each of the FFF proposed routes. Appendix A presents the full results from the initial demand modeling study (May 24, 2019).

ECONorthwest (ECO) was not involved in the creation of the assumptions for the initial demand modeling of the proposed ferry system. Subsequently, FFF asked ECO to review the results of the initial demand modeling to determine if the approach was like those used by other regional ferry services, and to see if there were any best practices or suggested revisions to the initial methodology and assumptions.

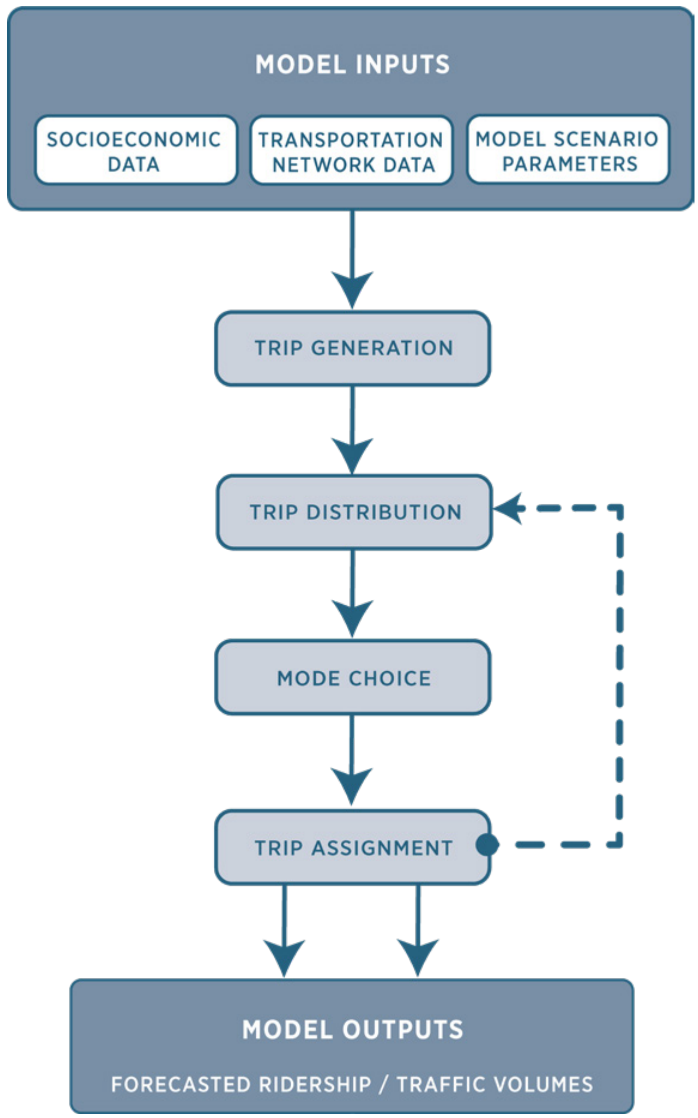
This technical memorandum outlines the steps taken to build on the preliminary ridership estimates and describes the results of that effort. Additionally, it describes key highlights from discussions with other transit agencies regarding their approaches to model ridership for ferry service.

This process was a collaborative effort with Metro as it involved updating some of the assumptions in their initial travel demand model. The focus of the update was on: (1) assumptions that influence a change in mode of transportation toward ferry service and (2) assumptions that represent a range of perceived costs and benefits associated with ferry service. The results of the updated modeling efforts are summarized in this memo, along with results from Metro's memorandum, attached as Appendix B.

MODELING APPROACH

To estimate ridership along the proposed water transit routes, Tri-Met requested the use of Metro's travel demand model (TDM), which is frequently used to model demand for planned transit investments within the Portland-Vancouver Metropolitan region. TDM's are analytic tools used to forecast travel patterns and evaluate the effectiveness of proposed infrastructure and transit projects in a region's transportation network. There are several methods for developing TDM's, but trip-based models generally revolve around four primary steps to estimate demand: trip generation, trip distribution, mode choice, and trip assignment.

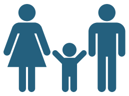
EXHIBIT 1.
CONVENTIONAL FOUR-STEP TDM PROCESS



Each of the four steps are complicated and data intensive. This memo does not describe Metro's TDM in detail. For those who are curious about modeling travel demand broadly, or Metro's model specifically, more information is available on their website.[1] Relevant to this analysis is understanding the "mode choice" or the number of travelers choosing to use the various modes of transportation included in the model. Broadly, mode choice is a function of several key variables:

TRAVEL TIME: time spent in-vehicle or out-of-vehicle to reach destination.

TRAVEL COST: the cost of parking, transit fares, tolls, and operating vehicle.



HOUSEHOLD CHARACTERISTICS: household size, income level, age, number of workers, and auto ownership.

URBAN FORM: the physical characteristics, such as density, shape, and size that make up the built area being studied.

The number of trips estimated for each mode of travel is a function of how competitive the mode is across each of these variables, conditioned on the demand for travel between each of the origin-destination pairs. Underlying this choice of mode is an assumed utility function, which describes the benefits and costs of that mode to each hypothetical person included in the model. In this context, "utility" simply means the benefits that a consumer derives from using a particular mode of transportation. In the context of travel demand modeling, benefits account for the perceived advantages from traveling to a location, while costs account for the real and perceived costs of using that mode for travel.

Source: Frog Ferry

Source: Frog Ferry

The sequential nature of the four-step trip generation process, along with the constrained choice set for how individuals choose to move through a transportation network, make these types of models an efficient tool for forecasting and decision-making. Like any analytic tool, however, TDMs have limitations. For example, trip-based models do not account for non-utilitarian travel, including tourism or novelty trips. They instead focus on home-based trips to work. Network reliability is also not typically a component of these models. Therefore, travel costs associated with variable congestion are not considered within the individual's choice set.[2]

Water transit has specific characteristics that are difficult to characterize in a model built for land-based transportation modes. Studies have identified that users of ferry services valued safety, reduced stress, and vessel comfort as relevant characteristics for choosing water transit.[3,4] Additionally, researchers have found that travelers are willing to trade longer travel times for increased amenities on water transit services, resulting in different perceptions of how travelers weigh the benefits and costs associated with choosing water transit.[5] With these limitations and distinctions in mind, ECO collaborated with regional transit planners and Metro to refine key model parameters so that they are reflective of user preferences for ferry service within the existing model's structure.

Ferry service is not a mode of transportation included in Metro's TDM. Therefore, to best approximate consumer decision making, ECO modeled ferry service as a new light rail line (MAX). In the construct of the Metro TDM, light rail has the highest individual utility making it the most likely mode to induce a mode split relative to other modes of transportation in the model.

[1] Oregon Metro provides a well-written overview on the components of transportation modeling, which can be found at: https://www.oregonmetro.gov/sites/default/files/2014/05/22/transportation_modeling_overview.pdf

[2] For a more detailed discussion of the general limitations and future op of the four-step travel demand model, see Mladenovic's & Trifunovic's 2014 article titled "The Shortcomings of the Conventional Four Step Travel Demand Forecasting Process" published in the Journal of Road and Traffic Engineering.

[3] Outwater, M., et al. 2003. "Attitudinal market segmentation approach to mode choice and ridership forecasting: Structural equation modeling." *Journal of the Transportation Research Board:* 32-42.

[4] Camay, S., Ellen Zeilinski, Adam Zaranko. 2012. "New York City's East River Ferry: Expanding Passenger Ferry Service and Stimulating Economic Development in the New York City Region." *Journal of the Transportation Research Board:* 192-200.

[5] Tanko, M., Matthew I. Burke & Barbara Yen. 2019. "Water transit and excess travel: discrete choice modeling of bus and ferry trips in Brisbane, Australia." *Transportation Planning and Technology:* 244-256.

DISCUSSIONS WITH TRANSIT PROVIDERS

ECO reached out to several west coast ferry operators to discuss their approaches for route selection and demand modeling as well as to provide technical advice, based on their experiences, to help refine key parameters in the TDM. ECO consulted with San Francisco Bay Ferry and Kitsap County. Both conversations provided useful context and insight for our work. The highlights from those conversations are:

San Francisco Bay Ferry
Source: Wikipedia

San Francisco Bay Ferry

The San Francisco Bay Area Water Transit Authority went through a process of determining how to expand commuter ferry service within the region. Determining ridership for new routes was analytically challenging. Their initial attempts to use travel-demand models to estimate ridership were inconclusive. As a result, they launched an extensive market study to determine appropriate strategies for route selection and to understand which characteristics of ferry travel were relevant for measuring traveler preferences for service across various segments.[6] The results of the analysis provided a better understanding of key characteristics for route selection and served as the foundation for an analytic tool for estimating demand.

In addition to evaluating commuter routes, the agency uses intercept surveys to estimate tourism and non-commuter traffic. This allows trips to be segmented by purpose in addition to origin-destination pairs, cost, and household characteristics. In other words, this approach provides San Francisco Bay Ferry a glimpse into how, when, and *why* people choose to use the ferry system. This additional step is important for San Francisco Bay Ferry because on several routes 25-30 percent of passengers are non-commuters.

The time San Francisco Bay Ferry spent refining their approach appears to be successful. According to San Francisco Bay Ferry, the East Bay Corridor generates an average of 280,000 trips per day. During peak hour traffic, this can represent up to 10 percent of total demand for trips along that corridor. Ridership is highly dependent on the corridor measured. However, average ridership estimates show increases in both new users and loyal users (those riding 10+ years) of the ferry system. San Francisco Bay Ferry expects this trend to continue into future years.

Kitsap County

The Puget Sound region has an extensive history of ferry service dating back to the early 20th Century. Passenger-only service declined after World War II as the road network expanded, despite several attempts to revive this service. Kitsap County recently went through the process of developing a business plan and implementing a passenger-only ferry service for direct commute service to Seattle. After exploring several approaches for their route selection, the County settled on a robust community engagement approach. This included numerous community meetings with local stakeholders to gauge interest in the service. Additionally, they used intercept surveys to understand where residents were commuting to work and their existing mode of transportation.

Like San Francisco Bay Ferry, an analytic approach using a TDM was eventually used for sensitivity testing. This was a result of an extensive data collection process rather than the foundation of further analysis. This approach was a success for the county. Their surveys and community engagement efforts helped identify key strategies that would yield the desired outcomes for a pedestrian ferry service. A key outcome resulting from this effort was connectivity to the ferry service — a critical component of the service.

Southworth Ferry Terminal, Kitsap Peninsula
Source: Wikimedia

[6] Outwater, M. (2003)

Cars loading on a ferry of the Washington State Ferry at the Colman Dock ferry terminal from Seattle to Bainbridge Island. Source: Shutterstock

In addition to developing optimal routes and testing sensitivity to fare structure, Kitsap County developed park-and-rides and aligned bus schedules and routes to ensure residents could use multiple modes to access the ferry terminal. Since the service was implemented, the County has worked with Sound Transit to expand their connective services into Pierce County to meet demand. Since December 2018, Kitsap County's fast ferry service averaged just under 40,000 riders per month,[7] operating near 78 percent capacity.

Like San Francisco Bay Ferry, Kitsap County also found that demand for the service extended beyond commuters. During peak summer months, non-peak weekday service can include up to 30 non-commuter trips (~25 percent of capacity) and weekend service to Seattle can often be at capacity during that time. Since launching the service, Kitsap County has continued to refine its scheduling and reservation system to work out inefficiencies. In general, however, the County has found that demand was in-line with their early ridership estimates.

Ferry Wenatchee enroute to Bainbridge Island Source: Wikipedia

[7] Kitsap County created a dashboard to monitor route performance, which can be found at: https://www.kitsaptransit.com/agency-information/fast-ferry-program

REVISED FERRY SERVICE ASSUMPTIONS

Based on our discussions with the ferry planners and review of technical literature, several modeling recommendations emerged. Recommendations were incorporated into the revised demand analysis (see appendix B). The recommended strategies focused on modifying parameters around cost, quality, access, and reliability to better reflect a ferry service (as opposed to light rail as initially modeled). These strategies generally aligned with the literature on modeling travel demand for ferry services and sought to include them using the following approach:

RELIABILITY: Metro's regional transportation model does not constrain for capacity;[8] those strategies were noted but not directly included in this analysis.

COST: During the preliminary analysis, Metro developed cost parameters intended to mimic the fare structure of ferry service. Because the cost parameters were already considered to be a reasonable comparator to other modes, we chose to focus on the amenity value associated with ferry service. This is intended to minimize the *perceived* cost of choosing the ferry over other modes.

ACCESS: To encompass the connectivity required for successful ferry service, it was recommended that ECO expand the catchment areas to be as generous as possible. The most expedient approach to incorporate access in the existing TMD is to increase park-and ride services at the proposed ferry terminals.

QUALITY: A higher quality ride represents increased consumer utility, which Metro attempted to account for by assuming that ferry is preferred to other transit modes.[9] Additionally, we attempted to capture other measures of quality by reducing the perceived walking and waiting time ("transfer penalty") required to access the ferry system. We also increased ferry speeds to capture the *perceived* benefit of that mode, which incorporates research demonstrating that ferry travelers are willing to accept longer trip times for increased amenities.

After identifying the set of parameters that would be revised, ECO worked with Metro to operationalize changes within their regional transportation model. Cost and time were barriers to major revisions of the model scenarios. However, after several discussions we determined that there were specific parameters that could be modified to reflect the behavioral responses that reflected preference for ferry service.

TRANSFER PENALTY (COST):

- *Preliminary:* Ten-minute walk for St. John's (due to distance and slope); five-minute walk for all other terminals
- *Supplemental:* Assumed five-minute walk to reach all terminals

DRIVE ACCESS (ACCESS):

- *Preliminary:* 30 available park-and-ride spaces at St. Johns and Sellwood terminals
- *Supplemental:* Increased to 500 park-and-ride spaces at the Oregon City, St. John's, and Vancouver terminals

AVERAGE SPEED (QUALITY):

- *Preliminary:* 23.98 knots (27.6 mph)
- *Supplemental:* 24.77 knots (28.5 mph)

FARE STRUCTURE (QUALITY):

- *Preliminary:* One-way fare: $2.50
- *Supplemental:* Changed to the existing TriMet fare structure ($1.39-$1.72) based on origin and destination

Preferences for ferry service cannot be measured directly within the existing model. Instead, we must rely on indirect measures (proxies) of preference for ferry service that induce a mode split. In other words, we are seeking to condition the set of parameters in the model to act "as if" they are representative of the perceived costs and benefits associated with traveler preference for ferry service.

This approach allows for identification of key parameter changes that may be most effective at inducing a mode split along the proposed corridors. TDMs are complex and there are many interactive effects between variables. As such, it is difficult to measure the impact of a single input/assumption through sensitivity testing.

[8] Metro has indicated that research on this topic is emerging and may be included in subsequent iterations of their regional transportation model
[9] In Metro's regional transportation model, light rail is the preferred mode of transit. Within that mode they ensured that ferry service was given preferential treatment.

PROJECT ALTERNATIVES

Several routes were proposed for the preliminary analysis. Table 1 displays each of the proposed routes, along with the cities that would be served for each alternative. Each of the routes are intended to serve slightly different populations. Both Express routes emphasize routes and schedules that focus on commuter traffic originating on the north end or south end of the Portland Metro region. The Circulator route is intended to also capture non-commuter pedestrians who are traveling to the downtown corridor for reasons other than morning or evening commutes (i.e. errands, meetings, etc.). The hybrid route encompasses both populations, but with reduced service.

Schedule and budget limited the number of alternatives considered for this analysis. As a result, we focused our attention on the North and South Express routes. Additionally, we included a St. John's terminal as an option in these alternatives, as it met several conditions for a successful ferry service:

- There is a relatively direct path along the waterway between St. John's and Portland's downtown area.
- Congestion along the St John's bridge and lack of access to rapid transit in the area could make ferry service an effective alternative to existing modes.
- The location of St. John's downtown area, along with increasing density in Cathedral Park make the site attractive for potential connective service along the waterfront.

Aside from this adjustment, we did not make any modifications to the proposed routes developed in the preliminary analysis.

TABLE 1. PROPOSED ROUTES FROM PRELIMINARY ANALYSIS

CITY	EXPRESS-NORTH	EXPRESS-SOUTH	HYBRID	CIRCULATOR
Vancouver	X		X	X
St. John's			X	X
Portland, Downtown	X	X	X	X
South Waterfront				X
Sellwood			X	X
Milwaukie				X
Lake Oswego			X	X
Oregon City		X	X	X

Source: Oregon Metro Transportation Research and Modeling Services

MODEL OUTPUTS AND ESTIMATED RIDERSHIP

Based on the parameter changes described above, ridership estimates across all Express routes increased. Across all three segments, park-and-ride users accounted for a larger portion of the increased ridership. Using park-and-ride as a proxy for access to the terminal suggests that access is a critical feature to increasing ridership. This generally aligns with feedback from ferry planners that increasing the catchment area for connectivity to the terminal is a key feature of successful ferry service. However, some caution should be used in interpreting these results. We do not have a complete set of comparisons across all parameter changes and interactions in the model. This makes the marginal effect of each parameter adjustment difficult to describe without further information.

From the limited model runs conducted, it appears that access to the terminals through optimal placement and connective services is likely to be a key driver of demand for a proposed route. For a more detailed description of the results, we provide Metro's memorandums in appendices A and B, which also provides intermediate outputs for the test scenarios used in the preliminary analysis.

TABLE 2. PRELIMINARY AND SUPPLEMENTAL RIDERSHIP ESTIMATES BY PROPOSED ROUTE

	EXPRESS-NORTH	EXPRESS-ST JOHN'S	EXPRESS-SOUTH	HYBRID	CIRCULATOR
Preliminary Analysis	6	28	48	126	210
Supplemental Analysis	195	1,050	617	N/A	N/A
Increase from P&R Riders (%)	84%	78%	58%	N/A	N/A
Increase from non-P&R Riders (%)	16%	22%	42%	N/A	N/A

Source: Oregon Metro Transportation Research and Modeling Services

RECOMMENDATIONS

The intent of this analysis was to analyze ridership estimates for the preliminary Frog Ferry demand analysis by looking to modify parameters that could represent a range of perceived costs and benefits associated with traveler preference for ferry service. In effect, this analysis attempts to build a "best case" scenario of ridership demand within the existing specifications of Metro's regional transportation model. As Metro notes within their own description of the results, these ridership estimates are intended to be exploratory and are not official forecasts of ridership.

We cannot determine, based on this analysis alone, whether there is enough demand to justify ferry service in the region. These estimates are context dependent and comparison to existing modes of transit may not be relevant. Ferry service has a different carrying capacity and financial structure than land-based modes of transit. The basis for understanding whether these estimates are sufficient can only be determined within the context of similar modes of transit.

To demonstrate the viability of ferry service, a financial feasibility study should be completed to ensure enough revenues can be generated to cover the cost of providing the service. Within that context, the revised demand estimates may be sufficient to sustain a financially feasible initial phase of operations proposed by Frog Ferry. Additionally, this analysis cannot, on its own, speak to the efficiency of the proposed program. That measure should be quantified through a benefit-cost analysis which can help determine if the benefits of using public dollars to invest in this service outweigh the costs. Finally, this demand analysis does not answer questions about equity and how the service may improve the well-being of low-income and vulnerable populations in the Metro area.

Each of these analyses provide a different lens to understand the demand estimates reported by this study. Therefore, we recommend using this analysis as a foundation to further investigate the range of potential benefits associated with Frog Ferry's proposed service.

APPENDIX A

METRO PRELIMINARY DEMAND MODELING MEMO

APPENDIX B

METRO SUPPLEMENTAL DEMAND MODELING MEMO


Source: Shutterstock

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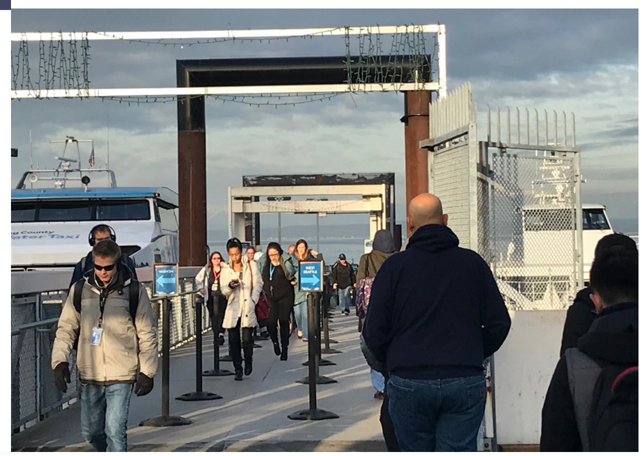
IDAHO
Eagles Center
223 North 6th Street, Suite 430
Boise, ID 83702
208-515-3353

Appendix D – Case Studies



Passenger Ferry Best Practice Case Studies for the Portland-Vancouver Market

How cities are taking advantage of underutilized waterways to reduce traffic congestion, improve air quality and strengthen community connections.

Fall 2019

Completed by the Friends of Frog Ferry

FRIENDS OF
FROG FERRY

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Introduction

The transportation infrastructure of most metropolitan U.S. cities is being rapidly outgrown. “Greater Portland,” or as it is also known, the Portland metropolitan area (PMA), is the last major river city region in the country without water-based commuter transportation. This plan involves reviewing the best practices gleaned from a variety of case studies and then applying the lessons learned to a potential Portland, Oregon regional water ferry service. The selected markets were based on the findings of two years of meetings and interviews, after multiple conversations with passenger ferry experts who suggested similarities between the featured ferry markets in this report and the Portland market due to parallel operational or governance challenges.

Interviews were conducted with the leadership of most of the operators to help generate comparisons with the Portland regional service, in order to identify best practices that apply to our region from a political, cost or operational perspective. The six ferry transit operations analyzed were:

I. KITSAP COUNTY TRANSIT - WASHINGTON STATE

II. KING COUNTY WATER TAXI - WASHINGTON STATE

III. SAN FRANCISCO BAY AREA FERRY - CALIFORNIA

IV. POTOMAC RIVERBOAT COMPANY - WASHINGTON, DC

V. CITYCAT - BRISBANE

VI. THAMES CLIPPER - LONDON

The approaches used by these operations are helping to reduce greenhouse gas emissions, air pollution and road gridlock. Furthermore, they are strengthening communities through social interaction and connections to natural waterways and local history.

The following case studies provide a snapshot of passenger-only ferry services, also known as “foot ferries” or “water taxis”. Though the studies cover a wide variety of topics ranging from operational requirements to the governance of publicly-run versus privately-held organizations, they are not exhaustive; rather, the studies provide introductory insights into services, funding mechanisms, schedules, ticket costs and (skyrocketing) rider demand.

Like Portland, Oregon and Vancouver, Washington, the cities in which these services operate are experiencing unprecedented population and economic growth, worsening traffic congestion and air quality, and a potential stifling of continued economic vitality. A growing number of public and private operators have launched or expanded water transit services as an efficient and attractive method for improving commerce by giving workers another commuting option and by freeing up congested roadways for commercial vehicles.

The sectors of transportation and energy are shifting the community infrastructure landscape and rewriting how business is conducted. With the ever-changing demands of the traveling public and the general “greening” of the ferry industry, many new strategic alliances are being forged.

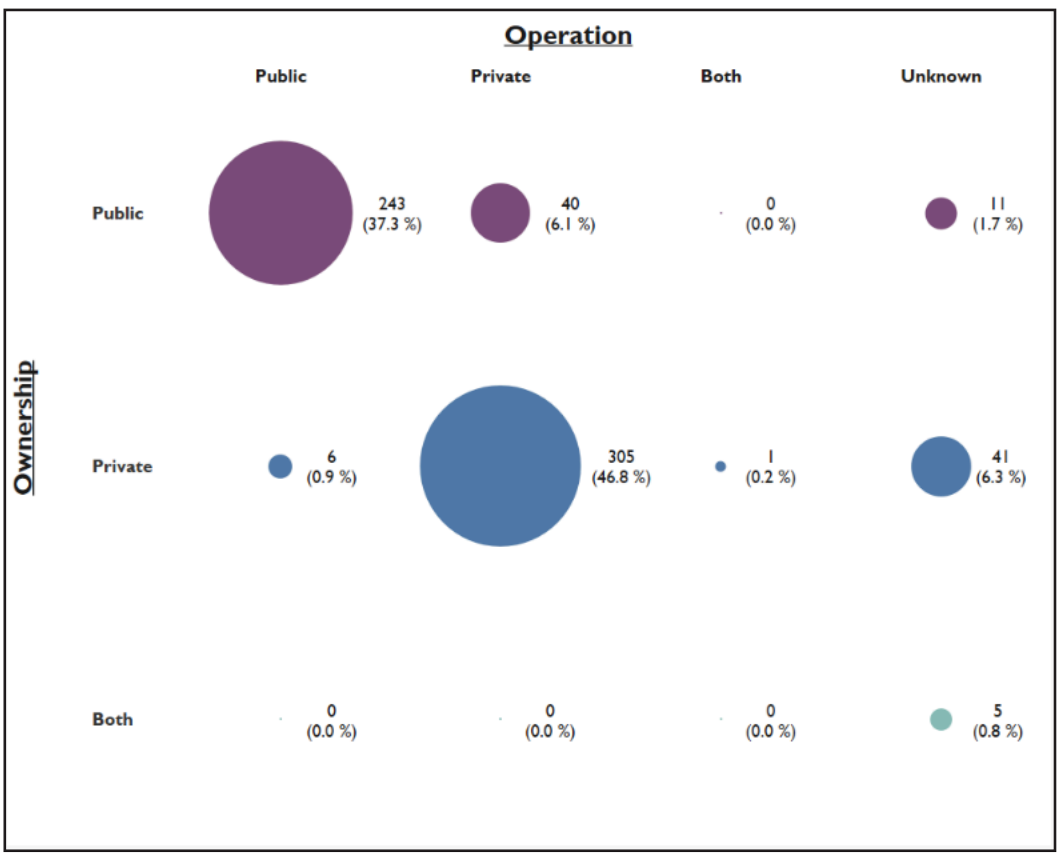
Obviously, foot, also known as passenger, ferries are not the sole solution to urban transit woes; however, as these water-based services clearly demonstrate, they can and do serve as integral players in a well-functioning and truly multimodal transportation ecosystem.

Situational Analysis: U.S. Ferry Service Overview

US Ferry Operation Highlights: Ferries are used to commute to work in river/coastal cities, to cross water in rural areas, to receive services in island regions and for recreation and tourism. There are approximately 220 ferry operators across 37 states, operating 652 vessels. In 2016, more than 119 million passengers were transported by ferry, with New York and Washington State accounting for the top passenger numbers. In New York City and San Francisco, there has been a recent resurgence in ferry use. New York City plans to add 10 new ferry terminals and 19 new vessels by 2020, to facilitate 4.6 million annual trips across six routes. From 2013-2015, San Francisco's ridership increased 25 percent, prompting the construction of new terminals, vessels and added route segments.

Of the 652 vessels, 313 are passenger-only vessels, with the average passenger capacity of 323 passengers, and a median passenger capacity of 149. The average operating speed reported 14 knots, with a maximum speed of 43 knots. 92% are fueled by diesel, 3.4% by gasoline engines, and 4 are powered by electricity (US Dept of Transportation, Bureau of Transportation Statistics, National Census of Ferry Operators 2017).

Figure 5: Number of Vessels by Ownership and Operation (2015) U.S. Bureau of Transportation Statistics.
Source: U.S. Department of Transportation Bureau of Transportation Statistics, National Census of Ferry Operators 2016, Appendix A, Table 5, available at www.bts. gov as of October 2017.



History of Ferry Service on the Columbia & Willamette Rivers

Sources: Ruby, Brown. Ferry Boats on the Columbia River. Superior Publishing Company. 1974.
Charles F. Query. A History of Oregon Ferries since 1826. Maverick Publications. Revised 2008.

With special thanks to the Oregon Historical Society's research library.

Long before fur traders, miners, and early settlers arrived in the area, the Columbia and Willamette rivers were regulated, highly-utilized passageways that connected tribes throughout the region. These were the major arterials that made the shipment and trade of the region's bounty possible. Highly trafficked and well-worn paths led down to the river's edge, with many of these original Indian trails located where major thoroughfares exist today—most notably Sandy River Boulevard.

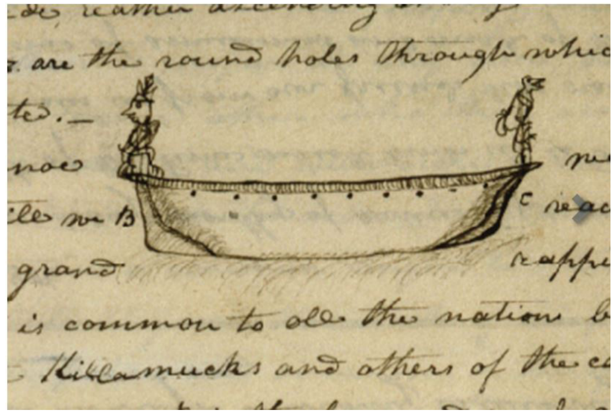


Photo: Confederated Tribes of Grand Ronde

The influx of people descending on the region—early enterprisers such as the Hudson's Bay fur trading company, explorers like Lewis and Clark, miners and treasure seekers, and migrants such as Americans from other states looking to move out West—had a profound impact on river utilization. Tribal sovereignty was disrupted and regulation over the waterways and what traveled down them began to unravel. In 1848, the Oregon Territory boundary was established.

Many people were interested in operating ferries along the river and for unique reasons: some wished to "cross" miners to the Indian trails to look for gold, some wished to shuttle livestock, some got in the business of transporting Oregon Trail settlers. All of this activity created economic opportunity (and opportunities to gouge ferry passengers with steep fares). In 1849, the newly formed Oregon Territory legislature passed "An Act Regulating Ferries" which granted licenses and set rates and taxes for would-be ferry operators. With this legislation came an untold number of applications for licenses. As the city of Portland was settled and growing into a bustling center for transport of freight along the Willamette valley, (with East Portland as its own city at the time), the need for ferry service crossing east and west along the river led to several ferry crossings whose notable names are recognizable to this day.

In addition to the smaller operators, Portland Railway Light & Power (PRL&P) played a heavy hand in large-scale ferry service between Portland and Vancouver. PRL&P was the local industrial monopoly that controlled all transportation facilities (and the still emerging electrical grid) in the Portland region. After 1853 when the Washington Territory made a break from the Oregon Territory, the Columbia River officially became the dividing boundary (and technically a federal highway) between the two territories, both of which would soon become states. Governance and regulation over the Columbia River fell under the control of the PRL&P. This included the major ferry crossing that connected Vancouver and Portland. With the advent of the automobile, and changing preferences by locals who wished for quicker ways of getting from 'point A to point B,' ferry service began to fall out of favor. PRL&P saw an opportunity to create an 'interstate' bridge that would allow rail freight to be moved at greater speed and efficiency. With strong public support, PRL&P underwrote the cost of the bridge. In 1917, the day that the new Interstate Bridge opened, Portland Railway Light & Power officially shut down ferry operations between Vancouver and Portland.

With public sentiment now wholly focused on automotive transportation, passenger ferry service effectively disappeared along the region's waterways. What were once bustling, activated routes of transportation, the Columbia and Willamette rivers went dormant for most uses, save for occasional barge freight such as gravel and wheat, and occasional sightseers and pleasure boaters.

Today's Transportation Challenge

The Portland Metro Area has experienced tremendous growth; it has become a regional daily topic of conversation. With inbound interstate migration increasing by 150 people per day, the enhanced density contained within the defined urban growth boundary has dramatically increased traffic congestion.

Portland has long been an innovator for multimodal transportation. In 1986, east-to-west and north-to-south running MAX Light Rail lines were installed; splinter systems including the Portland Streetcar, which operates as a central city circulator and the Willamette Shore Trolley, which runs summer weekends were later established. There are three ferry services that run in the Willamette Valley, that reflect passenger boarding counts (2015) of more than one million.

Costs of Congestion: Transportation infrastructure transforms communities and is a vital component of community development.

Traffic congestion is projected to increase by as much as thirty percent by the year 2040. Transportation comprises 37% of Oregon's greenhouse gas emissions. Investing in transit methods that employ green technologies will reduce net operating expenses while minimizing the impact on the environment.

Reduction of road congestion is the highest priority action item for the Oregon Business Plan Transportation Advisory Committee. Every day, more than 230,000 vehicles cross between Oregon and Washington using the Interstate (I-5) and Glenn L. Jackson Memorial (I-205) Bridges. Passage of the $5.3B Oregon Transportation HB 2017 Funding Bill focused on infrastructure improvements over the next 10 years to stimulate the economy and improved the quality of life while reducing gridlock. The City of Portland approved $36 million in transportation projects in November 2018. PMA traffic congestion impacted businesses and families with $1.8 billion in lost time and increased fuel consumption costs.

Portland's distinctive personality shines through in nicknames and slogans like "River City", "Portlandia", "Stumptown", "Keep Portland Weird" and "City of Bridges." Locals take pride in being unique and creative, and they support using new and multiple modes of transportation to reduce PMA's carbon footprint. Bicycle lanes are a cultural norm, with 15,000 cyclists crossing five bicycle-friendly bridges each day. Portland is a walking friendly city with short blocks; the City of Portland, with support from Nike and other local business, has started BIKETOWN. This bike sharing program deploys 1,000 bikes to more than 100 stations across Portland. Recently, Portland approved the use of electric scooter sharing and in the 120-day trial period, people took 700,369 trips covering 801,887 miles. Of those with favorable opinions, 71% are using e-scooters as transportation to a destination. Portland was an early test market for Uber and Lyft, where usage has skyrocketed. These two companies gained 35% of the Portland International Airport market within the first two years of launch.

These diverse transportation choices are designed to give residents and visitors a fun, affordable and convenient alternative to autos, taxis and ride-sharing to help efficiently and effectively move people who are seeking to avoid congestion and high downtown parking fees.

Although there is a lot of proactive transportation planning in the PMA, the obvious passenger ferry option is currently not available. Naysayers may cite a lack of expertise or fear of unanticipated costs; however, Portland and Vancouver are iconic in that the communities sit at the confluence of two major rivers, there is ample expertise in the passenger ferry service in hundreds of markets around the world, where passenger ferries are considered a best practice and strategic use of public funding. This underutilized natural highway infrastructure must be seriously considered as another forward-looking solution to our traffic problems.

Mission Statement

Create a safe and sustainable river-friendly public passenger ferry service to better connect people to their river while alleviating traffic congestion in the Portland-Vancouver Metropolitan area.

Objectives

- New transit mode to connect people to workforce
- Emergency Response capacity builder
- People-driven, through a social equity lens
- Environmental Benefit, lower carbon emissions
- Cost effective: 30% farebox recovery, strategic public subsidy
- Efficient: Short 3-year time table to implementation. Low project management costs

Photo: Aerial view of Willamette Falls Locks

Photo: Seattle ferry

Case Studies

KITSAP COUNTY TRANSIT (WASHINGTON STATE)

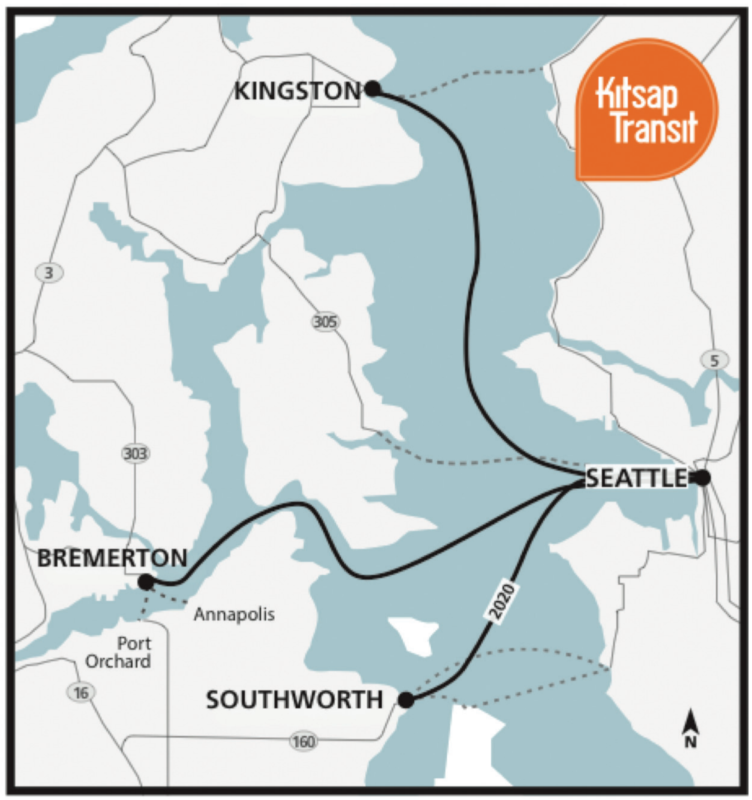
Fun fact: Between 1850 and 1930, hundreds of small, steam-powered ferries called the Mosquito fleet carried travelers to and from islands and peninsulas in the Puget Sound.

BACKGROUND

Kitsap County voters approved a ballot measure in 2016 for a sales tax to support passenger-only "fast ferry" service to downtown Seattle from Bremerton, Kingston and Southworth. The Bremerton route launched in July 2017 and Kingston in November 2018. Southworth boats will hit the water in 2020.

FUNDING

Operations for the Kitsap County local and fast ferry service are funded primarily from fares and the dedicated sales tax. Capital projects are supported chiefly by federal and state grants. They have a 30% fare box recovery; the fare is $12 per round trip while $36 is the true cost. They move approximately 37,000 passengers a month.



KINGSTON FAST FERRY

The 40-minute commuter service features six round-trips (no Sunday service) — three in the morning and three in the afternoon — between the Kingston Ferry Terminal and Colman Dock in downtown Seattle. The cost is $2 to Seattle and $10 for the return trip. The ferry carries 350 passengers. All seats face forward for a clear line of sight and operate at 30+ knots. They run a hybrid model, which adds battery weight.

BREMERTON FAST FERRY

The 40-minute commuter service makes eight round trips - three in the morning, five in the afternoon. The cost is $2 to Seattle and $10 for the return trip. The ferry has a capacity of 118, including 12 spots for bicycles.

RIDERSHIP MILESTONE

The fast ferry service (across both routes) attracted a record 45,000 riders in May 2019. Ridership exceeded 334,912 passengers last year. Kitsap Transit forecasts a ridership of at least 500,000 passengers by 2023.

VESSELS

Kitsap County Transit runs two high-speed catamarans on each route, each with four engines and four jets. The area has wake restrictions, and these boats are designed to create a very low wake while operating at high speeds (roughly 40 miles per hour). The ferry carries 350 passengers. All seats face forward for a clear line of sight and operate at 30+ knots. They run a hybrid model, which adds battery weight.

The transit agency has also ordered two new 250-passenger vessels with delivery expected around 2020 for service on both the Kingston and Southworth routes. The 140' by 37' by 12' aluminum, high-speed catamarans will have capacity for 26 bicycles.

(Image, King County)

INNOVATION

In addition to the fast ferries, Kitsap Transit operates two local ferry routes - between Bremerton and Port Orchard and Bremerton and Annapolis. A first-of-its-kind, hybrid-electric vessel will soon service the Bremerton/Port Orchard route.[1] The 150-passenger boat uses a diesel engine to power a generator, which then charges a battery bank that propels the vessel. Once the batteries are charged, the engines shut off.

LESSONS LEARNED:

- Consider fuel burn, energy sources and vessel type.
- Impact of increased speed = increased fuel cost, vibration, maintenance cost.
- River debris can be an issue; Forward-Looking Infrared (FLIR) system is better in fog than in rain.
- Offer competitive compensation plan to retain great talent. Staffing Requirements: Eight employees (1 captain, 2 deckhands, 1 additional - AM and PM crews).
- Reliability is the primary determinant of success.
- Frequency is key factor.
- Dock facility specialized with proper ramping for the operation.

1 Electric ferries are gaining steam. Taking a cue from industry pioneers in Norway, the Washington State Ferry system is converting (slowly) to hybrid and electric vessels. "But if you want an electric boat, you're not going to have a fast boat," says Sanjay Bhatt, a spokesperson for Kitsap County Transit. The charging infrastructure and battery size aren't sufficient to enable rapid marine transit, and for those reasons, the new hybrid vessel will not be put into service on the fast ferry route.

II. KING COUNTY WATER TAXI (WASHINGTON STATE)

Fun fact: Public ferry service between West Seattle and downtown Seattle ran from 1888 to 1913.

BACKGROUND: King County Department of Metro Transit Marine Division operates two passenger-only ferry services from Pier 52 in downtown Seattle to Vashon Island and West Seattle. The Washington State Ferry system operated the Vashon service from 1994 through mid-2008. Argosy Cruises, a private company, operated the West Seattle route from 1998 through 2009. This service was contracted by King County Metro and was a seasonal service. The Marine Division is responsible for the operations, moorage, and maintenance of the vessels that provide ferry services. Passenger-only ferry services are provided from Pier 50 in downtown Seattle, with service to Vashon Island and West Seattle.

FUNDING

Operation and capital funding come from fares, federal grants and a special property tax levied on all property in the county. Operating expenditures in 2018 were $7.74 million. Fare revenues clocked in at around $3.2 million. Fare box collection is 45% of revenue.

VASHON ISLAND FERRY[2]

The service features six round-trips daily, weekdays only and during the morning and evening commute. Tickets cost $6.75 one way. In 2018, this route carried nearly 250,000 passengers, an 11% increase over 2017. The route has doubled annual ridership since taking over the operation in 2010.

WEST SEATTLE

The service features 12 round-trips during the morning and evening commute, with additional weekend and mid-day service April thru October. Tickets cost $5.75 one way and the route carried nearly 415,000 passengers in 2018, which was a 10% increase over 2017.

RIDERSHIP MILESTONES

- 665,000 passengers were transported system-wide in 2018, bringing the total passenger count to more than 5.8 million since inception in 2009.
- The West Seattle route carried nearly 415,000 passengers in 2018, a 10.4% increase over 2017.
- Year-round commute ridership increased by 4.3% during this period.
- The Vashon Island route carried nearly 250,000 passengers in 2018. This is an 11.3% increase over the previous year, with the Vashon route doubling in annual ridership since King County took over service in 2010.
- Use of a 10% biodiesel blend fuel. High efficiency technology and design.

2 The City of Tacoma is also pursuing fast ferry service to Seattle. A feasibility study completed last year estimated capital costs would be about $40 million, with operating expenses running about $2.83 million. The trip would take around 43 minutes, compared to 50 to 120 minutes by car.

VESSELS

The King County water taxi service operates two vessels, each with a capacity of 278 passengers. Federal funds covered 80% of the $11.8 million cost.

SAFETY: To ensure safety, King County Water Taxi vessels are U.S. Coast Guard Certified under Subchapter K rules, crews are properly credentialed with merchant mariner documents and TWIC's, the division is in the process of implementing a safety management system, there is careful maintenance of a U.S. Coast Guard-approved vessel and carefully trained crews. The KCMD vessels are considered very stable due to the catamaran hull form. Crews are trained to navigate waterways shared with paddle boarders, kayakers, and recreational divers.

REDUCING GREENHOUSE GAS EMISSIONS: The King County Water Taxi has taken the following actions to reduce greenhouse gas emissions:

- Use of a 20% biodiesel blend fuel.
- High efficiency hull technology and design.
- Regional green mobility, including storage for 26 bike rack spaces on vessels.
- Facility energy audits.
- Strategies to reduce garbage and increase recycling from on-board operations.
- Green initiatives and Passenger Vessel Association memberships.

EMERGENCY PREPAREDNESS: Whether in response to an extreme weather event or seismic activity, a natural disaster or a threat to national security, ferries serve as an essential marine link for the transport of supplies or to serve as an evacuation platform as well as to transport first responders.

EDUCATION: Advancing the opportunities for career development and creating pathways to maritime jobs is supported through the Seattle Maritime Academy. Training opportunities exist through the King County Wastewater Division, internships, on-board response scenarios, and partnerships with other agencies.

PARTNERSHIPS: The King County Marine Division has formed many partnerships with agencies, businesses and communities throughout the Puget Sound region to develop solutions for providing efficient transportation solutions. Examples include partnerships with counties for transit, lease agreements with other agencies for use of docks and facilities, partnering on parking solutions at key stops, joint ownership of float/docks, partnering with transit agencies to align scheduled departures, presentations to community advisory groups, multi-jurisdictional maritime emergency response exercises, and local recreational group engagement.

LESSONS LEARNED:

- Operated by the mobility operating agency, Metro, and known for their bus services, they connect communities and are focusing their current strategic planning on underserved communities.
- The farebox recovery of 45% is considered best in class in the United States; however, the agency is also resisting increasing fares to remain cost effective and equitable for all riders.
- Their seven-month peak season begins in late March (coinciding with the Mariner's Season) and runs through the fourth week of October.
- Round-Trip Fares: Seattle to West Seattle – Cash: $11.50 and ORCA $10. Vashon to Seattle – Cash - $13.50 and ORCA - $11.50
- Waterways are less congested than roadways and experience far less variability in travel time; accordingly, on-time performance is 98% and the trip reliability rate is 99%.
- Integrated with the ORCA card for seamless transfers between other modes of transit; bus, light rail, street car.
- In order to encourage use, there is no additional cost for bike rack usage.
- 2018 ridership was up 11% over 2017 numbers to 660,000 passengers a year.
- Operations occur in a 14-foot tide variation.

III. SAN FRANCISCO BAY AREA FERRY (CALIFORNIA)

Fun fact: In the mid-1930s, boats ferried more than 150,600 passengers daily across San Francisco Bay.

BACKGROUND: The San Francisco Bay Area Water Emergency Transportation Authority (WETA)[3] operates the San Francisco Bay passenger-only ferry system with service to the cities of Alameda, Oakland, Richmond, San Francisco, South San Francisco and Vallejo. An aggressive 20-year strategic plan calls for increasing the fleet from 17 to 44 vessels and growing ridership five-fold by 2035. Additional services to the Mission Bay neighborhood of San Francisco and Seaplane Lagoon in Alameda are expected to be up and running within a few years. For nearly 10 years, the agency was called "WTA," but resilience planning was added to the mission in 2008 and "E" for "Emergency" was added. WETA was created in 1999 by the Bay Area Council, as a public-private taskforce, which was chartered to create and maintain the vision to start a service.

Ferry service is modular, and if a route changes, there is no need to remove rail lines or roadways. The modularity of the infrastructure means that special services for sporting events, can be added and dock sites are relatively easy to reconfigure depending on market demand. The San Francisco Bay has a fluctuating tide of approximately seven feet (the Willamette River is at 26 feet variance), and they have been challenged to create ADA-compliant gangways and docks that don't exceed a 12:1 slope with a flexible dock design that works with multiple vessel freeboards, that are flat and can interface with fixed points on land.

Key drivers of success include reliability, ride quality, and the ability for passengers to multitask and make good use of their time. Customer satisfaction ranks in the 90th percentile, and 92% of passengers have other transit options but choose the ferry: 40% BART/Rail, 12%Bus, 18% Drive Alone, 8% Carpool, 4% Casual Carpool, 7% TNC/Uber-Lyft. Passengers choose to ride the ferry: 65% to avoid traffic/parking; 50% ride quality; 50% relaxing experience; 30% ability to multi-task; 28% faster commute; 15% environmental benefit; 13% sightseeing; 5% no car; 5% less expensive; 5% other.

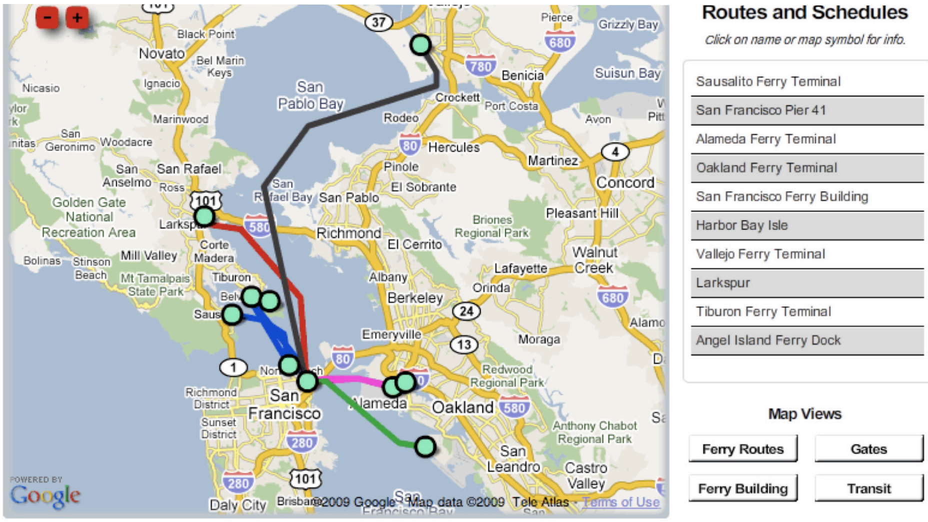
LESSONS LEARNED:

- WETA was created by a public-private partnership in 1999. These partnerships are considered a best practice for starting new organizations and modes.
- A ferry service is modular and provides more operational flexibility. When a route changes, rail lines or roadways needn't be removed.
- Ability to customize capacity for special events, ball games, emergency response.
- Flexible dock design accommodates a fluctuating tide while maintaining ADA compliance.
- Key success metric: On-time performance followed by highest use of personal time during transit. (i.e. Wi-fi for work, relaxing atmosphere.)
- Ferry commuters are willing to take multiple modes of transit when looking at first and last mile.
- Fluctuating tides can be challenging for ADA-compliant dock slopes.

FUNDING

Operating revenues are comprised chiefly of bridge toll revenues and fare revenues. Total operating expenses for 2017/2018 were $38 million. Capital funding sources include California Proposition 1B transportation emergency bonds, federal transit dollars and regional levies. In January 2019, WETA launched service to Richmond, which was a project that included a $20 million partnership between the Contra Costa Transportation Authority and the City of Richmond to build the Richmond Ferry Terminal.

3 WETA was created in the aftermath of the Loma Prieta earthquake in 1989, when damage to the Bay Bridge forced the return of ferry service. The system's popularity, along with renewed interest in water transit as a critical emergency response tool, led the state legislature to approve funding for the agency in 2007.

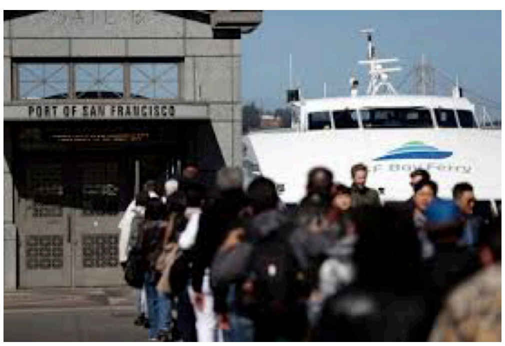


RIDERSHIP MILESTONES

The new Richmond line attracted more than 740 daily riders during April and May 2019 – up from the agency's projected ridership of 480 daily rides. Ridership on the San Francisco-Alameda-Oakland run is up 115 percent over five years ago, while the San Francisco-Vallejo ferries are carrying 66 percent more passengers. The entire system carries around 2.7 million riders annually.

VESSELS

In the past two years, WETA has added four new 400-passenger ferries at a cost of $15 million each. The 135' aluminum catamarans are each equipped with a urea-based exhaust aftertreatment system from Hug Engineering, allowing them to meet new EPA standards for cleaner marine vessels. The engines burn biodiesel, further reducing emissions.[4] Three additional high speed 445-passenger ferries will be delivered late in 2019, and a 300-passenger vessel is expected to be in service by 2020.



Passengers line up to catch the SF Bay ferry (Image: San Francisco Chronicle)

REFERENCE:

https://sanfranciscobayferry.com/sites/sfbf/files/pr/MANewVessel181004.pdf

San Francisco Examiner https://www.sfexaminer.com/the-city/new-richmond-to-sf-ferry-service-nets-incredible-ridership-growth-years-early/

San Francisco Chronicle https://www.sfchronicle.com/bayarea/nativeson/article/Even-the-SF-Bay-ferries-are-crowded-these-days-12871007.php

IV. POTOMAC RIVERBOAT COMPANY (WASHINGTON, DC)

Fun fact: White's Ferry is the last of 100 ferries that used to operate on the Potomac River. Elijah White, a former confederate officer, operated the ferry in the 1870s and named his boat after his former General, Jubal A. Early. The ferry connects Whites Ferry Road in Montgomery County, Maryland with a road by the same name in Loudoun County, Virginia.

BACKGROUND: The Potomac Riverboat Company, which launched its first water taxi in 2008, has operated dinner/tour boat cruises since 1974 and connects Alexandria to National Harbor and the Gaylord National Hotel and Convention Center in Oxon Hill, Maryland. In 2012 and 2018, respectively, Potomac added additional service from National Harbor and Alexandria to the National Mall and then to the Wharf. Round-trip tickets start at $18.00 for adults and $12.60 for children. (Potomac was acquired by Entertainment Cruises in 2016 and is pending another sale.)[5]

RIDERSHIP MILESTONES

In 2018, the company served about 250,000 riders. While most current passengers are tourists, the operator and public transit officials aim to attract more daily commuters. A test of commuter appetite is currently underway: As of Memorial Day, Potomac Riverboat had added extra service through September 8 to compensate for the Metro shutdown at the stops beyond the National Airport.

VESSELS

In June of 2018, the company invested $10 million in the acquisition of four new boats and increased the water taxi fleet to seven ferries. Each of the 87-foot taxis carry 149 passengers and reach speeds of roughly 26 miles per hour. Unique open-air decks on the outside – a second level provides space during the pleasant summer months, with the rails and seats holding an additional 50 people. Mechanizing the folding rails in 6-8-foot sections has been recommended, as currently, they manually set 128 pin lanyards and bench seats. The seating on the lower deck accommodates 74, with standing room for 99. It is a T-boat classification of under 149 passengers (K-boat for more than 149 passengers). Bucket seats are installed on the lower deck and bench seating is found above. Additional room for six bikes exists on the back. As the longest route is only 45 minutes, the single restroom can support the ridership numbers.

Image, Potomac Riverboat

The bow slopes up near the forward gate for bow landing, however, considereration should be made to eliminate the slope. The engine rooms are tight, and there should be consideration of a wider and longer platform with more length and width at the hull. Consider narrowing and reinforcing the bow for potential impact with river debris. The Potomac operation uses propeller propulsion, which has experienced challenges with river debris and operates Sanya 500 HP twin engines. The ramps are built on the boat with a pulley-system ramp.

LESSONS LEARNED:

- Start with your culture: it's difficult to start if the public doesn't have a history or understand the value of water-based transit.
- From a policy perspective, boats are much easier than land-side planning and development.
- Remember that every plan starts with an idea. There is always room to grow and expand upon ideas. Don't try to accommodate everyone at the start.
- The BMT vessel meets most of our operational requirements. We must look at improvements for handling river debris and minimizing carbon output.
- Do your outreach early and get familiar with those who are most impacted by operations on the river. Citizens living near the river who are accustomed to no traffic will need considerable outreach.

REFERENCE:

Business Journals: https://www.bizjournals.com/washington/news/2018/06/05/alexandria-company-adds-four-water-taxis-to-meet.html

Washington Post: https://www.washingtonpost.com/express/2019/05/14/during-metro-shutdown-riders-could-turn-water-taxis-transportation/

Greater Greater Washington: https://ggwash.org/view/71933/metro-bus-bike-maybe-ill-take-the-water-taxi-to-work-today

4 Funded in part by California cap-and-trade appropriations, a private company, Clean Marine Energy, is building a proof of concept 70-foot, 84-passenger, hydrogen-powered catamaran to be piloted in San Francisco Bay. Clean Marine hopes eventually to sell its zero emissions fleet to transit agencies.

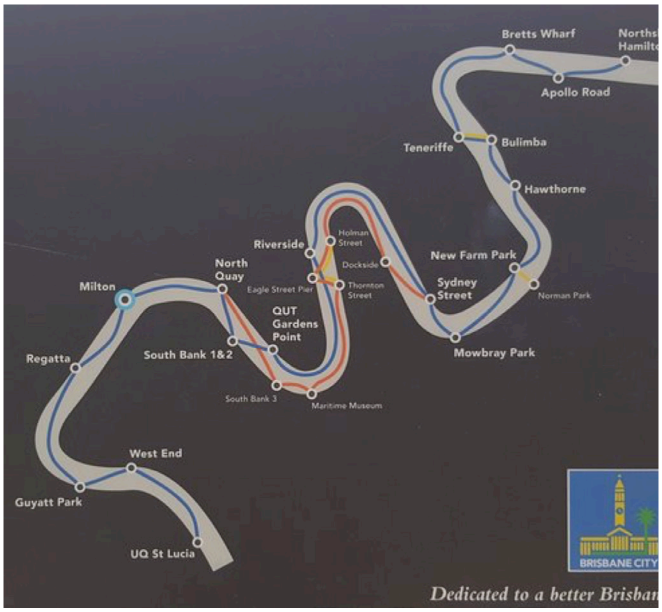
5 Although Potomac is the only private system featured in this roundup, it should be noted that many public transit ferry systems grew out of private companies that eventually merged under the auspices of a public authority.

V. CITYCAT, BRISBANE

Fun fact: The first ferry in Queensland started on January 1, 1843 with service crossing the Brisbane River.

HISTORY/BACKGROUND

Brisbane's CityCat passenger ferry service launched in November 1996. Today, the ferry transports approximately 5.4 million passengers during more than 219,000 annual trips. The fleet is managed by private operator TransDev on behalf of the Brisbane City Council. The network serves the University of Queensland, St Lucia Campus and Northshore Hamilton with daily services from 25 terminals along the Brisbane River.



Background - In June 2019, the city council approved a $30 million budget for six high speed double-decker CityCats, which are scheduled to be completed by 2020. The first vessel to be delivered is the $3.7M Supercat, featuring an upper-deck with 16 seats. The interior features table and lounge seating options, USB charging ports and larger windows.

CREW: All CityCats are operated by a crew of three - a master, a deck hand and a ticket seller.

SCHEDULE: The CityCat operates daily with the first route starting at 5:25 a.m. and the last ferry docking at 12:55 a.m. A $5.60 ticket is good for two hours.

VESSELS: A fleet of 21 CityCats (catamarans) and nine monohulled ferries. A peak hour express service, SpeedyCats, launched in September 2018.

LESSONS LEARNED:

- Single-floor design for passengers (easy wheelchair and stroller/pram access)
- Faster loading/unloading when you don't need to allow for people changing floors
- Less liability by eliminating stairs
- Low staffing needs: captain + deckhand (plus optional barista)
- Low-wake
- Reliability and safety should be givens
- Plenty of inside room, but both front and rear outside decks are available for when the weather is good; available seating addresses the needs of the commuters and tourists
- Room for bicycles — a critical factor here in Portland
- Short stops of less than 2 minutes at each riverside ferry terminal help minimize commute times (see https://www.brisbane.qld.gov.au/traffic-transport/public-transport/citycat-ferry-services/citycat-journeys)

Amenities:

- Elevated bridge so that the captain can better see trees and other debris in the river; I don't know what can be done from a ship design/technology perspective to mitigate impacts to ferry schedules and avoid damage to vessels when conditions are sub-optimal.
- Espresso/snack counter.
- On-board Wi-Fi.

REFERENCE:

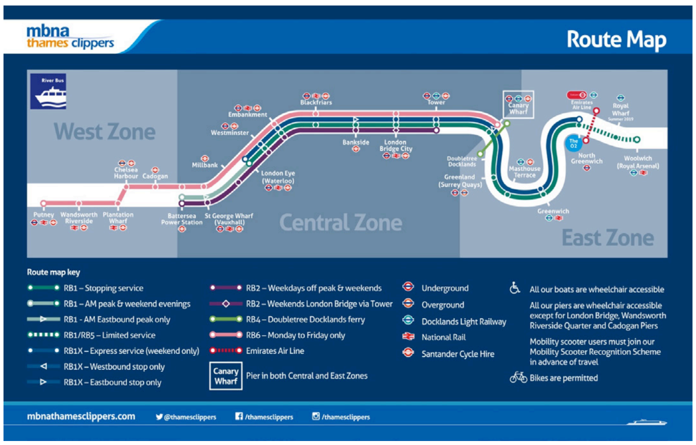
Brisbane Times https://www.brisbanetimes.com.au/national/queensland/cat-s-out-of-the-bag-first-look-at-brisbane-s-double-decker-citycat-20190820-p52iuf.html

Brisbane City Council: https://www.brisbane.qld.gov.au/traffic-and-transport/public-transport/citycat-and-ferry-services

VI. THAMES CLIPPER, LONDON

Fun fact: The first ferry on the Thames can be traced back to the 1300s, when it ran from a North Shore fishing village known today as Woolrich to Warren Lane on the South shore.

BACKGROUND: The company serves 8,500 commuters and tourists a day, running operations from eastern and central London. CEO Sean Collins founded MBNA Thames Clippers in 1999 with partner Alan Woods, recognizing the need for a reliable high-speed commuter and passenger river service. The service was acquired in September 2006 by U.S.-based Anschutz Entertainment Group. The network features six fast ferry routes (four commuter and two tourist) serving 22 piers between Woolwich, the O2, Greenwich, Rotherhithe and central London. A fleet of 19 vessels carries more than four million passengers a year, a number that continues to rise from the three million passengers who rode in 2013. Transport for London (TfL), a public agency, licenses the system and manages the piers. TfL and London councils subsidize a few of the routes.



Brisbane City Cat

PASSENGERS: Commuters during peak times and tourists during the day.

TICKETS: An adult single trip fare ranges from £4.40/$5.30 to £9.90/$11.90 (£3.90/$4.70 to £7.50/$9.00 if payment is made online, in an app or with an Oyster or Contactless Card) and is integrated into London's public transport payment system, Oyster and Contactless payments. Passengers save one-third off standard fares with a London Travelcard. A River Roamer ticket, valid for one day, is available for hop on/off service along the banks of the Thames.

SCHEDULE: Clippers depart every twenty minutes from the major piers of Westminster Millennium Pier, Woolwich Arsenal Pier, as well as 12 other stops. The Thames Clipper also operates a service at the Hilton Hotel Rotherhithe for guests of the hotel as well as the general public.

Thames Clipper

VESSELS: The Thames Clipper operates 19 vessels, 17 of which are high speed catamarans, at a maximum speed of 28 knots, with capacity for around 200 passengers. The newest vessel, the Venus Clipper, featuring twin symmetric hulls, has a capacity of 222 passengers and is the most energy efficient model to date.[6] Collectively, the newer vessels are equipped to navigate the Thames shallow waters and pass under London's low-slung bridges.

6 A low sulfur-fuel cap that goes into effect in 2020 is expected to add extra costs for conventional car-based ferries but should boost prospects for passenger ferries, Peter Morton, CEO, Wight Shipyard, told Maritime Executive. "This is because it does not have to worry about finding the increased capex to fit scrubbers or face a huge surge in costs by changing to low sulfur fuel, as fast ferries already run on low sulfur fuel. When fuel costs go up for conventional ferries for low sulfur fuel post 2020, fast ferries will be in a much more competitive position."

MILESTONES: A joint venture finalized in 2018 handed the Clippers a five-year contract to manage the Central London Cruise Moorings, alongside the Port of Tilbury. The partnership will transport cruise passengers from their ships to the center of London. In October 2019, Clipper services began running to the new Royal Wharf, a new neighborhood on the north bank of the Thames.

INNOVATION: Thames Clippers is working in partnership with Beckett Rankine and Aus Yachts on a proposed electric, fully accessible ferry cross-river solution. The Clipper is also part of the Port of London Thames Vision that calls for doubling the number of trips using the Thames to 20 million a year by 2035. In addition, in September 2017, Thames Clippers ran a trial commuter service between Gravesend and Central London.

LESSONS LEARNED:

- Deckhand compiles passenger counts on and off and maintains the passenger log (for passenger counts in case of an emergency).
- There are eight CCTV camera locations that the captain can view, to help expedite boarding and de-boarding. Deckhand uses signals as well.
- Real-time data posted on the app as well as at the boarding location. They use paper and paperless tickets.
- They guarantee a seat. The vessel is popular for sightseeing as well as for commuters. (There are multiple water-based transit operators on the Thames River.)
- They have a low aircraft and low water draft requirement on the Thames River.

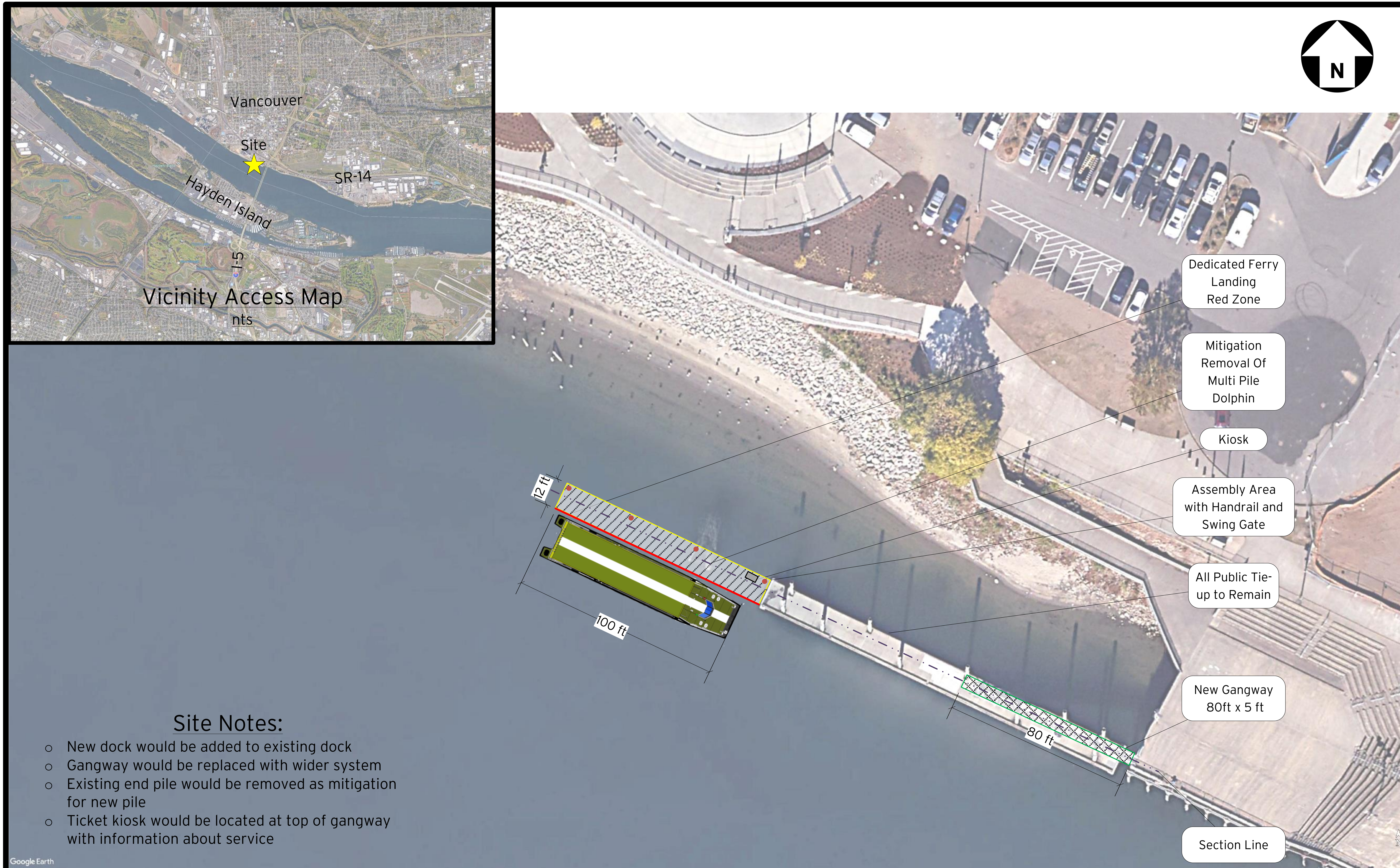
REFERENCE:

Port of London Authority

https://www.pla.co.uk/Port-Of-London-Authority-awards-London-Cruise-Moorings-contract

Maritime Executive: https://www.maritime-executive.com/corporate/wight-delivers-first-in-class-to-mbna-thames-clippers

Appendix E – Concept Drawings

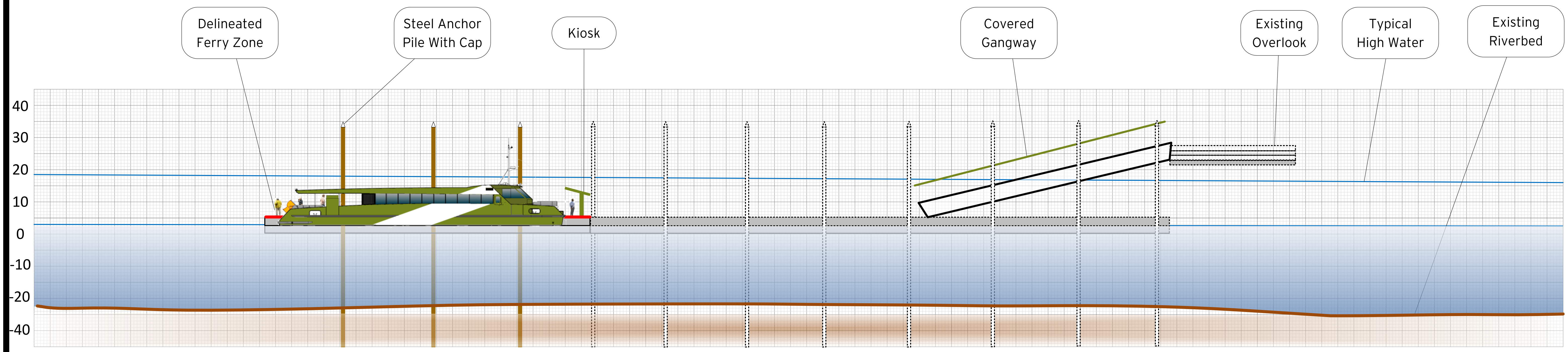


Site Notes:

- New dock would be added to existing dock
- Gangway would be replaced with wider system
- Existing end pile would be removed as mitigation for new pile
- Ticket kiosk would be located at top of gangway with information about service

Vancouver Watefront Landing Plan

Figure 4.A.Plan - Vancouver Waterfront Landing



Vancouver Waterfront Landing Section

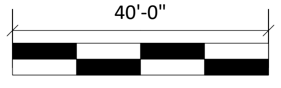
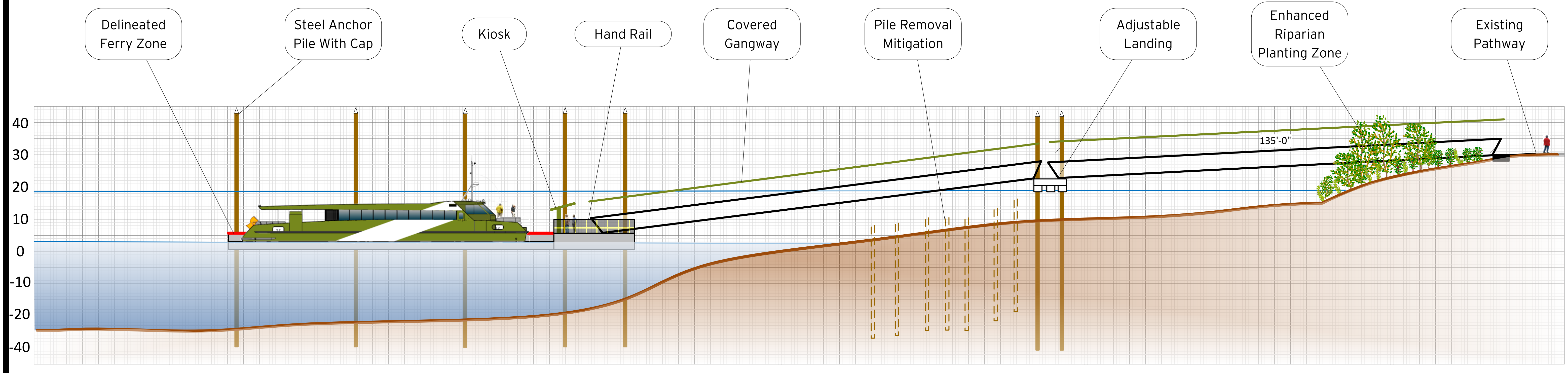


Figure 4.A.Section - Vancouver Waterfront Landing

Figure 4.B.Plan - Cathedral Park Landing



Cathedral Park Landing Section

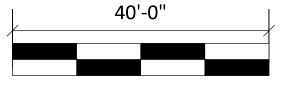
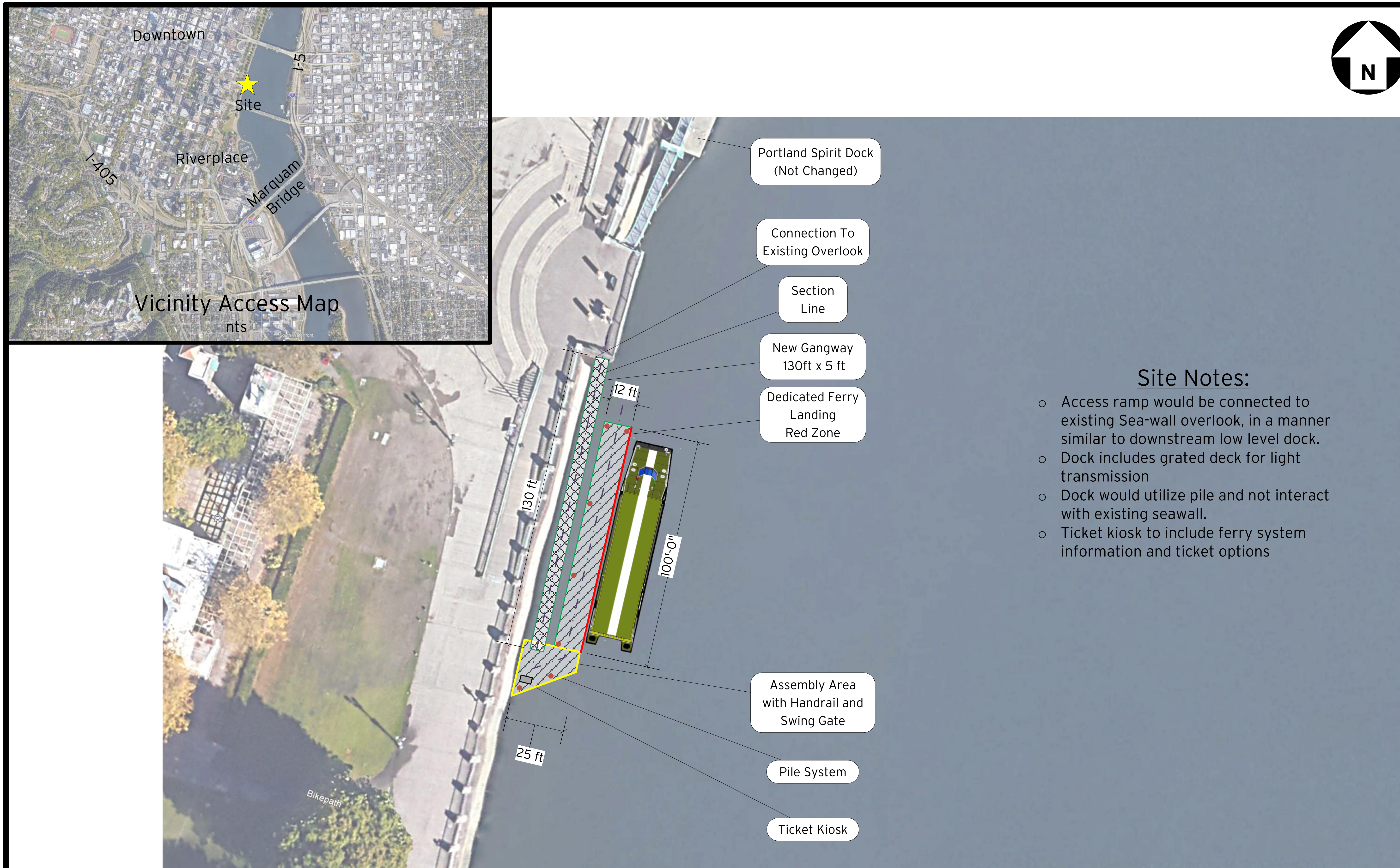


Figure 4.B.Section - Cathedral Park Landing



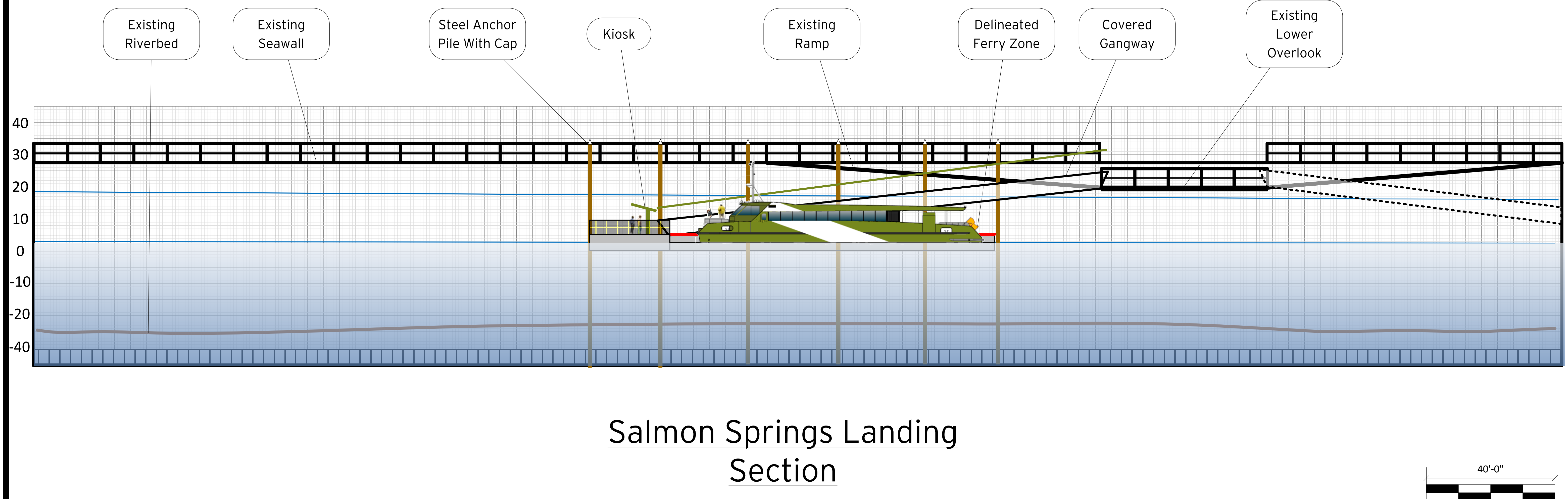
Site Notes:

- Access ramp would be connected to existing Sea-wall overlook, in a manner similar to downstream low level dock.
- Dock includes grated deck for light transmission
- Dock would utilize pile and not interact with existing seawall.
- Ticket kiosk to include ferry system information and ticket options

Salmon Springs Landing Plan

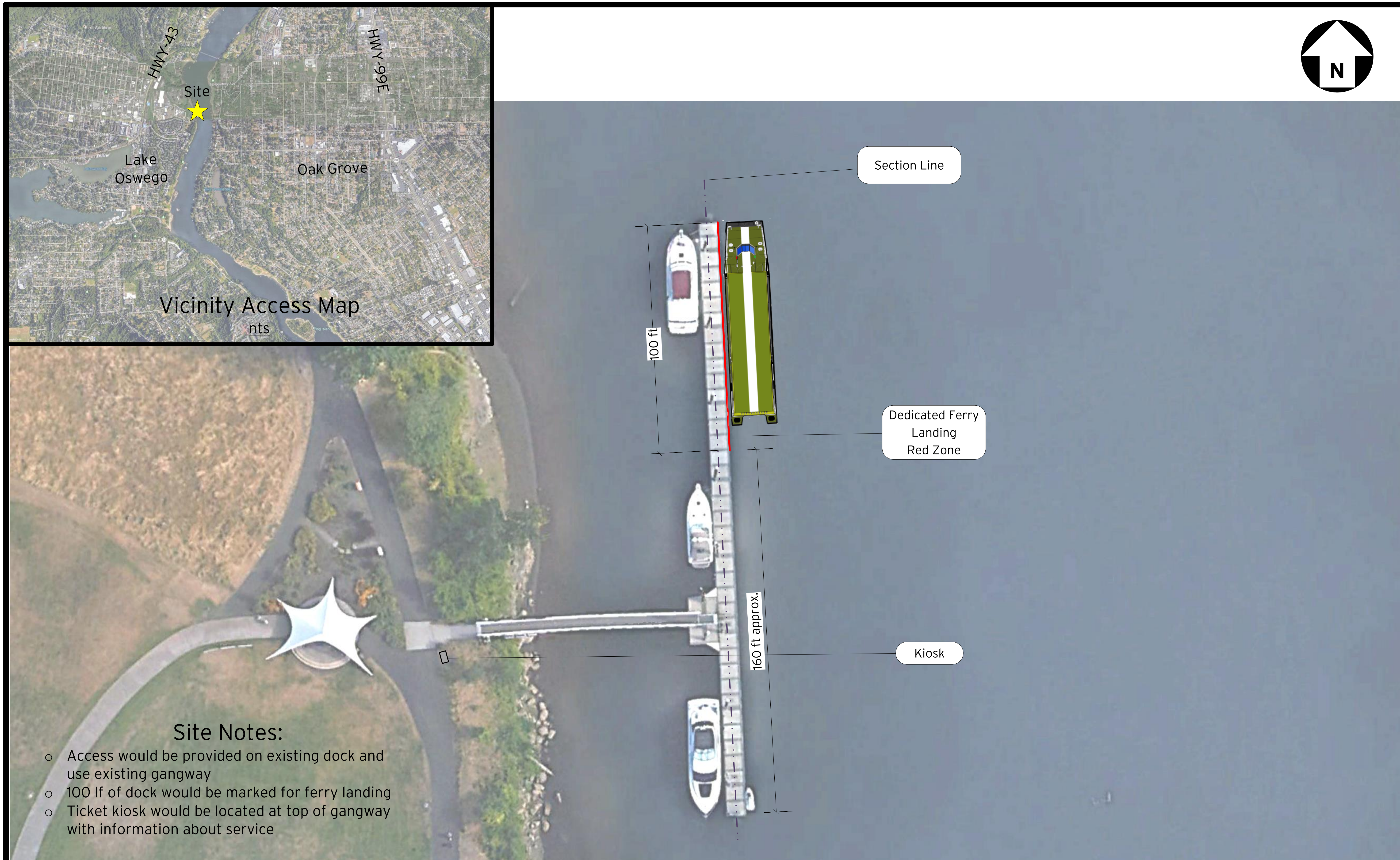
40'-0"

Figure 4.C.Plan - Salmon Springs Landing



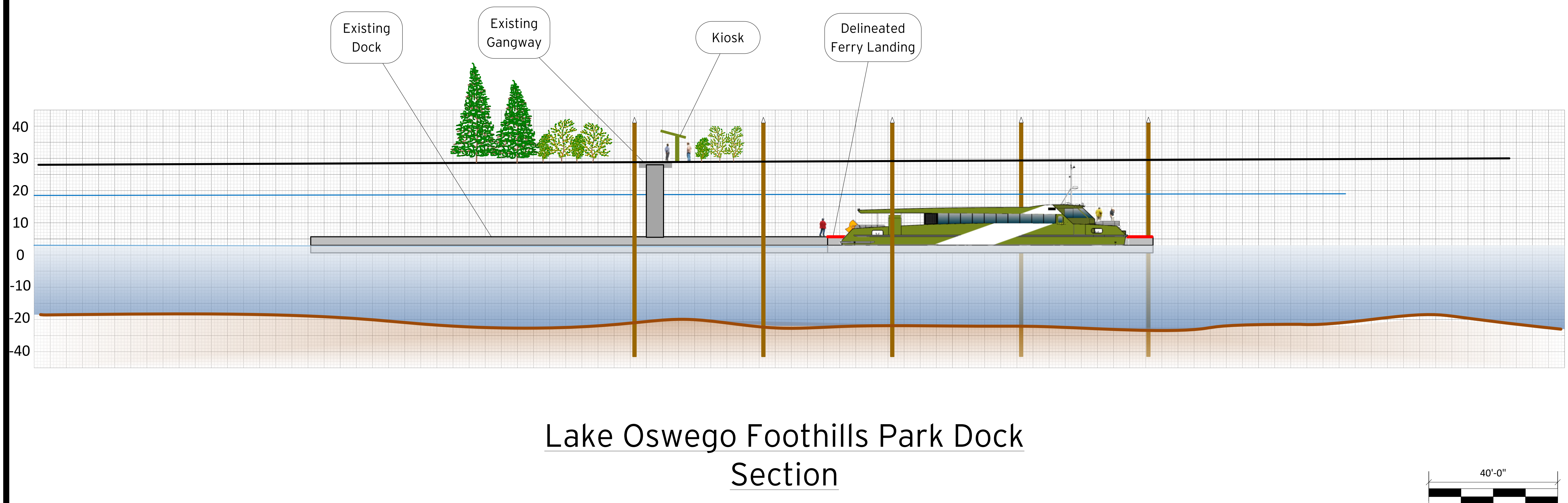
Salmon Springs Landing Section

Figure 4.C.Section - Salmon Springs Landing



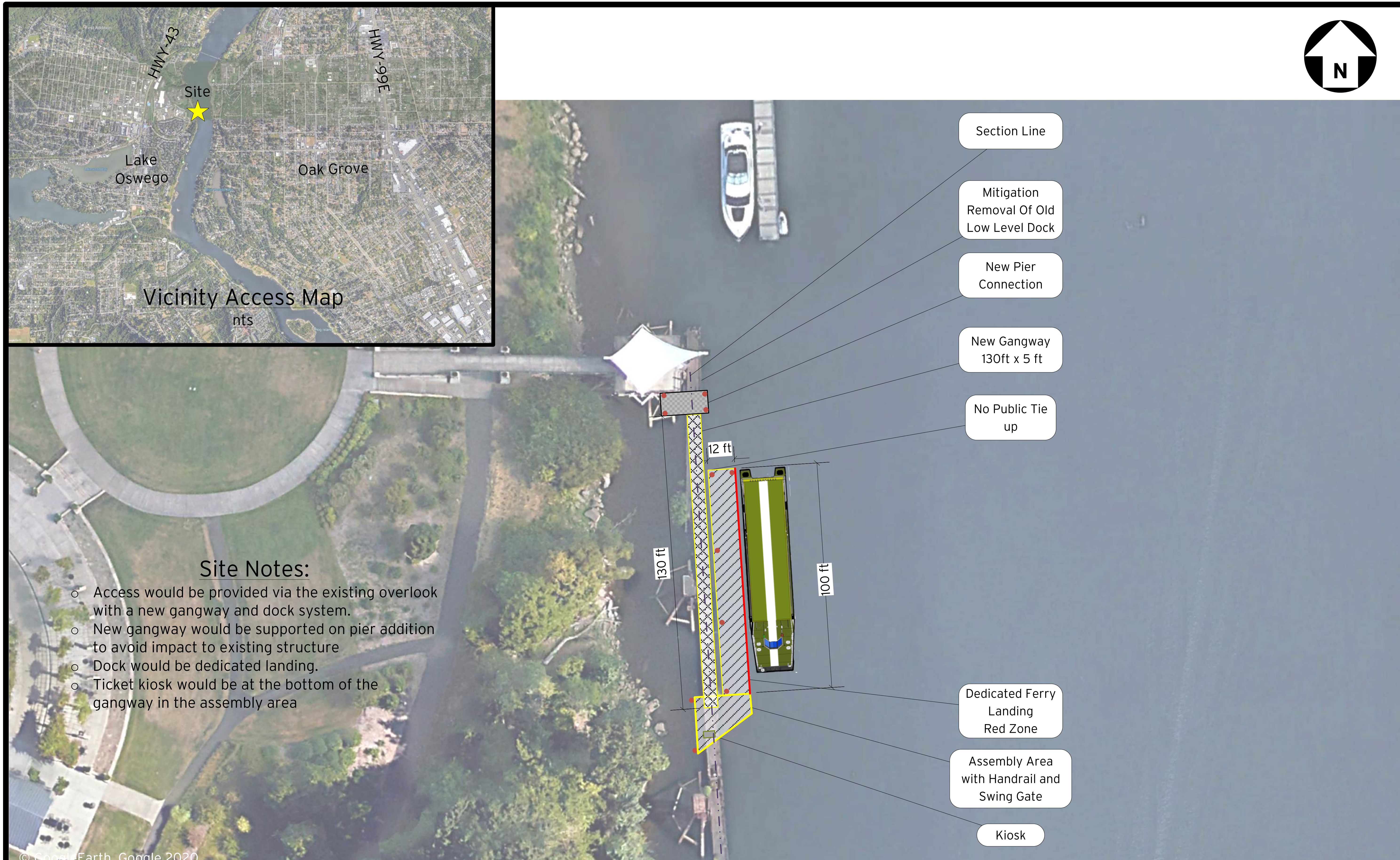
Lake Oswego Foothills Park Dock Plan

Figure 4.D.Plan - Lake Oswego Foothills Park Dock



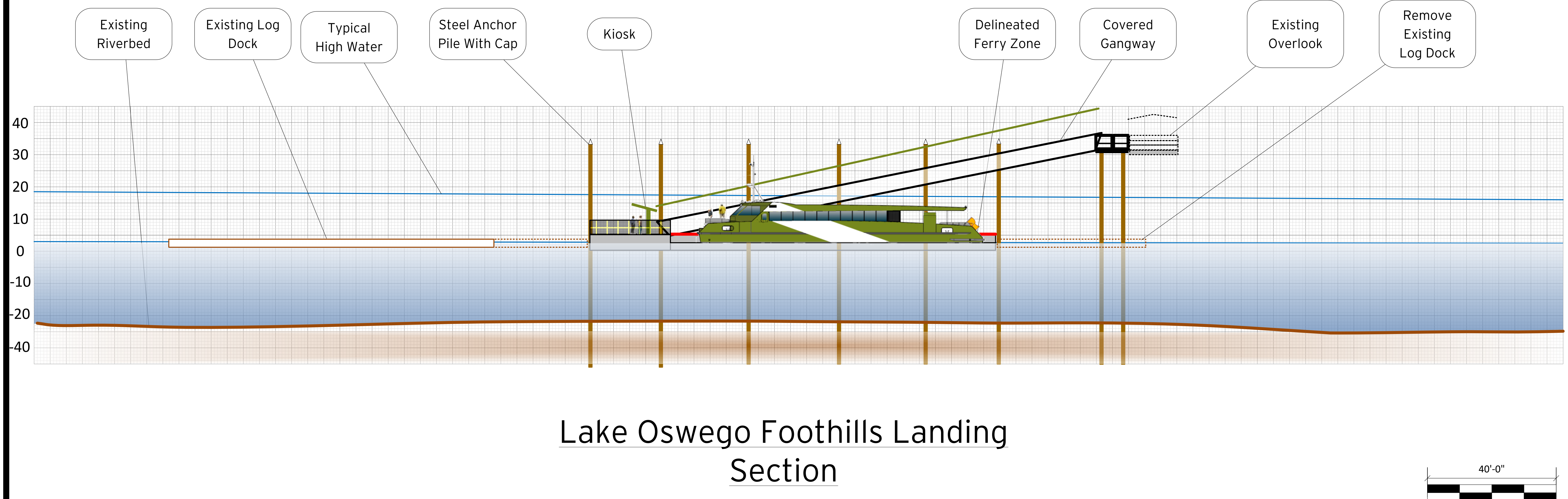
Lake Oswego Foothills Park Dock Section

Figure 4.D.Section - Lake Oswego Foothills Park Dock



Lake Oswego Foothills Landing Plan

Figure 4.E.Plan - Lake Oswego Foothills Landing Plan(Alternate)



Lake Oswego Foothills Landing Section

Figure 4.E-Section - Lake Oswego Foothills Landing Section (Alternate)