City of Redwood City

Draft Final Report

Ferry Financial Feasibility Study &
Cost-Benefit and Economic Impact Analyses

October 2020

CDM Smith

Acknowledgments

City of Redwood City Council Members

Diane Howard, Mayor

Shelly Masur, Vice Mayor

Alicia C. Aguirre, Council Member

Ian Bain, Council Member

Janet Borgens, Council Member

Giselle Hale, Council Member

Diana Reddy, Council Member

Port of Redwood City Commission

Ralph A. Garcia, Chair

Richard (Dick) Claire, Vice Chair

R. Simms Duncan, Port Commissioner

Richard “Dick” Dodge, Port Commissioner

Lorianna Kastrop, Port Commissioner

San Mateo County Transportation Authority

Jennifer Williams, Analyst II, San Mateo County Transportation Authority

Peter Skinner, Director of Grants and Funding, San Mateo County Transportation Authority

Project Team

Christopher Dacumos, Management Analyst II, City of Redwood City

Jessica Manzi, Transportation Manager, City of Redwood City

Radha Mehta, Management Fellow, City of Redwood City

Kristine A. Zortman, Executive Director, Port of Redwood City

Kevin Connolly, Planning & Development Manager, WETA

Arthi Krubanandh, Transportation Planner, WETA

Chad Mason, Senior Planner & Project Manager, WETA

James Connolly, Project Manager, COWI

Jessica Rivas, Marine Engineer, COWI

Ashleigh Kanat, Executive Vice President, EPS

Jason Moody, Principal, EPS

Kate Traynor, Senior Associate, EPS

Lindsey Klein, Project Planner, PlaceWorks

Charlie Knox, Principal, PlaceWorks

Bill Hurrell, Vice President, CDM Smith

Piyali Chaudhuri, Project Manager, CDM Smith

Peter Martin, Project Technical Lead, CDM Smith

Sean R. Vienna, Senior Transportation Planner, CDM Smith

Eric McClellan, Senior Economist, CDM Smith

Evan Bigos, Economist, CDM Smith

Chiranjivi S. Bhamidipati, Transportation Planner, CDM Smith

Paula F. Hirsch, Lead Administrative Assistant, CDM Smith

Table of Contents

List of Figures

List of Tables

Appendices

Acronyms

ABAG	Association of Bay Area Governments'
ADA	Americans With Disability Act
APIs	Application Programming Interfaces
BAAQMD	Bay Area Air Quality Management District
BAC	Bay Area Council
BART	Bay Area Rapid Transit District
BCA	Benefit-cost analysis
BCR	Benefit-cost ratios
C/CAG	City/County Association of Governments of San Mateo County
CEQA	California Environmental Quality Act
CES	Current Employment Statistics
City	City of Redwood City
CMA	County Congestion Management Agency
ECR	El Camino Road
EDD	Employment Development Department
EL	Elevation
EPS	Economic & Planning Systems Inc.
IMPLAN	Impact Analysis for Planning
I/O	Input-Output
IRR	Internal rates of return
LEHD	Longitudinal Employer-Household Dynamics
MLLW	Mean Lower Low water
MOU	Memorandum of Understanding
MTC	Metropolitan Transportation Commission
NPV	Net present value
O&M	Operations and maintenance
OAK	Oakland
Port	Port of Redwood City
Redwood City	The geographical area of Redwood City
RWC	Collectively the organizations of the City of Redwood City and Port of Redwood City, and sometimes used to refer to the geographical area
SAMCEDA	San Mateo County Economic Development Association

SamTrans	San Mateo County Transit District
SF	San Francisco
SIA	Seaport Industrial Association
SMCTA	San Mateo County Transportation Authority San Mateo County
Study	RWC Ferry Financial Feasibility Study & Cost Benefit and Economic Impact Analyses
SOV	Single Occupancy Vehicle
TAC	Technical Advisory Committee
TDM	Transportation demand management
TMA	Transportation management association
TOD	Transit-oriented development
USACE	United States Army Corps of Engineers
VHT	Vehicle hours traveled
VMT	Vehicle miles traveled
VOC	Vehicle Operating Cost
VTA	Santa Clara Valley Transportation Authority
WETA	Water Emergency Transportation Authority
WTA	San Francisco Bay Water Transit Authority (the previous iteration of WETA)

Section 1
Introduction

The San Francisco Bay Area is one of a handful of major metropolitan regions in the United States that has a passenger ferry system as part of its transportation network. Between 2009 and 2016, the number of jobs in the San Francisco Bay Area, specifically in San Francisco and San Jose and on the Peninsula increased by 19.9 percent to over 3.8 million jobs, representing the fastest rate of growth in the United States. Traffic congestion was at an all-time high with the number of highway miles traveled in congested conditions rising from 3.1 percent to 5.8 percent between 2009 and 2016.[1] The Bay Area is planning for and investing in multimodal solutions to ease congestion including expansion of the regional ferry system. In 2016 the region's primary ferry operator, the Water Emergency Transportation Authority (WETA), made plans to add 11 terminals and 8 routes by the year 2035 including a potential terminal in Redwood City (RWC). WETA is the main transit operator providing ferry service over much of the San Francisco Bay and previously existed as the San Francisco Bay Water Transit Authority (WTA). Water transportation has potential to be an effective mode of transport in the Bay Area because it exploits the barrier effect of the Bay on other forms of surface transportation. Yet there are still challenges to making ferry service feasible, especially with limited access for travelers to and from the terminals, which are often located a distance from employment destinations, and the lack of funding to pay for facilities, operations and maintenance.

Source: City of Redwood City, 2020

This Study was funded by the San Mateo County Transportation Authority and managed by Redwood City (referred to sometimes throughout this report as "City" or "Redwood City") and the Port of Redwood City (Port, collectively the City and Port are referred to as RWC) with technical assistance from WETA. This multi-year effort was conducted by a consultant team lead by CDM Smith, with outreach conducted by PlaceWorks, conceptual terminal engineering designs developed by COWI, and financial feasibility/economic impacts analyzed by Economic & Planning Systems Inc. (EPS).

Redwood City and WETA first studied ferry service at a Port location in 2012.[2] The partnership predates 2012 and began when WETA was first known as the WTA in 1999. This Study set out to evaluate ferry service feasibility from five interconnected perspectives, as illustrated in **Figure 1-1**. An introduction is provided in **Section 1**, Existing Conditions in **Section 2**, and extensive public outreach that provides the basis for ensuring that the proposed ferry service is consistent with both Redwood City's and WETA's development plans is presented in **Section 3**. Transport market analysis

1 Vital Signs, Metropolitan Transportation Commission, 2016.
2 Redwood City Ferry Terminal Site Feasibility Report.

and ridership forecasts used to identify ferry routes and forecast ferry user demand is shown in **Section 4** followed by ferry terminal facility plans and engineering costs in **Section 5**.

Combined, this background information addresses what service is needed, who would use it, and how much a new terminal would cost. It is used with new ferry purchase and operation costs, to assess the Financial Feasibility (**Section 6**) and Economic Feasibility (**Section 7**)[3]. Whereas the financial analysis addresses WETA farebox recovery objectives, the economic analysis quantifies how monetized user benefits compare with total project costs (both Redwood City terminal and WETA ferry operations). The Economic Impacts Analysis (**Section 8**) illustrates the quantitative impacts associated with building the new terminal and operating the ferries, as well as the broader qualitative impacts associated with transport amenities to Redwood City residents and area businesses. Should this Study help Redwood City determine that public commuter ferry service is feasible, Redwood City would then need to develop a Business Plan to receive additional San Mateo County Transportation Authority (SMCTA) Measure A funding. The SMCTA requires a business plan for Redwood City ferry service that demonstrates how the transit service would be cost-effectively provided, how ridership will be attracted, and how the overall project would be financed. Provided the business plan is accepted by the SMCTA, the next phase will be preliminary design (and associated environmental and permitting activities) for the construction of the ferry terminal.

A diagram from the Scope of Work is available in **Appendix A**, to help better understand the workflow of this Study, from Existing Conditions analysis to Economic Impact Analysis, to get to a determination of feasible or not.

Figure 1-1: Feasibility Perspectives

Source: CDM Smith, 2020

[3] i.e., benefit-cost analysis.

Should this Study help Redwood City determine that public commuter ferry service is feasible, Redwood City would then need to develop a Business Plan to receive additional San Mateo County Transportation Authority (SMCTA) Measure A funding. The SMCTA requires a business plan for Redwood City ferry service that demonstrates how the transit service would be cost-effectively provided, how ridership will be attracted, and how the overall project would be financed. Provided the business plan is accepted by the SMCTA, the next phase will be preliminary design (and associated environmental and permitting activities) for the construction of the ferry terminal.

Section 2
Existing Conditions

2.1 Background

For many years, WETA has had plans for a future terminal in Redwood City to accommodate travelers headed for major employment destinations on the Peninsula.[4] The shallow depth of the southern portion of the Bay leaves few viable sites for a South Bay terminal that would be allowable under environmental restrictions or require costly dredging. In 2012, WETA conducted initial assessment studies, including environmental assessment and location studies, a coastal engineering report, and a ferry site assessment report to determine the most appropriate site for a future terminal.

Source: WETA, 2020

While San Mateo County Measure A has programmed $30 million in funding for capital costs in support of cost-effective ferry service in San Mateo County, the recent passage of Regional Measure 3 in June 2018 could provide funding for the expansion of ferry service in the region by allocating up to $300 million in capital funding and up to $35 million in annual operating funds. Redwood City and South San Francisco have agreed in principal to evenly split the $30 million between the two cities. This confluence of local funding sources, along with growth in employment and traffic congestion has encouraged major employers and the City to search for viable commute alternatives for City residents and workers. Private entities are partnering with the public sector to study Bay Area congestion problems in order to implement transportation infrastructure projects that have been in the planning

[4] 2016 Strategic Plan, San Francisco Bay Area Water Emergency Transportation Authority, 2016; The Peninsula refers the area that includes San Mateo County and northern Santa Clara County, home to many of the region's major employers.

stages for years, including improvements to the Dumbarton Transportation Corridor, which would serve the East Bay and Peninsula commute markets.

The City has been a proponent of sustainable transportation solutions, denser development around transit facilities, and an active participant in addressing regional transportation challenges. Its central location on the Peninsula, high level of transit access, and lively Downtown district, continue to attract major employers and residents. The City is projected to add 15,670 jobs (22 percent increase) between 2020 and 2040.[5] These factors, combined with the presence of an active port, have positioned Redwood City as a viable candidate for future ferry service. The City has led, as well as participated in, multiple studies to improve transportation access in Redwood City, including the Citywide Transportation Plan, Streetcar/Urban Circulator and Transit Center Improvements Feasibility Study. Since 2014, a few private tech companies have operated private ferry service pilot programs from the Port of Redwood City to transport employees from locations that were otherwise very long shuttle bus commutes.[6] The pilot programs were only available to the employees of the sponsors. A future terminal in Redwood City that is funded with public dollars would have to be available to all members of the public as a condition of receiving funding.

2.2 Transportation Context

2.2.1 Regional Commute Patterns

There are a number of regional trends underway that are likely to worsen the jobs housing balance. Plan Bay Area 2040 projected the region would add 1.3 million jobs (37.7 percent increase) and 2.3 million people (33.2 percent increase) between 2010 and 2040, but half of this projection had already materialized by 2015.[7] The cost of housing and local housing policies have long constrained the construction of housing units in the region, making it difficult for housing supply to keep up with demand. Between 2010 and 2015 San Mateo County added 72,500 new in-commuters to the county.[8] Additionally, many workers choose to reside in other parts of the Bay Area for affordability or family reasons, instead of residing on the Peninsula for purposes of short commutes which will be further explored under Section 8. Recently, attempts have been made at the state level to address California's housing shortage.

As shown in **Figure 2-1**, average commute times from Redwood City averaged between 28 and 32 minutes, in 2016. These are commute time averages with many Redwood City commuters spending more than 32 minutes commuting. For workers commuting into Redwood City, commute times averaged 34.2 minutes overall, specifically 32.5 minutes by auto, 35.8 minutes by carpool, and 59.8 minutes by transit.[9] Average transit travel times tend to be longer compared to commuting by auto for all destinations and as **Figure 2-2** shows, 40.2 percent of transit commuters to San Mateo County spend over 60 minutes traveling to work, 23.2 percent spend 45-59 minutes commuting, and 26.4 percent spend 30-44 minutes commuting.[10] The tolerance for longer commute times on transit can be attributed to the commuter's out-of-pocket cost (influenced by employer transit subsidies and parking policies), transit reliability (more applicable to rail and ferries, which are not subject to delays caused

---

5 *Regional Forecast for Plan Bay Area 2040,* Metropolitan Transportation Commission & Association of Bay Area Governments, February 2016.

6 "Google ferry programs come to an indefinite end," *The Mercury News*, February 7, 2014; "Facebook to use ferries to get employees to work under trial program," *Daily Post*, June 15, 2018.

7 *Plan Bay Area 2040, Final Supplemental Report*, Metropolitan Transportation Commission & Association of Bay Area Governments, July 2017.

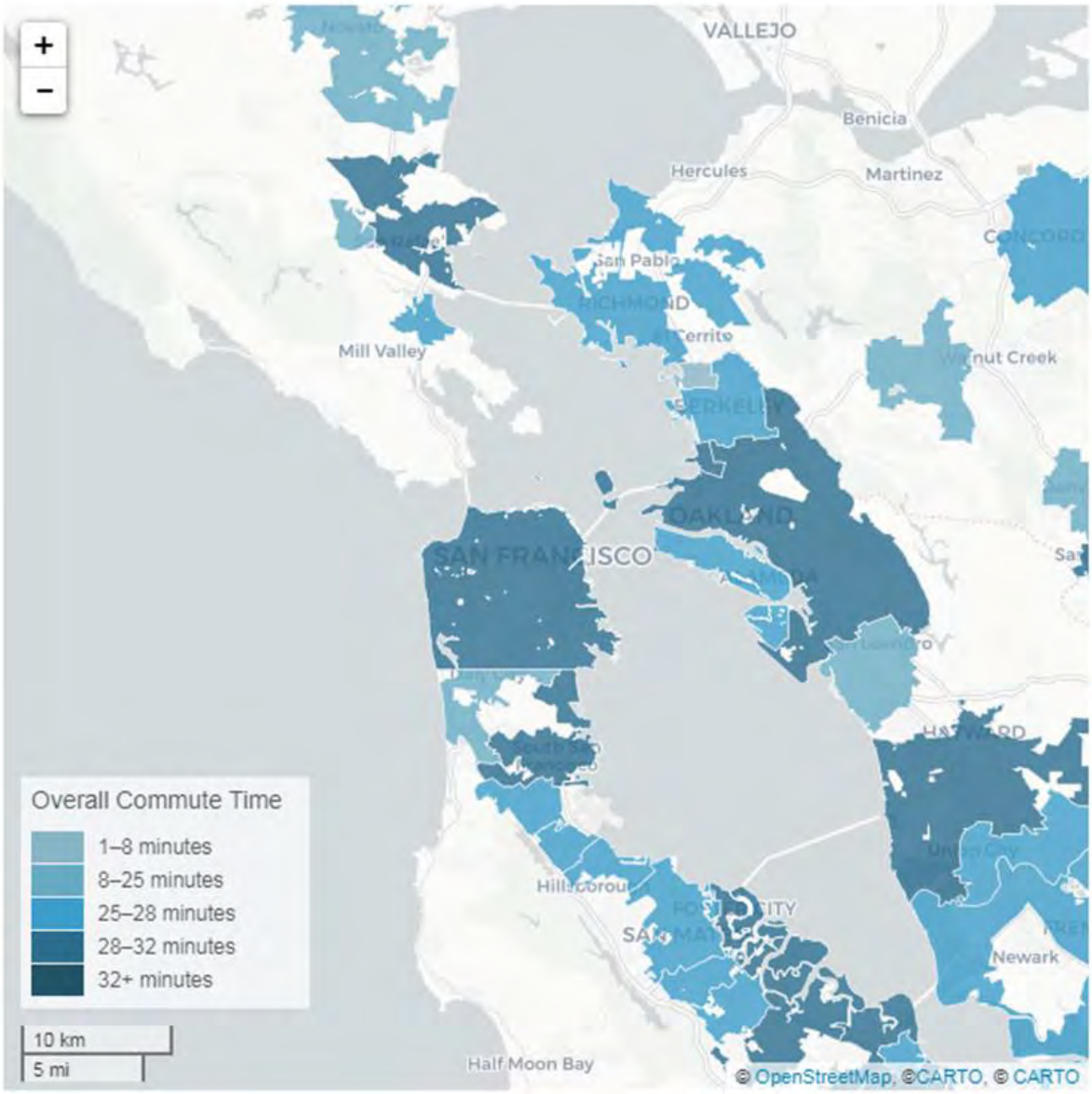
8 "Moving San Mateo County Forward – Housing and Transit at a Crossroads", Housing Leadership Council and TransForm, June 2018.

9 Vital Signs - Commute Time, Metropolitan Transportation Commission, May 2018.

10 Ibid.

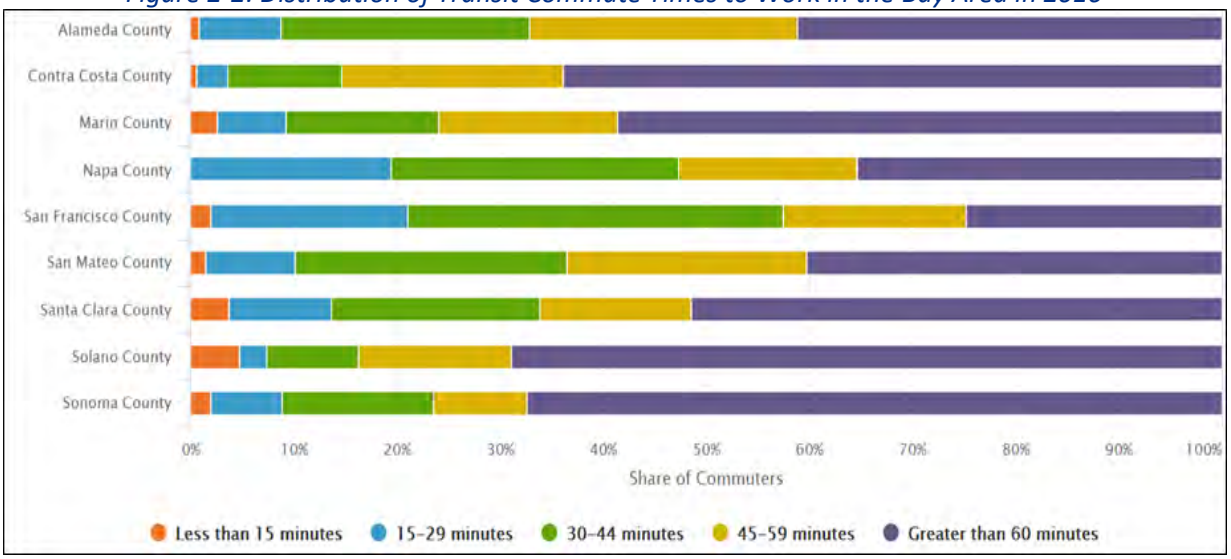
by traffic congestion), reduced stress compared to driving, and the ability to be productive during one's commute.

Figure 2-1: County Average Commute Times for Bay Area Residents to Work Destinations in the Bay Area in 2016



Source: Vital Signs – Commute Time, Metropolitan Transportation Commission, May 2018

Figure 2-2: Distribution of Transit Commute Times to Work in the Bay Area in 2016



Source: Vital Signs – Commute Time, Metropolitan Transportation Commission, May 2018

2.2.2 Transportation Demand Management

Transportation Demand Management (TDM) is a set of practices and strategies to reduce single occupancy vehicle travel or move it away from AM and PM commute peak periods. Local jurisdictions often have TDM requirements for large commercial developments to manage or reduce the amount of single-occupancy automobile travel to the site. TDM requirements tend to exist for land where parking is scarce and where there is a high demand for travel. Therefore, large employers, such as Stanford University, Google, and Facebook, to name a few, actively promote and encourage their employees to use alternative modes of transportation through incentives, including free transit passes, private shuttle services, and sometimes housing subsidies for employees to live close to their employer. In 2000, San Mateo County implemented the land use component of its congestion management program requiring that all new developments generating more than 100 net AM peak or PM peak period trips provide mitigation, including the option of implementing a TDM plan.

Commute.org

Commute.org is a public agency in San Mateo County with TDM responsibilities and is an alliance of 17 cities and the County of San Mateo. Commute.org receives funding from the City/County Association of Governments of San Mateo County (C/CAG), the SMCTA, the Bay Area Air Quality Management District (BAAQMD), and the Metropolitan Transportation Commission (MTC) for the shuttle program which provides first mile and last mile shuttle service between employment centers and transit stations in San Mateo County. First mile is the term used to describe the trip segment from home to transit stop, and last mile is the term used to describe the trip segment from transit stop to destination. Commute.org also works with Caltrain, WETA, BART, San Mateo County Transit District (SamTrans), and employers in the county to coordinate, operate, and fund the shuttle program. Additional discussion of shuttles is found in Section 2.2.3 Transportation Providers and Future Projects.

City of Redwood City

In July 2018, the City created a policy outline for a full TDM program. The program's goal is to encourage and increase accessibility, awareness, and the convenience of non-single occupancy vehicle (SOV) modes of transportation through harnessing existing programs and resources and the creation

of new partnerships. The program sets required triggers for participation for individual developments, goals and targets, a compliance process, and TDM measures, as well as a monitoring and enforcement process. This plan recommends that commercial or institutional sites with over 300 employees and residences with over 51 units invest in new and/or improved bus service or participation in a shuttle operated by the applicable Transportation Management Association (TMA). This type of service could plausibly support the proposed Redwood City ferry terminal.

City of Menlo Park

Menlo Park, which neighbors Redwood City and is the home of Facebook's headquarters, has also implemented a TDM program focused on mitigating the traffic impacts caused by new development by reducing peak hour vehicle trips. Menlo Park allows developments generating 0.5 to 1 seconds of vehicle-delay at impacted intersections to opt into the TDM program in lieu of environmental impact review. The program allows developers to implement TDM elements, which then count towards a reduced number of peak-hour trips the development is considered to have generated. Among the TDM measures enumerated by the plan is the operation by developers of a dedicated shuttle service during the peak period to a rail station or an urban residential area, or the opportunity for the developers to buy into a shuttle consortium replicating the same service, and the implementation of jitneys and vanpools to downtowns and transit centers. These programs could plausibly support the proposed Redwood City ferry terminal.

Employer TDM Programs

As part of this Study, multiple employers provided information on their TDM programs to provide insight on the policies in place and the commute patterns of their employees. This information was used to inform the ridership forecasts for Redwood City ferry service.

Section 2.4.2 below, lists the major employers in Redwood City and others that are being considered as major trip attractors to the study area. Additional discussion of the market analysis will be covered in Section 4 of this document.

2.2.3 Transportation Providers and Future Projects

The following are transportation providers in the region that serve the study area as well as future projects that will have an impact on travel between the origins and destinations in this Study.

Ferry Operators

This section briefly describes the state of ferry operations in the region and identifies the public and private operators.

WETA

WETA is the Bay Area's largest ferry operator and one of the largest passenger-only ferry operators in the United States. In 2020, WETA has a fleet of 16 vessels and operates using twelve terminals: Pier 41, Downtown San Francisco, South San Francisco, Alameda Main Street, Oakland, Harbor Bay Alameda, Vallejo, Mare Island, Richmond, Seaplane Lagoon (Alameda), Oracle Park and Pier 48.5 (Chase Center). WETA carried up to 13,000 riders on an average weekday in 2020. With new funding from San Mateo County Measure A and Regional Measure 3 the WETA system is primed for significant expansion out to 2035. WETA also coordinates the regional water transit response to natural emergencies. WETA maintains the following routes:

- Alameda Main Street/Oakland/San Francisco
- Mare Island/Vallejo/San Francisco

- South San Francisco/Alameda Main Street/Oakland
- Alameda Harbor Bay/San Francisco
- Richmond/San Francisco
- Alameda Main Street/Oakland/Vallejo/Oracle Park (on San Francisco Giants home game days)
- Alameda Main Street/Oakland/Pier 48.5 (Chase Center) on Warriors home basketball games

WETA has an ambitious development program, with a mission to expand ferry service to the entire Bay Area. In recent years, WETA has opened new terminals in Richmond, Mare Island, and Alameda along with expansion of its Downtown San Francisco terminal. A new terminal in the Mission Bay area of San Francisco has already completed the necessary design and permitting requirements. Once a funding gap of $12 million can be addressed, the Mission Bay Ferry Landing will enter construction. WETA is also considering a new terminal location in Berkeley through a feasibility study. In addition, WETA is exploring the use of new technologies such as hovercraft or electric vessels for use at existing or new terminals. Enhancing service at existing terminals is a primary objective in WETA's 2016 Strategic Plan, which envisions the ferry system one day expanding to 16 terminals and up to 44 vessels.

See **Figure 2-3** for a map of the WETA ferry services and terminal locations available to the public and **Figure 2-4** for a map of near-term and future WETA terminals and facilities.

Figure 2-3: Existing WETA Ferry Services and Terminal Locations

Source: WETA Short Range Transit Plan, 2020

Figure 2-4: Near-Term and Future WETA Terminals and Facilities

Source: WETA Short Range Transit Plan, 2020

WETA conducted a systemwide survey of their passengers in 2017. Over 60 percent of WETA riders said their number one "reason for riding a ferry" was to "avoid traffic/parking." Fifty (50) percent of respondents that said that "ride quality" and "relaxing" were also their respective reasons for ferry use. These elements are quite attractive to commuters, as almost half (47 percent) of WETA passengers have started to use the ferry within the last two years that the survey was administered. Additionally, 69 percent of riders use the ferry service three days or more per week. The ferry mode sets itself apart from all other forms of transport, as 88 percent of riders responded that they are "very satisfied" or "somewhat satisfied" with ferry service, whereas, Bay Area Rapid Transit District (BART), Caltrain, and Valley Transportation Authority, scored 69 percent, 79 percent, and 79 percent, respectively.[11]

Golden Gate Transit

Golden Gate Transit is a public transportation system providing bus and ferry service to the North Bay region. Golden Gate Transit operates seven different vessels that can carry between 400 and 750 passengers each. The agency operates the following ferry routes between locations in the North Bay and San Francisco daily:

- Sausalito/ San Francisco
- Larkspur/San Francisco
- Tiburon/San Francisco
- Larkspur/Oracle Park (during San Francisco Giants home games)
- Larkspur/Pier 48.5 (Chase Center) on Warriors home basketball games

[11] "2017 On-Board Passenger Survey", *Water Emergency Transportation Authority*, 2017.

PROP SF

PROP SF is a private ferry service operating catamaran boats of capacities ranging from 36 to 70 passengers. PROP SF has operated several pilot charter ferry services for employers, such as Facebook and Google, exclusively for their employees. In December 2018, PROP SF discontinued charter service operations for employees of Facebook in and out of the Port.[12] Because PROP SF runs smaller boats (36-70 passengers), the ride quality in winter months deteriorates due to rougher conditions in the Bay, resulting in decreased ridership.

According to PROP SF, six (6) routes are being considered within the coming years, including:

- San Francisco – Emeryville
- San Francisco – Berkeley
- Alameda – Redwood City
- Redwood City – Berkeley
- San Francisco – Redwood City
- Alameda – San Francisco

Tideline

Tideline is a private ferry service that began in April of 2019. It operates boats that carry between 22 and 145 passengers. Tideline serves commuters traveling between Berkeley and San Francisco Pier 1.5 (next to the Downtown SF Ferry Building) and Pier 52 (Mission Bay). It runs two round trips in the morning and two round trips in the afternoon. It also runs charter service between the City of Napa and San Francisco. Tideline can provide on-call water taxi service, with no specific routes. Tideline has dock use agreements at locations in the Bay Area.

Blue & Gold Fleet

Blue & Gold Fleet is a private operator in the Bay Area offering sightseeing cruises for tourists. Blue & Gold is the contract operator for WETA services. It also operates daily service between the North Bay and San Francisco:

- Sausalito/San Francisco Pier 41
- Tiburon/ San Francisco Pier 41
- Angel Island/ San Francisco Pier 41
- Tiburon / Angel Island

San Francisco Water Bus (Pilot Program Study)

The San Francisco Water Bus Pilot Program Study is looking into a two-year pilot program that would initiate water bus service in the City of San Francisco. This program would operate two 100-passenger vessels, utilizing existing dock infrastructure providing 16 daily roundtrips between the Marina and Mission Bay. Operations for the proposed pilot program would be funded through the San Francisco Transportation Sustainability Fees (TSF) from the Potrero Power Station development, and capital costs would be made available through corporate sponsors.

---

[12] "Port of Redwood City loses private service", *The Daily Journal*, March 5, 2019.

Other Transit Operators

Caltrain

Caltrain is a fixed guideway commuter rail service with 32 stations (29 are served during weekdays and 24 on weekends) between San Francisco and Gilroy, running over 77 miles. It runs north-south paralleling US 101 and El Camino Real most of its route, providing service throughout the day. In recent years, Caltrain ridership has risen dramatically from a low point of 23,947 in 2004 to a high of 65,095 in 2018.[13] This ridership gain is attributed to the competitive travel time offered by express trains in the peak hours. There is a Caltrain station located in downtown Redwood City, with daily ridership of 4,212 passengers in 2018, and the northernmost station is the 4th and King terminal, not far from Oracle Park. Caltrain serves many Peninsula communities with large employment centers such as South San Francisco, Belmont, San Carlos (closest to Redwood Shores), Menlo Park, Palo Alto, Mountain View, and Sunnyvale.

Source: City of Redwood City, 2020

Caltrain has three types of service: local stop, limited stop, and Baby Bullet Express. Local stop services serve all stations, limited stop trains skip stations, and Baby Bullet Express trains travel between San Francisco and San Jose in under one hour, stopping at a few intermediate stations. On weekdays, 16 trains run northbound from Redwood City station before noon, and 22 trains run northbound and after noon, and 18 run southbound before noon on weekdays, while 20 trains run southbound after noon. Travel time to San Francisco and San Jose from Redwood City on the Baby Bullet Express is 37 and 24 minutes, respectively. Almost ten percent of Caltrain riders access its stations by bicycle.

---

[13] Caltrain 2018 Annual Passenger Counts, Caltrain, 2018.

Caltrain is currently in the process of modernizing its system with positive train control, electrification and a new fleet of electric-powered trains. Once modernized, Caltrain will be able to deliver service that is more akin to rapid transit in terms of time between trains and ride quality than conventional commuter rail. This will enable Caltrain to provide better service to its customers along the Peninsula, making an already competitive transit service even more attractive.

Bay Area Rapid Transit District (BART)

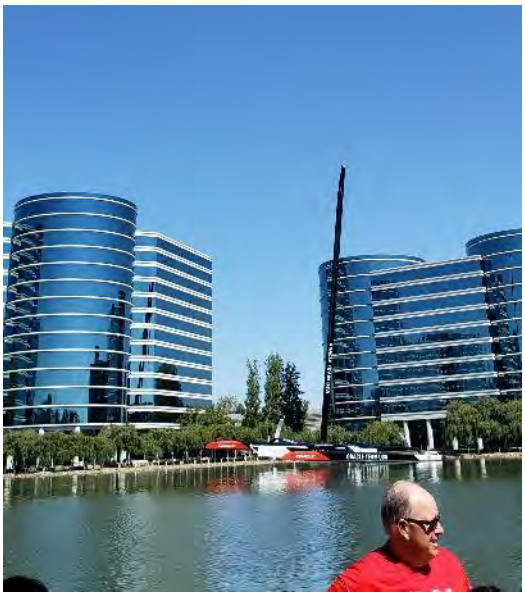
BART is a regional fixed guideway rail system that serves San Francisco, Alameda, Contra Costa, Santa Clara and San Mateo Counties. There are five BART stations in northern San Mateo County plus the San Francisco International Airport station (part of San Francisco County). The station closest to Redwood City and the southernmost BART station on the Peninsula is the Millbrae station. BART passengers going to destinations in southern San Mateo County or Santa Clara County can transfer to Caltrain at the Millbrae station.

San Mateo County Transit District (SamTrans)

SamTrans is San Mateo County's bus operator, operating 76 bus routes throughout San Mateo County and into San Francisco and Palo Alto. SamTrans operates nine routes (routes 95, 274, 275, 276, 279, 295, 296, 397, and 398) as well as the El Camino Road (ECR) and Rapid ECR shuttles at the Redwood City Transit Center. Like many bus operators, SamTrans ridership has been declining over the past decade, likely due to traffic congestion increasing transit travel times and reducing reliability.

Public and Private Employer Shuttles

Commute.org shuttles provide first and last mile service to commuters and residents in San Mateo County. The shuttles transport commuters from BART, Caltrain, and SF Bay Ferry stations to many San Mateo County employers during peak commute hours. The Pacific Shores Shuttle, serving the office park immediately adjacent to the proposed Redwood City ferry terminal, offers free non-stop weekday morning and afternoon/evening service between the Redwood City Caltrain Station and six stops at the Pacific Shores center. The shuttle runs eight times in the morning and six in the afternoon. While operated by Caltrain, the Pacific Shores Shuttle is funded by the Peninsula Corridor Joint Powers Board, the BAAQM, the SMCTA, and Google.



Source: City of Redwood City, 2020

There are five other shuttle routes operating in Redwood City via Commute.org. They are:

- The Electronic Arts shuttle running between the Hillsdale Caltrain Station, San Carlos Caltrain Station, the Electronic Arts corporate campus, and neighboring employers in Redwood Shores. This route is managed by Electronic Arts and operates Monday to Friday during commute hours.
- The Mid Point Area shuttle running between the Redwood City Caltrain Station and Mid Point Technology business park. This route is managed by Commute.org and operates Monday to Friday during commute hours.

- The Oracle shuttle running between the Hillsdale Caltrain Station, San Carlos Caltrain Station, the Oracle corporate campus, and neighboring Belmont and Redwood Shores employers. This route is managed by Oracle and operates Monday to Friday during commute hours.
- The Seaport Centre Business Park Area shuttle running between the Redwood City Caltrain Station and Seaport Centre business park. This route is managed by Commute.org and operates Monday to Friday during commute hours.
- The Twin Dolphin Area shuttle running between the San Carlos Caltrain station and Belmont and Redwood Shores business parks. This route is managed by Caltrain and operates Monday to Friday during commute hours.

Beginning in the early 2010s, private companies, most of them tech companies, began to offer long-haul subsidized or free bus shuttle service for commuting purposes as a benefit to employees. Unlike the Commute.org shuttles, the employer shuttles provide inter-county transportation and typically pick-up employees at park-and-ride facilities and other convenient locations and then deliver them directly to their place of work. They typically offer a high-quality experience with executive coach buses equipped with Wi-Fi to facilitate employee productivity during their commute. These shuttles are not open to the public. Until 2016, little was understood about the size and extent of these services in total. In 2016, the Bay Area Council (BAC) and MTC published a report on these services based on data on operations from 2012 – 2014.

The 2016 study showed that between 51 and 100 shuttles operated within San Mateo County itself and between San Mateo County and San Francisco on a daily basis.[14] If all private shuttles were operated by one agency, it would be among the ten largest transit operators in the region. More than ten shuttles travel between San Mateo County and Alameda County and between San Mateo County and Santa Clara County on a daily basis.[15]

In recent years, publicly-funded shuttle operations have been negatively affected by drastic operator/driver shortages owing to more competitive salaries offered by private companies and the movement of middle- and low-income workers out of the Bay Area to more affordable areas. This represents a severe constraint on the ability to expand shuttle services regionwide.

2.3 Future Transportation Projects

There are several major transportation projects that will bring changes to the context of regional transportation in the future. They may ease auto or multimodal travel to, from, and along the Peninsula and could impact where ferry service could be competitive.

2.3.1 San Mateo 101 Express Lanes Project

The San Mateo 101 Express Lanes Project will implement 22 miles of express lanes on US 101 from the I-380/US 101 junction in San Bruno to the border of San Mateo County and Santa Clara County to connect with express lanes in Santa Clara County. The project will convert existing HOV lanes to express lanes and then add an additional lane to US 101 in each direction. Construction began in the winter of 2018 and will be finished in mid-2022. This will increase person throughput on the US 101 corridor and is anticipated to ease some congestion for those traveling north-south in San Mateo County. Eventually, the express lanes in San Mateo County would connect with express lanes in Santa

---

14 "2016 Bay Area Shuttle Census". Bay Area Council, September 2016.

15 "2016 Bay Area Shuttle Census". Bay Area Council, September 2016.

Clara County and San Francisco County (currently under study). Buses would be able to use these express lanes improving both travel times and service reliability.

2.3.2 Dumbarton Transportation Corridor

The Dumbarton Transportation Corridor study was initiated by SamTrans in February 2016 to identify possible mobility-enhancing improvements along the Dumbarton corridor. The study recommended a phased, multimodal approach to implementing operational and infrastructural improvements on the study corridor.

In the summer of 2017, the Dumbarton Transportation Corridor Study was completed and short- and mid-term draft improvements were issued, including enhanced bus service, all-electronic tolling, bus-only lanes, and ramps between Dumbarton Rail right-of-way and US 101 for extra bus speed. Ultimately, the project could include a rail shuttle service between Redwood City and Newark.[16] If implemented, these improvements could shift trips from automobiles to transit between southern Alameda County and the Peninsula, especially to destinations in Redwood City and northern Santa Clara County.

2.3.3 BART to Silicon Valley Extension

The BART to Silicon Valley Extension is a series of transportation improvements in a corridor extending from the southern boundary of Alameda County in Fremont through Milpitas, San Jose, and Santa Clara. The chief improvements are a 16-mile extension of the existing BART system into Santa Clara County with six new stations. Phase 1, the Berryessa extension, consists of ten miles and two stations, and Phase 2 will include the remaining six miles and four stations along with a maintenance and storage yard.

The Berryessa extension opened for passenger service on June 13, 2020 to the VTA transit centers in Milpitas and North San Jose. The extension of BART to the South connects commuters traveling from the East Bay to San Jose and employment sites along the Tasman Corridor in Santa Clara County.

2.3.4 BART Second Transbay Rail Crossing

BART has been investigating the possibility of a second bay crossing in order to address system capacity constraints that occur at the approaches to the existing crossing under the Bay between Oakland and San Francisco. Various alignments have been studied that either follow the current alignment or diverge from it to serve other areas that require improved access to the BART system. The second rail crossing is envisioned to include tracks for BART and for conventional rail services. In the year 2020, BART will likely commence with feasibility studies to determine which alignment, station locations, and type of crossing would be most suitable. This will include analysis of travel markets and land use, operational analysis, alignment alternatives, and a wide range of public engagement strategies.

Although a second crossing would likely not be constructed for 20 to 25 years, it could significantly improve BART and conventional rail travel between the East Bay and Peninsula via San Francisco and could impact the areas where ferry service could be effective. It is yet to be determined which conventional rail operator would cross the Bay (ACE, Caltrain, Capitol Corridor, and/or High-Speed Rail).

---

[16] "Update on the Dumbarton Transportation Corridor Study", *City of Menlo Park*, September 12, 2017.

2.4 Redwood City

While the proposed ferry terminal in Redwood City could serve destinations beyond the Redwood City limits, the focus of this section is on Redwood City since the many of the travelers using the proposed terminal would likely originate from or go to destinations in Redwood City.

Source: City of Redwood City, 2020

2.4.1 City Characteristics

Redwood City, a city of 86,200 people, is the county seat for San Mateo County and is midway between two major urban centers (San Francisco and San Jose). Located between the San Mateo-Hayward and Dumbarton highway bridges, Redwood City is accessible from US 101 and El Camino Real (State Route 82) and has a Caltrain Station in its downtown that is also served by SamTrans bus service. Redwood City has a walkable downtown with mixed uses and newer mid-rise housing developments. Its downtown is within three miles of the proposed ferry terminal. This is a distance conducive to shuttle and bike access. The City has also recently conducted a feasibility study of a streetcar/urban circulator that would initially serve the downtown area but could possibly serve the ferry terminal in a future phase.

According to the Association of Bay Area Governments' (ABAG) Plan Bay Area 2040 (November 2018), by 2040 the population in Redwood City is expected to grow to over 100,000 residents. The same report forecasts that there will be an addition of over 15,000 jobs in the city, with over 86,000 jobs projected in 2040.[17]

---

[17] "Plan Bay Area 2040: Plan Bay Area Projections 2040, A Companion to Plan Bay Area 2040", Association of Bay Area Governments (ABAG) and Metropolitan Transportation Commission (MTC), November 2018.

2.4.2 Major Employers in Redwood City

Redwood City is home to several of the Peninsula's large employers, such as Oracle, Kaiser, Electronic Arts, as well as the County of San Mateo. Additionally, large institutions such as Stanford University and NASA employ large numbers of Redwood City residents. Facebook's headquarters are located in neighboring Menlo Park.

The top ten largest employers in Redwood City are shown in **Table 2-1**. These employers are either located downtown or in the Redwood Shores area, which is about four miles from downtown Redwood City.

Table 2-1: Top 10 Employers in Redwood City, Fiscal Year 2018

Corporation	No. of Employees
Oracle Corporation	5,955
County of San Mateo	2,446
Kaiser Foundation Hospitals & Clinics	1,727
Electronic Arts	1,520
Sequoia Hospital	915
Box Inc	840
Redwood City School District	742
Nevro Corporation	672
Shutterfly	580
Genomic Health Inc.	551

Source: Redwood City Comprehensive Annual Financial Report, 2018

The following major employers are not on the above list; however, they are also considered in this Study:

- Google, in Redwood City only
- Stanford University and Hospital and Clinics medical campus, in Redwood City only
- Facebook headquartered in Menlo Park, adjacent to Redwood City
- Equinix
- Cañada College
- Chan Zuckerberg Initiative
- Eat Club

2.4.3 Development Trends and Pipeline

Recent new residential and commercial development in the City is contributing to demand for travel options to and from Redwood City.

- In the five years since 2014, the number of residential units in the City increased by more than 1,200. Of this increase, approximately 95 percent were multifamily units.[18]

[18] California Department of Finance: E-5 Data Set: City/County Population and Housing Estimates, 1/1/2014 and 1/1/2019.

- In the past five years, nine office buildings were constructed, totaling more than 720,000 square feet and representing a 6 percent increase to Redwood City's pre-2015 office inventory of 11.6 million square feet.[19]
- During the same time period, two retail buildings were constructed, adding approximately 77,000 square feet to the city's pre-2015 retail inventory of 4.1 million square feet, a nearly 2 percent increase.[20]
- Only one building classified as industrial was built since 2015, adding nearly 16,000 square feet, or less than 1 percent, to the City's 4.6 million square feet of industrial inventory.[21]

Meanwhile, Redwood City has many commercial, residential and mixed-use projects at various stages of development which will provide additional demand for travel options to and from the city. In 2020, there are 30 projects that are proposed, approved, or under construction, that include more than 2,000,000 square feet of office/medical space, 250,000 square feet of retail space, 1,175 residential units and two hotels. The projects planned for development are shown in **Table 2-2**, **Table 2-3**, **Table 2-4** and **Figure 2-5**. New ferry service to Redwood City potentially could provide additional travel options for trips to/from these new developments

Table 2-2: Commercial Development Proposed, Approved, or Under Construction in Redwood City in 2019

Commercial Development Project	SF (000s)	Type	SF (000s)	Type	Status (Aug. 2019)
Stanford Outpatient Center & Parking					Garage Built
Stanford in Redwood City	570.0	Office			In Construction
Broadway Station Redwood City	66.8	Office	26.8	Retail	In Construction
Kaiser Medical Office Building 2	197.8	Medical			In Construction
851 Main St	78.8	Office	6.9	Retail	In Construction
Harbor View	800.0	Office			Env Review
610 Walnut St	65.0	Office			Approved
Young's Automotive			8.0	Retail	Approved
1180 Main St	109.4	Office			Approved
Toyota 101			201.0	Retail	Application
240 Twin Dolphin	203.8	Office	5.2	Retail	Planning
Stanford Precise Plan Block E	227.0	Medical			Planning
Total	**2,318.6**	**Office / Med**	**247.9**	**Retail**	

Source: City of Redwood City, 2019

[19] CoStar Group, data extracted August 2019.
[20] Ibid.
[21] Ibid.

Table 2-3: Residential Development Proposed, Approved, or Under Construction in Redwood City in 2019

Residential Development Project	Units	Type	Status (Aug. 2019)
515 Cleveland St	17	Townhouse	In Construction
601 El Camino Real	33	Multifamily	In Construction
707 Bradford St	117	Multifamily	In Construction
Greystar 2 – 103 Wilson St.	175	Multifamily	In Construction
Greystar 4 – 1409 El Camino Real	350	Multifamily	In Construction
Habitat for Humanity – 612 Jefferson Ave	20	Multifamily	In Construction
120 El Camino Real	12	Townhouse	Approved
353 Main St	125	Multifamily	Approved
3700-block Laurel Way	16	Single Family	Approved
849 Veterans Blvd	90	Multifamily	Approved
910 Woodside Road	10	Single Family	Approved
Strada – 1548 Maple St	131	Multifamily	Approved
Vera Avenue Townhomes	10	Townhouse	Approved
31 Center St	7	Townhouse	Application
Greystar 3 – 1305 El Camino Real	137	Multifamily	Application
150 Charter St	72	Multifamily	Planning
505 East Bay Shore	60	Townhouse	Planning
Redwood City Harbor – 1 Uccelli Blvd	402	Single Family	Planning
1125 Arguello St	68	Townhouse	Planning
Total	**1,852**	**Units**	

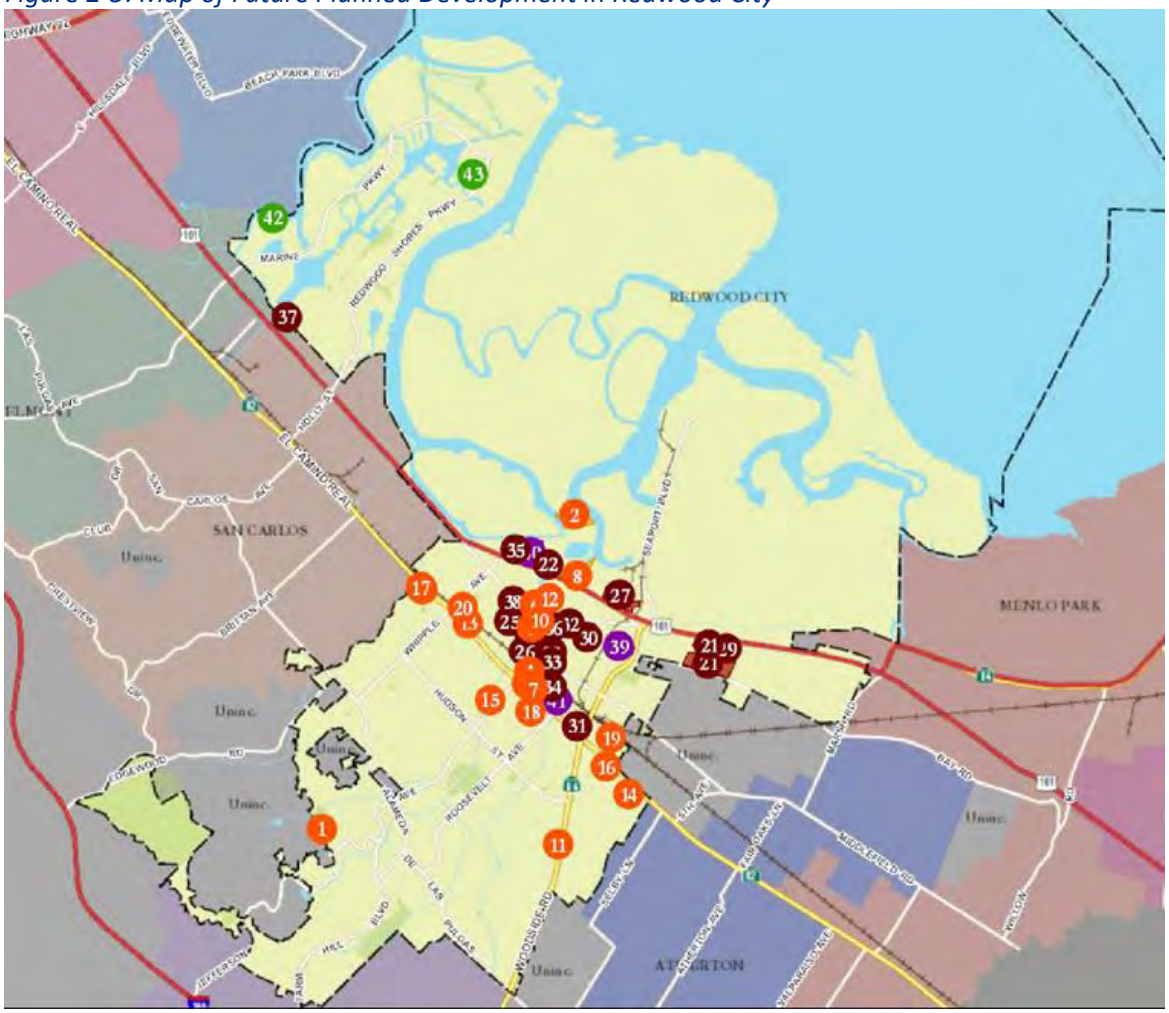
Source: City of Redwood City, 2019

Table 2-4: Mixed-Use Development Proposed, Approved, or Under Construction in Redwood City in 2019

Mixed-Use Development Project	Residential Units	SF (000s)	Type	SF (000s)	Type	Status (Aug. 2019)
Broadway Plaza	520	420	Office	26	Retail	Approved
South Main Mixed-Use	291	550	Office	28	Retail	Application
Syufy Site	480	100	Recreation	-	-	Env Review
Total	**1,291**	**1,070**	**Office / Rec**	**54**	**Retail**	

Source: City of Redwood City, 2019

Figure 2-5: Map of Future Planned Development in Redwood City



Source: City of Redwood City, 2019

To help streamline the development process, the City Council of Redwood City has directed planning staff to initiate a one-time "Gatekeeper" process. The Gatekeeper process is an approach to address the multiple proposed General Plan Amendment and Downtown Precise Plan Amendment requests. The City Council will consider, at a high level, multiple potential projects at one time to decide which projects should be reviewed and considered for General Plan/Downtown Precise Plan amendments. Consideration of these projects would be based on basic submittal requirements and a detailed project narrative that would be analyzed against the Council's Strategic Plan and Priorities to determine if a project should continue to move forward with discretionary planning and environmental review.

2.5 Proposed Ferry Terminal Site

As shown in **Figure 2-6**, the proposed ferry terminal site is located at the northern end of Seaport Boulevard, where Westpoint Slough and Redwood Creek meet, on land owned by the Port of Redwood City. The parcel is 9.2 acres and is undeveloped, and therefore, would require landside improvements for it to function as a terminal. While parking facilities are assumed as part of the project, it is also assumed that some patrons would arrive by other modes, including transit, shuttles, bikes or rideshare. The site is approximately three (3) miles north of the downtown business district and Caltrain station. The site is also directly adjacent to the 106-acre Pacific Shores high-tech park, where Google and other companies occupy offices; and the Seaport Centre which offers over 550,000 square feet of office space.

Figure 2-6: Previously Analyzed Ferry Terminal Sites in Redwood City

Source: Google Maps, COWI, 2019

In 2007, the "Port of Redwood City Ferry Terminal Locational Analysis, Environmental Assessment, & Conceptual Design" analyzed three sites: Wharf 5, F-dock, and Pacific Shores/Westpoint Slough, which can be seen in **Figure 2-6**. Pacific Shores/Westpoint Slough site was chosen as it had the fewest major disadvantages. The Pacific Shores/Westpoint Slough site is shown in **Figure 2-7**.

Figure 2-7: Proposed Ferry Terminal Site in Redwood City

Source: Google Maps, COWI, 2019

The 2007 study found that Wharf 5 increased the "potential for cars to conflict with large trucks" and the "potential for vessels to conflict with larger vessels and marine industrial uses," making this site inferior. Additionally, the F-dock site suffers from "conflicts with recreational uses of the channel" and "longer ferry travel time."

The location analysis concluded that the major constraint of the Westpoint Slough site is the width of the slough at low tide. However, a small amount of dredging could remove this constraint. Furthermore, the proposed site wouldn't require the dredging of the Greco Island side of the channel.[22] The proposed location could offer dual side boarding and overnight berthing.

The proposed site and alternative site locations are located within the Port, approximately three (3) miles from downtown Redwood City. Located at the northern edge of the Port, the site features a natural depth that is conducive to heavy boat traffic. Along with most of the northern portion of the Port, the parcel is zoned as general industrial, boasting a lot size of 480,000 square feet (about 11 acres). It is owned by the Port of Redwood City.[23]

The Redwood Creek Slough and adjacent shoreline in Redwood City is a hub for a wide variety of water and land recreational activities. Daily, year-round non-motorized water activities include rowing, sailing, kayaking, stand-up paddling, windsurfing, and kite surfing. Recreationists can access the water in multiple locations, including by using equipment rented from two outlets in close proximity to the potential ferry dock site: California Canoe and Kayak on Seaport Court, and 101 Surf Sports at the Westpoint Harbor. Both of these equipment rental providers regularly curtail activities if winds are too high, independent of whether motorized boat traffic is occurring.

---

22 "Port of Redwood City Ferry Terminal Locational Analysis, Environmental Assessment, & Conceptual Design," Port of Redwood City, 2007. Report issued by CHS Consulting Group.

23 Port of Redwood City, 2007. Port of Redwood City Ferry Terminal Locational Analysis, Environmental Assessment, & Conceptual Design. Report issued by CHS Consulting Group.

Sail and motorized boat traffic emanate largely from the approximately 350 berths at Westpoint Harbor south of Westpoint Slough, which joins Redwood Creek Slough at the ferry landing site. Another 125 or more boats may be berthed at any time at the Sequoia Yacht Club on Seaport Blvd. near US 101. Both marinas offer sailing tours and instruction. A smaller dock also fronts the residential condominium development near the entrance to Seaport Court. Speed restrictions that extend into the San Francisco Bay are in place for safety reasons, while wake restrictions are intended to protect both non-motorized water users and sea and land species and habitat potentially affected by wake and noise impacts. Walkers, runners, birdwatchers, photographers, artists, and water-gazers are common along the shoreline around the ferry site, including lunchtime activity from the neighboring office, industrial, and residential developments.

The feasibility study conducted in 2012 confirmed the Westpoint Slough location as the preferred site.[24] In 2019, COWI conducted a review of the feasibility study to determine if the Westpoint Slough is a viable location. It was concluded that it is a viable location although some modifications to the ferry terminal concept layout are needed to be consistent with WETA current operations. See Section 5 for updates to the concept layout.

Further investigation within the proposed site noted that an alternative location at the west end of the site might also be feasible for the ferry terminal. The alternative site eliminates the need of dredging due to the existing navigation channel which provides deeper water for vessels operating at the Port. The alternative site would provide easier maneuvering in and out of the berth and it also eliminates the need to demolish the existing wharf structure. Although the alternative site offers benefits, it also comes with constraints. The alternative location encroaches onto the turning basin and facilities to the south, the float would be limited to one (1) side berthing, the float is not compatible with WETA's spare float and the site is closer to the wetland areas. A spare float is additional infrastructure that would allow ferry operations to continue ferry service while maintenance is performed on the main float.

There may be some operational constraints in the vicinity of the Port that may affect the proposed ferry service. Coast Guard regulations may limit the travel routes, types of vessel, and hours of service that the ferry system might operate in the area, and the Port may enforce speed and wake limits. These items are typically addressed by establishing ferry operational requirements along the route to the ferry terminal and at the ferry terminal berth. Passing vessel wave patterns caused by Port and recreational vessel traffic should also be studied during final design of the terminal. The terminal design should account for the passing vessel wave loading. Safety protocols can be established for safe operations between ferries and other vessels operating in the vicinity.

2.5.1 Ferry Terminal Requirements

The waterside structural components noted in the 2012 feasibility study called for a 110-foot long by 42-foot wide dual side boarding concrete float, four (4) 42-inch diameter steel float guide piles, two (2) donut fender piles, ADA gangway and covered passenger platform. The Study also called for the existing slough channel to be dredged to a maximum dredge elevation of -10.0 mean lower low water (MLLW) and to elevation -12.0 MLLW below the footprint of the dual side boarding concrete float. The landside improvements in the study called for diesel fuel tanks, bus stop, 250 parking spots, a pedestrian trail and access roads for the terminal.

COWI reviewed the feasibility study concept layout with WETA, Port and City staff. The following modifications to the 2012 concept layout have been incorporated into the current layout. WETA

[24] Water Emergency Transportation Authority, July 2012. Redwood City Ferry Terminal Site Feasibility Report, Draft Report. Report issued by KPFF Consulting Engineers.

requires for the navigational channels and area around the barge to have a minimum dredge elevation of -12.0 MLLW. WETA also prefers floats to be the same standard size of 135 foot by 42 feet wide. This would allow for use of WETA's spare float at the site during float maintenance periods. WETA also concluded that the need for diesel fuel tanks was not essential at the site and that shore power would be required for long period berthing. See Section 5 for more information.

The minimum requirements for a functional ferry terminal are discussed below.

Water Side improvements

The minimum navigable requirements set by the existing ferry terminal facilities operated by WETA require channels to have a minimum elevation of -12.0 MLLW for safe passage of their fleet. The north location would require the existing slough to be dredged. The alternative location on the west end would not require dredging. The existing USACE soundings show that the current channel slopes up from EL -30.0 MLLW to EL-14.0 MLLW.[25]

The ferry terminal waterside requirements call for a 135-foot-long by 42-foot-wide steel float, 5,670 square feet. The float would be compatible with the ferry facilities in the North and East Bay. The float is to be moored in place by up to six (6) 36-inch diameter steel float guide piles. To aid vessels during berthing, the site would require two (2) 36-inch donut fender piles. Walking platforms on the barge and ADA aluminum gangway would provide passenger access to a pile-supported shelter platform.

Land Side Improvements

The landside improvements would consist of the removal of existing bulk material stockpiled at the site. The existing lot is to be modified to accommodate a minimum of 250 parking spaces, a bus stop, electrical utilities for shore power and communications systems, mechanical utilities for potable water and fire protection.

2.5.2 Site Characteristics

Site Access

At present, the proposed site has no fixed-route transit service nearby. The closest transit service is Route 270 SamTrans bus, 1.87 miles away. However, two shuttles serve adjacent office complexes, Pacific Shores and Seaport Centre. The Pacific Shores office complex, adjacent to the site, is served by the Pacific Shores shuttle which runs between the Redwood City Caltrain station and Pacific Shores eight times in the morning and six times in the evening (see **Figure 2-8**). The shuttle is scheduled within ten minutes of Caltrain arrivals and serves the Redwood City Caltrain station between 6:52 AM and 11:06 AM approximately every 30 – 40 minutes, and between 4:09 PM and 8:14 PM approximately every 50 minutes. The Pacific Shores shuttle is managed and contracted by Google Transportation. The Seaport Centre Office Business Park, less than two miles to the proposed ferry terminal, is served by a shuttle that takes passengers between the Seaport Centre and the Redwood City Caltrain station (see **Figure 2-9**). The shuttle makes seven trips in the morning and serves the Redwood City Caltrain station between 6:38 AM and 9:31 AM and six trips in the evening between 4:06 PM and 7:11 PM approximately every 30 – 40 minutes. The shuttle is operated by Commute.org and funded by CBRE and multiple public grants.

Hypothetically, the Pacific Shores and Seaport Centre shuttles could stop at the Redwood City Ferry Terminal after stopping at the office complexes. This would provide access for ferry passengers between the ferry terminal and downtown Redwood City, increasing use of the shuttle in both directions during the peak periods.

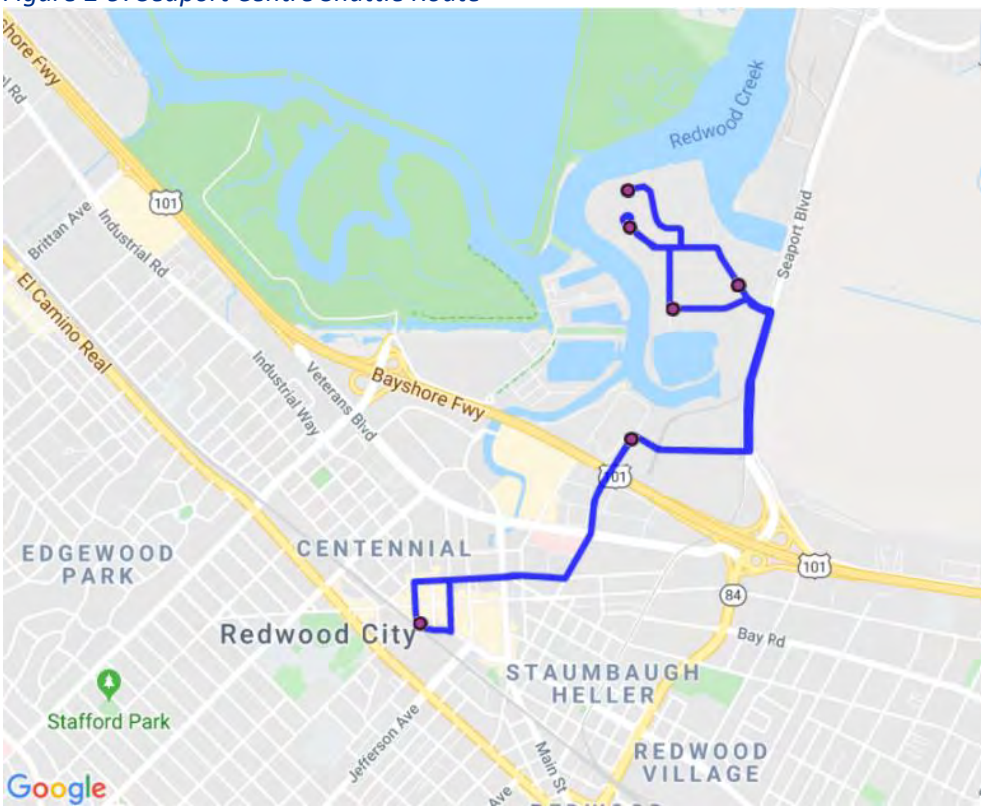
---

[25] U.S. Army Corps of Engineers. Retrieved from http: http://navigation.usace.army.mil/Survey/Hydro.

Figure 2-8: Pacific Shores Shuttle Route

Source: www.SamTrans.com

Figure 2-9: Seaport Centre Shuttle Route



Source: Commute.org

As the terminal location is within the Port, two (Class 1) Union Pacific Railroad freight tracks (at-grade crossings) border both the southern and eastern boundaries of the parcel. Access to Seaport Boulevard, the main thoroughfare which extends the entire length of the port, is hindered by the single track. At this time, Union Pacific has no plans for the two-mile Redwood City branch line. Train traffic is infrequent and operates at a low speed; and sometimes train cars are stowed in a manner that could block access to the proposed ferry location.

The San Francisco Bay Trail is a 500-mile planned regional hiking and bicycling trail network that follows the perimeter of the San Francisco and San Pablo Bays. It is approximately 70 percent complete. **Figure 2-10** shows that the trail section (Map 5) referred to as Belmont Slough to Bedwell Bayfront Park traverses through Redwood Shores, along Seaport Boulevard up to the ferry terminal site, and into Menlo Park along the Bayfront Expressway. The Bay Trail will be a feasible alternative for ferry passengers wishing to bike to destinations near the ferry terminal. Downtown Redwood City is also a reasonable biking distance to the ferry terminal where most destinations are within four miles.

Figure 2-10: Bay Trail Map 5 - Belmont Slough to Bedwell Bayfront Park

Source: www.baytrail.org

Commercial Activities

The Port is the only deep-water port in the South San Francisco Bay, sporting a 30-foot MLLW channel depth. As a result of this competitive advantage, the port received an annual revenue of $8.6 million dollars, 2.3 million metric tons of cargo annually, and 65 vessel and 53 barges in the year FY 2017-18.[26] According to the port's management, the port specializes in "bulk, neo-bulk, and liquid cargoes." The parcel is within the northern terminus of the Port, 3,000 feet west of the ship berths. Based on the locational analysis report created previously, there would be no conflicts between the ferry service and the shipping channel.

Public Activities

A public boat launch located south of Coyote Point (about ten miles to the north), provides 24/7 access at a cost of $5 per boat launch. As a large water recreational community is present, the Redwood City channel is well used. Also, there's over a mile of waterfront which consists of a pedestrian path and viewing areas that are also open to the public. The Port also sponsors "PortFest," an annual all-day long waterfront festival which promotes the recreational activities of the surrounding bay and its facilities.

Land Use Impacts

As is the entire Port including the 408,568 square foot terminal parcel is zoned as "GI- General Industrial" intended for light manufacturing. The Port environs, and the adjacent Pacific Shores

[26] "Port of Redwood City sees $8.6M Revenue and Increased Tonnage," *The Daily Journal*, September 15, 2016.

development are not designed to be walkable, and have an auto-oriented urban form, with the Port adapted to accommodate Port related traffic and trucks, and Pacific Shores to accommodate auto commuters. As mentioned in the recreational activity section, a public waterfront directly neighbors the proposed ferry terminal, with 83 public parking spaces potentially shared with recreational users during low demand recreational use times.

Water Impacts

The wake analysis from the 2007 "Redwood City Preliminary Wake Analysis" found that there would be "no significant impacts on the shorelines of these islands" It is concluded, however, that a low wake travel zone within the estuary must be observed, as this should mitigate the impacts of strong wakes on the shores of the islands. Greco Island would be more sensitive to additional swash transport, whereas, Bair island experiences "larger beach material may result in a beach configuration that is not sensitive to some additional transport."

Section 3
Public Outreach

As part of the Redwood City Ferry Financial Feasibility Study and Cost-Benefit and Economic Impact Analysis, Redwood City employed tools and strategies to solicit input from waterfront users, the business community, and the general public regarding ferry service to and from Redwood City.

Public outreach included two main components:

1. **Getting the Word Out** about the process to a variety of interested stakeholders.
2. **Multiple Channels for Participation** to engage a wide audience and facilitate a forum for people to identify community concerns and provide input on potential ferry service.

These components together were designed to achieve the project outreach goals of:

- Identifying the intended audiences for the outreach
- Describing the types of input to be solicited
- Offering a range of methods that make it easy for people to provide input
- Making sure people's input is effectively used
- Increasing public awareness of the Study and its relationship to the ferry project
- Obtaining guidance from stakeholders, advisory groups, and the general public
- Ensuring broad-based community participation
- Keeping the general public up-to-date regarding project milestones and events

The target audience for outreach included: people interested in waterfront activities and environmental protection; in using ferry service; and in having employees use ferry service. The audience also included the broader Redwood City community, both to receive general information about the status and objectives of the Study, and to help determine the level of interest in ferry service on weekday commute-only basis.

Source: City of Redwood City, 2020

The outreach process was divided into two phases. Phase I engaged the general public through pop-up events. Phase I's primary objective was to help increase awareness about the project. In addition to providing basic information about the objectives of the Study and how to comment, these events were designed to obtain information about potential riders' needs, factors that can encourage ridership, and community concerns that could be addressed in the project.

The Phase II objectives were to garner feedback from two stakeholder groups: one composed of waterfront users, and another made up of major employers, commuters, and the business

community. The discussion with waterfront users was expected to focus on safety and environmental concerns. The discussion with employers and businesses was anticipated to focus on determining the level of interest in commute ferry ridership to/from Redwood City and of influencing factors that would increase the number of people desiring to commute via ferry. Results from the two phases are summarized below.

3.1 Phase One

PlaceWorks conducted Phase I outreach for the Study with the general public at various locations between August and September 2019. To ensure that the Redwood City community was aware of the project and to publicize information about opportunities to participate, the team utilized a project webpage, printed posted and digital flyers, a fact sheet and map, and questionnaires; these materials are available in **Appendix B**. Outreach from these events is summarized in the following sections.

3.1.1 Public Outreach

PlaceWorks and the City administered a questionnaire to the public at different events in the mid-Peninsula area including Redwood City and San Carlos. The survey sought to get a snapshot of mid-Peninsula participants' commute and travel habits and potential ferry use. The questionnaire results are not reflective of people in the Greater Bay Area who would take a ferry to Redwood City. Pop-up tables were set up at the following five events:

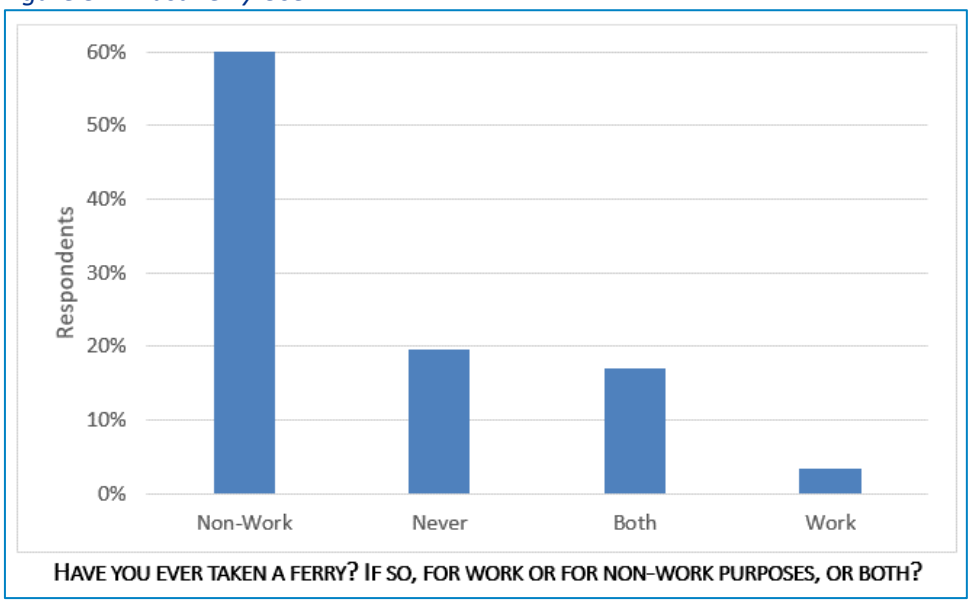
- Music in the Park, August 14, 2019
- Pub in the Park, September 7, 2019
- Salsafest, September 21, 2019
- PortFest, October 5, 2019
- San Carlos Art and Wine Faire, October 12, 2019

A total of 272 individuals offered input during Phase I of outreach for the project. Participants were asked questions about familiarity with ferry service, current commute patterns, and preferences for potential ferry service to and from Redwood City. Since some respondents offered multiple answers to single questions or skipped questions, the total number of responses by question does not match the number of total participants. The results of each individual questionnaire question are summarized below.

Past Ferry Use

The first prompt asked participants, "Have you ever taken a ferry? If so, for work or for non-work purposes, or both?" A total of 272 responses were gathered and, as shown in **Figure 3-1** below, approximately 60 percent of respondents indicated they have taken the ferry for "Non-Work" purposes, approximately 20 percent indicated they've never taken the ferry, roughly 15 percent indicated they take the ferry for both "Non-Work" and "Work" purposes, with only approximately 5 percent indicating they exclusively take the ferry for "Work" purposes.

Figure 3-1: Past Ferry Use

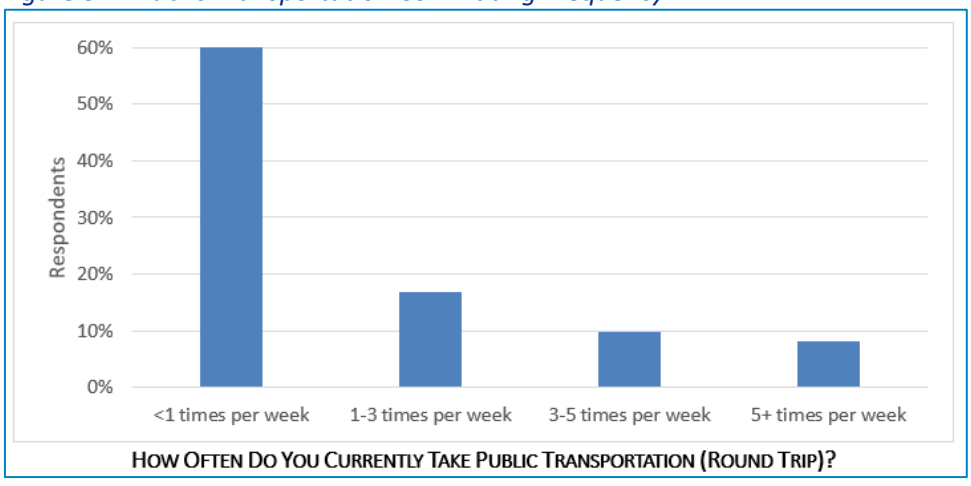


Source: PlaceWorks, 2020

Public Transportation Commuting Frequency

The second question asked participants, "How often do you currently take public transportation (round trip)?" As shown in **Figure 3-2** below, a total of 272 responses were gathered. Most respondents, 60 percent, indicated they take public transportation "<1 times per week" while approximately 19 percent take public transportation "1-3 times per week," roughly 11 percent "3-5 times per week" and 9 percent "5+ times per week."

Figure 3-2: Public Transportation Commuting Frequency

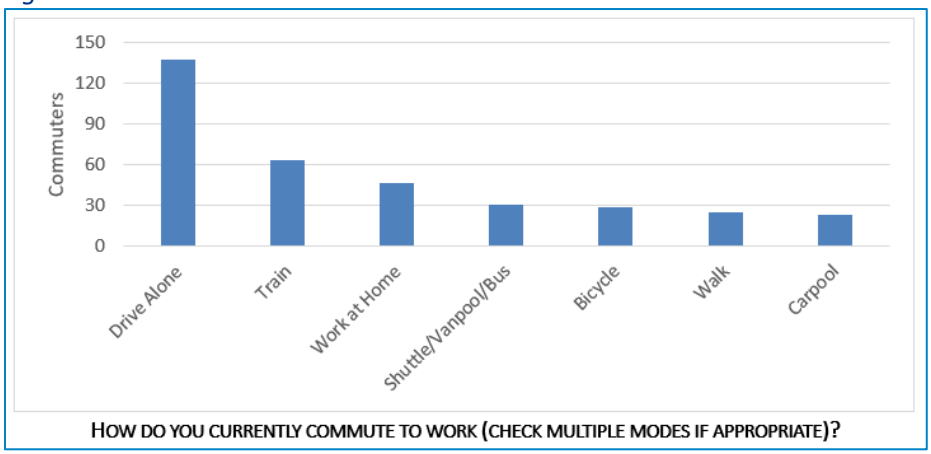


Source: PlaceWorks, 2020

Current Commute Mode

The third questionnaire question prompted participants with, "How do you currently commute to work (Check multiple modes if appropriate)?" Participants were allowed to mark multiple answers, resulting in a total of 354 responses. A total of 62 respondents, shown in **Figure 3-3** below, indicated that they took multiple modes "Shuttle/Vanpool/Bus," and an additional 16 indicated that they do not commute to work at all because they are retired. The predominant answer to question three was that respondents drive alone, followed by the train, work from home (no commute), multiple modes (shuttle/vanpool/bus), bicycle, walking, and finally, carpool.

Figure 3-3: Current Commute Mode

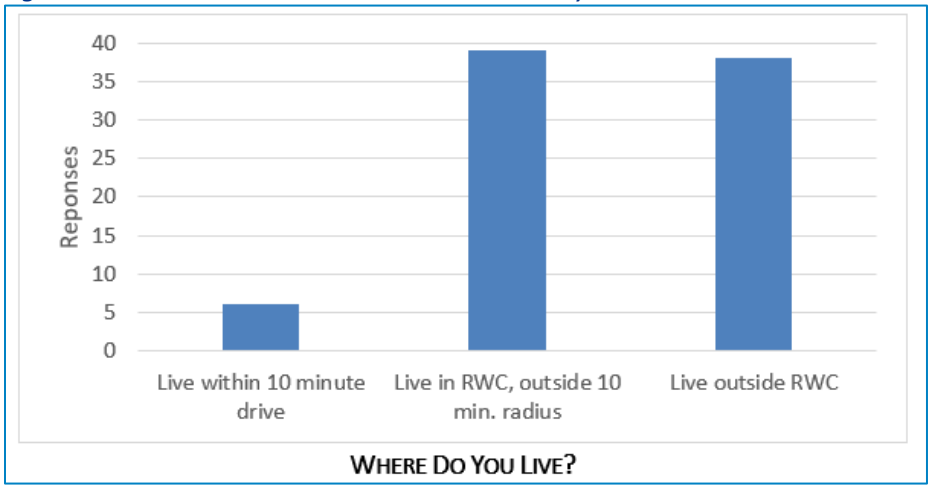


Source: PlaceWorks, 2020

Live and Work Patterns

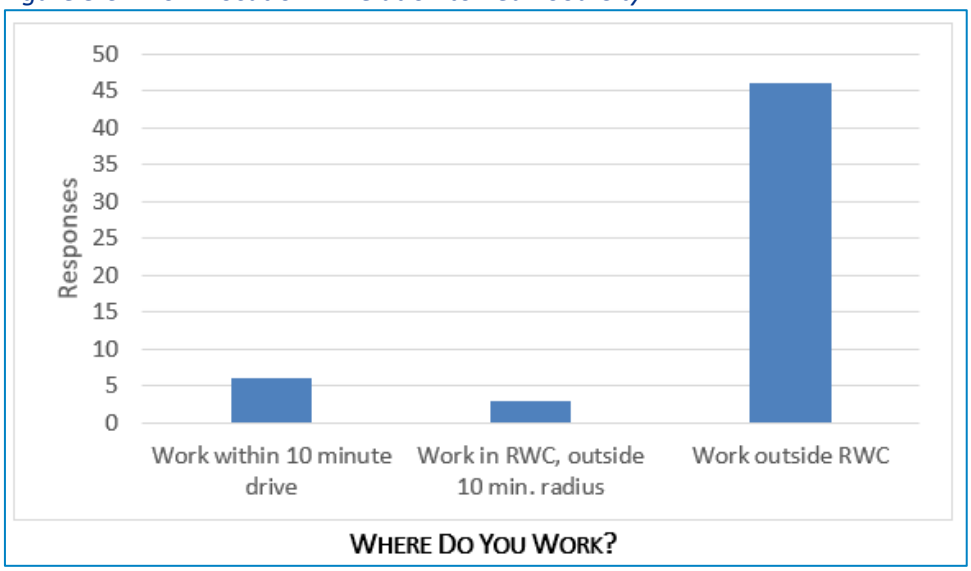
The fourth and fifth questions asked, "Where do you live?" and "Where do you work?" Many individuals who took the questionnaire opted to skip this question. This may be due to their location not being represented on the map, lack of time, and/or privacy concerns. Overall, 31 percent of questionnaire participants chose to identify where they live, and 20 percent marked where they work. These results, illustrated in **Figure 3-4** and **Figure 3-5** below, should be reviewed with consideration due to the low response rate.

Figure 3-4: Residence in Relation to Redwood City



Source: PlaceWorks, 2020

Figure 3-5: Work Location in Relation to Redwood City

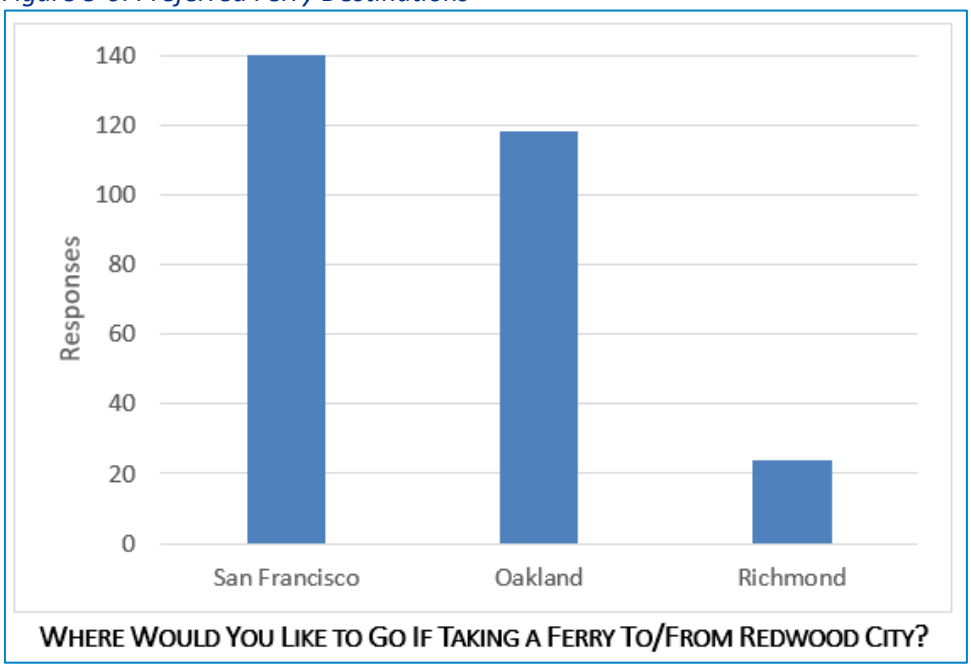


Source: PlaceWorks, 2020

Preferred Ferry Destinations

The sixth questionnaire question was the first to ask respondents about their preferences for potential ferry service. This question asked participants, "Where would you like to go if taking a ferry to/from Redwood City?" Respondents were allowed to mark multiple destinations. A total of 263 individuals responded, illustrated in **Figure 3-6** below. A select few chose to not respond, indicating in a subsequent question that they would not use ferry service. The majority of respondents, approximately 140 of them, indicated they would prefer a ferry to San Francisco, with roughly 120 respondents indicating Oakland, and approximately 23 indicating Richmond.

Figure 3-6: Preferred Ferry Destinations

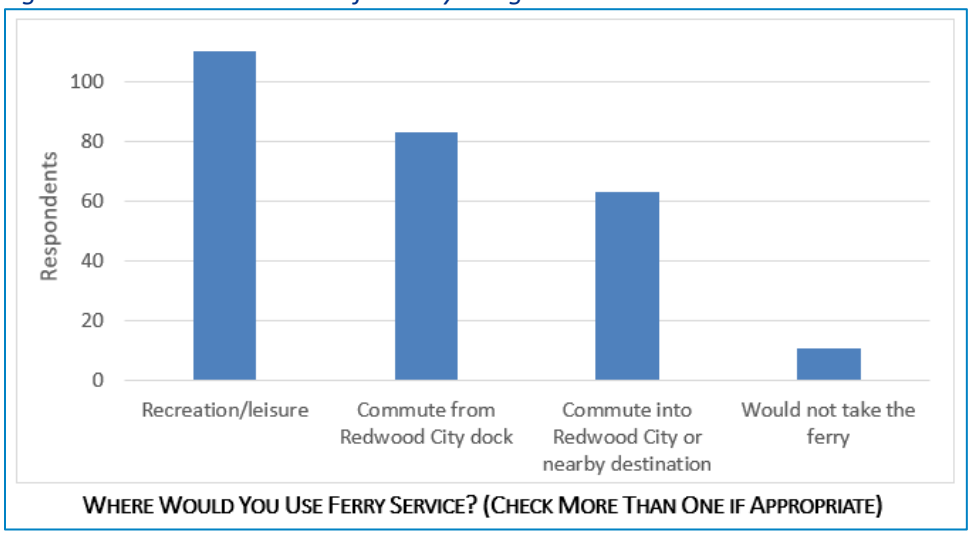


Source: PlaceWorks, 2020

Potential Ferry Service Use

In question seven, questionnaire participants were asked, "Where would you use ferry service (check more than one if appropriate)?" to understand whether their use would be primarily for their work commute, leisure travel, both, or neither. Respondents were allowed to mark more than one answer, and 269 individuals replied as shown in **Figure 3-7** below. Approximately 29 percent of respondents marked that they would take the ferry for both commute and leisure activities, while approximately four percent of respondents indicated they would not take the ferry.

Figure 3-7: Potential Reasons for Ferry Usage

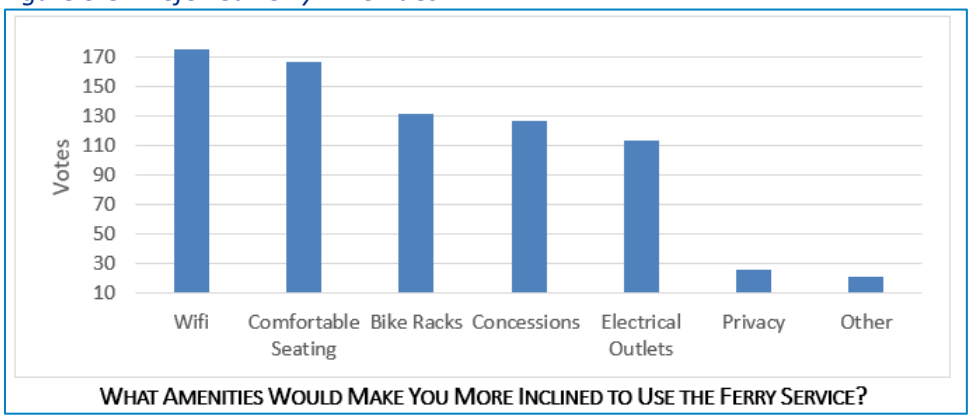


Source: PlaceWorks, 2020

Preferred Ferry Amenities

The final questionnaire question asked respondents, "What amenities would make you more inclined to use the ferry service?" Respondents could choose multiple responses. As shown in **Figure 3-8** below, a total of 272 responses were gathered. Generally, respondents felt that Wi-Fi, comfortable seating, bike racks, concessions, and electrical outlets would make them more inclined to utilize ferry services. Only 21 individuals marked "Other," and some provided clarifying comments that convenient parking, a consistent and reliable schedule, and late-hour return ferry trips would encourage their ridership.

Figure 3-8: Preferred Ferry Amenities



Source: PlaceWorks, 2020

3.2 Phase Two

PlaceWorks conducted Phase II outreach for the Study in April and May 2020 with local employers, the Redwood City Chamber of Commerce Housing and Transportation Committee, and water users including boaters, kayakers, rowers, and wildlife refuge conservationists. Engagement with these groups was facilitated with the help of staff at San Mateo County Economic Development Association (SAMCEDA) and at the Seaport Industrial Association (SIA). Outreach from these events is summarized in the following sections.

3.2.1 Employer Outreach

Employer outreach was conducted through individual conversation meetings with employers and an online stakeholder meeting with employers and commuters.

Individual Meetings

PlaceWorks conducted individual discussions with employers, as follows:

- Google's Transportation Planning and Operations Manager (April 3)
- Chan Zuckerberg Initiative's Workplace Services Coordinator (April 7)
- Oracle's Senior Employee Services Manager (April 7)
- The Sobrato Organization's Senior Vice President, Real Estate Development (April 7)
- Kaiser Permanente's Commuter Services Manager and Transportation Demand Coordinator, (April 14), and Redwood City Campus Public Affairs Director (May 15)
- Sequoia Hospital's President, Dignity Health (April 30)
- Stanford Health Care's Director of Local Government & Community Relations; a Senior Project Manager; and their Senior Manager, Transportation Operations (May 1)

The employer contacts offered confidential estimates of employee ridership that would in aggregate appear to meet the minimum threshold outlined by WETA for initiation of ferry service during commute times. Each employer contact expressed definite interest in ferry service for their commuting employees, as well as in an ensuing online session (with employees from multiple employers simultaneously) to discuss the potential service and help gauge additional ridership potential.

Each employer also indicated that the Oakland route makes more sense than a San Francisco route since the former has fewer parallel options that offer a reasonable commute duration. The Sobrato Organization, also a landlord for major tenants, and Hexagon Transportation also provided insight on ferry route options. The Sobrato Organization's representative pointed out that ferry service from other points around the San Francisco Bay would also be helpful, to which Hexagon's representative responded that Oakland makes the most sense to be established first, given easier logistics to get to the water.

Several employer contacts noted the potential for ferry service to the mid-Bay, especially Oakland, to create opportunities for recruiting new employees, as well as for current employees to relocate for housing affordability if desired. The representative from Kaiser Permanente indicated interest in additional trips once the ferry is running to accommodate non-traditional on-site shifts, such as from 7 AM to 3 PM.

Stakeholder Meeting

PlaceWorks hosted a stakeholder meeting via Zoom.us, an online audio/video conferencing platform, on May 12 at 1:00 PM due to shelter-in-place mandates resulting from COVID-19 pandemic public health concerns. The meeting was advertised via an e-blast, Eventbrite, and word of mouth. Approximately 15 participants joined the call with representatives from Google, SIA, Stanford, Altrans, Krupka Consulting, and Stanford Children's Health. A Redwood City Council Member and Mayor Howard also participated in the call, along with the City's project manager for the Study, and the Port of Redwood City Executive Director.

The meeting began with a presentation by PlaceWorks, followed by a poll and a question-and-answer period. The poll asked meeting attendees, "Which choice best describes your current perspective on potential ferry service?" In response, 60 percent of attendees were "very supportive," and 40 percent were "supportive." No participants answered "neutral," "opposed," or "very opposed."

During the question-and-answer period, the Google representative asked whether the project timeline would be impacted by the COVID-19 pandemic. The consultant team's project manager clarified that the project timeline is primarily driven by the engineering and construction phases. The project is currently in the initial feasibility phase, so impacts from public health concerns are likely minimal for the overall timeline for establishing ferry service. Changes to traffic and commute patterns in a post-COVID-19 context will be evaluated as any new trends emerge.

3.2.2 Water Users Outreach

Outreach with the water user community was conducted through an informative stakeholder meeting with both water and waterfront users of the Redwood Creek Channel and Westpoint Slough and conservationists. The meeting was advertised through an e-blast to the City's ferry contact list, Port of Redwood City's water user contact list, Eventbrite, and word of mouth among water users. The meeting was hosted online via Zoom.us due to shelter-in-place mandates from COVID-19 pandemic public health concerns.

Source: Center for Land Use Interpretation, 2020

Approximately 40 water users attended the online meeting, with participants from Bair Island Aquatic Center, Citizens Committee to Complete the Refuge, the State Department of Fish & Wildlife, MV Calypso, NorCal Crew, Peninsula Youth Sailing Foundation, Pied à Mer Plus, Prairie Rowing, PROP SF, Redwood Scullers, Save the Bay, Sea Scout Ship Gryphon, Seaport Industrial Association, Sequoia Yacht Club, Spinnaker Sailing, Stanford, USGS, and Westpoint Harbor. Port Commissioner, Port Director, City project manager, Water Emergency Transportation Authority (WETA) Transportation Planner and Senior Planner also attended and fielded technical questions.

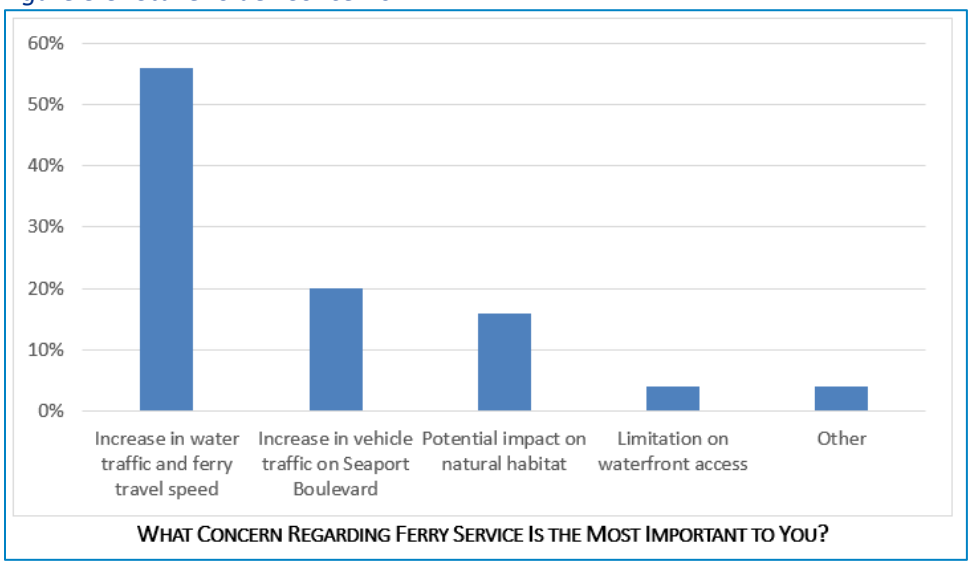
The meeting began with a welcome and introductions followed by an introductory poll to understand the primary interests of meeting participants. When asked "What are your water-related interests and activities?" approximately 73 percent of participants answered the multiple-option question with "water recreation." Approximately 36 percent chose "environmental conservation," 24 percent selected "shoreline recreation," and 12 percent were interested in each of "cargo/shipping uses," "marine life research and education," and "other activities."

The subsequent presentation on ferry feasibility analysis to date was followed by a question and answer period, in which water users asked questions, shared concerns, and provided comments and recommendations to the project team. Feedback and abbreviated answers from the project team are listed in **Appendix B**, and general themes are listed here:

- Wake size is a common concern
- Boat speed is another concern
- Water user compatibility across various channel uses is a common concern, and safety issues should be studied in-depth
- Environmental impacts, primarily bank and tidal erosion from ferry wakes, on Bair and Greco Islands are a concern
- A new ferry terminal at the end of Seaport Boulevard will generate significant traffic impacts, and the City will need to provide connections from the terminal to Downtown Redwood City
- Regular channel maintenance and dredging is mutually beneficial for water users and generally supported

Following the question and answer period, water users were asked to answer two questions as part of a second poll. To the first question, "What concern regarding ferry service is the most important to you?" approximately 56 percent of water users chose "increased water traffic and ferry travel speed." Other responses are show in **Figure 3-9** below.

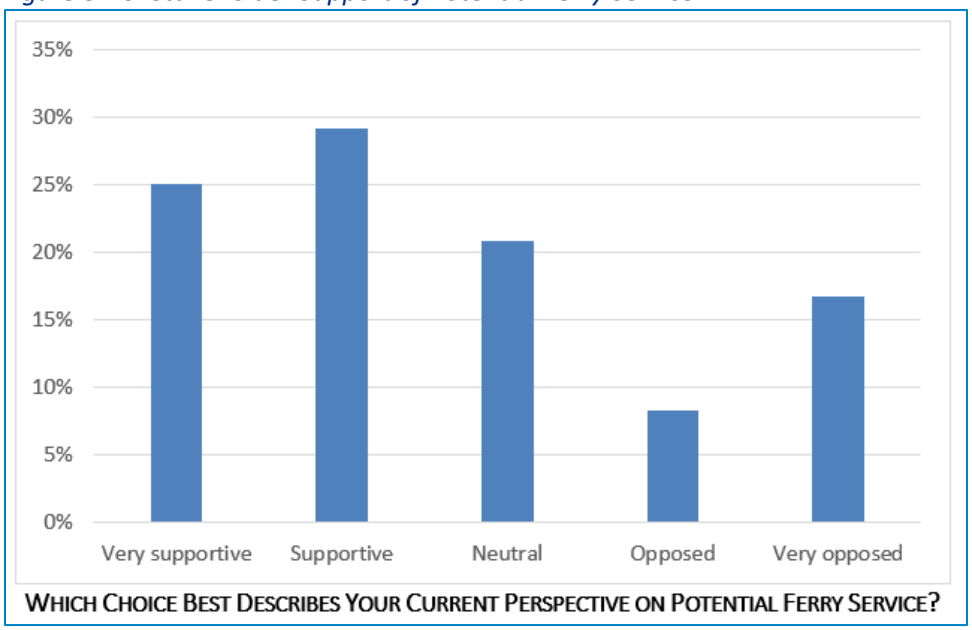
Figure 3-9: Stakeholder Concerns



Source: PlaceWorks, 2020

The second question asked participants, "Which choice best describes your current perspective on potential ferry service?" As shown in **Figure 3-10**, approximately 29 percent of water users were "supportive," and 25 percent were "very supportive," while 8 percent were "opposed," and 17 percent were "very opposed."

Figure 3-10: Stakeholder Support of Potential Ferry Service



Source: PlaceWorks, 2020

Following the online event, three meeting attendees submitted additional comments via email, some noting that they felt more comfort not sharing their opinions with the larger group. Comments from these emails include:

- The project should consider and build in the requirements for safe operation upfront.
- Slower ferry speeds appear to increase safety but decrease ridership numbers.

- Redwood City does not seem like an ideal place for a new ferry terminal due to expensive dredging, the incompatible working waterfront activities, and farther proximity from job centers. Consider Alviso Marina in Mountain View instead.
- The increase in traffic on Seaport Boulevard without any public transit component will have significant negative impacts on circulation in the area.
- Safety concerns should consider new water users in addition to the experienced water users engaged through this outreach. Safety during low tide is an especially high concern.
- The Redwood Creek Channel is an area used by many types of vessels, from one-person kayaks to commercial ships docking at the Port. That is a fact which is unlikely to change and all boat users, including the commercial ships, have the right to operate in the channel.

3.2.3 Chamber of Commerce Outreach

A presentation on the Study was made to the Redwood City Chamber of Commerce Transportation and Housing Committee during its regular meeting on May 14, 2020. Approximately 21 attendees participated in the online meeting, and the Chamber Committee indicated strong support of both ferry service and a public shuttle connection to downtown Redwood City, including a stop west of US 101 en route. Participants noted that many of them have been involved in discussions about and planning for ferry service for more than a decade and are excited by the progress of this Study.

3.3 Key Findings

As indicated in the meeting summaries above, the overall sentiment regarding potential ferry service in Redwood City from the various community stakeholder groups is generally supportive of ferry service. Employers agree that ferry service is needed and would be used by their employees. They are wholly in support of ferry service and would be interested in playing a supportive role to improve commute options for their employees. Water users are a more divided group, but they generally agree that ferry service has the potential to be a positive resource in the community. While the water users are more tentative, primarily due to concerns regarding the potential for wakes to capsize rowing vessels, they would like any ferry service to minimize safety concerns, infringement on other water activities, and traffic and environmental impacts. The Chamber Committee is wholly supportive of ferry service as well, including land-based transit connections to Downtown Redwood City and the developing office campus area along US 101.

All of the community members contacted indicated a desire to be kept apprised of the latest information available on the ferry project. Members of the water user group offered to facilitate a land and water tour of Redwood Creek Channel and Westpoint Slough with decision-makers to help understand and plan for traffic management on the water with a potential new ferry dock.

Section 4

Ferry User Demand

4.1 Development of Service Scenarios

This section outlines draft service plan scenarios envisioned for a new ferry service to/from Redwood City (mid-Peninsula) market.[27] These draft service scenarios will be used for ridership forecasting, operating costs and fare revenue estimations, benefit/cost analyses, and public outreach discussions. The general assumptions which were used to develop the service plans are:

- WETA would operate two ferry boats per route, such as the new Dorado class vessel that has a passenger capacity of 320, to serve Redwood City terminal; smaller vessels like the Gemini class vessels, with a passenger capacity of 225 could be used on these routes with little change to passenger comfort but could add 10-15 minutes to travel time.
- Three ferry trips in peak, per WETA Board-adopted standards.
- There are no plans for overnight vessel layovers to occur in Redwood City, but they may occur in the future.
- Commute peak period headways of approximately 55-65 minutes are planned.
- The East Bay would access ferry service to Redwood City through the Oakland terminal.

Source: CDM Smith, 2020

- Transfers between ferries in San Francisco require up to 10 minutes to allow ample time for disembarking / embarking as well as schedule adherence aberrations.
- No weekend service at this time, but once operational there could be an option of a Weekend Ferry Service Pilot Program, like the Richmond to San Francisco route's 3-month pilot project which ran in 2019.
- Ridership was not estimated for special events such as baseball or basketball games, but special event service would be considered for a Redwood City terminal.

It is important to note that the precise schedule will be tailored to market needs if the project moves forward to implementation and will be continually adjusted based on actual operating conditions and rider demands. A refinement in the number of ferry trips will be simple to adjust in the future, based on ridership experience. If there is greater demand than projected in this Study, service could be extended into the shoulders of the peak by WETA vessels and crews. Potential routes were explored that would connect Redwood City to other existing or planned WETA ferry terminals throughout the

---

[27] Although, a majority of the work-related market area falls within Redwood City limits, an extension of the work-related market area into the mid-Peninsula City of Menlo Park, particularly, the Facebook Campus located just outside the 15-minute access distance was done in this analysis.

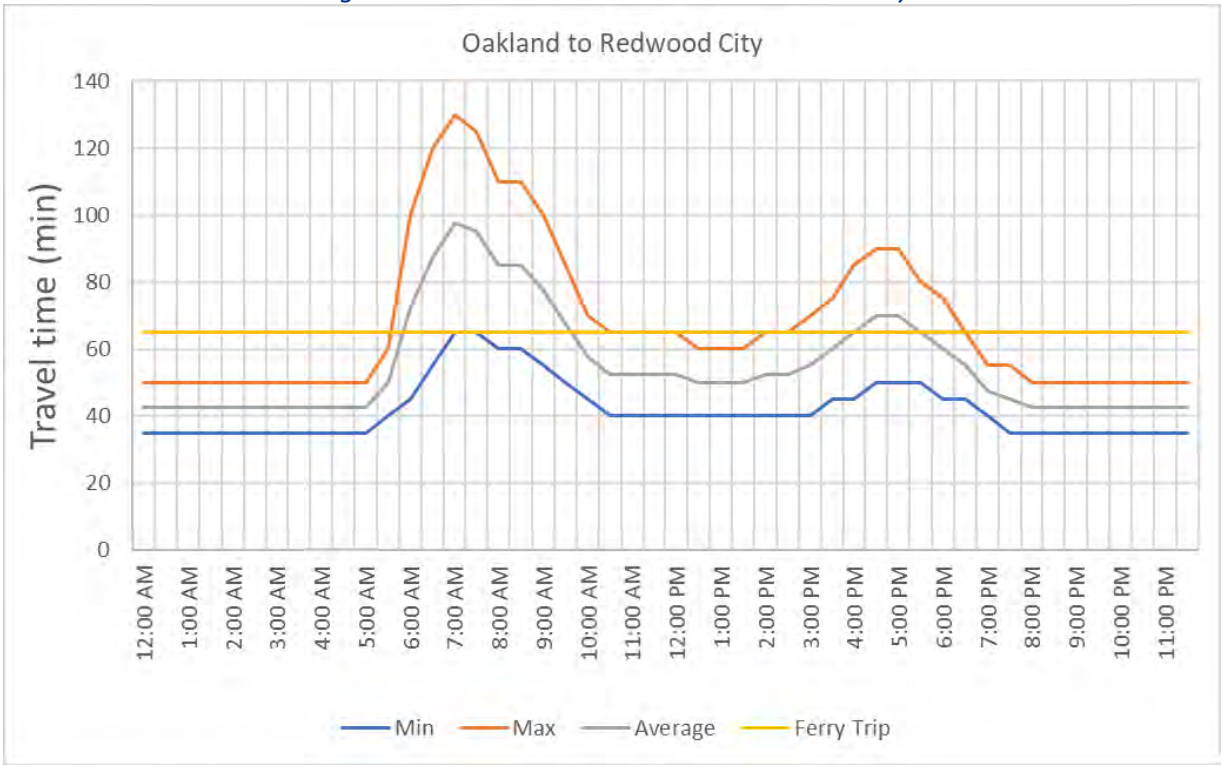
San Francisco Bay Area. On the westside of San Francisco Bay, potential ferry linkages were assessed for South San Francisco, Mission Bay, and for Downtown San Francisco. The Downtown ferry terminal would be the most promising of these three options as it has excellent multimodal access connections, high density of pedestrians and bicyclists, accessible employment, and strong connections to other ferry services. On the eastside of San Francisco Bay, linkages to Richmond, Berkeley, Oakland/Main Street in Alameda, Seaplane Lagoon in Alameda, and Harbor Bay in Alameda were explored. Since Berkeley does not have an existing ferry terminal and the timeline for building it is unknown, this option was dismissed. The Seaplane Lagoon and Harbor Bay terminals were deemed less attractive compared to the nearby Oakland terminal because patrons would have to drive further into Alameda to access them. The Vallejo terminal has too small of a market to support primary service. Similarly, there does not appear to be a strong enough market for direct service between Richmond and Redwood City, therefore the effort focused on linkages to Downtown San Francisco and Oakland. Riders from Vallejo, Richmond or Harbor Bay could potentially transfer at the San Francisco Ferry Building to reach Redwood City.

Three routes or service scenarios were originally proposed but adjusted down to two based off of comments received from WETA relating to travel time, operational costs and potential ridership. The scenario eliminated from consideration would have linked San Francisco to Oakland via Redwood City in a “V” pattern, but the travel times were too great to meet WETA service standards. The two remaining service scenarios were defined based on analyses of commute patterns, existence of ferry terminals and likely rider maximum tolerance of ferry running times. As a result, Scenario 1: Oakland to Redwood City, and Scenario 2: San Francisco to Redwood City were carried forward to the travel demand modeling stage to help establish potential ridership numbers. The potential commute markets for new Redwood City ferry service are discussed in a greater detail in Section 5, summarizing the market analysis and ridership forecasts. Almost all the potential ridership will need to transfer modes at least once and sometimes two or more transfers. Typically, riders do not like to transfer, particularly for long headway connections; however, survey results from WETA on-board passenger surveys have shown that ferry riders will trade longer travel times on a ferry with multiple transfers (e.g. first/last mile connections) compared to a one seat commute in a car.

An analysis was conducted to identify at what times the largest potential for capturing ridership exists. **Figure 4-1** through **Figure 4-4** illustrate one way auto travel times for Oakland-to-Redwood City, Redwood City-to-Oakland, San Francisco-to-Redwood City, and Redwood City-to-San Francisco, respectively. Using Google Maps travel data, travel times were examined for the Oakland-Redwood City and San Francisco-Redwood City routes. The blue lines in the chart illustrate the minimum auto travel times between the points throughout the day, the orange lines illustrate the maximum auto travel times and the grey lines illustrate the average auto travel times. The yellow line represents the ferry travel time between the two points and would remain constant regardless of the time of day.

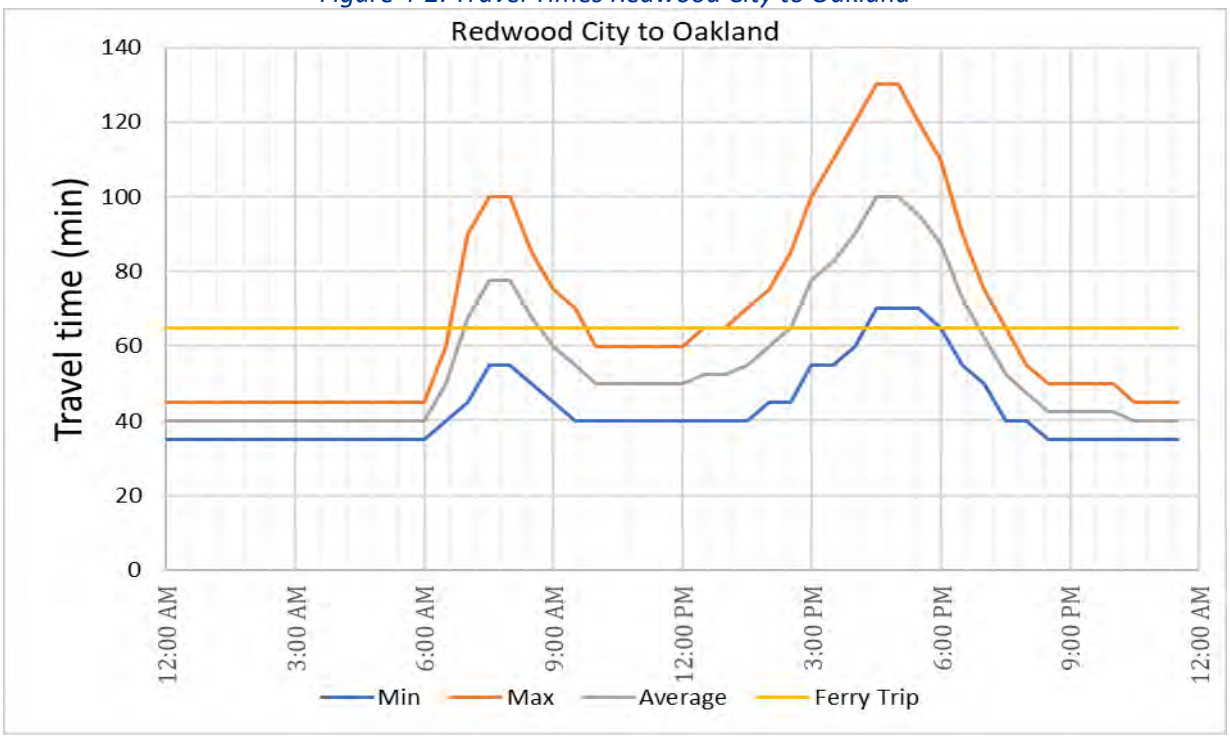
The greatest potential for capturing ferry ridership would exist during the times of day where on-ferry times are comparable or better than the travel times of auto travel, as well as when travel time reliability is low for auto travel times. Travel time reliability is the consistency or dependability in travel times between two points. In the following charts the closer that the blue and orange lines are together, the greater the travel time reliability would be, so the times of day where the biggest difference between the minimum and maximum travel times should yield the greatest potential ridership for the ferry. Using the general assumptions discussed above, along with WETA service standards and the comparison of travel times, draft ferry service scenario schedule times were established and are discussed below as Scenario 1: Oakland to Redwood City, Redwood City to Oakland; and Scenario 2: San Francisco to Redwood City, and Redwood City to San Francisco.

Figure 4-1: Travel Times Oakland to Redwood City



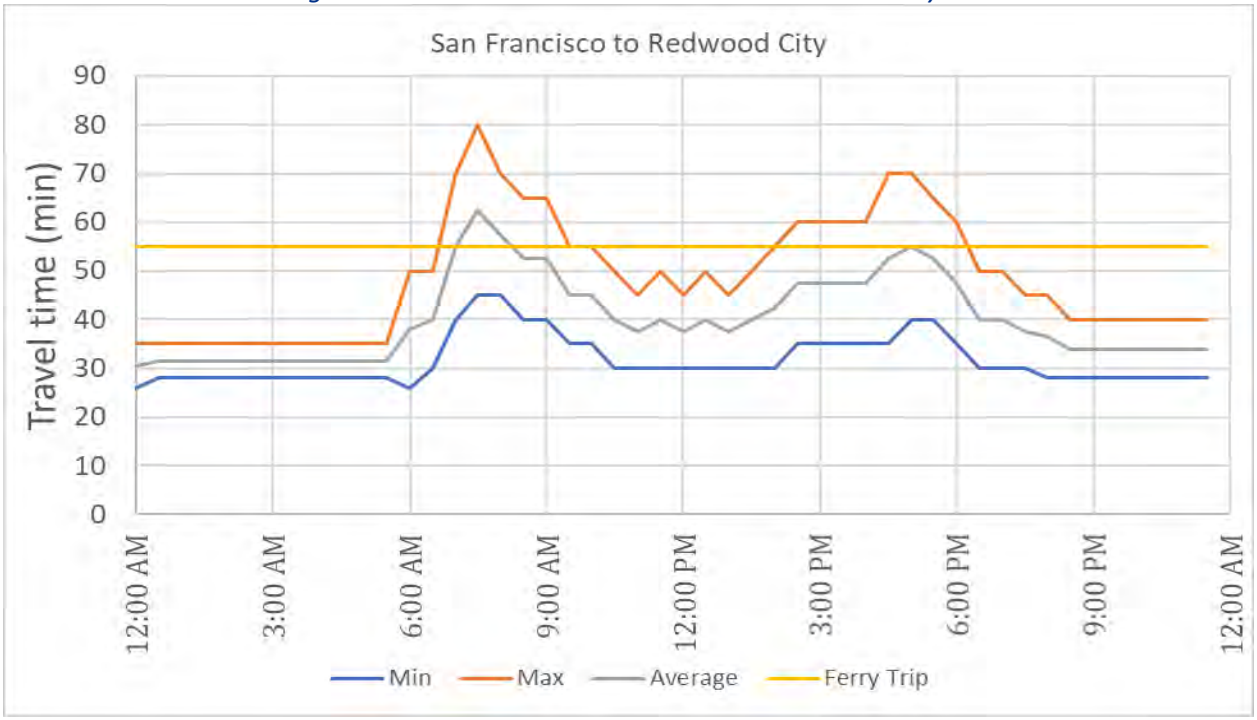
Source: CDM Smith, 2020

Figure 4-2: Travel Times Redwood City to Oakland



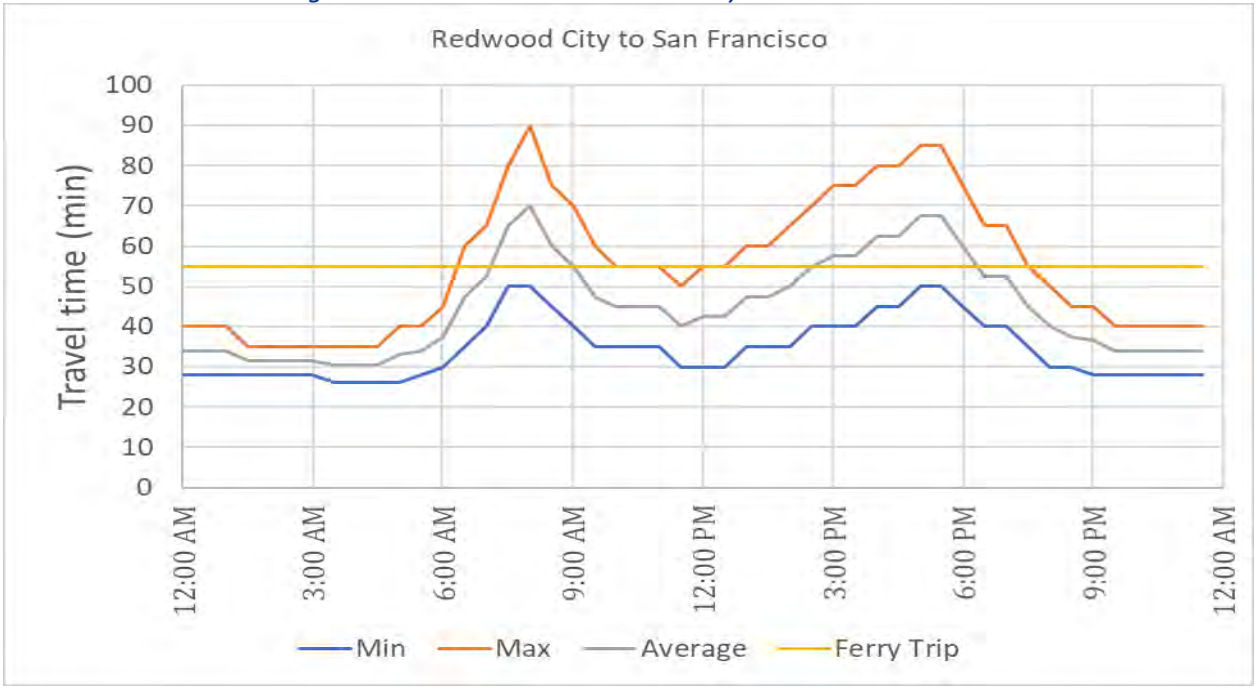
Source: CDM Smith, 2020

Figure 4-3: Travel Times San Francisco to Redwood City



Source: CDM Smith, 2020

Figure 4-4: Travel Times Redwood City to San Francisco



Source: CDM Smith, 2020

4.1.1 Service Scenario 1: Oakland to Redwood City

This route is a round trip service between the East Bay and Redwood City with an approximate one-way running time of 65 minutes from Oakland. The service would depart Oakland and head westbound out of the Estuary before heading south to Redwood City. Two ferry boats would be deployed for this service with three peak period roundtrip ferry trips in the morning and three in the evening, to meet the WETA service standards. **Table 4-1** describes an illustrative schedule for two boats and **Figure 4-5** illustrates this service.

Table 4-1: Draft Service Scenario 1: Oakland to Redwood City

Scenario 1	Depart	Arrive	Depart	Depart
	Oakland	Redwood City	Redwood City	Oakland
AM Weekdays				
Boat 1	6:15 AM	7:20 AM	7:30	8:35
Boat 2	7:15	8:20	8:30	9:35
Boat 1	8:45 AM	9:50 AM	10:00	11:05
PM Weekdays				
Boat 2	3:00 PM	4:05 PM	4:15	5:20
Boat 1	4:15	5:20	5:30	6:35
Boat 2	5:30	6:35	6:45	7:50

Source: CDM Smith, 2020

Figure 4-5: Service Scenario 1 Oakland to Redwood City, Redwood City to Oakland

Source: CDM Smith, 2020

4.1.2 Service Scenario 2: San Francisco to Redwood City

This route is a round trip service between San Francisco Ferry Terminal and Redwood City. It assumes passengers originating from ferry terminals in the North or East Bay could transfer in San Francisco to a ferry destined for Redwood City. This provides the greatest regional ferry access to Redwood City but would yield lengthy travel times with the transfer in San Francisco. The one-way running time would be about 55 minutes. **Table 4-2** describes an illustrative schedule and **Figure 4-6** illustrates this route. This scenario would provide four round trips between San Francisco and Redwood City. Two boats would be deployed for this service.

Table 4-2: Draft Service Scenario 2: San Francisco to Redwood City

Scenario 2	Depart	Arrive	Depart	Arrive
	SF Ferry Building	Redwood City	Redwood City	SF Ferry Building
AM Weekdays				
Boat 1	5:50 AM	6:45 AM	6:55	7:50
Boat 2	6:20	7:15	7:25	8:20
Boat 1	8:00 AM	8:55 AM	9:05	10:00
Boat 2	8:30	9:25	9:35	10:30
PM Weekdays				
Boat 1	3:20 PM	4:15 PM	4:25	5:20
Boat 2	4:05	5:00	5:10	6:05
Boat 1	5:30 PM	6:25 PM	6:35	7:30
Boat 2	6:15	7:10	7:20	8:15

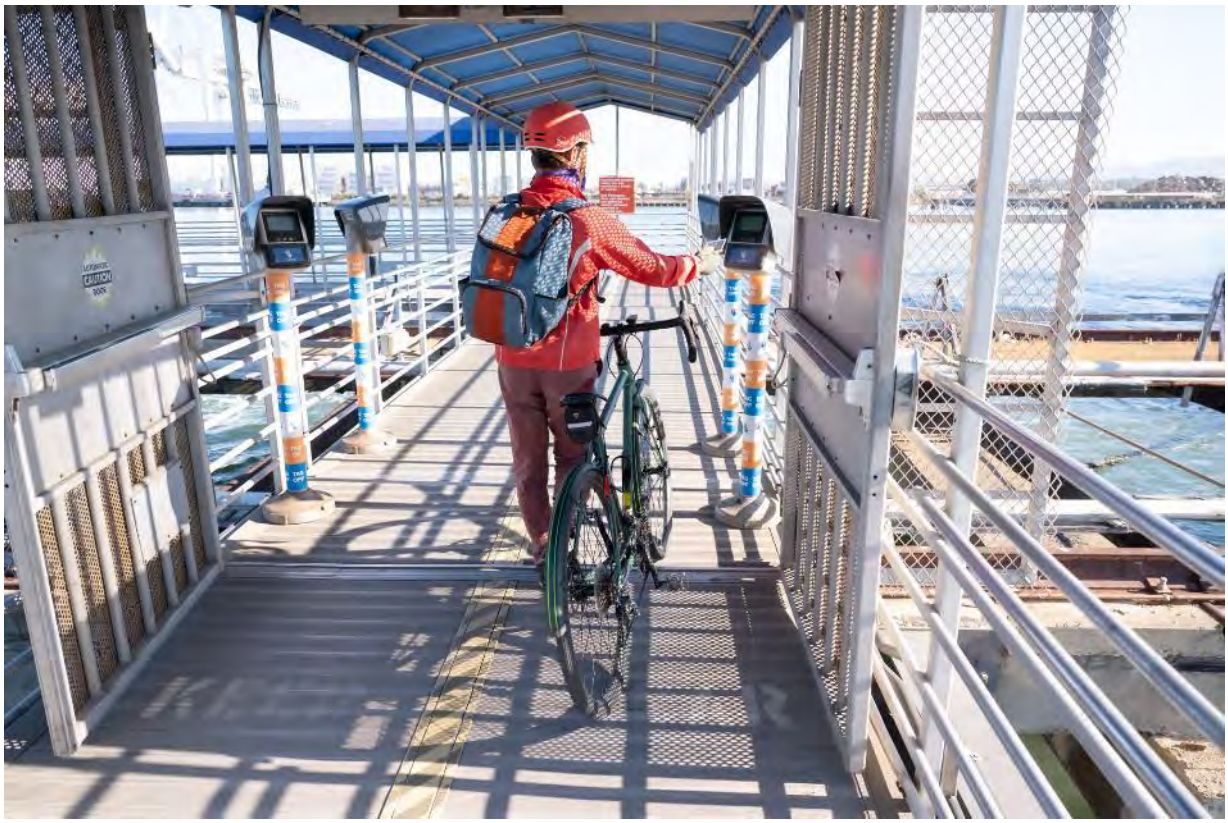
Source: CDM Smith, 2020

Figure 4-6: Service Scenario 2: San Francisco to Redwood City

Source: CDM Smith, 2020

4.1.3 First and Last Mile Access Connections

First Mile describes the effort required to travel from home to the ferry terminal and Last Mile describes the effort required to travel from the ferry terminal to job sites and other destinations. In recent on-board customer satisfaction surveys conducted on WETA operated ferries (2017 and 2019), customers stated that commute time spent on-board ferries tends to be relaxing and pleasant but getting to and from ferry terminals for long headway ferry services can be somewhat stressful. Minimizing first and last mile access times will be important to successful ridership. Many major employment sites including Downtown Redwood City are within a 15 to 20-minute bike ride, but few are within walking distance. Bike links to Facebook, Electronic Arts, Oracle and Downtown Redwood City should be enhanced if possible. Outreach to SamTrans to consider operating a regular bus route to the ferry terminal and adjacent development would also help, as would a discussion with Commute.org, which already provides a shuttle between the Caltrain station and the adjacent Pacific Shores Center, “timed” transfers between these shuttles and the ferry would help reduce passenger stress. Major employers might also consider employer shuttle service for last mile connections similar to the last mile vanpool that Facebook provided for their employees during their pilot ferry project with PROP SF in 2019.



Source: WETA, 2020

4.2 Travel Demand Modeling and Ridership Estimates

This section discusses the ridership demand modeling that was used to establish potential ridership for the Redwood City Ferry Service. The CDM Smith team evaluated the following two scenarios that were proposed in Section 4.1, for potential ridership looking at the years 2019 and 2040:

- Scenario 1: Oakland to Redwood City, Redwood City to Oakland
- Scenario 2: San Francisco to Redwood City and Redwood City to San Francisco

Initial results from a data-driven ridership analysis based on conservative assumptions were presented at a Technical Advisory Committee (TAC) meeting on February 21, 2020. With input from the TAC composed of City, Port, and WETA staff, the CDM Smith team went back to the model to adjust some existing inputs and add some additional inputs to better refine the ridership forecast. This section discusses the assumptions, inputs and methodology that were used in developing the ferry ridership estimates. This section also summarizes the ridership results – estimated total weekday rider boardings and average ferry rider boardings per direction by service scenario during the peak hour commute period and presents preliminary conclusions on the service scenarios from a ridership standpoint.

4.2.1 Ridership Travel Demand Model

The assumptions and inputs for ridership estimation are discussed below.

Data Sources

Data sources used to develop a ferry ridership demand model were:

- Comparative travel time data was collected using Google Maps Traffic Model and Google Maps Application Programming Interfaces (APIs), that provided “best guess” and “pessimistic” drive travel times for commute patterns during the proposed ferry service times, as well as helping in determining the catchment area around the proposed ferry terminal.
- The regional transportation demand model developed by the Santa Clara Valley Transportation Authority (VTA) and C/CAG was used to determine trips and travel time information for commuter flows for the years 2015, 2025, and 2040.
- Employee workflows were developed using national data sources of US Census data from the 2015 Longitudinal Employer-Household Dynamics (LEHD) database as well using Work Area Profile Analysis in the US Census’ “OnTheMap” Tool based Current Employment Statistics (CES). Employment data was updated and adjusted to 2019 using state and local data sources, including Comprehensive Annual Financial Reports from various municipalities around the proposed ferry terminals, and the California Employment Development Department (EDD).
- Employer surveys conducted by the City were also used to collect zip code level counts of employees residing near the existing ferry terminals of Oakland and San Francisco and working in Redwood City and the mid-Peninsula market.
- Survey results from the system wide WETA On-Board Passenger Survey (2017) and the subsequent Richmond On-Board Passenger Survey (2019) were also used to determine key reasons for using the ferry and to collect a wide range of demand factors including non-

commute trips and ferry access/egress drive mode shares. 2040 Plan Bay Area population projections by city were combined with this data to produce non-commute trip generation rates transferrable to the proposed San Francisco to Redwood City ferry service.

Assumptions

Employee Flows

Travel time isochrones were used for employee flows identification and to determine the origin and destination terminal catchment area size. An isochrone is a curved line drawn on a map connecting points with equal travel time. Typically, these are based upon following transportation routes such as public transit, roadways, or foot paths rather than using a simple circle (a.k.a. buffer of a point, "as the crow flies" distance). For this analysis 30-minute "home isochrones" were developed for the origin ferry terminal and 15-minute "work isochrones" were developed for the destination ferry terminal.

The data on zip code level counts for employees residing near the San Francisco and Oakland ferry terminals was converted to a percentage distribution by access time (15- or 30-minute) to a ferry terminal. For residents near the proposed ferry terminal in Redwood City, the percentage distribution by access time was assumed as 75 percent with 15-minute access time and 25 percent with 30-minute access time.

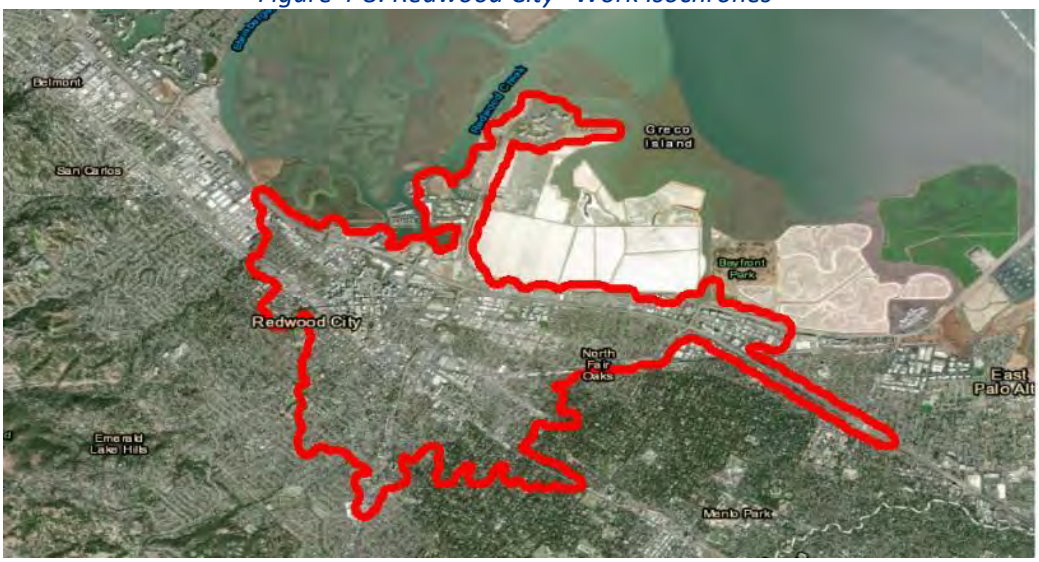
For illustrative purposes, **Figure 4-7** and **Figure 4-8** show the "home isochrones" for the San Francisco and Oakland markets and the "work isochrones" for the Redwood City (mid-Peninsula) market[28] respectively; although analysis was done for "work isochrones" in the San Francisco and Oakland markets as well as the "home isochrones" in Redwood City market. Although outside of the 15-minute "work isochrone" the Oracle and Facebook campuses were added to the destination catchment area based off input from the TAC. **Table 4-3** displays the estimated employee flows for Redwood City and both market areas (Oakland and San Francisco).

Figure 4-7: San Francisco and Oakland "Home Isochrones"

Sources: Google Maps Traffic Model and Application Programming Interfaces (APIs); ESRI ArcGIS; CDM Smith analysis

[28] Although, a majority of the work related market area falls within Redwood City limits, an extension of the work related market area into the mid-Peninsula City of Menlo Park, particularly, the Facebook Campus located just outside the 15-minute access distance was done in this analysis.

Figure 4-8: Redwood City "Work Isochrones"



Sources: Google Maps Traffic Model and Application Programming Interfaces (APIs); CDM Smith analysis

Table 4-3: 2019 Employment Flow Estimates (Updated from 2015)

Market Pair	From Redwood City to Market Area	From Market Area to Redwood City	Bi-Directional Total
Between Redwood City and San Francisco	**9,190**	**10,330**	**19,520**
- Within 15-minute access time from Home Terminal	6,890	3,350	10,240
- Between 15-minute to 30-minute access time from Home Terminal	2,300	6,980	9,280
Between Redwood City and Oakland	**1,970**	**5,900**	**7,870**
- Within 15-minute access time from Home Terminal	1,480	2,770	4,250
- Between 15-minute to 30-minute access time from Home Terminal	490	3,130	3,620

Sources: US Census2015 Longitudinal Employer-Household Dynamics (LEHD) database and OnTheMap Tool; Comprehensive Annual Financial Reports for Redwood City, Menlo Park, San Francisco and Oakland; California Employment Development Department (EDD); CDM Smith Analysis.

Ferry Ridership Factors

Based off the results from the WETA On-Board Passenger Surveys, the key reasons for ferry usage were as follows: Avoidance of Traffic/Parking (at destination), Ride Quality, Relaxation, Ability to Multitask and "Faster" (read and understood as more reliable) travel times.

Parking Accessibility at Origin Ferry Terminal

Parking accessibility at the ferry terminal that forms a commute origin in the AM greatly increases the distance that could be traveled in the "home isochrone." The following assumptions were made as to whether or not parking is easily accessible at the origin ferry terminal: the Oakland Ferry Terminal has accessible parking, the San Francisco Ferry Terminal does not have easily accessible parking, and the Redwood City Ferry Terminal would include parking or last mile connection service (or both).

Ferry Capture of Peak Commuter Demand

The employment flows shown in **Table 4-3** (also referred to as the commuter demand) were assumed to be spread over the AM and PM peak periods, the exact temporal distribution of these trips is not known from any available data. The proposed ferry service schedules call for three round trips from the Oakland Ferry Terminal and four round trips from the San Francisco Ferry Terminal. To differentiate the provision of three services and four services during peak periods, this analysis assumed that the three ferry services during the peak period of the Oakland service would capture about 75 percent of the that market's peak period commuter demand. Additionally, the four ferry services during the peak period of the San Francisco service would capture 90 percent of that market's peak period commuter demand. The commuter demand for the markets before and after the ferry service period was assumed to remain captive to existing modes of transportation.

Drive Travel Time Distribution

For a given origin-destination pair and given time of departure, the drive travel times can vary from day-to-day. These drive travel times were assumed to follow a log-normal (normally distributed curve) type probability distribution. Google Maps-based "best guess" drive travel time was assumed to represent the mean for this distribution, while the "pessimistic" drive travel time was assumed to be the 85th percentile value for this distribution. These assumptions were used to estimate the mean and standard deviation parameters for the log-normal distribution and estimate probability of the drive travel time exceeding the total ferry transit time.

Working on the Ferry

The ability to multitask on the ferry was determined to be a major benefit and reason why people choose to ride the ferry. To use this information in the model, it was assumed that 50 percent of commuters could work on the ferry. Productive time on ferry was assumed to be on-ferry transit time minus ten minutes (5 minutes just after boarding and 5 minutes just before alighting). It was also assumed that there was a 50 percent relative value of productive time on the ferry versus the workplace meaning that productivity declines by 50 percent when compared to in an office. So, although 50 percent of the commuters could choose to work on the ferry, their productivity would only be half as much as it would be in the office.

Similarity Assumptions to Existing Ferry Services

The data based on on-board passenger surveys at Richmond and Vallejo ferry terminals was used as empirical evidence to the potential use of the proposed ferry service for non-commute trip purposes and ferry access/regress mode usage. To average the empirical data based on the surveys, the Richmond ferry terminal was weighted as 80 percent similar and the Vallejo ferry terminal was weighted as 20 percent similar to the proposed ferry terminal. The reason for selecting these weights is that Richmond is geographically more similar to Redwood City. They are about the same distance from Oakland and San Francisco markets, and both have commuter rail (BART and Caltrain, respectively) as a transportation option.

Ferry Terminal Access and Egress Times

Average ferry terminal access and egress times were assumed as one-half of the isochrone size around a ferry terminal, that is, 7.5 minutes on average for trips starting or ending in a 15-minute isochrone, and 22.5 minutes on average for trips starting or ending between 15-minute and 30-minute isochrones.

Ferry Terminal Wait Times

Ferry terminal wait time was assumed as 20 minutes on average. This includes parking or walking from transit stop, ticket purchase, wait and boarding times.

Source: WETA, 2020

Transit Ridership Gain Elasticity

This was defined as the ratio of percentage growth in transit ridership for all transit modes per unit change in travel time difference between drive alone and transit modes. This represented the expected transit ridership gain between Redwood City market area and other market areas (San Francisco and Oakland) and is estimated based off the VTA-C/CAG model outputs in the base year (2015) and the forecast year (2040). Transit Ridership Gain Elasticity was lowered by 50 percent of its original value only for the San Francisco ferry service market. The reason is that ferry service time would remain mostly the same in the future, but travel on Caltrain corridor would be faster due to future plans[29] and employer shuttles would also be able to travel faster with the expanding/improved managed lanes on US 101. Ferry ridership gain for the Oakland ferry service market was kept at par with the expected transit ridership gain.

Demand Parameters

The assumptions and inputs discussed above were the same for both ferry service scenarios. However, following discussions from the TAC meeting, the project team landed on refining a few of the inputs for Scenario 1: Oakland to Redwood City, and Scenario 2: San Francisco to Redwood City. Those refinements to the ridership demand model parameters are discussed below:

- Scenario 1: Oakland to Redwood City:
  - Commuter based trips only;
  - Maximum ferry terminal access and egress times of 15 and 30 minutes respectively, with an additional 20 minutes of wait time; and

[29] https://caltrain2040.org/long-range-service-vision/ (last accessed on March 6, 2020).

- Slower than expected transit ridership gain for the Oakland service market due to non-ferry transit competition.
    - *Transit Ridership Gain Elasticity was defined as the ratio of percentage growth in transit ridership for all transit modes per unit change in travel time difference between drive alone and transit modes. This represented the expected transit ridership gain and is estimated based off the VTA-C/CAG model outputs in the base year (2015) and the forecast year (2040). Under this scenario the elasticity for the Oakland Market was lowered by 50 percent of its original estimated value.*

- Scenario 2: San Francisco to Redwood City:
    - Commuter and Non-Commuter (mostly recreational) based trips;
    - Average ferry terminal access and egress times of 7.5 and 22.5 minutes respectively, with an additional 20 minutes of wait time; and
    - Slower than expected transit ridership gain due to non-ferry transit competition.
        - *Under this scenario, Transit Ridership Gain Elasticity was lowered by 50 percent of its original value only for the San Francisco ferry service market, which was assumed to be impacted by faster travel times on Caltrain in the future.*

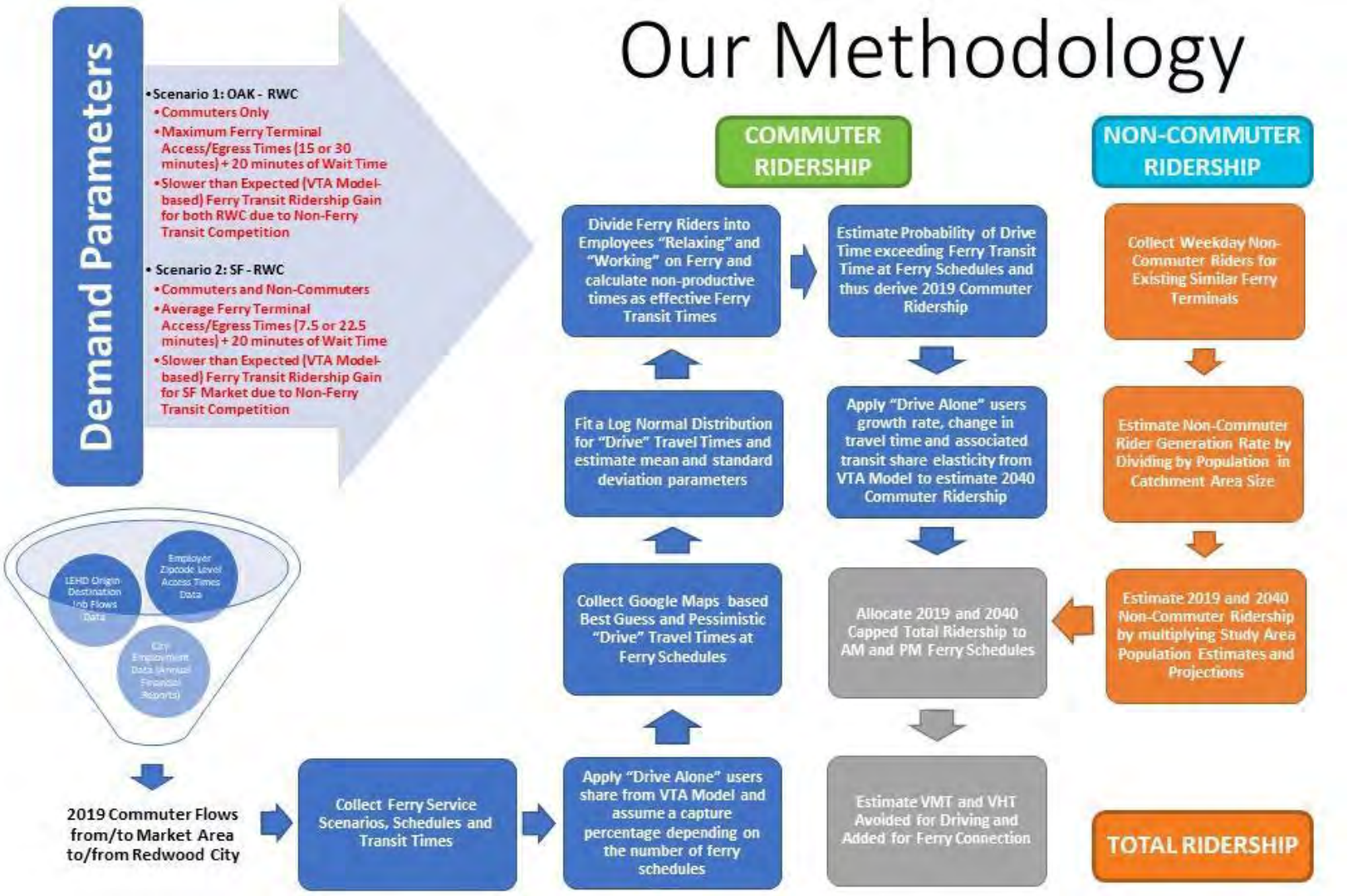
Methodology

This section discusses the methodology used to establish the number of boardings for both service scenarios. **Figure 4-9** illustrates the methodology for determining the total ridership for the travel demand model.

Commuter Ridership

Commuter ridership estimation was conducted using a probability-based method which quantified the ability of the ferry service to provide a reliable travel option where a commuter could multi-task to current and future "drive alone" users. The commuter flows that are "drive alone" (excluding non-ferry transit users) between catchment areas represent the market potential for ferry service. The market capture potential was defined based on the number of ferries scheduled, and the probability that the travel times of "drive alone" users at the scheduled ferry times would be in excess of the ferry transit times in order to identify the market share for the ferry service. The market growth potential was linked to the growth potential of the market areas. The 2019 and 2040 commuter ridership estimation involved the following steps:

Figure 4-9: Travel Demand Model Methodology



Source: CDM Smith, 2020

1. 2019 commuter flows were determined between the two selected market areas (San Francisco and Oakland) and Redwood City. 2015 LEHD data on origin-destination job flows data was used to collect 2015 employee flows between a 30-minute "home isochrone" at the AM origin ferry terminal (Redwood City or Market Area) and a 15-minute "work isochrone" at the AM destination ferry terminal (Market Area or Redwood City). City level employment totals in the LEHD data were compared to the data provided by the California EDD and in the 2015 Comprehensive Annual Financial Reports from various municipalities to establish local employment data adjustment factors. The adjusted employee flows were then updated to the year 2019 using the 2019 Comprehensive Annual Financial Reports from various municipalities. The 2019 employee flows were finally adjusted to include the 2019 employment in Oracle and Facebook campuses just outside the 15-minute "work isochrones" of Redwood City.
2. The model collected the proposed ferry service scenarios and schedules along with on-ferry and out-of-ferry transit times between the two markets and Redwood City. The survey data and assumptions on the distribution of residents by access time to a "home" ferry terminal were applied to the employee flows. Out-of-ferry transit time includes ferry access times and wait times.
3. The percentage share of "drive alone" users based on the VTA model (selecting the origin-destination pairs in the catchment areas only) and the capture percentage assumptions based on the number of ferries scheduled in a peak period were applied to the total employee flows to estimate the market capture potential for the proposed ferry service.
4. The drive times were collected from Google Maps Traffic Model under the "best guess" and "pessimistic" travel settings at each of the proposed ferry departure times and log-normal distributions were fitted for at these travel times.
5. Ferry riders were divided into "relaxing" versus "working" on ferry type employees. For the "working" on ferry employee, using the productive time available and relative productivity assumptions, non-productive time was calculated and used as the effective ferry transit time.
6. The 2019 commuter ridership or the market share for the proposed ferry service was then estimated based on the probability of the drive travel times exceeding the ferry transit travel times for the "relaxing" and "working" ferry riders.
7. The 2040 commuter ridership was estimated from the 2019 commuter ridership by applying the "drive alone" users growth rate, change in drive travel time and transit ridership gain elasticity from the VTA Model, and adjustment assumptions for the market areas.

Non-Commuter Ridership

The results from the WETA On-Board Passenger Survey, showed that there are reasons other than commuting for people to ride the ferry, even on ferry services that primarily operate during the peak commute hours. An empirical method of non-commuter trip generation rate was used in non-commuter ridership estimation. It was determined that the Richmond and Vallejo ferry services most closely resembled the possible patterns of travel that could be anticipated for a Redwood City ferry service. The non-commuter ridership estimation started off by collecting all weekday non-commuter riders and population estimates/projections for the Richmond and Vallejo service areas. A weighted average non-commuter trip generation rate in terms of riders per people living in service area was

estimated and applied to the 2019 population estimate and 2040 population projection of the Redwood City service area to estimate the 2019 and 2040 non-commuter ridership.

Ridership Performance Measures

The following types of ridership performance measures were estimated by service scenario: (a) ridership (total boardings per direction during the peak hours); (b) net change in vehicle miles traveled (VMT); and (c) net change in vehicle hours traveled (VHT). They were estimated as follows:

1. The total ridership is an aggregation of the commuter and non-commuter ridership estimates.
2. The maximum ridership per ferry was estimated by allocating the total ridership to the different ferry services based on the proportionality of drive travel time indices at the ferry departure times ("pessimistic" travel time to "best guess" travel time ratio) and determining the ferry service with the maximum allocation.
3. Average miles traveled and average travel time by "drive alone" users was collected from the VTA model and multiplied by the total number of riders to estimate VMT and VHT avoided. The VMT and VHT added due to the access/egress to the Redwood City ferry terminal was estimated based on the total ridership estimate, empirical data collected from the On-Board Passenger Surveys and assumptions. Percentage of drive mode users (including drive alone, carpool, private shuttle, taxis and transportation network companies) for access/regress at the Richmond and Vallejo ferry terminals, occupancy assumptions for the driving modes and ferry terminal access times were used. The net VMT and VHT change of driving avoided and ferry connection movements added due to the mode shift were computed.

Results

Below are the results for the ridership demand for both Scenario 1: Oakland to Redwood City, Redwood City to Oakland, and Scenario 2: San Francisco to Redwood City and Redwood City to San Francisco. The results from the 2019 and 2040 travel demand model runs are illustrated in **Table 4-4** below. Ridership is expressed as boardings, the model assumes a balance between the AM and PM peak boardings, where a boarding in one direction will equal a boarding in the opposite direction during the PM peak. The capacity of the proposed vessel is assumed at 320 passengers.

Table 4-4: Results for the Service Scenarios

	2019 Ferry Total Ridership Estimate			2040 Ferry Total Ridership Estimate Change			Total Change	% Change
	Peak Direction	Reverse	Daily Total Boardings	Peak Direction	Reverse	Daily Total Boardings	Daily Total Boardings	Daily Total Boardings
Scenario 1: Oakland - Redwood City (6 Departures per peak)	381	45	**852**	756	181	**1,874**	1,022	120%
Scenario 2: San Francisco - Redwood City (8 departures per peak)	441	206	**1,294**	730	363	**2,186**	892	69%

Source: CDM Smith

Note: Commuter ridership only for Scenario 1, both commuter and non-commuter ridership for Scenario 2.

Ridership projections reflect commuter ridership only for the Redwood City/Oakland route and both commuter and non-commuter ridership for the Redwood City/San Francisco route at WETA's direction. As shown above in **Table 4-4**, Scenario 2: San Francisco to Redwood City has greater total ridership potential for both 2019 and the future year of 2040. Although Scenario 2: San Francisco to Redwood City has the highest estimated daily boardings in both the first year and 2040, it is operating one more departure per direction in the peak than Scenario 1: Oakland to Redwood City. In later years, Scenario 1: Oakland to Redwood City is predicted to gain ridership at a higher rate than Scenario 2: San Francisco to Redwood City. Peak hour boardings and the number of departures have a bearing on occupancy and passengers per revenue hour, this will be examined further under the WETA Performance measures section below.

Table 4-5 below shows the average occupancy per vessel for both the peak direction and the reverse direction for both Scenario 1: Oakland to Redwood City, and Scenario 2: San Francisco to Redwood City. As seen in **Table 4-5**, Scenario 2: San Francisco to Redwood City has a more balanced ridership for two ways compared to Scenario 1: Oakland to Redwood City, although Scenario 1: Oakland to Redwood City has higher occupancy rates than Scenario 2: San Francisco to Redwood City.

Table 4-5: Average Passengers Per Vessel

	2019 Average Boardings per Departure		2040 Average Boardings per Departure	
	Peak Direction	Reverse	Peak Direction	Reverse
Scenario 1: Oakland - Redwood City (3 departures per direction)	127	15	252	60
Scenario 2: San Francisco - Redwood City (4 departures per direction)	110	52	183	91

Source: CDM Smith Analysis (2020)

4.3 Key Findings

The ridership analysis reveals that regardless of scenario, the highest commute demand exists in the southbound direction in the AM peak hour period, and the northbound direction during the PM peak hour period, in the 2019 and 2040. Scenario 2: San Francisco to Redwood City has the highest ridership estimate for both the 2019 and 2040.

- Scenario 1 Oakland-Redwood City:
  - 2019: 852 daily boardings; 2040: 1,874 daily boardings
- Scenario 2 San Francisco-Redwood City:
  - 2019: 1,294 daily boardings; 2040: 2,186 daily boardings

Both scenarios have a directional ridership with a dominant directional flow of employees to Redwood City from the two markets. However, the reverse-flow boardings from Redwood City are seen growing at a faster rate than ridership going to Redwood City, in the future. The percentage change in boardings is greater in Scenario 1: Oakland – Redwood City than Scenario 2: San Francisco – Redwood City, this may be due to rising congestion, while drive travel times increase and ferry travel times stay constant there is a gradual shift from "drive alone" commuting.

Ridership forecasts for both San Francisco and Oakland ferry services from Redwood City both look promising. As these services would not compete with each other, operations of both services would share much of the capital costs associated with providing the Redwood City Terminal. Ridership associated with operation of both services would be the sum of the two forecasts since virtually no transfers are likely at Redwood City.

Section 5

Terminal Facility (Engineering Report)

This section provides a summary of the conceptual designs for the Redwood City Ferry Terminal. The 2012 Redwood City Ferry Terminal Site Feasibility Report[30] concluded that the Westpoint Slough location was the preferred site for the ferry terminal. The Westpoint Slough location is located at the northern end of Seaport Boulevard, where Westpoint Slough and Redwood Creek meet, on land owned by the Port of Redwood City, see **Figure 5-1**. COWI verified with the City and Port staff that the Westpoint Slough location is still the preferred site.

COWI updated the 2012 conceptual layout (Option 1) for the ferry terminal located on the north side of the preferred Westpoint Slough site and developed a new conceptual layout (Option 2) for the ferry terminal on the west side of the preferred site. The terminal requirements and conceptual designs are summarized in the following sections. A comparison of the pros and cons for each option is provided along with cost estimates to establish the construction cost range for a new ferry terminal.

Figure 5-1: Location Map of Preferred Site and Option 1 and Option 2 Layouts

Source: Google Maps and COWI, 2020

[30] Water Emergency Transportation Authority, July 2012. Redwood City Ferry Terminal Site Feasibility Report, Draft Report. Report issued by KPFF Consulting Engineers.

5.1 Ferry Terminal Requirements

It is assumed that the San Francisco Bay Area WETA will be the primary operator of the Redwood City Ferry Terminal. The following functional requirements are based on similar ferry terminals operated by WETA in San Francisco Bay.

5.1.1 Design Vessels

A summary of WETA's current ferry fleet is provided in **Appendix C**. **Table 5-1** provides the characteristics of the controlling WETA vessel (the maximum size vessel type used for terminal design purposes). Other ferry operators will be able to land at the terminal provided they have similar freeboard and displacement as the WETA ferry fleet.

Table 5-1: Controlling Vessel Characteristics

Vessel	WETA NB445
Hull Type	Catamaran
Passenger Capacity	450 people
Displacement	225.1 long tons
Length at Waterline	144.3 ft.
Beam	39.4 ft.
Draft	4.92 ft.

Source: COWI, 2020

5.1.2 Terminal Components

The functional requirements for the Redwood City Ferry Terminal have been broken into various components and summarized in the following sections.

Water Depth

The recommended minimum water depth at the ferry terminal and access channel for safe passage of WETA's fleet is -12.0 ft. MLLW. This is the minimum dredge depth found at any of the existing ferry terminals in San Francisco Bay, see **Table 5-2**.

Table 5-3 summarizes the minimum dredge depth based on the site and vessel that will operate at the terminal. The required dredge depth is dependent on three parameters: deepest vessel or float draft, lowest water level, and minimum under keel clearance. A minimum under keel clearance of 2 feet is required to account for vessel motions and to provide clearance for propulsion systems.

Table 5-2: Dredge Depth at Similar Ferry Facilities

Terminal	Operator	Dredge Depth
Vallejo	WETA	-15-ft. MLLW
North Bay (Mare Island) Operation & Maintenance Facility	WETA	Water depth at site greater than EL-15-ft.
Richmond	WETA	-14-ft. MLLW
Downtown SF South Basin	WETA	-12.5-ft. MLLW
Treasure Island	WETA	-14-ft. MLLW
Central Bay (Alameda) Operation & Maintenance Facility	WETA	-12-ft. MLLW
Alameda Harbor Bay	WETA	-12-ft. MLLW
South San Francisco	WETA	-12-ft. MLLW
Oakland Clay Street (Jack London Sq.)	WETA	-15-ft. MLLW
Alameda Main Street	WETA	Water depth at site greater than EL-15-ft.
Alameda Sea Plane Lagoon	WETA	-12-ft. MLLW
Mission Bay	WETA/GG	-15-ft. MLLW
Port of San Francisco Pier 46.1	WETA/GG	-15-ft. MLLW
Larkspur (Berths 1-3)	Golden Gate	-15-ft. MLLW
Larkspur (Berth 4 and Navig. Channel)	Golden Gate	-13-ft. MLLW
Sausalito	Golden Gate	Water depth at site greater than EL-15-ft.

Source: COWI, 2020

Table 5-3: Minimum Dredge Depth

Draft or Depth	Float	Vessel [1]	Units
Maximum Draft	4.0	6.75	ft.
Lowest Observed Water Elev.	-2.77	-2.77	ft. MLLW
Under Keel/Float Clearance	2.0	2.0	ft.
Total Specified Dredge Depth	-8.77	-11.52	ft. MLLW

Source: COWI, 2020

(1) The assumed deepest draft vessel that WETA will operate at the terminal is the Hydrus Class vessels with a draft of 6.56 ft. The following are additional items considered when establishing the redocumented dredge depth:

- Reducing the dredge depth below EL-12ft would limit what vessels could be used in emergency response scenarios. WETA or other ferry agencies may want to bring in their larger vessels in an emergency. A dredge depth of EL-12ft allows for no restrictions.
- Reducing the dredge depth will require more maintenance dredging as there will be less depth for siltation to accumulate before it starts impacting operations.
- The overall dredge cost will be more if the site is initially dredged to one depth and deepened later versus dredging to the final design depth immediately due to additional mobilization costs.

Float

The float acts as the landing for the vessels servicing the terminal and provide access for passengers boarding and disembarking. The following are WETA's preferred parameters for the float:

- Plan area of 42-ft. x 135-ft. This is the same size float used at the San Francisco Downtown, Alameda Sea Plane Lagoon, Treasure Island, and Mission Bay terminals. The size of the float is controlled by the different sizes of vessels that it will accommodate. At 135 feet long there is sufficient room for the gangway landing support frame, a boarding ramp system with two high ramps and one low ramp, and deck space for workers. The boarding ramp configuration will

allow for the full range of WETA vessels to land at the float and be ADA compliant. Having high and low ramps will also allow non WETA vessels that may have low freeboards to use the float. The width of the float is controlled by ADA requirements for boarding from both sides of the float.

- The 42-ft. x 135-ft float size matches WETA's spare steel float, allowing the spare float to be used when the terminal float is taken out of service for maintenance.
- WETA prefers that the float allow for dual side boarding. This aids operations as the preferred boarding side may depend on the currents at the time of landing. Dual side boarding also allows two vessels to operate at the terminal at the same time.
- WETA prefers that the float be of steel construction. This is based on compatibly with the spare float and ease of repair compared to a concrete float. Note, concrete floats have been previously used at the South San Francisco and Richmond Ferry terminals.
- The float is to be moored in place by up to six (6) 36-inch diameter steel guide piles. The guide pile locations should be orientated to match other terminals using the same size float. The top elevation of the guide piles should account for sea level rise.

Fenders

- Knee fenders are located along the sides of the float. Fender elements are to be Morse Extruded Trapezoidal 13W, so they are compatible with other terminals operated by WETA.
- Two 36-inch diameter steel piles with 6-foot diameter floating donut fenders are to be located at the offshore end of the float. The donut fenders protect the corners of the float and provide a pivot point for vessels entering and leaving the berth. The donut fenders shall be free to rotate around the supporting pile and move up and down along the pile to accommodate the tide.

Gangway and Boarding Ramps

- The gangway shall be ADA compliant and not exceed a slope of 1:12 for tides between MLLW and MHHW.
- It is recommended that the gangway have 8 feet minimum clear width between handrails to accommodate two rows of passengers. Final width should be based on expected passenger loading operations and consider room needed for passengers boarding with bicycles.
- Walkway and ramps to be ADA compliant. The maximum slope of fixed ramps is 1:12. Per ADA Rule 405.6 Rise: The rise for any ramp run shall be 30 inches maximum.
- Two adjustable high boarding ramps and one low boarding ramp should be provided. The fore and aft adjustable boarding ramps are for high freeboard vessels and are to have fifty foot spacing to line up with the door spacing on the WETA boats. A center boarding ramp should be provided for low freeboard vessels. The adjustable boarding ramps are to work for the range of design vessel boarding elevations while maintaining 1:12 slope.

Source: CDM Smith, 2020

Access Pier

- The deck elevation of the access pier should be set so it is equal to or above the landside elevation. Sea level rise should be considered when establishing the deck elevation.
- A security gate is typically placed on the access pier, just landside of the gangway connection.
- Access pier should have a canopy to provide protection from the elements (rain, wind-driven rain, and sun) for queuing passengers.

Utilities

- Power is to be provided to operate the adjustable boarding ramp lift system, lighting, and vessel lay berth shore power.
- Lighting should be provided on the access pier, gangway and float. Rail lighting is typically provided along the gangway and float walkway system.
- Telecom is required to operate the security system, PA, and Clipper card reads.
- Potable water is needed to provide hose bibs on the float for general operations.
- Fire water system is to be provided. The specific requirements are typically controlled by local fire department rules and regulations.

Landside Components

- Parking for passengers and bus stops are to be provided.
- Locations for general public and ride share pick-up and drop-off should be included.
- Facilities for secure bike parking to be provided.
- Bike share and scooter location to be considered.

- Covered queuing areas are preferred by passengers, although it is not a requirement.
- WETA does not require a bathroom at their terminals. Bathrooms are available on the vessels.
- Utility connections are to be provided onshore.

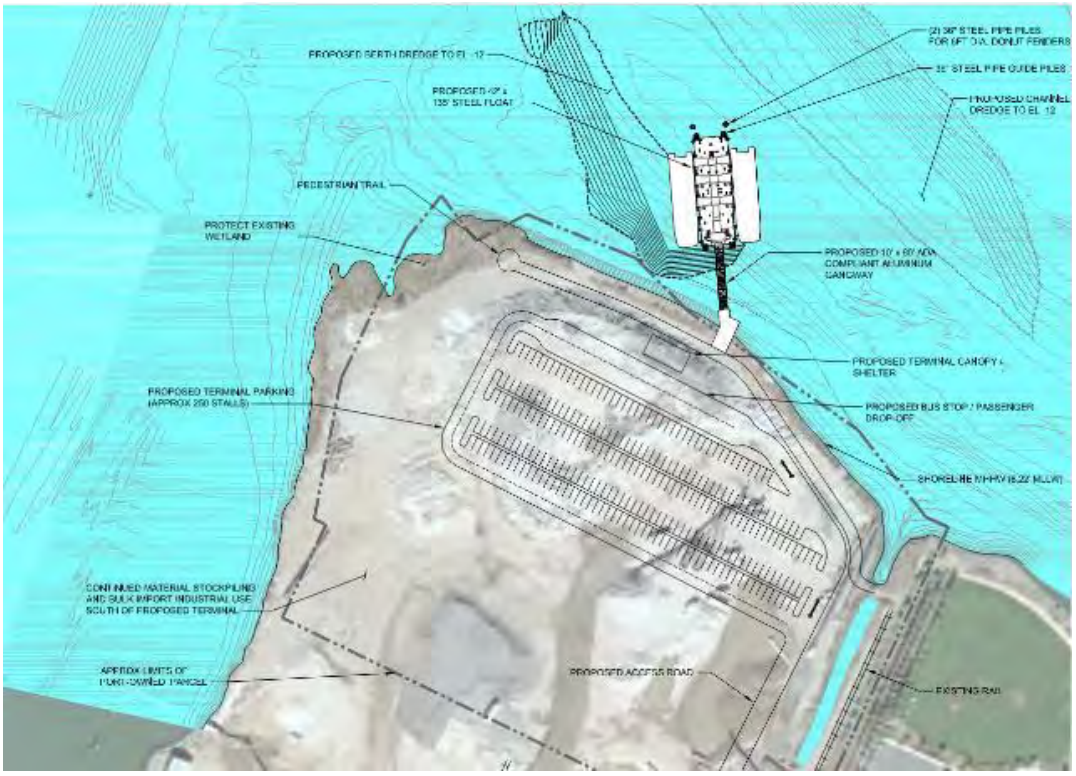
General

- Like the Richmond Terminal, this terminal will not be staffed. Material selected should be maintenance free and vandal resistant.
- All components are to be designed for a salt water environment.
- Typically, WETA's ferry terminals are designed as an "essential" facility so that they remain operational after a seismic event.

5.2 Option 1 - North Side at Westpoint Slough Location

COWI reviewed and updated the 2012 conceptual design for the North Side of the Westpoint Slough site, see **Figure 5-2**. In general, the 2012 conceptual design was found to be feasible. As part of the review, COWI met with WETA, Port and City staff on May 23rd, 2019 to discuss the concept design and proposed changes. **Table 5-4** summarizes the Option 1 conceptual design and notes changes to the 2012 conceptual design based on COWI's review.

Figure 5-2: Option 1 Conceptual Layout
(See Appendix D for Concept Drawing)



Source: COWI, 2020

Table 5-4: Summary of Option 1 Conceptual Design

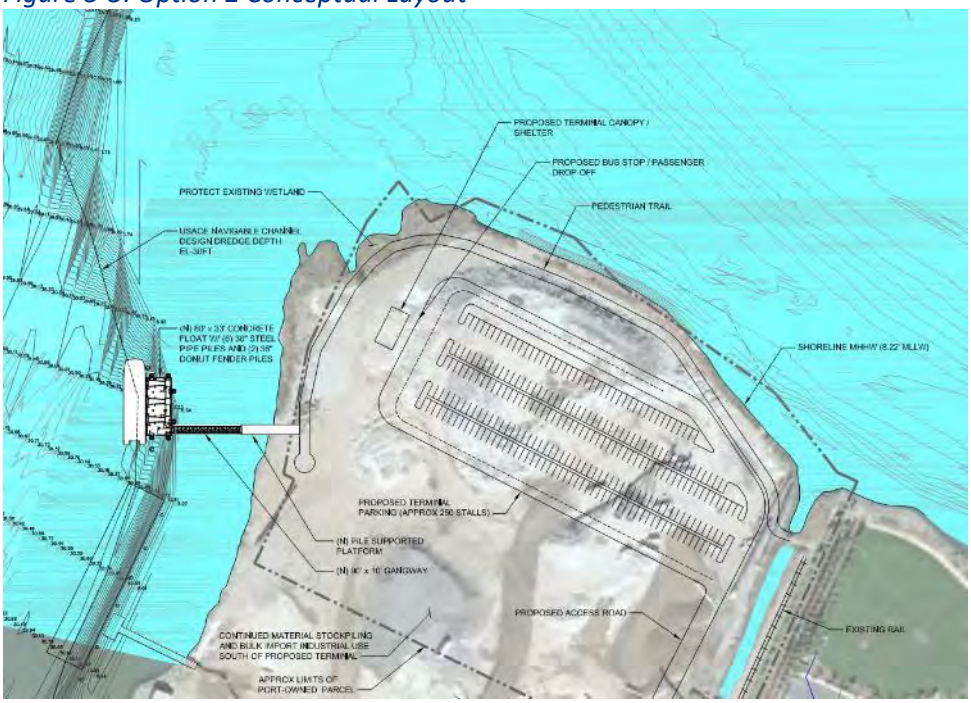
Component	2012 Concept	2019 Update	Notes
Dredge Depth in Channel	EL -10ft.	EL -12ft.	Deeper dredge depth required for WETA's vessels
Dredge Depth at Float	EL -12ft.	-	This is minimum depth. Final dredge depth to consider siltation rates and future maintenance dredging
Float Size	42-ft. x 110-ft.	42-ft. x 135-ft.	Changed to be compatible with WETA's Spare Float
Board Sides	2 sided	-	No change
Float Material	Concrete	Steel	Based on WETA's recommendation
Float Guide Piles	(4) 42" diameter steel	(4) to (6) 36" diameter steel	Changed to be compatible with WETA's Spare Float
Knee Fenders	Provided along sides of float	-	No change
Donut Fenders	2 donut fenders	-	No change
Gangway	ADA compliant	-	No change
Walkway & Boarding Ramps	2 boarding ramps	3 boarding ramps	Ramp system should match other WETA terminals to accommodate both high and low freeboard vessels.
Access Pier	Covered pier	-	No change. Construction of the access pier will require at least partial demolition of the existing wharf structure located at the site.
Utilities	Includes: ▪ Power ▪ Lighting ▪ Telecom ▪ Potable Water ▪ Fire System ▪ Fuel	Fuel system is removed Shore power added No change to other systems	WETA does not require fuel at the terminal. The onshore diesel fuel tanks and fuel system has been removed. WETA will use shore power for vessels at the terminal for an extended period (i.e. between morning and afternoon trips).
Landside	Includes: ▪ Bus stop ▪ Parking lot with 250 spots ▪ Pedestrian trail ▪ Access roads ▪ Terminal Canopy Shelter	-	No Change. Landside improvements will require removal of existing bulk material currently stockpiled at the site, grading, stormwater system and connections to utilities. It is recommended that the terminal canopy shelter be adjusted that it extends along where passengers will queue.

Source: COWI, 2020

5.3 Option 2 - West Side at Westpoint Slough Location

COWI reviewed the Port preferred location at Westpoint Slough to determine if the terminal can be located elsewhere along the shore. COWI developed an alternative conceptual layout that locates the float on the west side of the site. See **Figure 5-3** for the Option 2 conceptual layout. Note that landside improvements are not shown in Figure 5-3, as they will be similar to Option 1.

Figure 5-3: Option 2 Conceptual Layout



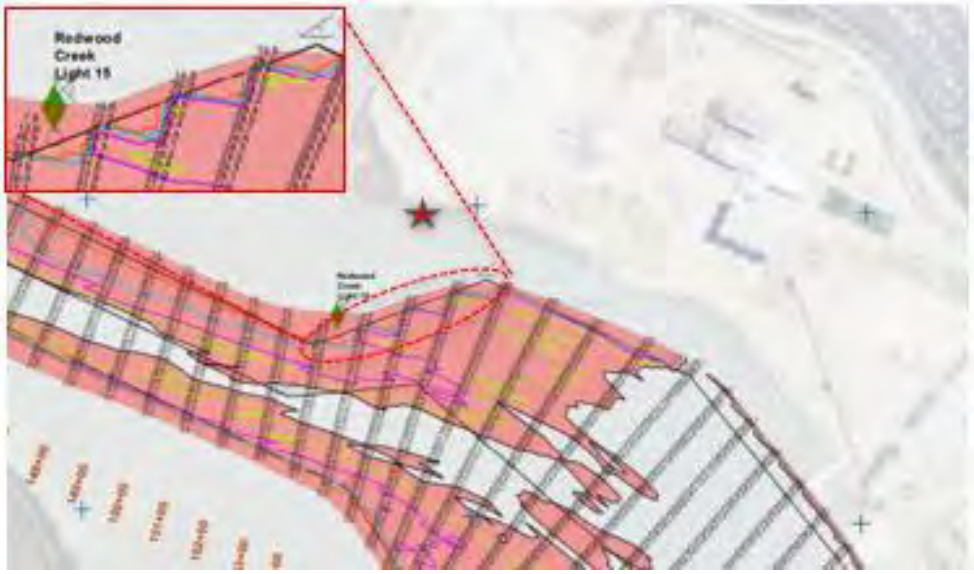
Source: COWI, 2020

The Option 2 location eliminates the need for dredging due to the presence of the existing navigation channel along Redwood Creek that provides deeper water for vessels operating at the Port of Redwood City. The existing USACE soundings show that the current channel slopes up from EL -30.0 MLLW to EL-14.0 MLLW.[31] See **Figure 5-4**.

The Option 2 location would provide easier vessel maneuvering in and out of the berth and it also eliminates the need to demolish the existing wharf structure located at the north site. Some disadvantages with the Option 2 location are that it encroaches onto the turning basin and facilities to the south, the float is limited to one (1) side berthing, the float is not compatible to WETA's spare float.

[31] U.S. Army Corps of Engineers. Retrieved from http: http://navigation.usace.army.mil/Survey/Hydro.

Figure 5-4: USACE Soundings of Redwood Creek Channel and Turning Basin



Source: COWI, 2020

Table 5-5 summarizes the components of the Option 2 conceptual design.

Table 5-5: Summary of Option 2 Conceptual Design

Component	Alternative Concept	Notes
Dredge Depth in Channel	EL -30ft.	No dredging required
Dredge Depth at Float	EL -12ft. and Deeper	Depending on final layout, little to no dredging will be required.
Float Size	34-ft. x 80-ft.	Will be similar to WETA Richmond terminal. May be possible to use WETA's standard size float but given only one side of the float is accessible this is larger than what is needed.
Board Sides	1 sided	Only one side of the float can be accessed by ferry
Float Material	Steel	As the spare float cannot be used given the smaller size float, the use of a concrete float should be studied further as it does not require future drydocking for maintenance.
Float Guide Piles	(4) to (6) 36" diameter steel	
Knee Fenders	Provided along sides of float	
Donut Fenders	2 donut fenders	
Gangway	ADA compliant	
Walkway & Boarding Ramps	3 boarding ramps	Will be similar to WETA Richmond terminal
Access Pier	Covered pier	Eliminates need to demolish existing wharf structure locate at the north side site. Proximity to wetlands will need to be further studied.
Utilities	Includes: ▪ Power ▪ Lighting ▪ Telecom ▪ Potable Water ▪ Fire System	Utilities would be the same as Option 1
Landside	Includes: ▪ Bus stop ▪ Parking lot with 250 spots ▪ Pedestrian trail ▪ Access roads ▪ Terminal Canopy Shelter	Landside improvements will be the same as Option 1

Source: COWI, 2020

5.4 Comparison of Options

5.4.1 Cost Estimates

Table 5-6 and **Table 5-7** show cost estimates for Option 1, based on the 2012 Study Conceptual design updated as noted in Section 5.2, and Option 2 as described in Section 5.3. Unit costs are based on pricing from WETA's Richmond, Alameda Sea Plane Lagoon and Mission Bay Ferry terminals. All final values have assumed a compounded 3 percent increase per year for escalation up to 2022.

Table 5-6: Cost Estimate: Option 1 - North Side at Westpoint Slough Location

Item No	Item Name	Description of Components	Quantity		Cost Per Unit	Total Cost
Ferry Terminal						
1	Mobilization/ Demobilization	Indirect Cost	1	LS	$304,000	$310,000
2	Demolition	Demo of existing structures	10400	SF	$40	$420,000
3	Ferry Float	135' long x 42' wide x 11' high steel barge with all fittings	5670	SF	$1,110	$6,300,000
4	Float Piles	36" diameter x 1.25" Thick by 120 ft long	6	EA	$91,500	$550,000
5	Fender Piles	Donut Fender Piles	2	EA	$165,000	$330,000
6	Installation	Float Installation	1	LS	$115,000	$115,000
7	Platform	Gangway Access Platform	591	SF	$1,500	$890,000
8	Platform Piles	6-24" Octagonal PP Piles	6	EA	$36,000	$220,000
9	Gangway	92' x 10' gangway	1	LS	$175,000	$180,000
10	Dredging	Channel and Float	23600	CY	$47	$1,100,000
11	Slope Protection	Wetland Protection	1	LS	$55,600	$56,000
12	Mechanical	Fire Water/Service Water	7161	SF	$30	$220,000
13	Electrical	Electrical/lighting/Comms for Fixed pier, ramps, curb	1	LS	$574,000	$574,000
14		Shore Power	1	LS	$250,000	$250,000
15	Entrance	Misc. Door/Entrances Features	1	LS	$245,000	$245,000
16	Fence	Fence for fixed platform	1	LS	$100,000	$100,000
17	Misc.	Site Furnishings and Installation	1	LS	$200,000	$200,000
	Subtotal					**$ 12,060,000**
	Contingency	Allow for 25% Contingency				$3,015,000
	Subtotal					**$ 15,075,000**
	Contingency	Allow for 10% Construction Contingency				$1,507,500
	Total Estimated Cost					**$ 16,600,000**
Parking Lot						
1	Lot	Parking Lot	1	LS	$2,281,000	$2,300,000
2	Bus Stop	Bus Stop Bench and Structure, Other Misc. Items	1	LS	$100,000	$100,000
					Subtotal	**$2,400,000**
	Contingency	Allow for 25% Contingency				$600,000
					Total Estimated Cost	**$3,000,000**

Item No	Item Name	Description of Components	Quantity		Cost Per Unit	Total Cost
Permitting						
1	Float	Permit Compliance and support	1	LS	$167,000	$167,000
2	Lot	Permit Compliance and support	1	LS	$167,000	$167,000
Total						
		Total Estimated Cost (Float, Parking Lot, Permitting)				**$19,934,000**
		Total Estimated Cost Escalated to 2022 Construction Date				**$21,800,000**

Source: COWI, 2020

Table 5-7: Cost Estimate: Option 2 - West Side at Westpoint Slough Location

Item No	Item Name	Description of Components	Quantity		Cost Per Unit	Total Cost
Ferry Terminal						
1	Mobilization/ Demobilization	Indirect Cost	1	LS	$304,000	$310,000
2	Ferry Float	80' long x 33' wide steel barge Steel Pile Brackets and Vertical Fenders	2640	SF	$802	$2,120,000
		Barge Fittings and Design	1	LS	$1,750,000	$1,750,000
3	Float Piles	36" diameter piles x 120' long	6	EA	$91,500	$550,000
4	Fender Piles	Donut Fender Piles	2	EA	$165,000	$330,000
5	Installation	Float Installation	1	LS	$115,000	$115,000
6	Platform	Gangway Access Platform (55' long x 12' wide)	660	SF	$1,500	$990,000
7	Platform Piles	10-24" Octagonal PP Piles	10	EA	$36,000	$360,000
8	Gangway	92' x 10' gangway	1	LS	$175,000	$175,000
9	Slope Protection	Wetland Protection	1	LS	$55,600	$60,000
10	Mechanical	Fire Water/Service Water	4200	SF	$30	$126,000
11	Electrical	Electrical/lighting/Comms for Fixed pier, ramps, stairs, curb	1	LS	$574,000	$574,000
12		Shore Power	1	LS	$250,000	$250,000
13	Entrance	Misc. Door/Entrances Features	1	LS	$245,000	$245,000
14	Fence	Fence for fixed platform	1	LS	$100,000	$100,000
15	Misc.	Site Furnishings and Installation	1	LS	$200,000	$200,000
					Subtotal	**$8,300,000**
	Contingency	Allow for 25% Contingency				$2,075,000
					Subtotal	**$10,375,000**
	Contingency	Allow for 10% Construction Contingency				$1,037,500
					Total Estimated Cost	**$11,500,000**
Parking Lot						
1	Lot	Parking Lot	1	LS	$2,281,000	$2,300,000
2	Bus Stop	Bus Stop Bench and Structure, Other Misc. Items	1	LS	$100,000	$100,000

Item No	Item Name	Description of Components	Quantity		Cost Per Unit	Total Cost
					Subtotal	**$2,400,000**
	Contingency	Allow for 25% Contingency				$600,000
					Total Estimated Cost	**$3,000,000**
Permitting						
1	Float	Permit Compliance and support	1	LS	$167,000	$167,000
2	Lot	Permit Compliance and support	1	LS	$167,000	$167,000
Total						
					Total Estimated Cost (Marine Waterside, Marine Landside and Permitting)	**$14,900,000**
					Total Estimated Cost for 2022 Construction	**$16,300,000**

Source: COWI, 2020

5.5 Key Findings

Maintenance dredging will have to occur on average of every two to three years for with either option, but the frequency and amount dredged would vary between the options. Additional study on sedimentation rates will be required prior to selection of a preferred option. **Table 5-8** summarizes the pros and cons for each option.

Table 5-8: Waterside Options Pro/Con Table

Option 1 -North Side at Westpoint Slough Location	
Pros	Cons
Allows for two boats to berth at the same time.	Requires dredging during construction as well as maintenance dredging
Compatible with WETA's spare float which is used for boarding, when the main float would be taken out of service for maintenance	Higher cost
Reduces interferences with vessels using the turning basin	Closer to wetland Area
Option 2 - West Side at Westpoint Slough Location	
Pros	Cons
Eliminates/Reduces need for dredging both during original construction and in future	On turning basin and facilities to the south.
Lower cost float, due to smaller float	Limited to 1-sided boarding.
Eliminates need to demolish old wharf structure	Float not compatible with WETA’s spare float.
Lower overall cost	

Sources: CDM Smith, 2020

Note: At this time, the assumed landside improvements are similar for both options.

Section 6
Financial Analysis

6.1 Approach

Financial analysis helps to guide future research and planning, investment priorities, and funding efforts by the City, the Port, WETA, other transit providers, or the associated origin/destination cities for which the service is planned (e.g., Oakland and San Francisco). This financial analysis assesses the ferry operation feasibility as well as ferry acquisition and terminal funding sources.

6.1.1 Evaluation Metrics

The three alternatives evaluated include each route, Oakland-Redwood City (OAK/RWC) and San Francisco-Redwood City (SF/RWC) and a combined alternative of both routes. The alternatives were evaluated according to their farebox revenue recovery ratio (i.e., revenues from ticket sales as a percentage of ferry operating costs). These ratios are compared to WETA's minimum 40 percent recovery ratio within the first ten years of operation.[32] For mature services, WETA farebox revenue recovery ratios range between 50 and 70 percent.

In this context, a ferry operation feasibility measure also accounts for the cost magnitude versus fare revenues and the likelihood to increase revenues or reduce ferry operation costs. While each service faces initial capital and future replacement costs, this financial feasibility focuses on each route's operating costs.

6.1.2 Route Summaries

While similar, the number of services and running time differ between the two routes:

- *RWC to/from OAK* – Approximate one-way running time of 65 minutes with three peak period roundtrips in both the morning and evening. Two crews are required in the morning and in the afternoon (four crews in all). The crews could split time between the Redwood City service and midday services in the Central Bay portions of WETA's system.
- *RWC to/from SF* – Approximate one-way running time of 55 minutes with four peak period roundtrips in both the morning and evening. Two crews are required in the morning and in the afternoon (four crews in all). The crews would split time between the Redwood City service and midday services in the Central Bay portions of WETA's system.

6.1.3 Ferry Services

An illustrative service schedule is shown in Section 4.1.1, Table 4-1. General financial analysis assumptions include:

- *Ferry Boats* – WETA would operate two boats per route, such as the new Dorado class waterjet propulsion vessel with a passenger capacity of 320.
- *Access* – East Bay users would access the Oakland terminal at Jack London Square, and San Francisco users would access at the San Francisco Ferry terminal.

---

[32] The minimum farebox recovery ratio of 40 percent for commuter services is based on Regional Measure 2 performance standards for commuter ferry services. WETA uses the figure as a systemwide reference point.

- *Other Service* – once the commuter service is established:
  - *Weekend* – not available initially, but could introduce a pilot program, such as the three-month project in 2019 between Richmond/SF.
  - *Non-Peak Period* – could be extended into the peak-shoulders depending on demand.
  - *Special Events* – future potential possible to/from Mission Bay and Oakland.

6.1.4 WETA

Senate Bill 976 (Senator Tom Torlakson), repealed the WTA and established WETA to consolidate and operate ferry services in the San Francisco Bay Area and to respond to emergencies or disasters affecting the transportation system. The bill provides authority to WETA to determine any water transportation service or facility, and authorizes WETA to plan, develop, and operate all aspects of water transportation facilities within the Bay Area including, terminals, parking lots, and structures. A further discussion of WETA's role can be found in **Appendix G**.

Source: WETA, 2020

6.1.5 Other Considerations

Additional ferry services and associated infrastructure would expand the potential for emergency response services to/from Redwood City, as the vessels and terminals could be used to provide emergency response services. Potential emergency response services were not studied as part of this Report. WETA's position is that new ferry routes must meet farebox recovery thresholds so that any emergency benefits rest on solid financial feasibility grounds.

6.2 Assumptions

Capital and operating costs are evaluated differently between the ferry terminal and the ferry service. This reflects cost responsibilities between the different entities (i.e., Redwood City and ferry operator). Ferry service comprises most of the capital and operating costs and are the focus of this analysis. Nonetheless, other terminal costs require initial and operation funding.

Capital costs primarily include a new Redwood City terminal, new ferries, landside improvements at the Oakland ferry terminal, and potentially ferry maintenance facility expansion. Operating costs include both the ferry (labor, fuel, etc.) and terminal maintenance. Whereas the farebox recovery ratio analysis focuses on covering an acceptable share of operation costs, capital project funding is critical, as is the operating gap (farebox recovery shortfall).

These cost components are summarized by facility (terminal versus ferry) and type (capital versus on-going operation). Also, ridership forecasts derived in the Section 4 analysis are summarized for financial purposes.

6.2.1 Terminal Costs

Construction costs are notable compared to ferry acquisition costs. Conversely, annual operations and maintenance (O&M) costs are marginal compared to ferry operations, as outlined below.

Terminal Construction Costs

Preliminary planning, design and engineering work was completed as part of the overall Study. Section 5 summarizes conceptual engineering work and confirms that the Westpoint Slough is the preferred location for a ferry terminal. Cost estimates account for water depth, float parameters, fenders, gangway and boarding ramps, access pier, utilities, and landside components (e.g., parking, bus stops, ride share pick-up/drop-off, bike/scooter facilities, queue covering, etc.).

Terminal and related facilities range from $15 million (West Side at Westpoint Slough) to $20 million (North Side at Westpoint Slough) depending on the terminal location and existing conditions (in 2019 dollars). Even at $15 million to $20 million, current estimates for the Redwood City terminal are at the lower end of WETA's recent experience with terminal construction projects, which range from $19 million to close to $100 million:

- *Richmond Ferry Termi*nal – $19 million
- *Seaplane Lagoon Ferry Terminal* – $22 million (estimate)
- *Treasure Island Ferry Terminal* – $47 million (estimate; note WETA is not responsible for the capital or operating costs of this project)
- *Mission Bay Ferry Terminal* – $51 million (estimate)
- *Downtown San Francisco Ferry Terminal Expansion Project* – $98 million

Terminal Maintenance Costs

Require ongoing maintenance such as security, landscaping, general maintenance, electricity, water/wastewater, telecommunications, and trash service. Preliminary estimates indicate annual maintenance costs of approximately $200,000.

6.2.2 Ferry Costs

Both initial ferry acquisition and annual operation costs are significant. The farebox recovery analysis focuses on covering annual operation costs, which are detailed below.

Vessel Acquisition Costs

WETA's ferry fleet will need new two vessels for each service route, plus a half of a spare vessel. If the routes are combined, the two routes could share the spare vessel, resulting in five new vessels. Each new ferry is estimated to cost approximately $16 million, which may vary depending on vessel class and costs at time of acquisition. In summary, ferry acquisition costs would total $40 million for either route, or $80 for both routes combined.

Vessel Operating Costs

The key cost element is the farebox recovery analysis, which is considered central to the broader financial analysis. Costs were prepared by WETA (in 2019 dollars) based upon existing ferry route experience and were inflated per WETA's assumptions. As such, there is a high degree of confidence in the cost assumptions. However, various circumstances could affect service costs in unforeseen ways including a fuel price "shock," and service configuration changes requiring additional labor hours and/or expenses.

Ferry operating costs include vessel expenses (crew-labor and maintenance), non-vessel expenses, fixed operator expenses, direct expenses, and fuel. Operating costs for each alternative are shown in **Table 6-1**. Costs are very similar for both routes; the San Francisco route is slightly higher due to the extra daily trip (4 versus 3, respectively). Costs are shown in 2019/20 dollars for the opening year 2025 and the first ten-years, in net present value (NPV) terms. The detailed calculations for each service route are provided in **Appendix E.**

- *Crew Labor* – Affected by required minimum shift lengths and the required vessels. Trip length determines round-trip trips served by a single vessel within a shift period. Crew shifts are 8-hours per labor requirements. Even if the actual shift is shorter, crew is paid for an 8-hour shift. Crew hours are multiplied by a standard hourly rate consistent with current labor contracts. Four crew members are required per each 320-passenger vessel.
- *Maintenance* – Annual vessel maintenance costs nearly $1 million, and include vessel repair, related materials and supplies, and urea (a necessary reactant involved in marine vessel catalytic systems). New services are assumed to need a spare vessel, and maintenance expenses apply to the spare vessel as well.
- *Non-Vessel Expenses* – Fairly consistent across the services evaluated and include a guest assistance representative, professional fees, and non-vessel materials/supplies. Non-vessel expenses are calculated as a percentage of total Vessel Expenses.
- *Fixed Operator Expenses* – Include wages and benefits for dispatch and supervision staff and administration staff. Insurance is also included.
- *Direct Expenses* – Include docking fees, advertising and marketing, consultant services, wireless services on the vessels, Clipper card-related technology maintenance, and WETA administration and facility O&M expenses. Assumptions are provided by WETA based on current operations.
- *Fuel* – Affected by the vessel type, trip length (distance and time), and water/current conditions. As the least certain expense, fuel varies significantly depending on current energy market conditions. The fuel assumption is based on the estimated nautical miles of each

service, multiplied by the fuel needed per mile (gallons per mile), multiplied by the forecasted cost per gallon.

Table 6-1: Ferry Service Operating Costs by Route (Annual and Ten-Year NPV)

Item	OAK *Jack London Sq.*	SF *Ferry Building*	Combined [1]
Service Assumptions			
AM Trips (Peak Dir./ Rev.)	3/3	4/4	7/7
PM Trips (Peak Dir./ Rev.)	3/3	4/4	7/7
Trip Time (Minutes)	65	55	~60
Total Daily Crews	4	4	8
Number of Vessels [2]	2	2	5
Annual Operating Expenses (2019/2020 Dollars)			
Crew Labor	$1,546,000	$1,819,000	$3,365,000
Maintenance	$1,139,000	$1,139,000	$2,278,000
Non-Vessel Expenses	$129,000	$129,000	$258,000
Fixed Operator Expenses	$253,000	$253,000	$506,000
Direct Expenses	$874,000	$874,000	$1,748,000
Fuel	$1,085,000	$1,343,000	$2,428,000
Total, Operating Expenses	$5,026,000	$5,557,000	$10,583,000
10-Year Operating Expenses (NPV, 2025 - 2034)			
Crew Labor	$17,121,000	$20,142,000	$37,263,000
Maintenance	$12,612,000	$12,612,000	$25,224,000
Non-Vessel Expenses	$1,429,000	$1,429,000	$2,858,000
Fixed Operator Expenses	$2,806,000	$2,806,000	$5,612,000
Direct Expenses	$7,891,000	$7,891,000	$15,782,000
Fuel	$9,794,000	$12,128,000	$21,922,000
Total, Operating Expenses	$51,650,000	$57,010,000	$108,660,000

Sources: CDM Smith; WETA; Economic & Planning Systems

(1) "Combined" service assumes both routes start operation at the same time and share a spare vessel.

(2) Exclude spare vessel required for each route.

6.2.3 Ridership

Defined in terms of "boardings," represents the number of passengers boarding a vessel and paying a fare. For example, if daily boardings are 100 and every passenger makes a round-trip, 50 unique people use the service. One-way trips would, of course, imply more unique passengers. A "basic" level of ferry service was studied for each route focusing on commuters between the respective cities.

Travel demand modeling estimated daily one-way person-trips by specific route-times, with balanced morning/evening round trips (i.e., same day) for base year 2019 and forecast year 2040 (see Section 4.3). Other analysis years were interpolated/extrapolated based on the implicit growth and annualized by 255 days/year. Ridership was subcategorized into commuting and other trips. Commuting comprises about 90 percent for the San Francisco route, 100 percent for Oakland (no non-commuting). Projections below in **Table 6-2** reflect fares as provided by WETA.

Table 6-2: Ridership Estimates (2019, 2040)

Origin	Destination	2019 Daily Boardings [1]					2040 Daily Boardings [1]				
		Peak Dir.		Reverse Dir.		Total	Peak Dir.		Reverse Dir.		Total
		AM	PM	AM	PM		AM	PM	AM	PM	
OAK	RWC	381	381	45	45	**852**	756	756	181	181	**1,874**
SF	RWC	441	441	206	206	**1,294**	730	730	363	363	**2,186**

Source: CDM Smith

(1) Commuter ridership only for the RWC/OAK route, both commuter and non-commuter ridership for RWC/SF route

6.3 Financial Feasibility

The analysis primarily focusses on ferry operational feasibility. The approach identifies ridership levels required to cover operating costs based on service assumptions, unit costs, and fare assumptions. Ridership requirements are then compared to actual forecasts. Annual farebox recovery ratio reflects revenues divided by operating costs. The operating gap identifies additional funding required to breakeven, versus an operating surplus (revenues surpass costs). Additionally, ferry terminal costs are compared to ridership levels at previous Bay Area facilities.

6.3.1 Ferry Operating Revenues

Revenues are based on fares paid by passengers. Fare assumptions are based on the current service and average fares between Vallejo and San Francisco due to similar route lengths, the one-way 2020 Adult Clipper Fare for the Vallejo route was $11.30. Fares are assumed the same for both routes given similar distances. Fares are inflated at an annual rate of 3 percent, consistent with WETA's internal modeling practices. Average fares reflect discounts for youth, seniors, school groups, etc. Average fares are calculated as total revenue divided by total ridership, and are projected to increase each year based on WETA's systemwide fare policies as seen in **Table 6-3.**

Table 6-3: Assumed Route Fares by Type and Year

Year	Adult Clipper	Average
2020	$11.30	$10.05
2025	$13.10	$11.65
2040	$20.41	$18.15

Sources: WETA, Economic & Planning Systems

Note: One-way fares are the same for both routes and are weighted by ridership (e.g., WETA's Vallejo service), thereby accounting for discounts (seniors, youth, etc.). Fares are escalated by 3% per year consistent with WETA's adopted fare structure policies.

6.3.2 Farebox Recovery Findings

Financial feasibility is evaluated in terms of the farebox recovery ratio for a ten-year analysis period between 2025 through 2034. Daily ridership numbers are multiplied by 255 days, consistent with WETA's total days of operation in FY2019. Annual ridership is multiplied by the average fare to calculate annual farebox revenue, which are compared with annual operating costs.

The OAK/RWC route generates sufficient ridership such that farebox recovery addresses 61 percent of operating costs during the first ten years of operation (52 percent in year 1), while the SF/RWC route achieves a farebox revenue recovery ratio of 74 percent of operating costs during the first ten years of operation (66 percent in year 1).

These ratios exceed WETA's minimum farebox recovery target of 40 percent within the first ten years of operation. WETA's farebox recovery ratio target is between 50 and 70 percent for mature services.[33] Both routes fall within this range even at the outset of service. The model results are summarized below in **Table 6-4**. The estimated, average operating subsidy to operate both routes would be $3.5 million per year. The detailed calculations by route are provided in **Appendix F** and show the farebox recovery ratios for each year during the first ten years of operation. It should be noted that when developing business plans and budget estimates, WETA typically adjusts model-generated ridership and farebox estimates downwards to be more conservative in their assumptions. It is likely that ridership assumptions for WETA's budget and business plan could be 50 percent lower than what is assumed in this Study.

Table 6-4: Summary of Ferry Service Farebox Recovery Ratios by Route

Item	Redwood City Routes		
	OAK	SF	Combined [2]
10-Year NPV of Annual Operating Expenses[1]	$51,650,000	$57,010,000	$108,660,000
Target Ridership			
One-Way Trips to Fund Operating Expenses [3]	5,293,803	5,842,619	11,136,423
Operating Gap given Ridership Projections			
10-Year Ridership (255 service days/year) [4]	3,240,901	4,299,804	7,540,705
10-Year NPV of Annual Fare Revenue [5]	$31,622,386	$41,954,397	$73,576,782
Farebox Recovery Percentage	61%	74%	68%
Ridership Gap (versus Required Pass.)			
Number	2,052,902	1,542,815	3,595,718
Percent	39%	26%	32%
Operating Expense Gap (versus Operating Exp.)			
Amount	$20,030,745	$15,053,685	$35,084,431
Percent	39%	26%	32%

Sources: WETA; Economic & Planning Systems, Inc.
(1) The NPV calculation discounts 10-years of operating expenses, using an annual discount rate of 3%.
(2) "Combined" service assumes both routes start operation at the same time.
(3) Required one-way trips during the 10-year period to fully fund operating expenses.
(4) Daily ridership based on CDM Smith's projections. 255 days of service/year, per WETA's FY2019 daily operations.
(5) NPV calculation discounts 10 years of operating expenses, using a 3% discount rate. Ticket prices provided by WETA in 2019/2020 nominal dollars are inflated by 3.0%.

Other Farebox Recovery Considerations

WETA's System Performance Target Policy, **Table 6-5**, evaluates the competitiveness and fiscal sustainability of existing and new ferry services. The measures are evaluated in terms of minimum, target and maximum. Minimum levels are required after the initial ten years of operation. Target levels are consistent with expected performance of mature services such as Alameda/Oakland, Vallejo, and Harbor Bay. When a service achieves maximum levels, it indicates service enhancement or increase may be justified.

[33] As reference points, WETA's 2020 Short Range Transit Plan indicates that the systemwide farebox recovery ratio is 56.8 percent as of FY 2018/19. The Alameda/Oakland route has a farebox recovery ratio of 58.3 percent; the Harbor Bay route has a ratio of 45.6 percent; and the Vallejo/San Francisco routes has a 65 percent ratio.

Table 6-5: WETA Performance Measures and Standards

Measure	Minimum	Target	Maximum
Pass. per Revenue Hour (Commute-only services)	100	150	250
Pass. per Revenue Hour (All-day services)	100	125	250
Farebox Recovery	40%	50%-70%	100%
Peak Hour Occupancy	50%	60%-75%	80%

Source: WETA 2016 Short Range Transit Plan

6.3.3 Terminal Cost to Annual Ridership Ratio

Gauges the cost-effectiveness of the terminal capital investment. For example, in its first year of operations, approximately 200,000 passengers passed through the Richmond Terminal. At a cost of $20 million, the ratio is $100 per passenger. The Richmond Terminal is the most recently completed terminal that is part of the WETA system.

For RWC, the projected cost-per-passenger ratio varies from $23 per passenger under the combined route scenario ($15 million terminal) to $73 per passenger under the OAK/RWC route scenario (a $20 million terminal), as shown in **Table 6-6**.

Table 6-6: Terminal Cost to Annual Ridership Ratio

	Ridership	Terminal Construction Cost	
Route	(2025)	$15 million	$20 million
OAK/RWC	272,137	$55	$73
SF/RWC	383,298	$39	$52
Combined	655,435	$23	$31

Source: WETA; Economic & Planning Systems

6.4 Funding

Farebox revenue is typically insufficient to cover capital investment. Even fare revenue from very successful U.S. public transit services rarely covers operating costs, much less capital expenses. However, a range of funding sources may be available to help fund the capital costs associated with new RWC service, if the project emerges as a regional priority. The ridership analysis, financial feasibility analysis, benefit/cost analysis, etc. provide feasible perspective.

6.4.1 Capital Funding Sources

Historically, ferry terminals are funded by bridge toll revenues, federal grants, county transportation sales tax funding, and other local sources. The most recent terminals constructed, South San Francisco and Richmond, were funded through bridge toll revenue (Regional Measure funds), a FTA (federal) grant, and a State of California Proposition 1B grant. Specifically, Regional Measure 3 (which is currently held up in court) will fund up to $300 million for capital expenditures across WETA's system. With so many prominent employers located in or close to Redwood City, the private sector may emerge as an important funding partner.

Source: WETA, 2020

SMCTA Measure A

In 2004 San Mateo County voters approved extension of the Measure A transportation sales tax to fund transportation projects. This program includes $30 million to support capital development of new ferry services to South San Francisco and Redwood City. While approximately $8 million of the funding was spent to develop the South San Francisco terminal, revenue may be available to fund (or partially fund) a Redwood City Terminal. WETA states in its 2020 Short Range Transit Plan that they will work with local entities and county transportation authorities as they develop and pursue future countywide transportation sales tax initiatives to support continued ferry transit operations.

SMCTA Measure W

As indicated earlier, $9 million in annual Measure W funding is available to support regional transit connections, including capital expenditures. The "Regional Transit Connections" will be a competitive funding program and public agencies providing transit service or constructing transit projects in San Mateo County are eligible. A 10 percent minimum match is required for infrastructure projects.

6.4.2 Other Operational Services and Funding Sources

Beyond ferry service operations, other costs include annual maintenance of the terminal and shuttle support services to facilitate first/last mile connections.

Shuttle Support Services

Public or privately-funded service is required to support the first/last mile connections. Additional study needs to define the service and identify potential partners. Based on a review of other commuter shuttle systems currently operating in San Mateo County, it appears that that annual operating costs range from approximately $250,000 to more than $1 million depending on the service offered. Currently Commute.org operates two shuttles out towards the project site; the

Pacific Shores shuttle and the Seaport Centre shuttle both provide 6 trips during the peak period and are financed through businesses and grant funding.

Other Operational Funding Sources

Potential funding sources for shuttle support services include SMTCA Measures A and W, and private employers.

- *SMCTA Measure A* – includes a funding provision specifically for shuttle services, generating approximately $60 million during the 25-year life of the sales tax measure (through 2033).
- *SMCTA Measure W* – targets a range of transportation improvements and services, including Countywide Highway Congestion Relief Improvements (e.g., shuttles). Approximately 22.5 percent of annual Measure W revenue, or approximately $20.5 million per year, is targeted for congestion relief improvements. Commute.org, which operates several shuttle services throughout the Bay Area is considered an "Eligible Project Sponsor" and could apply for Measure W funding.

Non-Farebox Operating Funding

Public ferry operations typically require subsidy to offset operating costs not covered by fares. While the mix of funding sources has not been determined, potential sources could include Regional Measure 3, San Mateo County Transportation Agency Measure W, transportation impact fees, and/or private funding from employers/developers. In partnership with employers and developers, the City can incorporate funding for ferry operations in future Transportation Demand Management plans. Funding stability is also a feasibility concern; it will be important for any new sources to be committed over multi-year periods and be resistant to elimination by voters or elected officials.

- *Regional Measure 3* – The MTC is the transportation planning, financing, and coordinating agency for the nine-county San Francisco Bay Area that administers Regional Measure 3 Program revenue. Regional Measure 3 is a plan to build major roadway and public transit improvements via an increase in bridge tolls on all Bay Area toll bridges (except the Golden Gate Bridge). Final certified Regional Measure 3 election results were released in July 2018 and confirmed that 55 percent of Bay Area voters supported the measure. Although currently tied up in court, the Regional Measure 3 Expenditure Plan includes funding for ferry operations that provide WETA up to $35 million in annual operating funds for expansion.
- *SMCTA Measure W* – San Mateo County voters approved Measure W in 2018, generating additional sales tax revenue to improve transit and relieve traffic congestion in the County. Of the funds generated, 50 percent are administered by the San Mateo County Transportation Agency. Measure W funding supports "Regional Transit Connections" at more than $9 million annually, and public agencies that operate regional transit including San Mateo County infrastructure. "Eligible Project Sponsors" include the City, BART, Caltrain, WETA, or public bus operators. The SMCTA's strategic plan indicates a 10 percent minimum match is required for infrastructure projects, and a 50 percent minimum match is required for operations and promotions or measures made to increase ridership. How a project or service may qualify or how funds may be made available are still to be determined by the SMCTA.
- *Local Funding* – Local (City or Port) funding sources may also be established such as transportation impact fees, benefit improvement districts, or local property taxes. Examples include a local property tax charged in Bay Farm Island or a portion of Contra Costa County sales tax revenue for the Richmond service to provide this operating subsidy.

- *Private Funding* – Local developers or employers can help fund ferry service through Transportation Demand Management agreements and negotiated plans that generate operating subsidies. Private financial support can be especially important in the early years of operating a new ferry service as ridership is established.

6.4.3 Steps to Improving Feasibility

Financial feasibility findings help guide future planning, investment priorities, and funding efforts conducted by the City, the Port, destination cities for planned service, WETA, and potential private employers. Key follow-up efforts may include:

- *Other Destinations* – expand analysis to identify additional potential ridership.
- *Emergency Response* – evaluate potential role that ferries (WETA or other providers) could fulfill in Redwood City.
- *Funding* – other City/Port efforts at obtaining capital or operating funding. (i.e., city capital improvement programs, and special property tax for the Bay Farm Island service).
- *Planning and Development* – further study of terminal areas in respective cities.
- *Study* – Local efforts to evaluate other ferry service development impacts/benefits.

6.5 Key Findings

Table 6-7 summarizes the costs and revenues associated with establishing a new ferry service to Redwood City.

Table 6-7: Ferry Service Operating Expenses and Revenues

Item	OAK/RWC *Jack London Sq.*	SF/RWC *Ferry Building*	Combined[1]
Operating Metrics (2019/20 Dollars)			
Expenses			
Year 1 (2025)	$6,100,000	$6,700,000	$12,800,000
Year 10 (2034)	$8,200,000	$9,000,000	$17,200,000
Revenues			
Year 1 (2025)	$3,200,000	$4,500,000	$7,700,000
Year 10 (2034)	$5,800,000	$7,300,000	$13,100,000
Subsidy Gap			
Year 1 (2025)	$2,900,000	$2,200,000	$5,100,000
Year 10 (2034)	$2,400,000	$1,700,000	$4,100,000

Sources: CDM Smith; WETA; Economic & Planning Systems

[1] "Combined" service assumes both routes start operation at the same time. If both services are pursued, it may be that start dates are staggered.

Based on the analysis performed as part of this Study, Redwood City ferry service revenue projections would surpass WETA's minimum 40 percent farebox recovery ratio for new services, and meet broader 50-70 percent targets for established service.

- *Farebox Recovery* – Both services would exceed ferry operating costs requirements (40 percent) by the 10th year of operation, making them financially feasible.
    - *Oakland Route* – ratio would increase from 52 percent in the first operating year (2025) to 71 percent by Year 10 (2034). Over ten years, farebox recovery averages 61 percent.

  - *San Francisco Route* – ratio would increase from 67 percent in the first operating year to 81 percent in Year 10. Over ten years, farebox recovery averages 74 percent.
  - *Combined Route* – ratio would increase from 60 percent in the first operating year to 76 percent in Year 10. Over ten years, farebox recovery averages 68 percent.
- *Operating Subsidies* – While projected ridership would meet WETA's farebox revenue ratios, service would require operating subsides, like most public transit systems. However, annual subsidies decline over time as ridership increases.
  - *Oakland Route* – annual subsidies would fall from $2.9 million in 2025 to $2.4 million in 2034.
  - *San Francisco Route* – annual subsidies would fall from $2.2 million in 2025 to $1.7 million in 2034.
  - *Combined Route* – annual subsidies would fall from $5.1 million in 2025 to $4.1 million in 2034.
- *Funding Sources* – Both public and private sources are needed to fund vessel acquisition, terminal construction, and other facility costs. While existing sources can be leveraged, each ferry service requires a unique blend and effort to implement.
  - *Ferry Terminals* – historically funded by bridge toll revenues, federal grants, county transportation sales tax funding, and other local sources.
  - *Ferry Service* – SMCTA Measures A and W can be used to help fund both capital and operation expenses.
- *Connecting Transit* – Non-farebox operation funding includes SCMTA Measure W, transportation impact fees, and/or private funding from employers and/or developers.

Section 7
Benefit Cost Analysis

A benefit-cost analysis (BCA) was conducted for proposed ferry services between Redwood City to/from Oakland (OAK), to/from San Francisco (SF), and the combined service scenario that looks at both locations at the same time. A BCA, sometimes called a cost-benefit analysis, compares the benefits and costs of certain decisions or actions. The BCA quantifies the net societal benefits to ferry riders. It compares monetized benefits (savings in travel time, passenger vehicle operating costs, accidents, emissions, and parking fees/tolls) to the costs of constructing a terminal, acquiring ferries, and annual O&M.

Source: CDM Smith, 2020

- Ridership Forecasts – A travel demand model was used to forecast ridership and trip characteristics for driving-alone between the city origin-destination pairings[34] and the ferry alternatives. Resultant model metrics were forecast for two benchmark years (2019 and 2040), interpolated over the operating analysis horizon (2024 opening to 2050), and monetized using applied factors.

[34] i.e., San Francisco to/from Redwood City and Oakland to/from Redwood City.

- Discounting and Evaluation Metrics – Annual benefits and costs were discounted at three rates: 3 percent (low), 4 percent (Caltrans recommended), and 7 percent (high/FHWA recommended).[35] Net present value (NPV), benefit-cost ratios (BCR), and internal rates of return (IRR) are calculated, as well as required breakeven benefits per rider.
- On-Ferry Time Scenarios – Typically, transportation BCAs consider the value of travel time as universal between mode choices. However, the opportunity cost of ferry travel is different than in-vehicle captivity via surface modes (passenger vehicles, rail, or bus). As such, the three time-value scenarios are evaluated:
  - Penalty scenario – considers all travel time between the alternatives equally
  - Awash scenario – time on-ferry is not attributed any value
  - Amenity scenario – on-ferry time is valued positively

  Ferry riders do not perceive on-ferry time the same as other modal transport. If they did, the longer total time for connecting-with and riding the ferry would be irrational relative to the shorter drive-alone or transit alternatives. Instead, ferry riders realize an inherent on-ferry time value, otherwise, they would not ride.
- Feasibility Perspective – A benefit cost analysis is one of five feasibility perspectives evaluated:
  - Plan Consistency – whether the ferry service is consistent with agency planning documentation
  - Construction Feasibility – whether a terminal could be built at a reasonable cost
  - Ferry Service Feasibility – whether ferry operations accommodate demand
  - Financial Feasibility – whether passenger revenues cover farebox recovery thresholds
  - Economic Feasibility – establishes whether ferry user benefits outweigh the implementation costs

  This economic feasibility task builds upon previous sections' data and assumptions. Section 8 contains an economic impact analysis evaluating how the project components and feasibility perspectives affect the region quantitatively (jobs, income, output, etc.) and qualitatively (development opportunities and equitability) terms. While each project component/feasibility perspective includes interrelated components, they are different analyses.

[35] Traditionally, the federal perspective recommends discounting at a real 7% (per OMB A-94 and FHWA guidance), especially for certain grant applications, which is steep. Conversely, a real 3% rate was historically used to illustrate a less austere perspective. Caltrans applies a real 4% rate in their BCA modules, which is between the federally recommended rates.

7.1 Methodology and Assumptions

BCA is a quantitative process of determining if a project, program, or policy alternative is societally worthwhile, given certain assumptions. Unlike financial feasibility, which compares annual farebox revenues to capital and operational cost, a BCA compares expected monetized benefits against the incremental implementation cost over the analysis period. For this analysis, alternatives are the provision of ferry services from/to Redwood City compared with the baseline of driving between the cities. BCAs typically follow four steps, with details contingent on project complexity:

1. *Define Project/Program and Assumptions* – baseline and alternatives, analysis horizon, cost and benefit types, timing, and discount rate(s).
2. *Calculate Implementation Costs* – e.g., construction, operations, maintenance, etc.
3. *Calculate Benefits* – e.g., time, vehicle-operating, accidents, emissions, etc.
4. *Conduct BCA and Standard Metrics* – Benefit-Cost Ratio, Net Present Value and Internal Rate of Return, etc.

Of the four, calculating benefits is typically the most complex. Regardless of complexity, the BCA framework enables standardized and comparable metrics that help identify if an alternative is economically worthwhile to implement. Such metrics are defined as:

- *Net Present Value (NPV)* – discounted benefits less discounted costs; a positive monetary value indicates the investment is economically feasible. Effectively, the absolute gain (or loss) in current net worth associated with the alternative.
- *Benefit-Cost Ratio (BCR)* – discounted benefits divided by discounted costs; a ratio greater than 1.0 indicates the project is economically feasible. Effectively, the relative multiplier on the alternative's investment.
- *Internal Rate of Return (IRR)* – discount rate at which the present value of the benefits equals the present value of the costs; an IRR greater than the threshold discount rate (either 3 percent, 4 percent, or 7 percent) indicates the project is economically feasible. Effectively, the yield on an alternative indicates the relative speed in which benefits are returned. In instances, an IRR is incalculable, which may occur when benefits are notably insufficient and/or costs are varied and staggered.

Benefits are compared with costs across a multi-year period for the different results metrics, which provide different feasibility perspectives of the dollar-magnitude, relativity, robustness, and timeframe. While each metric is different, the economic feasibility can be determined by any single metric.

7.1.1 Ferry Alternatives

Two route-alternatives are assumed, one connecting Redwood City with Oakland, and the other with San Francisco. Each route operates two ferries. Departures vary between routes with three in both the morning and evening peak periods for Oakland, and four for San Francisco. One-way trip time averages 65 and 55 minutes, respectively. The analysis comprises a conservative operational perspective that primarily focuses on commuting trips, and does not consider weekend or recreational events service (i.e., sports games).[36] A third alternative includes both route pairings operating concurrently – seven daily services (three OAK, four SF) with four operating ferries (two for each route). The three alternatives (either OAK or SF, or both combined) would be new ferry services connecting the respective cities, and providing an additional modal option around the San Francisco Bay.

Analysis Assumptions

Ferries would operate weekdays (255 days/year),[37] beginning in 2024, following two years of time for purchasing ferries and constructing the Redwood City terminal. The analysis horizon spans year 2020 (current) to 2050 (30-years out, which is a typical analysis horizon for transportation BCAs).[38] Discounting future monetized benefits and costs are applied 3 percent, 4 percent (Caltrans), and 7 percent (FHWA) discount rates. All dollars presented are in constant 2019$ terms.

Benefit Types

Benefits and disbenefits of ferry ridership are calculated relative to the drive-alone alternative. Demand forecasting and associated travel characteristics were estimated, from which (dis)benefits are derived, such as travel time savings, avoided passenger vehicle operating costs, emissions, accidents, parking fees, and tolls. Ridership demand forecasting produced various metrics for each ferry route; the travel demand model methodology is presented in Section 4. Ferry emissions are also estimated. No highway network-level benefits were estimated, as the diverted highway-to-ferry users are too few to appreciably affect (reduce) roadway congestion.[39]

Ridership Estimates

Travel demand modeling estimated daily one-way person-trips by specific route-times, with balanced morning/evening round trips (i.e., same day) for base year 2019 and forecast year 2040. Other analysis years were interpolated/extrapolated based on the implicit growth and annualized by 255 days/year. Ridership was subcategorized into commuting and other trips, with commuting comprising about 90 percent for San Francisco. No non-commuting trips were assumed for Oakland. Such ridership forecasts were characterized by the time and VMT between the no-ferry drive-alone baseline scenario and the ferry alternatives.[40] **Table 7-1** illustrates daily ridership (boardings), annual ridership and the Compound Average Growth Rate for the two proposed ferry service scenarios and a "total" which represents the combined alternative.

---

[36] Such event service is possible with the terminal and vessels, but was excluded to avoid crude assumptions that yield comparatively minor benefits.

[37] Operations could extend to weekends, select holidays, evening sports events, etc., as qualitatively discussed in the Sensitivity Consideration Section.

[38] The ridership forecast provides benchmark years, the 30-year BCA provides a round-analysis period, as is common.

[39] The few hundred users (depending on scenario) transferring from roadways to ferries per day would not have a measurable effect on roadway congestion.

[40] While other special event and weekend travel will arise, the level and frequency is comparatively minor and is excluded from this BCA analysis to avoid confusion and/or assumption uncertainty.

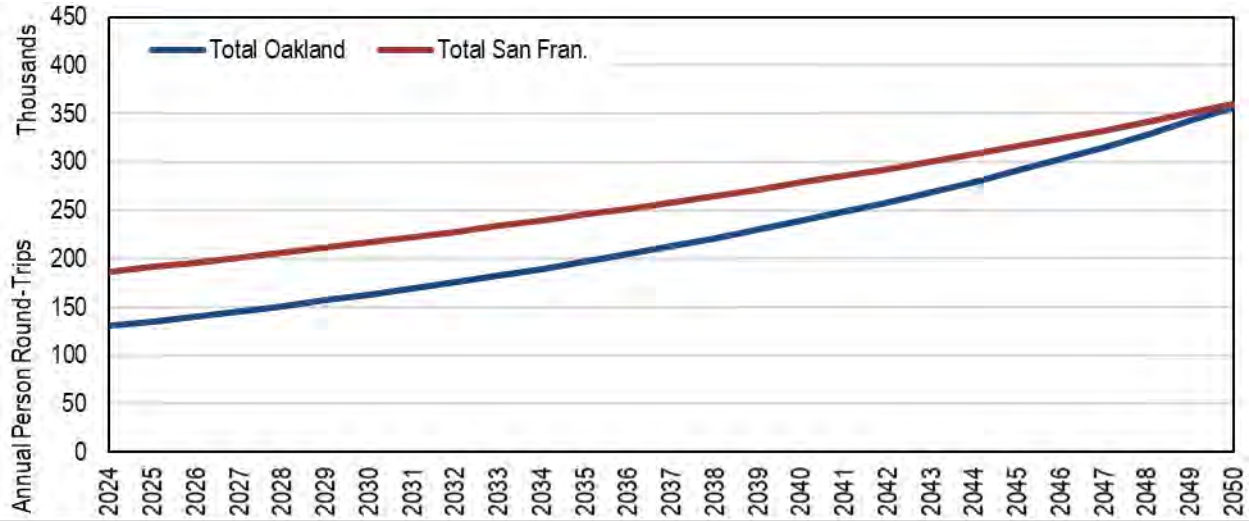
Table 7-1: Ridership Estimates (Peak Period Boardings by Route Alternative (Round Trips)

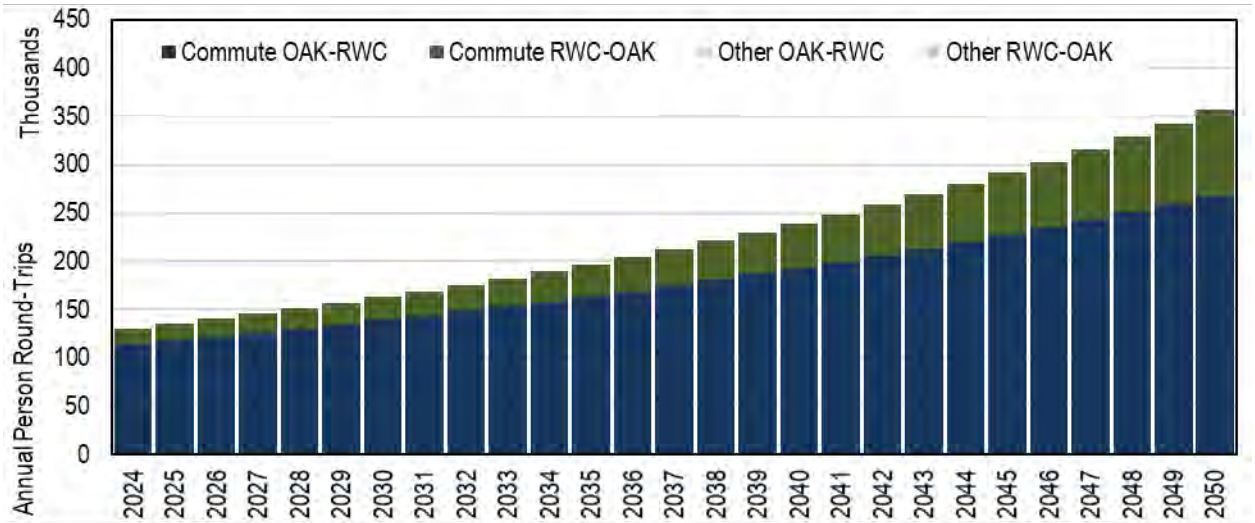
	Oakland			San Francisco			Total
	OAK-RWC	RWC-OAK	Subtotal	SF-RWC	RWC-SF	Subtotal	
Daily Ridership							
2019							
Commute	381	45	426	409	152	561	987
Other	0	0	0	32	54	86	86
Total	**381**	**45**	**426**	**441**	**206**	**647**	**1,073**
2040							
Commute	756	181	937	690	295	985	1,922
Other	0	0	0	40	68	108	108
Total	**756**	**181**	**937**	**730**	**363**	**1,093**	**2,030**
Annual Ridership							
2019							
Commute	97,155	11,475	108,630	104,295	38,760	143,055	251,685
Other	0	0	0	8,160	13,770	21,930	21,930
Total	**97,155**	**11,475**	**108,630**	**112,455**	**52,530**	**164,985**	**273,615**
2040							
Commute	192,780	46,155	238,935	175,950	75,225	251,175	490,110
Other	0	0	0	10,200	17,340	27,540	27,540
Total	**192,780**	**46,155**	**238,935**	**186,150**	**92,565**	**278,715**	**517,650**
Compound Average Growth Rate (2019-2040)							
Commute	3.3%	6.9%	3.8%	2.5%	3.2%	2.7%	3.2%
Other	na	na	na	1.1%	1.1%	1.1%	1.1%
Total	**3.3%**	**6.9%**	**3.8%**	**2.4%**	**2.7%**	**2.5%**	**3.1%**

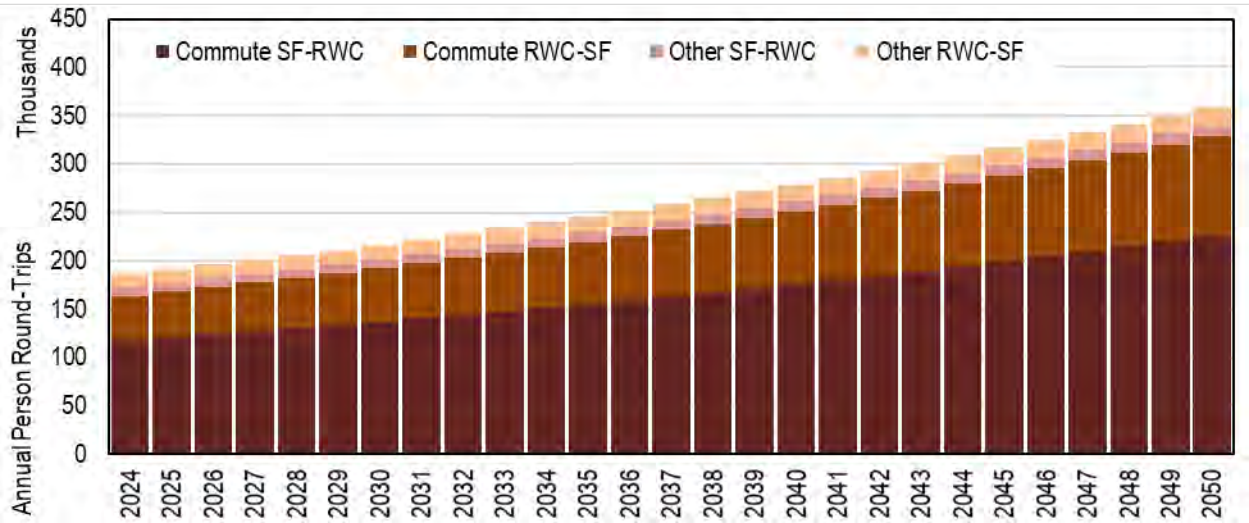
Source: CDM Smith, 2020

Note: compound average growth rate (a.k.a. average annual growth rate).

Figure 7-1: Annual Person Round Trip Ridership Summary







Source: CDM Smith, 2020

7.1.2 Costs

Costs of connecting Redwood City with San Francisco and Oakland entail capital (upfront) and annual O&M for both the terminal and ferries. Capital costs are assumed to occur in years 2022 and 2023, split evenly between the two years, O&M recur annually thereafter. **Table 7-2** illustrates the capital and O&M costs associated with all three alternatives.

Redwood City Terminal

COWI estimated capital costs for two options, detailed by terminal construction, parking, and permitting. The $19.8 million versus $14.6 million costs reflect the waterside location, float configuration, footprint and waterside capacity differences (parking and permitting are identical between options). The larger terminal cost is applied to the BCA. Estimated terminal O&M is commensurate with the existing O&M at the Richmond terminal, which is about $200,000 annually for security, landscaping, maintenance, and utilities.

Ferries

Discussion with WETA personnel indicate that 2.5 vessels would be purchased to serve either proposed alternative route (the half represents a portion of a spare vessel with that cost being split between a Redwood City ferry service and another WETA service). If both routes operate concurrently, five ferries would be purchased. Per the discussion, each 320-passenger Dorado class ferry would cost $16.0 million (2019$). As such, the total ferry acquisition capital cost is $40.0 million over two years for each individual route, and $80.0 million for both combined. In separate communications with WETA personnel, the annual O&M costs of servicing Redwood City with such vessels amounts to $5.0 million for Oakland and $5.6 million for San Francisco, categorized by vessel expenses, fuel, direct expenses, fixed operator fees, and non-vessel expenses.

Table 7-2: Capital and O&M Costs

(2019$ millions)

	Terminal	Ferries	Total
Capital			
OAK	$19.8	$40.0	$59.8
SF	$19.8	$40.0	$59.8
Combined	$19.8	$80.0	$99.8
Annual O&M			
OAK	$0.2	$5.0	$5.2
SF	$0.2	$5.6	$5.8
Combined	$0.2	$10.6	$10.8

Source: CDM Smith, 2020

7.1.3 Benefits

Benefits are calculated for operating years 2024 through 2050 based on travel demand model characteristics, per unit rates, and monetization factors. Monetization factors are summarized below, in **Table 7-3**, for values of travel time; passenger vehicle operating costs, emissions, and accidents; parking fees and tolls; and, ferry emissions. Each factor is discussed below in the respective (dis)benefit narratives. Aside from benefits discussed below, economic impacts are analyzed in Section 8 of this report.

Table 7-3: Benefit Monetization Factors

Assumptions	Applied	Terms	Source
Travel Time Value			
Personal	$22.16	2019$/person-hour	FHWA BCA Guidance 2020, BLS and BEA
per Passenger Car VMT			
Vehicle Operating	$0.42	2019$/VMT	FHWA BCA Guidance 2020 and BEA
Emissions 2019	$0.021	2019$/VMT	CalBC and BEA
Emissions 2040	$0.011	2019$/VMT	CalBC and BEA
Accidents	$0.12	2019$/VMT	CalBC and BEA
Parking + Toll			
OAK-RWC	$7.00	2019$/round trip	CDM Smith
RWC-OAK	-$8.00	2019$/round trip	CDM Smith
SF-RWC	$0.00	2019$/round trip	CDM Smith
RWC-SF	-$15.00	2019$/round trip	CDM Smith
Ferry Emissions			
Emissions Rate	$0.81	2019$/ferry-mile	EPS and BEA
Ferry-Miles/Day (OAK)	271	miles/day	CDM Smith
Ferry-Miles/Day (SF)	334	miles/day	CDM Smith
Ferry-Miles/Day (Comb.)	606	miles/day	CDM Smith

Source: CDM Smith, 2020

Travel Time Characteristics

The travel demand model provided time characteristics between the drive-alone alternatives and the ferries, with detail by:

- on-ferry
- connecting with the ferry in-vehicle (passenger vehicles[41])
- connecting with the ferry non-vehicle (e.g., walking to/from terminals/vehicles, queuing, etc.)

Generally, the Oakland route takes longer than the San Francisco route, for either ferry or drive alone-times. And future non-ferry times increase as roadway network congestion increases. Although there are nuances between routes, directional pairings, and years, the general round trip time characteristics detailed in **Table 7-4** are as follows:[42]

- drive-alone time is about 2 hours
- on-ferry time is about 2 hours
- connecting with the ferry is about 1.5 hours
  - includes more than 1 hour connecting non-vehicle (walking, queuing, etc.)
  - and slightly less than 0.5 hours connecting in-vehicle (OAK > SF)

The "Total" column for "Mins/Round trip" is the average of the subtotals from the OAK and SF routes.

[41] Assumed as personal passenger cars, but theoretically could be rentals, taxis, ride-hailing, etc.

[42] Note, totals are round-trip weighted averages; e.g., Oakland's subtotal is weighted by OAK-RWC and RWC-OAK directional trips, total is weighted by OAK and SF.

Table 7-4: Travel Time Characteristics by Route (Round Trip)

	Oakland			San Francisco			Total
	OAK-RWC	RWC-OAK	Subtotal	SF-RWC	RWC-SF	Subtotal	
Minutes/Round trip							
2019							
Base: Drive-Alone	136	108	133	97	88	94	109
Build: Ferry							
On-Ferry	130	130	130	110	110	110	118
Connecting, Veh.	37	37	37	17	16	17	25
Connecting, Non-Veh.	74	69	74	67	60	65	69
On-Ferry+Connecting	241	236	241	195	186	192	211
2040							
Base: Drive-Alone	153	121	147	104	95	101	122
Build: Ferry							
On-Ferry	130	130	130	110	110	110	119
Connecting, Veh.	38	38	38	18	17	17	27
Connecting, Non-Veh.	76	69	74	70	60	67	70
On-Ferry+Connecting	244	237	242	198	187	195	217
Annual Person-Hours							
2019							
Base: Drive-Alone	219,678	20,655	240,333	181,802	77,044	258,846	499,180
Build: Ferry							
On-Ferry	210,503	24,863	235,365	206,168	96,305	302,473	537,838
Connecting, Veh.	59,967	7,121	67,088	32,049	13,686	45,735	112,823
Connecting, Non-Veh.	120,278	13,165	133,443	126,511	52,949	179,460	312,903
On-Ferry+Connecting	390,748	45,148	435,896	364,727	162,940	527,667	963,563
2040							
Base: Drive-Alone	490,943	93,319	584,262	323,787	145,842	469,628	1,053,890
Build: Ferry							
On-Ferry	417,690	100,003	517,693	341,275	169,703	510,978	1,028,670
Connecting, Veh.	122,297	29,050	151,347	54,913	25,891	80,804	232,151
Connecting, Non-Veh.	242,991	53,230	296,220	218,428	93,322	311,749	607,970
On-Ferry+Connecting	782,978	182,283	965,260	614,616	288,915	903,531	1,868,791

Source: CDM Smith, 2020

Travel Time Monetization

FHWA recommends $15.20/hour (2018$) for personal travel time (including commuting) applicable for highway BCAs. The $22.16/hour is inflated to 2019$ via the BEA's real GDP factors, and localized to reflect the prevailing wage premium in the SF-OAK MSA versus the nation (43 percent), via BLS.

Typically, such time values reflect the opportunity cost of vehicle captivity – the inability to conduct other activities besides sitting behind a wheel, or on a noisy bus, etc., in traffic. As such, the time values are applied to the drive-alone and connecting-with-ferry times. Since ferry rides are notably different than surface-mode vehicle captivity, on-ferry time is addressed in three scenarios to reflect the possible range in how riders use that time:

- *Penalty* – on-ferry travel time is valued the same as drive-alone and connecting travel time. Given the total ferry round-trip times (on-ferry plus connecting) are over 3.5 hours versus drive-alone times of about 2 hours or less, the additional hour-plus per passenger results in a time disbenefit.
- *Awash* – on-ferry travel time is not valued, positively or negatively – the average rider may perceive on-ferry time with some disbenefit (like vehicle captivity opportunity cost) and some benefit (amenities), offsetting. By zeroing-out on-ferry time, the net difference between using ferries and drive-alone yields slight net time benefits.
- *Amenity* – on-ferry travel time is valued as a positive attribute due to the multitasking opportunities afforded by ferry rides such as high-speed Wi-Fi for electronic teleworking, social media, streaming media use, etc., purchasing food and drink and entertainment, and enjoying the vistas and weather. Half of the refactored time value ($11.08/hour) is applied as a positive amenity, increasing the benefits from "awash."

Applying the value of time with the annualized person-hours from Table 7-4, **Table 7-5** yields the time (dis)benefits for the benchmark years (2024 and 2050).[43]

Table 7-5: Monetized Travel Time Benefits

(2019$ millions)

	Penalty	Awash	Amenity
OAK			
2024	-$5.1	$1.2	$4.3
2050	-$11.8	$5.3	$13.9
SF			
2024	-$6.7	$0.9	$4.7
2050	-$12.1	$2.5	$9.8
Combined			
2024	-$11.7	$2.1	$9.0
2050	-$23.9	$7.8	$23.7

Source: CDM Smith, 2020

- *Penalty* – additional total trip times yield year 2024 disbenefits of -$5.1 and -$6.7 million for Oakland and San Francisco, respectively, which more than double by 2050.
- *Awash* – net time benefits are slightly positive, at $1.2 and $0.9 million in 2024, respectively, and escalate to $5.3 and $2.5 million, respectively.
- *Amenity* – benefits start at $4.3 and $4.7 million, and escalate to $13.9 and $9.8, respectively.

Given the magnitude of on-ferry time (two-hours per round trip) valuation is a key factor in the BCA results. This illustrates modeling sensitivities and range of outcomes. Realistically, ferry riders realize some degree of amenity; a penalty scenario would likely entail forgoing the modal shift, and the awash scenario is at the decision-making cusp.

Vehicle Miles Traveled

The travel demand model also provided VMT between the drive-alone alternatives and ferry in-vehicle connections. Driving between Redwood City and paired cities is over 60 miles/round trip; ferry in-vehicles connections are about 10-20 miles/round trip, resulting in a per-vehicle VMT savings of 40-50

[43] Annual values for all years are shown in the detailed BCA tables (See Appendix H Figure H-2 through Figure H-10).

miles/day. Such VMT savings translate into vehicle operating cost, accidents, and emissions benefits, as summarized in **Table 7-6**. The "Total" column for "Miles/Round trip" is the average of the subtotals from the OAK and SF routes.

Table 7-6: VMT Characteristics by Route

	Oakland			San Francisco			Total
	OAK-RWC	RWC-OAK	Subtotal	SF-RWC	RWC-SF	Subtotal	
Miles/Round trip							
2019							
Base: Drive-Alone	68.2	69.4	68.4	65.2	63.6	64.6	66.1
Build: Connecting, Veh.	18.6	19.1	18.7	8.7	8.4	8.6	12.6
2040							
Base: Drive-Alone	68.2	69.4	68.5	65.2	63.6	64.6	66.4
Build: Connecting, Veh.	19.1	19.4	19.1	9.0	9.0	9.0	13.7
Annual VMT							
2019							
Base: Drive-Alone	6,629,504	795,945	7,425,450	7,326,767	3,338,649	10,665,416	18,090,866
Build: Connecting, Veh.	1,809,157	219,117	2,028,273	980,609	439,516	1,420,125	3,448,398
2040							
Base: Drive-Alone	13,154,607	3,201,469	16,356,076	12,128,209	5,883,153	18,011,362	34,367,438
Build: Connecting, Veh.	3,672,486	895,678	4,568,163	1,669,787	836,581	2,506,367	7,074,530

Source: CDM Smith, 2020

- *Vehicle Operating Cost (VOC) Monetization* – FHWA recommends $0.41/VMT (2018$) for vehicle operating costs applicable for highway BCAs, reflecting AAA estimates for light-duty vehicles. BEA real GDP factors are used to inflate VOC/VMT to year 2019 values, $0.42. VOC benefits are estimated to rise from $2.7 million in 2024 to $7.3 million in 2050 for Oakland, and from $4.4 to $8.3 million for San Francisco, as shown in **Table 7-7.**
- Emissions Monetization – Various emissions types exist, with varying rates by vehicle type, engine and fuel type, travel speed, etc. These can get overly complicated. Caltrans developed various BCA modules, with California-specific emissions parameters for automobiles, in years 2016 and 2036, at various speeds, including CO, CO2e, NOX, PM10, SOX, and VOC. Such data were leveraged to calculate an average emissions cost in 2019$/VMT, amounting to about two cents in 2019 and one cent in 2040. Estimated benefits range between $100,000 and $200,000 in each year and route (see **Table 7-7**).
- *Accidents Monetization* – Similar to emissions, various accident nuances exist and get overly complicated. Leveraging Caltrans average accident rates/VMT and costs/accident assumptions, by fatalities, injuries, and property damage only, an average accident cost in 2019$/VMT is estimated at $0.12. Estimated benefits range between $0.7 million in 2024 (OAK) to $2.3 million in 2050 (SF), see **Table 7-7**.

Table 7-7: Monetized VMT Benefits

(2019$ millions)

	VOC	Emissions	Accidents
OAK			
2024	$2.7	$0.1	$0.7
2050	$7.3	$0.2	$2.0
SF			
2024	$4.4	$0.2	$1.2
2050	$8.3	$0.2	$2.3
Combined			
2024	$7.1	$0.3	$1.9
2050	$15.6	$0.3	$4.3

Source: CDM Smith, 2020

Parking Fees and Tolls

For trips originating in San Francisco or Oakland, parking is assumed to cost ferry riders nothing (subsidized/validated in Oakland, and limited availability in San Francisco). Riders originating from Redwood City to Oakland are assumed to pay $15. A $7 toll between Oakland and Redwood City is assumed for the bridge, which are thus avoided (savings) when diverting from driving to ferries.

As such, directional-route tolls and parking fees range from a per-user (dis)savings of -$15 (RWC-SF) to $7 (OAK-RWC) per round trip. As such, some net benefits arise for the Oakland route (with most riders originating from Oakland, avoiding the toll and with no parking costs), and slight disbenefits for San Francisco (parking costs for those originating in Redwood City), see **Table 7-8**.

Table 7-8: Monetized Parking/Tolls Benefits by Route

(2019$ millions)

	OAK	SF	Comb.
2024	$0.7	-$0.9	-$0.2
2050	$1.2	-$1.8	-$0.7

Source: CDM Smith, 2020

Ferry Emissions

EPS conducted a BCA for the San Francisco Mission Bay Ferry Service in 2018, estimating ferry emissions by CO2e, NOX, and PM10 (see **Appendix H** for detail). Ultimately, the average effective rate amounts to about $0.81/ferry-mile; applying that to the estimated annual ferry operating-miles yields about $60,000 in annual ferry emissions disbenefits for Oakland and $70,000 for San Francisco – a very small disbenefit relative to the other costs and benefits. Ultimately, the ferry emissions disbenefits are more than offset by the saved vehicle emissions from avoided driving – a net positive emissions savings to the region.

7.1.4 Breakeven Round-Trip Benefit

Given $59.8 million in initial capital costs for each route ($99.8 million combined), annually recurring $5.2 or $5.8 million in O&M ($10.8 million combined), and total ridership forecasts, a relatively simple breakeven calculation is conducted to determine the required net benefits per person-round-trip. The average breakeven net benefits differ by applied discount rate.

- 3 percent – ferry riders require between $35.41 and $40.93 in benefits for every round trip
- 4 percent – breakeven benefits increase to between $37.62 and $43.93
- 7 percent – breakeven is between $45.13 and $54.27

A breakeven requirement per round trip increases with higher discount rates, as future riders' benefits are discounted more severely, and the earlier-years' ridership is more heavily weighted.[44] As seen in **Table 7-9**, Oakland has a higher breakeven requirement than San Francisco because of lower early year ridership. The combined alternative has the lowest breakeven requirements because of the combined ridership and a lower capital investment per rider (e.g., the Redwood City terminal serves both markets). Regardless of the discount rate, the breakeven benefit requirements are reasonable and achievable.

Table 7-9: Breakeven Requirements per Person Round Trip
(2019$)

	OAK	SF	Combined
Breakeven @ 3%	$40.93	$35.99	$35.41
Breakeven @ 4%	$43.93	$38.22	$37.62
Breakeven @ 7%	$54.27	$45.81	$45.13

Source: CDM Smith, 2020

7.2 Findings

Economic feasibility ranges depending on the applied discount rates, treatment of on-ferry travel time, and other assumptions. Some variables and assumptions are more influential on feasibility results than others. In this BCA, the ridership forecasts, time values (especially on-ferry), and ferry acquisition costs are the major variables. Other important variables include parking fees and tolls, vehicle operating cost savings, and the ferry O&M. Lesser important variables/assumptions include emissions, accidents, and terminal O&M, which are minor factors in the BCA results.

7.2.1 Results

These results are summarized in **Table 7-10** by on-ferry time assumption (Penalty, Awash, Amenity), route, and discount rate. Results are discussed below by the key variable, and on-ferry time scenarios. Annual undiscounted monetary flows by cost and benefit type are presented by route and on-ferry time assumption in **Appendix H** (Figure H-1 through Figure H-10), inclusive of the three evaluation metrics and breakeven benefit for each discount rate.

[44] This reflects the time value of money; the higher the discount rate, the less future monetary flows are worth in present monetary values.

Table 7-10: BCA Results Metrics

(NPV in 2019$ millions)

	Penalty	Awash	Amenity
OAK			
NPV @ 3%	-$160.6	$7.4	$91.4
NPV @ 4%	-$145.1	-$2.9	$68.2
NPV @ 7%	-$111.6	-$21.6	$23.3
BCR @ 3%	-0.12	1.05	1.64
BCR @ 4%	-0.11	0.98	1.52
BCR @ 7%	-0.10	0.79	1.23
IRR	#N/A	3.7%	10.0%
SF			
NPV @ 3%	-$192.7	-$21.0	$64.8
NPV @ 4%	-$172.5	-$26.1	$47.2
NPV @ 7%	-$129.5	-$34.7	$12.7
BCR @ 3%	-0.27	0.86	1.43
BCR @ 4%	-0.25	0.81	1.34
BCR @ 7%	-0.21	0.68	1.12
IRR	#N/A	0.5%	8.9%
Combined			
NPV @ 3%	-$331.6	$8.1	$178.0
NPV @ 4%	-$296.7	-$8.1	$136.3
NPV @ 7%	-$222.4	-$37.6	$54.7
BCR @ 3%	-0.21	1.03	1.65
BCR @ 4%	-0.20	0.97	1.55
BCR @ 7%	-0.17	0.80	1.29
IRR	#N/A	3.5%	11.3%

Source: CDM Smith, 2020

On-Ferry Time Scenario

The three scenarios yield notably different results.

- *Penalty Time Scenario* – If on-ferry time is valued the same as other transportation time (i.e., as an opportunity cost of not traveling), the ferry service is economically infeasible. Negative NPV ranges between -$111.6 and -$331.6 million, negative BCRs range between -0.10 and -0.27, and IRRs are incalculable. A negative net benefit stream between 2024 and 2050 occurs, with the ridership benefits insufficient to even offset ongoing annual O&M.

  Intuitively, this appears impractical; if the ferry users viewed the ferry time the same as non-ferry time, ferry usage would be notably less than experienced on existing routes. This scenario is illustrative, it depicts that an equal treatment of on-ferry time as other modes is unrealistic – ferry riders do not perceive the additional on-ferry time as a penalty similarly to driving-alone or walking, etc. This is reinforced by previously conducted surveys, indicating that time is not the major determinate factor in choosing to ride ferries.

- *Awash Time Scenario* – If no value is applied to on-ferry time, the ferry service is close to or economically feasible at the 3 percent discount rate. Scenarios' NPVs range from a low of -$37.6 to high of $8.1 million, BCRs between 0.68 and 1.05, and IRRs between 0.5 percent and 3.7 percent. A positive benefit stream between 2024 and 2050 occurs, enough to exceed annual O&M, but not quite offset upfront capital costs. This scenario illustrates the difference between driving alone and connecting with the ferry, ignoring the on-ferry time altogether.
- *Amenity Time Scenario* – If on-ferry time is applied a modest amenity value ($11.08/hour),[45] the ferry service is unquestionably economically feasible, with NPVs from $12.7 to $178.0 million, BCRs between 1.12 and 1.65, and IRRs between 8.9 percent and 11.3 percent. This amenity scenario is likely the most realistic, as ferry riders tend to perceive the ride positively (not a penalty).

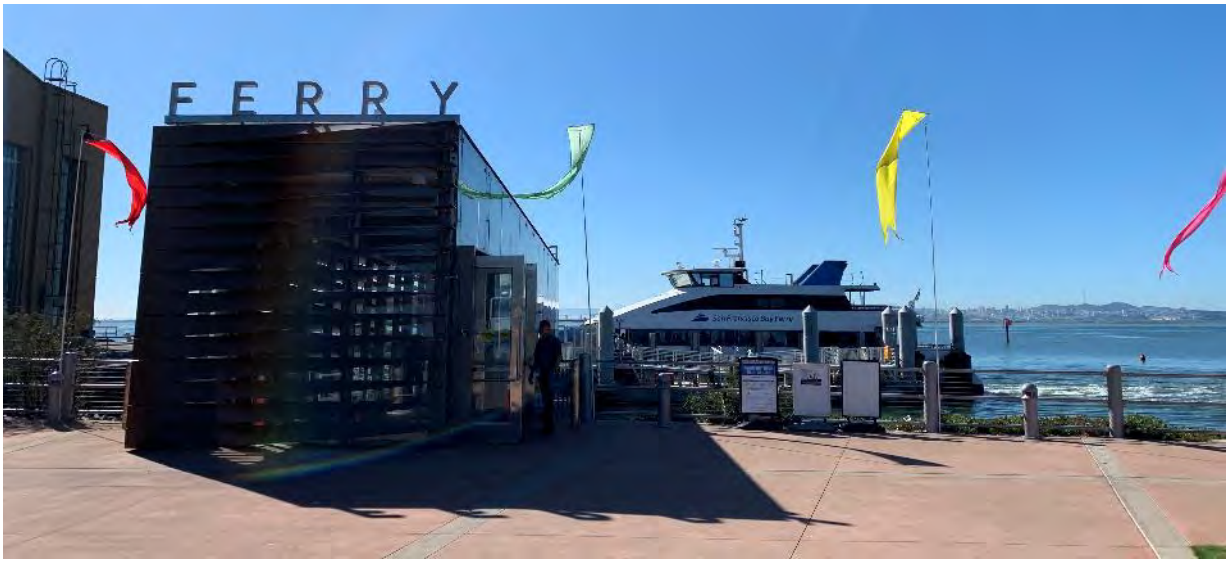
  However, the reasonings and justification for the positive perception are myriad and include different reasons for different rider types (e.g., teleworking, social media, food and drink and entertainment, and enjoying the vistas and weather and wildlife, etc.). As such, and in the absence of stated preference or revealed preference surveys, the assumed half-value of normal travel time serves as a conservative proxy for an aggregated amenity value per rider.

Regarding which scenario is most appropriate, one should consider traffic forecasts, other WETA route experience, and common sense. The route forecasts are based on established principles/procedures and well-vetted assumptions. The resultant forecasts are in line with passenger volumes on other existing WETA routes. And, if the passengers did not benefit from the on-ferry passenger time (compared to drive-time), they would not travel by ferry. For these reasons, average perceived on-ferry passenger time value probably lies between zero (awash scenario) and $11.08 (amenity scenario).

Route Alternatives

Results for Oakland and San Francisco are relatively close, given identical capital outlays. Slightly higher San Francisco O&M costs are offset by the slightly higher early year ridership forecasts, but the differences in parking and avoided tolls lean slightly in Oakland's favor. Combining the two services concurrently yields slightly higher economic feasibility than either single route, since the single Redwood City terminal costs are offset by the combined ridership benefits.

[45] Half the average time value of $22.16 per hour.



Source: CDM Smith, 2020

7.2.2 Sensitivity Considerations

A BCA combines myriad assumptions and data inputs, some of which are more accurate and/or influential than others. Additionally, some societal benefits (and disbenefits) are difficult to quantify and incorporate without further complicating the process or results. As such, delineating the major assumptions, and possible other considerations, is helpful in contextualizing the calculated results and how such metrics likely change with alterations or additional factors. A few such sensitivities are listed below by type, followed by a table summarizing economic feasibility influence. **Table 7-11** illustrates the sensitivity factors and their economic feasibility effect.

Time-Related

Time is typically the primary benefit in a BCA; hence all related assumptions can notably affect findings:

- *On-Ferry Amenity* – The assumed on-ferry amenity value/time may be over-or under-representative of actual user perceptions. A half-value of normal travel time is probably conservative, but future riders would have to state or express such value to adjust. An amenity value is one of the largest economic feasibility factors.
- *Ferry-Connecting Times* – The travel demand model assumed about 1.5 hours per daily round trip for ferry-connection (both in-vehicle and out-of-vehicle). Observed connecting time at other terminals and routes is typically not as long. If the actual connecting time is less, the net time and connecting vehicle VMT-related savings would increase. And, as ferry riders become accustomed to the services/schedules, they would narrow connecting time. As such, the current assumptions yield conservative savings.
- *Drive-Alone Times* – Driving (or possibly transiting) between Redwood City and Oakland or San Francisco is assumed about an hour one-way, two per round trip, on average. However, such surface modes are subject to some unreliability, due to congestion, weather conditions, roadway accidents, etc., which may get worse than predicted via the travel demand model by 2040. As such, potential drive alone VHT and VMT savings may be conservative.

Table 7-11: Sensitivity Factors

Factor by Type	Economic Feasibility Effect		
	Negative	Positive	Net
Time-Related			
On-Ferry Amenity	unlikely underrepresented	potential for larger amenity value	+++
Ferry-Connecting Time	possible road network worsening	likely less time than estimated	++
Drive-Alone Times	unlikely improved times	possible road network worsening	++
Ridership/Use			
Expanded Services	marginal operating costs increases	expanded ridership	+
Induced Ridership	none	expanded ridership	+
Emergency Services	none	incalculable externality benefits	+
Other Facility			
Subsidized RWC Parking	none	reduced parking disbenefits	+
Smaller Terminal	none	reduced capital costs	+

Source: CDM Smith, 2020

Ridership/Use

Forecasted ferry rider volumes are purposefully conservative. Additional use for several purposes could easily generate additional benefits:

- *Expanded Services* – New terminal and purchased ferries could easily expand to weekday shoulder-hours, weekends, holidays, and/or special sporting events. Adding a scheduled or non-recurring service would incur marginal operating costs, and, would yield additional net benefits (if ferries are well-occupied).
- *Induced Ridership* – Given that the ferry services would be new, providing an alternative mode otherwise currently unavailable, it may not only divert existing/prospective riders from driving, but also induce riders without any vehicle. Induced ridership would marginally increase benefits.
- *Emergency Services* – WETA, the ferry operator, is responsible for emergency services, which provides an implicit societal benefit, albeit difficult to accurately quantify, as the frequency/need and severity of any emergency response is speculative.

Other Facility

Comparatively minor, other developments could yield marginal benefits:

- *Subsidized Redwood City Parking* – $15/rider is assumed for riders originating in Redwood City, which yields net parking disbenefits for those relative to drive-alone. Although most riders are forecast to originate from either Oakland or San Francisco, subsidizing the Redwood City parking would eliminate such slight disbenefits.
- *Cheaper Terminal Option* – BCA assumes the more expensive option is constructed, but the smaller option would reduce initial capital costs by about $5.0 million and bolster the economic feasibility metrics, all else equal.

Most of the abovementioned sensitivity factors would likely yield a net positive effect on the BCA metrics and improve the economic feasibility of the new ferry services. Therefore, the existing BCA results are likely relatively conservative.

7.3 Key Findings

Implementing ferry services between Redwood City and Oakland and/or San Francisco provides a relatively pleasant alternative to a grueling drive around the San Francisco Bay. It also provides a direct transit alternative for Oakland where today one does not exist. In 2024, such services may entice almost 1,250 people/day to shift from drive-alone to ferry riders, which nearly doubles over 20 years.

Such modal shift removes vehicles from the roadway network, resulting in VMT reductions leading to vehicle operating cost-, accident-, and vehicle emissions-related benefits, as well as avoided tolls. Depending on-ferry time valuation, the differences between driving alone and ferry ridership could be either a benefit or disbenefit. Project economic feasibility hinges on how best to evaluate on-ferry time. Deliberation suggests that on-ferry time is a user benefit. Otherwise, the resultant monetary metrics do not square with either the ridership forecasts or other WETA route volumes. At half the average time value per hour, the on-ferry time values evaluated under the amenity scenario are considered conservative.

Another way to distill the project costs and benefits for the three alternatives is to consider the breakeven benefits required per roundtrip. This avoids the on-ferry time debate (penalty/awash/amenity), since it avoids actual benefit quantification. Doing so, indicates that the San Francisco alternative yields lower benefits hurdles (i.e., is favored) than the Oakland alternative regardless of discount rate. However, the combined service (both SF and OAK) yields slightly lower feasibility hurdles since the Redwood City ferry terminal construction and operations and maintenance (O&M) costs are shared between the two routes.

Roundtrip breakeven benefits are summarized by alternative and discount rate in **Table 7-12**. At the Caltrans recommended 4 percent discount rate, the breakeven range between alternatives ($37.62 to $43.93) appears economically feasible. It is reasonable to expect that ferry users would experience such benefits by using the ferry instead of driving. Even at the higher, more austere, 7 percent discount rate, ferry user benefits ranging between $45.13 to $54.27 are considered realistic under an amenity scenario perspective. With the lower, less austere, 3 percent discount rate, ferry user benefits are also considered realistic under an amenity scenario, with user benefits ranging between $35.41 and $40.93.

Table 7-12: Trip Breakeven by Route and Discount Rate

Rate	OAK	SF	Combined
3%	$40.93	$35.99	$35.41
4%	$43.93	$38.22	$37.62
7%	$54.27	$45.81	$45.13

Source: CDM Smith 2020

Section 8
Economic Impacts

The economic impact of ferry service in the nine-county study region focuses on Redwood City and the mid-Peninsula. The impacts reflect the various route planning, terminal construction, and passenger forecasts that went into the financial (i.e., farebox recovery) and economic (i.e., BCA) feasibility analyses. The analysis also evaluates the local in-commute employment pressures and other planning dynamics.

8.1 Approach

A quantitative and qualitative impact approach is taken to address the easily identified and more opaque impacts emanating from the proposed ferry services.

The quantitative economic impacts associated with implementing ferry service are based on the construction and operating costs presented in the previous sections. These impacts are run through the IMPLAN (Impact Analysis for Planning) model to assess the additional indirect and induced impacts associated with suppliers and income respending (income received from one party is spent again by the receiving party, and so on …), respectively.

The qualitative impacts address the potentially more substantive long-term economic-development impacts associated with increased accessibility that make Redwood City a more attractive place to live and/or work. However, such amenity-oriented benefits are difficult to quantify, attribute solely to new ferry service, and are dependent on many other factors – some of which Redwood City and WETA can control, many of which they cannot.

8.2 Ferry Service Implementation Impacts

The IMPLAN software, an Input-Output (I/O) model, was used to estimate the multiplier impacts associated with the direct initial ferry terminal construction expenditures and subsequent annual ferry operations.

The IMPLAN model draws on state and federal data sources. I/O analysis is premised on the concept that industries in a geographic region are interdependent and thus the total contribution of an activity is larger than its individual (direct) output or employment. Consequently, an economic activity such as the construction and operation of a ferry has a “multiplier” effect that generates successive rounds of spending and output in other economic sectors within a region. This analysis focuses on the nine county Bay Area (consistent with the jurisdiction of the MTC).

I/O models rely on economic multipliers that mathematically represent the relation between the initial change in one sector of the economy and the effect of that change on employment, income, economic output, and value added in other regional industries. These economic data provide a quantitative estimate of the magnitude of shifts in jobs and revenues within a regional economy. The analysis begins with an estimate of the initial economic injection associated with expenditures on ferry operations and capital investment and then quantifies the impacts associated with the ripple or multiplier effects that result from subsequent expenditures. The so-called direct, indirect, and induced effects are defined as follows:

- *Direct Effect* – initial change in spending or employment associated with an activity, in this case, the terminal construction and/or subsequent annual ferry operation costs, shown on **Table 8-1**.
- *Indirect Effect* – supplier inputs to the production of goods and services consumed during the construction/operation period.
- *Induced Effect* – recirculation of direct and indirect labor income associated the direct construction/operation activity.

8.2.1 Ferry Terminal Construction Impacts

Costs range from $15 million to $20 million depending on location and footprint (see Section 5). For impact analysis purposes, the high-end cost of $20 million is used. IMPLAN modeling suggests the $20 million expenditure creates 185 one-time construction jobs, as shown in Table 8-1. An additional 86 multiplier related jobs (25 direct and 61 induced) yield a total construction period employment impact of 271 jobs, earning a total $25.1 million and generating $39.1 million in expenditures.

Table 8-1: Select Economic Impacts of Terminal Construction

Economic Impact	Jobs Years [1]	Labor Income	Output
Terminal Construction Costs [2]			**$20,000,000**
Total Economic Impacts [3]			
Direct Construction	185	$18,050,700	$20,000,000
Indirect	25	$2,415,100	$6,609,100
Induced	61	$4,609,400	$12,501,700
Total	**271**	**$25,075,200**	**$39,110,80**

Sources: IMPLAN; Economic & Planning Systems, Inc.
(1) Represents a full-time job-year.
(2) Actual construction output/sales entered into IMPLAN model.
(3) Comprehensive IMPLAN model output associated with direct construction, indirect suppliers, and induced income respending.

8.2.2 Terminal Operation Impacts

Once constructed and in operation, the terminal will require ongoing maintenance, including expenses such as security, landscaping, general maintenance, electricity, water/wastewater, telecommunications, and trash service. Preliminary estimates indicate annual maintenance costs of approximately $200,000, generating, at most, one new job and inducing minimal multiplier effects.

8.2.3 Ferry Operation Impacts

Annual ferry operation costs range between $5.0 million (RWC/OAK) to $5.6 million (RWC/SF) depending on route. WETA estimates that four crews per route will be required to operate new ferry service to Redwood City. Terminal O&M costs comprise an addition $200,000 in annual expenditures.

- *Single-Route Impacts* – IMPLAN modeling suggests the $5.2 million annual operation expenditure creates 8 direct jobs. An additional 20 annual multiplier related jobs (13 direct and 7 induced) yield a total annual ferry operation employment impact of 28 jobs, earning $2.8 million in income, and generating $10.1 million in output (total expenditures).
- *Combined-Route Impacts* – IMPLAN modeling suggests the $10.6 million annual operation expenditure creates 16 direct jobs, which spur 42 multiplier related jobs (27 direct and 15 induced). Combined-route annual ferry operation employment impact totals 16 jobs, earning $5.9 million in income, and generating $20.9 million in output (total expenditures).

The Single-Route and Combined-Route annual operation and maintenance impacts are presented by impact type (direct, indirect, induced, total) and measure (jobs, income, output) in **Table 8-2**.

Table 8-2: Ferry Operations and Maintenance Impacts

	Jobs	Income	Output
Maintenance Costs			
Ferry Terminal [1]			200,000
Ferry Operations [2]			5,026,000
Economic Impacts			
Single-Route Service			
Direct [3]	8	$936,800	$5,226,000
Indirect	13	$1,342,300	$3,407,700
Induced	7	$513,100	$1,455,300
Total	28	$2,792,200	$10,089,000
Combined Route Service			
Direct [3]	16	$1,972,600	$10,783,000
Indirect	27	$2,826,400	$7,099,400
Induced	15	$1,080,300	$2,997,000
Total	58	$5,879,300	$20,879,400

Sources: IMPLAN; Economic & Planning Systems
(1) Includes security, landscaping, general maintenance, electricity, water/wastewater, telecommunications, and trash service.
(2) Expenses assume ferry running to both Oakland and San Francisco to Redwood City.
(3) Comprehensive IMPLAN model output associated with direct construction, indirect suppliers, and induced income respending.

8.3 Ferry Service and Economic Development Factors

New or expanded transit, such as a ferry service, can enhance the competitive position of a neighborhood, community, or region by increasing economic connectivity and integration. Transit service economic impacts vary depending on service, regional economic role, and abilities to harness emerging opportunities. Independent factors also affect transit impacts, such as evolving employment patterns, remote work/commute trends, technological changes, and transit preferences. Commute patterns and catchment area market dynamics were evaluated to qualitatively assess ferry-service oriented economic development potential in the Redwood City/mid-Peninsula market area.

8.3.1 Commute Patterns

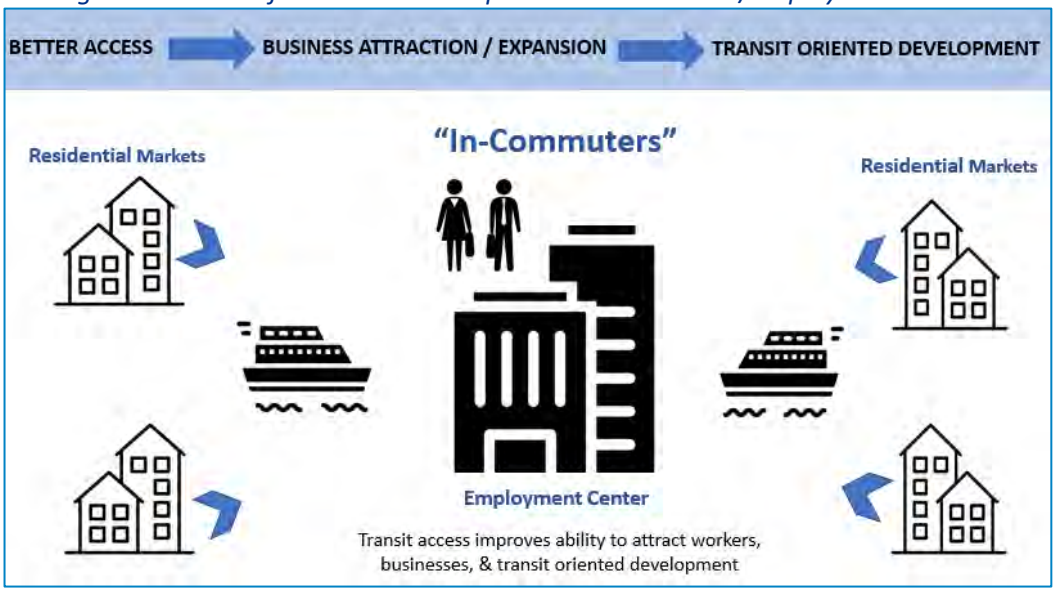
These broad themes can be differentiated by whether the station areas and host communities primarily serve as an in-commute or an out-commute location. While not mutually exclusive, these roles have different implications in local economies.

In-Commute Impacts

Transit that brings external workers into local markets fosters local development. As illustrated in **Figure 8-1**, increased access to commercial and employment hubs via efficient transit service allows local markets to accommodate more jobs and concentrate commercial space, often within a walkable area of the transit facility. It facilitates growth by reducing auto-congestion and/or the need for costly or space-intensive parking facilities.

- *Conglomeration Economies* – Better transit access and employment node connectivity encourage industries in similar or related sectors to locate near one another. "In-commute" hub amenities support higher property values and increased development activity.
- *Evolution* – While the "in-commute" model is historically associated with well-developed business and commercial districts in large urban centers, this characterization is evolving. Specifically, numerous station areas and host communities gradually evolve from primarily bedroom communities into successful commercial and job centers. Redwood City is among several such examples in the San Francisco Bay Area, which include Palo Alto and Mountain View, (served by Caltrain), South San Francisco (served by the San Francisco Bay Ferry), and Pleasanton and Walnut Creek, (served by BART). The nature and design of the transit service (short- versus long-haul, inter-versus intra-urban) influences "in-commute" versus "out-commute" orientation.

Figure 8-1: Flow of Economic Development in Commercial/Employment Centers



Source: Economic & Planning Systems

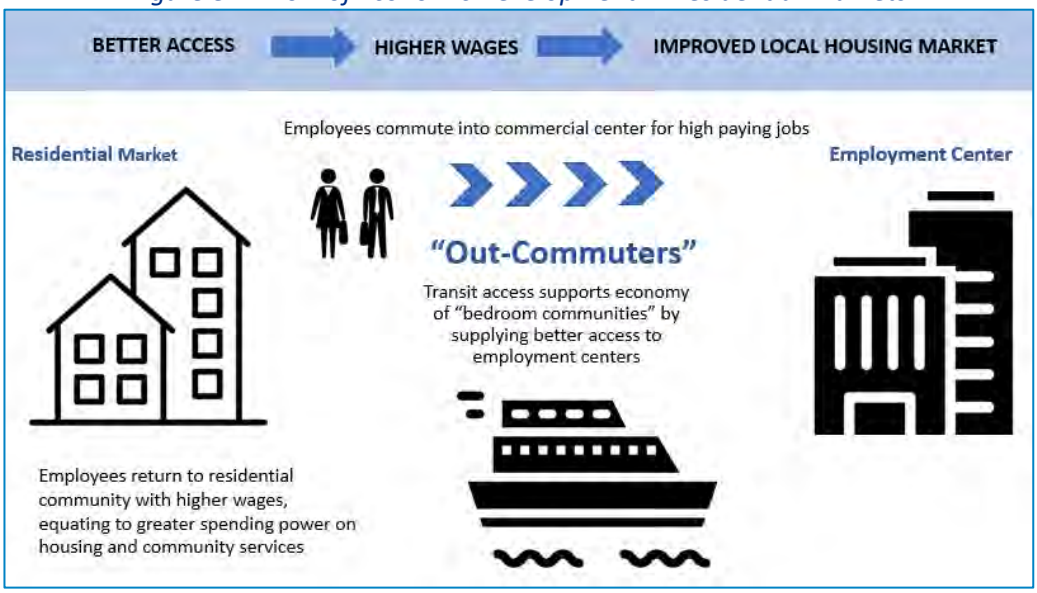
Out-Commute Impacts

Transit that takes residents to external employment destinations is historically more prevalent for small to medium size communities. This model is rooted in the "streetcar suburb," which facilitated early growth in many American cities. Subsequent suburban growth was more attributable to the rise of the automobile, and new housing demand in lower density and more exclusive locations. Increasing traffic congestion, especially in/near metro areas, led to a resurgence in the transit-facilitated out-commute growth model in many larger and expanding mega-regions, such as the San Francisco Bay Area.

Figure 8-2 illustrates how the "out-commute" model facilitates economic development in smaller to medium size cities. Transit connections can increase the attractiveness of housing away from major employment centers, especially with improved commutes (e.g. time and/or experience) and access to affordable and desirable communities. This helps alleviate housing demand within the in-commute city. As this migration occurs, residential communities—the so-called "out-commute" communities—continue to grow.

- *South San Francisco* – established ferry service to Oakland and Alameda in 2012 at a terminal location like the proposed Redwood City site in that it is located on the opposite side of Highway 101 from the historic downtown and in a primarily commercial / industrial area (i.e., not a residential area). The surrounding area, called "Oyster Point," is the subject of several planning efforts over the past decade (e.g., Oyster Point Specific Plan, the Genentech Master Plan, and the Bay West Cove Specific Plan), driving major redevelopment and attracting employers such as Amgen, Claritas, and Genentech. Oyster Point is now a recognized hub for life sciences and South San Francisco is an in-commute destination. San Mateo County partially funds free shuttle services to the ferry terminal and local employers subsidize employee ferry transit as a part of their Transportation Demand Management agreements with South San Francisco.
- *Richmond* – launched ferry service to San Francisco in 2019. Although the service is too new to report significant trends in the terminal area, the arrival of the ferry has generated an uptick in proposals for development from both private and public sector interests. The City of Richmond provides a free shuttle connecting the terminal with the Richmond BART and Amtrak station.

Figure 8-2: Flow of Economic Development in Residential Markets



Source: Economic & Planning Systems. 2020

Role of Transit-Oriented Development

Transit-oriented development (TOD) refers to real estate investment (usually a mixture of housing, office, and retail) that is integrated within walking distance (e.g. within a quarter to a mile distance) from high-quality public transportation. While the economic impacts cover regional benefits of increased accessibility, TOD focuses on how these impacts are manifested at the neighborhood, station area, and/or site-specific level.

While TOD is well-documented in established urban markets (high land values and transit ridership rates), it can be more limited and slower to materialize in remote or less dense locations, such as the prevailing conditions around the Redwood City ferry terminal. In these circumstances, two factors that appear to be particularly determinant include (1) the existing and evolving land use and market context, and (2) the planning and regulatory context surrounding the station area. Proactive planning efforts and strategic land use designations can prepare cities to capitalize on transit access as specific opportunities arise.

The MTC TOD policy includes guidelines for funding transit expansion. The policy sets minimums for the average number of existing and/or permitted housing units within a half-mile of each station (i.e. the "station area"). Minimum Station area housing requirements for ferry is 750 units. (See https://mtc.ca.gov/our-work/plans-projects/focused-growth-livable-communities/transit-oriented-development.)

8.3.2 Redwood City Ferry Terminal Catchment Area Areas

The new ferry service will likely have the greatest economic impact on users located nearest to the terminal and a less pronounced impact on users that require multi-modal connectivity. Three mid-Peninsula catchment areas were evaluated, as illustrated in **Figure 8-3** and described below:

1. *15-minute walkshed* – approximately one mile from the terminal. Captures the population who can access the service using the fewest additional transit modes. A common deterrent to public transit is the need to change modes to reach a destination. Users who can walk the last mile from the ferry are most likely to take advantage of the ferry service.
2. *Redwood City* – Captures major transit connections within the City: Caltrain, SamTrans bus lines, Commute.org shuttles, and the El Camino Real Corridor. Users who can access connecting transit may consider the ferry service.
3. *Radial area of 3-4 miles from the terminal* – Captures major employers in adjacent jurisdictions, such as Menlo Park and San Carlos. These employers are potential partners in shuttle service delivery as this area constitutes the likely coverage of a shuttle system that might service the terminal.

8.3.3 Ferry Ridership Forecasts and Market Share

Transit ridership is a key factor in the scale and type of development impacts (e.g., in-commute versus out-commute benefits). Ridership projections for the Redwood City ferry represent a very small fraction of total regional commute activity, hence the related impacts are likely more localized to mid-Peninsula submarkets. Initial ridership projections suggest 850 daily boardings for OAK/RWC service and roughly 1,100 daily boardings for SF/RWC service, the bulk of which is AM in-commute.[46]

Market Share

The proposed service comprises less than 2 percent of total daily commutes (120,000) to/from Redwood City. This excludes the many through trips (i.e., no origin or destination in Redwood City) that also congest roadways. Comparatively, Caltrain delivers roughly 4,500 commuters into Redwood City every weekday, roughly four times the ferry's projected one-way load.[47]

Real Estate Development

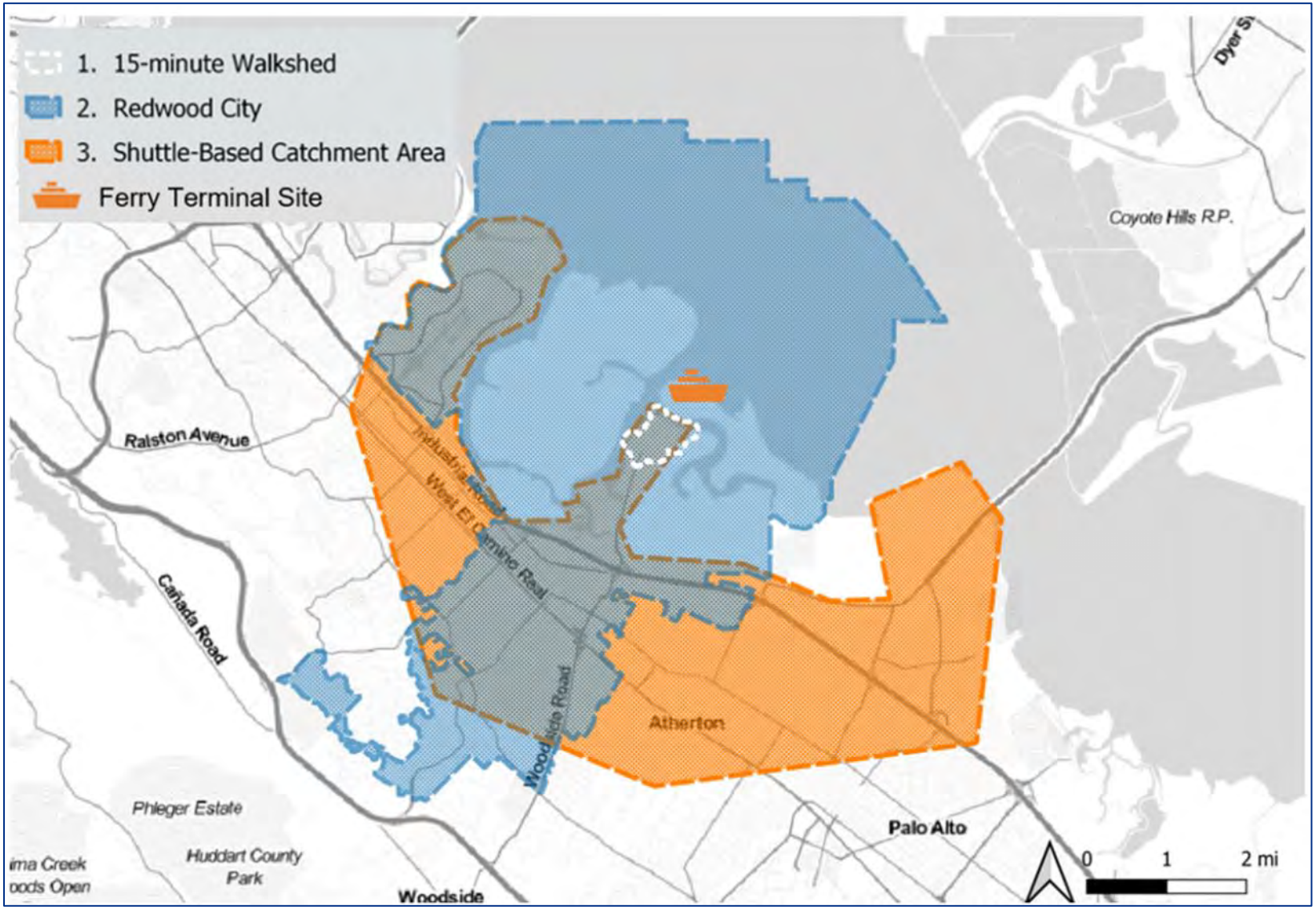
Given this broader commute context, the proposed ferry service is unlikely to change local travel patterns or the Peninsula's economic growth trajectory. Rather, new service is more likely to affect the local real estate markets. The mid-Peninsula may be better positioned to attract developer investment due to improved transit connectivity. However, this impact is primarily redistributive, shifting a small number of commuters from other modes and changing the work-life calculus for employees proximate or with strong last mile connection to the terminal.

---

[46] Ridership is defined in terms of "boardings," which represents the number of times passengers that board a ferry vessel and pay a fare. If daily boardings are 100, for example, and if every person who rides the ferry is making a round-trip, then the 100 boardings would represent 50 unique people. See, CDM Smith Memorandum: Final Task 1.6 Redwood City Ferry Feasibility Study - *Ridership Demand Analysis and Forecasting*, July 2, 2020.

[47] Caltrain 2019 Annual Passenger Count Key Findings: https://www.caltrain.com/Assets/Stats+and+Reports/2019+Annual+Key+Findings+Report.pdf.

Figure 8-3: 15-Minute Walkshed



Source: Economic & Planning Systems. 2020

In-commuters

Residents of San Francisco or the East Bay will also benefit from ferry service due to increased access to job opportunities in the mid-Peninsula. However, the geographic distribution of this positive economic impact is likely to be relatively diffuse and small relative to the size of the economies in which they originate. For example, the San Francisco ferry terminal is in one of the densest regional employment centers on the West Coast and is already served by multiple transit services (e.g. San Francisco Municipal Transportation Agency, BART, other ferry routes). Similarly, commuters accessing the ferry from Oakland are likely to originate from a relatively wide and highly populated catchment area in the East Bay.

8.3.4 Redwood City's In-Commute Market

Redwood City is home to major employers who draw on a regional labor pool. As shown in **Table 8-3**, nearly 57,100 workers commute into Redwood City every day and another 24,600 to the broader catchment area. Accordingly, new ferry service to Redwood City will expand access to the Bay Area's regional labor force. Of course, in-commuters and job seekers living in the cities served by the ferry also benefit from improved access to the mid-Peninsula job market.

Major Employment Location

Figure 8-4 shows the geographic concentration of Redwood City jobs and the possible shuttle-based catchment area, respectively. Redwood City jobs are clustered in the Pacific Shores (adjacent to the proposed terminal), Redwood Shores, the El Camino Real corridor, and Downtown. Additional job concentrations exist in Menlo Park (downtown and the Bayfront area) and downtown San Carlos.

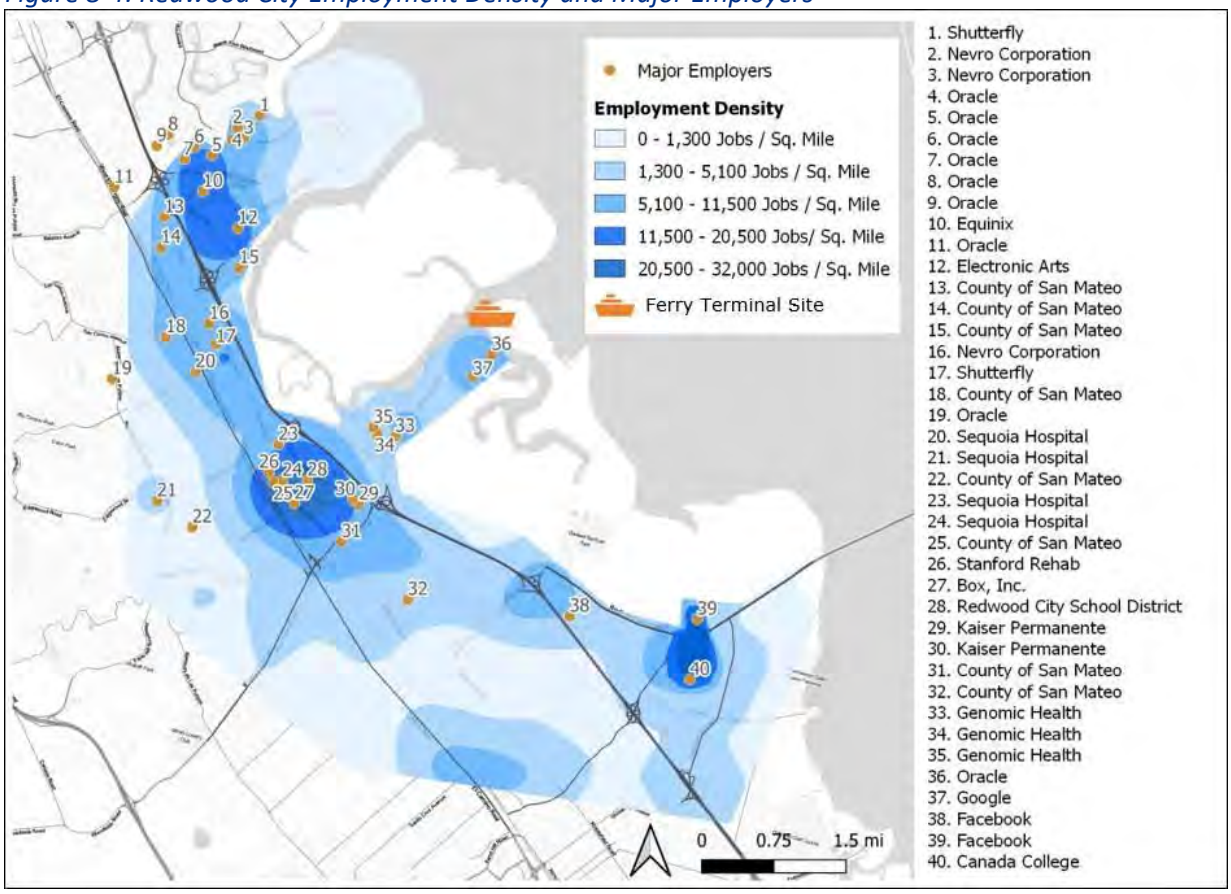
Redwood City's largest employers, shown in **Table 8-4**, employ over 16,000 – nearly a third of the City's total jobs. Major employers also considered due to their proximity, include the Google satellite offices (Pacific Shores Office Center), Facebook headquarters (Menlo Park), adjacent to Redwood City, Equinix, and Cañada College, as mapped in **Figure 8-4**. The benefit of added ferry service may allow these mid-Peninsula employers to accommodate expansion closer to their office headquarters rather than establishing satellite offices to access labor pools in lower cost housing markets.

Table 8-3: Inflow-Outflow Residents and Employees by Catchment Areas (2017)

	15-Minute Walk [1, 2]	Redwood City	Shuttle-Based Ferry User [3]
Residents			
Out Commuters	NA	33,594	40,795
Total	25	82,887	132,081
Employees			
In Commuters	NA	57,077	81,746
Resident Workers	NA	5,587	9,351
Total	1,319	62,664	91,097

Sources: ESRI; 2014-2018 American Community Survey; 2017 Longitudinal Employer-Household Dynamics.
(1) Assuming the average person can walk 1 mile in 15 minutes.
(2) Origin-Destination Employment Statistics are intentionally diffused with statistical sampling technique to avoid disclosure of physical locations—particularly of small establishments in small geographic areas, such as 15-minute walksheds. As such the data are not reliable, so are not reported here.
(3) See Figure 8-4 for map of possible shuttle-based ferry user catchment area.

Figure 8-4: Redwood City Employment Density and Major Employers



Source: US Census 2017 Longitudinal Employer-Household Dynamics (LEHD) database and OnTheMap Tool

Table 8-4: Top 10 Employers in Redwood City, Fiscal Year 2019

Corporation	Employees	Miles from Terminal (as crow flies)
Oracle Corporation	6,154	3.0
County of San Mateo	2,446	2.5
Electronic Arts	1,478	2.8
Kaiser Foundation Hospitals	923	2.3
Sequoia Hospital	915	3.6
Box Inc	855	2.6
Stanford University Hospital and Clinics	750	2.1
Redwood City School District	713	2.3
City of Redwood City	574	2.5
Nevro Corporation	672	3.3
Shutterfly	580	3.3
Genomic Health Inc.	551	1.3
Total Employment	**16,611**	

Source: Redwood City Comprehensive Annual Financial Report, 2019

Housing Costs

Except for the public sector, mid-Peninsula's largest employers are in the technology or healthcare industries. Both industries rely on a highly educated workforce commanding high pay. High Peninsula housing costs require employers to further raise salaries to enable workers to live locally. The following sections further document the regional salary and jobs-housing balance differentials affecting regional employment and commute patterns.

Regional Salary Differentials

Table 8-5 compares average salaries on the Peninsula (San Mateo and San Francisco Counties) with those in the East Bay (Alameda and Contra Costa Counties). The weighted average shows Peninsula salaries are about 23 percent higher than the East Bay. The most clustered Peninsula sector, Computer and Mathematical Occupations, commands a 13 percent premium.

Expanded access to areas with lower living and labor costs, such as the East Bay, would represent a positive economic impact on mid-Peninsula employers. By the same token, the new ferry service will positively impact East Bay residents, who gain increased access to higher-paying jobs on the Peninsula. However, this report is focused on mid-Peninsula economic impacts because the benefits to employees elsewhere are more diffuse.

Regional Jobs-Housing Balance

The housing affordability crisis in the Bay Area is well documented, as are the significant variations. Housing costs are a key consideration in selecting where to live as an employee and where to establish a firm as an employer. From an employee standpoint, high housing costs often result in living farther away (more affordable), accepting the trade-off of a long commute.

The regional jobs-housing imbalance will worsen as continued job growth far outpaces new housing development. Between 2010 and 2015 San Mateo County added 72,500 total jobs but permitted the construction of 8,000 housing units and built only 3,844 new housing units, meaning that the majority of new commuters to the county must live elsewhere.[48] A too high jobs-housing balance leads to inadequate housing supply, unaffordability, and in-commuting traffic congestion.

As shown below, Oakland has the smallest jobs-housing imbalance among the jurisdictions considered, suggesting better housing affordability. Although suffering from the same affordability challenges as the rest of the region, the East Bay offers a relatively lower cost of living than the Peninsula, as shown in **Table 8-6**.

---

[48] "Moving San Mateo County Forward – Housing and Transit at a Crossroads," Housing Leadership Council and TransForm, June 2018.

Table 8-5: Average Salary Comparison, East Bay versus the Peninsula

Occupation Category	Average Salary (2020)		Number of Jobs		Peninsula Salary Premium
	Alameda and Contra Costa Counties	San Francisco and San Mateo Counties	Alameda and Contra Costa Counties	San Francisco and San Mateo Counties	
Management	$149,990	$171,965	81,060	116,890	15%
Business and Financial Operations	$92,190	$103,072	71,590	116,240	12%
Computer and Mathematical	$117,687	$132,509	51,100	108,320	13%
Architecture and Engineering	$106,030	$112,975	32,990	22,590	7%
Life, Physical, and Social Science	$98,582	$107,899	15,270	18,600	9%
Community and Social Services	$64,438	$68,398	17,930	16,510	6%
Legal	$136,591	$160,910	8,440	16,040	18%
Education, Training, and Library	$68,673	$76,237	70,580	55,000	11%
Arts, Design, Entmt., Sports, and Media	$67,681	$85,546	21,340	30,030	26%
Healthcare Practitioners and Technical	$114,681	$127,058	66,820	39,210	11%
Healthcare Support	$37,752	$39,536	71,860	38,930	5%
Protective Service	$68,632	$68,912	20,800	23,830	0%
Food Preparation and Serving Related	$35,310	$40,048	99,870	109,180	13%
Building and Grounds Cleaning/Maintenance	$45,796	$41,901	26,710	35,380	-9%
Personal Care and Service	$39,445	$41,287	26,260	24,990	5%
Sales and Related	$52,883	$67,552	107,510	97,530	28%
Office and Administrative Support	$52,467	$57,159	136,810	134,410	9%
Farming, Fishing, and Forestry	$39,327	$40,694	1,180	930	3%
Construction and Extraction	$77,160	$78,830	58,430	35,310	2%
Installation, Maintenance, and Repair	$63,957	$66,893	40,480	25,610	5%
Production	$49,781	$48,645	66,080	21,780	-2%
Transportation and Material Moving	$46,078	$54,978	97,870	74,610	19%
Total Jobs/Weighted Avg Peninsula Premium	**$70,337**	**$86,481**	**1,190,980**	**1,161,920**	**23%**

Source: California Employment Development Department, Occupational Employment Statistics and Wages by Metropolitan Division, 2020 1st Quarter.

Table 8-6: Housing Cost Comparison

	Oakland	Redwood City	Alameda County	San Mateo County
Total Housing Units [1]	175,457	31,536	611,752	280,879
Labor Force [2]	355,658	68,178	1,335,756	622,386
Jobs Housing Balance [3]	2.03	2.16	2.18	2.22
Median Income [4]	$68,442	$107,469	$119,200	$143,100
Average Asking Rent [5]	$1,906	$2,789	$2,090	$2,679
Zillow Home Value Index [6]	$790,238	$1,572,431	$874,856	$1,368,711

Sources: California Department of Finance; American Community Survey, California Department of Housing and Community Development; Costar; Zillow; Economic & Planning Systems, Inc.
(1) California Department of Finance, 2020 Estimates.
(2) ACS 2018 5-Year Estimates.
(3) Number of jobs number of housing units.
(4) California Department of Housing and Community Development, 2020 Income Limits.
(5) Derived from Costar.
(6) Zillow Home Value Index is a smoothed, seasonally adjusted measure of home value and market changes.

In-Commute Mode Options and Trade-offs

While transit may provide a variety of benefits relative to auto travel (e.g., costs, worker productivity, peace of mind), it generally takes longer. According to MTC's Vital Signs survey, about 40 percent of transit commuters to San Mateo County spend over 60 minutes traveling to work, 23.2 percent spend 45-59 minutes commuting, and 26.4 percent spend 30-44 minutes commuting.[49] At the same time, due to the long distance, costs (including bridge toll), and congestion auto commutes from the East Bay to the Peninsula are also prohibitive to many.

Trips that require commuters to switch between modes (i.e., from ferry to bus, or bicycle to train) present additional challenge to commuters. While lengthy, cross-regional, multi-modal commutes do occur, they deter mid-Peninsula employer recruiting per conversations with major area employers, including Google and Facebook, as detailed in the Existing Conditions report. At present, all public transit options between the mid-Peninsula and the East Bay require a mode switch (although some employers provide private shuttle service). As a result of difficult public transit options and long drive times by car, the commutes between the East Bay and the Peninsula are less common.

Bi-directional commuter flow in 2019 shows significantly more trips (all modes) between the Redwood City to San Francisco route relative to the Oakland route. In particular, the commuter flow with 30-minute access between Redwood City and Oakland terminals represents 29 percent of the total commuter flow with 30-minute access to any of the three ferry terminals (see **Table 8-7**). In other words, the current commuter flow between Redwood City and Oakland is less than half the commuter flow between Redwood City and San Francisco.

Nevertheless, in stakeholder interviews and discussions between the City and employers, it was clear that the East Bay is considered a more valuable source of employees than San Francisco because of its untapped labor force. Commuters living in San Francisco already have several options to get to the Peninsula, but East Bay residents are limited to vehicle travel on congested roads. A ferry service between Oakland and Redwood City would expand the range of options available to East Bay residents considering employment in Redwood City.

Table 8-7: 2019 Employment Flow Estimates

Market Pair	From RWC to Ferry Markets		From Ferry Markets to RWC		Bi-Directional Total	
	Riders	%	Riders	%	Riders	%
Between Redwood City and San Francisco						
Within 15-minute access time from Home Terminal	6,890	67%	3,350	33%	10,240	
Between 15 to 30-min. access time from Home Terminal	2,300	25%	6,980	75%	9,280	
Subtotal	**9,190**	**47%**	**10,330**	**53%**	**19,520**	**71%**
Between Redwood City and Oakland						
Within 15-minute access time from Home Terminal	1,480	35%	2,770	65%	4,250	
Between 15 to 30-min. access time from Home Terminal	490	14%	3,130	86%	3,620	
Subtotal	**1,970**	**25%**	**5,900**	**75%**	**7,870**	**29%**
Totals	**11,160**		**16,230**		**27,390**	

Sources: CDM Smith Memorandum: Ridership Demand Analysis and Forecasting, July 2, 2020; US Census2015 Longitudinal Employer-Household Dynamics (LEHD) database and OnTheMap Tool; Comprehensive Annual Financial Reports for Redwood City, Menlo Park, San Francisco and Oakland; California Employment Development Department (EDD); CDM Smith Analysis.

[49] Vital Signs, Metropolitan Transportation Commission, May 2018.

8.3.4 Redwood City's Out-Commute Market

Ferry ridership projections suggest that primary demand will be generated by in-commuters (e.g. Redwood City workers who live elsewhere). Specifically, ridership projections estimate 822 in-commuters during the peak AM commute, compared to 251 out-commuters leaving Redwood City each morning, nearly 80 percent of the total boardings. Although mid-Peninsula residents will certainly benefit from expanded transit access to San Francisco and the East Bay, these trips are driving the service need to a lesser extent.

More importantly, the minimal housing or land zoned for residential development within a quarter to half-mile walk-shed of the ferry terminal currently limits potential "out-commute" volume. From an out-commute perspective, Redwood City residents commuting to San Francisco are most likely to use Caltrain because of the more central station location in Downtown Redwood City. Finally, regional employment patterns currently demonstrate minimal propensity for morning work commutes from the mid-Peninsula to the East Bay, in part because of salary differentials. Accordingly, current conditions suggest that "out-commute" economic impacts will be low.

8.4 Catchment Area Growth Opportunities

Future growth and development opportunities also affect the long-term economic impacts of new ferry service. Transit service can allow in-commute locations to accommodate more jobs and commercial space in a concentrated, often walkable area, and reduce the need for costly or space-intensive parking facilities.

8.4.1 Development Pipeline

There is substantial large-scale development activity in Redwood City that would benefit from additional transit service. Over 370,000 square feet of nonresidential and roughly 1,000 housing units have been completed since 2010 and there are 4.7 million square feet of nonresidential and over 3,700 housing units in the development pipeline, as shown in **Table 8-8**. Among the nonresidential uses, roughly half of new nonresidential development underway is office space with the remainder made up of medical, hotel, school, and retail uses. The office development alone could add an additional 15,500 to 18,700 jobs in the City (estimate based on 250 to 300 square feet/ employee).

Table 8-8: Redwood City Development, by Status

Status	Nonresidential (sq ft)	Residential (units)
Recently Completed	**372,000**	**990**
In Development		
Under Construction	1,087,900	670
Approved	420,000	770
Proposed [1]	3,166,400	2,270
Subtotal	**4,674,300**	**3,710**
Total	**5,046,300**	**4,700**

Source: City of Redwood City, Current Development Projects.
(1) Includes submitted "Gatekeeper" projects, as of August 2020.

Figure 8-5: Redwood City Development, by Status

Source: Economic & Planning Systems, 2020

8.4.2 Development Potential

Transit services expansion in an "in-commute" hub can increase property values, development activity, and economic activity. However, station area development usually supports a favorable market, real estate development opportunities, and existing and/or emerging business districts nearby.

15-minute Walkshed

Attractions include an industrial waterfront, office campus, open space, and Westpoint Harbor (a recreational marina). Pacific Shores, developed in the early 2000s as a ten-building, 1.7-million-square-foot campus, is held by multiple owners. Google now owns six buildings (934,000 square feet), Divco owns two buildings 447,000 square feet), and the tech-company Informatica owns two buildings (290,000-square-feet).

Only commercially zoned land was evaluated for potential development, which excludes industrial waterfront, roadways, open space, and the marina. Nearly 72 acres of commercial land within the 15-minute walkshed consists predominantly of office campus, surface parking and adjacent landscaping. Existing low-density development (under a floor area ratio or FAR of 0.5) may be underutilized, which comprises 38 percent of the land, as summarized in **Table 8-9** and **Figure 8-6**.[50]

Table 8-9: Development within Walking Distance

15 Minute Walkshed		
Existing Development [1]	71.9	acres
Existing Low-Density Parcels [2]	27.5	acres
% Existing Low-Density Parcels	38%	

Sources: Metropolitan Transportation Commission; San Mateo County; EPS.
[1] Omits 10+ acres due to incomplete data, as well as roadways and industrial waterfront uses.
[2] Includes acreage with existing developed FAR under 0.5.

[50] The Floor Area Ratio represents the total building area divided by the total land area for a particular property or parcel

Figure 8-6: Low-Density Pacific Shores Development (within 15-minute Walk from Terminal)

Source: Economic & Planning Systems, 2020

The 27 acres of low utilized property (FAR below 0.5) suggest significant development potential within the 15-minute walkshed. Notwithstanding the regulatory context, partnering with Pacific Shores employers to plan land use designations could allow Redwood City to capitalize on new ferry access.[51] In other words, a new ferry terminal could spur real estate investor interest in new development. Currently, most of the terminal area is zoned commercial or industrial, limiting housing potential. However, the upcoming Housing Element Update could identify opportunities for housing sites.

8.4.3 Land Side Planning Context

Realizing the existing potential for ferry-oriented development will be contingent upon the City's willingness to approve such projects. It will also require participation by local businesses and developer interest to facilitate strong last-mile connections.

Local Planning

While a well-served transit station enhances nearby property marketability, other factors are needed to spur development. The creation and approval of locally-based planning designations and authority provide a framework and vision for terminal area land uses that incentivize TOD. These plans provide certainty to permissible uses and local official policy goals, and send a positive signal to local developers, property owners, businesses, and others. Redwood City and surrounding jurisdictions are currently undertaking several long-term planning initiatives that further define and increase development potential in the terminal area, these include:

- *Redwood City Housing Element Update* – In line with the State mandate that all jurisdictions update their Housing Elements regularly, Redwood City began its update for the sixth Regional Housing Needs Allocation cycle (2022-2030).

[51] This analysis did not consider the physical or environmental factors that might inhibit the development potential of these sites.

- *Central Redwood City* –A series of planning actions to shape future development and transit service in Downtown Redwood City, including:
  - *Transit District* – A sub-district of the Downtown Precise Plan that will consider additional commuter rail right of way, a new bus depot, and a signature transit station. The Plan includes a General Plan Amendment process to consider redevelopment of the Sequoia Station shopping center into a retail, housing, and office development.
  - *Community Visioning* – Collecting community input on the now outdated 2011 Downtown Precise Plan.
- *ConnectMenlo* – Menlo Park is undertaking a long-range planning effort, a two-year review of the City's 2016 General Plan Update. It focuses on the Bayfront Area, which is home to much of Menlo Park's Facebook real estate and other office uses.
- *San Carlos General Plan Update* – The City of San Carlos is updating its General Plan, a process that will define the City's policy and land use opportunities for the next 20 years.
- *San Carlos East Side Innovation District* – a planning initiative to manage a recent influx of jobs in the City's industrial/commercial area east of Highway 101.

Source: City of Redwood City, 2020

Ferry Service Value Capture Considerations

As noted, new ferry service will likely bolster nearby property owners, developers, and businesses. Considering ongoing interest in mid-Peninsula real estate, these groups may serve as partners in supporting ferry service through last mile connections (e.g., shuttle service, ridership subsidies, and other contributions). As noted, employers near ferry terminals are increasingly aware of

Transportation Demand Management policy benefits such as subsidizing ridership (i.e., Clipper cards and shuttle service support). Additionally, such contributions are integral to the entitlement approval process for major projects and often serve as required mitigation for the California Environmental Quality Act (CEQA) review process.

Redwood City's new Gatekeeper Process might be leveraged to ensure Redwood City obtains improved multimodal connectivity to support last-mile ferry access. The Gatekeeper Process currently focuses on pending General Plan and Downtown Precise Plan amendment requests and enables the City Council to consider multiple projects at one time using strategic evaluation criteria. The aim is to prevent delay to projects that meet the City's future vision, as determined in a strategic plan adopted by Council in early 2020.

8.5 Key Findings

The quantifiable impacts associated with ferry service implementation/operation are modest. Long-term development impacts are complex and assessed from a qualitative perspective, which could be much greater – but are also dependent on a myriad of other independent variables.

8.5.1 Quantifiable Impacts

Based on ferry terminal service construction and subsequent annual operations:

- *Ferry Service Implementation Impacts* – Including direct and multiplier effects, construction impacts total $39.1 million in output, of which $25.1 million is paid to 271 jobs. These short-term impacts are envisioned to occur over a single year.
- *Ferry Service Operation and Maintenance Impacts* – Including direct and multiplier effects, annual O&M impacts of operating a single route (either SF/RWC or OAK/RWC) total $10.1 million in output, of which $2.8 million is paid to 28 jobs. These annual operational impacts would double if both ferry services were implemented.

Qualitative Impacts

The in-commute nature of potential ferry ridership between both San Francisco and Oakland to Redwood City reflects the mid-Peninsula's position as an employment destination. The largest beneficiaries of the new service will likely be current and future businesses in the region as well as their employees from Oakland and/or San Francisco.

- *RWC Employers* – Ferry service will help recruit employees, but estimated daily boardings, 1,950 for combined service, is only 2 percent, of Redwood City's in/out commute flow (120,000 daily trips).
- *Terminal Location Investment* – Current development and economic activity within the 15-minute walkshed includes the Pacific Shores Center, an eleven-building complex spanning a 1.7 million square foot high-tech business park. Nonetheless, development is relatively limited. New ferry service could bolster the real estate market and spur property development. Existing commercial property within a 15-minute walking distance to the terminal suggests nearly 30-acres of underutilized, low density land use.
- *Last Mile Connections* – Ferry service impacts to the mid-Peninsula will partly hinge on the provision of reliable to nearby business districts, including shuttle service, bike-ped improvements, and effective wayfinding.

- *Coordinated Planning* – Local planning designations provide vision for terminal area land uses that incentivize TOD. These plans provide certainty to permissible uses and policy goals, and send a positive signal to developers, property owners, businesses.

Section 9

Key Findings, Recommendations, Future Considerations and Risks, and Next Steps

This Study was conducted to assess the feasibility of establishing public ferry service in Redwood City. In order to move on to the next steps of establishing ferry service in Redwood City, the ferry service needed to be evaluated for feasibility in five different areas, as illustrated in **Figure 9-1**. This section summarizes the key findings which lead to the conclusion that the answer to each question asked below is Yes, and that ferry service in Redwood City is indeed feasible. This Study shows how an Oakland-Redwood City route, a San Francisco-Redwood City route, and a combined scenario where both routes run simultaneously can be feasible. This section will also look at next steps and recommendations for a Redwood City Ferry service.

Redwood City and WETA have worked towards ferry service since 2012.[52] This Financial Feasibility and Economic Impact Study evaluated ferry service feasibility from five interconnected perspectives. Existing Conditions (**Section 2**) and extensive public outreach (**Section 3**) provide the basis for ensuring that the proposed ferry service is consistent with both Redwood City's and WETA's development plans. Transport market analysis and ridership forecasts (**Section 4**) were used to identify ferry routes and forecast ferry user demand. Ferry terminal facility plans and engineering costs are presented in **Section 5**.

Figure 9-1: Feasibility Perspectives

Source: CDM Smith, 2020

[52] Redwood City Ferry Terminal Site Feasibility Report.

Combined, this background information addresses what service is needed, who would use it, and how much a new terminal would cost. It is used with new ferry purchase and operation costs, to assess the Financial Feasibility (**Section 6**) and Economic Feasibility (**Section 7**).[53] Whereas the financial analysis address WETA farebox recovery objectives, the economic analysis quantifies how monetized user benefits compare with total project costs (both Redwood City terminal and WETA ferry operations).

This Study jointly evaluates the five feasibility perspectives to assess if ferry service is warranted. The resultant Economic Impacts (**Section 8**) illustrate the quantitative impacts associated with building the new terminal and operating the ferries, as well as the broader qualitative impacts associated with transport amenities to Redwood City residents and area businesses.

Source: CDM Smith, 2020

[53] i.e., benefit-cost analysis.

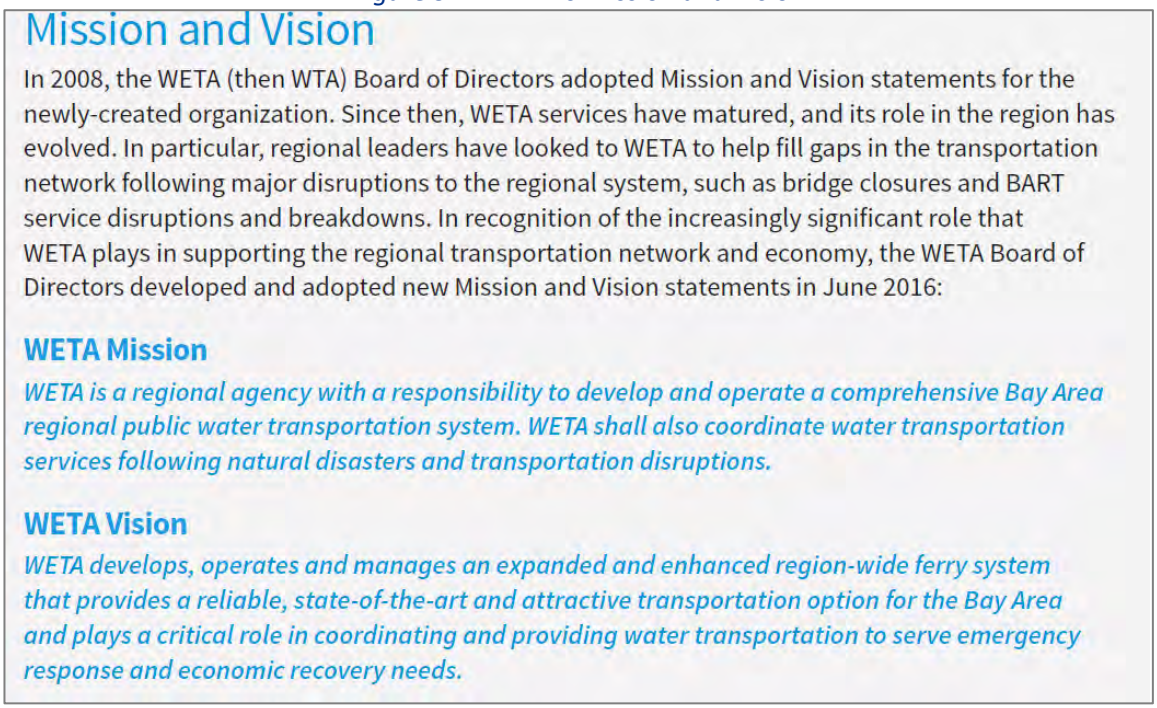
9.1 Key Findings

9.1.1 Redwood City and WETA Plan Consistency *(Section 2)*

Redwood City Plans – ferry service supports City objectives of promoting sustainable transportation solutions, denser downtown development, and expanded transit facilities.

WETA's Mission and Vision – Redwood City ferry service expands viable network service into the South Bay for the first time (see **Figure 9-2**).

Figure 9-2: WETA's Mission and Vision



Mission and Vision

In 2008, the WETA (then WTA) Board of Directors adopted Mission and Vision statements for the newly-created organization. Since then, WETA services have matured, and its role in the region has evolved. In particular, regional leaders have looked to WETA to help fill gaps in the transportation network following major disruptions to the regional system, such as bridge closures and BART service disruptions and breakdowns. In recognition of the increasingly significant role that WETA plays in supporting the regional transportation network and economy, the WETA Board of Directors developed and adopted new Mission and Vision statements in June 2016:

WETA Mission

WETA is a regional agency with a responsibility to develop and operate a comprehensive Bay Area regional public water transportation system. WETA shall also coordinate water transportation services following natural disasters and transportation disruptions.

WETA Vision

WETA develops, operates and manages an expanded and enhanced region-wide ferry system that provides a reliable, state-of-the-art and attractive transportation option for the Bay Area and plays a critical role in coordinating and providing water transportation to serve emergency response and economic recovery needs.

Source: San Francisco Bay Area WETA 2016 Strategic Plan

9.1.2 Public Outreach *(Section 3)*

Questionnaires – multiple public outreach events identified San Francisco and Oakland as favored destinations for serving Redwood City.

Route Purpose – the San Francisco route was favored for "Recreation and Leisure" more than commuting. Major area employers[54] preferred Oakland service to reach new employees that lack easily accessible transit service to the Redwood City or mid-Peninsula area.

9.1.3 Market Analysis and Ridership Forecasts *(Section 4)*

Primary Market – include mid-Peninsula employment centers from Oakland (Jack London Square) and San Francisco (Ferry Building) due to comparative travel times, labor markets and existing ferry facilities.

Other mid-Peninsula Transit – public and private transportation services to/from the South Bay

- *San Francisco* – public services include Caltrain and SamTrans, while "Tech Buses" serve as private transportation for major employers in the area.

[54] Within the Greater Redwood City Market Area and the Redwood City Chamber of Commerce.

- *East Bay* – limited existing public transit links offer few commute options and private transport services (e.g. tech buses) contribute to highway congestion, despite utilizing HOV lanes. More workers could locate in the East Bay and commute to mid-Peninsula employment centers, were public transportation options provided.

Oakland to/from Redwood City Ferry Service – is forecast to serve around 850 weekday boardings with 89 percent during the peak commute direction from Oakland to Redwood City in the opening year, increasing to 1,870 boardings by 2040. With 3 trips in the peak commute direction, boardings average 130 per boat trip in 2019 increasing to around 250 in 2040 versus boat capacities of 320 passengers. Ridership forecasts vary by day, season, and year. Peak hour boardings are higher than the average boat trips (around 50 percent) suggesting that larger boat size and/or additional peak boat trips would be needed by 2040.

San Francisco to/from Redwood City Ferry Service – is forecast to serve around 1,300 weekday boardings in the opening year, with two thirds in the peak commute direction (from San Francisco to Redwood City). By 2040, weekday ridership will increase to 2,190 boardings. With 4 trips in the peak commute direction, average ridership per boat trip is estimated at 140 in 2019 increasing to around 230 by 2040 which are within boats capacities. Like the Oakland service, the San Francisco service might need additional capacity in 2040.

Vessel Needs – for a single route alternative, Redwood City service requires the purchase of two, jet-propulsion 320 passenger vessels like those in WETA's "Dorado" class plus a portion of a spare vessel (shared with another service) for either route; the combined alternative would require the purchase of 5 vessels. Vessels cost of $16 million each in 2019 dollars and represent a significant capital investment.

WETA Performance Measures and Standards – forecast passenger volumes for all three alternatives meet the minimum Peak Hour Occupancy of 50 percent by the 10th year of operation and the minimum Passengers Per Revenue Hour (100 boardings).

9.1.4 Ferry Terminal Construction *(Section 5)*

Cost – estimated between $15 million and $20 million in 2019 dollars, depending on terminal location and size. The lower end estimate would include a one-sided float that could limit the number of vessels that would be able to access the terminal around the same time, while the higher-end estimate includes a two-sided float that could be accessed by two vessels at the same time. This configuration increases the ability for in-commuters to coordinate with landside transportation options for first/last mile connectivity at the same time reducing connection times. These costs are in-line with recent WETA Ferry Terminal construction costs at other locations (e.g. Richmond Ferry Terminal at $19 million).

Funding – Redwood City appears eligible to receive nearly $15 million in Measure A Ferry Program funding administered by the SMCTA. Redwood City is also eligible to receive capital funding through SMCTA's Measure W, as well as MTC's Regional Measure 3.

9.1.5 Financial Feasibility Assessment *(Section 6)*

WETA's farebox recovery ratio – projected ridership revenue and ferry operating costs indicate that both Redwood City services would far exceed requirements of 40 percent by the 10th year of operation and thus are considered financially feasible; with the Oakland route covering 61 percent, the San Francisco route covering 74 percent and the combined alternative covering 68 percent.

Annual Operating Subsidies – annual operating subsidies decline over time as ridership increases. Required annual operating subsidies average about $2 million for Oakland and $1.5 million for San Francisco. This estimate assumes fares will be priced comparatively to other long-distance WETA services such as the Vallejo service.

Capital Expenditures – new service to Redwood City will require initial capital expenditures to construct the terminal and to purchase vessels, as well as future capital replacement and maintenance expenditures. Given the likelihood of need for operational subsidies for the foreseeable future, a variety of public and private financial resources will need to be leveraged to fund vessel acquisition, terminal construction, and other facility costs.

Local Funding – Measure A Ferry Program funding is only allowed for capital related costs; there is no local funding source currently identified for ferry service operations.

9.1.6 Benefit Costs Assessment *(Section 7)*

User Benefits – ferry services provide a relatively pleasant alternative to a grueling drive around the San Francisco Bay. Such modal shift removes vehicles from the roadway network, resulting in reduced vehicle miles traveled and vehicle operating-, accident-, and emission-cost-saving benefits. Also, avoided parking fees and tolls benefit users.

Net benefits – are relatively close for both route alternatives, given identical capital outlays, and similar O&M. As such, the economic feasibility results are nearly identical at the various discount rates considered, with a slight favor towards San Francisco.

Project Economic Feasibility – hinges on how best to evaluate on-ferry time. Deliberation suggests that on-ferry time is a user benefit. Otherwise, the resultant monetary metrics do not square with either the ridership forecasts or other WETA route volumes. At half the average time value per hour, the on-ferry time values evaluated under the amenity scenario are considered conservative.

Roundtrip Breakeven Benefits – at the 4 percent discount rate, each roundtrip user requires benefits between $37.62 to $43.93, depending on alternative. Compared to driving, this appears reasonable.

9.1.7 Economic Impact Assessment *(Section 8)*

Quantifiable Impacts – comprise the development and operation of both the new Redwood City Terminal and ferry-route operations.

- *Terminal Construction* – Terminal facilities costs range from $15 million to $20 million depending on size and location. The higher end project development cost will create approximately 185 one-time construction jobs.
- *Terminal Operation* – Once in operation, the terminal will require maintenance (security, landscaping, electricity, water/wastewater, telecommunications, trash service, etc.) costing approximately $200,000 annually, generating, at most, one new job.
- *Ferry Operations* – WETA stated that four crews would operate a new Redwood City ferry service. Including multiplier effects, ferry service will generate “indirect” and “induced” economic activity that will range from $4.8 million to $10 million annually.

Qualitative Impacts – The in-commute nature of potential ferry ridership between both San Francisco and Oakland to Redwood City reflects the mid-Peninsula's position as an employment destination. The largest beneficiaries of the new service will likely be current and future businesses in the region as well as their employees from Oakland and/or San Francisco.

- *Terminal Location* – the current level of development and economic activity within the immediate walkshed surrounding the proposed ferry terminal is relatively limited.
- *Last Mile Connections* – ferry service impacts to the mid-Peninsula will partly hinge on the provision of reliable connections to nearby business districts, including shuttle service, bike-ped improvements, and effective wayfinding.
- *Investment Near the Proposed Terminal* – new ferry service could bolster the real estate market and spur development of nearby properties. Existing commercial property within a 15-minute walking distance to the terminal suggests nearly 30 acres of underutilized, low density land uses.

9.2 Recommendations, Risks and Next Steps

With the analysis in the preceding Study concluding that a Redwood City ferry service is feasible by all five measures of feasibility, this section will look at the next steps needed to get to implementation of a commuter ferry service in Redwood City, if the City should determine that public commuter ferry service is feasible.

9.2.1 Recommendations

With all three service alternatives (Oakland-Redwood City, San Francisco-Redwood City and a Combined Service) having varying levels of feasibility when measured against the five areas that define feasibility for this project (Consistency, Engineering, Economic, Operational and Financial), it is recommended that the Redwood City Council, the Redwood City Port Commission and the WETA Board of Directors consider moving the project to the next phase of development and begin to develop a Business Plan that also includes how the project and service would be funded.

9.2.2 Future Considerations and Risks

In addition to the costs and factors analyzed, many known and unknown factors affect Redwood City ferry ridership, and the resulting financial and/or economic feasibility. Such risks are typical and include:

Considerations

First/Last Mile Costs and Responsibilities – the location of the ferry terminal at the end of Seaport Boulevard in the Port of Redwood City means more effort is needed to provide First/Last Mile connections. Potential providers include public transit (SamTrans), employer-based Transportation Management Associations, public shuttle service (Commute.org), or privately funded shuttles (like were operated for the Facebook Pilot Ferry Service).

Capital/Operating/Maintenance Costs

- *Capital Ownership* – Which entity ultimately owns the ferry terminal? Is it split between ownership for the landside portion of the terminal and the waterside of the terminal? There are possibly grant funding implications for ownership (e.g. WETA is eligible for federal grants for maintenance of waterside facilities).

- *Private Ferry Operations* – Is there a possibility for privately operated ferries to use the ferry terminal or develop a parallel facility that will benefit from shared landside connections?
- *Public-private investment opportunities* – As mentioned above, the potential transportation investment brings significant economic benefits (increase in land values, access to new labor markets) for mid-Peninsula businesses. Is there a possibility for participation by these companies in either the capital or operational expense of the project?

Ridership – many factors affect ferry user decisions.

- *Fare schedules* – The cost of a long-haul ferry trip may be too high for individuals and could affect ridership, so subsidies from employers may be needed to offset those costs and increase ridership.
- *New and Emerging Technology*
  - Transportation is changing quickly and the advent of Autonomous Vehicles (AVs) could impact ferry ridership negatively if people see travel time in an AV as a gain in productivity, or positively if AVs cause even more congestion on freeways.
  - Similarly, ferry service may also be influenced by advancements in vessel technology if capital or operating costs of new vessels are lower or if speed is increased.

Risks

Capital/Operating/Maintenance Costs

- *Terminals* – Construction and maintenance costs are not fixed and could change over time (increase or decrease) versus those analyzed.
- *Construction Window* – there is a tight construction window due to environmental requirements. A short construction delay could delay overall construction by a year.
- *Fuel Cost* – is not fixed and could increase future operating expenses.
- *Operating Funding* – Regional Measure 3 funds are not set aside for a specific route and could be diverted to another service that is operational ready.

Ridership – factors that may negatively affect ridership.

- Regional Transportation Improvement Investments and Funding
  - If regional transportation investments (transit and highway, e.g. implementation of high speed rail, reconstruction of the US 101/84 Interchange) greatly reduce comparative travel times between the mid-Peninsula and the proposed markets, it could lead to lower ridership.
  - However, ferry travel times are fixed, so if comparable travel times for other modes continue to degrade, ferry ridership could increase beyond what was modeled for this Study.
- COVID-19 ridership effects
  - In March of 2020, the San Francisco Bay Area entered into shelter-in-place as part of public health orders to help prevent the spread of the SARS-CoV-2 virus, commonly known as the Coronavirus or COVID-19. These shelter-in-place orders forced non-essential employees to

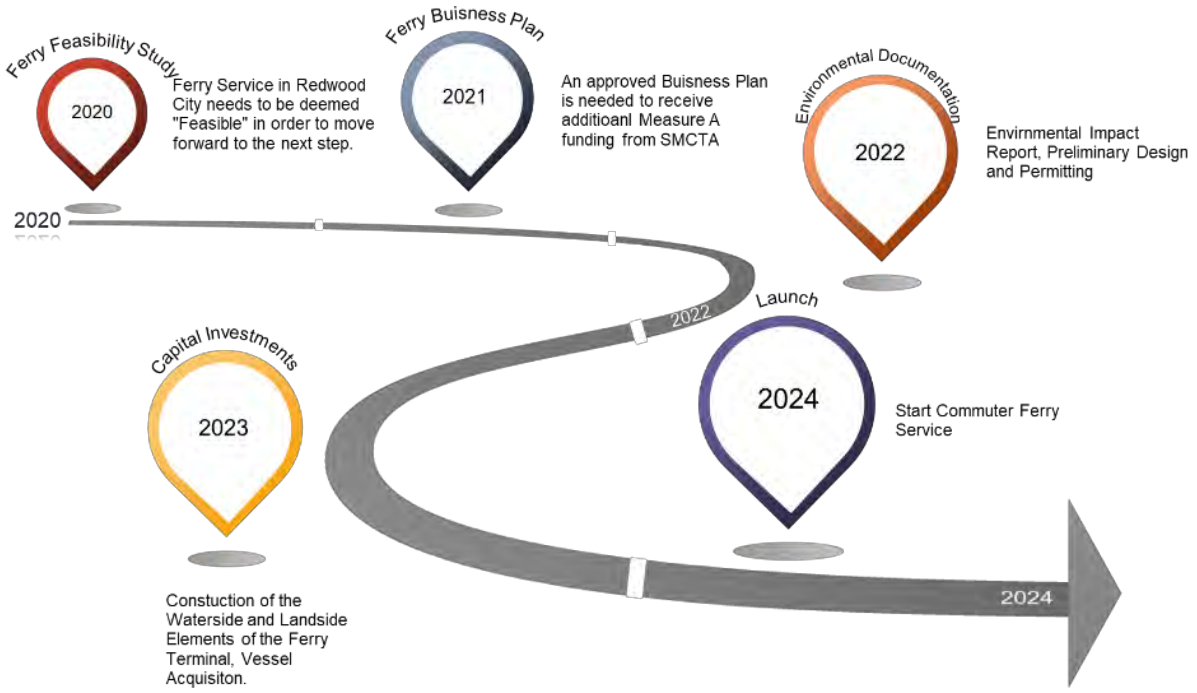
work from home, and greatly reduced the use of public transit and congestion on regional roads.

- As the region recovers from the pandemic, if employees continue to work from home in large numbers it could reduce ridership. Alternatively, if more employees drive alone, congestion on area freeways will increase, making ferry trips more time competitive. When choosing among transit services, large ferries may be more desirable than other forms of mass transit where it is more difficult to maintain social distancing, but this has not yet been studied.
- While the lasting effects of COVID-19 on commuting is unknown, it is generally expected that in the 4 to 5 years that it would take for WETA to start operating ferry service, commute and work patterns should be similar to pre-COVID-19 conditions.

9.2.3 Next Steps

Timeline to Ferry Service – **Figure 9-3** is a high-level timeline of the steps needed to begin operating a commuter ferry service in Redwood City in 2024. It is important to note that waterside improvements can only happen during an annual construction window between June 1st and November 30th.This work window is established by the various regulatory agencies to minimize the disturbance to endangered and special status species found in the project area. The start of ferry service could be deferred due to construction delays or other unanticipated challenges.

Figure 9-3: Timeline to Launch



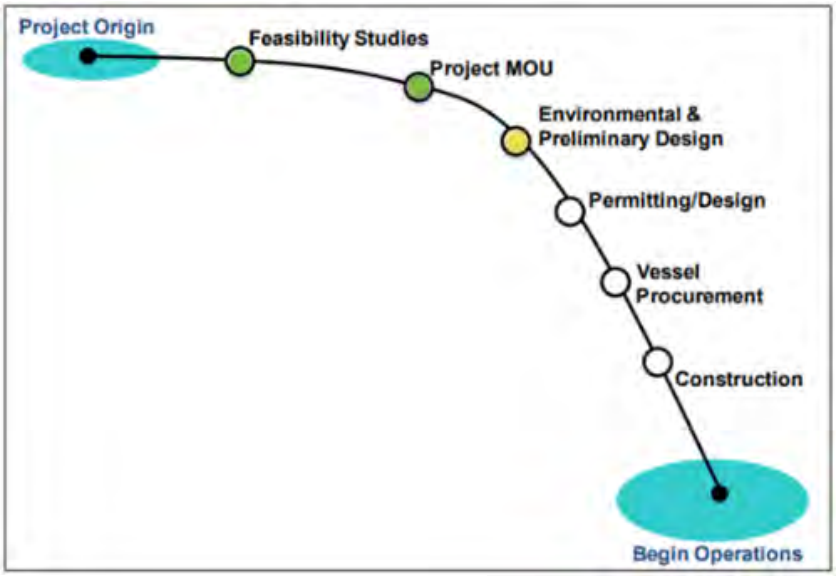
Source: CDM Smith, 2020

Business Plan Development – Given the project's financial feasibility, the SMCTA requires the City and Port of Redwood City to develop a Business Plan to identify how riders will be attracted to the new service, and how the service will be funded and operated. When the Business Plan is accepted by the SMCTA, the project will likely advance into Environmental and Preliminary Design, and subsequent

permitting activities. The costs for these activities are eligible for SMCTA funding. The existing Memorandum of Understanding (MOU) between the City and WETA which covers the Feasibility and Business Plan Phase of the ferry project will be amended as needed for future phases of work.

WETA's Project Implementation Process – If the Business Plan is approved by SMCTA and funds are made available for construction of the ferry terminal, the next step in WETA's process would be an "Environmental and Preliminary Design" of the ferry terminal and service plan, as seen in **Figure 9-4**. As the next phase of the project is becomes better defined, the existing MOU between the City and WETA will be amended.

Figure 9-4: WETA's Project Implementation Process

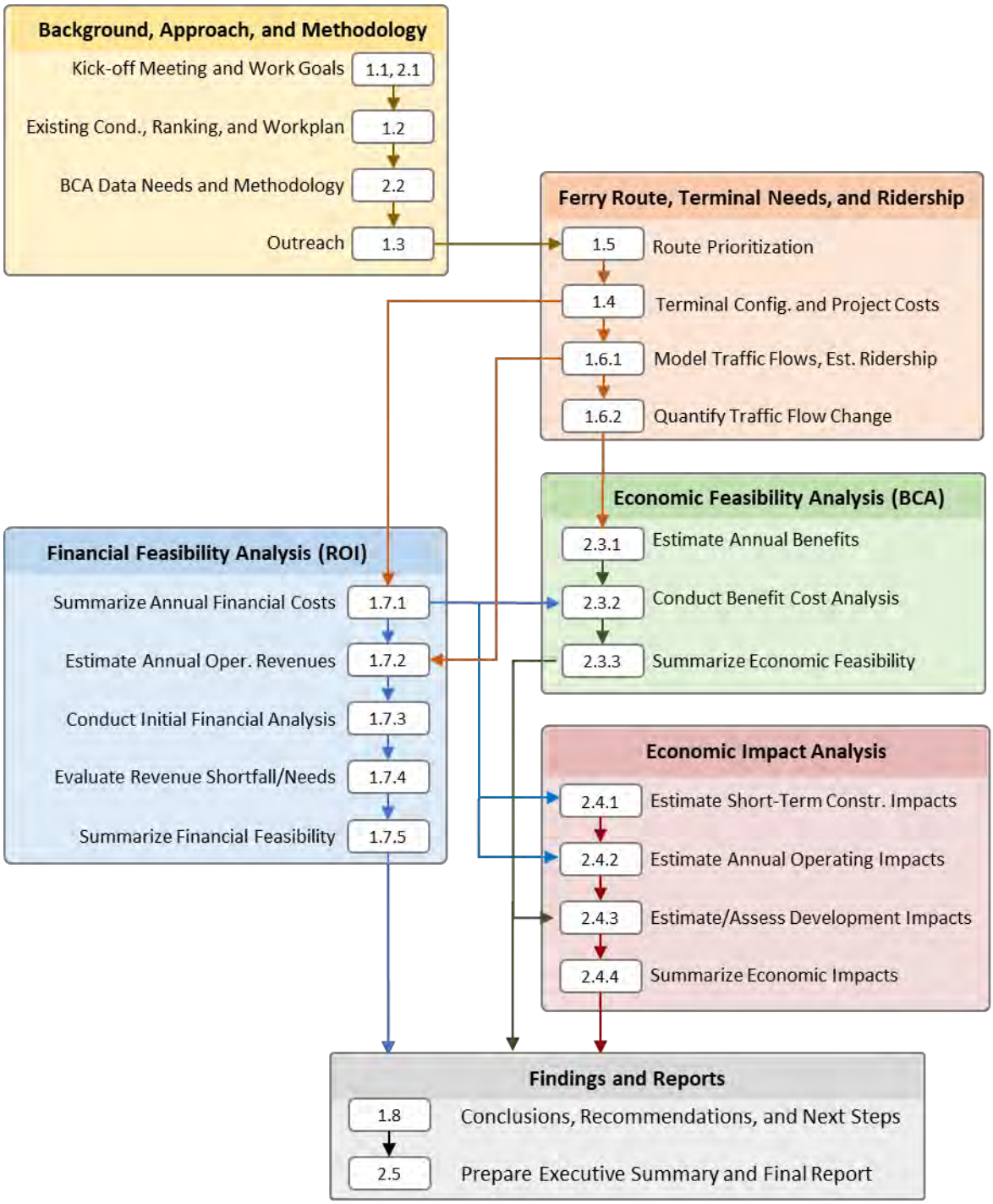


Source: WETA 2020 Short Range Transit Plan

Appendices

Appendix A

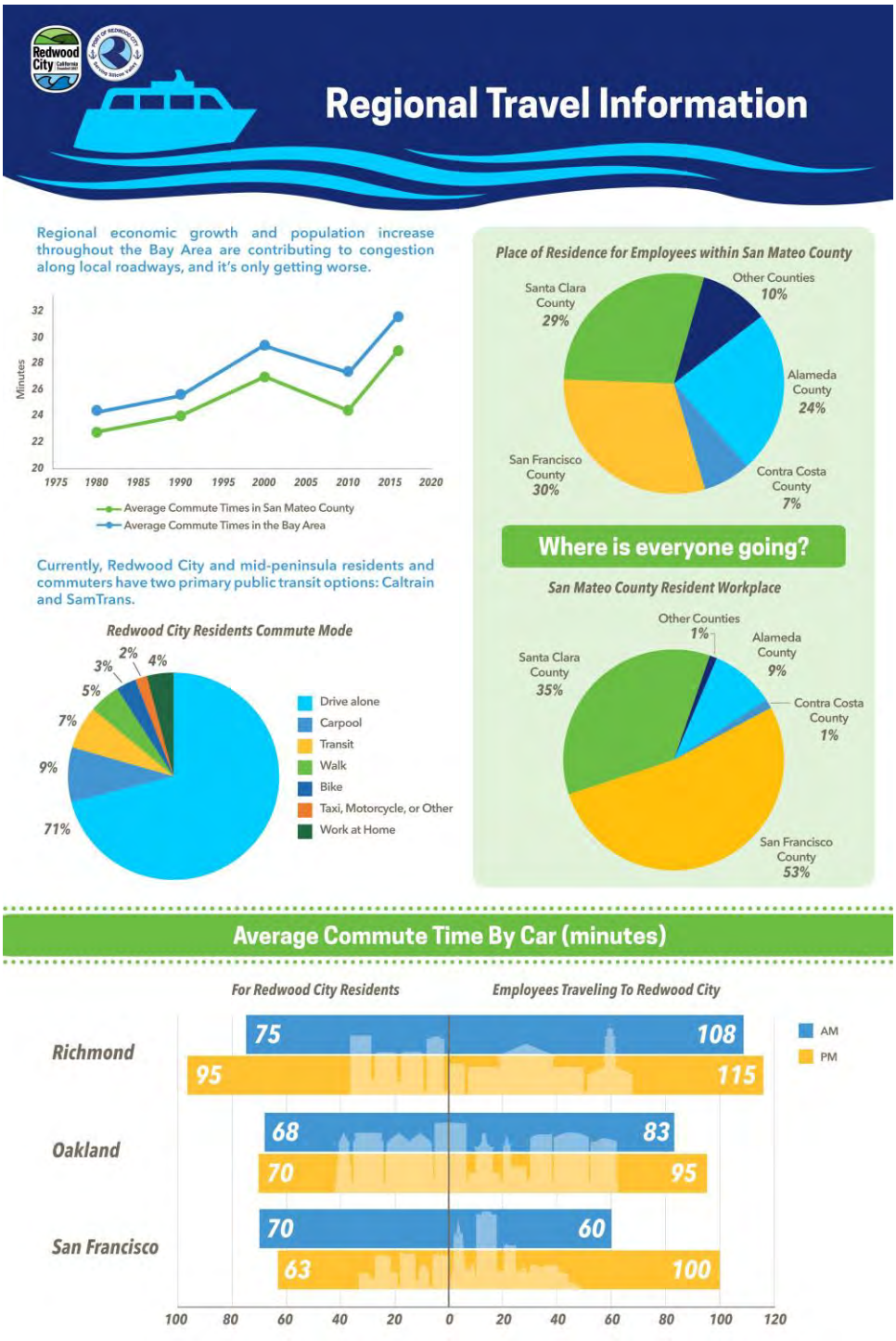
Workflow by Task from the Scope of Work



Appendix B

Public Outreach

Public Outreach Materials



Where Do You Live And/Or Work?

Instructions: Place a dot on where you live and/or your primary location of employment if within the boundaries of this map.

Source data: San Mateo County, 2018; SamTrans, 2019; MTC, 2017; ESRI, 2019; PlaceWorks, 2019

Questions and Answers from Public Outreach

Questions, comments, and answers by the project team from the Water User stakeholder meeting on May 13, 2020 are summarized below.

- Question (Q): Will ridership estimates be impacted based on trip length?
- Answer (A): Yes, there is a trip length tipping point for people to use the ferry service. That threshold varies by person. The ferry travel time estimates conservatively account for slow travel in the Redwood Creek Channel and the Oakland estuary.
- Comment (C): Wake size is a major concern for water users, especially rowers, as many recreational boats are very close to the water and even small wakes can flip boats. Past ferry service in the channel has not operated to minimize safety hazards for small boats.
- Q: Have speed limits been contemplated for ferries entering the harbor?
- A: Ferry speeds in the channel would be reduced to about 5 knots. WETA's new SF Bay Ferry boats have minimal wakes. Safety is of the utmost concern for WETA and the ferry service considered through this project.
- C: The ferry should begin slowing down farther out than is currently proposed in this plan.
- Q: The proposed dock site is around the corner from where it was previously analyzed in 2012. Why has the site changed? The proposed ferry dock site is one of the most congested areas in the channel because water users travel through the area leaving or entering WestPoint Slough. This creates water user conflicts. Have other sites been considered?
- A: From information gathered through background studies, this new site would require less dredging. This dock site has the fewest impacts on recreational water users and the environment compared to other feasible sites considered near the Port.
- Q: The 2016 pilot ferry funded by Google and the 2019 pilot ferry funded by Facebook both yielded considerably lower ridership numbers than those forecasted in the ridership model for this potential ferry service. Why are these numbers so much higher? Were these results considered when developing the ridership estimates for this potential ferry service?
- A: The Google and Facebook pilot ferry services were private ferries only serving their employees. The ridership estimates for the current study are based on public transit forecasts (using modeling by C/CAG), allowing the general public to ride rather than just Google or Facebook employees. This data is consistent with transit modelling best practices performed throughout the state. The project team has conducted outreach with various large employers on the Peninsula, including Google, and these employers have indicated that many employees would be interested in the ferry. In addition, the prior ridership numbers are lower because the service provided was on much smaller boats with less capacity.

- C: I encourage you to run a pilot study, rather than just use modeling, to determine "real" ridership levels.
- Q: Sailboats need room to tack back and forth across the channel to leave and enter the San Francisco Bay. Has the ferry feasibility study considered operation at the proposed dock site with constrained access for other water users?
- A: Yes, WETA ferries are conditioned to operate at low speeds to minimize wake and conflicts with other boats, including sailboats. WETA's operations specifically at the Richmond and Oakland terminals are highly aware of potential sailboat conflicts and minimize their impacts to ensure water user compatibility.
- C: There are eight rowing clubs, multiple stand up paddlers, swimmers, adaptive rowing camps, and children water users in the Redwood Creek Channel and Westpoint Slough. Please do an in-depth study of safety issues associated with a new ferry service.
- Q: With the change to travel patterns associated with the current shelter-in-place mandate in effect from COVID-19, will people gravitate towards public transit or will more people work from home, minimizing travel demand?
- A: The project team is hesitant to predict the future, but we anticipate that regional travel will still ramp back up, especially since this is a long-term project with WETA rolling out service in 2025-2027. We do not want to assume that we are not looking at the same parameters to reduce vehicle use and pollution parameters.
- C: My primary concern is ferry wakes causing bank and tidal erosion on Bair Island and Greco Island. We are concerned that this study's polls and surveys that present travel time scenarios could be misleading if travel times are not realistic and do not consider environmental concerns. For environmental reasons and safety reasons, you may need to reduce speeds. Mitigation measures required upon CEQA analysis of the ferry dock site could derail the entire fiscal analysis of this work. The study should also incorporate costs for enforcement of speed limits, acknowledging that private ferry operators may not take reduced speeds as seriously.
- Q: Was the 2007 Biological Resources Assessment (BRA) Redwood City Ferry Terminal considered when reviewing potential dock sites?
- A: Yes, the 2007 BRA was considered as part of the location assessment for a ferry dock site. Analysis indicates that there are potential impacts, but they are not anticipated to significantly affect Bair Island or Greco Island. Regardless, environmental impacts would be studied in-depth at the time of proposed dock construction under CEQA.
- Q: Could you bring a WETA ferry to the channel for the water community to see it in person and how it operates within the channel?
- A: While WETA cannot commit outright to this request, the WETA representative agreed it would be a prudent action and likely very feasible to host a trial trip to Redwood City.

- Q: Would a new ferry terminal at the end of Seaport Boulevard generate significant landside traffic impacts? Is there a plan to provide connections from the terminal to Downtown Redwood City?
- A: Yes, the City's long-range transportation plan envisions bus rapid service to the end of Seaport Boulevard to facilitate first- and last-mile connections for ferry users and other travelers and to decrease traffic impacts to the area. Both public and private transit would service the route.
- Q: I assume that the area would need regular dredging to accommodate a ferry, which I support as it seems to be an effective way to privately fund regular maintenance of the channel. What is the draft and who would dredge?
- A: The draft is five to seven feet. Either the Port or the US Army Corps of Engineers would be responsible for dredging and maintenance.
- C: Redwood City's waterfront is not a bustling downtown area where people can walk to their job from the dock. The increase in travel time caused by a subsequent bus trip after arriving at the Redwood City ferry terminal will make this a less attractive travel option.
- C: Wake problems are exacerbated at low tide. While the Port is responsive to reports of boat speeding causing large wakes, the Port does not continue to enforce boat speed limits over time.
- C: As a member of the Redwood City Marina and member of Sequoia Yacht Club, I support the ferry proposal as a viable solution to relieve congestion on highways. Rowers can avoid ferries during the limited time they enter the harbor.

Appendix C

WETA Ferry Fleet

San Francisco Bay Ferry Fleet

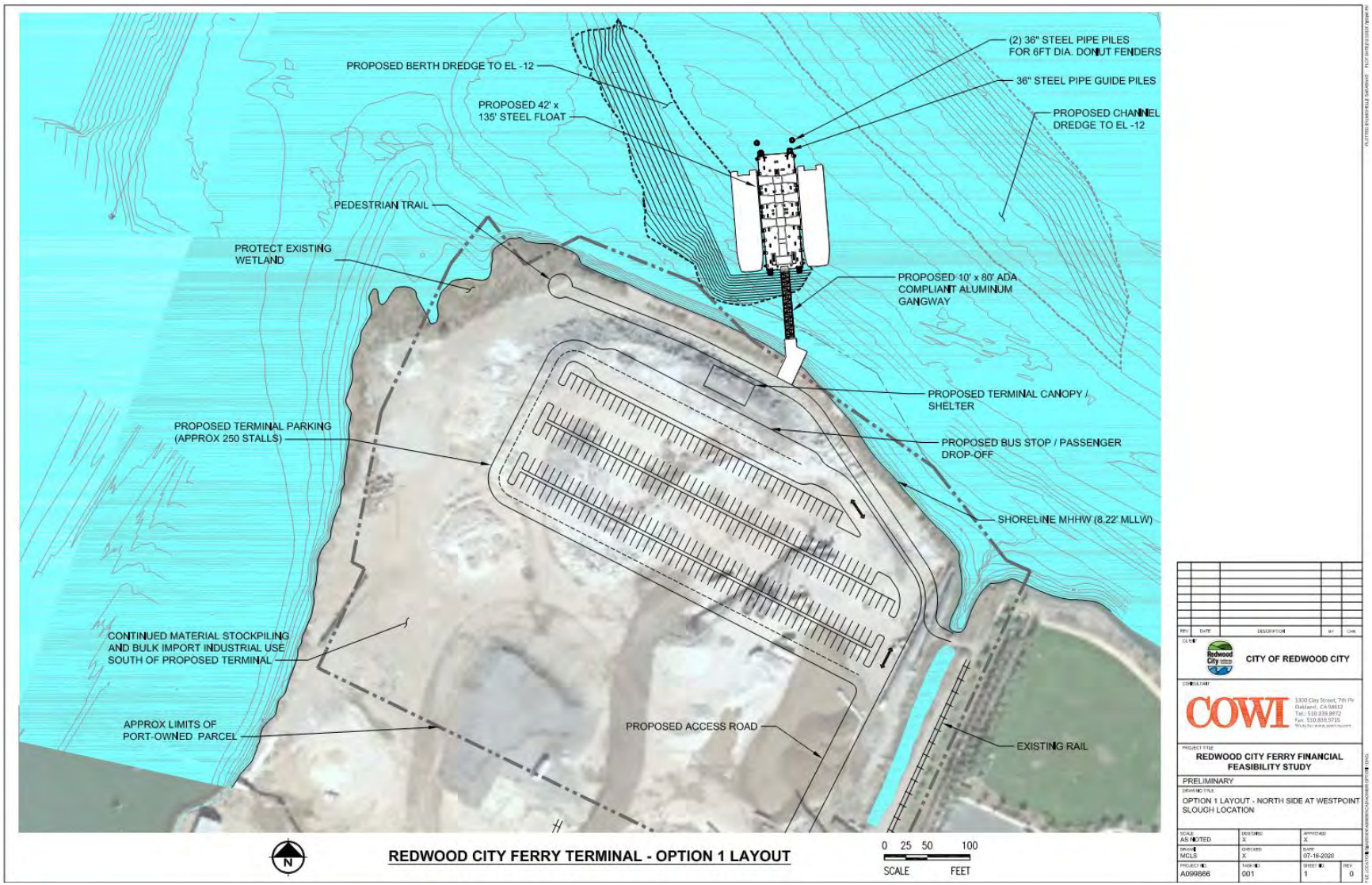
Water Emergency Transportation Authority

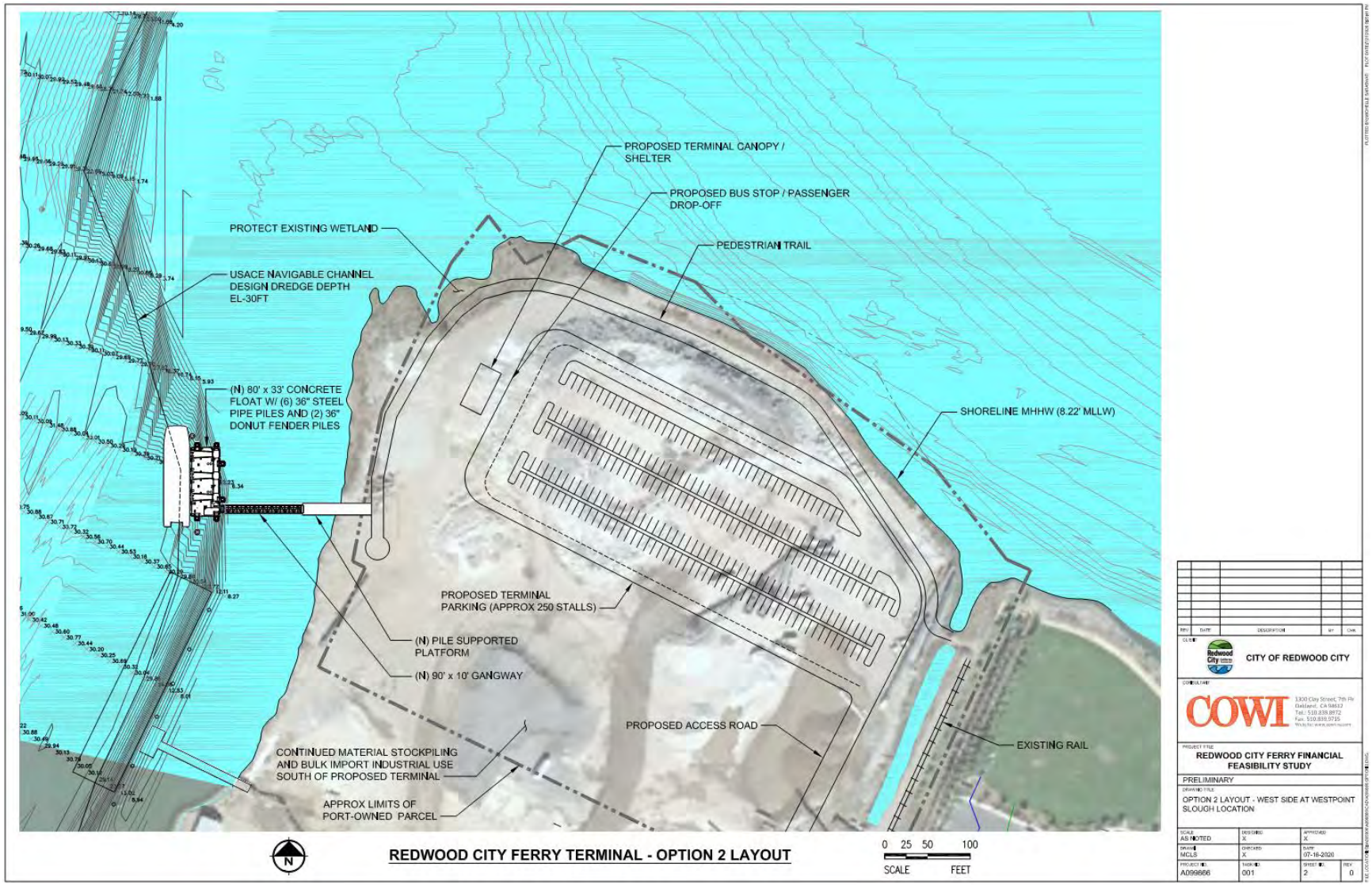
Vessel [A]	Peralta	Encinal	Bay Breeze	Intintoli	Mare Island	Solano	Vallejo	Gemini Class	Central Bay: Hydrus	Central Bay: Cetus	Central Bay: Vessels 3 & 4	North Bay/ Richmond High Speed
												
No. of Vessels	1	1	1	1	1	1	1	4	1	1	2	3
Built By	Nichols Brothers Boat Builders	Nichols Brothers Boat Builders	Nichols Brothers Boat Builders	Dakota Creek Industries	Dakota Creek Industries	Dakota Creek Industries	Gladding-Hearn	Kvichak Marine Industries and Nichols Brothers Boat Builders	Vigor (formerly Kvichak Marine)	Vigor (formerly Kvichak Marine)	Vigor (formerly Kvichak Marine)	Dakota Creek Industries
In Service Date	2002	1985	1994	1997	1997	2004	1994	2008-2009	April 2017	July 2017	Projected #3: January 2018 #4: November 2018	Projected #1: December 2018 #2: July 2019 #3: December 2019
Original Cost	$5.2 million	$2.1 million	$2.1 million	$6 million	$6 million	$11.2 million	$3.2 million	$8.6 million each	$15.1 million	$15.1 million	$15.1 million each	$19.2 million each
Number of Decks	2	3	2	2	2	2	2	2	2	2	2	2
Passenger Capacity	331	395	250	349	330	320	267	Pisces and Gemini: 225 Taurus and Scorpio: 199	400	400	400	445
Bike Capacity	20	20	20	10	10	10	10	34	50	50	50	24
Wheelchair Access	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Onboard Restrooms, Snacks, Drinks	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Engines	2 x Cummins QSK50	2 x DD Series 4000	2 x MTU 16V2000	2 x MTU 16V4000 M73	2 x MTU 16V4000 M73	2 x MTU 16V4000 M71	2 x MTU 12V4000 M70	2 x MTU 16V2000	2 MTU 12V4000 EPA Tier 3**	2 MTU 12V4000 EPA Tier 3**	2 MTU 12V4000 EPA Tier 3**	2 MTU 16V4000 EPA Tier 4
Propulsion	Propeller	Propeller	1994-2014: Water Jet 2014 to present: Propeller	2 x MJP 750 Mk 2 Water Jet	2 x MJP 750 Mk 2 Water Jet	2 x Hamilton 811 Water Jet	2 x Hamilton 721 Water Jet	Propeller	Propeller	Propeller	Propeller	2 Hamilton HT810 Water Jet
Service Speed Knots (miles per hour)	25 (28.7)	23 (26.5)	26 (30)	34 (39)	34 (39)	34 (39)	34 (39)	26 (30)	27 (31)	27 (31)	27 (31)	34 (39)
Length, Overall (meters)	37	27.4	29.6	41.3	41.3	41.3	33.7	35.9	41	41	41	44
Beam, Extreme (meters)	10	9.6	8.9	12	12	12	8.7	8.8	11.5	11.5	11.5	12
Mean Draft, Loaded	2	2.7	1.2	1.5	1.5	1.5	1	1.9/2.0	2	2	2	1.5
Gross Tonnage	91	96	97	95	95	91	84	90	95	95	95	<100
Fuel Type	Bio Diesel B5	Bio Diesel B5	Bio Diesel B5	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel	Bio Diesel B5	Bio Diesel B5	Bio Diesel B5	Bio Diesel B5	Ultra Low Sulfur Diesel
Fuel Capacity (US gallons)	4,400	5,400	2,000	5,000	5,000	6,600	4,500	2,400	3,000	3,000	3,000	4,400
Fresh Water Capacity (US gallons)	750	500	750	500	500	500	400	500	500	500	500	600
Hull Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum
Retirement Date	2027	2017	2020	2022	2022	2029	2018	2033-2034	2042	2042	2043	2043-2044
Note		Replacement: Cetus					Replacement: new 34 knot high speed vessel					1st boat replaces MV Vallejo.

(A) There are 12 vessels in the WETA fleet including the M.V. Harbor Bay Express II which has been out of service for several years and is not detailed in this table. The M.V. Hydrus replaces the Express II.
** Tier 3 engine with Selenium Catalytic Reduction = Tier 4 level emissions reduction.

Appendix D

Concept Drawings


PROPOSED BERTH DREDGE TO EL -12
PROPOSED 42' x 135' STEEL FLOAT
(2) 36" STEEL PIPE PILES FOR 6FT DIA. DONUT FENDERS
36" STEEL PIPE GUIDE PILES
PROPOSED CHANNEL DREDGE TO EL -12
PEDESTRIAN TRAIL
PROTECT EXISTING WETLAND
PROPOSED 10' x 80' ADA COMPLIANT ALUMINUM GANGWAY
PROPOSED TERMINAL CANOPY / SHELTER
PROPOSED TERMINAL PARKING (APPROX 250 STALLS)
PROPOSED BUS STOP / PASSENGER DROP-OFF
SHORELINE MHHW (8.22' MLLW)
CONTINUED MATERIAL STOCKPILING AND BULK IMPORT INDUSTRIAL USE SOUTH OF PROPOSED TERMINAL
APPROX LIMITS OF PORT-OWNED PARCEL
PROPOSED ACCESS ROAD
EXISTING RAIL
N
REDWOOD CITY FERRY TERMINAL - OPTION 1 LAYOUT
0 25 50 100
SCALE FEET
CITY OF REDWOOD CITY
COWI
REDWOOD CITY FERRY FINANCIAL FEASIBILITY STUDY
PRELIMINARY
OPTION 1 LAYOUT - NORTH SIDE AT WESTPOINT SLOUGH LOCATION
AS NOTED
MCLS
07-16-2020
A099666
001
1
0


PROPOSED TERMINAL CANOPY / SHELTER
PROPOSED BUS STOP / PASSENGER DROP-OFF
PROTECT EXISTING WETLAND
PEDESTRIAN TRAIL
USACE NAVIGABLE CHANNEL DESIGN DREDGE DEPTH EL-30FT
(N) 80' x 33' CONCRETE FLOAT W/ (6) 36" STEEL PIPE PILES AND (2) 36" DONUT FENDER PILES
SHORELINE MHHW (8.22' MLLW)
PROPOSED TERMINAL PARKING (APPROX 250 STALLS)
(N) PILE SUPPORTED PLATFORM
(N) 90' x 10' GANGWAY
PROPOSED ACCESS ROAD
EXISTING RAIL
CONTINUED MATERIAL STOCKPILING AND BULK IMPORT INDUSTRIAL USE SOUTH OF PROPOSED TERMINAL
APPROX LIMITS OF PORT-OWNED PARCEL
N
REDWOOD CITY FERRY TERMINAL - OPTION 2 LAYOUT
0 25 50 100
SCALE FEET
CITY OF REDWOOD CITY
COWI
REDWOOD CITY FERRY FINANCIAL FEASIBILITY STUDY
PRELIMINARY
OPTION 2 LAYOUT - WEST SIDE AT WESTPOINT SLOUGH LOCATION
AS NOTED
MCLS
07-16-2020
A099866
001
2
0

Appendix E

Operating Costs by Route

Appendix E, Table 1
Redwood City - Oakland Ferry Service Operating Costs
Redwood City Ferry Feasibility Study; EPS #181131

Item	Assumptions	10-Year Net Present Value [1]	2019	Year 1 2025	Year 2 2026	Year 3 2027	Year 4 2028	Year 5 2029	Year 6 2030	Year 7 2031	Year 8 2032	Year 9 2033	Year 10 2034	Years 1 - 10 10-Year Total
Service Assumptions														
AM Trips (Peak Direction/ Reverse)	3/3													
PM Trips (Peak Direction/ Reverse)	3/3													
Trip Time (Minutes)	65													
Total Daily Crews [2]	4													
Number of Vessels [3]	2													
Ridership [4]			852	1,067	1,108	1,150	1,194	1,240	1,288	1,337	1,388	1,441	1,496	
Operating Expenses [5]														
Vessel Expenses														
Crew Labor	4.0% per year	$17,120,725	$1,546,307	$1,956,572	$2,034,835	$2,116,228	$2,200,877	$2,288,912	$2,380,469	$2,475,687	$2,574,715	$2,677,703	$2,784,812	$23,490,809
Maintenance	4.0% per year	$12,612,181	$1,139,105	$1,441,331	$1,498,984	$1,558,944	$1,621,302	$1,686,154	$1,753,600	$1,823,744	$1,896,694	$1,972,561	$2,051,464	$17,304,777
Non-Vessel Expenses	4.0% per year	$1,429,396	$129,100	$163,353	$169,887	$176,682	$183,750	$191,100	$198,744	$206,693	$214,961	$223,559	$232,502	$1,961,230
Fixed Operator Expenses	4.0% per year	$2,805,957	$253,428	$320,667	$333,494	$346,834	$360,707	$375,135	$390,141	$405,746	$421,976	$438,855	$456,410	$3,849,966
Direct Expenses	2.0% per year	$7,890,579	$873,831	$984,076	$1,003,757	$1,023,832	$1,044,309	$1,065,195	$1,086,499	$1,108,229	$1,130,394	$1,153,001	$1,176,061	$10,775,354
Fuel/Urea	2.0% per year	$9,794,293	$1,084,655	$1,221,498	$1,245,928	$1,270,846	$1,296,263	$1,322,188	$1,348,632	$1,375,605	$1,403,117	$1,431,179	$1,459,803	$13,375,059
Total, Operating Expenses		**$51,653,131**	**$5,026,426**	**$6,087,496**	**$6,286,885**	**$6,493,366**	**$6,707,207**	**$6,928,684**	**$7,158,084**	**$7,395,705**	**$7,641,856**	**$7,896,860**	**$8,161,051**	**$70,757,194**

[1] NPV calculation uses an annual discount rate of 3%.
[2] Although 4 crews are shown, the assumption is that there will be some shared crewing, so reflects the equivalent of 3 crews in terms of hours and costs
[3] The number of vessels shown here does not include the spare vessel that each route is required to have. If both Redwood City routes (Oakland and San Francisco) were to operate, the two routes could share a spare vessel.
[4] Ridership forecasts provided by CDM Smith and based on commuter trips only to be conservative.
[5] 2019 operating expenses and annual rates of inflation provided by WETA based on analysis of current operations.
Source: WETA; Economic & Planning Systems, Inc.

Appendix E, Table 2
Redwood City - San Francisco Ferry Service Operating Costs
Redwood City Ferry Feasibility Study; EPS #181131

Item	Assumptions	10-Year Net Present Value [1]	2019	Year 1 2025	Year 2 2026	Year 3 2027	Year 4 2028	Year 5 2029	Year 6 2030	Year 7 2031	Year 8 2032	Year 9 2033	Year 10 2034	Years 1 - 10 10-Year Total
Service Assumptions														
AM Trips (Peak Direction/ Reverse)	4/4													
PM Trips (Peak Direction/ Reverse)	4/4													
Trip Time (Minutes)	55													
Total Daily Crews [2]	4													
Number of Vessels [3]	2													
Ridership [4]			1,294	1,503	1,541	1,580	1,620	1,661	1,703	1,746	1,790	1,835	1,882	
Operating Expenses [5]														
Vessel Expenses														
Crew Labor	4.0% per year	$20,142,033	$1,819,185	$2,301,849	$2,393,923	$2,489,680	$2,589,267	$2,692,838	$2,800,552	$2,912,574	$3,029,077	$3,150,240	$3,276,249	$27,636,250
Maintenance	4.0% per year	$12,612,181	$1,139,105	$1,441,331	$1,498,984	$1,558,944	$1,621,302	$1,686,154	$1,753,600	$1,823,744	$1,896,694	$1,972,561	$2,051,464	$17,304,777
Non-Vessel Expenses	4.0% per year	$1,429,396	$129,100	$163,353	$169,887	$176,682	$183,750	$191,100	$198,744	$206,693	$214,961	$223,559	$232,502	$1,961,230
Fixed Operator Expenses	4.0% per year	$2,805,957	$253,428	$320,667	$333,494	$346,834	$360,707	$375,135	$390,141	$405,746	$421,976	$438,855	$456,410	$3,849,966
Direct Expenses	2.0% per year	$7,890,579	$873,831	$984,076	$1,003,757	$1,023,832	$1,044,309	$1,065,195	$1,086,499	$1,108,229	$1,130,394	$1,153,001	$1,176,061	$10,775,354
Fuel/Urea	2.0% per year	$12,127,936	$1,343,091	$1,512,539	$1,542,789	$1,573,645	$1,605,118	$1,637,220	$1,669,965	$1,703,364	$1,737,431	$1,772,180	$1,807,624	$16,561,876
Total, Operating Expenses		**$57,008,082**	**$5,557,740**	**$6,723,815**	**$6,942,835**	**$7,169,618**	**$7,404,453**	**$7,647,642**	**$7,899,500**	**$8,160,350**	**$8,430,533**	**$8,710,397**	**$9,000,310**	**$78,089,452**

[1] NPV calculation uses an annual discount rate of 3%.
[2] Although 4 crews are shown, the assumption is that there will be some shared crewing, so reflects the equivalent of 3 crews in terms of hours and costs
[3] The number of vessels shown here does not include the spare vessel that each route is required to have. If both Redwood City routes (Oakland and San Francisco) were to operate, the two routes could share a spare vessel.
[4] Ridership forecasts provided by CDM Smith and based on commuter trips only to be conservative.
[5] 2019 operating expenses and annual rates of inflation provided by WETA based on analysis of current operations.
Source: WETA; Economic & Planning Systems, Inc.

Appendix F

Farebox Recovery Ratios

Appendix F, Table 1
Redwood City - Oakland Ferry Operating Costs and Farebox Revenues
Redwood City Ferry Feasibility Study; EPS #181131

Item	Assumptions	10-Year Net Present Value [1]	Year 1 2025	Year 2 2026	Year 3 2027	Year 4 2028	Year 5 2029	Year 6 2030	Year 7 2031	Year 8 2032	Year 9 2033	Year 10 2034	Years 1 - 10 10-Year Total
Service Assumptions													
AM Trips (Peak Direction/ Reverse)	3/3												
PM Trips (Peak Direction/ Reverse)	3/3												
Trip Time (Minutes)	65												
Total Daily Crews	4												
Number of Vessels	2												
Total Annual Operating Expenses (see Appendix A)		**$51,653,131**	**$6,087,496**	**$6,286,885**	**$6,493,366**	**$6,707,207**	**$6,928,684**	**$7,158,084**	**$7,395,705**	**$7,641,856**	**$7,896,860**	**$8,161,051**	**$70,757,194**
Fare Assumptions													
Average One-Way Ticket Price [2]	3.0%		$11.65	$12.00	$12.36	$12.73	$13.11	$13.51	$13.91	$14.33	$14.76	$15.20	
Target Ridership													
Required Annual Number of One-Way Trips to Fund Operating Expenses			522,500	523,897	525,343	526,839	528,384	529,979	531,623	533,318	535,062	536,857	5,293,803
Ridership													
Daily, Weekday Ridership			1,067	1,108	1,150	1,194	1,240	1,288	1,337	1,388	1,441	1,496	12,709
Annual Ridership (Assumes 255 Days of Service per Year) [3]	255		272,137	282,546	293,353	304,574	316,223	328,319	340,876	353,914	367,451	381,506	3,240,901
Annual Fare Revenue		**$31,622,386**	$3,170,593	$3,390,620	$3,625,917	$3,877,542	$4,146,629	$4,434,389	$4,742,119	$5,071,204	$5,423,127	$5,799,471	$43,681,611
Farebox Recovery Percentage		61%	52%	54%	56%	58%	60%	62%	64%	66%	69%	71%	62%
Ridership Gap (Variance from Required Passenger Estimate)													
Number			250,363	241,351	231,990	222,265	212,161	201,660	190,747	179,403	167,611	155,351	2,052,902
Percent			48%	46%	44%	42%	40%	38%	36%	34%	31%	29%	39%
Operating Expense Gap (Variance from Estimated Operating Expenses)													
Amount		**$20,030,745**	$2,916,903	$2,896,264	$2,867,449	$2,829,666	$2,782,056	$2,723,695	$2,653,586	$2,570,652	$2,473,733	$2,361,580	$27,075,583
Percent		39%	48%	46%	44%	42%	40%	38%	36%	34%	31%	29%	38%

[1] NPV calculation uses an annual discount rate of 3% and is presented in 2020 dollars.
[2] Average one-way fares assume "average" fares weighted by ridership (consistent with WETA's Vallejo service which is used as a proxy for the Redwood City service), thereby accounting for discounted fares for seniors, youth, etc. Fares are escalated by 3% per year consistent with WETA's adopted fare structure policies.
[3] The annual estimate assumes 255 days of service per year, consistent with WETA's total days of operation in FY2019.

Sources: CDM Smith; WETA; Economic & Planning Systems, Inc.

Appendix F, Table 2
Redwood City - San Francisco Ferry Operating Costs and Farebox Revenues
Redwood City Ferry Feasibility Study; EPS #181131

Item	Assumptions	10-Year Net Present Value [1]	Year 1 2025	Year 2 2026	Year 3 2027	Year 4 2028	Year 5 2029	Year 6 2030	Year 7 2031	Year 8 2032	Year 9 2033	Year 10 2034	Years 1 - 10 10-Year Total
Service Assumptions													
AM Trips (Peak Direction/ Reverse)	4/4												
PM Trips (Peak Direction/ Reverse)	4/4												
Trip Time (Minutes)	55												
Total Daily Crews	4												
Number of Vessels	2												
Total Annual Operating Expenses (see Appendix A)		**$57,008,082**	**$6,723,815**	**$6,942,835**	**$7,169,618**	**$7,404,453**	**$7,647,642**	**$7,899,500**	**$8,160,350**	**$8,430,533**	**$8,710,397**	**$9,000,310**	**$78,089,452**
Fare Assumptions													
Average One-Way Ticket Price [2]	3.0%		$11.65	$12.00	$12.36	$12.73	$13.11	$13.51	$13.91	$14.33	$14.76	$15.20	
Target Ridership													
Required Annual Number of One-Way Trips to Fund Operating Expenses			577,117	578,559	580,055	581,606	583,212	584,873	586,588	588,359	590,185	592,066	5,842,619
Ridership													
Daily, Weekday Ridership			1,503	1,541	1,580	1,620	1,661	1,703	1,746	1,790	1,835	1,882	16,862
Annual Ridership (Assumes 255 Days of Service per Year) [3]	255		383,298	392,988	402,924	413,111	423,556	434,264	445,244	456,501	468,042	479,876	4,299,804
Annual Fare Revenue		**$41,954,397**	$4,465,687	$4,715,950	$4,980,237	$5,259,335	$5,554,074	$5,865,331	$6,194,031	$6,541,151	$6,907,725	$7,294,842	$57,778,362
Farebox Recovery Percentage		74%	66%	68%	69%	71%	73%	74%	76%	78%	79%	81%	74%
Ridership Gap (Variance from Required Passenger Estimate)													
Number			193,819	185,570	177,131	168,495	159,656	150,608	141,344	131,858	122,143	112,191	1,542,815
Percent			34%	32%	31%	29%	27%	26%	24%	22%	21%	19%	26%
Operating Expense Gap (Variance from Estimated Operating Expenses)													
Amount		**$15,053,685**	$2,258,127	$2,226,885	$2,189,381	$2,145,118	$2,093,568	$2,034,169	$1,966,320	$1,889,381	$1,802,673	$1,705,468	$20,311,090
Percent		26%	34%	32%	31%	29%	27%	26%	24%	22%	21%	19%	26%

[1] NPV calculation uses an annual discount rate of 3% and is presented in 2020 dollars.
[2] Average one-way fares assume "average" fares weighted by ridership (consistent with WETA's Vallejo service which is used as a proxy for the Redwood City service), thereby accounting for discounted fares for seniors, youth, etc. Fares are escalated by 3% per year consistent with WETA's adopted fare structure policies.
[3] The annual estimate assumes 255 days of service per year, consistent with WETA's total days of operation in FY2019.

Sources: CDM Smith; WETA; Economic & Planning Systems, Inc.

Appendix G
Role of WETA

WETA operates five ferry routes on San Francisco Bay, providing transbay service from the East Bay and North Bay to San Francisco and from the East Bay to South San Francisco. The Oakland/Alameda, Alameda Harbor Bay, Vallejo, and Richmond routes provide service to the San Francisco Ferry Building with limited service to Pier 41 at San Francisco's Fisherman's Wharf. The South San Francisco route provides service between Oakland, Alameda, and Oyster Point in South San Francisco.

Because this feasibility study occurs within the context of WETA's legislative mandates, plans and programs, and operating experience, this section provides a summary of WETA, its planning and policy documents, and its operations.

Agency Overview

The Water Transit Authority (WTA) was formed in October 1999 by the California State legislature with the mandate to create a long-term plan for new and expanded water borne transit and related services on the San Francisco Bay. The enabling legislation (Senate Bill 428–1999) directed the new regional agency to prepare an Implementation and Operations Plan (IOP) in order to evaluate ridership demand, cost-effectiveness and environmental impact of expanded water transit on San Francisco Bay. In July 2003, the State Legislature approved the IOP and authorized the WTA to operate a comprehensive public water transit system of ferries, feeder buses, and ferry terminals.

WTA was dissolved in January 2008 by State law (SB 976), and replaced by a new agency. The new agency, WETA, was given responsibility for consolidating and operating public ferry services in the Bay Area, planning new service routes and coordinating ferry transportation response to emergencies or disasters affecting the Bay Area transportation system. Under SB 976, WETA was directed to gain control over the existing publicly operated ferries in the Bay Area, except those owned and operated by the Golden Gate Bridge Highway and Transportation District. SB 1093 was subsequently adopted by the State Legislature to clarify the transition of existing Alameda and Vallejo ferry services to WETA. In October 2010 the Alameda City Council and WETA Board adopted the transition agreement for the Alameda/Oakland and Alameda/Harbor Bay services. The transition was completed in April 2011, transforming WETA into a transit operating entity. In October 2011, the Vallejo City Council and WETA Board adopted the transition agreement for the Vallejo service. Transition of the Vallejo Service was completed on July 1, 2012. In addition to operating the three routes transitioned from the cities of Alameda and Vallejo, WETA initiated its first expansion of service in June 2012: a ferry running between Alameda, Oakland, and South San Francisco. Since then, WETA expanded its service again in January 2019 with service between Richmond and San Francisco.

Supporting Bay Area emergency response is another mission of WETA. Ferry service is a safe and reliable means of moving commuters in the event of a major bridge failure or other

disaster that disrupts other transit choices. Solano County is strategically located outside the Bay Area's urban core with good access to ferry service, I-80, I-505, I-5, and Travis Air Force Base, a key facility for emergency relief efforts. Establishing ferry service to Solano County jurisdictions beyond Vallejo would bring the potential for emergency response services to other parts of the County, as the vessels and terminals used for transit services could be redeployed to provide emergency response services if needed.

WETA Guiding Planning Documents

WETA's operations and investments have been guided by a number of planning documents prepared for and adopted by the WETA Board of Directors. These documents include:

- *WETA Strategic Plan.* WETA's 2016 Strategic Plan outlines a vision for the San Francisco Bay Ferry system over the next 20 years that responds to passenger demand, makes critical infrastructure investments, and increases WETA's ability to respond to emergencies and system disruptions. With funding and environmental approvals, WETA's long-range plan calls for new terminals in Treasure Island, Mission Bay, Berkeley, Redwood City, Seaplane Lagoon, the South Bay, and the Carquinez Strait, ultimately creating a robust 16-terminal regional network to meet the Bay Area's demand for a safe, sustainable and environmentally responsible transportation alternative.

- ***WETA's System Expansion Policy.*** The WETA expansion policy is intended to provide a framework for evaluating the feasibility of new ferry projects. The framework consists of policy statements that provide guidance for developing candidate project elements such as landside and waterside facilities, vessels, and service plans. In addition, a set of evaluation measures defines a range of productivity and efficiency metrics that inform the WETA Board and funding partners regarding a project's financial feasibility and sustainability.

- *Implementation & Operations Plan (IOP).* WETA prepared a guiding document called A Strategy to Improve Public Transit with an Environmentally Friendly Ferry System – Final Implementation & Operations Plan, in July 2003. This Plan set out how WETA would achieve its legislative mandate.

- *WETA Short Range Transit Plan 2020 – 2029.* Federal statute requires MTC, in partnership with State and local agencies, to develop and periodically update a long-range RTP and a Transportation Improvement Program (TIP). The TIP implements the RTP by programming federal funds to transportation projects contained in the RTP. In order to effectively execute these planning and fund programming responsibilities, MTC, in cooperation with Region IX of the Federal Transit Administration (FTA), requires each transit operator receiving federal funding to prepare, adopt, and submit a *Short-Range Transit Plan* (SRTP).

  The WETA SRTP has been prepared consistent with MTC's guidelines for all transit operators in the San Francisco Bay Area. It will be updated periodically, consistent with MTC schedules and requirements, to reflect changes to WETA's plans, projects, operations and funding over time. The SRTP has a ten-year horizon (2020 through

2029) and provides a forecast of operating expenses and revenues and capital expenditures and funding, as well as supporting information about WETA's operations and planning activities.

- *Capital Improvement Program.* WETA included a 10-Year Capital Improvement Program (CIP) into the SRTP, as required. The CIP identifies $584.4 million worth of capital projects to be completed during the duration of the Plan (FY 2020 through FY 2029). These capital projects implement its regional program of public transit and emergency response ferry services. The CIP includes both one-time expansion and cyclical rehabilitation and replacement needs for the combined WETA capital assets. The WETA CIP consists of the following five project categories:
  - Revenue Vessel Projects – This includes $422.7 million in projects to rehabilitate, replace and expand the ferry vessel fleet required to operate WETA's ferry vessel fleet, which will consist of a total of 33 revenue vessels by FY2028-29.
  - Major Facilities Rehabilitation/Replacement – This includes $44.9 million in projects to rehabilitate and replace floats and gangways, conduct maintenance dredging, and terminal maintenance.
  - Service Expansion Projects – This includes $111.2 million in projects to build additional ferry terminals and berthing capacity necessary to effectively operate expanded ferry services and emergency response services.
  - Capital Equipment/Small Projects – This includes $5.6 million in expenditures for capital equipment, non-revenue vehicles (e.g., work skiffs, boat trailers, shop vans, and utility carts), and miscellaneous terminal maintenance projects.

Existing WETA Ferry Service Operations

Providing regional public water transportation ferry service in the San Francisco Bay Area is part of WETA's primary mission. WETA's ferry service now consists of five operating lines, summarized in Figure G-1: Alameda/Oakland ferry service, Vallejo ferry service, Richmond ferry service, South San Francisco ferry service, Harbor Bay ferry service. WETA's experience operating these service routes are the basis for the operating cost estimates considered in Section 6 of this Study.

New Ferry Service Planning, Engineering Studies and Environmental Review

Along with securing funding, planning and development of the other proposed ferry lines has been an ongoing WETA activity with substantial funding directed towards engineering and environmental review of the proposed ferry line terminals and operations. From its outset WETA has been involved in planning and analysis of a set of identified potential ferry service routes. These future service routes include those that have moved through the planning process and have been included in the SRTP capital improvement program those that have not yet been funded. The SRTP defines near-term projects as "projects are active or have ongoing or completed major planning milestones". While the SRTP defines future-expansion projects as

"projects are still in preliminary planning or have been proposed and studied in the past but are not currently in active development due to issues such as financial feasibility concerns, environmental constraints, or shifting priorities from local sponsors". Figure G-2 shows WETA's Neat-Term and Future-Expansion terminals and facilities.

Figure G-1 Map of Current WETA Service Routes

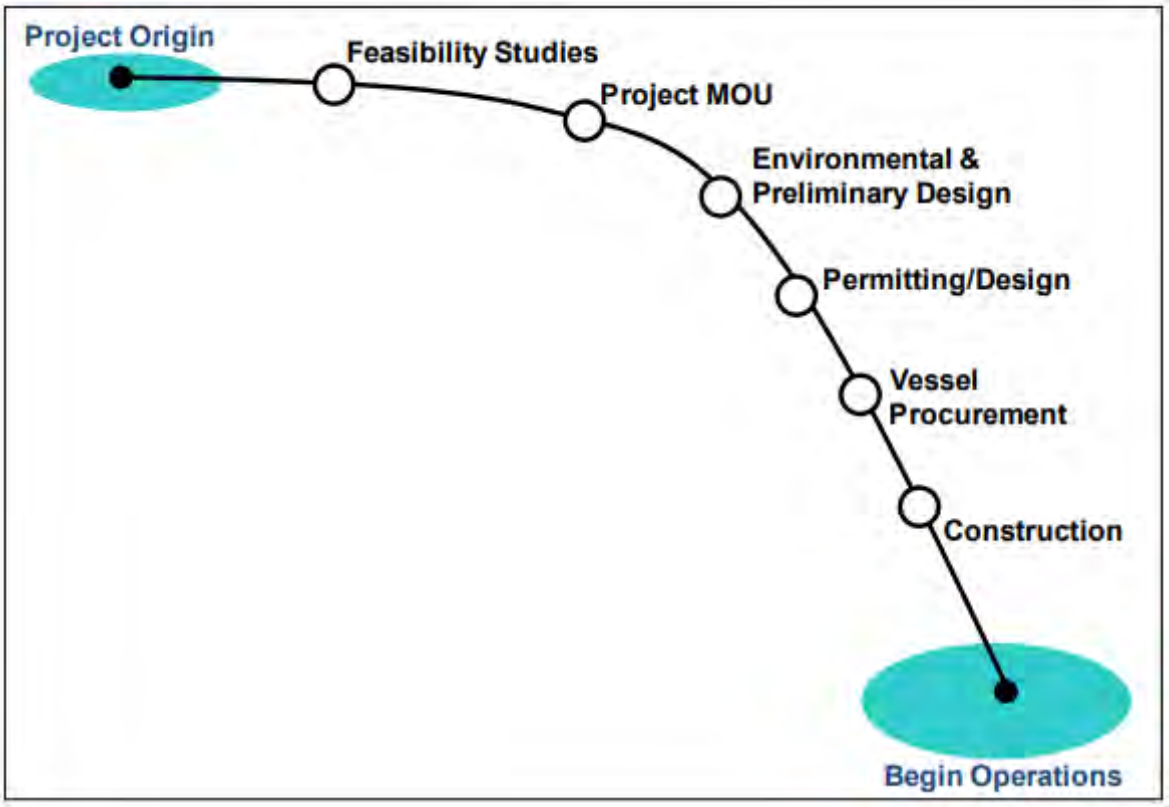
Source: WETA 2020 Strategic Plan

Figure G-2 Map of Near-Term and Future WETA Terminals and Facilities

Source: WETA 2020 Strategic Plan

Developing, and ultimately implementing new ferry services and associated facilities requires an extensive process, including environmental review, design, and construction, as well as securing funding and developing long-term operating plans for new services, as demonstrated in Figure G-3.

Figure G-3 WETA Project Implementation Process



Source: WETA 2020 Short Range Transit Plan

Appendix H

Detailed BCAs and Emissions Calculations

H-1 Detailed BCAs

Figure H-1 Oakland Penalty Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	-$5.06	$2.70	$0.12	$0.75	$0.67	-$0.83	-$0.06	-$0.88	-$6.78	$0.00	-$5.23	-$5.23	-$6.11
5	2025	-$5.22	$2.80	$0.12	$0.77	$0.69	-$0.84	-$0.06	-$0.90	-$6.64	$0.00	-$5.23	-$5.23	-$6.12
6	2026	-$5.39	$2.90	$0.12	$0.80	$0.71	-$0.86	-$0.06	-$0.91	-$6.50	$0.00	-$5.23	-$5.23	-$6.14
7	2027	-$5.56	$3.01	$0.12	$0.83	$0.73	-$0.87	-$0.06	-$0.93	-$6.36	$0.00	-$5.23	-$5.23	-$6.15
8	2028	-$5.74	$3.12	$0.12	$0.86	$0.75	-$0.88	-$0.06	-$0.94	-$6.22	$0.00	-$5.23	-$5.23	-$6.17
9	2029	-$5.92	$3.24	$0.12	$0.90	$0.76	-$0.90	-$0.06	-$0.95	-$6.08	$0.00	-$5.23	-$5.23	-$6.18
10	2030	-$6.11	$3.36	$0.12	$0.93	$0.78	-$0.91	-$0.06	-$0.97	-$5.95	$0.00	-$5.23	-$5.23	-$6.20
11	2031	-$6.31	$3.49	$0.12	$0.96	$0.80	-$0.93	-$0.06	-$0.98	-$5.81	$0.00	-$5.23	-$5.23	-$6.21
12	2032	-$6.51	$3.62	$0.13	$1.00	$0.82	-$0.94	-$0.06	-$1.00	-$5.68	$0.00	-$5.23	-$5.23	-$6.22
13	2033	-$6.73	$3.76	$0.13	$1.04	$0.84	-$0.95	-$0.06	-$1.01	-$5.54	$0.00	-$5.23	-$5.23	-$6.24
14	2034	-$6.95	$3.91	$0.13	$1.08	$0.86	-$0.97	-$0.06	-$1.02	-$5.41	$0.00	-$5.23	-$5.23	-$6.25
15	2035	-$7.17	$4.06	$0.13	$1.12	$0.88	-$0.98	-$0.06	-$1.04	-$5.28	$0.00	-$5.23	-$5.23	-$6.27
16	2036	-$7.41	$4.22	$0.13	$1.16	$0.90	-$1.00	-$0.06	-$1.05	-$5.14	$0.00	-$5.23	-$5.23	-$6.28
17	2037	-$7.65	$4.38	$0.13	$1.21	$0.92	-$1.01	-$0.06	-$1.07	-$5.01	$0.00	-$5.23	-$5.23	-$6.29
18	2038	-$7.91	$4.55	$0.13	$1.26	$0.94	-$1.02	-$0.06	-$1.08	-$4.88	$0.00	-$5.23	-$5.23	-$6.31
19	2039	-$8.17	$4.73	$0.13	$1.31	$0.96	-$1.04	-$0.06	-$1.09	-$4.76	$0.00	-$5.23	-$5.23	-$6.32
20	2040	-$8.44	$4.92	$0.13	$1.36	$0.98	-$1.05	-$0.06	-$1.11	-$4.63	$0.00	-$5.23	-$5.23	-$6.33
21	2041	-$8.72	$5.11	$0.14	$1.41	$1.00	-$1.06	-$0.06	-$1.12	-$4.50	$0.00	-$5.23	-$5.23	-$6.35
22	2042	-$9.02	$5.32	$0.14	$1.47	$1.02	-$1.08	-$0.06	-$1.13	-$4.38	$0.00	-$5.23	-$5.23	-$6.36
23	2043	-$9.32	$5.53	$0.14	$1.53	$1.04	-$1.09	-$0.06	-$1.14	-$4.26	$0.00	-$5.23	-$5.23	-$6.37
24	2044	-$9.64	$5.75	$0.14	$1.59	$1.06	-$1.10	-$0.06	-$1.16	-$4.13	$0.00	-$5.23	-$5.23	-$6.38
25	2045	-$9.97	$5.98	$0.14	$1.65	$1.07	-$1.11	-$0.06	-$1.17	-$4.01	$0.00	-$5.23	-$5.23	-$6.40
26	2046	-$10.31	$6.23	$0.14	$1.72	$1.09	-$1.12	-$0.06	-$1.18	-$3.89	$0.00	-$5.23	-$5.23	-$6.41
27	2047	-$10.66	$6.48	$0.15	$1.79	$1.11	-$1.14	-$0.06	-$1.19	-$3.77	$0.00	-$5.23	-$5.23	-$6.42
28	2048	-$11.03	$6.75	$0.15	$1.86	$1.12	-$1.15	-$0.06	-$1.20	-$3.66	$0.00	-$5.23	-$5.23	-$6.43
29	2049	-$11.41	$7.03	$0.15	$1.94	$1.14	-$1.16	-$0.06	-$1.21	-$3.54	$0.00	-$5.23	-$5.23	-$6.44
30	2050	-$11.81	$7.32	$0.15	$2.02	$1.15	-$1.17	-$0.06	-$1.22	-$3.43	$0.00	-$5.23	-$5.23	-$6.45

	NPV	BCR	Breakeven	IRR
3%	-$160.65	-0.12	$40.93	#N/A
4%	-$145.09	-0.11	$43.93	#N/A
7%	-$111.57	-0.10	$54.27	#N/A

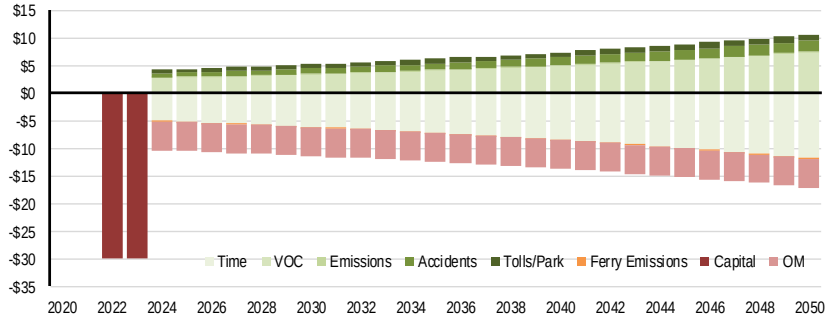


Figure H-2 Oakland Awash Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving												
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Ferry Emissions	Total	Average /Round-Trip	Capital	OM	Total	Net Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	$1.20	$2.70	$0.12	$0.75	$0.67	$5.43	-$0.06	$5.37	$41.22	$0.00	-$5.23	-$5.23	$0.15
5	2025	$1.27	$2.80	$0.12	$0.77	$0.69	$5.65	-$0.06	$5.59	$41.36	$0.00	-$5.23	-$5.23	$0.37
6	2026	$1.35	$2.90	$0.12	$0.80	$0.71	$5.88	-$0.06	$5.82	$41.50	$0.00	-$5.23	-$5.23	$0.60
7	2027	$1.43	$3.01	$0.12	$0.83	$0.73	$6.12	-$0.06	$6.06	$41.64	$0.00	-$5.23	-$5.23	$0.84
8	2028	$1.52	$3.12	$0.12	$0.86	$0.75	$6.37	-$0.06	$6.32	$41.78	$0.00	-$5.23	-$5.23	$1.09
9	2029	$1.61	$3.24	$0.12	$0.90	$0.76	$6.63	-$0.06	$6.58	$41.92	$0.00	-$5.23	-$5.23	$1.35
10	2030	$1.71	$3.36	$0.12	$0.93	$0.78	$6.91	-$0.06	$6.85	$42.06	$0.00	-$5.23	-$5.23	$1.62
11	2031	$1.81	$3.49	$0.12	$0.96	$0.80	$7.19	-$0.06	$7.14	$42.19	$0.00	-$5.23	-$5.23	$1.91
12	2032	$1.92	$3.62	$0.13	$1.00	$0.82	$7.49	-$0.06	$7.43	$42.33	$0.00	-$5.23	-$5.23	$2.21
13	2033	$2.03	$3.76	$0.13	$1.04	$0.84	$7.80	-$0.06	$7.75	$42.46	$0.00	-$5.23	-$5.23	$2.52
14	2034	$2.15	$3.91	$0.13	$1.08	$0.86	$8.13	-$0.06	$8.07	$42.60	$0.00	-$5.23	-$5.23	$2.85
15	2035	$2.28	$4.06	$0.13	$1.12	$0.88	$8.47	-$0.06	$8.41	$42.73	$0.00	-$5.23	-$5.23	$3.19
16	2036	$2.41	$4.22	$0.13	$1.16	$0.90	$8.82	-$0.06	$8.77	$42.86	$0.00	-$5.23	-$5.23	$3.54
17	2037	$2.55	$4.38	$0.13	$1.21	$0.92	$9.20	-$0.06	$9.14	$42.99	$0.00	-$5.23	-$5.23	$3.91
18	2038	$2.70	$4.55	$0.13	$1.26	$0.94	$9.59	-$0.06	$9.53	$43.12	$0.00	-$5.23	-$5.23	$4.30
19	2039	$2.86	$4.73	$0.13	$1.31	$0.96	$9.99	-$0.06	$9.94	$43.25	$0.00	-$5.23	-$5.23	$4.71
20	2040	$3.03	$4.92	$0.13	$1.36	$0.98	$10.42	-$0.06	$10.36	$43.37	$0.00	-$5.23	-$5.23	$5.14
21	2041	$3.20	$5.11	$0.14	$1.41	$1.00	$10.87	-$0.06	$10.81	$43.50	$0.00	-$5.23	-$5.23	$5.58
22	2042	$3.39	$5.32	$0.14	$1.47	$1.02	$11.33	-$0.06	$11.28	$43.62	$0.00	-$5.23	-$5.23	$6.05
23	2043	$3.59	$5.53	$0.14	$1.53	$1.04	$11.82	-$0.06	$11.76	$43.75	$0.00	-$5.23	-$5.23	$6.54
24	2044	$3.79	$5.75	$0.14	$1.59	$1.06	$12.33	-$0.06	$12.28	$43.87	$0.00	-$5.23	-$5.23	$7.05
25	2045	$4.01	$5.98	$0.14	$1.65	$1.07	$12.87	-$0.06	$12.81	$43.99	$0.00	-$5.23	-$5.23	$7.59
26	2046	$4.24	$6.23	$0.14	$1.72	$1.09	$13.43	-$0.06	$13.37	$44.11	$0.00	-$5.23	-$5.23	$8.15
27	2047	$4.49	$6.48	$0.15	$1.79	$1.11	$14.02	-$0.06	$13.96	$44.23	$0.00	-$5.23	-$5.23	$8.73
28	2048	$4.75	$6.75	$0.15	$1.86	$1.12	$14.63	-$0.06	$14.58	$44.35	$0.00	-$5.23	-$5.23	$9.35
29	2049	$5.02	$7.03	$0.15	$1.94	$1.14	$15.28	-$0.06	$15.22	$44.46	$0.00	-$5.23	-$5.23	$10.00
30	2050	$5.31	$7.32	$0.15	$2.02	$1.15	$15.96	-$0.06	$15.90	$44.58	$0.00	-$5.23	-$5.23	$10.67

	NPV	BCR	Breakeven	IRR
3%	$7.36	1.05	$40.93	3.7%
4%	-$2.89	0.98	$43.93	3.7%
7%	-$21.63	0.79	$54.27	3.7%

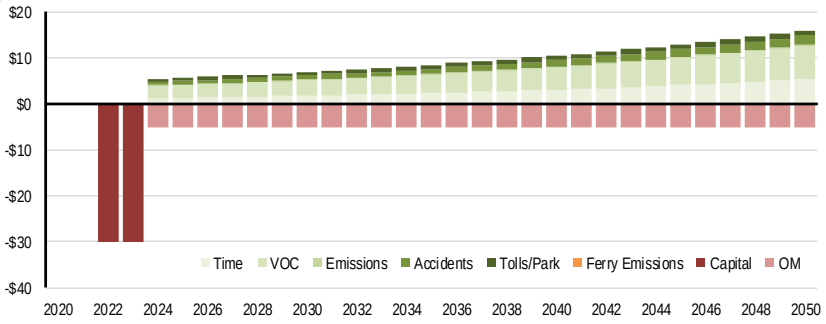


Figure H-3 Oakland Amenity Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	$4.33	$2.70	$0.12	$0.75	$0.67	$8.56	-$0.06	$8.50	$65.22	$0.00	-$5.23	-$5.23	$3.28
5	2025	$4.52	$2.80	$0.12	$0.77	$0.69	$8.90	-$0.06	$8.84	$65.37	$0.00	-$5.23	-$5.23	$3.61
6	2026	$4.72	$2.90	$0.12	$0.80	$0.71	$9.25	-$0.06	$9.19	$65.51	$0.00	-$5.23	-$5.23	$3.97
7	2027	$4.93	$3.01	$0.12	$0.83	$0.73	$9.62	-$0.06	$9.56	$65.64	$0.00	-$5.23	-$5.23	$4.33
8	2028	$5.15	$3.12	$0.12	$0.86	$0.75	$10.00	-$0.06	$9.94	$65.78	$0.00	-$5.23	-$5.23	$4.72
9	2029	$5.38	$3.24	$0.12	$0.90	$0.76	$10.40	-$0.06	$10.34	$65.92	$0.00	-$5.23	-$5.23	$5.12
10	2030	$5.62	$3.36	$0.12	$0.93	$0.78	$10.82	-$0.06	$10.76	$66.06	$0.00	-$5.23	-$5.23	$5.53
11	2031	$5.87	$3.49	$0.12	$0.96	$0.80	$11.25	-$0.06	$11.20	$66.19	$0.00	-$5.23	-$5.23	$5.97
12	2032	$6.13	$3.62	$0.13	$1.00	$0.82	$11.71	-$0.06	$11.65	$66.33	$0.00	-$5.23	-$5.23	$6.42
13	2033	$6.41	$3.76	$0.13	$1.04	$0.84	$12.18	-$0.06	$12.13	$66.46	$0.00	-$5.23	-$5.23	$6.90
14	2034	$6.70	$3.91	$0.13	$1.08	$0.86	$12.68	-$0.06	$12.62	$66.60	$0.00	-$5.23	-$5.23	$7.39
15	2035	$7.00	$4.06	$0.13	$1.12	$0.88	$13.19	-$0.06	$13.14	$66.73	$0.00	-$5.23	-$5.23	$7.91
16	2036	$7.32	$4.22	$0.13	$1.16	$0.90	$13.74	-$0.06	$13.68	$66.86	$0.00	-$5.23	-$5.23	$8.45
17	2037	$7.66	$4.38	$0.13	$1.21	$0.92	$14.30	-$0.06	$14.24	$66.99	$0.00	-$5.23	-$5.23	$9.02
18	2038	$8.01	$4.55	$0.13	$1.26	$0.94	$14.89	-$0.06	$14.84	$67.12	$0.00	-$5.23	-$5.23	$9.61
19	2039	$8.38	$4.73	$0.13	$1.31	$0.96	$15.51	-$0.06	$15.45	$67.25	$0.00	-$5.23	-$5.23	$10.23
20	2040	$8.76	$4.92	$0.13	$1.36	$0.98	$16.15	-$0.06	$16.10	$67.37	$0.00	-$5.23	-$5.23	$10.87
21	2041	$9.17	$5.11	$0.14	$1.41	$1.00	$16.83	-$0.06	$16.77	$67.50	$0.00	-$5.23	-$5.23	$11.55
22	2042	$9.59	$5.32	$0.14	$1.47	$1.02	$17.54	-$0.06	$17.48	$67.63	$0.00	-$5.23	-$5.23	$12.25
23	2043	$10.04	$5.53	$0.14	$1.53	$1.04	$18.27	-$0.06	$18.22	$67.75	$0.00	-$5.23	-$5.23	$12.99
24	2044	$10.51	$5.75	$0.14	$1.59	$1.06	$19.05	-$0.06	$18.99	$67.87	$0.00	-$5.23	-$5.23	$13.77
25	2045	$11.00	$5.98	$0.14	$1.65	$1.07	$19.86	-$0.06	$19.80	$67.99	$0.00	-$5.23	-$5.23	$14.58
26	2046	$11.52	$6.23	$0.14	$1.72	$1.09	$20.71	-$0.06	$20.65	$68.11	$0.00	-$5.23	-$5.23	$15.42
27	2047	$12.07	$6.48	$0.15	$1.79	$1.11	$21.59	-$0.06	$21.54	$68.23	$0.00	-$5.23	-$5.23	$16.31
28	2048	$12.64	$6.75	$0.15	$1.86	$1.12	$22.52	-$0.06	$22.47	$68.35	$0.00	-$5.23	-$5.23	$17.24
29	2049	$13.24	$7.03	$0.15	$1.94	$1.14	$23.50	-$0.06	$23.44	$68.46	$0.00	-$5.23	-$5.23	$18.21
30	2050	$13.87	$7.32	$0.15	$2.02	$1.15	$24.52	-$0.06	$24.46	$68.58	$0.00	-$5.23	-$5.23	$19.24

	NPV	BCR	Breakeven	IRR
3%	$91.36	1.64	$40.93	10.0%
4%	$68.21	1.52	$43.93	10.0%
7%	$23.35	1.23	$54.27	10.0%

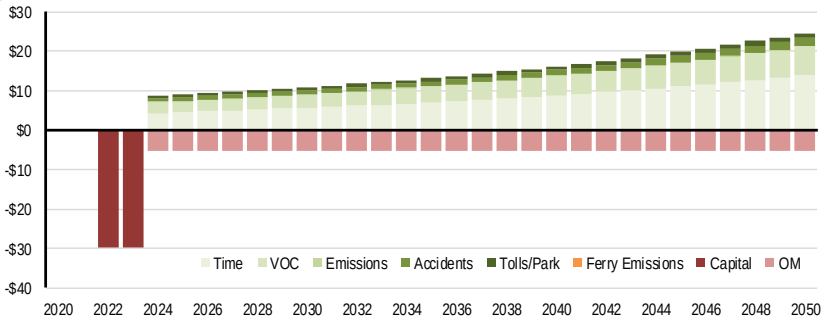


Figure H-4 San Francisco Penalty Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	-$6.67	$4.36	$0.19	$1.20	-$0.90	-$1.82	-$0.07	-$1.89	-$10.12	$0.00	-$5.76	-$5.76	-$7.65
5	2025	-$6.82	$4.46	$0.19	$1.23	-$0.92	-$1.86	-$0.07	-$1.93	-$10.08	$0.00	-$5.76	-$5.76	-$7.69
6	2026	-$6.98	$4.57	$0.19	$1.26	-$0.95	-$1.90	-$0.07	-$1.97	-$10.04	$0.00	-$5.76	-$5.76	-$7.73
7	2027	-$7.14	$4.69	$0.19	$1.30	-$0.97	-$1.94	-$0.07	-$2.01	-$10.01	$0.00	-$5.76	-$5.76	-$7.77
8	2028	-$7.30	$4.80	$0.19	$1.33	-$1.00	-$1.99	-$0.07	-$2.06	-$9.97	$0.00	-$5.76	-$5.76	-$7.81
9	2029	-$7.47	$4.92	$0.19	$1.36	-$1.03	-$2.03	-$0.07	-$2.10	-$9.93	$0.00	-$5.76	-$5.76	-$7.86
10	2030	-$7.65	$5.05	$0.18	$1.39	-$1.06	-$2.07	-$0.07	-$2.14	-$9.89	$0.00	-$5.76	-$5.76	-$7.90
11	2031	-$7.82	$5.17	$0.18	$1.43	-$1.08	-$2.12	-$0.07	-$2.19	-$9.85	$0.00	-$5.76	-$5.76	-$7.95
12	2032	-$8.00	$5.30	$0.18	$1.47	-$1.11	-$2.17	-$0.07	-$2.24	-$9.81	$0.00	-$5.76	-$5.76	-$7.99
13	2033	-$8.19	$5.44	$0.18	$1.50	-$1.15	-$2.21	-$0.07	-$2.28	-$9.77	$0.00	-$5.76	-$5.76	-$8.04
14	2034	-$8.38	$5.57	$0.18	$1.54	-$1.18	-$2.26	-$0.07	-$2.33	-$9.73	$0.00	-$5.76	-$5.76	-$8.09
15	2035	-$8.57	$5.71	$0.18	$1.58	-$1.21	-$2.31	-$0.07	-$2.38	-$9.69	$0.00	-$5.76	-$5.76	-$8.14
16	2036	-$8.77	$5.85	$0.18	$1.62	-$1.24	-$2.36	-$0.07	-$2.43	-$9.64	$0.00	-$5.76	-$5.76	-$8.19
17	2037	-$8.97	$6.00	$0.18	$1.66	-$1.28	-$2.41	-$0.07	-$2.48	-$9.60	$0.00	-$5.76	-$5.76	-$8.24
18	2038	-$9.18	$6.15	$0.18	$1.70	-$1.31	-$2.46	-$0.07	-$2.53	-$9.56	$0.00	-$5.76	-$5.76	-$8.29
19	2039	-$9.39	$6.31	$0.18	$1.74	-$1.35	-$2.52	-$0.07	-$2.58	-$9.51	$0.00	-$5.76	-$5.76	-$8.34
20	2040	-$9.61	$6.47	$0.18	$1.79	-$1.39	-$2.57	-$0.07	-$2.64	-$9.47	$0.00	-$5.76	-$5.76	-$8.40
21	2041	-$9.84	$6.63	$0.18	$1.83	-$1.43	-$2.62	-$0.07	-$2.69	-$9.42	$0.00	-$5.76	-$5.76	-$8.45
22	2042	-$10.07	$6.80	$0.18	$1.88	-$1.47	-$2.68	-$0.07	-$2.75	-$9.37	$0.00	-$5.76	-$5.76	-$8.51
23	2043	-$10.30	$6.97	$0.18	$1.93	-$1.51	-$2.74	-$0.07	-$2.81	-$9.33	$0.00	-$5.76	-$5.76	-$8.56
24	2044	-$10.54	$7.15	$0.17	$1.98	-$1.55	-$2.79	-$0.07	-$2.86	-$9.28	$0.00	-$5.76	-$5.76	-$8.62
25	2045	-$10.79	$7.33	$0.17	$2.03	-$1.60	-$2.85	-$0.07	-$2.92	-$9.23	$0.00	-$5.76	-$5.76	-$8.68
26	2046	-$11.04	$7.52	$0.17	$2.08	-$1.64	-$2.91	-$0.07	-$2.98	-$9.19	$0.00	-$5.76	-$5.76	-$8.74
27	2047	-$11.29	$7.71	$0.17	$2.13	-$1.69	-$2.97	-$0.07	-$3.04	-$9.14	$0.00	-$5.76	-$5.76	-$8.80
28	2048	-$11.56	$7.90	$0.17	$2.18	-$1.74	-$3.04	-$0.07	-$3.10	-$9.09	$0.00	-$5.76	-$5.76	-$8.86
29	2049	-$11.83	$8.11	$0.17	$2.24	-$1.79	-$3.10	-$0.07	-$3.17	-$9.04	$0.00	-$5.76	-$5.76	-$8.93
30	2050	-$12.11	$8.31	$0.17	$2.30	-$1.84	-$3.16	-$0.07	-$3.23	-$8.99	$0.00	-$5.76	-$5.76	-$8.99

	NPV	BCR	Breakeven	IRR
3%	-$192.70	-0.27	$35.99	#N/A
4%	-$172.53	-0.25	$38.22	#N/A
7%	-$129.51	-0.21	$45.81	#N/A

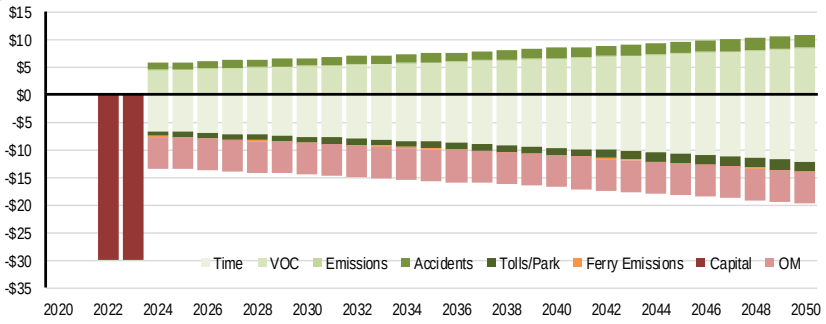


Figure H-5 San Francisco Awash Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	$0.91	$4.36	$0.19	$1.20	-$0.90	$5.76	-$0.07	$5.69	$30.50	$0.00	-$5.76	-$5.76	-$0.06
5	2025	$0.95	$4.46	$0.19	$1.23	-$0.92	$5.91	-$0.07	$5.84	$30.54	$0.00	-$5.76	-$5.76	$0.09
6	2026	$0.99	$4.57	$0.19	$1.26	-$0.95	$6.07	-$0.07	$6.00	$30.57	$0.00	-$5.76	-$5.76	$0.24
7	2027	$1.03	$4.69	$0.19	$1.30	-$0.97	$6.23	-$0.07	$6.16	$30.61	$0.00	-$5.76	-$5.76	$0.40
8	2028	$1.07	$4.80	$0.19	$1.33	-$1.00	$6.39	-$0.07	$6.32	$30.65	$0.00	-$5.76	-$5.76	$0.56
9	2029	$1.11	$4.92	$0.19	$1.36	-$1.03	$6.56	-$0.07	$6.49	$30.69	$0.00	-$5.76	-$5.76	$0.73
10	2030	$1.16	$5.05	$0.18	$1.39	-$1.06	$6.73	-$0.07	$6.66	$30.73	$0.00	-$5.76	-$5.76	$0.90
11	2031	$1.20	$5.17	$0.18	$1.43	-$1.08	$6.91	-$0.07	$6.84	$30.77	$0.00	-$5.76	-$5.76	$1.08
12	2032	$1.25	$5.30	$0.18	$1.47	-$1.11	$7.09	-$0.07	$7.02	$30.81	$0.00	-$5.76	-$5.76	$1.26
13	2033	$1.30	$5.44	$0.18	$1.50	-$1.15	$7.28	-$0.07	$7.21	$30.85	$0.00	-$5.76	-$5.76	$1.45
14	2034	$1.35	$5.57	$0.18	$1.54	-$1.18	$7.47	-$0.07	$7.40	$30.89	$0.00	-$5.76	-$5.76	$1.64
15	2035	$1.41	$5.71	$0.18	$1.58	-$1.21	$7.67	-$0.07	$7.60	$30.93	$0.00	-$5.76	-$5.76	$1.84
16	2036	$1.46	$5.85	$0.18	$1.62	-$1.24	$7.87	-$0.07	$7.80	$30.97	$0.00	-$5.76	-$5.76	$2.05
17	2037	$1.52	$6.00	$0.18	$1.66	-$1.28	$8.08	-$0.07	$8.01	$31.02	$0.00	-$5.76	-$5.76	$2.26
18	2038	$1.58	$6.15	$0.18	$1.70	-$1.31	$8.30	-$0.07	$8.23	$31.06	$0.00	-$5.76	-$5.76	$2.47
19	2039	$1.64	$6.31	$0.18	$1.74	-$1.35	$8.52	-$0.07	$8.45	$31.11	$0.00	-$5.76	-$5.76	$2.70
20	2040	$1.71	$6.47	$0.18	$1.79	-$1.39	$8.75	-$0.07	$8.68	$31.15	$0.00	-$5.76	-$5.76	$2.92
21	2041	$1.77	$6.63	$0.18	$1.83	-$1.43	$8.99	-$0.07	$8.92	$31.20	$0.00	-$5.76	-$5.76	$3.16
22	2042	$1.84	$6.80	$0.18	$1.88	-$1.47	$9.23	-$0.07	$9.16	$31.24	$0.00	-$5.76	-$5.76	$3.40
23	2043	$1.92	$6.97	$0.18	$1.93	-$1.51	$9.48	-$0.07	$9.41	$31.29	$0.00	-$5.76	-$5.76	$3.65
24	2044	$1.99	$7.15	$0.17	$1.98	-$1.55	$9.74	-$0.07	$9.67	$31.34	$0.00	-$5.76	-$5.76	$3.91
25	2045	$2.07	$7.33	$0.17	$2.03	-$1.60	$10.00	-$0.07	$9.93	$31.38	$0.00	-$5.76	-$5.76	$4.17
26	2046	$2.15	$7.52	$0.17	$2.08	-$1.64	$10.27	-$0.07	$10.20	$31.43	$0.00	-$5.76	-$5.76	$4.45
27	2047	$2.23	$7.71	$0.17	$2.13	-$1.69	$10.55	-$0.07	$10.48	$31.48	$0.00	-$5.76	-$5.76	$4.73
28	2048	$2.32	$7.90	$0.17	$2.18	-$1.74	$10.84	-$0.07	$10.77	$31.53	$0.00	-$5.76	-$5.76	$5.01
29	2049	$2.41	$8.11	$0.17	$2.24	-$1.79	$11.14	-$0.07	$11.07	$31.58	$0.00	-$5.76	-$5.76	$5.31
30	2050	$2.50	$8.31	$0.17	$2.30	-$1.84	$11.44	-$0.07	$11.37	$31.63	$0.00	-$5.76	-$5.76	$5.61

	NPV	BCR	Breakeven	IRR
3%	-$21.01	0.86	$35.99	0.5%
4%	-$26.06	0.81	$38.22	0.5%
7%	-$34.73	0.68	$45.81	0.5%

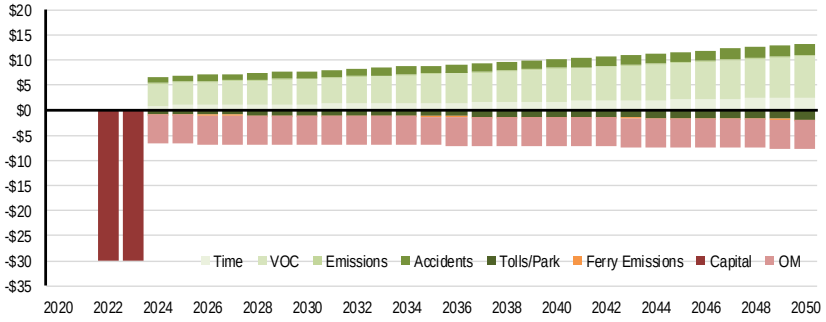


Figure H-6 San Francisco Amenity Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$29.92	$0.00	-$29.92	-$29.92
4	2024	$4.70	$4.36	$0.19	$1.20	-$0.90	$9.55	-$0.07	$9.48	$50.81	$0.00	-$5.76	-$5.76	$3.73
5	2025	$4.84	$4.46	$0.19	$1.23	-$0.92	$9.80	-$0.07	$9.73	$50.85	$0.00	-$5.76	-$5.76	$3.97
6	2026	$4.97	$4.57	$0.19	$1.26	-$0.95	$10.05	-$0.07	$9.98	$50.88	$0.00	-$5.76	-$5.76	$4.22
7	2027	$5.11	$4.69	$0.19	$1.30	-$0.97	$10.31	-$0.07	$10.24	$50.92	$0.00	-$5.76	-$5.76	$4.48
8	2028	$5.26	$4.80	$0.19	$1.33	-$1.00	$10.58	-$0.07	$10.51	$50.96	$0.00	-$5.76	-$5.76	$4.75
9	2029	$5.41	$4.92	$0.19	$1.36	-$1.03	$10.85	-$0.07	$10.78	$51.00	$0.00	-$5.76	-$5.76	$5.02
10	2030	$5.56	$5.05	$0.18	$1.39	-$1.06	$11.13	-$0.07	$11.06	$51.04	$0.00	-$5.76	-$5.76	$5.30
11	2031	$5.72	$5.17	$0.18	$1.43	-$1.08	$11.42	-$0.07	$11.35	$51.08	$0.00	-$5.76	-$5.76	$5.59
12	2032	$5.88	$5.30	$0.18	$1.47	-$1.11	$11.72	-$0.07	$11.65	$51.12	$0.00	-$5.76	-$5.76	$5.89
13	2033	$6.05	$5.44	$0.18	$1.50	-$1.15	$12.02	-$0.07	$11.95	$51.16	$0.00	-$5.76	-$5.76	$6.19
14	2034	$6.22	$5.57	$0.18	$1.54	-$1.18	$12.34	-$0.07	$12.27	$51.20	$0.00	-$5.76	-$5.76	$6.51
15	2035	$6.40	$5.71	$0.18	$1.58	-$1.21	$12.66	-$0.07	$12.59	$51.24	$0.00	-$5.76	-$5.76	$6.83
16	2036	$6.58	$5.85	$0.18	$1.62	-$1.24	$12.99	-$0.07	$12.92	$51.28	$0.00	-$5.76	-$5.76	$7.16
17	2037	$6.77	$6.00	$0.18	$1.66	-$1.28	$13.33	-$0.07	$13.26	$51.33	$0.00	-$5.76	-$5.76	$7.50
18	2038	$6.96	$6.15	$0.18	$1.70	-$1.31	$13.68	-$0.07	$13.61	$51.37	$0.00	-$5.76	-$5.76	$7.85
19	2039	$7.16	$6.31	$0.18	$1.74	-$1.35	$14.04	-$0.07	$13.97	$51.42	$0.00	-$5.76	-$5.76	$8.21
20	2040	$7.37	$6.47	$0.18	$1.79	-$1.39	$14.41	-$0.07	$14.34	$51.46	$0.00	-$5.76	-$5.76	$8.58
21	2041	$7.58	$6.63	$0.18	$1.83	-$1.43	$14.79	-$0.07	$14.72	$51.51	$0.00	-$5.76	-$5.76	$8.97
22	2042	$7.80	$6.80	$0.18	$1.88	-$1.47	$15.18	-$0.07	$15.12	$51.55	$0.00	-$5.76	-$5.76	$9.36
23	2043	$8.02	$6.97	$0.18	$1.93	-$1.51	$15.59	-$0.07	$15.52	$51.60	$0.00	-$5.76	-$5.76	$9.76
24	2044	$8.26	$7.15	$0.17	$1.98	-$1.55	$16.00	-$0.07	$15.93	$51.65	$0.00	-$5.76	-$5.76	$10.17
25	2045	$8.49	$7.33	$0.17	$2.03	-$1.60	$16.43	-$0.07	$16.36	$51.69	$0.00	-$5.76	-$5.76	$10.60
26	2046	$8.74	$7.52	$0.17	$2.08	-$1.64	$16.87	-$0.07	$16.80	$51.74	$0.00	-$5.76	-$5.76	$11.04
27	2047	$8.99	$7.71	$0.17	$2.13	-$1.69	$17.32	-$0.07	$17.25	$51.79	$0.00	-$5.76	-$5.76	$11.49
28	2048	$9.26	$7.90	$0.17	$2.18	-$1.74	$17.78	-$0.07	$17.71	$51.84	$0.00	-$5.76	-$5.76	$11.95
29	2049	$9.52	$8.11	$0.17	$2.24	-$1.79	$18.25	-$0.07	$18.19	$51.89	$0.00	-$5.76	-$5.76	$12.43
30	2050	$9.80	$8.31	$0.17	$2.30	-$1.84	$18.74	-$0.07	$18.67	$51.94	$0.00	-$5.76	-$5.76	$12.92

	NPV	BCR	Breakeven	IRR
3%	$64.84	1.43	$35.99	8.9%
4%	$47.18	1.34	$38.22	8.9%
7%	$12.66	1.12	$45.81	8.9%

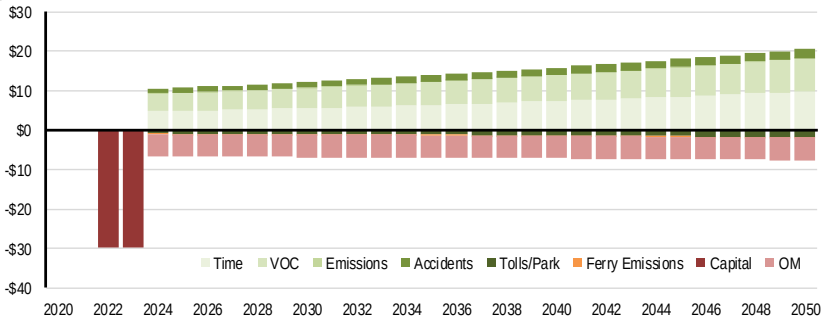


Figure H-7 Combined Penalty Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
4	2024	-$11.73	$7.05	$0.31	$1.95	-$0.23	-$2.65	-$0.13	-$2.77	-$8.74	$0.00	-$10.78	-$10.78	-$13.56
5	2025	-$12.04	$7.26	$0.31	$2.01	-$0.23	-$2.70	-$0.13	-$2.83	-$8.65	$0.00	-$10.78	-$10.78	-$13.61
6	2026	-$12.37	$7.48	$0.31	$2.07	-$0.24	-$2.76	-$0.13	-$2.88	-$8.57	$0.00	-$10.78	-$10.78	-$13.67
7	2027	-$12.70	$7.70	$0.31	$2.13	-$0.25	-$2.81	-$0.13	-$2.94	-$8.47	$0.00	-$10.78	-$10.78	-$13.72
8	2028	-$13.04	$7.93	$0.31	$2.19	-$0.25	-$2.87	-$0.13	-$3.00	-$8.38	$0.00	-$10.78	-$10.78	-$13.78
9	2029	-$13.39	$8.17	$0.31	$2.26	-$0.26	-$2.93	-$0.13	-$3.05	-$8.29	$0.00	-$10.78	-$10.78	-$13.84
10	2030	-$13.76	$8.41	$0.31	$2.32	-$0.27	-$2.99	-$0.13	-$3.11	-$8.20	$0.00	-$10.78	-$10.78	-$13.90
11	2031	-$14.13	$8.66	$0.31	$2.39	-$0.28	-$3.05	-$0.13	-$3.17	-$8.10	$0.00	-$10.78	-$10.78	-$13.96
12	2032	-$14.52	$8.93	$0.31	$2.47	-$0.29	-$3.11	-$0.13	-$3.23	-$8.01	$0.00	-$10.78	-$10.78	-$14.02
13	2033	-$14.91	$9.20	$0.31	$2.54	-$0.30	-$3.17	-$0.13	-$3.29	-$7.92	$0.00	-$10.78	-$10.78	-$14.08
14	2034	-$15.32	$9.48	$0.31	$2.62	-$0.32	-$3.23	-$0.13	-$3.36	-$7.82	$0.00	-$10.78	-$10.78	-$14.14
15	2035	-$15.74	$9.77	$0.31	$2.70	-$0.33	-$3.29	-$0.13	-$3.42	-$7.72	$0.00	-$10.78	-$10.78	-$14.20
16	2036	-$16.18	$10.07	$0.31	$2.78	-$0.34	-$3.36	-$0.13	-$3.48	-$7.63	$0.00	-$10.78	-$10.78	-$14.27
17	2037	-$16.63	$10.38	$0.31	$2.87	-$0.36	-$3.42	-$0.13	-$3.55	-$7.53	$0.00	-$10.78	-$10.78	-$14.33
18	2038	-$17.09	$10.71	$0.31	$2.96	-$0.37	-$3.49	-$0.13	-$3.61	-$7.43	$0.00	-$10.78	-$10.78	-$14.40
19	2039	-$17.56	$11.04	$0.31	$3.05	-$0.39	-$3.55	-$0.13	-$3.68	-$7.33	$0.00	-$10.78	-$10.78	-$14.46
20	2040	-$18.05	$11.39	$0.31	$3.15	-$0.41	-$3.62	-$0.13	-$3.74	-$7.23	$0.00	-$10.78	-$10.78	-$14.53
21	2041	-$18.56	$11.74	$0.31	$3.24	-$0.43	-$3.69	-$0.13	-$3.81	-$7.13	$0.00	-$10.78	-$10.78	-$14.60
22	2042	-$19.08	$12.12	$0.31	$3.35	-$0.45	-$3.76	-$0.13	-$3.88	-$7.03	$0.00	-$10.78	-$10.78	-$14.66
23	2043	-$19.62	$12.50	$0.31	$3.45	-$0.47	-$3.82	-$0.13	-$3.95	-$6.93	$0.00	-$10.78	-$10.78	-$14.73
24	2044	-$20.18	$12.90	$0.32	$3.56	-$0.50	-$3.89	-$0.13	-$4.02	-$6.83	$0.00	-$10.78	-$10.78	-$14.80
25	2045	-$20.75	$13.31	$0.32	$3.68	-$0.52	-$3.97	-$0.13	-$4.09	-$6.73	$0.00	-$10.78	-$10.78	-$14.87
26	2046	-$21.35	$13.74	$0.32	$3.80	-$0.55	-$4.04	-$0.13	-$4.16	-$6.63	$0.00	-$10.78	-$10.78	-$14.95
27	2047	-$21.96	$14.19	$0.32	$3.92	-$0.58	-$4.11	-$0.13	-$4.23	-$6.53	$0.00	-$10.78	-$10.78	-$15.02
28	2048	-$22.59	$14.65	$0.32	$4.05	-$0.61	-$4.18	-$0.13	-$4.31	-$6.43	$0.00	-$10.78	-$10.78	-$15.09
29	2049	-$23.24	$15.13	$0.32	$4.18	-$0.65	-$4.25	-$0.13	-$4.38	-$6.32	$0.00	-$10.78	-$10.78	-$15.16
30	2050	-$23.92	$15.63	$0.32	$4.32	-$0.68	-$4.33	-$0.13	-$4.45	-$6.22	$0.00	-$10.78	-$10.78	-$15.24

	NPV	BCR	Breakeven	IRR
3%	-$331.57	-0.21	$35.41	#N/A
4%	-$296.73	-0.20	$37.62	#N/A
7%	-$222.36	-0.17	$45.13	#N/A

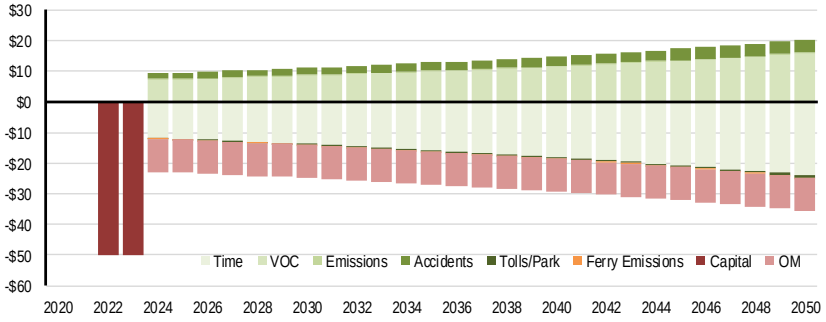


Figure H-8 Combined Awash Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry		Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions	Total	/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
4	2024	$2.11	$7.05	$0.31	$1.95	-$0.23	$11.19	-$0.13	$11.07	$34.91	$0.00	-$10.78	-$10.78	$0.28
5	2025	$2.22	$7.26	$0.31	$2.01	-$0.23	$11.56	-$0.13	$11.44	$35.02	$0.00	-$10.78	-$10.78	$0.65
6	2026	$2.34	$7.48	$0.31	$2.07	-$0.24	$11.95	-$0.13	$11.82	$35.13	$0.00	-$10.78	-$10.78	$1.04
7	2027	$2.46	$7.70	$0.31	$2.13	-$0.25	$12.35	-$0.13	$12.22	$35.25	$0.00	-$10.78	-$10.78	$1.44
8	2028	$2.59	$7.93	$0.31	$2.19	-$0.25	$12.76	-$0.13	$12.63	$35.36	$0.00	-$10.78	-$10.78	$1.85
9	2029	$2.72	$8.17	$0.31	$2.26	-$0.26	$13.19	-$0.13	$13.06	$35.47	$0.00	-$10.78	-$10.78	$2.28
10	2030	$2.87	$8.41	$0.31	$2.32	-$0.27	$13.64	-$0.13	$13.51	$35.59	$0.00	-$10.78	-$10.78	$2.73
11	2031	$3.01	$8.66	$0.31	$2.39	-$0.28	$14.10	-$0.13	$13.97	$35.70	$0.00	-$10.78	-$10.78	$3.19
12	2032	$3.17	$8.93	$0.31	$2.47	-$0.29	$14.58	-$0.13	$14.45	$35.82	$0.00	-$10.78	-$10.78	$3.67
13	2033	$3.33	$9.20	$0.31	$2.54	-$0.30	$15.08	-$0.13	$14.95	$35.94	$0.00	-$10.78	-$10.78	$4.17
14	2034	$3.51	$9.48	$0.31	$2.62	-$0.32	$15.60	-$0.13	$15.47	$36.06	$0.00	-$10.78	-$10.78	$4.69
15	2035	$3.69	$9.77	$0.31	$2.70	-$0.33	$16.14	-$0.13	$16.01	$36.18	$0.00	-$10.78	-$10.78	$5.23
16	2036	$3.88	$10.07	$0.31	$2.78	-$0.34	$16.70	-$0.13	$16.57	$36.30	$0.00	-$10.78	-$10.78	$5.79
17	2037	$4.08	$10.38	$0.31	$2.87	-$0.36	$17.28	-$0.13	$17.16	$36.42	$0.00	-$10.78	-$10.78	$6.37
18	2038	$4.29	$10.71	$0.31	$2.96	-$0.37	$17.89	-$0.13	$17.76	$36.55	$0.00	-$10.78	-$10.78	$6.98
19	2039	$4.50	$11.04	$0.31	$3.05	-$0.39	$18.52	-$0.13	$18.39	$36.67	$0.00	-$10.78	-$10.78	$7.61
20	2040	$4.74	$11.39	$0.31	$3.15	-$0.41	$19.17	-$0.13	$19.05	$36.79	$0.00	-$10.78	-$10.78	$8.26
21	2041	$4.98	$11.74	$0.31	$3.24	-$0.43	$19.85	-$0.13	$19.73	$36.92	$0.00	-$10.78	-$10.78	$8.94
22	2042	$5.23	$12.12	$0.31	$3.35	-$0.45	$20.56	-$0.13	$20.44	$37.04	$0.00	-$10.78	-$10.78	$9.65
23	2043	$5.50	$12.50	$0.31	$3.45	-$0.47	$21.30	-$0.13	$21.17	$37.17	$0.00	-$10.78	-$10.78	$10.39
24	2044	$5.78	$12.90	$0.32	$3.56	-$0.50	$22.07	-$0.13	$21.94	$37.30	$0.00	-$10.78	-$10.78	$11.16
25	2045	$6.08	$13.31	$0.32	$3.68	-$0.52	$22.87	-$0.13	$22.74	$37.43	$0.00	-$10.78	-$10.78	$11.96
26	2046	$6.39	$13.74	$0.32	$3.80	-$0.55	$23.70	-$0.13	$23.58	$37.55	$0.00	-$10.78	-$10.78	$12.79
27	2047	$6.72	$14.19	$0.32	$3.92	-$0.58	$24.57	-$0.13	$24.44	$37.68	$0.00	-$10.78	-$10.78	$13.66
28	2048	$7.07	$14.65	$0.32	$4.05	-$0.61	$25.47	-$0.13	$25.35	$37.81	$0.00	-$10.78	-$10.78	$14.56
29	2049	$7.43	$15.13	$0.32	$4.18	-$0.65	$26.42	-$0.13	$26.29	$37.95	$0.00	-$10.78	-$10.78	$15.51
30	2050	$7.81	$15.63	$0.32	$4.32	-$0.68	$27.40	-$0.13	$27.27	$38.08	$0.00	-$10.78	-$10.78	$16.49

	NPV	BCR	Breakeven	IRR
3%	$8.13	1.03	$35.41	3.5%
4%	-$8.06	0.97	$37.62	3.5%
7%	-$37.64	0.80	$45.13	3.5%

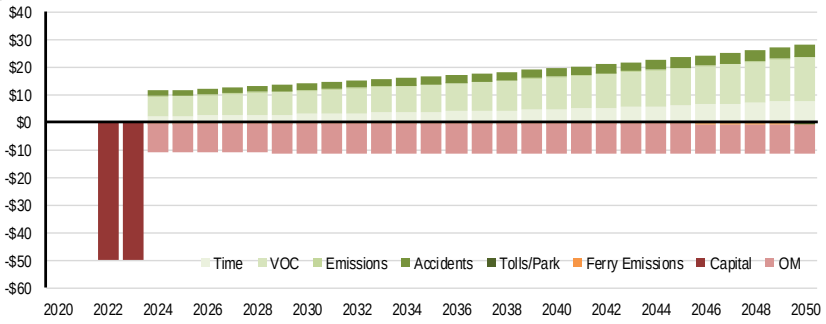
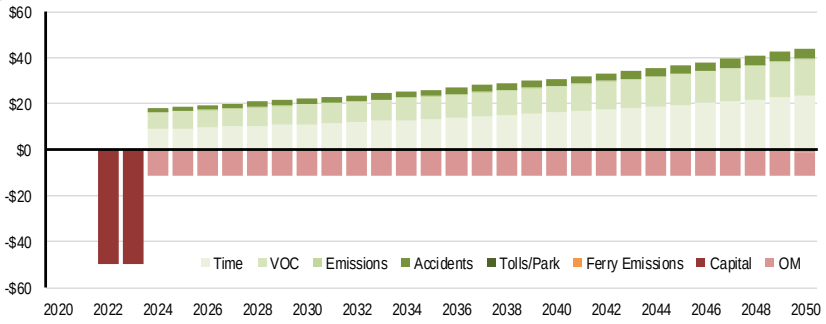


Figure H-9 Combined Amenity Scenario Detail (2019$ millions)

		Benefits									Costs			Summary
		Avoided Driving						Ferry	Total	Average				Net
Year	Calendar	Time	VOC	Emissions	Accidents	Tolls/Park	Subtotal	Emissions		/Round-Trip	Capital	OM	Total	Total
0	2020	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
1	2021	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	2022	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
3	2023	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$49.92	$0.00	-$49.92	-$49.92
4	2024	$9.03	$7.05	$0.31	$1.95	-$0.23	$18.11	-$0.13	$17.99	$56.74	$0.00	-$10.78	-$10.78	$7.20
5	2025	$9.35	$7.26	$0.31	$2.01	-$0.23	$18.70	-$0.13	$18.57	$56.86	$0.00	-$10.78	-$10.78	$7.79
6	2026	$9.69	$7.48	$0.31	$2.07	-$0.24	$19.30	-$0.13	$19.17	$56.98	$0.00	-$10.78	-$10.78	$8.39
7	2027	$10.04	$7.70	$0.31	$2.13	-$0.25	$19.93	-$0.13	$19.80	$57.10	$0.00	-$10.78	-$10.78	$9.02
8	2028	$10.40	$7.93	$0.31	$2.19	-$0.25	$20.58	-$0.13	$20.45	$57.23	$0.00	-$10.78	-$10.78	$9.67
9	2029	$10.78	$8.17	$0.31	$2.26	-$0.26	$21.25	-$0.13	$21.12	$57.36	$0.00	-$10.78	-$10.78	$10.34
10	2030	$11.18	$8.41	$0.31	$2.32	-$0.27	$21.95	-$0.13	$21.82	$57.48	$0.00	-$10.78	-$10.78	$11.04
11	2031	$11.59	$8.66	$0.31	$2.39	-$0.28	$22.67	-$0.13	$22.55	$57.61	$0.00	-$10.78	-$10.78	$11.76
12	2032	$12.01	$8.93	$0.31	$2.47	-$0.29	$23.42	-$0.13	$23.30	$57.74	$0.00	-$10.78	-$10.78	$12.51
13	2033	$12.46	$9.20	$0.31	$2.54	-$0.30	$24.20	-$0.13	$24.08	$57.87	$0.00	-$10.78	-$10.78	$13.29
14	2034	$12.92	$9.48	$0.31	$2.62	-$0.32	$25.01	-$0.13	$24.89	$58.00	$0.00	-$10.78	-$10.78	$14.10
15	2035	$13.40	$9.77	$0.31	$2.70	-$0.33	$25.85	-$0.13	$25.73	$58.13	$0.00	-$10.78	-$10.78	$14.94
16	2036	$13.90	$10.07	$0.31	$2.78	-$0.34	$26.73	-$0.13	$26.60	$58.26	$0.00	-$10.78	-$10.78	$15.82
17	2037	$14.43	$10.38	$0.31	$2.87	-$0.36	$27.63	-$0.13	$27.51	$58.40	$0.00	-$10.78	-$10.78	$16.72
18	2038	$14.97	$10.71	$0.31	$2.96	-$0.37	$28.57	-$0.13	$28.45	$58.53	$0.00	-$10.78	-$10.78	$17.66
19	2039	$15.54	$11.04	$0.31	$3.05	-$0.39	$29.55	-$0.13	$29.42	$58.67	$0.00	-$10.78	-$10.78	$18.64
20	2040	$16.13	$11.39	$0.31	$3.15	-$0.41	$30.57	-$0.13	$30.44	$58.81	$0.00	-$10.78	-$10.78	$19.66
21	2041	$16.75	$11.74	$0.31	$3.24	-$0.43	$31.62	-$0.13	$31.50	$58.94	$0.00	-$10.78	-$10.78	$20.71
22	2042	$17.39	$12.12	$0.31	$3.35	-$0.45	$32.72	-$0.13	$32.60	$59.08	$0.00	-$10.78	-$10.78	$21.81
23	2043	$18.06	$12.50	$0.31	$3.45	-$0.47	$33.86	-$0.13	$33.74	$59.22	$0.00	-$10.78	-$10.78	$22.95
24	2044	$18.77	$12.90	$0.32	$3.56	-$0.50	$35.05	-$0.13	$34.92	$59.36	$0.00	-$10.78	-$10.78	$24.14
25	2045	$19.50	$13.31	$0.32	$3.68	-$0.52	$36.28	-$0.13	$36.16	$59.50	$0.00	-$10.78	-$10.78	$25.38
26	2046	$20.26	$13.74	$0.32	$3.80	-$0.55	$37.57	-$0.13	$37.44	$59.65	$0.00	-$10.78	-$10.78	$26.66
27	2047	$21.06	$14.19	$0.32	$3.92	-$0.58	$38.91	-$0.13	$38.78	$59.79	$0.00	-$10.78	-$10.78	$28.00
28	2048	$21.89	$14.65	$0.32	$4.05	-$0.61	$40.30	-$0.13	$40.18	$59.93	$0.00	-$10.78	-$10.78	$29.39
29	2049	$22.76	$15.13	$0.32	$4.18	-$0.65	$41.75	-$0.13	$41.63	$60.08	$0.00	-$10.78	-$10.78	$30.84
30	2050	$23.67	$15.63	$0.32	$4.32	-$0.68	$43.26	-$0.13	$43.14	$60.22	$0.00	-$10.78	-$10.78	$32.35

	NPV	BCR	Breakeven	IRR
3%	$177.98	1.65	$35.41	11.3%
4%	$136.27	1.55	$37.62	11.3%
7%	$54.72	1.29	$45.13	11.3%



H-2 Ferry Emissions Calculations

EPS' provided ferry emissions tables and figures form the Mission Bay Ferry Service study in 2018, which was leveraged to calculate a 2019$/ferry-mile by combining the assumed emissions grams/mile for NOX, PM10, and CO2e with Caltrans' emissions costs in 2018$/short-ton. Short tons were converted to grams and 2018$ were inflated to 2019$ via BEA's real GDP factors.

Figure H-10 EPS' Mission Bay Ferry Emissions

The increase in emissions due to MB ferry service is based on increase in ferry miles and emission levels for the HOPTR boat per mil. These assumptions are shown in **Figure 17**.

Figure 17 HOPTR Boat Emission Rate Assumptions

	Miles	Emission Category		
		NO_X	PM_{10}	CO_2e
Annual Ferry Miles Traveled	31,050			
Avg. Ferry Speed MPH	20			
Emission Factor (gm/mile)		27.30	0.63	3,112
Total Emission Increase		847,665	19,562	96,633,810

Source: Benefit Cost Analysis for San Francisco Mission Bay Ferry Service (01/20/2018)

Table 1: Ferry Emissions Calculations

	NOX	PM10	CO2e	Total
Grams/Ferry-Mile	27.3	0.63	3,112	
2018$/Short Ton	$18,700	$151,100	$38	
2018$/Ferry-Mile	$0.56	$0.10	$0.13	$0.80
2019$/Ferry-Mile				$0.81

Appendix I

Redwood City Ferry Project Memorandum of Understanding

ROUTING COVER SHEET
FOR
PROFESSIONAL SERVICES AGREEMENT/AMENDMENT OR SUPPLIES/EQUIPMENT

■ **AGREEMENT**	☐ LESS THAN $60,000 →NO COUNCIL/AGENCY ACTION REQUIRED
☐ **AMENDMENT**	☐ GREATER THAN $60,000 →COUNCIL/AGENCY ACTION REQUIRED
☐ **SUPPLIES/EQUIPMENT**	

DATE: 6/8/2020 **NAME OF CONSULTANT/VENDOR:** Redwood City/Port of Redwood City

ORIGINATOR: C. Dacumos / K.Mateo **DEPT**: CDT **EXT**: _____

PURPOSE/DESCRIPTION: Redwood City Ferry Facility and Service Project

AGREEMENT/PURCHASE AMOUNT: $ _____ **APPROPRIATION AVAILABLE** □ YES ■ NO*

ACCOUNT NUMBER: _____ **AVAILABLE BALANCE**: _____

ROUTE TO	INITIALS	DATE RECEIVED	DATE FORWARDED
☐ DIVISION MANAGER (IF APPLICABLE)			
☐ DEPARTMENT HEAD (May sign agreement to execute if less than $10,000)			
■ CITY ATTORNEY (Approve as to form)	VR	7/16/2020	7/18/2020
■ CITY MANAGER (Must sign agreement to execute if $10,000 or more)	MSD	6/25/20	7/6/20
■ CITY CLERK	YFD	7/20/2020	7/20/2020

AGREEMENT/AMENDMENT REQUIREMENTS (Check items required):

■ Proper Signature(s) ■ Exhibits ☐ Business License

■ Review and Approved by City Attorney's Office ■ Motion/Resolution/ Minute Order ☐ Certificate of Insurance/ Endorsements to Insurance Policy

☐ Notary Required

SUPPLIES/EQUIPMENT REQUIREMENTS (Check items required):

☐ Supplies ☐ Equipment ☐ Services ☐ Other _____

☐ Proper Signature(s) ☐ Exhibits ☐ 3 Bids/Quotes ☐ Sales Tax Accrued? ☐ Terms

Comments/Attach Memo: MOU with partner transit agencies for completion of technical studies and planning work supporting the creation of the Transit District and coordination re: Dumbarton Rail Corridor Proj, RWC Station Visioning and Concept Planning, Whipple Ave Grade Sep. Study & Reimagine SamTrans

*If funds are not available at this time, an Appropriation Transfer Request Form, or a request for mid-year budget amendment must accompany this routing sheet.

MINUTE ORDER
JOINT CITY COUNCIL / SUCCESSOR AGENCY BOARD
PUBLIC FINANCING AUTHORITY MEETING

May 18, 2020
MO. 20-078

CITY CLERK DEPARTMENT
Redwood City

Date: May 20, 2020

Attention: City Attorney
Community Development and Transportation Director

hard copy available upon request

SUBJECT: Memorandum of Understanding with partner transit agencies for completion of technical studies and planning work supporting the creation of the Transit District and coordination regarding the Dumbarton Rail Corridor Project, Redwood City Station Visioning and Concept Planning, Whipple Avenue Grade Separation Study, and Reimagine SamTrans

AGENDA STAFF REPORTS ITEM: 8.A. (304)

Meeting of the Joint City Council/Successor Agency Board/Public Financing Authority Meeting on May 18, 2020.

Present: Council Members Aguirre, Bain, Borgens, Hale, Masur, Reddy and Mayor Howard

M/S Aguirre/Hale to authorize the City Manager to execute a Memorandum of Understanding (MOU) with partner transit agencies for completion of technical studies and planning work supporting the creation of the Transit District as well as coordination regarding the Dumbarton Rail Corridor Project, Redwood City Station Visioning and Concept Planning, Whipple Avenue Grade Separation Study, and Reimagine SamTrans, and further authorize the City Manager to execute MOU amendments within the scope of this authorization.

Motion passes 7-0 by roll call vote.

Pamela Aguilar, CMC
City Clerk

PROJECT MEMORANDUM OF UNDERSTANDING

REDWOOD CITY/PORT OF REDWOOD CITY FERRY FACILITY PROJECT AND SERVICE: FEASIBILITY AND BUSINESS PLAN PHASES

March 5, 2020

Term, Parties

1. General	This Memorandum of Understanding ("**MOU**") establishes the framework for the feasibility analysis of a proposed ferry terminal in Redwood City (the "**Project**", as further described in paragraph 5 below). The Project is anticipated to be carried out in the following six consecutive phases: (1) Feasibility, (2) Business Plan, (3) Planning, (4) Design, (5) Construction, and (6) Operation. This MOU covers the Phase 1 Feasibility and Phase 2 Business Plan phases. The City has secured the necessary funding needed for the Phase 1 Feasibility work but has not secured funding for the subsequent Phase 2 Business Plan work. The Parties will commence the Phase 2 Business Plan work, if Redwood City and WETA determine during Phase 1 Feasibility that ferry service is feasible and financially viable, and funding is secured for the Phase 2 Business Plan. The Parties anticipate executing either amendments to this MOU, or separate agreements to govern the precise terms of subsequent Planning, Design, Construction, or Operation Phases, each of which shall be subject to the approvals of the City Council, the Port Commission and the WETA Board.
2. Term	The term ("**Term**") of this MOU shall commence on _____, 2020 ("**Effective Date**") and shall remain in effect until the date which is six (6) months following completion of the Phase 1 Feasibility and Phase 2 Business Plan work, or such later date as the Parties may mutually agree. The terms of this MOU, including scope and timeframes, can be modified by amendment at any time upon approval by the City Council, Port Commission, and WETA Board.
3. Parties	This MOU is entered into among the San Francisco Bay Area Water Emergency Transportation Authority ("**WETA**") the City of Redwood City ("**City**") and the Port of Redwood City ("**Port**"). WETA was established in 2008 as the successor agency to the Water Transit Authority with a mission to consolidate and operate certain existing publicly operated ferry services on the San Francisco Bay, expand new routes, and coordinate ferry services in the event of an emergency. City is a charter city and municipal corporation located within San Mateo County. The Port is an enterprise department of the City with ownership and control of certain waterfront property within the City.

	City and Port are collectively referred to herein as "**Redwood City**". Redwood City and WETA may be individually referred to herein as a "**Party**," and collectively as the "**Parties**."
4. WETA System Expansion Policy	On June 4, 2015 the WETA Board of Directors adopted a System Expansion Policy attached hereto as Exhibit A and incorporated herein ("**System Expansion Policy**") to serve as a framework for evaluating the feasibility of new ferry projects. This Policy is applicable to the proposed Project and it is the intent of Redwood City and WETA to explore the feasibility of developing a ferry terminal facility in the City of Redwood City.
5. Project Definition	WETA's 2016 WETA Strategic Plan indicates the desire to construct a terminal and operate a ferry service in Redwood City. The Parties agree to work collaboratively to pursue public ferry service in Redwood City. The project is conceptually defined as a ferry terminal located in the eastern portion of the Port of Redwood City complex. The terminal will be capable of landing WETA vessels at a berthing facility consistent with WETA operational and design standards. In addition, the terminal facility will include upland property that provides automobile parking, bike and transit facilities and other features consistent with WETA terminals. The new ferry terminal will be capable of connecting to other terminals throughout the WETA system, including San Francisco, Oakland and the East Bay, special event terminals and future terminals currently in the planning or construction phase.
6. Partnering	The City of Redwood City and WETA agree to work diligently and in good faith to actively evaluate the possibility of future ferry service at a Redwood City Ferry Terminal located in the Port of Redwood City by, among other things, working cooperatively in areas such as funding and grants, community and stakeholder relations, environmental analysis and financial feasibility. Federal, state, regional or local funding for transit capital and operations may become available during the term of this MOU. Should the parties determine that the project is feasible and decide to move forward with project development, Redwood City and WETA will work in partnership and coordinate closely to actively pursue capital and operating subsidy sources for the Redwood City ferry service. WETA and Redwood City agree to work collaboratively to support one another in seeking and securing ferry grant funds (e.g. San Mateo County Measure A, regional transportation measures, federal discretionary funds, etc.) to support the Planning, Design, Construction, or Operation Phases for Redwood City ferry service, the latter of which includes ongoing operation and maintenance of vessels and facilities. Such support may include, but not

	be limited to: application support letters, provision of ridership data, operating or capital cost information or other technical information required by funders, and WETA Board or City Council or Port Commission resolutions in support of one another's funding applications. Redwood City and WETA agree to work collaboratively to advocate for and coordinate with the San Mateo County Transportation Authority ("**SMCTA**"), SamTrans, Commute.org and other potential local transit operators to provide frequent, reliable, and convenient bus or shuttle service to the Project.

Feasibility Study (Feasibility Study, Public Engagement, and Funding)

7. Feasibility Study	As part of the Phase 1 Feasibility Phase, Redwood City is preparing a feasibility study for provision of ferry service to and from Redwood City ("**Feasibility Study**"). The Feasibility Study will examine ridership demand; develop models for projected operating costs and fare revenue; evaluate the "cost-effectiveness" of a new ferry terminal and service; and evaluate possible ferry routes for public ferry service provided by WETA at a future Redwood City Ferry Terminal. The Feasibility Study will also develop concept-level designs and cost estimates for terminal facilities consistent with other WETA terminals throughout the WETA system. While the City has secured funding for the Feasibility Study, Redwood City and WETA have not secured funding for the subsequent Business Plan, Planning, Design, Construction, and Operations phases. If the Parties determine during the Phase 1 Feasibility and Phase 2 Business Plan that ferry service to and from Redwood City is both feasible and financially viable, and additional necessary funding is secured, WETA, Port and City will amend this MOU or enter into a new agreement defining specific roles and responsibilities, including funding, for subsequent Project phases. City will serve as the project lead, with assistance from WETA and the Port, for the Feasibility Study that will include technical analyses, ridership demand, route evaluation, outreach, cost-benefit and economic impact analyses, preliminary terminal configuration and financial feasibility analysis, including estimates of capital and operating costs and forecasts of ridership and fare revenue.
8. Public Engagement	Public interactions, initiated by Redwood City, as part of the Phase 1 Feasibility Phase will be managed by Redwood City with assistance and participation from WETA. Public interactions regarding provision of ferry service to and/or from Redwood City initiated by WETA outside of the specific context of the

	Phase 1 Feasibility Phase, if any, will be managed by WETA with assistance and participation by Redwood City.
9. Contracting	City has contracted for professional services to conduct the Feasibility Study.
10. Funding	The Feasibility Study is funded through SMCTA's Measure A program along with a local match provided by the City. The SMCTA has an agreement with the City of Redwood City but is not a part of this MOU or any separate agreement with WETA.
11. Feasibility Determination	It is anticipated that the Feasibility Study will conclude with a determination by Redwood City and WETA regarding the feasibility of ferry service to and from Redwood City. If, upon completion of the Feasibility Study, either Redwood City or WETA determines that ferry service to and from Redwood City is infeasible or that it no longer desires to proceed with further work on the proposed Project, this MOU shall automatically terminate and the Parties shall have no further obligations under this MOU.
12. Business Plan and Next Steps	At the conclusion of the Phase 1 Feasibility phase, the Parties, subject to identification of sufficient funding, may elect to develop a Business Plan. SMCTA, requires Redwood City to develop a Business Plan in order to receive future Measure A funding for construction of a ferry terminal. The Business Plan will address the Parties' respective roles and efforts related to building ferry ridership. The Business Plan will be subject to the concurrent approvals by the City Council, Port Commission and the WETA Board. WETA acknowledges that the Business Plan is required for the City to obtain necessary Measure A funding from SMCTA, and agrees to provide input in connection with development of such plan. If the Business Plan is accepted by SMCTA and the Parties agree to proceed to the Planning phase of the Project, the Parties will amend this MOU or enter into a new agreement defining specific roles and responsibilities, including funding, for subsequent Project phases.

WETA, Port and City have entered into this Memorandum of Understanding as of the last date set forth below.

San Francisco Bay Area Water Emergency Transportation Authority

By: _____
Nina Rannells,
Executive Director

Date: _____

Reviewed:

By: _____
Madeline Chun,
Legal Counsel to Authority

City of Redwood City

By: Melissa Stevenson Diaz
Melissa Stevenson Diaz,
City Manager

Date: 7/2/2020

Attest: _____ 7/20/2020
Yessika Dominguez, Assistant City Clerk

Approved as to form:

By: _____
Veronica Ramirez,
City Attorney

Port of Redwood City,

By: _____
Kristine Zortman,
Executive Director

Date: 7-4-2020

Approved as to Form:
By: _____
Francois Sorba,
Port Attorney

WETA System Expansion Policy

The WETA expansion policy is intended to provide a framework for evaluating the feasibility of new ferry projects. The framework consists of policy statements that provide guidance for developing candidate project elements such as landside and waterside facilities, vessels and service plans. In addition, a set of evaluation measures defines a range of productivity and efficiency metrics that inform the WETA Board and funding partners regarding a project's financial feasibility and sustainability.

There is no pre-determined level of evaluation that determines whether a project is feasible. There are many factors that contribute to whether a project is developed and becomes part of the WETA system. Instead, the System Expansion Policy provides policy makers with an agreed-upon framework, bringing objective measures and predictability to the project development process.

I. System Expansion Policy Statements

System Expansion Overview	WETA will expand ferry service throughout San Francisco Bay, working with local and regional partners to increase ferry ridership and relieve traffic congestion and transit crowding. New ferry services will be financially sustainable, contribute to the ferry system and enhance WETA's emergency response capabilities.
Minimum Service Period	New services will need to be in service for a minimum of 10 years to allow adequate time to build a ridership base. Services will be evaluated after a 10-year initial period to determine their continued operation.
New Service Project Evaluation	The WETA System Expansion Policy establishes a range of evaluation measures that help the WETA Board determine whether a candidate project will be successful and meet WETA's strategic goals. The new service evaluation is typically performed prior to entering environmental clearance, during the feasibility study phase of a project.
New Service Ongoing Evaluation	Once in operation, new ferry services will be evaluated on regular quarterly and yearly intervals to ensure performance is meeting expectations. Adjustments to the service plan, fare program or access conditions may be warranted.
Service Design	New ferry services typically begin as origin terminals offering commute- period service to San Francisco's Ferry Building. However, they can act as a destination terminal or offer non-commute period service, depending on local transportation goals and funding availability. WETA will work with project partners to develop a concept service design that meets travelling needs while offering a competitive, sustainable service. For commute-only origin terminals, a minimum level of service would be defined as three peak-direction trips in both the AM and PM commute periods.

WETA System Integration	New projects will enhance the WETA ferry system by adding terminals and vessels while attracting new riders to ferry service. Required system elements such as capacity at maintenance facilities and destination terminals or spare vessels will be estimated and incorporated into a project's capital cost.
Emergency Response	New projects will enhance WETA's emergency response capabilities by providing terminals and vessels for use in the response and recovery phases after a natural event. The benefits of interoperable ferry assets such as vessels, floats and terminals mean that new projects must be compatible with WETA facilities. The deployment of WETA vessels and use of ferry terminals will be a decision of state and regional authorities and not necessarily WETA or its local partner.
Vessels, Infrastructure	WETA owns and operates a network of ferry vessels along with landside and waterside facilities that are economically and operationally efficient because they are interchangeable. Therefore, candidate WETA projects must be consistent with this established infrastructure. New projects will utilize WETA catamaran-style vessels powered by marine diesel engines and ranging in capacity from 149 to over 500 passengers. Infrastructure such as maintenance facilities and terminals will be consistent with existing WETA facilities. Alternative vessel technologies or non-compliant terminals will not be considered as
Public-private partnership opportunities	Ferry terminals and vessels are complex and expensive investments that require a variety of funding sources. Operational expenses can also be significant and require long-term dedicated funding streams. WETA encourages partnerships with public or private entities interested in ferry service as a means of financing both capital and operational needs.
Capital Funding	Ferry project capital funding can come through a variety of local, regional, state and federal sources and even private contributions. Candidate expansion projects must demonstrate that there is full capital funding prior to entering the Final Design phase of a project.
Operating Subsidy	The operating subsidy is defined as the portion of the operating expense not covered by fare revenue. New ferry projects must demonstrate that there is a stable, dedicated source for an operating subsidy for a minimum period of ten years.
Terminal Access	WETA supports the use of alternative modes such as walking, biking and transit as a means of accessing origin ferry terminals. At the same time, minimum parking levels are required to ensure a service will be well utilized and accessible to all users. The ideal access environment provides customers with a choice of safe, convenient and attractive access options.

Project Agreement	A Project Agreement will be required for candidate projects prior to entering into the environmental clearance phase of a project. The Project Agreement establishes a project service plan, identifies likely funding sources and defines partner roles and responsibilities. Both the WETA Board and the policy body from the project partner must adopt the Project Agreement.

II. System Expansion Evaluation Measures

The following measures are intended to evaluate the competitiveness and financial feasibility of candidate WETA ferry projects. The measures are expressed in three ways: minimum, target and maximum (as applicable). Minimum levels are what will be required after the initial 10 years of operation. Target levels are consistent with expected performance of mature services such as Alameda/Oakland, Vallejo and Harbor Bay.

Passengers per Revenue Hour (Commute-only service)

Passengers per revenue hour measures the number of boardings in a given hour of service. Services that have high two-way ridership along with a short travel time, enabling vessels to offer multiple runs in a given commute period will be strong performers. This measure provides an evaluation of ridership and the efficiency of operating resources.

Minimum	Target	Maximum
100	150	250

Passengers per Revenue Hour (All-day service)

All-day services typically operate seven days per week and generally from 6 AM up to 8 PM. Today, only Alameda-Oakland and Vallejo are all day services. The target for Passengers per Revenue Hour is slightly lower, given lower volumes in the midday and off-peak periods.

Minimum	Target	Maximum
100	125	250

Farebox Recovery

Farebox recovery is defined as the portion of operating expenses covered by fare revenues. Farebox recovery measures ridership, operating expense and financial sustainability.

Minimum	Target	Maximum
40%	50% – 70%	100%

Peak Hour Occupancy

Peak hour occupancy – defined as the combined peak direction occupancy level during the highest ridership hour of a commute service – indicates ridership demand and provides guidance for vessel deployment and service planning. High levels of peak hour occupancy indicate the possibility of leave-behinds or standees and would require corrective action.		
Minimum	Target	Maximum
50%	60% -- 75%	80%

CDM Smith

cdmsmith.com