M-580 Corridor Multimodal Freight Network Optimization Study

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CPCS

Solutions for
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M-580 Corridor Multi-Modal Freight Network Optimization Study

The purpose of the M-580 Corridor Multimodal Freight Network Optimization Study, is to assist stakeholders in identifying and prioritizing investment opportunities to efficiently manage assets and equipment in the I-580 and I-80 multimodal corridors between the San Francisco Bay Area and Northern San Joaquin Valley.

Acknowledgements

The CPCS Team acknowledges and is thankful for the input of those stakeholders consulted, as well as the guidance and the input of representatives from the California Department of Transportation.

Opinions and Limitations

Unless otherwise indicated, the opinions herein are those of the authors and do not necessarily reflect the views of the California Department of Transportation.

CPCS makes efforts to validate data obtained from third parties, but CPCS cannot warrant the accuracy of these data.

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Acronyms / Abbreviations

AAQS	Ambient Air Quality Standards
BNSF	Burlington Northern Santa Fe
CA	California
CARB	California Air Resources Board
CCT	Central California Traction
CFS	Commodity Flow Survey
CHE	Cargo Handling Equipment
CHP	California Highway Patrol
CIRIS	California Inter-Regional Intermodal System
CO2	Carbon Monoxide
CO2	Carbon Dioxide
COVID	Coronavirus Disease Of 2019
CPI	Consumer Price Index
CSFFM	California Statewide Freight Forecasting Model
CTP	California Transportation Plan
EMFAC	Emission Factor
EPA	Environmental Protection Agency
ESAL	Equivalent Single Axle Loads
FAF	Freight Analysis Framework
FAZ	Freight Analysis Zone
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GHG	Greenhouse Gas
GRT	Gross Registered Tonnage
ILWU	International Longshore And Warehouse Union
ITE	Institute Of Transportation Engineers
KPRA	Kingpin-To-Rearmost Axle
MNL	Multinomial Logit
MPR	Mobility Performance Report
MSEI	Mobile Source Emission Inventory
NIT	Norfolk International Terminals
NNMT	Newport News Marine Terminal
NOx	Nitrogen Oxides And Dioxides
NV	Nevada
OD	Origin-Destination
OSOW	Oversized Overweight
PM	Particulate Matter
PMT	Portsmouth Marine Terminal

SJCOG	San Joaquin Council Of Governments
SP	Stated Preference
SPS	Stated Preference Survey
SR	State Route
STAA	Surface Transportation Assistance Act
SWITRS	Statewide Integrated Traffic Records System
RP	Revealed Preference
RTG	Rubber Tyred Gantry
TCEP	Trade Corridor Enhancement Program
TEU	Twenty-Foot Equivalent Unit
TIGER	Transportation Investment Generating Economic Recovery
TPEF	Truck Payload Equivalency Factor
UP	Union Pacific
US	United States
UFT	Underground Freight Transportation
VA	Virginia
VIT	Virginia International Terminals
VIUS	Vehicle Inventory And Use Survey
VPA	Virginia Port Authority

Executive Summary

Nearly 72 tons of Nitrogen Oxides, 6.5 tons of PM, and 33,000 tons of Carbon Dioxide were emitted by the trucks traveling in the M-580 study area in 2019.

Trucking costs have also risen significantly in Northern California over the last 15 to 20 years. This cost differential increases for longer travel distances. The cost to move goods 120 miles from the Northern Central Valley to the Port of Oakland rose from just over $200 in 2003 up to $800 in 2020. This dramatic increase in costs implies that other modes can become relatively more cost-competitive with trucking.

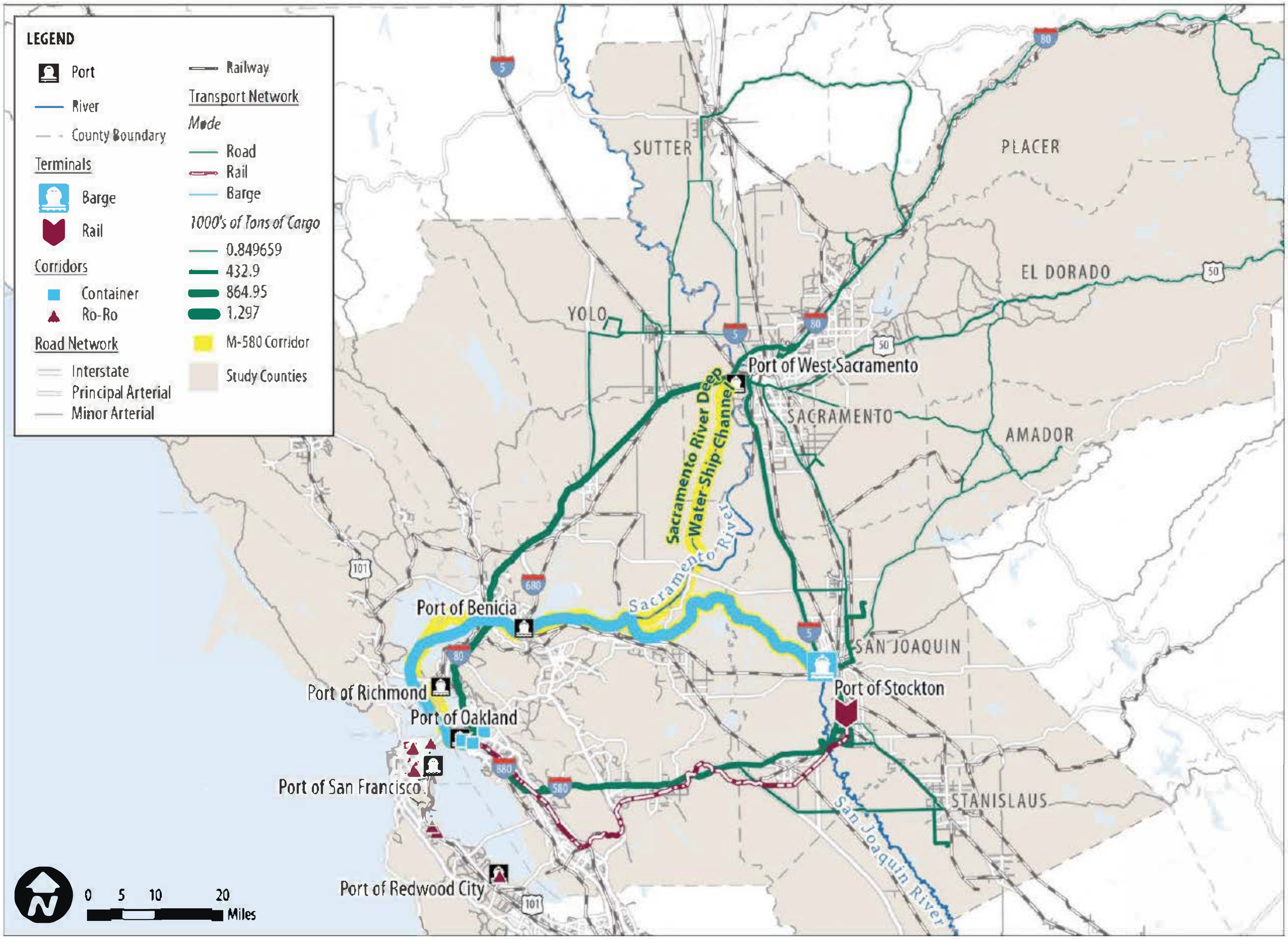
In terms of rail freight performance, a variety of challenges and needs such as capacity issues and infrastructural limitations, highway-rail crossings maintenance, delay and safety impacts, and emissions pose some concerns in the M-580 study area. Over the past decade, rail-related fatal incidents have declined in the study area. However, there has been a percent increase in trespassing casualties due to a variety of factors, including increasing commuter and freight rail volumes and growth in urban and suburban populations also, although freight trains are relatively more fuel-efficient compared to trucks, the projected growth in the future rail freight volumes with the current locomotive engines is expected to lead to an up to 80% increase in the annual freight rail diesel consumption.

Multimodal Network Optimization Model

A multimodal optimization model is developed to provide insights on the potential mode shifts and the resulting impacts of the M-580 corridor barge or short line rail service. The overall model consists of three sub-models: Freight Transportation Demand Model, Multimodal Traffic Assignment Model, and Fleet Performance Model. The model is implemented in a user-friendly spreadsheet format, allowing the users to freely test different scenarios by introducing changes in the inputs and assumptions to identify a range of potential outcomes in the future. Different scenarios can be evaluated by modifying the model inputs associated with the outcomes of regulatory policies, network characteristics, terminal operation, heterogeneous commodity criteria, and user costs, etc. The base model starts with the “do-nothing” scenario that assumes 100% of freight tonnages are traveled by trucks. The model then allows the users to simulate modal shift behaviors among truck, rail, and barge under “High,” “Medium,” and “Low” service specifications for each mode, by changing transit time, total transport cost, and service frequency. These future freight demand matrices are then assigned to the M-580 network to obtain more insights on how the traffic flows. The following map shows the High Scenario multimodal freight demand in 2025, assigned to the study area network.

In general, the model outputs show that as the cost and time of truck service increases (holding other factors constant), the model user should expect to see relatively higher shares of trips utilizing rail and barge. In other words, shippers will behave rationally to maximize their utility in response to the prevailing attributes of the mode-route options available. This suggests that barge is certainly a feasible option for many shippers under certain conditions, with the caution that the results are based on a small sample size of respondents. The model shows that the level of total emissions (i.e., CO2, Hydrocarbons, CO, NOX, and PM) along the corridor will be lower, while the level of fatality and injury will be higher in 2045 compared to 2020.

Annual Freight Demand by Mode in 2025 (High Scenario)



Source: CPCS analysis

Barge Financial Model

To estimate the market for a potential M-580 barge service, the past M-580 data is used as a starting point to estimate the potential M-580 market growth projection. The following three service inception options are examined using different market assumptions:

- Option 1 – Small Barge: starting a new M-580 service by operating a single small barge scenario only. The strategy is to keep up with the traffic growth by adding weekly trips only as demand grows to justify this additional capacity.
- Option 2 – Use of Similar Barge to Previous M-580 Service: use of the existing M-580A barge on a weekly service with optimized terminal operations.
- Option 3 – Roll-on/Roll-off to Stockton or Sacramento: this option focuses on truck trailers on chassis rather than the containers, targeting domestic trade executed by heavy trucks and trucking companies.

Analysis results show that almost none of the M-580 Barge scenarios and options would be financially self-sustaining. For all cases, inception years are crucial to building up a customer base, and the losses would vary between $2.7 million and $5.8 million per year. In most cases, the loss per container would mostly be around $250/container.

Barge Inception Option Financial Information Summary

	Year 1	Year 5	Year 10	Year 15	Year 20
Annual Profit (Loss)					
Container Small Barge (Optimistic)	$ (2,758,817)	$ (1,649,192)	$ (945,199)	$ (158,853)	$ 708,897
Container Small Barge	$ (2,935,617)	$ (2,891,232)	$ (5,911,427)	$ (5,879,973)	$ (5,845,263)
Container Large Barge (Optimistic)	$ (3,877,460)	$ (2,767,835)	$ 694,025	$ 1,480,371	$ 2,348,121
Container Large Barge	$ (3,939,860)	$ (3,895,475)	$ (6,567,483)	$ (6,536,029)	$ (6,501,319)
RoRo Stockton Small Barge	$ (5,628,213)	$ (4,256,073)	$ (2,540,898)	$ (2,365,916)	$ (2,182,007)
RoRo Sacramento Small Barge	$ (5,814,516)	$ (5,187,588)	$ (4,403,928)	$ (4,323,979)	$ (4,239,952)
Profit (Loss) per Container or Trailer					
Container Small Barge (Optimistic)	$ (965)	$ (283)	$ (47)	$ (7)	$ 29
Container Small Barge	$ (1,026)	$ (497)	$ (295)	$ (266)	$ (239)
Container Large Barge (Optimistic)	$ (1,356)	$ (476)	$ 35	$ 67	$ 96
Container Large Barge	$ (1,378)	$ (669)	$ (328)	$ (295)	$ (266)
RoRo Stockton Small Barge	$ (4,430)	$ (670)	$ (200)	$ (177)	$ (155)
RoRo Sacramento Small Barge	$ (13,726)	$ (2,449)	$ (1,040)	$ (971)	$ (906)

Source: CPCS

For the RoRo options, it would be possible to operate a service that provides advantages to some shippers. The RoRo option also allows for a significant reduction in terminal costs and cargo handling costs compared to the container options, which are significant drivers of financial impacts for all options. For the container-on-barge options, the total service capacity is greater than RoRo, especially on a per-barge basis.

For this kind of short sea shipping project, port handling cost (both equipment and labor) is a crucial success factor. Most container terminals are organized in a way to optimize handling for large container vessels. Throughout different short sea shipping projects across North America, we have been told by shipowners that the only way to be competitive against the truck is to avoid large port administrations and to control cargo handling. Container terminals have important cost structures that can be amortized by the size of the container vessel and the distance of the marine transportation. This is not the case for the M-580 project since it brings a small fraction of the volume of an oceangoing vessel, and the travel distance is less the 100 nautical miles.

Reducing terminal costs is difficult at container terminals located in the San Francisco Bay Area. The labor organization, terminal operation setup, and the relatively small market capture of the M-580 barge project on overall container business make it difficult to entice stakeholders to be commercially aggressive in regards to this service. Some stakeholders feel that it is much easier to keep getting this traffic through trucks passing the terminal gates rather than to have to operationally manage a barge service in the current environment, including the difficulties of finding space amongst the large container vessels and utilizing ship-to-shore cranes.

Barge Governance Options

From a governance perspective, it is ideal that the operator of a future M-580 service is the barge operator. This operating structure aligns the success of the barge operations with the entity that will financially gain the most from its success. If a renewed M-580 service were to be subsidized, then careful attention needs to be made to ensure that incentives are properly aligned. A subsidy paid to the barge operator would set up the potential for the barge operator to not operate as efficiently as possible. On the other hand, a subsidy paid directly to the customer would retain the alignment with the barge operator and the barge operations.

Key Findings of this Report

Financial Feasibility of Re-launching the M-580 Service

This study identifies the following key findings in regards to self-sustaining financial feasibility of relaunching M-580:

- The market assessment and estimates of the annual costs/revenues of the six M-580 barge inception options show that none of the options are likely going to be financially feasible without initial subsidies from external sources (i.e., grants or subsidies).
- The container-on-small-barge option offers the lowest average loss per container over 20 years of service, which is between $250 (optimistic) and $460 (realistic). Although the RoRo options offer the lowest port handling costs, their service capacity is much less than the container options, leading to a higher average loss per container over 20 years (over $ 1,126).
- Port handling costs account for about 60% of the total barge service cost, and although container terminals optimize/reduce handling costs for large vessels, the relatively small number of containers carried by the M-580 barge may not justify a significant reduction in port handling cost.
- Despite the estimated annual loss presented in this report, the financial feasibility of the M-580 barge can come from the potential social advantages such as emission and GHG reduction, safety improvements, and maintenance cost-saving impacts.

Potential Short and Long-term Funding Options

Various local, regional, and state transportation agency funding sources can be applicable to re-launching the M-580 barge service in the short and long-term. Example sources include the Trade Corridors Enhancement Plan (TCEP), California Air Resources Board's Low Carbon Transportation and Community Air Protection Programs, the FAST Act's Congestion Mitigation and Air Quality Improvement (CMAQ) Program, and Maritime Administration's Marine Highway Grant, Small Shipyard Program, Capital Construction Fund, and Construction Reserve Fund, Port Infrastructure Development Grants. Several other funding sources can also be available for the M-580 re-launch as there are several stakeholders that will benefit from the barge operations.

Performance Tracking

From the perspective of the shippers, terminal operators, and other stakeholders interviewed in this project, the most important factor in the success of the M-580 barge service is service reliability, which can be benchmarked by tracking the percentage of on-time arrivals/departures over a certain period. The duration of stay at each port for each roundtrip can provide insights into the ports scheduling and handling operation performance. A successful example of transparent barge performance monitoring is at the Port of Rotterdam in the Netherlands, where the "Barge Performance Monitor" online tool is used to communicate the above-mentioned metrics. Beyond reliability, shippers have an expectation that alternative modal offerings will be cost-competitive with the current truck option.

Potential Operators and Customers

This study has identified the following key findings in regards to potential barge operators and customers in the study area:

- Inputs collected through stakeholder interviews that the M-580 barge service can offer significant transport cost savings for the businesses in the agricultural industry located east of Stockton and Sacramento. These shippers export large volumes of cargo from the Port of Oakland and other ports in the Bay Area through I-5, I-80, and I-580 highways, where congestion and truck weight limits pose major constraints to their operations. The M-580 barge service can allow the shippers to send oversized overweight (OSOW) shipments to Ports of Stockton or West Sacramento and use the marine highway to access Oakland and the Bay Area. This would require close collaboration between the ports and the Caltrans Office of Highway Operations to devise a permitting system for regular port-bound OSOW shipments.
- Ideally, the operator of the future M-580 service would be the barge operator as well. This encourages the barge operator to attract more customers and optimize the administrative and logistical operations to reduce or eliminate unnecessary costs.
- If a renewed M-580 service were to be subsidized, then careful attention needs to be made to ensure that incentives are properly aligned. A subsidy paid to the barge operator would set up the potential for the barge operator to not operate as efficiently as possible.
- To support the potential operator, a subsidy could be paid directly to the customer (either the shipper, receiver, or a logistics firm), closely monitored by the operator to track the demand trends.

Potential Future Options

Based on these key findings, this study recommends the following options in terms of moving forward:

- Periodically track market to determine if there are significant changes that would increase the potential for using an M-580 barge service such as a significant increase in truck costs or significant growth in the industries that would utilize an M-580 barge service such as agriculture and imported containerized goods.
- Conduct a bottom-up outreach strategy to develop memoranda of understanding with potential users to commit to a certain amount of usage at a given price and service level. As determined in this study, when the volumes reach particular thresholds, certain service options can come close to achieving breakeven operations.
- Determine the willingness of various public agencies to subsidize the M-580 barge service. Over the years, there have been a range of stakeholders that have subsidized previous services, including the previous M-580 barge service. By canvassing these types of agencies, a rough amount of reasonable subsidy level can be determined.
- Compare the subsidy implied by the bottoms-up outreach strategy to the willingness of agencies to subsidize the service. As this gap closes, advance to formal negotiations to move forward on a future M-580 service.

Potential for Short Haul Rail Operations

Currently, there is no short haul rail service to connect the Bay Area to the Central Valley or the Reno Nevada region, because rail costs are higher than truck costs to move goods between these relatively short distances. However, with increased volumes moving between the Pot Oakland, the industrial region of Alameda County and the Reno/Fernley area, there is the potential that sufficient volume can be achieved coupled with sufficient distance travelled to make rail competitive. Additional information on specific origin-destination pairs and customer service requirements are needed before a conclusion can be reached about the feasibility of this service.

Report Map and Answers to Key Questions

The M-580 Multimodal Corridor Optimization Study is framed around the following key questions that are investigated in the following chapters of this report:

1. **What is the optimal mix of freight modal usage in the I-580/M-580 Corridor?** Currently the containerized freight in this corridor moves exclusively by truck. Based on the current operating conditions, 100% truck mode share is optimal. However, with subsidies a barge or rail service can operate in the corridor resulting in significant benefits, including reduced congestion, improved air quality, lower greenhouse gases, reduced crashes, and less pavement damage/maintenance. Current freight demand is described in Chapter 2, while Chapter 4 discusses the optimized multimodal scenarios, and Chapter 5 investigates the value proposition of shipping by barge for specific businesses in the M-580 study area.
2. **What are the key service and demand characteristics of a potential restart of the M-580 barge service?** A restarted M-580 service would need to have multiple barges per week to provide sufficient options for customers in the study area. Additionally, because the service would require a subsidy for several years, there needs to be a reliable subsidy source in place to give customers the confidence to change their logistics practices in the study area. A detailed discussion of the re-launching the M-580 barge service are presented in Chapter 5.
3. **What are the key service and demand characteristics for short-haul rail between the industrial portion of Alameda County and Northern San Joaquin Valley?** Similar to a restarted barge service, a short-haul rail service would need to be offered multiple days per week to provide customer service options and there needs to be confidence that this service would be available (through subsidies) over a period of years to ensure that there is incentive for customers to switch their service. The optimal rail mode share, potential social and environmental benefits, and cost competitiveness of the rail mode are discussed in Chapter 4.
4. **What is the financial and operational feasibility of barge and rail services in the I-580/M-580 corridor?** The operational feasibility of the barge and rail service has validated through extensive stakeholder outreach a stated preference survey, and a review of the previous proposed and actual services in this corridor. The financial feasibility is much less certain. All of the service options examined in this study require a financial subsidy for operations typically in the tens of millions and a specific subsidy source has not been identified. Chapters 5 and 6 of this report present a cost-revenue analysis of potential barge operation options and Chapter 4 discusses the potentials for short line rail services in the study area.

1 | Introduction

Key Chapter Takeaway

The M-580 Corridor Multimodal Freight Network Optimization Study aims to identify and prioritize the investment opportunities for efficient asset management of the I-580 and I-80 multimodal corridors in the San Francisco Bay Area. The study is framed around a series of key questions to guide the analysis of multimodal freight activities in the state and encompasses a comprehensive approach for engaging and communicating with the stakeholders.

1.1 Study Background

The M-580 Corridor Multimodal Freight Network Optimization Study aims to assist stakeholders in identifying and prioritizing investment opportunities to efficiently manage assets and equipment in the I-580 and I-80 multimodal corridors between the San Francisco Bay Area and Northern San Joaquin Valley.

The current freight flows along the I-80 and I-580 corridors are almost exclusively moved by truck. However, there are extensive multimodal assets in the study area that also have the potential to move additional freight, notably inland waterways (barge) and rail. These opportunities are accentuated by the port operations at the Port of Oakland and the Port of Stockton, which have excess capacity and along the waterways connecting these two ports. Additionally, the primary Class I railroad in the study area, the Union Pacific, is reported to have excess capacity along its local rail line, indicating there is the potential to operate short-haul rail in the corridor.

The development of alternative modes to connect the Bay Area and Northern California has several benefits, including the potential to reduce transportation costs for the private sector, promote business growth within the region through reduced transportation costs and accessibility, enhance local supply chains and attract new freight-related business to Northern California, mitigate congestion on the I-580 and I-80 corridors, and reduce greenhouse gas emissions and criteria pollutants through the use of barge and rail services.

The M-580 corridor has been studied intermittently over the last 20 years in search of modal alternatives to improve the flow of goods movement. The most relevant previous work related to this study are the documents that were developed to plan and operate the previous M-580 barge service. The 2015 California Department of Transportation (Caltrans) District 10 Long-Term Implementation of the M-580 Marine Highway Report stated that the service was successful in demonstrating the following aspects of the barge service:

- A barge service between the Port of Oakland and the Port of Stockton is feasible from an engineering and logistical perspective through its fourteen months of operation.
- There is an existing base of shippers that is interested in utilizing barge services in the M-580 corridor, and that they are willing to absorb the additional logistical elements of this service under the proper conditions.

- There are tangible economic development and community benefits to operating a container on barge service along M-580.

1.1.1 Lessons Learned from the Previous M-580 Service

The M-580 California Green Trade Corridor Marine Highway System started service in 2013 through a collaboration among the Ports of Stockton, Oakland, and West Sacramento to connect the California Central Valley to the global shipping market. A 2010 TIGER grant of $30million was provided for the purchase of two barges and two mobile harbor cranes at Port of Stockton, a mobile harbor crane and a warehouse at Port of West Sacramento,[1] and a Shore-to-Ship power facility at Port of Oakland.[2] All three ports also financed terminal and dock improvement projects using the grant.

The M-580 service ceased operation in August 2014, after moving more than 7,400 containers over 61 roundtrip voyages.

Estimates show that over the 14-months of operation, the barge service saved over 20,000 truck trips between Central Valley and Port of Oakland, eliminating nearly 6,000 tons of diesel emissions.[3] This section summarizes the key takeaways from the previous M-580 service.

Identified Issues

High initial capital and operating costs of the M-580 barge service occurred due to an initial service design that included routes to both the Port of Stockton and the Port of West Sacramento. This was exacerbated by having an initial service that operated multiple times during the week. Successful container on barge services, such as the one operating between Newport News and Richmond by the Port of Virginia, typically start as small, infrequent services that scale up as it acquires more customers.

Limited active marketing and customer service for the M-580 barge service meant that only the shippers on the Ports' property could consider it as an option. Stakeholder inputs unanimously agreed that limited attempts to attract customers and sell the service created a major setback for the M-580 project.

Labor productivity issues and equipment inefficiencies were impediments to the M-580 success. The hourly productivity of the mobile harbor cranes used for the barge service was 50 percent lower than a standard gantry crane. The need for warming up and cooling down the mobile cranes combined with mandatory labor break times kept the number of productive hours per shift as low as five. Additionally, the oceangoing barges used for the M-580 service required retrofits to the tug, which reduced the versatility and flexibility of the operations.

Long gate delays due to lack of customs scanning technology at the port terminals led to additional truck movements that compromised the sustainability of the M-580 barge service and contributed to congestion at the gates.

Unpredictable and unreliable service affected potential customers' decisions as well. The initial M-580 launch was postponed when the private sector operator pulled out due to a lack of customers. The Port of Stockton took over the barge operations, but with changes in the schedule occurring prior to starting and

[1] Caltrans, The Marine Highway 580 (M-580) Fact Sheet, 2019.

[2] Cold ironing: the process for providing shoreside electrical power to vessels at berth.

[3] Stakeholder consultations, November and December 2019.

more changes to the schedule that occurred after operations started, potential customers had the impression that the barge service was unpredictable and unreliable. Many took a wait-and-see approach to the barge service rather than taking advantage of the new offering.

Large operating losses due to the combination of high operating costs and limited revenues. The barge service generated large losses that were beyond the capacity of any of the stakeholders to absorb.

Potential for Improvement

Building customer trust through a comprehensive marketing plan is key to attracting and maintaining a reliable list of shippers for the barge service. A review of the costs and prices of the M-580 shows that the barge service could become more competitive to trucking if the primary customers were approached directly by the barge operator prior to service initiation to arrange for guaranteed schedules and cargo volume deliveries.

Improving shore side infrastructure and waterborne equipment and vessels offers the potential to significantly improve future barge operation. Using standard inland push boats and inland hopper barges would offer reduced labor costs while offering load type (container, bulk) versatility and crane maneuver flexibility.

Optimizing the cargo handling moves at the port terminals can reduce costs by eliminating unnecessary maneuvers and unproductive labor hours. For instance, by adding a top lifter to move containers to and from the chassis at the port terminals, the cranes that load and unload the barges can save on unnecessary maneuvers and have greater productivity.

Monitoring the performance of the barge operation as a unified system serving all the involved ports can help in identifying the inefficiencies and effectively addressing the productivity issues.

Re-establishing the M-580 Service

Opinions vary on the benefits of re-establishing a barge service in the M-580 corridor. There is general agreement that cooperation between the barge service operator and the International Longshore and Warehouse Union (ILWU) would be critical to the success of any potential future operation. Additionally, there are increasing examples around the country of successful barge operations that demonstrate the economic development and transportation improvements that these services can generate.

1.2 Methodology

To achieve the project objectives, the study is framed around a series of key questions to guide the analysis of multimodal freight activities in the M-580 corridor:

- What is the optimal mix of freight modal usage in the I-580/M-580 Corridor?
- What are the key service and demand characteristics of a potential restart of the M-580 barge service?
- What are the key service and demand characteristics for short-haul rail between the industrial portion of Alameda County and Northern San Joaquin Valley?
- What is the financial and operational feasibility of barge and rail services in the I-580/M-580 corridor?

A search was conducted for the plans, studies, reports, public agency documents, academic papers, and other pertinent material available on the freight activities in the Study Area, with special attention paid to the subject of marine highways across the US and their relevance to the potential M-580 barge service.

After the literature review, the project team used a combination of desk research and stakeholder consultations to assess the existing freight flows in the M-580 study area and analyze the multimodal network capacity to accommodate goods movement activity.

A Multimodal Network Optimization Model was then developed based on inputs provided by the stakeholders and the potential users of the future barge or rail services. The resulting Model is a user-friendly spreadsheet tool that enables strategic network optimization over medium- or long-term planning and offers different scenarios by modifying the inputs associated with the outcomes of environmental and safety policies, network characteristics, terminal operation, heterogeneous commodity criteria, and user costs, etc. Meanwhile, a Financial Model was developed and used to estimate the market for a potential M-580 barge service, using past M-580 data and inputs from the study area ports, terminal operators, and ocean carriers.

1.3 Study Area

The Study Area (also referred to as the *M-580 corridor*) for this multimodal freight system assessment includes the marine environment of the San Joaquin and Sacramento Rivers, Carquinez Strait, San Pablo Bay, and San Francisco Bay, as well as the Counties of Alameda, Contra Costa, San Joaquin, Sacramento, San Francisco, San Mateo, Stanislaus, and Yolo. In this area, the following focal freight infrastructure is located:

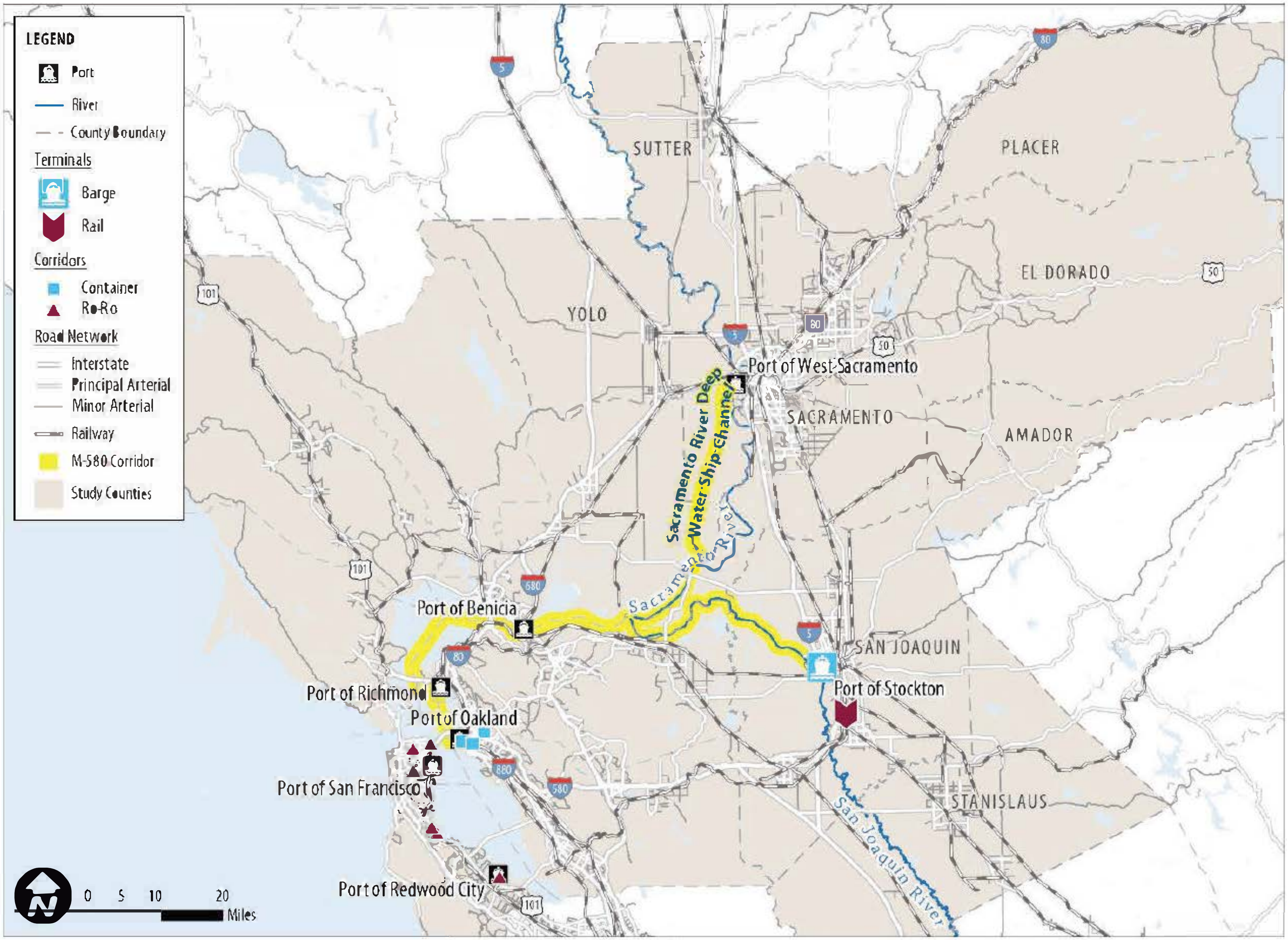
- Ports of Oakland, Stockton, and Richmond
- Port of West Sacramento in Yolo County
- Port of Benicia in Solano County
- Port of San Francisco in San Francisco County
- Port of Redwood city in San Mateo County
- Interstates 580 (I-580), Interstate 680 (I-680), Interstate 80 (I-80), Interstate 880 (I-880), Interstate 205 (I-205), Interstate 5 (I-5)
- BNSF railroad River Bank Subdivision
- Union Pacific railroad Northern California Service Unit

Additionally, Counties of Solano, Marine, Sonoma, Napa, Amador, Sutter, El Dorado, and Placer are considered in various analysis steps of this study due to their proven impacts on the freight activities in the study area. Figure 1-1 shows the M-580 study area.

1.4 Limitations

Unless otherwise indicated, the opinions herein are those of the authors and do not necessarily reflect the views of the California Department of Transportation. Some of the findings in this report are based on the analysis of third-party data. CPCS makes efforts to validate data obtained from third parties, but CPCS cannot warrant the accuracy of these data.

Figure 1-1: M-580 Study Area



Source: CPCS

2 Network Demand and Capacity

Key Chapter Takeaway

The economy of the M-580 corridor communities is closely tied to the multimodal freight transportation network that supports its agriculture and food manufacturing sectors. Interstates, US highways, and state routes stretched across the M-580 corridor provide freight connectivity between San Joaquin Valley and other major facilities in the San Francisco Bay Area. I-5 connects Sacramento and Stockton to the I-580 corridor, I-680 runs north-south through the Central Valley, and I-80 connects San Francisco with Sacramento. Additionally, Union Pacific and BNSF Class I railroads, multiple short line railroads, rail terminals and yards and ports serve the Central Valley and Bay Area.

This chapter presents an overview of the M-580 corridor multimodal transportation network, as well as an assessment of current performance gaps, issues, and needs. The chapter is informed through desk research and consultations with the project stakeholders.

2.1 Multimodal Transport Network

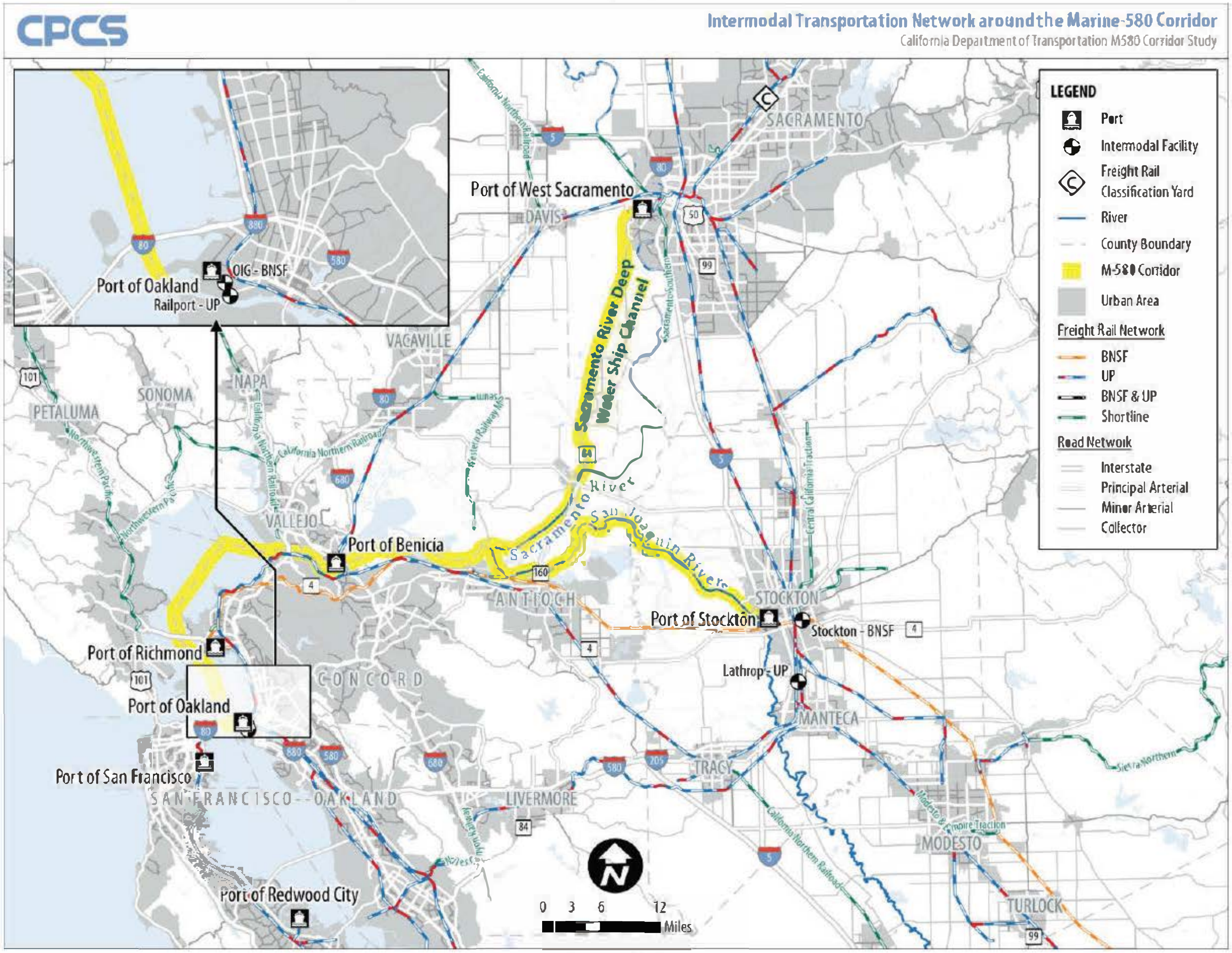
The multimodal freight transportation system of the M-580 corridor consists of highways, railroads, ports, and airports that facilitate goods movement between the freight-dependant industries and businesses of the region and the national and international markets.

327 miles of Interstate Highway	604 miles of US and State Highways	766 miles of Class I and Short Line Railroads	7 Ports

Figure 2-1 illustrates the multimodal freight network of the M-580 corridor. Major highways that provide freight connectivity in the study area include I-580, which connects the Central Valley to the Port of Oakland and the Port Richmond as well as the Bay Area region, I-5 that connects Sacramento and Stockton to the I-580 corridor, I-680 that runs north-south through the Central Valley, and I-80 which connects San Francisco with Sacramento. Additionally, more than 600 miles of US and state highways serve the road activities in the M-580 corridor. CA-4 is a major east-west corridor in the Central Valley region that runs parallel to I-580 for much of its extent. It is also used to move goods between the Central Valley and the Bay Area.

There are 766 miles of rail tracks running across the M-580 corridor, primarily serving Union Pacific and BNSF Class I railroads, as well as multiple short line railroads, active at ports and freight terminals of the Central Valley and Central Coast regions.

Figure 2-1: The Multimodal Freight System of the M-580 Corridor



Source: CPCS

The Port of Stockton and Port of West Sacramento are the two California inland ports located in the M-580 corridor. Port of Benicia is located on the northern bank of the Carquinez Strait, while Port of Richmond and Port of Oakland are on the eastern banks of the San Francisco Bay. Port of Richmond is located seven nautical miles north of Port of Oakland. Port of San Francisco is also located about four miles west of Port of Oakland across the San Francisco Bay, while Port of Redwood City in San Mateo County between San Mateo and Dumbarton highway bridges.[4]

2.1.1 Highway Network Performance

Mobility and Accessibility

Two of the major highways, namely the I-880 and I-580, are of the nation's most congested freight corridors.[5] This creates mobility challenges for the shippers and receivers in the Bay Area and poses quality of life issues for the local communities. Figure 2-2 shows the top 20 locations with the highest annual hours of delay, and Figure 2-3 is a map of the traffic bottlenecks located within the M-580 study area, both according to the Mobility Performance Report (MPR) traffic bottleneck database prepared by Caltrans.

Figure 2-2: Top 20 Traffic Bottlenecks in the M-580 Study Area

Rank	Location	Annual Delay (hours)	Rank	Location	Annual Delay (hours)
1	Winton Ave, Alameda Co.	370,206	11	SFOBB Toll Plaza, Alameda Co.	157,577
2	I-580 / I-80 Split, Alameda Co.	319,554	12	Vasco Rd, Alameda Co.	152,903
3	Mission Blvd, Alameda Co.	283,444	13	I-880, Alameda Co.	139,483
4	Caldecott Tunnel, Alameda Co.	268,724	14	Auto Mall Pkwy, Alameda Co.	138,465
5	Gilman St, Alameda Co.	226,383	15	Mission Blvd, Alameda Co.	137,358
6	Loveridge Rd, Contra Costa Co.	217,338	16	Wilder Rd, Contra Costa Co.	129,545
7	Altamont Pass, Alameda Co.	212,402	17	Fremont Blvd, Alameda Co.	125,415
8	Pinole Valley Rd, Contra Costa Co.	204,268	18	98th Ave, Alameda Co.	122,171
9	Ashby Ave, Alameda Co.	186,241	19	Andrade Rd, Alameda Co.	122,076
10	Hacienda Dr, Alameda Co.	167,820	20	Alvarado Blvd/Fremont Blvd, Alameda Co.	112,395

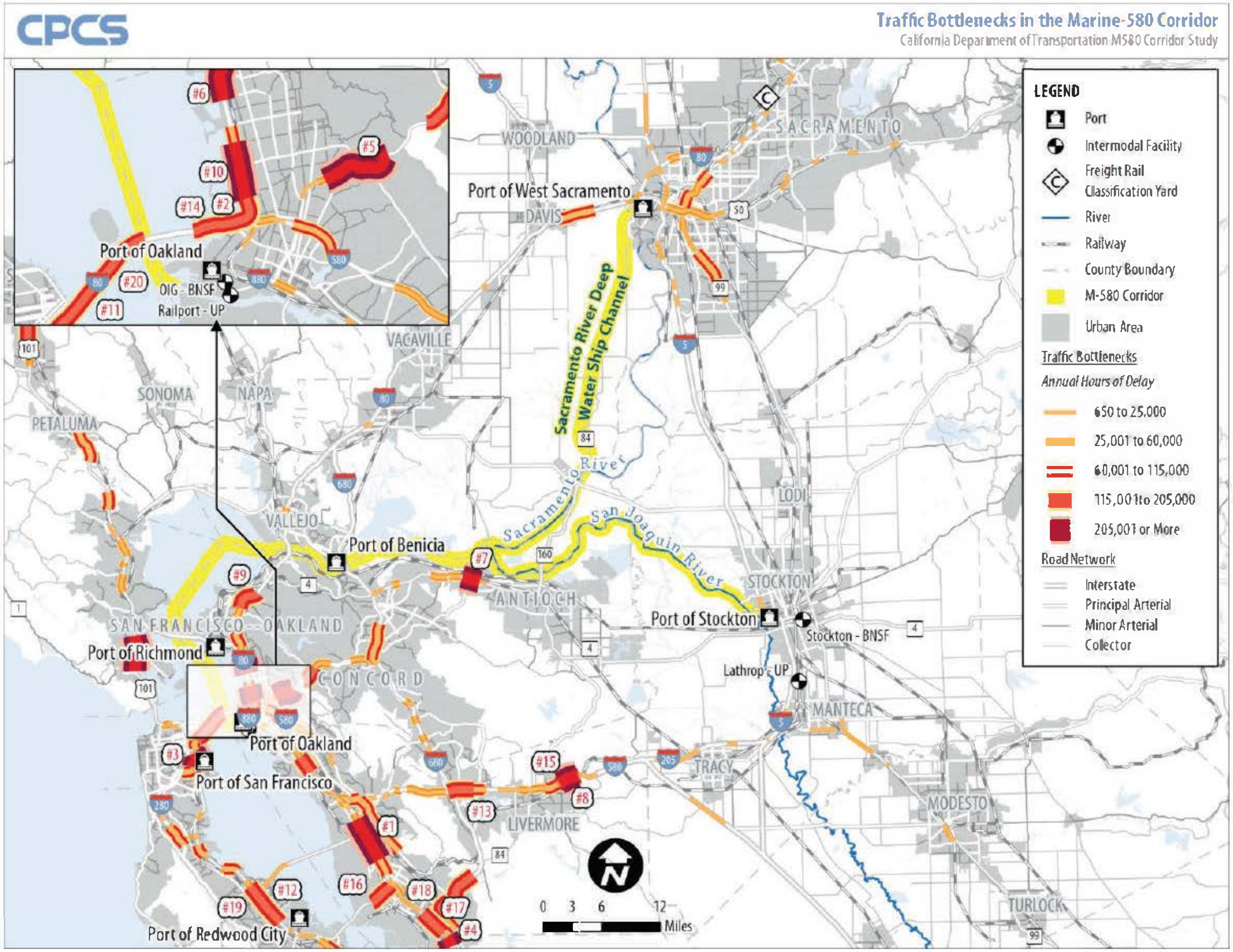
Source: CPCS analysis of Caltrans Mobility Performance Report (MPR) data, 2019.

In general, traffic bottlenecks in the M-580 study area with the highest annual hours of delay are clustered along I-880 and I-580 between Fremont and Oakland, I-580 near Tracy, and SR-4 in Antioch. Of note are the congestion points along I-80 and I-880 near Port of Oakland, as well as the segments on I-580, SR-4, and Vasco Rd., which provide a connection between Port of Oakland and Port of Stockton. Bottlenecks on I-580 stretch from west of I-580/I-680 interchange to east of Vasco Rd. interchange near Altamont, posing an average of 267 average daily hours of delay to highway users. Bottlenecks on SR-4 pose the highest daily delays to the traffic at the Route's intersection with Railroad Avenue west of Antioch and near SR-4/I-80 interchange.

[4] In addition to the road, rail, and maritime facilities, several cargo airports also serve the M-580 corridor. However, air cargo activities are not considered in this multimodal analysis since they pose minimal impacts on the market demands and capacities across the M-580 multimodal freight network.

[5] American Transportation Research Institute, Top 100 Truck Bottlenecks, 2019.

Figure 2-3: Traffic Bottlenecks Within the M-580 Study Area



Source: CPCS analysis of Caltrans Mobility Performance Report (MPR) data (2019).

Figure 2-4 and Figure 2-5 display the average travel time for trucks from Port of Oakland and Port of Stockton to freight-related businesses and facilities within the M-580 study area and points beyond. To better illustrate access from/to the ports to/from the freight-related establishments in the study area, clusters of businesses active in freight industries are added to the maps. Freight-related industries consist of agriculture, manufacturing, retail and wholesale, transportation, construction, mining, and oil and gas extraction. More than 18,000 freight-related businesses are situated around the primary corridors in the M-580 study area. About 40% of these are retail trade businesses, including auto parts, clothing, and general merchandise. Other major sectors of business establishments are manufacturing and wholesale trade (each with more than 16% of businesses), construction (with 17%), and transportation and warehousing (with 8%).[6]

As Figure 2-4 presents, the average accessibility from Port of Oakland to the businesses clustered near Stockton along I-5, as well as the establishments located in Modesto, is relatively better compared to the Port's access to the businesses in Sacramento Area. Comparison of average travel times in Figure 2-4 and Figure 2-5 shows that there is an imbalance in the average accessibility for trucks traveling from the Port of Oakland vs. the trucks traveling to the Port. Average accessibility from the ports of West Sacramento and Stockton towards the Port of Oakland is relatively less constricted.

Truck Size and Weight Restrictions

Bridge and highway weight, length, and height restrictions aim to protect the road system from these adverse impacts of trucking. However, these restrictions affect freight mobility and constraint truck access to origins, terminal facilities, and destinations. California poses route restrictions to trucks based on their size and weight as follows:

National Truck Network: Surface Transportation Assistance Act (STAA) dimensioned trucks are the largest commercial shipping trucks on highways. As the map in Figure 2-6 shows, the STAA trucks are restricted from traveling on many routes throughout California and the M-580 study area. Because of their length, the STAA trucks often have limited turning capacity and pose significant impacts on the highway and bridge networks. Within the M-580 study area, the STAA trucks travel on I-580, I-5, I-80, I-680, and I-880.

California Legal Truck Routes: large commercial vehicles that are smaller in length compared to the STAA trucks typically due to smaller cabs. The maximum length of these trucks can be 40 feet from kingpin-to-rearmost-axle and 65 feet overall. As the map shows, due to this slight difference in size, CA 65' KPRA trucks can only access sections of the routes designated for California Legal Trucks.

Terminal Access Routes: local roads that provide access to freight facilities for STAA and California legal trucks. Local transportation agencies can request for terminal access route designation through Caltrans and are responsible for determining if an access route can accommodate specific vehicles.

Special Route Restrictions: In addition to the route designations listed above, 13 special route restriction points are located within the M-580 study area that limit truck movements based on a variety of factors, including size, weight, and cargo type. The majority of these points are located in Alameda County, on bridges, tunnels, on/off ramps, and highway-rail crossings between Oakland and Fremont.[7]

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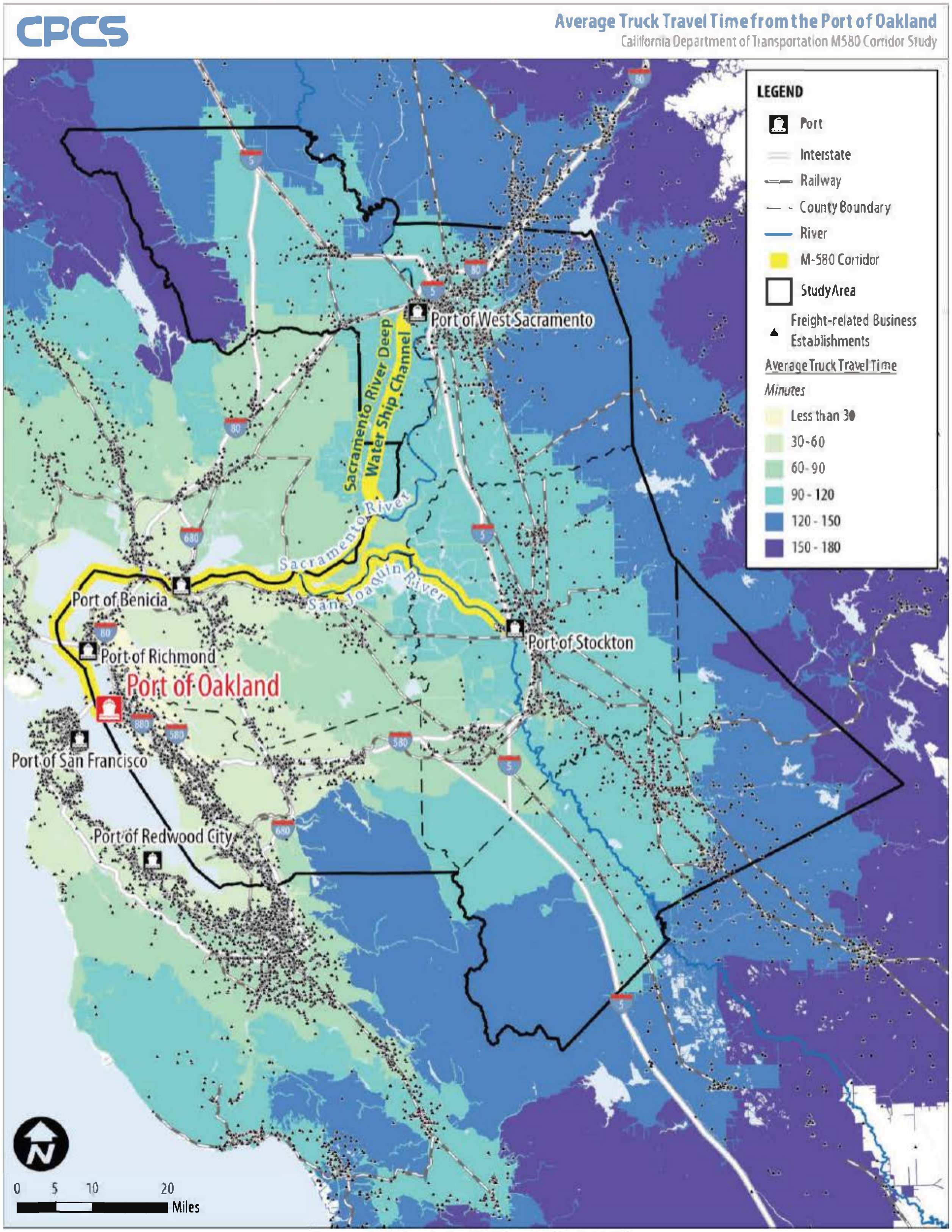
[6] CPCS analysis of aggregated Infogroup, InfoUSA data, 2016.

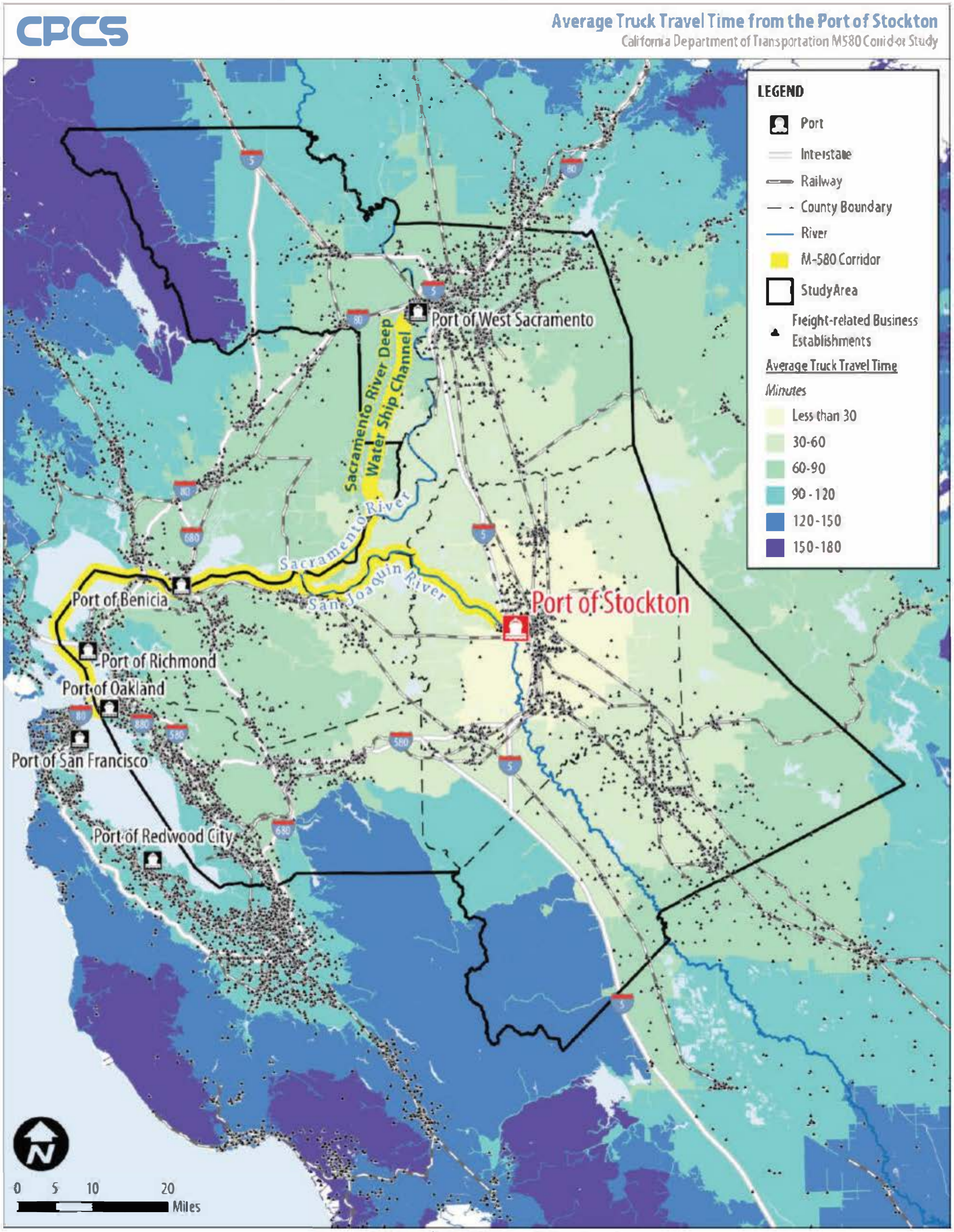
[7] Caltrans, CA Truck Network Maps, accessed June 2020.

Figure 2-4: Truck Accessibility – From Port of Oakland



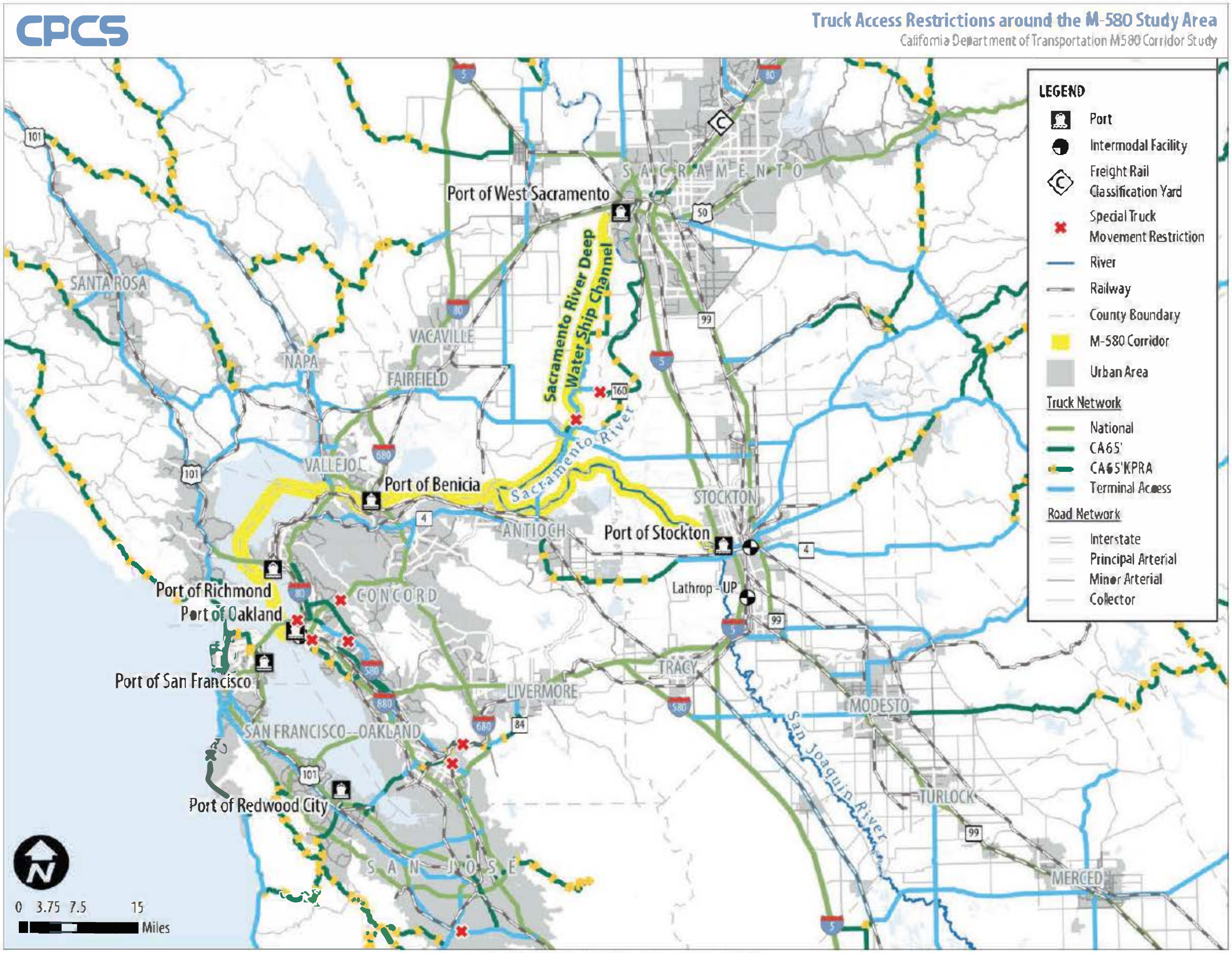
Source: CPCS analysis of Caltrans GIS Data, 2019.

Figure 2-5: Truck Accessibility – From Port Stockton



Source: CPCS analysis of Caltrans GIS Data, 2019.

Figure 2-6: Truck Access Restrictions in the M-580 Study Area



Source: Caltrans Legal Truck Access, 2020.

Highway Safety

Analysis of the 2018 Statewide Integrated Traffic Records System (SWITRS) database collected and processed by the California Highway Patrol (CHP) shows more than 1,200 injuries, and 46 fatal truck-involved collisions occurred within the M-580 study area in 2018. Fatal truck crashes have increased since 2013 by 7%, while injury truck crashes have increased by 47%.[8] On average, truck drivers were at fault in more than 37% of the truck-involved fatal collisions and more than 45% of injury collisions. The primary crash factors for both fatal and injury truck crashes were unsafe speed and improper turning.[9]

Within the study area, Alameda County had the highest number of truck injury accidents in 2018, while the majority of fatal truck crashes happened in San Joaquin and Sacramento Counties. Figure 2-7 shows the truck safety hotspots in the M-580 study area. In 2018, truck-involved crashes in the M-580 study area posed an estimated $727 million (in 2020 dollars) cost to society due to loss of life, health, and productivity.[10]

Highway Maintenance Impacts

Highway traffic volumes can also be translated into the potential annual maintenance costs. Roadways are engineered and constructed based on the number of Equivalent Single Axle Loads (ESAL) they can carry over a specified period. One ESAL is equal to 18,000 pounds per single axle for rigid pavement and 20,000 pounds per single axle for flexible pavement. Regardless of the pavement type, the amount of pavement life decreases drastically as the gross vehicle weight per axle increases exponentially. The most commonly applied method to approximate the relative impacts of different vehicle types on road surfaces is the Generalized Fourth Power Law which assumes a fourth-power relationship for the load-equivalence factors relative to different vehicle weights. Therefore, a 20,000 lb. single axle truck has 10,000 more impacts on the pavement compared to a 2,000 single axle car.

According to the 23rd Annual Highway Report, California's per-mile highway maintenance disbursement rate was about $84,000 in 2018. The common practice in estimating the trucking impacts on highway wear and tear is to estimate the marginal pavement cost assuming that every additional (mile of) truck trip would cause the highway surface to deteriorate and need resurfacing faster. In addition, more truck trips on the road would force the transportation agencies to construct more durable pavements in the future in anticipation of continued heavy truck traffic volume.[11] A wide range of marginal maintenance cost per truck-mile ($0.44 to $6.30 – in 2020 dollars) is recommended in the literature[12, 13] which without any shift from trucks to other modes, translates into up to $87 million in annual highway maintenance cost due to trucking activities in the study area by 2040.

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8 SWITRS, 2017 Annual Report.

9 ibid.

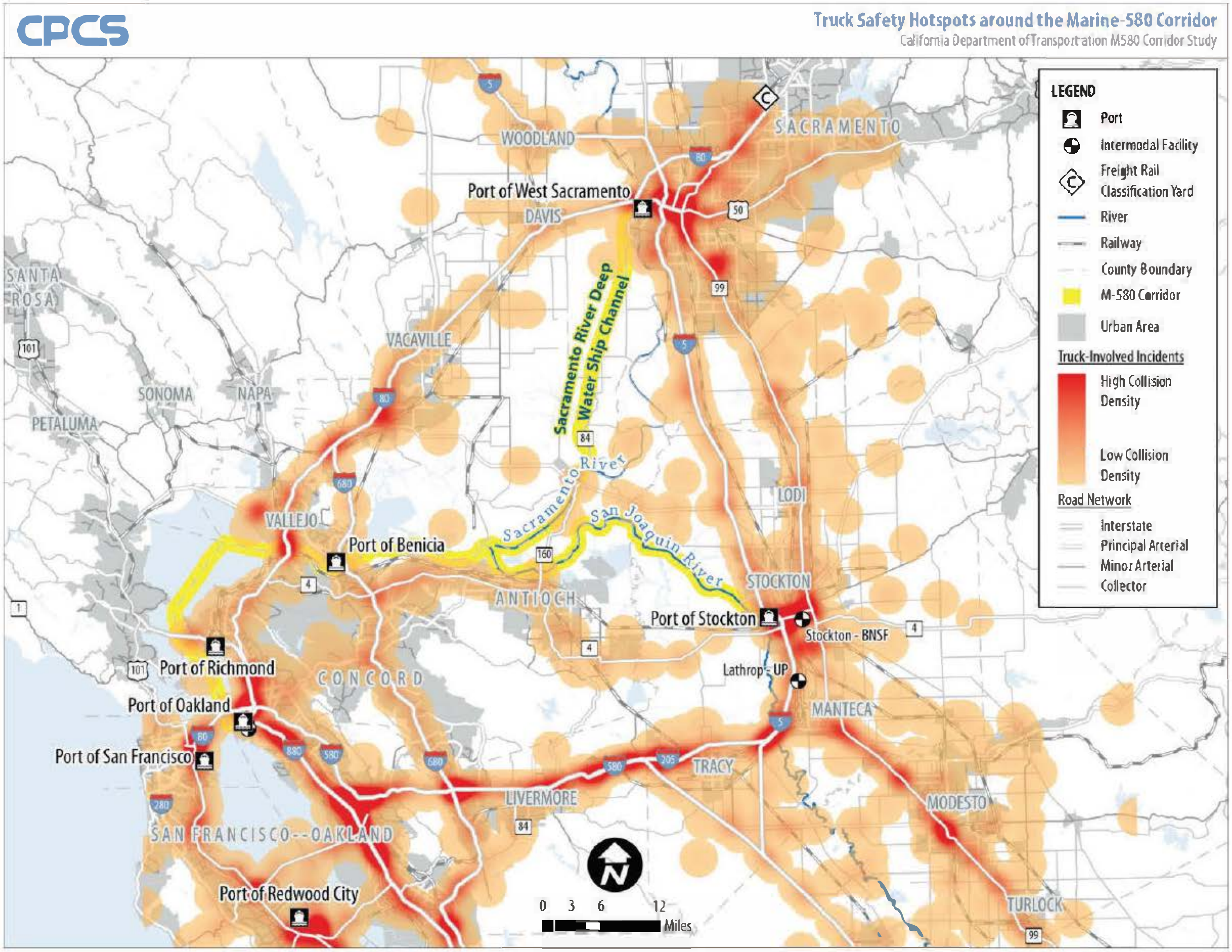
10 The estimated costs of safety events road fatality and injuries are extracted from Cal-B/C Model's parameters.

11 Transportation Research Board Special Report 246 "Paying Our Way: Estimating the Marginal Social Cost of Transportation" (1996). http://onlinepubs.trb.org/onlinepubs/sr/sr246.pdf

12 Over the past 30 years, the Reason Foundation has tracked the performance of the state-owned highway system using various metrics and methodologies. For more information see: https://reason.org/wp-content/uploads/2018/01/23rd_annual_highway_report.pdf

13 Yong Bai et. al, Estimating Highway Pavement Damage Costs Attributed to Truck Traffic, 2010. Mid-America Transportation Center.

Figure 2-7: Truck Safety Hotspots Within the M-580 Study Area



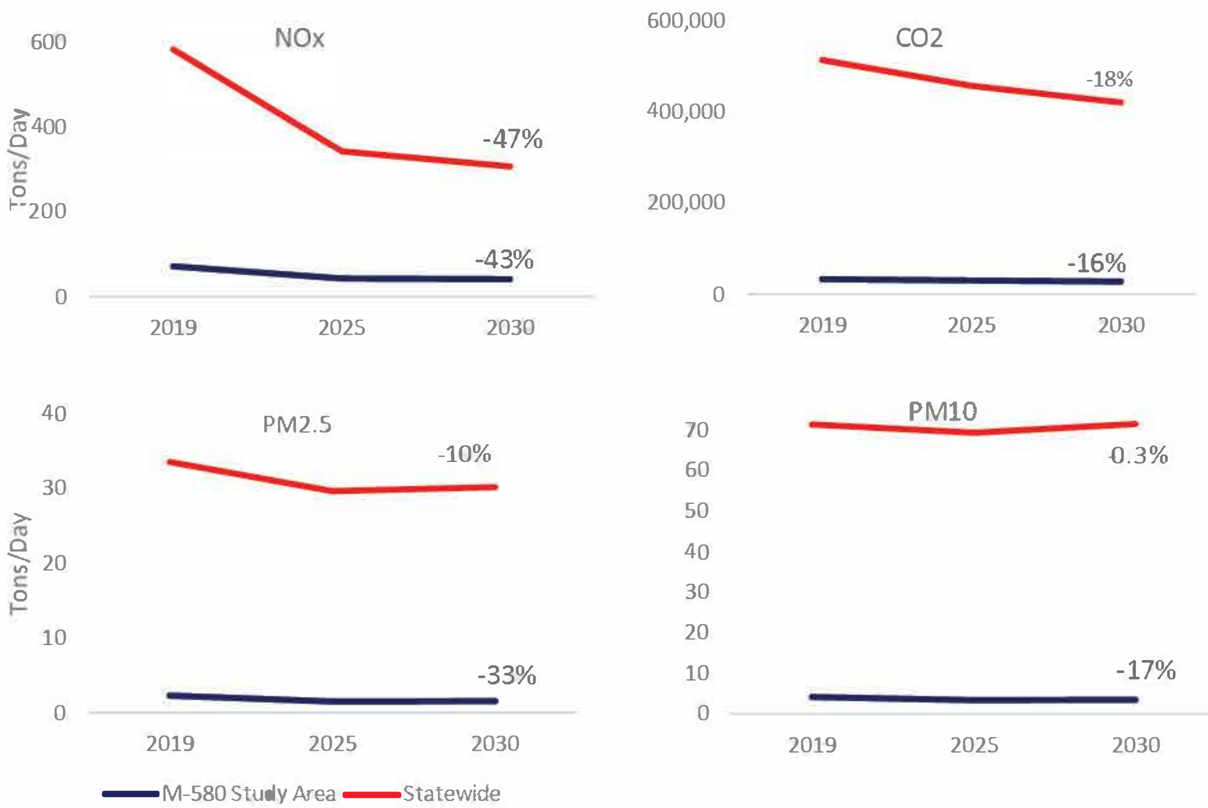
Source: CPCS analysis of California Statewide Integrated Traffic Records System (SWITRS) data (2018).

Truck Emissions

Fuel combusted in the truck engines leads to the emission of nitrogen, water vapor, and carbon dioxide (CO_2). Also, about one percent of the truck engine emissions consist of pollutants such as nitrogen oxides and dioxides (NOx), and particulate matter (PM). California Air Resources Board's (CARB's) Mobile Source Emission Inventory (MSEI) database documents and forecasts the emissions from on-road vehicles, including passenger vehicles, buses, and various types of trucks traveling in California.

Even though California has relatively stringent emission regulations, truck-related emissions are expected to become a challenge in the future. The statewide truck miles traveled are expected to increase by 20% (from 98 million truck miles in 2019 to about 119 million truck miles) by 2040.[14] Such an increase in the number of truck miles traveled along with the recent rise in the development of warehousing and distribution facilities (especially along the highways in Central Valley) can increase congestion, which in turn leads to added truck emissions.[15] Figure 2-8 displays the average weekday emission rates resulted from trucking activities within the M-580 study area and across California. The 2019, 2025, and 2030 emission forecasts are based on 2017 mobile source emission calculations.

Figure 2-8: Statewide and M-580 Study Area Truck Emission Impacts



Source: CPCS analysis of Mobile Source Emissions Inventory Data provided by the California Air Resources Board (2017 forecasts).

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[14] Caltrans, California Freight Mobility Plan 2020.

[15] EMFAC, An update to California On-road Mobile Source Emission Inventory, 2017.

As the graphs show, CARB's Ambient air quality standards (AAQS) and air quality improvement programs for consumers, vehicle operators, manufacturers, and the fuel technology industry, are expected to decrease diesel engine emissions by 2030.[16] $PM_{2.5}$ emissions are expected to decrease by more than 30% in the M-580 study area and up to 10% across the State. Meanwhile, PM_{10} emissions are forecasted to only slightly decline across the State while decreasing by about 17% in the M-580 study area. Forecasts also show a 16% decline in daily CO_2 emissions in the M-580 study area and an 18% decline across California. Diesel engine emissions of other pollutants such as NOx are also expected to decrease significantly (by more than 40%).

2.1.2 Rail Network Performance

The rail network in the M-580 study area plays a critical role in supporting the overall movement of commodities between the local businesses and industries and the major freight origins and destinations, distribution and warehousing facilities, and consumers of other geographic markets. In 2013, nearly 30 million tons of intermodal and 33 million carload tons entered the Central Valley and Northern California from the US Midwest and Northeast regions by rail. Meanwhile, 21 million tons of intermodal and about 6 million carload tons of cargo were carried by rail out of the Valley and Northern California by rail. The projected (2040) freight train volumes presented in the California State Rail Plan show significant growth in the expected rail freight traffic along the rail corridor in California.

Within the M-580 study area, the rail freight movements between Stockton and Sacramento are expected to increase by more than 60 trains per day, with relatively considerable growth projected along BNSF's Central Valley Route between Sacramento and Barstow.[17] Such an expected increase in the rail freight volumes implies the investments required for capacity improvements along the major rail corridors. In addition to freight operations, both BNSF and UP tracks serve passenger trains. Figure 2-9 the freight and passenger train volumes on tracks, and Figure 2-10 shows the freight and passenger rail routes within the M-580 study area.

Figure 2-9: Freight and Passenger Rail Volumes in the M-580 Study Area

Railroad	Subdivision	Freight Volume (trains per day)	Pax Volume (trains per day)	Total Trains per Day
UP	Martinez	18	42-44	60-62
UP	Niles - Oakland	16	16	32
UP	Niles - Fremont	11	22	33
UP	Coast	6	24	30
UP	Oakland	11	8	19
BNSF	Stockton	22	7	29

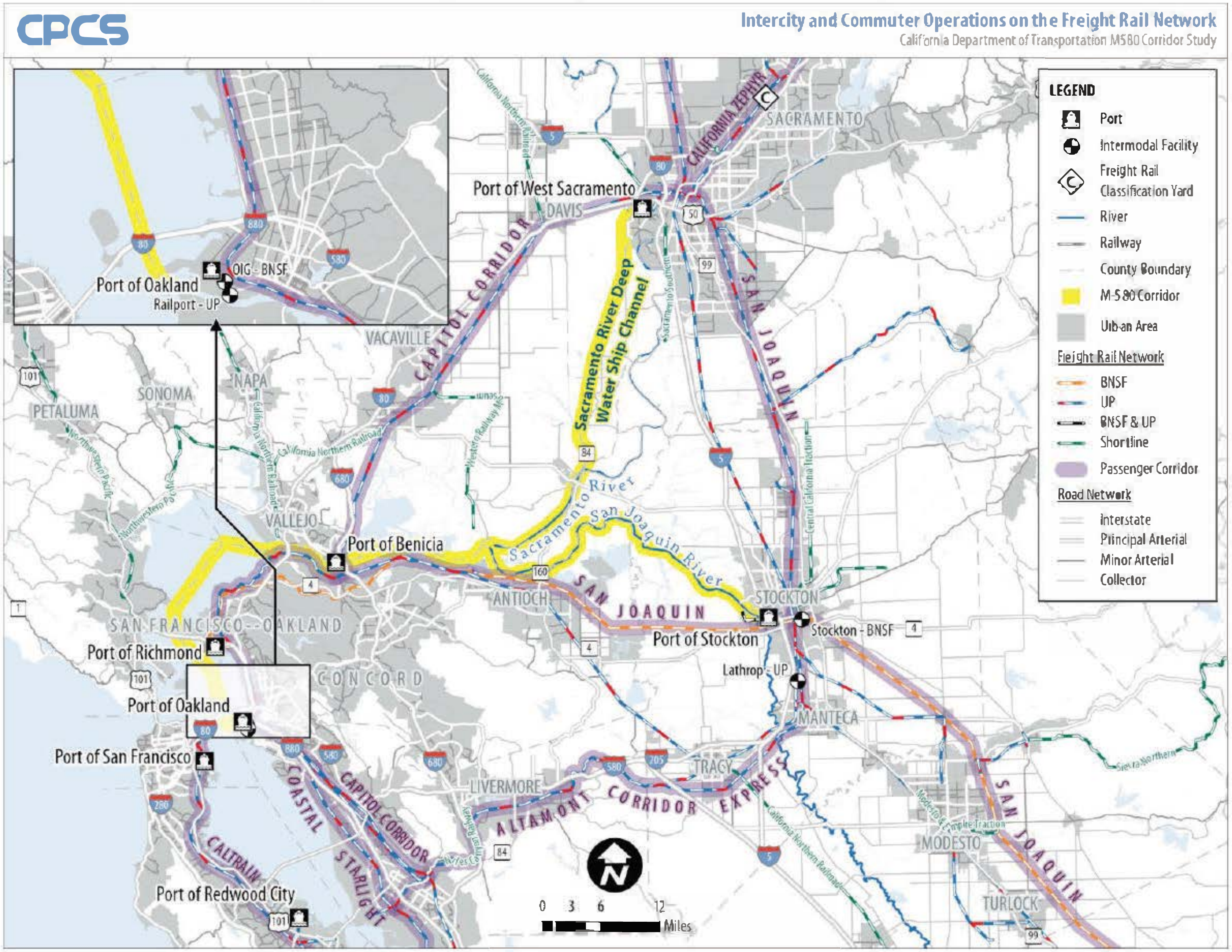
Source: Alameda County Transportation Commission, 2017; California State Rail Plan, 2018.

Rail Speed Constraints

Figure 2-11 shows the primary Class I track speed restriction sections or bottlenecks, as presented in the California State Rail Plan. Within the M-580 study area, UP's San Joaquin subdivision between Sacramento and Elvas, and the Capitol Corridor subdivision segment in Sacramento experience speeds lower than 40 miles-per-hour (mph).

[16] Such as the Goods Movement Emission Reduction Program and Low Carbon Transportation Investments and Air Quality Improvement Program. For more information see: https://ww3.arb.ca.gov/msprog/msprog.htm
[17] Caltrans, California State Rail Plan, 2018.

Figure 2-10: Freight and Passenger Rail Routes in the M-580 Study Area



Source: California State Rail Plan, 2018.

Figure 2-11: Track Segments Restricted to Speeds of 40 mph or Lower within Study Area

Route	Segment Starts at:	Segment Ends at:	Miles	Owner of Track	No. of Tracks	Max Speed
San Joaquin	Sacramento	Elvas	2.6	UP	2	35
Capitol Corridor	Rocklin	Roseville	4.1	UP	2	40
Capitol Corridor	Elvas	Sacramento	2.9	UP	2	35
Capitol Corridor	Sacramento	Sacramento River	0.4	UP	2	20
Capitol Corridor	Santa Clara	San Jose	2.8	PCJPB	3	40

Source: California State Rail Plan 2018.

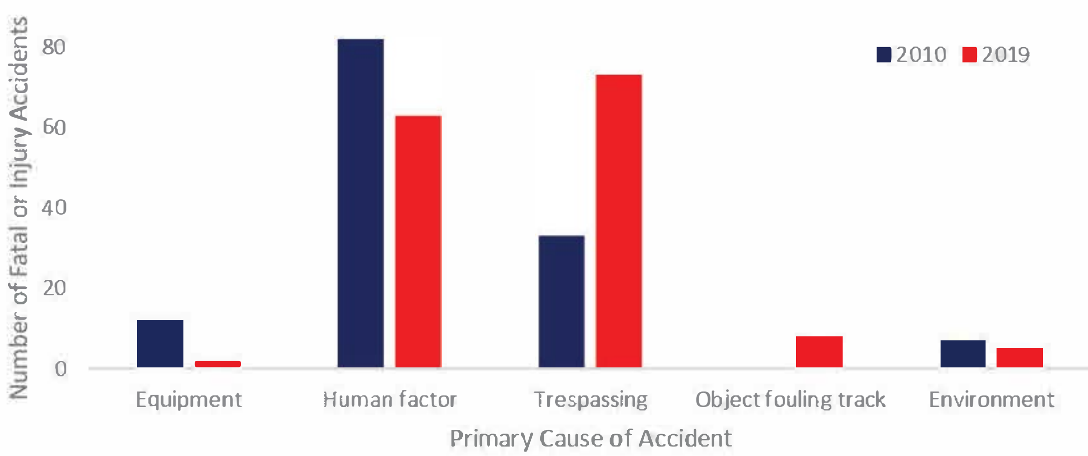
Figure 2-13 the rail track bottlenecks located within the M-580 study area. Of note are the very low speed (20 mph) sections near Port of West Sacramento as well as Northeast Sacramento. Speed reductions can be caused by a variety of factors, such as capacity issues and infrastructural limitations.

Rail Safety

Between 2017 and 2019, more than 105 rail equipment accidents and 57 highway-rail crossing accidents occurred on the BNSF, UP, and Central California Traction Company (CCT) tracks located within the M-580 study area. During the same time, 74 of the accidents have led to fatalities. Figure 2-12 illustrates the changes in railroad injury and fatality accidents between 2010 and 2019. As the figure shows, there has been a 120 percent increase in trespassing incidents.

The upward trend in the trespassing incidents is a nationwide issue that has been linked to a wide range of factors, including the rise in population density around major urban areas and the increase in passenger and freight rail activity to serve the growing population.[18]

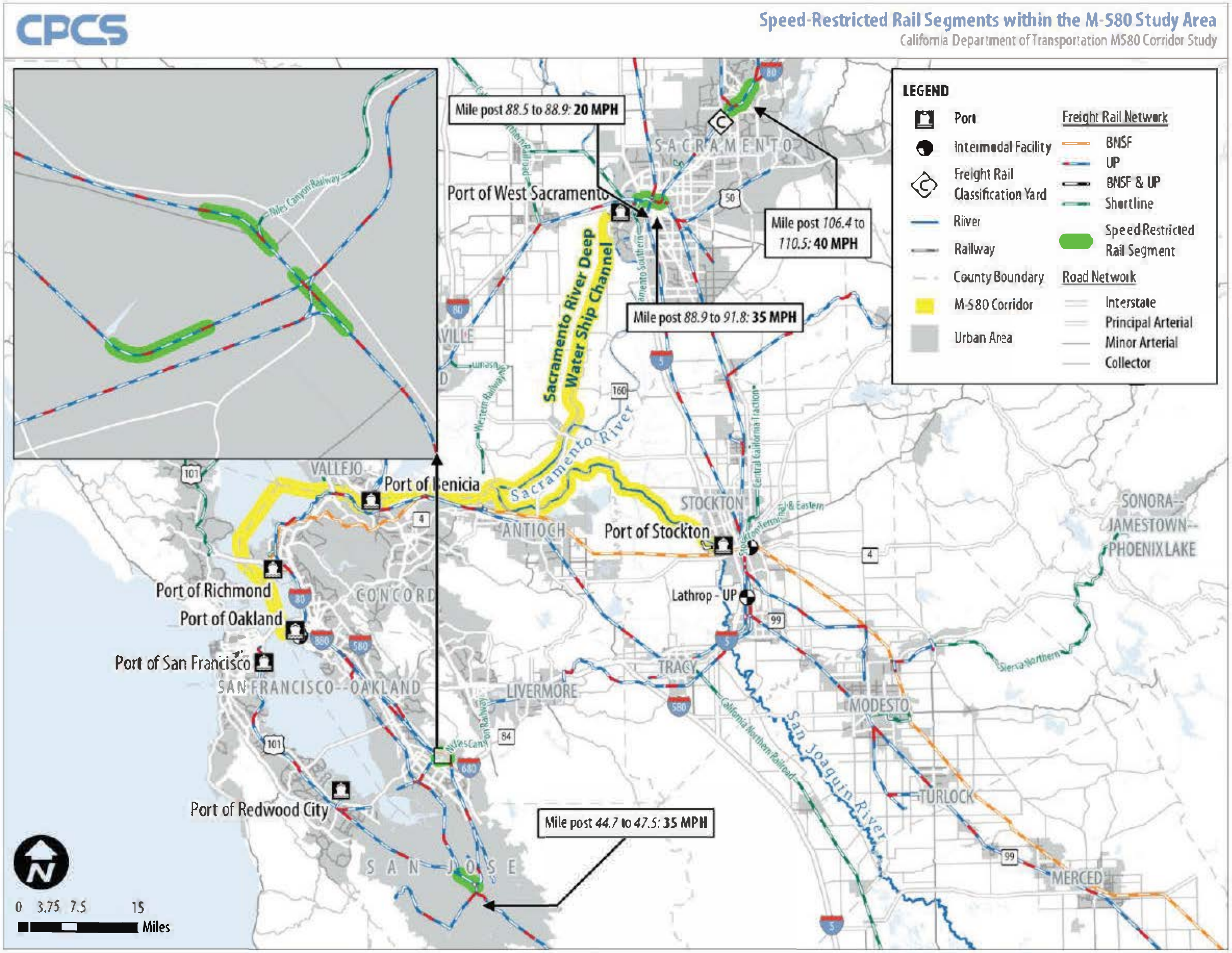
Figure 2-12: Rail Casualties and Causes in the M-580 Study Area, 2017 - 2019



Source: CPCS analysis of Federal Railroad Administration Rail Safety Data (2017-2019).

[18] FRA, Report to Congress: National Strategy to Prevent Trespassing on Railroad Property, 2018.

Figure 2-13: Rail Speed Restriction Sections within the M-580 Study Area



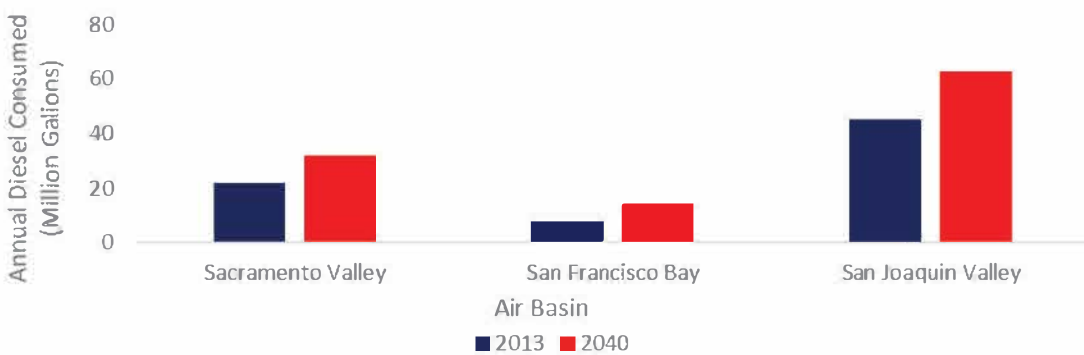
Source: CPCS analysis of data provided in the California State Rail Plan (2018) and Alameda CTC Rail Strategy Study (2018).

Rail Emissions

Figure 2-14 presents the annual diesel consumption of rail freight activities in and around the M-580 study area. Freight locomotive emissions are estimated based on the EPA emission rates and aggregated freight volumes (in ton-miles)[19] in the Sacramento Valley, San Francisco Bay, and San Joaquin Valley air basins that roughly align with the M-580 study area.

As Figure 2-14 shows, rail freight fuel consumption in San Joaquin Valley is approximately three times the diesel consumed due to rail freight operations in the Sacramento Valley, and about five times the Diesel fuel consumed within the San Francisco Bay air basin. This can be due to the relatively larger size of the San Joaquin air basin, which can reduce the overall emission impacts on the public.[20]

Figure 2-14: Annual Diesel Consumption by Rail Freight Operations – 2013 and Estimated 2040



Source: CPCS analysis of data provided in the California State Rail Plan (2018).

The anticipated growth in the future rail freight volumes is expected to lead to a significant increase (up to 80%) in the annual diesel consumption. Figure 2-15 shows the GHG emissions from rail activities in the M-580 study area. The rise in fuel consumption can result in about 50 percent more CO_2, NOx, and PM emissions by 2040.

Figure 2-15: Freight Locomotive Emissions – 2013 and Estimated 2040 (Tons/Day)

Geography	Year	CO_2	NOx	PM 10	PM2.5
Bay Area & Northern California	2013	1,525	20.79	0.74	0.72
Central Valley		1,390	18.95	0.68	0.66
Total Statewide		6,399	85.95	3.08	2.99
Bay Area & Northern California	2040	2,420	33	1.18	1.15
Central Valley		1,935	26.38	0.94	0.92
Total Statewide		9,923	132.81	4.76	4.62

Source: CPCS analysis of data provided in the California State Rail Plan (2018).

On the other hand, rail freight fuel consumption rates and emission impacts, when normalized by the ton of cargo carried and miles traveled, accounts for a small (7%) portion of the emission impacts of freight

[19] California State Rail Plan, 2018.

[20] An air basin generally has similar meteorological and geographic conditions throughout. For more information see: CARB, California Air Basin Map, accessed May 2020.

transportation activities while carrying more than one-third of the long-haul freight ton-miles.[21] Even this small share of emissions is expected to decrease by about 80% by 2050 to meet the GHG reduction goals presented in the California State Rail Plan in alignment with the California Transportation Plan (CTP) 2040 vision for a sustainable transportation system. The State Rail Plan lays the groundwork for rail emission reduction through prioritizing investments on projects that deploy zero- or near-zero-emission technologies such as locomotive electrification and emerging switching and cargo handling technologies.

Investments in rail freight operation can also contribute to reduced emission impacts by offering the shippers an alternative to trucks. The shift from trucks to rail can reduce roadway congestion and improve the average corridor travel times, resulting in reduced traffic emissions impacts.

2.2 Truck and Rail Freight Demands

Analysis of Port Area Trucking Activities

The Port of Oakland and the Port of Stockton are two major freight facilities in the M-580 study area, generating and attracting truck trips on their adjacent road network. Port of Oakland truck generations presented in Figure 2-16 are estimated using 2019 data of Port of Oakland's container handling performance, the information provided through a survey of trucks in the port subarea. The number of trucks generated in San Joaquin County is estimated based on information on the location, size, and type of freight moving through the county's warehousing and distribution facilities.

As Figure 2-16 shows, the majority of the port subarea's trucks (1,057 daily) travel to and from the port and other locations in Alameda County. Outside of Alameda County, San Joaquin County is the largest generator of truck trips to the Port of Oakland. In particular, Stockton and Tracy (with 6% and 4% share of truck trips attracted to the Port, respectively) are top truck origins in the County for trips destined to the Port of Oakland. This provides a rough upper bound estimate on the market size of containers moving between the Port of Oakland and Port of Stockton regions. Bulk grains, nuts, beverages, and finished manufactured goods are among the types of commodities shipped from San Joaquin County to the Port of Oakland by truck.

Similarly, the estimate of 189 daily truck trips from the Port of Oakland to San Joaquin County represents a rough estimate on the market size of containers between this origin-destination pair. Stockton and French Camp in particular (with 4% and 3% share of truck trips generated from the Port, respectively) are major attractors of trucks originated from the Port of Oakland. An estimated 238 daily trucks travel between the Sacramento–Richmond corridor and the Port of Oakland, about 85% of which (202 daily trucks) are originated from or destined to the industrial city of West Sacramento, and the rest are primarily from/to Rancho Cordova. Recycled material, nuts, dairy, and manufactured food products are among the types of commodities shipped from West Sacramento to Port of Oakland by truck.

Figure 2-16: Port of Oakland Truck Traffic Attraction and Generation

Origin County	Truck Trip Attraction Rate	Daily No. Trucks to Port of Oakland	Destination County	Truck Trip Generation Rate	Daily No. Trucks from Port of Oakland
Alameda	29.2%	434	Alameda	36.7%	623
San Joaquin	18.2%	270	San Joaquin	11.1%	189
Sacramento	8.4%	125	Stanislaus	7.8%	132

[21] Association of American Railroads, Freight Railroads Help Reduce Greenhouse Gas Emissions, 2019.

Origin County	Truck Trip Attraction Rate	Daily No. Trucks to Port of Oakland	Destination County	Truck Trip Generation Rate	Daily No. Trucks from Port of Oakland
Stanislaus	8.4%	125	Contra Costa	6.7%	113
Colusa	5.2%	77	Sacramento	6.7%	113
Contra Costa	4.5%	67	Monterey	5.6%	94
Monterey	3.2%	48	Solano	3.3%	57
Santa Clara	2.6%	39	Yolo	3.3%	57
Glenn	1.3%	19	Douglas, Nevada	2.2%	38
Madera	1.3%	19	Fresno	2.2%	38
San Francisco	1.3%	19	Siskiyou	2.2%	38
San Mateo	1.3%	19	Washoe, Nevada	2.2%	38
Solano	1.3%	19	Other CA Counties	10.0%	170
Tehama	1.3%	19			1,698
Yolo	1.3%	19			
Other CA Counties	5.2%	77			
Other States	5.8%	87			
Total		1,484			

Source: CPCS analysis of Port of Oakland 2019 truck volume data and Alameda County Transportation Commission Truck Movement Survey, 2016.

Vehicle-based trip generation rates determined by the Institute of Transportation Engineers (ITE) are used to calculate the truck trips associated with the warehousing and cargo distribution facilities in the Stockton area.[22] Warehousing and distribution land use include transfer points at which the shipments are handled before delivery to the final destination or after pickup for shipments and are an essential part of more complex supply chains. The ITE method correlates the truck trip generation with factors such as facility access, local goods movement historical data, and long-haul goods movement trends. In this method, warehousing and distribution land use are divided into four general categories: transload and short-term storage, cold storage, fulfillment center, and parcel hub. Among these land use categories, parcel hubs and cold storage facilities have relatively higher truck trip generation rates according to the travel patterns observed in the data analyzed by ITE.[23] Figure 2-17 shows the distribution of different categories of warehousing and distribution facilities in major cities of San Joaquin County. The data presented in this table is used to calculate truck trip generation.

Figure 2-17: Warehousing and Distribution Facility Categories and Area (sqft) in San Joaquin County

City	Stockton	Tracy	Lathrop	Manteca	Lodi	Total
Short-term Storage	10,679,768	6,731,070	4,612,906	1,207,517	587,000	23,818,261
Fulfillment	4,433,857	1,128,049	684,392	551,475	-	
Cold Storage	2,735,486	3,438,080	2,257,331	897,952	-	9,328,849
Parcel hub	2,820,341	3,328284	745,640	-	-	6,894,265
Total	**20,669,452**	**14,625,483**	**8,300,269**	**2,656,944**	**587,000**	**46,839,148**

[22] While truck traffic generations by warehousing and distribution facilities may not be reflective of all truck activity in the M-580 study area, they provide an estimation for understanding truck activities.

[23] High-Cube Warehouse Vehicle Trip Generation Analysis, Institute of Transportation Engineers, Washington, DC, 2016.

Source: San Joaquin Partnership, 2019.

Figure 2-18 summarizes the warehousing and distribution facility clusters in the Stockton area (San Joaquin County) and their associated average daily truck trips estimated.

Figure 2-18: Daily Truck Trip Generation Estimates for Stockton Area

City	Warehousing/Distribution Land Use Area (sq. ft.)	Total Trucks Trips	Daily Truck Trips (2,3,4 Axle)	Daily Truck Trips (5+ Axle)
Stockton	20,669,452	21,873	13,392	8,480
Tracy	14,625,483	20,278	12,512	7,765
Lathrop	8,300,269	7,541	3,837	3,704
Manteca	2,656,944	1,719	617	1,102
Lodi	587,000	269	131	138
Grand Total	46,839,148	51,680	30,490	21,190

Source: CPCS analysis of San Joaquin Partnership data, 2019.

Analysis of the tables above shows that the warehousing and distribution activity located in the Stockton area generates large volumes of truck traffic. Assuming that just a small fraction of these trucks move goods to and from the core Bay Area locations indicates that there is sufficient volume to consider additional alternative modes for moving freight between these two regions. Also, the warehousing and distribution facilities at Stockton, Tracy, and Lathrop generate the highest number of daily truck trips relative to the cities of Manteca and Lodi. These three locations appear to be the most critical freight-intensive regions in San Joaquin County.

Study Area Truck Origin-Designation Matrix

US Department of Transportation's Freight Analysis Framework (FAF) database provides commodity volumes, values, origins, and destinations by mode. The database is spatially aggregated into FAF zones comprising multiple counties. This makes it challenging to use FAF directly to assess goods movement by mode across the M-580 study area. The commodity flows in the M-580 study area presented in this section are based on the FAF 4.4 database disaggregated by Caltrans to Freight Analysis Zones (FAZs).[24]

The analysis presented in this report includes freight flows that originated or are destined in California. Commodity types in the FAF database are grouped according to the California Statewide Freight Forecasting Model (CSFFM), as shown in Figure 2-19. As the figure shows, gravel, sand, and non-metallic minerals is the top commodity group both in terms of truck volume generated and attracted, followed by food, beverages, and tobacco products, non-metal mineral products, agricultural products, and fuel and oil products. The industries associated with the top three products tend to spend a relatively large proportion of their costs on transportation, making their shipments typically more sensitive to price than other industries.

[24] FAZs are Transportation Analysis Zones defined at county and sub-county levels with maximum employment of 500,000. There are 146 FAZs in California, 21 of which are located within the M-580 study area.

Figure 2-19: Types of Commodities Moved by Trucks in the M-580 Study Area

Commodity Group for M-580 Origins	%	Commodity Group for M-580 Destinations	%
Gravel/ sand and non-metallic minerals	21.0%	Gravel/ sand and non-metallic minerals	25.7%
Food, beverage, tobacco products	13.1%	Agriculture products	13.7%
Agriculture products	11.7%	Food, beverage, tobacco products	12.1%
Non-metal mineral products	11.7%	Non-metal mineral products	10.4%
Fuel and oil products	11.3%	Fuel and oil products	9.9%
Waste material	8.9%	Waste material	9.1%
Manufactured products	6.6%	Manufactured products	5.2%
Chemical/ pharmaceutical products	4.1%	Chemical/ pharmaceutical products	3.5%
Wood, printed products	3.6%	Logs	3.2%
Metal manufactured products	2.8%	Wood, printed products	2.9%
Transportation equipment	1.8%	Metal manufactured products	1.9%
Electronics	1.7%	Transportation equipment	1.3%
Logs	1.7%	Electronics	1.2%
Total	100%	**Total**	100%

Source: CPCS analysis of disaggregated FAF 4 data of California.

Stanislaus County generates and attracts the highest volume of agricultural commodities and food, beverages, and tobacco products carried by trucks. The County also attracts relatively high quantities of gravel, sand, and non-metallic minerals that are mostly generated from Sacramento County. Fuel and oil products and non-metal mineral products carried by trucks are generated from and attracted to Sacramento County in relatively higher volumes compared to other origins and destinations in the study area.

To convert the truck tonnage data to an estimate of the number of trucks, a Truck Payload Equivalency Factor (TPEF) is used, calculated according to the truck type allocations (light, medium, and heavy-duty trucks) and average payload using Vehicle Inventory and Use Survey (VIUS) database.[25] The resulting estimated annual inter-county truck volumes in the M-580 study area are shown in Figure 2-20. There are well over 180,000 annual truck trips between Alameda County and Contra Costa County, over 100,000 annual truck trips between Alameda County and San Joaquin County, and nearly 200,000 annual truck trips between Alameda County and San Francisco County. The high levels of estimated intra-regional flows serve as a starting point for considering alternative freight services that serve the domestic market. An expanded truck OD matrix of the M-580 study area is presented in Appendix A.

[25] VIUS is the national and state-level estimates of the total number of trucks by truck type provided by the U.S. Economic Census.

Figure 2-20: Inter-County Annual Truck Volumes in the M-580 Study Area

Destination / Origin	Alameda County	Contra Costa County	Sacramento County	San Joaquin County	Stanislaus County	San Francisco County	Yolo County	Total
Alameda Co.	n/a	185,377	43,584	108,208	28,744	194,968	26,607	587,488
Contra Costa Co.	217,956	n/a	33,452	88,240	21,508	110,858	25,464	497,477
Sacramento Co.	34,133	25,754	n/a	45,348	20,958	19,220	55,394	200,806
San Joaquin Co.	155,516	113,158	66,462	n/a	63,470	88,743	41,771	529,121
Stanislaus Co.	38,798	26,933	24,446	51,607	n/a	19,249	11,119	172,152
San Francisco Co.	201,582	108,374	26,446	67,543	15,427	n/a	19,342	438,714
Yolo Co.	53,501	44,037	71,639	102,684	16,418	31,812	n/a	320,090
Total	701,486	503,632	266,028	463,629	166,525	464,851	179,697	2,745,848

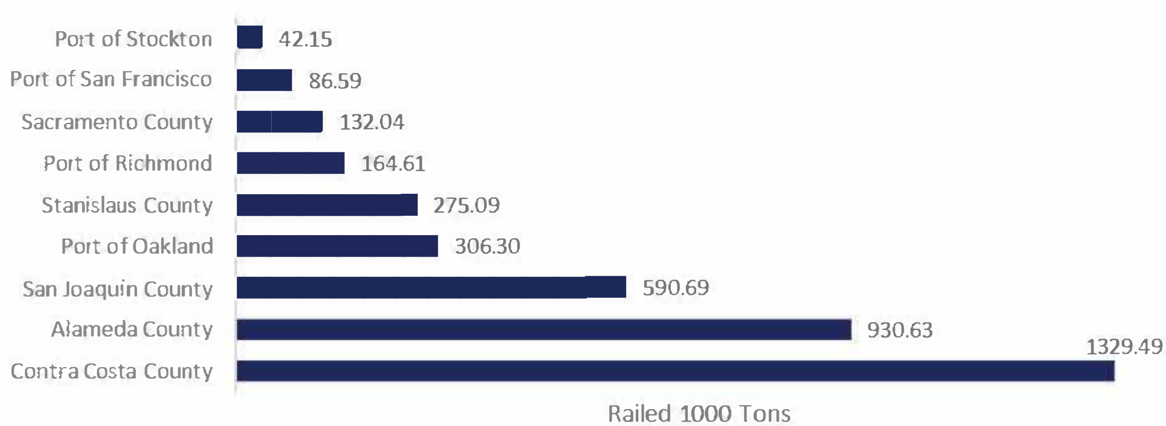
Source: CPCS analysis of Caltrans disaggregated FHWA FAF 4 data.

Rail Network Commodity Flow

Figure 2-21 presents the railed commodity volumes originated from the M-580 study area. The analysis presented in this section is based on 2015 forecasted commodity flows in disaggregated FAF 4.4 database. As shown, Contra Costa County is the top origin for rail freight movements in the study area, with nearly 1,330 ktons of cargo shipments on an annual basis, followed by Alameda County with 930 ktons, and San Joaquin County with more than 590 ktons railed annually.

Fuel and oil products and gravel and non-metallic minerals have the highest share of the total annual cargo volumes shipped by rail out of the M-580 study area. Additionally, Port of Oakland is the top generator of rail activities for several commodity groups, including agriculture products, wood, printed products, food, beverage, tobacco products, manufactured products, waste material, transportation equipment, and logs. Contra Costa, Alameda, San Joaquin, and Stanislaus Counties are other primary origins for rail cargo movement in the M-580 study area.

Figure 2-21: Railed Commodity Tonnages Originated from the M-580 Study Area

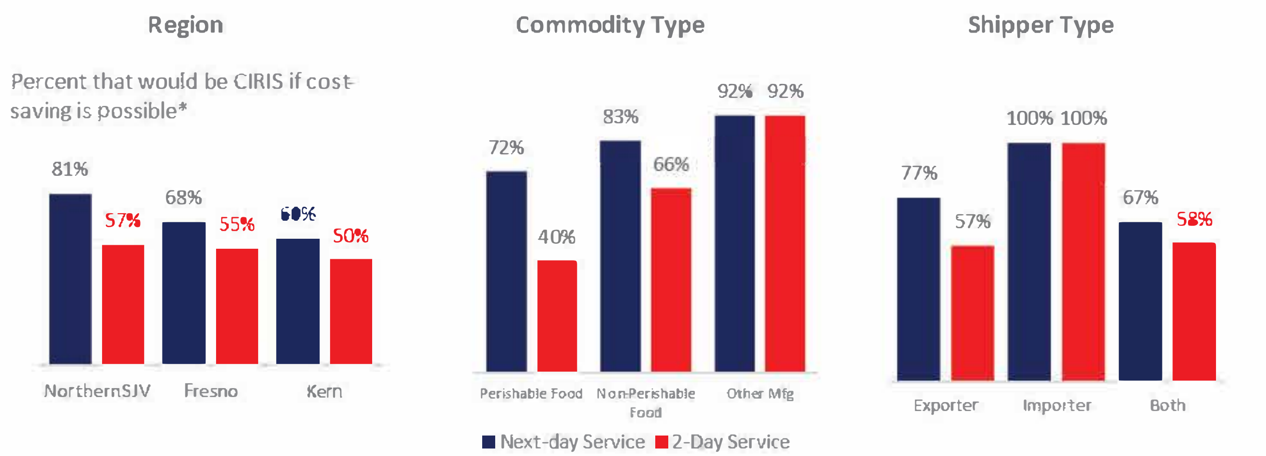


Source: CPCS analysis of disaggregated FAF 4 data of California.

There have been several analyses of potential short-line rail options in northern California. The San Joaquin Council of Governments (SJCOG) Inland Port Feasibility Study included a survey of potential users that determined the vast majority of customers would be willing to use a short-haul rail service if it were less expensive than the current trucking service under both 1-day and 2-day service alternatives. Figure 2-22 shows the percent of shippers that were willing to use a short-haul rail service by region, commodity type, and shipper type.

The cost and revenue analysis of the SJCOG study determined that even under favorable market conditions that there will be a need for a significant subsidy to support a short-haul rail service between the Port of Oakland subarea and several locations in the Central Valley. Rail service to the Stockton region was found to require the lowest level of subsidy. Also, the increase in trucking costs since the completion of the San Joaquin Inland Port Study indicates that a re-examination of short-haul service is warranted. SJCOG also completed the California Inter-Regional Intermodal System (CIRIS) in 2006. This study developed an umbrella concept to implement a short-haul rail service between the Port of Oakland and the Stockton region. It determined that the essential steps of implementation are to identify a sponsoring agency, obtain funding, arrange for a pilot project, and reach rate and service agreements with the railroad.

Figure 2-22: Percent of Shippers Preferring a Less Expensive Short-Haul Rail Option for 1-Day and 2-Day Services



Source: San Joaquin Council of Governments Inland Port Feasibility Study, 2016.

2.3 Ports and Waterway System Activities

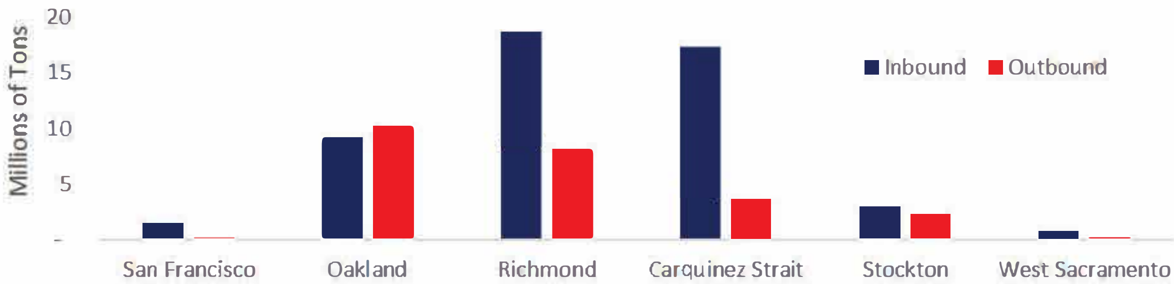
Around the M-580 Corridor, there are seven major port areas defined by navigational projects managed by the US Army Corps of Engineers:

- Port of Oakland, a major container gateway.
- Port of Stockton, a bulk and break-bulk port located up the San Joaquin River.
- Port of West Sacramento, a bulk/break-bulk port specializing in cement and agricultural products.
- Port of Richmond, which handles a large volume of liquid bulk associated with petroleum production.
- Carquinez Strait, which includes terminals in Tormey, Benicia, Martinez, and Crockett.
- Port of San Francisco, which handles some dry, liquid, and break-bulk goods.
- Port of Redwood City, handling bulk cement, scrap metal, petroleum, and other dry/liquid bulk.

Figure 2-23 shows the annual tonnages carried by the ports in the M-580 study area. It is important to note that this list of ports is not comprehensive,[26] however, the areas profiled here do account for the vast majority of tonnage handled on the M-580 system.

The high tonnages in Richmond and the Carquinez Strait are largely related to their roles as crude oil import points, and it is important to note that other ports, especially Oakland may show lower tonnage but is likely handling a higher value of cargo.

Figure 2-23: M-580 Port Area Tonnages, 2018



Source: CPCS Transcom analysis of US Army Corps of Engineers' Waterborne Commerce Statistics. 2019.

2.3.1 Navigation Channel

The San Francisco Bay Area and the San Joaquin and Sacramento Rivers to Stockton and Sacramento, respectively, are sailed by commercial domestic and international vessels. Therefore, Nautical Charts, Coastal Pilots, and other official documentation and regulations define the navigation rules and practices in the Bay Area.

The minimal channel depth near Port of Stockton and West Sacramento is around 30 feet in both cases,[27] and there are tidal currents that may affect sailing and navigation. The San Francisco Bay is relatively shallow due to sediments that continually wash into it from the waterways and rivers, as well as the Delta. Therefore, according to the Environmental Protection Agency (EPA) records, an average of 3 to 6 million cubic yards of sediments are dredged in the San Francisco Bay and the waterways nearby on an annual basis to maintain safe navigation.[28] The minimum width of the channel to the Port of Stockton is 250 feet, and it is narrower (as small as 200 feet width) near the Port of West Sacramento. The navigation channel on the San Joaquin River (towards Port of Stockton) and the Sacramento River (towards Port of West Sacramento) passes through wetlands and estuaries. Other navigational limitations include speed limitations on some sections of the navigation channels (depending on the current) and the dense fog and high winds that often occur in the San Francisco Bay Area.

Particularly, tugs with tows of 1,600 Gross Registered Tonnage (GRT) or more should *"(…) closely evaluate whether it is safe to transit in the Bay (…)"*[29] when the winds exceed 25 knots. Also, berthing should be considered when the wind speeds exceed 40 knots. Regarding visibility, it is recommended that tug and barge of 1,600 GRT or more should not transit in the Critical Maneuvering Areas when visibility is less than 0.5 nautical mile. Such navigational and weather conditions challenges may pose reliability issues on the potential future

[26] Port of Benicia's tonnage is included in the Carquinez Strait total inbound/outbound flows.
[27] National Oceanic and Atmospheric Administration, Sacramento River, 2020.
[28] EPA, San Francisco Bay Long Term Management Strategy for Dredging, 2020.
[29] San Francisco, San Pablo And Suisun Bays Harbor Safety Plan, Harbor Safety Committee of the San Francisco Bay Region, 2012.

M-580 barge service. For the purpose of this project, delays due to navigation and weather-related challenges are factored in the analysis by allowing some extra time in the schedule.

2.4 Performance Gaps and Issues

Virtually all goods are moved by truck for at least part of their trip. Trucks are not only a primary mode of choice for freight transport, but they are, in fact, the only choice for specific shippers in certain circumstances. Trucking services offer flexible terminal-to-door transportation of goods and are especially efficient for short-haul operations (less than 150 miles). Thus, it is essential to understand the condition and quality of trucking activities to identify inefficiencies and mitigate adverse impacts on the public. The following notes summarize the trucking performance gaps and specific issues that constraint goods movement fluidity within the M-580 study area:

- Traffic bottlenecks on I-580 from west of I-580/I-680 interchange to east of Vasco Rd. interchange near Altamont pose an average of 267 average daily hours of delay for all the highway users.
- Bottlenecks on SR-4 pose the highest daily delays to the traffic at the highway's intersection with Railroad Avenue west of Antioch, and near SR-4/I-80 interchange. In 2019, the traffic bottlenecks on SR-4 led to 387 hours of delay to the highway users on average.
- Trucking activities in the M-580 study area led to several crashes in 2018, leaving more than 1,200 persons injured and about fifty persons killed. The number of truck-involved crashes has increased since 2013. The primary causes of truck crashes in the M-580 study area are unsafe lane change maneuvers, unsafe speed, and improper turning.
- Truck-involved collisions are clustered along I-580 and I-880 near Port of Oakland, on the segment of SR-4 between Port of Richmond and Antioch, on I-580 near Tracy and Lathrop, and along I-5 and SR-99, between Stockton and Sacramento and near Port of West Sacramento.
- Ozone and PM emissions resulted from road activities pose moderate or unhealthy air quality conditions within the M-580 study area. In 2019, Stanislaus and San Joaquin Counties had the highest number of days with unhealthy air quality conditions due to a combination of pollutants.
- Trucking costs have risen significantly in Northern California over the last 15 to 20 years. This cost differential increases for longer travel distances. The cost to move goods 120 miles from the Northern Central Valley to the Port of Oakland rose from just over $200 in 2003 up to $800 in 2020. This dramatic increase in costs implies that other modes have become relatively more cost-competitive with trucking over the last 15 to 20 years.

In terms of rail freight performance, a variety of challenges and needs such as capacity issues and infrastructural limitations, highway-rail crossings maintenance, delay, and safety impacts, and emissions pose some concerns in the M-580 study area. Over that past decade, rail-related fatal incidents have declined in the study area, however, there has been a percent increase in trespassing casualties due to a variety of factors, including increasing commuter and freight rail volumes and growth in urban and suburban populations.

Although freight trains are relatively more fuel-efficient compared to trucks, the projected growth in the future rail freight volumes with the current locomotive engines is expected to lead to an up to 80% increase in the annual freight rail diesel consumption.

3 | Stakeholder Engagement and Outreach Efforts

Key Chapter Takeaway

A wide range of stakeholders have an interest in the M-580 Corridor Multimodal Freight Network Optimization Study. This includes statewide agencies outside of Caltrans, MPOs in California, county governments, private sector stakeholders ranging from shippers to trucking firms to freight facility operators to port dock workers.

3.1 Outreach and Engagement Methods

This project used a variety of outreach methods to meaningfully engage a broad array of public and private sector stakeholders to guide the development of the study and to gather their perspectives on M-580, how freight-dependent industries use the corridor, current needs, and issues, and potential opportunities.

Stakeholder Committee Meetings

As the state's transportation agency, Caltrans played a critical role in implementing the direction and outline of the stakeholder outreach and engagement activities. Additionally, a large group of public and private sector stakeholders supported the project by providing inputs in Project stakeholder Meetings. These meetings were scheduled at critical points in the study when inputs were needed in terms of clarifying methodologies, requesting input on key deliverables, or for the purpose of disseminating information on the study in regards to key findings and decisions. The meeting participants were from the following agencies and entities:

- Caltrans Headquarters Office of Freight Planning
- Caltrans Headquarters System Planning Branch
- Caltrans District 3, 4, and 10
- Caltrans Division of Rail and Mass Transportation
- California Governor's Office of Business and Economic Development (GO-Biz)
- California State Transportation Agency (CalSTA)
- California Trucking Association
- Bay Area Metropolitan Transportation Commission
- San Joaquin County Council of Governments
- Stanislaus County Council of Governments
- Alameda County Transportation Commission

- Contra Costa Transportation Authority
- Sacramento Area Council of Governments
- California Air Resource Board
- San Joaquin Valley Air Pollution control District
- Bay Area Air Quality Management District
- Ports of Oakland, Stockton, San Francisco, Redwood City, West Sacramento, Richmond, and Benicia
- Harbor Safety Committee of the San Francisco Bay Region
- US Maritime Administration
- US Coast Guard (San Francisco Sector)
- Pacific Merchant Shipping Association
- Trucking companies, third-party logistics, and other private sector stakeholders

The first stakeholder meeting was held at the Livermore Airport in Alameda County. The rest of the meetings were conducted virtually as online webinars due to COVID-19 travel restrictions.

One-on-one Consultations

A key step in the study was to contact the previous M-580 barge service customers to discuss their reasons for selecting the service, the extent of their satisfaction with the service, and their thoughts on how to improve the service for a re-launch. The outcomes of this step informed the market assessment process, such as the volumes that they previously shipped on M-580 and the volumes that they could ship on a new M-580 service. We conducted this outreach as one-on-one phone interviews to protect any proprietary information shared by the previous shippers.

Entities that were involved in the operation of the previous M-580 service were also interviewed to determine which components of the operations were successful and which components needed improvements. Most notably, extensive interviews were conducted with terminal operators and ocean carriers to better understand the cargo handling operations at the study area ports and collect information regarding wage levels for dockworkers involved in a new M-580 service, hours of operation, and labor pool considerations of the service that impact the current labor arrangements at the ports.

The approach to stakeholder consultations consisted of the following primary steps:

1. **Develop Stakeholder List:** Caltrans provided an extensive stakeholder list for the M-580 corridor to serve as a primary resource for identifying stakeholders and contacting them to arrange consultations.
2. **Develop Consultation Guide(s):** A series of open-ended questions based on the type of stakeholder consulted, e.g., private vs. public, key industry vs. carrier, etc., were developed.
3. **Conduct Outreach:** One-on-one consultations with direct, open-ended questions were conducted using a combination of email, phone, and online meeting interviews.
4. **Document Findings:** Consultation findings and summaries were shared with Caltrans.

4 | Multimodal Network Optimization Modeling and Results

Key Chapter Takeaway

This chapter provides an overview of the multimodal network optimization model structure, sub-models, assumptions used, and outputs. The demand sub-model takes the input data, such as Freight Analysis Framework (F AF), to construct a list of freight demand OD matrices by commodity type. Meanwhile, the fleet performance model converts the freight travel demand into fleet travel demand, fuel consumption, and related GHG emissions, maintenance cost savings, and safety impacts. The resulting model is implemented in a user-friendly spreadsheet format, allowing the users to freely test different scenarios by introducing changes in the inputs and assumptions and identify a range of potential outcomes in the future.

The model results suggest that barge is certainly a feasible option for many shippers under certain conditions, with the caution that the results are based on a small sample size of respondents. The model shows that the level of total emissions (i.e., CO_2, Hydrocarbons, CO, NOx, and PM) along the corridor will be lower while the level of fatality and injury will be higher in 2045 compared to 2020.

4.1 Overview of the Multimodal Network Optimization Model

Freight transportation in a corridor involves many interactions and interfaces between private supply chains and public and private assets, all governed by the participation of multiple actors/stakeholders (e.g., government, terminal operator, transport operator, shipper). They can introduce different objectives/conflicts in decision-making, which must be reconciled. Often a number of separate scenarios need to be examined, reflecting different choices and actions by both private and public stakeholders.

The proposed multimodal optimization model can be a useful tool for strategic network optimization over medium- or long-term planning.

Different scenarios can be evaluated by modifying the model inputs associated with the outcomes of regulatory policies, network characteristics, terminal operation, heterogeneous commodity criteria, and user costs, etc.

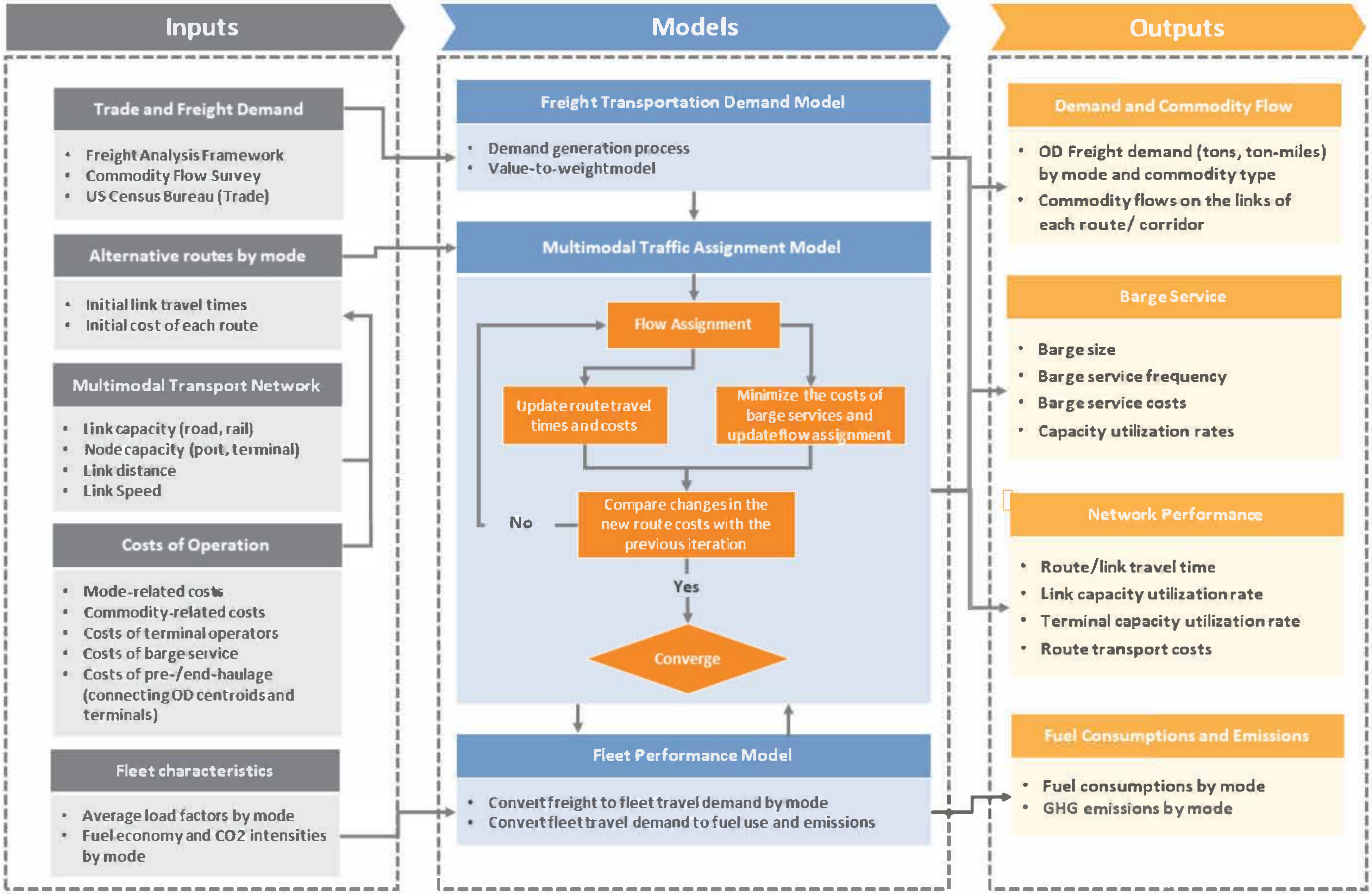
4.1.1 Description of Overall Model Framework

The overall model consists of three sub-models:

1. Freight Transportation Demand Model,
2. Multimodal Traffic Assignment Model, and
3. Fleet Performance Model.

Figure 4-1 presents the framework of the overall model structure and the relationships between the inputs, sub-models, and outputs.

Figure 4-1: Multimodal Network Optimization Model Structure



Source: CPCS

4.1.2 Multimodal Network Optimization Sub-models

The Freight Transportation Demand Model takes the input data, such as Freight Analysis Framework (FAF), to construct a list of freight demand origin-destination (OD) matrices by commodity type. The origin and destination zones are determined at an appropriate spatial level for the purpose of the study.

The Fleet Performance Model converts the freight travel demand into fleet travel demand, fuel consumption, and related greenhouse gas emissions (GHG) emissions. The average load factors by mode and vehicle type are used to convert the ton-miles traveled along different corridors into vehicle-miles traveled, rail-miles traveled, and barge-miles traveled. The vehicle-miles (rail or barge-miles) traveled are then used to estimate fuel consumption and GHG emissions by applying the fuel economies and emission intensities of different vehicle and fuel types.

The essential sub-model is the Multimodal Traffic Assignment Model, which assigns the freight demand and commodity flows onto the multimodal routes/corridors in the network. The Multimodal Traffic Assignment Model combines the mode choice and route choice together since we are interested in the corridor level modal competition in this study.

A choice set of multimodal alternative routes/corridors were generated in the input preparation phase. Stakeholder consultations were used to validate the list of alternative multimodal routes/corridors.

The model is implemented in a user-friendly spreadsheet format, allowing the users to freely test different scenarios by introducing changes in the inputs and assumptions to identify a range of potential outcomes in the future.

To reflect the multi-actor perspective, the model allows the users to test different scenarios to find optimal strategies, taking into consideration the objectives of different stakeholders involved, such as the public authorities, terminal operators, transport operators, and shippers.

- The public authorities can minimize the total network costs and GHG through introducing different strategic planning and climate policies, and network configuration measures, etc.
- From a private operator's perspective, they can test the strategies by minimizing the operating costs (terminal and transport operators) and user costs (shippers) of the barge service based on the network and service characteristics of the alternative multimodal routes.

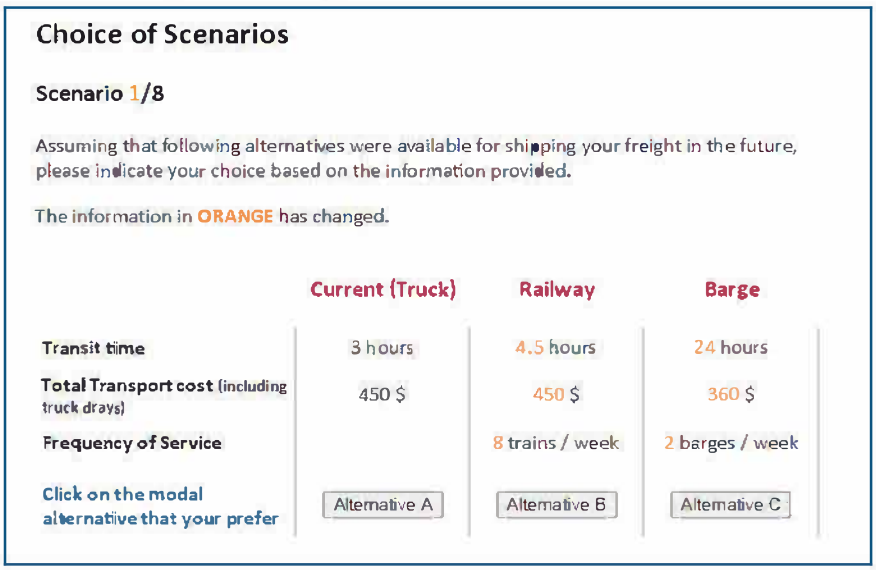
4.1.3 Model Inputs

Mode Choice Preferences

The stated preference (SP) discrete choice method relies on information collected from survey respondents, who select from various mode-route choice options in hypothetical scenarios. Limited sufficient historical observations on freight shipments using the previous M-580 barge service caused the project team to shift the focus from mathematical optimization using the RP method to optimization based on scenario analysis and sensitivity analysis using a stated preference survey (SPS) approach. The SPS was designed to calibrate the mode choice model with statistical significance. The initial market research conducted at the start of the project quickly provided the project team with a comprehensive list of potential survey participants. These potential participants were compiled through a detailed scan of the Bay Area and Central Valley ports' and intermodal yards' customers, freight-related industry associations' contacts, the region's list of businesses provided by the economic development agencies, and listed companies in the InfoUSA business establishment database.

In addition to the business contacts, the project team identified a list of Caltrans stakeholders who could help in collecting responses by forwarding the survey link to their contacts. The list included stakeholders from Caltrans District offices, transportation commissions, county transportation agencies, trucking associations, port authorities, councils of government, and port terminal operators. An email template accompanied by the online survey link was sent to these stakeholders with a request for transfer to shippers, 3PLs, and trucking companies active in the M-580 study area. The survey respondents provided 136 mode choice decisions that were incorporated into the mode choice model.[30] As Figure 4-2 shows, in the survey, each respondent was asked to make a mode-choice decision under eight hypothetical choice scenarios, where the characteristics of each mode of travel are presented.

Figure 4-2: SP Hypothetical Choice Scenario Screenshot



Source: CPCS

A multinomial logit (MNL) model was then used to estimate the choice situations with more than two alternatives. This MNL model uses a standard discrete choice approach, explaining the mode choice behavior of each individual with the attributes of each transport mode presented in the stated preference games (travel time, travel cost, and service frequency). The utility functions of each mode are specified as the following:

$$U_{ij} = ASC_{ij} + \beta_{tt_{ij}} * \ln tt_{ij} + \beta_{tc_{ij}} * \ln tc_{ij} + \beta_{freq_{ij}} * freq_{ij} \; + (td)$$

Where ASC is the alternative specific constant for each mode; tt is the total travel time of the trip; tc is the total cost of the trip, $freq$ is the service frequency level of the trip. i and j denote mode and individual, and β is the estimated coefficient. Travel time and travel cost are *logarithmized*.

Congestion Penalty

Inefficiencies in mobility (such as congestion) lower the average speed of goods movement on the freight transportation network, leading to an increased rate of fuel consumption and engine emissions. Average daily

[30] The overall model fit is acceptable (with an adjusted rho-square of 0.37), with statistically significant coefficients at the 95% confidence level. The adjusted rho-square value indicates that the model can explain 37% of the variability of the instances around the mean. This value is adjusted for the number of variables in the model. Since all variables of this model show statistical significance at a 95% confidence level, it is considered a statistically reliable model. It can be said with 95% confidence that the coefficients of this model are not errors caused by randomness.

hours of delay on the major corridors of the study area can be used as a penalty in the utility function of the truck mode. The penalty is calculated based on the additional miles that a truck could travel with an average speed of 57.7 mph during the estimated average per vehicle delay time.[31] This option (fixed travel time delay penalty (td)) is available to the users of the optimization model in any scenario to test the effect of congestion separate from other factors and variables.

Societal Cost of Freight Safety Impacts

Transportation safety incidents pose societal costs to the public through the loss of life (fatalities) and productivity (injuries). Figure 4-3 presents the multimodal network optimization model's assumptions used to estimate the potential safety impacts of a shift from trucks to rail or barge modes. Barge fatality and injury rates are extracted from the Federal Highway Administration's (FHWA) analysis of multimodal freight safety impacts presented in the annual Freight Quick Facts reports.[32] Freight rail fatality and injury rates are 3-year averages calculated based on the Federal Railroad Administration's (FRA) annual summaries of train accidents with reportable damage, casualties, and major causes. County-level accident rates in events per million train-miles are multiplied by 4,400 average tons per train to estimate the rates in events per billion ton-miles.[33]

Truck safety rates are estimated using 3-year truck-involved accident data of the major corridors in the study area, provided by the California Highway Patrol (CHP). As presented in previous chapters, analysis of the disaggregated FAF data showed that about 92% of the truck trips on the study area's highway system are made by heavy-duty trucks. Meanwhile, about 7.5% of the trucks traveling on the study area's road network are medium-duty, and about 0.5% are light-duty or small trucks. Assuming an average load factor of 50% and payload weights of 80,000 lbs, 26,000 lbs, and 22,000 lbs for heavy-, medium-, and light-duty trucks, respectively, an average weight of 18.9 tons per truck is calculated for this study. As a result, the per billion ton-miles truck accident rates are calculated as presented in Figure 4-3.

Figure 4-3: Transportation Safety Incident Assumptions

Mode	Safety Incident Type	Rate (Event per Billion ton-Miles)	Cost per Event (2020 $)
Barge	Fatality	0.05	$10,486,000
	Injury	0.199	$193,135
Rail	Fatality	0.22	$10,486,000
	Injury	1.75	$193,135
Truck	Fatality	0.32	$11,556,000
	Injury	15.34	$159,216
	PDO	29.10	$10,379

Source: CPCS analysis of FHWA, FRA, and CHP data.

[31] Average truck speed is based on FHWA's Office of Freight Management and Operations, Performance Measurement Program estimations. Annual average daily hours of delay are extracted from Caltrans Office of Freight Management and Operations, Performance Measurement Program data source: http://pems.dot.ca.gov/

[32] FHWA, 2016 Freight Quick Facts Report.

[33] BTS, US Ton-Miles of Freight, 2018.

The estimated costs of various types of safety events are extracted from Cal-B/C Model's parameters. Since the Cal-B/C values are in 2016 dollars, a Consumer Price Index (CPI) inflation rate of 1.07 is used to present the values in 2020 dollars.[34]

Emission Impacts

The fuel consumption rates and emission impacts of the truck, rail, and barge modes are calculated based on the California Air Resource Board (CARB)'s Emission Factor (EMFAC 2021) forecasts. Terminal and yard activity and equipment emissions are calculated using CARB's OFFROAD ORION Model 2020 forecasts. The annual rate of change in fuel consumption and emission of the truck and rail modes are estimated using CARB's Truck vs. Train Emissions Analysis assumptions and methodology.[35] For barge, we assume the Tier 1 tugs previously utilized in the M-580 service will be used for 20 years and then replaced by Tier 3 or 4 tugs. Tug boat fuel consumption and emissions are estimated based on the Federal non-road diesel engine standards.[36]

Additionally, the following assumptions have been made to translate the fuel efficiency and emission rates provided by the CARB and the EPA into per ton-miles values:

- Average truck weights at 50% payload: 20 tons for heavy-duty, 6.5 tons for medium-duty, and 5 tons for small trucks;[37]
- Average truck speed: 60 mph;[38]
- Non-road diesel engine power: 20.8 brake horsepower-hour (bhp-hr/gal);[39]
- The marginal emission impacts due to rail and barge terminal activities are negligible.

The following table presents a summary of the multimodal fuel efficiency and emission rates and their trajectory.

Figure 4-4: Multimodal Fuel Efficiency and Emission Rate Assumptions

Fuel Efficiency (ton-miles per gallon of diesel fuel)						
Mode	2021	2025	2030	2035	2040	2045
Barge	647.00	647.00	647.00	647.00	647.00	647.00
Rail	929.47	929.47	929.47	929.47	929.47	929.47
Truck-Small	43.65	57.05	57.05	57.05	57.05	57.05
Truck-Medium-Duty	88.47	101.83	106.04	106.04	106.04	106.04
Truck-Heavy-Duty	123.68	131.84	137.95	142.95	147.95	152.95
Barge Emissions (grams per ton-mile)						
Item	**2021**	**2025**	**2030**	**2035**	**2040**	**2045**
CO2	16.556	16.556	16.556	16.556	16.556	16.556

[34] Bureau of Labor Statistics CPI Inflation Calculator's estimated inflation rate between June 2016 and June 2020.
[35] CARB, Truck vs. Train Emissions Analysis, September 2020.
[36] US Environmental Protection Agency, Emission Standards for Nonroad Engines and Vehicles, 2016. Note: use of Tier 1 tugs for the barge service will increase PM and NOx emissions in the first 20 years.
[37] NHTSA, Commercial Medium- and Heavy-Duty Truck Fuel Efficiency Technology Study, 2015.
[38] FHWA, Freight Facts and Figures, 2010.
[39] CARB, tables for emission reduction and cost-effectiveness calculations, 2011.

Hydrocarbons	0.009	0.009	0.009	0.009	0.009	0.009
CO	0.273	0.273	0.273	0.273	0.273	0.084
NOx	0.222	0.222	0.222	0.222	0.222	0.042
PM	0.013	0.013	0.013	0.013	0.013	0.001
Rail Emissions (grams per ton-mile)						
CO2	10.92	10.92	10.92	10.92	10.92	10.92
Hydrocarbons	0.003	0.003	0.003	0.003	0.003	0.003
CO	0.029	0.029	0.029	0.029	0.029	0.029
NOx	0.111	0.107	0.103	0.089	0.068	0.068
PM	0.002	0.002	0.001	0.001	0.001	0.001
Truck-Heavy-Duty Emissions (grams per ton-mile)						
CO2	73.173	0.0156	0.0163	0.0171	0.0179	0.018
Hydrocarbons	0.006	0.006	0.001	0.001	0.001	0.001
CO	5.9206	0.2244	0.1836	0.1597	0.1423	0.14
NOx	8.1408	0.0946	0.0857	0.0792	0.0755	0.071
PM	0.0020	0.0185	0.0178	0.0176	0.0178	0.0176

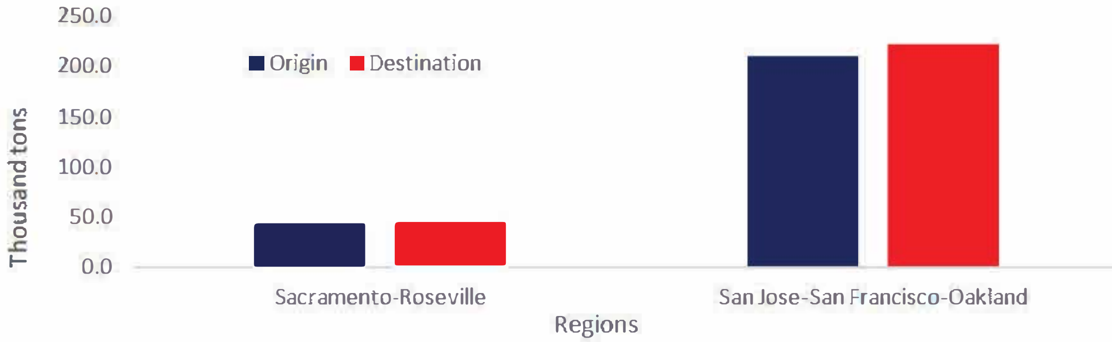
Source: CPCS analysis of CARB EMFAC 2021 and EPA data.

The Multimodal Network Optimization Model spreadsheet tool provides users with two options regarding fuel efficiency and emission impact rates. The Baseline option assumes that the fuel efficiency and emission rates will stay at their 2020 levels throughout the course of analysis. On the other hand, in the scenarios that use the Target Pathway option, the fuel efficiency and emission rates for the truck and rail modes will change consistent with the California Air Resource Board's forecasts and assumptions presented in the Truck vs. Train Emissions Analysis.

Travel Demand

To identify the existing travel demand along the study corridor between the San Francisco Bay area and northern San Joaquin Valley, 30 locations/centroids, including rail and barge terminals and FAZs, were identified as the critical locations. Along the corridor, barge and rail terminals are located in San Joaquin County, while container and Ro-Ro shipping ports are located near the San Francisco Bay area. The rest of the freight demand centroids are located in the north of San Joaquin Valley. As Figure 4-5 shows, the total freight demand is around 520 thousand tons along the M-580 corridors. About 17% of this demand is originated/destined between Sacramento-Roseville, CA Commodity Flow Survey (CFS) Area, while 83% is between San Jose-San Francisco-Oakland, CA CFS area.

Figure 4-5: Freight Demand (tonnage) along the Corridor in 2020



Source: CPCS analysis

The Freight Analysis Framework (FAF) integrates data from the CFS and the Census Bureau to estimate the future freight travel demand growth in major metropolitan areas. FAF estimates that freight demand (tonnage) will grow by 16% for the Sacramento-Roseville CFS area and 27% for the San Jose-San Francisco-Oakland CFS area over the next 25 years (see Figure 4-6). Overall, freight demand (tonnage) along the corridor is expected to grow, on average, by 0.9% annually over the next 25 years, reaching 3.73 million tons by 2045 (25% higher than 2020 level).

Figure 4-6: FAF Annual Growth Rates

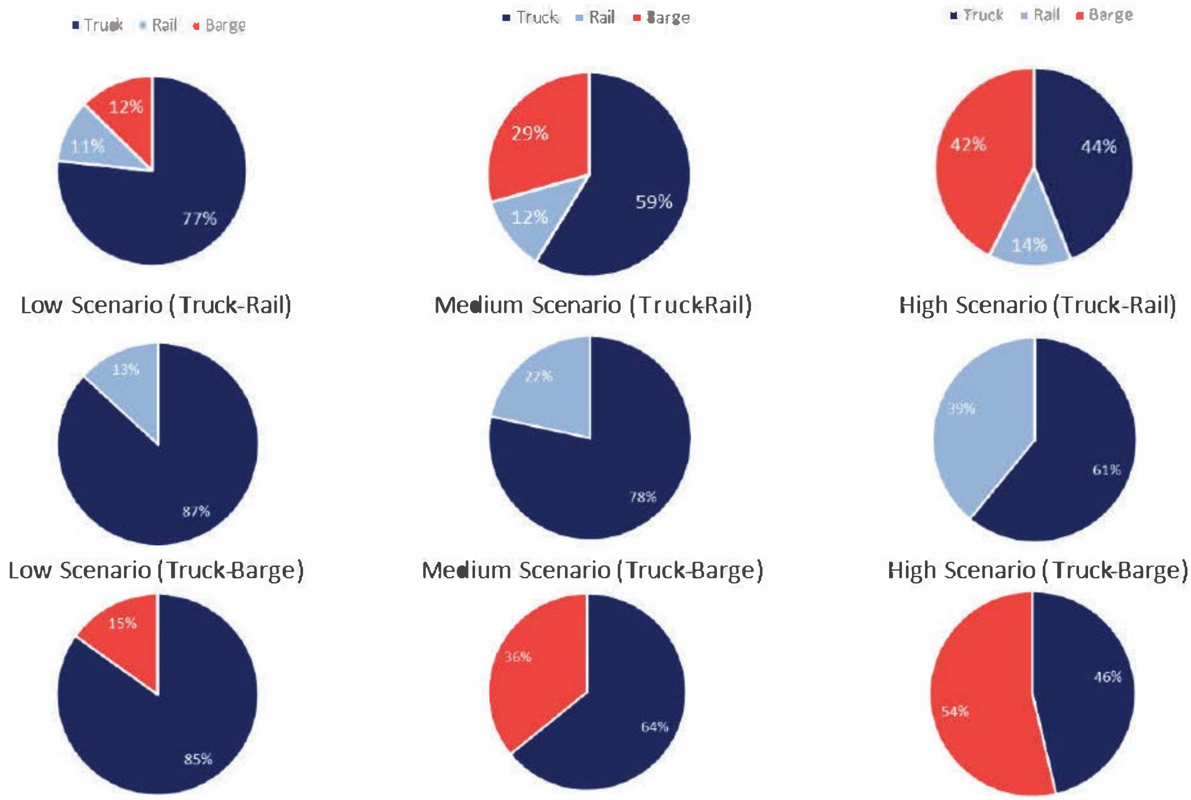
Source: CPCS analysis

4.1.4 Model Scenario Options

The base (current) model starts with the "do-nothing" scenario that assumes 100% of freight tonnages are traveled by trucks. The model then allows the users to simulate modal shift behaviors among truck, rail, and barge under different service specifications for each mode, in terms of transit time, total transport cost, and service frequency. As inputs to calculate the expected modal shift behaviors to barge and rail services, we have designed three additional scenarios corresponding to different service configurations, as: High Scenario, Medium Scenario, and Low Scenario. The expected modal shift behavior is obtained under each of these scenarios for rail and barge services are presented in Figure 4-7.

Figure 4-7: Expected Average Modal Split under Different Scenario Inputs

Low Scenario (Truck-Rail-Barge) Medium Scenario (Truck-Rail-Barge) High Scenario (Truck-Rail-Barge)



Source: CPCS analysis

Low Scenario - In the low scenario, (1) when truck, rail, and barge services are available, around 23% of the existing truck trips will shift to rail and barge, of which 11% to rail and 12% to barge; (2) when truck and rail services are available, around 13% of the existing truck trips will shift to rail; and (3) when truck and barge services are available, around 15% of the existing truck trips will shift to barge.

Medium Scenario - In the medium scenario, (1) when truck, rail, and barge services are available around 41% of the existing truck trips will shift to rail and barge, of which 12% to rail and 29% to barge; (2) when truck and rail services are available, around 22% of the existing truck trips will shift to rail; and (3) when truck and barge services are available, around 36% of the existing truck trips will shift to barge.

High Scenario - In the low scenario, (1) when truck, rail, and barge services are available, around 56% of the existing truck trips will shift to rail and barge, of which 14% to rail and 42% to barge; (2) when truck and rail services are available, around 39% of the existing truck trips will shift to rail; and (3) when truck and barge services are available, around 54% of the existing truck trips will shift to barge.

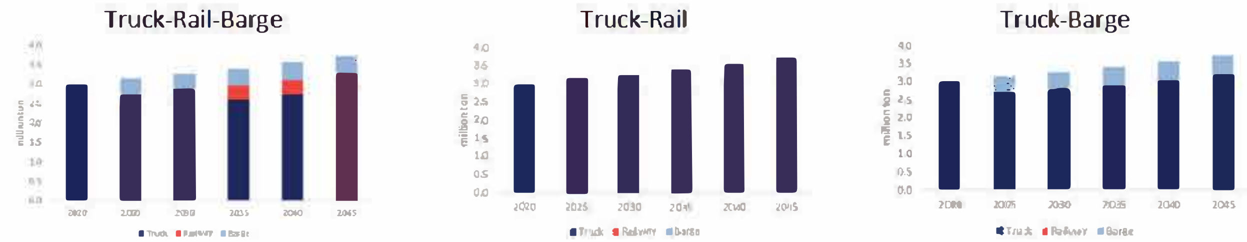
The difference between the current modal split of the whole sample and the expected modal split when rail and barge enter into service suggests that, on average, shippers are prepared to increase their intermodal share. When comparing the expected increase of barge and rail transportation, it can be concluded that shippers especially have their minds on an increasing share of barge transportation, more than rail transportation.

4.2 Multimodal Network Optimization Model Results

4.2.1 Future Demands

The Model output shows that in the low scenario, when all three services are available, barge and rail services are expected to transport about 0.40 and 0.34 million tons of freight in 2025, respectively. These barge and rail demands are expected to reach 0.45 and 0.38 million tons in 2045, respectively (Figure 4-8).

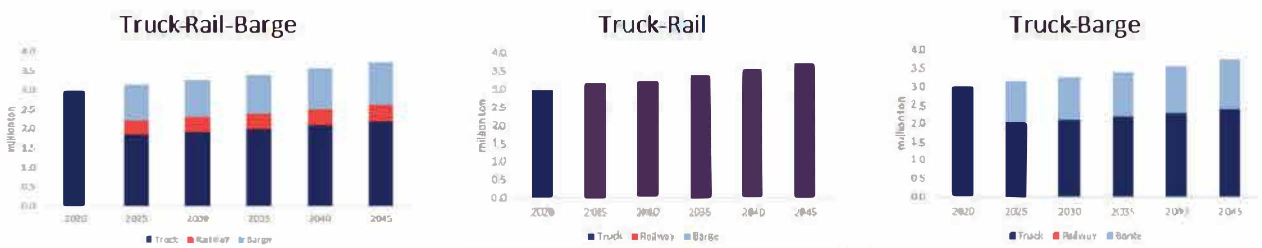
Figure 4-8: Annual Freight Demand (Low scenario)



Source: CPCS analysis

In the medium scenario (see Figure 4-9), when all three services are available by 2025, about 0.92 and 0.37 million tons of freight are expected to travel by barge and rail, respectively. These barge and rail demands are expected to reach 1.10 and 0.44 million tons in 2045, respectively.

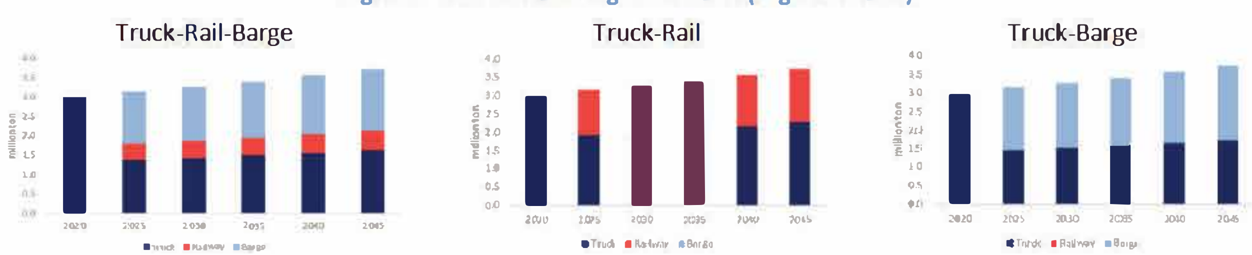
Figure 4-9: Annual Freight Demand (Medium scenario)



Source: CPCS analysis

In the high scenario (see Figure 4-10), when truck, rail, and barge services are available, barge and rail services are expected to transport about 1.34 and 0.43 million tons of freight in 2025, respectively. These barge and rail demands are expected to reach 1.59 and 0.50 million tons in 2045, respectively.

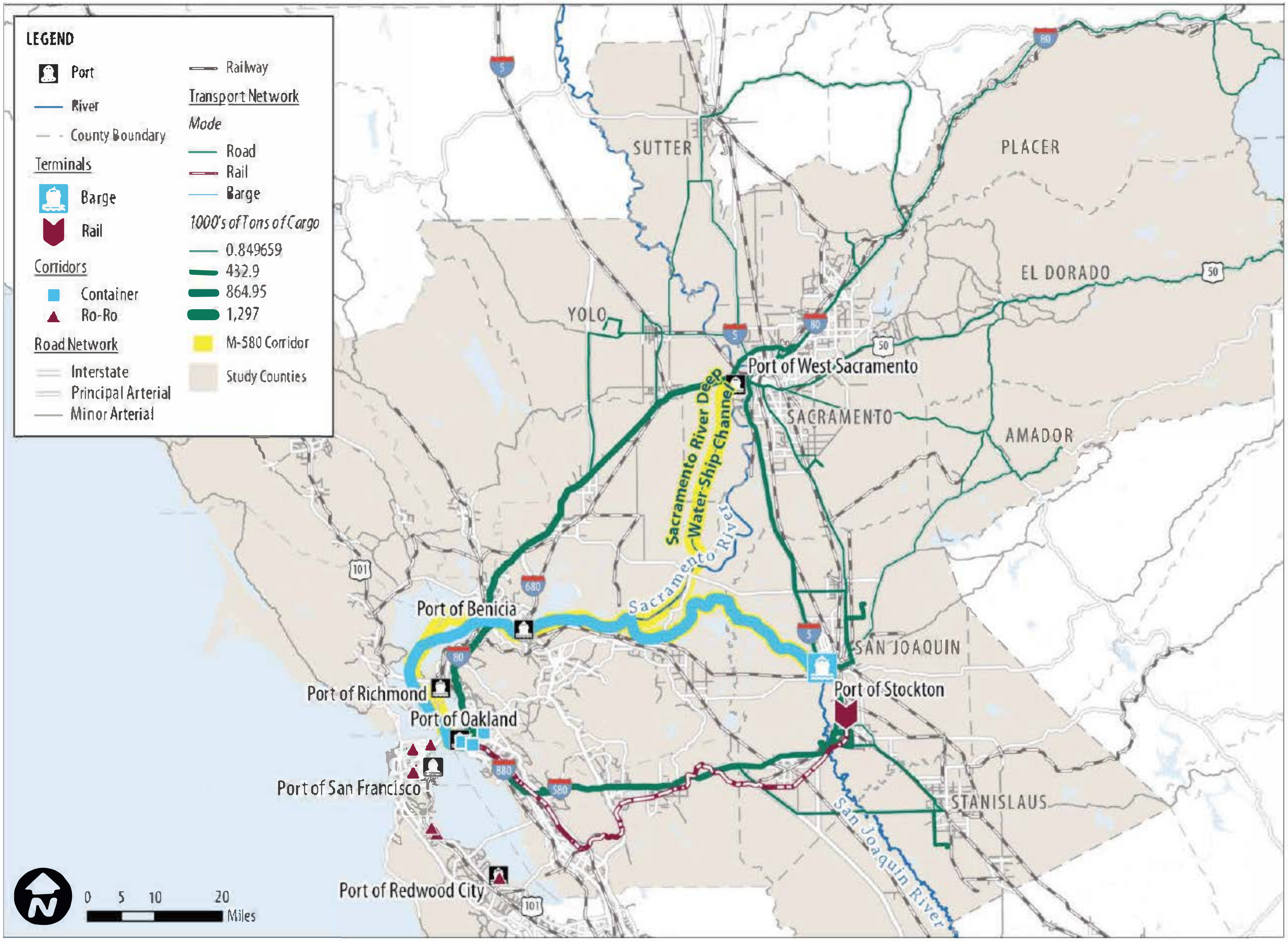
Figure 4-10: Annual Freight Demand (High scenario)



Source: CPCS analysis

These future freight demand matrices are assigned to the M-580 network to obtain more insights on how the traffic flows. Figure 4-11 shows the High Scenario multimodal freight demand in 2025, assigned to the study area network.

Figure 4-11: Annual Freight Demand by Mode in 2025 (High Scenario)



Source: CPCS analysis

In general, the Model outputs show that as the cost and time of truck service increases (holding other factors constant), the model user should expect to see relatively higher shares of trips utilizing rail and barge. In other words, shippers will behave rationally to maximize their utility in response to the prevailing attributes of the mode-route options available.

This suggests that barge is certainly a feasible option for many shippers under certain conditions, with the caution that the results are based on a small sample size of respondents. The model shows that the level of total emissions (i.e., CO2, Hydrocarbons, CO, NOX, and PM) along the corridor will be lower, while the level of fatality and injury will be higher in 2045 compared to 2021. A summary of the social and environmental impact outputs is presented in Figure 4-122. Detailed model output graphs have been presented in Working Paper 4 on Prioritized Optimization Strategies.

Figure 4-12: Social and Environmental Effect in 2045 Compared to 2021

	Scenarios			
	Do-Nothing	Low	Medium	High
Emissions				
CO2	-32%	-47%	-58%	-67%
Hydrocarbons	-79%	-74%	-67%	-61%
CO	-97%	-97%	-96%	-96%
NOX	-97%	-98%	-98%	-98%
PM	-19%	-26%	-30%	-34%
Safety				
Fatality	24%	29%	28%	27%
Injury	24%	15%	9%	3%
Maintenance cost				
Maintenance cost	12%	-2%	-14%	-23%

Source: CPCS analysis

4.3 Model Constraints

For purposes of determining shippers' average transport preferences, the model outcomes are valid. The outcomes are based on shippers' choices, which were made to the best of their ability, considering the most important transport attributes according to the literature study.

Based on surveys and interviews, shippers are generally receptive to shift from truck transportation to barge or railway transport. However, due to the limited number of observations in the survey, the calibrated modal shift behavior might not be precise enough to estimate the potential modal shift for each OD pair. The modal shift behavior should be interpreted at the corridor level rather than at the individual OD pair level. Furthermore, more attention should be placed on the relative magnitude of the modal split; instead of the exact percentages.

5 | Barge Financial Modeling and Results

Key Chapter Takeaway

This chapter presents the market analysis and financial model for a potential future barge service in the M-580 corridor. Majority of the inputs and assumptions that informed the financial model development were provided by the stakeholder through one-on-one consultations, and reviewed by Caltrans and the project stakeholders. Financial model output shows that none of the M-580 Barge scenarios and options would be financially self-sustaining. For all cases, inception years are crucial to building up a customer base, and the losses would vary between $2.7 million and $5.8 million per year. In most cases, the loss per container would be around $250/container.

5.1 Market Forecast

To estimate the market for a potential M-580 barge service, we considered the past M-580 data as a starting point. The potential M-580 market growth projection was developed using data from the Port of Oakland and insight provided through consultations.

5.1.1 Port of Oakland Container Market

Over time, the traffic on the M-580 barge service could become somewhat similar to the Port of Oakland trade profile. Therefore, growth trends at the Port of Oakland can be reasonably applied to the potential growth of a potential barge service for both imports and exports. As shown in Figure 5-1, the full container trade in Oakland is well balanced between inbound and outbound. The ten-year portion of full outbound containers represents about 53% of the total full containers handled. Over a ten-year service period, an average of 23% of the containers handled by the Port of Oakland was empty. This means that even though the trade is balanced as a whole, every ocean carrier may not have a fully-balanced trade on all their routes, hence the need to reposition empty containers. Through consultations, some stakeholders mentioned that they allowed shippers/trucking companies to drop/pick-up empties at the port of Stockton. Also, between 2009 and 2019, the average growth rate in container trade was around 2% per year at the Port of Oakland. This is a reasonable growth rate for the M-580 barge service once it has reached maturity.

Figure 5-1 – Container Traffic Balance in Oakland (2009 to 2019)

Source: Port of Oakland Website, accessed December 2020.

5.1.2 Virginia Port Authority Barge Service

The Virginia Port Authority has operated a barge service that runs between Richmond and Norfolk for over 12 years. At inception, the service moved a little less than 150 containers per week using a single barge.[40] Over a ten-year period, customer demand increased to the point that three barges per week are now utilized. In 2019, the Virginia container-on-barge service carried more than 31,500 TEU with 31% growth compared to 2017 traffic.[41] That same year, the Virginia Port Authority handled around 2.9 million TEUs, which is in the same order as the Port of Oakland (2.5 million TEUs in 2019).[42]

In the first quarter of 2020, the Virginia barge service carried 17,230 containers (despite the disruptions caused by the COVID-19 pandemic), which was a 24% increase compared to the same period in 2019.[43] Amazon, WestRock (corrugated packaging), Lidl (discount grocer), and Scoular (grain and food processor) have been customers of the Virginian barge service for years.

One of the lessons learned from the Virginia barge service is that offering a single bill of lading to the Port of Richmond significantly improves the customer experience and demand for the service. By using this offering, shippers no longer had to plan the barge service separately from the deep-sea ocean carrier transport. It also reinforces the barge service as a reliable adjunct to the ocean service operated by the ocean carrier. By 2018, 14 ocean carriers at the Port of Norfolk offered inclusive bills of lading to barge customers.[44] According to the Virginia Port Authority, this partnership with ocean carriers was a significant factor in boosting traffic growth for the barge service. The individual barges used for the Virginia service can carry 250 TEUs[45] , which is significantly smaller than the M-580A barge capacity of 432 TEUs. Therefore, the maximum theoretical capacity of the Virginia barge service is 78,000 TEUs per year. Considering that the Virginia barge service moved 31,500 TEUs in 2019, the barge service loading factor is around 40%.

One of the key benefits of the Virginia barge service is economic development in the Richmond region. In 2008, the Port of Richmond was struggling to attract customers, and there was significant excess capacity at the Port of Richmond wharf.[46] The barge service significantly increased traffic at the Port of Richmond and generated investments in the further development marine terminal. More importantly, the barge service contributed to attracting new businesses in the Richmond region, increasing employment opportunities to the local residents, and increasing the regional tax base. Other benefits of the barge operation include reducing emissions and truck traffic along parallel road corridors to the barge service. Additionally, the use of a single bill of lading makes the logistics less complex for shippers, receivers, carriers and 3PLs involved in moving the goods from Norfolk to Richmond. This has the potential to reduce costs overall, particularly if it frees up labor for other activities.

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[40] The Maritime Executive, A Decade of Success for the Richmond Barge Service, February 2021.

[41] https://richmond.com/business/barge-service-and-other-improvements-at-richmond-marine-terminal-sparking-shipment-growth-new-economic-investments/article_83b68f4c-afc9-51d9-b37c-bff72be58aeb.html

[42] About 5% of the total cargo handled at Port of Virginia is transferred to barge mode. The rest is carried by trucks. For more information, see: VDOT Statewide Freight Study

[43] https://www.joc.com/port-news/us-ports/port-virginia/richmond-container-traffic-bright-spot-virginia-port-volumes_20200623.html

[44] https://www.maritime-executive.com/corporate/a-decade-of-success-for-the-richmond-barge-service

[45] https://richmond.com/business/new-barge-is-latest-investment-in-richmond-marine-terminals-potential/article_2a602754-e3eb-59ca-a909-3b86c4339a6f.html

[46] https://richmond.com/business/new-barge-is-latest-investment-in-richmond-marine-terminals-potential/article_2a602754-e3eb-59ca-a909-3b86c4339a6f.html

5.1.3 M-580 Market Assumptions

The 2014 M-580 barge service traffic data is the starting point of the market evaluation presented in this study. We assumed a constant growth rate over two periods:

1. A growth rate for the first ten years based on the growth rate experienced by the Virginia barge service, and

2. A long-term growth rate is estimated based on the Port of Oakland's forecasted growth rate.

The Virginia barge carried an average of 1.1% of the Port of Norfolk annual traffic over the last ten years of operation. Through stakeholder consultations, some ocean carriers stated that they are willing to integrate the M-580 barge service into their bill of lading, which can help the M-580 barge service to grow rapidly. Ocean carriers also stated that it is important to confirm that a new M-580 service would be reliable and offer desirable service levels over a reasonable amount of time. This suggests that there could be a significant ramp-up period for acquiring customers to a new M-580 barge service as it proves its reliability.

To estimate the loading factor for the new M-580 barge service, profitability and seasonal factors were considered. A high average loading rate (85%, for example) is beneficial from a profitability standpoint. However, seasonal fluctuations in demand can affect this loading rate, and peak periods with demand exceeding capacity would diminish service reliability. For the period of time in which M-580 operates once a week, a second weekly voyage can be added to meet surges experienced through seasonal demand.

Cost-Effective Handling of Empty Containers

Using a lower average loading factor is more consistent with a scenario in which there is a balance in imports and exports by the ocean carriers and the barge service. Similar to the current Port of Oakland traffic, empties for M-580 will still need to be sent back and picked-up in Port of Oakland, free of charge for the ocean carriers and shippers.[47] By moving empties on the barge, the M-580 service can offer a lower drayage rate to the shippers by dropping empties at the Port of Stockton rather than Port of Oakland. This setup justifies the M-580 barge rate. Also, ocean carriers expect turn-over on container equipment and thus will not be interested in having dormant containers at the Port of Stockton. With this approach, the maximum average loading factor would be 50% for a service operating at full capacity.

In other words, 50% of the containers on board are full and are generating income, while the other half are empties moved back free of charge by the M-580 service. Based on these factors, we are assuming that the M-580 barge service would add a weekly voyage once it has reached an average capacity between 50% and 85%. Our inception options are based on adding a permanent barge weekly voyage once it reaches the least of 67% loading factor on average or 85% on any inbound/outbound leg.

We utilized market information to determine the amount of balance between exports and imports for the M-580 barge service. Data on warehouses and distribution centers indicate that there are major importers in the Stockton area, especially big-box retailers. These shippers tend to prefer faster transit, and they might not be patient enough for the barge to call in Stockton and release their containers. This situation is particularly true for a weekly barge service where shippers may have to wait up to a week longer if their containers are released in Oakland after barge departure. With 2 or 3 times a week sailing schedule, it would be possible to reduce overall transit time for the shippers to an acceptable level. Based on these factors, we will assume that trade will remain unbalanced between exports and imports using the M-580 barge service. In 2014, the inbound traffic to Stockton for the previous M-580 barge service was around 13% of the total

[47] Empty containers

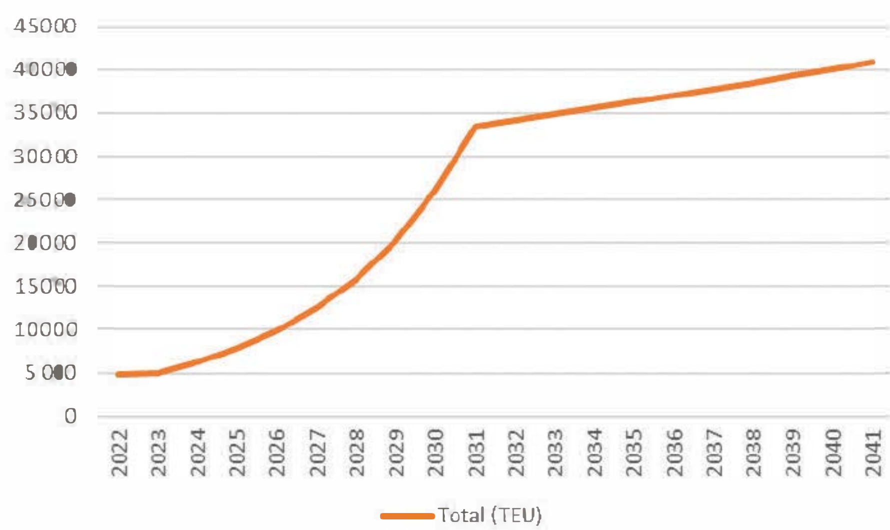
shipments. We also assume that the inbound traffic would remain 50% of the outbound traffic. The ramp-up from 13% to 50% of the outbound traffic would be split over the first ten-year period.

Summary of the Barge Inception Assumptions

- First-year traffic = traffic volume of the M-580 barge in 2014
- Year 10 barge traffic = 1.1% of 2019 container traffic at the Port of Oakland (2.5 million TEUs)
- Year 11 and on = 2% annual increase
- An average loading rate of 67% before adding weekly voyage
- Imports = 50% of exports using the barge
- First ten years for imports to catch-up from 13% of exports to 50% of exports.

Figure 5-2**Error! Reference source not found.** shows the potential traffic evolution based on the assumptions. The traffic could potentially grow relatively fast up to a certain point in 2031. It represents the year at which the M-580 could reach a certain maturity and therefore have a slower growth rate.

Figure 5-2 – Potential Traffic Estimation



Source: CPCS analysis.

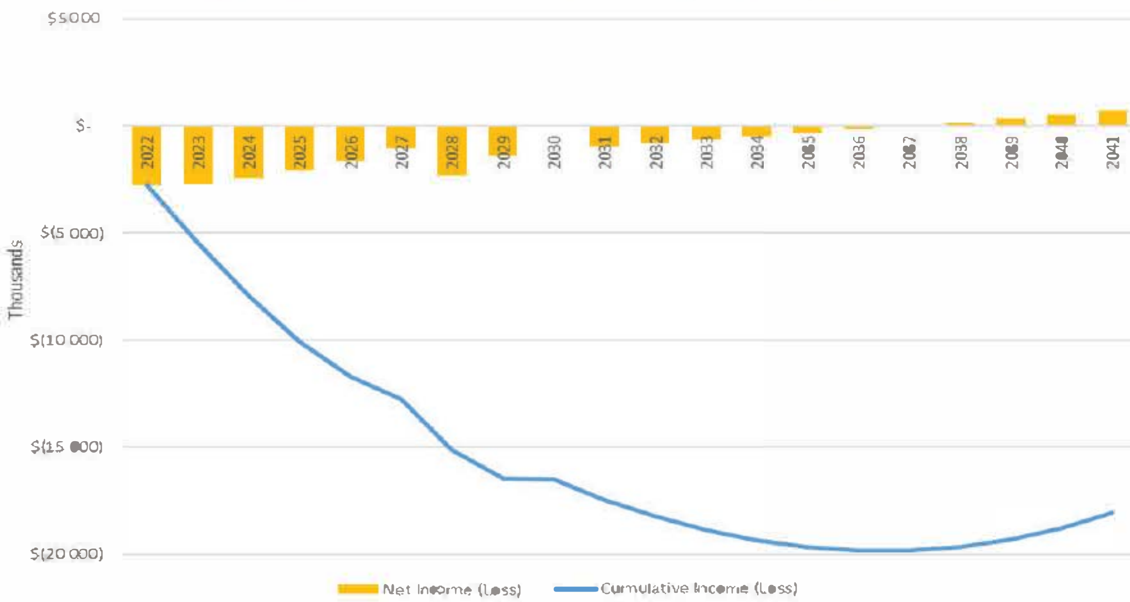
5.2 M-580 Market Assumptions and Inception Options

5.2.1 Option 1: Small Barge

This option consists of starting a new M-580 service by operating a single small barge scenario only. The strategy is to keep up with the traffic growth by adding weekly trips only as demand grows to justify this additional capacity. This approach refers to Scenario 1B (once a week), Scenario 1C (twice a week) presented in previous working papers. We also added Scenario 1CC to increase the service to three times a week. **Error! Reference source not found.** shows the potential traffic evolution in terms of 40' and 20' containers according to the assumptions made in the previous chapter. We observe that a second weekly trip should be added in 2028 to meet the demand and the third service in 2031. This setup should be sufficient to meet the demand through a few years beyond 2041.

Figure 5-3 shows the estimated loss for the new M-580 barge service under this option, which includes consideration of operating costs and revenues based on market demand and a price of $375 per container.[48] The graph demonstrates that the barge service is marginally profitable if it operates at almost full capacity. In the inception years, the annual loss would be between $1.3 million to $2.7 million per year, and the cumulative loss would reach almost $20 million by 2036. After 2039, this scenario has the potential to generate $500,000 per year.

Figure 5-3: Potential Income (Optimistic Cargo Handling Scenario)



Source: CPCS

The cost of scenarios (1B, 1C, and 1CC) used to evaluate this option are based on optimistic operating conditions in terms of cargo handling. Specifically, these scenarios assume the usage of cost-effective cargo handling equipment with minimum labor requirements and successful rate agreements with relevant labor unions.

Container handling accounts for the largest share of the barge service cost. Therefore, we further investigated the terminal cost through consultations with terminal operators. Based on these consultations, we estimate that the average transshipment cost of around $360 per container lift in large international terminals, primarily due to labor rates for people working on the docks.[49]

Using the current terminal handling cost (based on the actual experience), the total cargo handling cost may be 50 % higher than the optimistic scenario. Based on this assumption applied to the cargo handling cost at the Port of Oakland, we estimate an annual loss of around $3.0 million to $5.8 million per year. Under this more realistic case, the M-580 barge service would not be profitable even in the long run and would need to rely on subsidies for the indefinite future.

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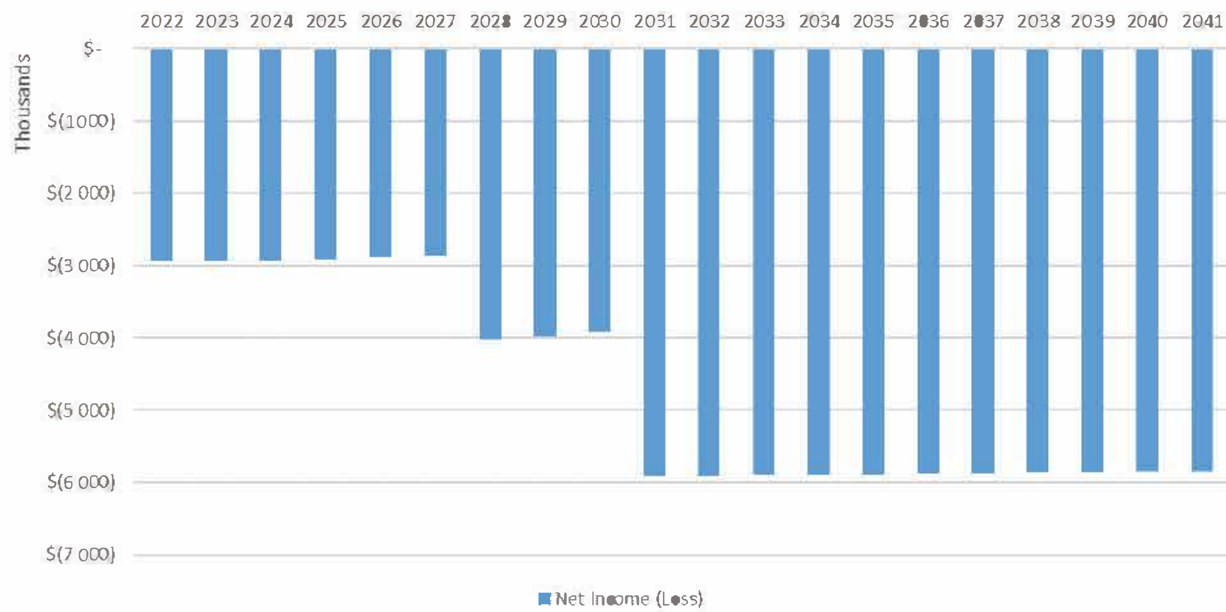
48 Estimated based on previous M-580 barge service operating cost details and consultations with shippers that used the previous service.

49 Provided by the stakeholders through consultations.

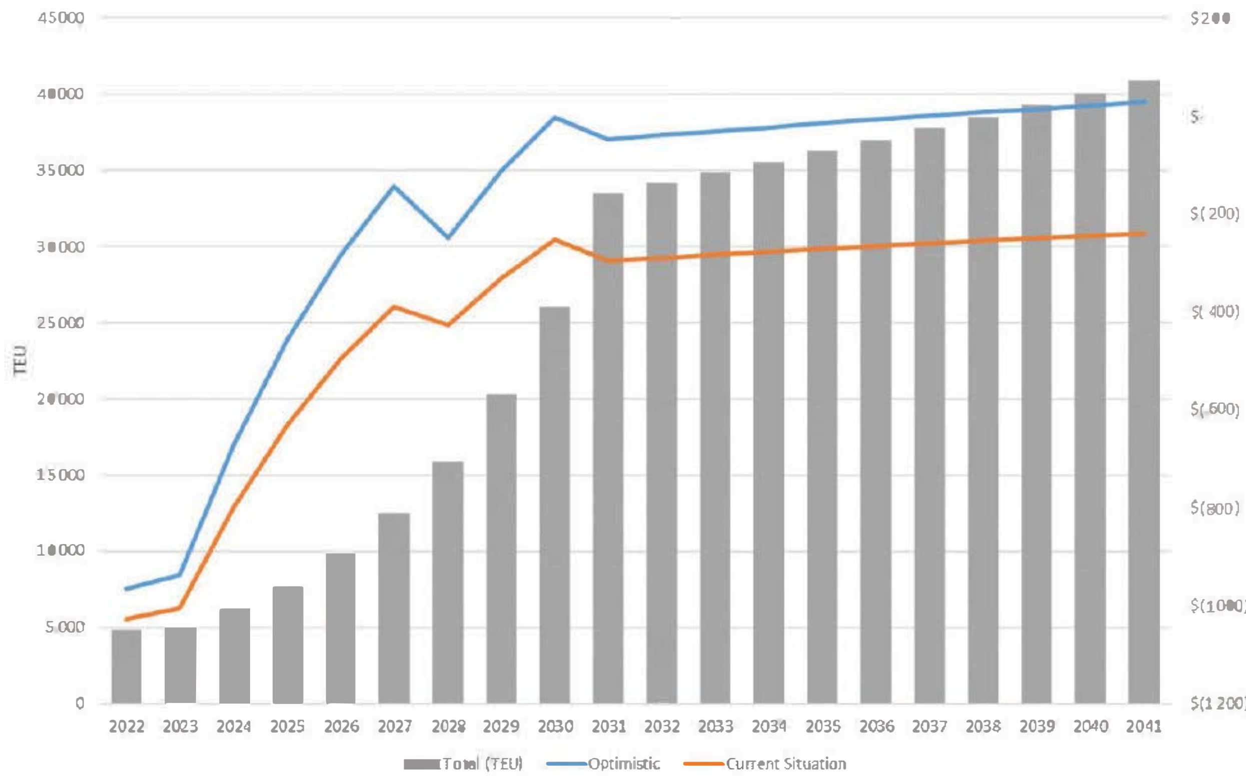
Figure 5-4 shows the annual as well as the cumulative loss. Combining the estimated income (loss) with the potential market shows that the loss per container would be very high in the first five years of inception. Figure 5-5 shows that for both approaches, the loss per container would be around $1,000 per container. The situation improves as the demand increases, however, the loss per container would remain around $250/container over the long-term.

Figure 5-4 – Potential Income (Unit Container Handling Cost in Oakland)



Source: CPCS.

Figure 5-5 – Income (Loss) per Container



Source: CPCS.

5.2.2 Option 2: Use of Similar Barge to Previous M-580 Service

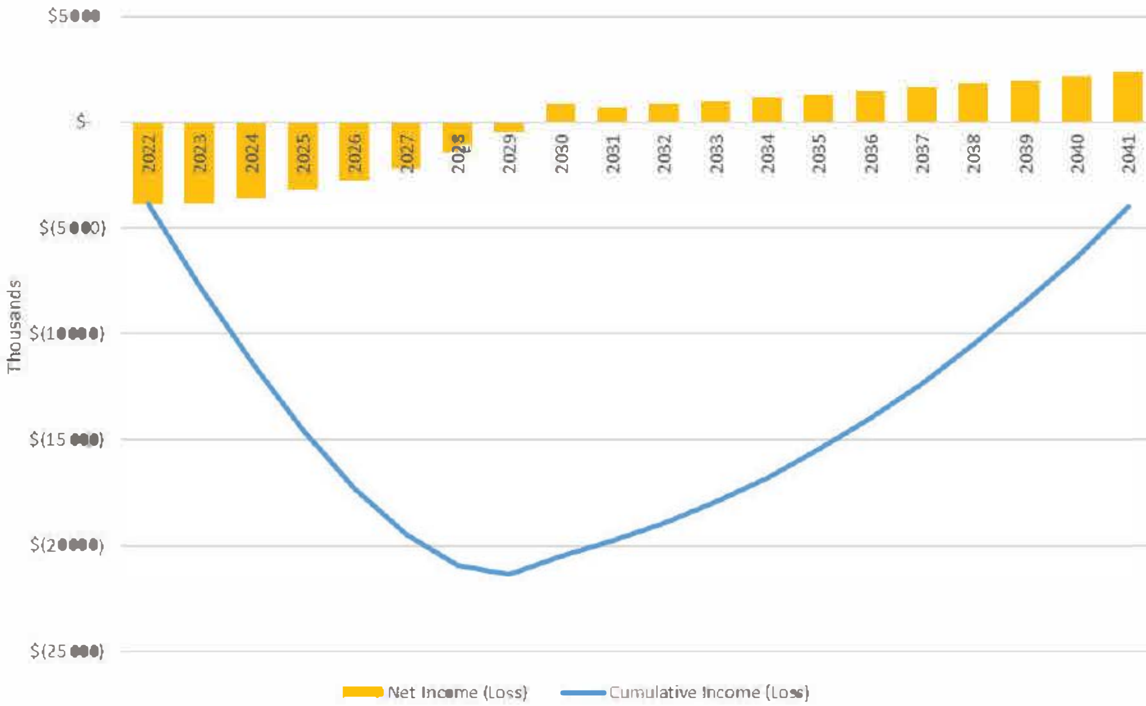
For this option, the cost estimated is based on the use of the actual M-580A barge on a weekly service with optimized terminal operations. This was noted as Scenario 2 in previous working papers. We added another scenario to calculate the cost for a twice-weekly service (Scenario 2A). As seen in Figure 5-6, the market reaches 81% of the M-580A barge weekly service capacity in 2030, and a second weekly service would be added the following year.

The annual loss for this option would be around $3.8 million for the first year. Over the long run, the financial situation improves such that this option generates a profit of $600K in 2030. The cumulative loss would be around $21 million between 2021 and 2029. The larger barge is more cost-efficient than the smaller barge as the demand rises. This allows the annual profit to increase to around $2 million in 2038 and beyond. The cumulative loss would therefore be significantly reduced in 2041 relative to the small barge option ($4 million loss for this option compared to $18 million for the smaller barge option).

As for the previous inception option with small barges, the M580A barge cost scenario (Scenario 2) estimated cargo handling cost optimistically. In this case, applying the same assumptions as before, concerning the terminal handling charges in Oakland ($360/lift), this inception strategy would generate annual losses varying between $3.9 million and $6.5 million (

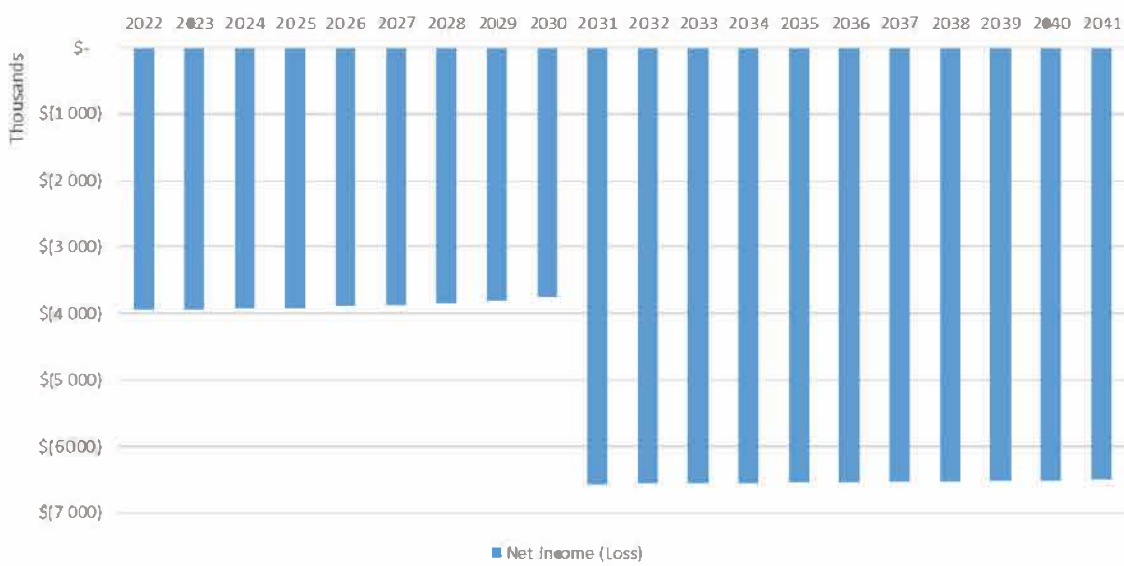
). In the early years of this option, the loss per container is greater than the small barge option reaching $1,300 in the first year. The loss reduces rapidly as traffic grows, and it stays below $300 per container on the sixth year of operation. With the optimistic cargo handling cost evaluation, the M-580A barge inception option could eventually generate a profit just below $100 per container.

Figure 5-6: Potential Income (Optimistic Cargo Handling Scenario)



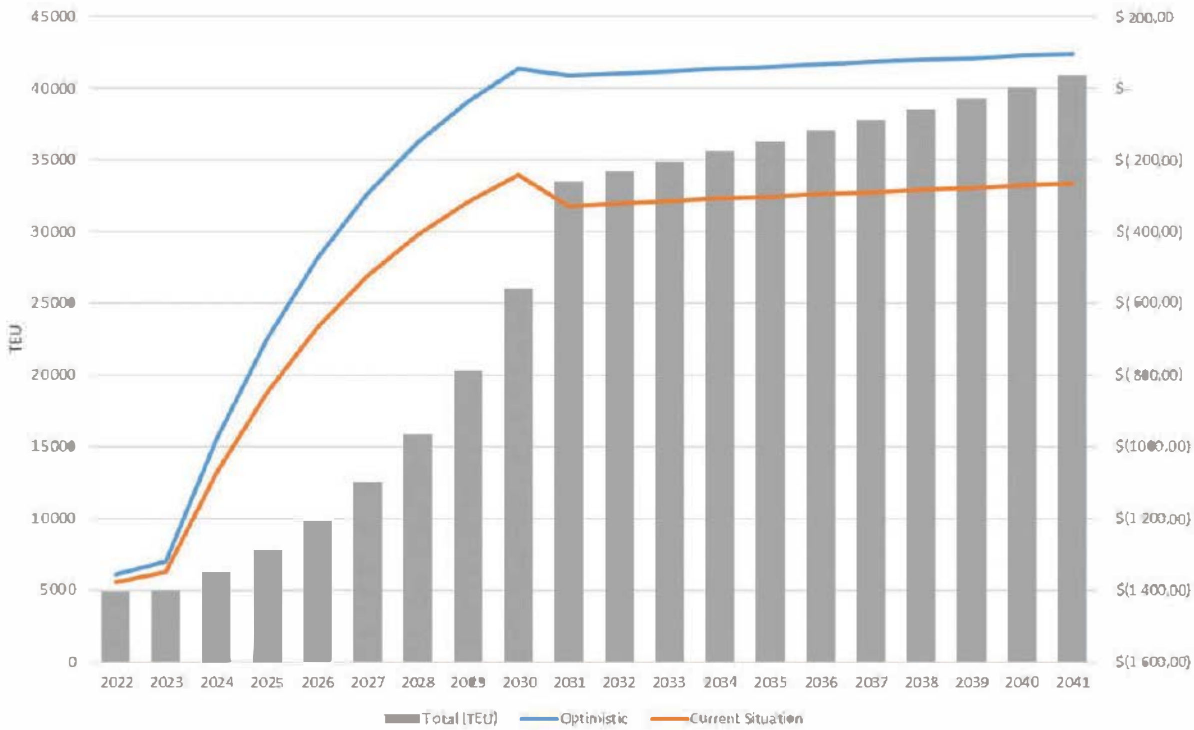
Source: CPCS

Figure 5-7: Potential Income (Unit Container Handling Cost in Oakland)



Source: CPCS.

Figure 5-8: Income (Loss) per Container



Source: CPCS.

5.2.3 Option 3: Roll-on/Roll-off to Stockton or Sacramento

This option focuses on truck trailers on chassis rather than the containers, which are the focus of the previous options. This option targets domestic trade executed by heavy trucks, and trucking companies would be the barge customers utilizing the barge as an option to reduce costs. RoRo services need to be much more competitive with regular trucking services because they will be purchased by trucking companies. Therefore, this RoRo barge service must offer daily services. With sailings overnight, two barges could guarantee next day port delivery if the trailers are dropped before noon. This level of service is likely to interest truckers as they would be close to what they are currently offering.

An advantage of the RoRo option is that it requires less equipment and labor to load/unload the trailers. This significantly reduces costs. A disadvantage of this option is that the barge would not be able to carry as many truck trailers compared to containers since they cannot be stacked directly without investing in a multi-deck barge.

We estimated the market demand for RoRo services under two different service options:

- A first service option from Port of Stockton to Port of Redwood City
- A second option is from Port of West Sacramento to Port of Redwood City.

Another advantage of a RoRo barge service option is that it would avoid congestions, bridge tolls, and uncertainties related to transit time for the truckers (Chapter 2). Through stakeholder consultations with trucking companies, we found that a significant amount of interest exists for a RoRo barge service. However, most of the interested shippers also noted that such a service would be more interesting for logistic/intermodal companies since they already integrate other transportation modes. The global approach using traffic capture rates is the basis of the traffic estimations in this option.

Stockton to West Bay Area Potential Market

Heavy truck traffic between Stockton (including some adjacent counties) and the San Francisco and San Mateo Counties is shown in Figure 5-9. Caltrans Mobility Performance Report (MPR) data shows that there are around 147,000 annual truck trips between these two regions. The traffic is not balanced since there are around 66,000 trucks leaving the San Francisco and San Mateo area going to the Stockton area, compared to 81,700 heavy trucks moving in the other direction (Figure 5-9). Trucks must come back to their origin one day or another, but they can do it through a different path outside the counties of interest for a RoRo barge service. This situation limits the potential market share for a RoRo barge service offering a static origin-destination service compared to the flexibility offered by the road network.

Figure 5-9: Annual Heavy Truck Traffic OD Matrix

Origin\Destination	Amador	Sacramento	San Joaquin	San Francisco	San Mateo	Total
Amador				1,277	1,209	**2,486**
Sacramento				9,864	8,785	**18,648**
San Joaquin				32,135	28,437	**60,571**
San Francisco	1,227	9,518	24,819			**35,564**
San Mateo	1,120	8,246	21,034		**30,400**	
Total	**2,347**	**17,764**	**45,853**	**43,275**	**38,431**	**147,669**
		Total Inbound	**65,963**			
		Total Outbound	**81,706**			

Source: CPCS analysis of Caltrans disaggregated FHWA FAF 4 data.

The traffic with San Joaquin County represents around 72% of the total traffic listed above. Implementing a RoRo barge service between Stockton (San Joaquin County) and Redwood City (San Mateo County) could capture a part of this traffic.

To estimate potential traffic capture by the RoRo barge service, we estimated a market share percentage for each county origin-destination pair as follow:

- San Joaquin County – San Mateo and San Francisco Counties = 10%
- Sacramento County and Amador County – San Mateo and San Francisco Counties = 5%

We assume that the maximum potential market share could be around 10% for transits between San Joaquin County and the Western Bay Area. This is where truckers would have the most benefits regarding traffic congestion and the shortest distance to one of the barge service ports (Stockton and Redwood City). For other origin-destination pairs, we assume that the potential market share to be 5% maximum. These percentages are optimistic, but they would give an idea of the potential income/deficit for a barge service in ideal conditions (Figure 5-10).

Figure 5-10: Potential RoRo Traffic Estimations

Origin\Destination	Amador	Sacramento	San Joaquin	San Francisco	San Mateo	Total
Amador				64	60	**124**
Sacramento				493	439	**932**
San Joaquin				3,213	2,844	**6,057**

San Francisco	61	476	2,482			**3,019**
San Mateo	56	412	2,103			**2,572**
Total	**117**	**888**	**4,585**	**3,771**	**3,343**	**12,705**

Source: CPCS analysis of Caltrans disaggregated FHWA FAF 4 data.

To evaluate the traffic over a twenty-year period, we assumed that it would take ten years to reach the maximum potential traffic as estimated above. After that, we assume that the traffic growth to be around 1%, which is the global truck traffic growth estimated from Caltrans truck traffic data.

West Sacramento to San Francisco and San Mateo Counties Potential Market

The other RoRo barge service option would be between West Sacramento and San Francisco, and San Mateo Counties. This option has the advantage of being on the path between Reno (NV), the second-largest truck market in Nevada. Consultations with trucking companies attracted our attention on this traffic between the Bay Area and Reno. The figure below shows heavy truck traffic between a selection of counties surrounding West Sacramento (including Reno[50]) and San Francisco and San Mateo Counties. In this option, there are 130,250 truck movements between the San Francisco and San Mateo Counties and the counties around Sacramento, including the rest of the Nevada area (Figure 5-11). The traffic between San Francisco and San Mateo Counties and the Rest of Nevada represents about half of the identified traffic (65,376).

Figure 5-11 – Annual Heavy Truck Traffic OD Matrix

Origin\Destination	Nearby Sac[51].	Sacramento	Rest of Nevada	San Francisco	San Mateo	Total
Around Sac.				7,498	6,815	**14,312**
Sacramento				9,864	8,785	**18,648**
Rest of Nevada				5,039	9,275	**14,314**
San Francisco	7,672	9,518	32,722			**49,911**
San Mateo	6,479	8,246	18,340			**33,064**
Total	**14,150**	**17,764**	**51,062**	**22,400**	**24,874**	**130,250**
			Total Inbound	**82,976**		
			Total Outbound	**47,275**		

Source: CPCS analysis of Caltrans disaggregated FHWA FAF 4 data.

The traffic volume to and from Sacramento County is the second highest with 36,400 truck movements. There is a large difference between inbound (83,000) and outbound (47,000) truck movements. This imbalance can be explained by the fact that trucks are delivering goods in nearby San Francisco and San Mateo Counties not included in the potential traffic count for the RoRo barge service.

To estimate the potential traffic capture from the barge service, we used similar assumptions as those made above for the Stockton/Redwood City option using 10% and 5% market shares, respectively. Regarding the rest of Nevada traffic capture rate, we used a lower rate that covers a large area outside Reno (2%). It also

[50] Traffic by counties are not available for Nevada. However, Reno is located in the Rest of Nevada data and since it is a major population center in the region, we assume that the major part of the traffic comes from Reno.
[51] Around Sacramento Counties. i.e. Amador, El Dorado and Placer Counties.

considers that it might be more difficult to convince trucking companies to interrupt their trips halfway in Sacramento. The maximum traffic capture rate assumptions in our analysis include:

- Sacramento – San Mateo and San Francisco = 10%
- Amador, El Dorado and Placer – San Mateo and San Francisco = 5%
- Rest of Nevada – San Mateo and San Francisco = 2%

This leads to maximum potential traffic of around 4,200 heavy trucks per year. This is about one-third of the potential traffic estimated for the Stockton/Redwood City option.

Figure 5-12: Potential RoRo Traffic Estimations

Origin\Destination	Around Sac[52].	Sacramento	Rest of Nevada	San Francisco	San Mateo	Total
Around Sac.				64	60	**124**
Sacramento				243	220	**463**
Rest of Nevada				76	68	**144**
San Francisco	384	952	654			**1,990**
San Mateo	324	825	367			**1,515**
Total	**708**	**1,776**	**1,021**	**382**	**349**	**4,236**

RoRo Options Financial Estimates

We received truck rates for moving a 53' trailer between Sacramento, Stockton, San Francisco, and San Mateo from trucking operators in the region. There is a gap between the low and high rates of around $200. The average rate from Sacramento tends to be $100 higher than those from Stockton.

Figure 5-13 – Truck Rates

		Low	High
Between Stockton and			
	Redwood City	$621	$804
	San Francisco	$538	$704
	Average	*$579*	*$754*
Between West Sacramento and			
	Redwood City	$713	$913
	San Francisco	$638	$813
	Average	*$675*	*$863*

Source: CPCS from stakeholder's data

We estimate that truck drayage rates from each RoRo terminal to be around $200.[53] We estimate a RoRo barge rate of $270/trailer from Stockton and $370/trailer from Sacramento. In this case, the combined RoRo barge and drayage costs are around the average of the truck-only rate. In brief, the assumptions used to estimate the income for each RoRo barge scenarios are:

- Ten years to get to full potential traffic capture rate

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[52] Around Sacramento Counties. i.e. Amador, El Dorado and Placer Counties.
[53] Estimation obtained from consultations

- Linear growth from year 1 to 10
- 1% traffic increase from year ten into the long-term
- Barge rate of $270/trailer from Stockton and $370/trailer from West Sacramento one-way
- Maximum barge loading factor = 85%
- Minimal repositioning of empty trailers, free of charge.

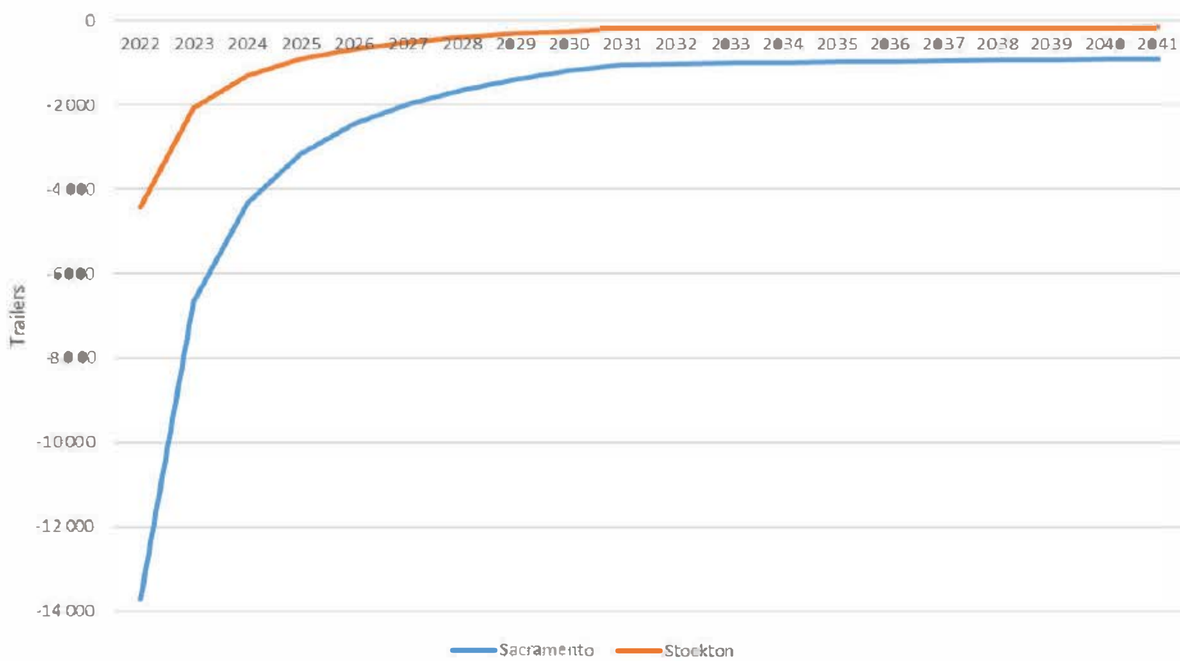
Using the operating costs from Scenario 6 (2 small barges and tugs, daily service), the annual loss varies from $5.8 million in inception years up to $2.2 million in the best case. The figure below shows the detail of the annual loss for each RoRo option.

Figure 5-14: Small RoRo Barge Option Annual Loss

Source: CPCS

For both RoRo Barge options, the losses per trailer are significant. The losses vary from -$13,700/trailer in the worst-case during inception up to -$100/trailer at maturity. The following figure shows the evolution of the loss per trailer for each RoRo options.

Figure 5-15: Loss per Trailer



Source: CPCS

5.2.4 M-580 Barge Options Summary

Figure 5-16 presents a summary of the financial characteristics of the three options examined in this chapter. As the table shows, almost none of the M-580 Barge scenarios and options would be financially self-sustaining. For all cases, inception years are crucial to building up a customer base, and the losses would vary between $2.7 million and $5.8 million per year. In most cases, the loss per container would mostly be around $250/container.

Figure 5-16– Barge Inception Option Financial Information Summary

	Year 1	Year 5	Year 10	Year 15	Year 20
Annual Profit (Loss)					
Container Small Barge (Optimistic)	$ (2,758,817)	$ (1,649,192)	$ (945,199)	$ (158,853)	$ 708,897
Container Small Barge	$ (2,935,617)	$ (2,891,232)	$ (5,911,427)	$ (5,879,973)	$ (5,845,263)
Container Large Barge (Optimistic)	$ (3,877,460)	$ (2,767,835)	$ 694,025	$ 1,480,371	$ 2,348,121
Container Large Barge	$ (3,939,860)	$ (3,895,475)	$ (6,567,483)	$ (6,536,029)	$ (6,501,319)
RoRo Stockton Small Barge	$ (5,628,213)	$ (4,256,073)	$ (2,540,898)	$ (2,365,916)	$ (2,182,007)
RoRo Sacramento Small Barge	$ (5,814,516)	$ (5,187,588)	$ (4,403,928)	$ (4,323,979)	$ (4,239,952)
Profit (Loss) per Container or Trailer					
Container Small Barge (Optimistic)	$ (965)	$ (283)	$ (47)	$ (7)	$ 29

		Year 1	Year 5	Year 10	Year 15	Year 20
	Container Small Barge	$ (1,026)	$ (497)	$ (295)	$ (266)	$ (239)
	Container Large Barge (Optimistic)	$ (1,356)	$ (476)	$ 35	$ 67	$ 96
	Container Large Barge	$ (1,378)	$ (669)	$ (328)	$ (295)	$ (266)
	RoRo Stockton Small Barge	$ (4,430)	$ (670)	$ (200)	$ (177)	$ (155)
	RoRo Sacramento Small Barge	$ (13,726)	$ (2,449)	$ (1,040)	$ (971)	$ (906)

Source: CPCS

For the RoRo options, it would be possible to operate a service that provides advantages to some shippers. The RoRo option also allows for a significant reduction in terminal costs and cargo handling costs compared to the container options, which are significant drivers of financial impacts for all options54. For the container-on-barge options, the total service capacity is greater than RoRo, especially on a per-barge basis.

For this kind of short sea shipping project, port handling cost (both equipment and labor) is a crucial success factor. Most container terminals are organized in a way to optimize handling for large container vessels. Throughout different short sea shipping projects across North America, we have been told by shipowners that the only way to be competitive against the truck is to avoid large port administrations and to control cargo handling. Container terminals have important cost structures that can be amortized by the size of the container vessel and the distance of the marine transportation. This is not the case for the M-580 project since it brings a small fraction of the volume of an oceangoing vessel, and the travel distance is less the 100 nautical miles.

Reducing terminal costs is difficult at container terminals located in the San Francisco Bay Area. The labor organization, terminal operation setup, and the relatively small market capture of the M-580 barge project on overall container business make it difficult to entice stakeholders to be commercially aggressive in regards to this service. Some stakeholders feel that it is much easier to keep getting this traffic through trucks passing the terminal gates rather than to have to operationally manage a barge service in the current environment, including the difficulties of finding space amongst the large container vessels and utilizing ship-to-shore cranes.

5.3 Short-Haul Rail Opportunities

5.3.1 Rail Infrastructure and Volumes in M-580 Study Area

Two Class I railroads, Union Pacific (UP) and BNSF Railway Company (BNSF) operate in the M-580 study area. Both UP and BNSF railroads have near-dock rail facilities within five miles of the Port of Oakland. In addition to freight operations, both BNSF and UP tracks serve passenger trains. Figure 5-17 summarizes the freight and passenger train volumes on subdivisions in the M-580 study area.

Figure 5-17: Freight and Passenger Rail Volumes in the M-580 Study Area

Railroad	Subdivision	Freight Volume (trains per day)	Pax Volume (trains per day)	Total Trains per Day

[54] Cargo handling represents between 59% to 64% of the costs for the container options compared to a range of 20% to 22% for the RoRo options.

UP	Martinez	18	42-44	60-62
UP	Niles - Oakland	16	16	32
UP	Niles - Fremont	11	22	33
UP	Coast	6	24	30
UP	Oakland	11	8	19
BNSF	Stockton	22	7	29

Source: Alameda County Transportation Commission, 2017; California State Rail Plan, 2018.

5.3.2 Short-Haul Rail Opportunities

Inland Rail Port

Currently, about 74 percent of the import and export cargo moving in the Central Valley and the San Francisco Bay Area transits through the Ports of Long Beach and Los Angeles,[55] often carried by trucks traveling along I-5, I-880, I-580, I-680, and other highways in San Pedro Bay and Central Valley regions.

Currently, there is no intermodal rail facility to connect the Central Valley to California's seaports through rail. With the recent uptake in the volume and market share of the San Pedro Bay ports and a highway system overburdened by the trucks carrying goods between freight origins, destinations, and international freight gateways, there has been an interest in improving the rail connection between San Joaquin Valley and the seaports.

This concept has recently been assessed in a feasibility study by the Central Valley Community Foundation. The study builds upon the inputs provided by a variety of freight stakeholders in Northern, Central, and Southern California, analyzing the potential scenarios for a future rail-served inland port to connect Ports of Long Beach and Los Angeles northward through the Central Valley, terminating in Sacramento.

Figure 5-18 shows the size of the market for a future rail intermodal inland port. The area shown in the figure includes Sacramento, Bay Area, and Central Valley regions, as well as the UP and BNSF rail infrastructure between San Pedro Bay and North of Sacramento.

The market area also includes about one billion square feet of industrial space, with nearly 1.1 million in annual inbound and outbound TEUs carried by trucks.

Figure 5-18: The Market for A Future Inland Port in California

Source: California Inland Port Feasibility Analysis, 2020.

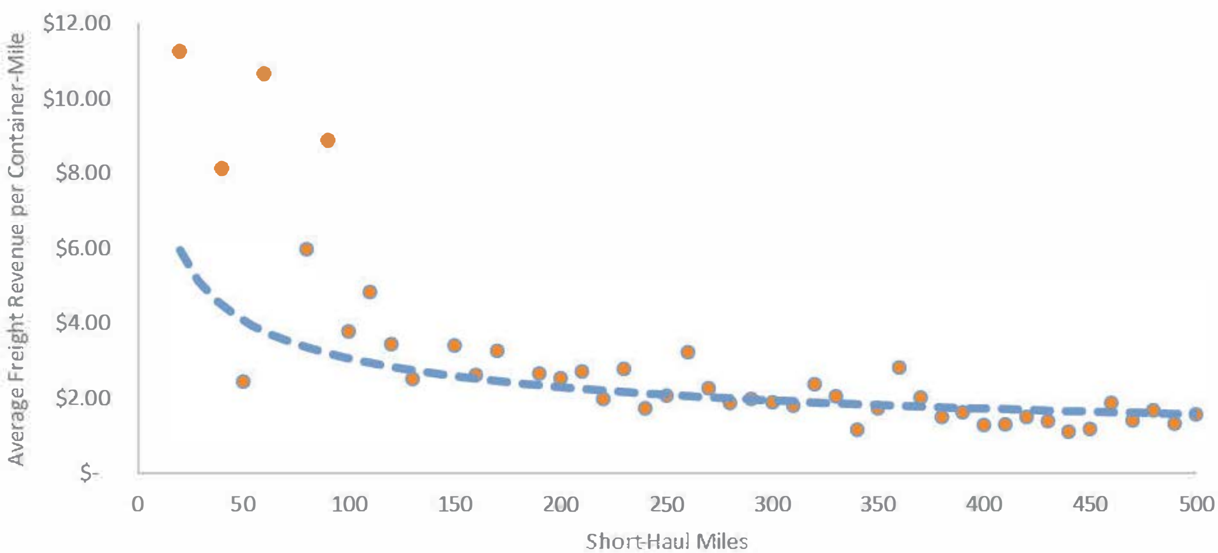
[55] Central Valley Community Foundation, California Inland Port Feasibility Analysis, 2020.

Shipping Costs

Rail shipping rates include revenue thresholds observed by individual railroads and a "variable cost" component calculated based on the Uniform Rail Costing System (URCS) that was adopted in 1989 as the costing program of the Interstate Commerce Commission (ICC). The URCS uses observed rail shipment characteristics to estimate the costs associated with carrying a "generic type of shipment."[56] Railroads set their revenue rates according to the demand, a process that has historically benefited both the shippers and the rail freight operations.

Rail rates are often calculated based on ton-mile of bulk cargo or unit-mile of intermodal container shipment. Rail rates usually decrease as the shipping distances increase. Figure 5-19 compares average short-haul rail per container revenues for short-haul operations between 10 and 500 miles. As the figure shows, rail revenues decrease by about 1 percent for every one-mile increase in short-haul rail distance. Rail revenues for shorter distances are necessary to cover the large fixed costs of operating a rail service. Revenue rates continue to decline at a slight, but relatively important rate, from 250 miles onward such that rail revenues ultimately decrease to lower than the $1.64 per mile costs of operating a truck noted in the American Transportation Research Institute, An Analysis of Operational Costs of Trucking: 2020 Update. This makes rail more competitive for longer distances of moving goods.

Figure 5-19: Average Rail Freight Revenue Per Container-Mile



Source: Analysis of Carload Waybill Sample data by Tioga Group, 2016.

There are similarities between the assumptions included in the California Inland Port Feasibility Analysis and the M-580 analysis regarding rail shipping cost components. Since no short-haul rail service currently exists between the San Joaquin Valley and the San Francisco Bay Area, in comparing the rail shipping costs with other modes (truck and barge), we use the Inland Port Study's assumptions as the basis to calculate potential

[56] Wilson and Wolak, Freight Rail Costing and Regulation: The Uniform Rail Costing System, Springer Science & Business Media, New York, 2016. DOI 10.1007/s11151-016-9523-2

rail rates. We also assume that the rates for carrying loaded and empty containers would be approximately equal.

Figure 5-20 summarizes the rail cost assumptions used in this study.

Figure 5-20: Rail Cost Assumptions

Item	Assumption
Cost range for the trip between Lathrop, Tracy, or Stockton Area and a destination in Bay Area Region	$760 to $830 per trip
Approximate Distance	80miles
Average Travel Speed	40mph
Terminal Dwell Time*	2 to 3 days
Existing railroad tracks, or combination	No assumption
Train Length	250 containers
Lift cost at each end	$50 per container
Empty to full container cost ratio	0.77

*Currently, Port terminals have regular schedules for UP and BNSF operations.
Source: California Inland Port Feasibility Analysis, 2020.

The 2003 Inland Port Feasibility Study by the San Joaquin Council of Governments provides rail costing details for that could be compared to our assumptions. With the assumption of 100 daily containers, the study estimates $173 per container rate for roundtrips between Lathrop and Oakland through UP's Altamont subdivision. A $138 rate is estimated if the trains travel between Stockton and Oakland through Richmond using BNSF's Stockton subdivision. The total costs per container approximately triple as the distances fall below 50 miles. These numbers include line haul and locomotive costs and exclude railcar, drayage, and terminal handling expenses. However, as the prior table shows, there is a significant difference between the rail rate assumptions of the 2003 study and this present study, which is in alignment with the increase in the rail shipping rates across the US over the past two decades.[57]

The cost assumptions summarized in the above table indicate that under the current scenario, rail is not competitive with truck for moving goods between the Port of Oakland and the Port of Stockton, particularly when considering the cost per lift of the container at each end and the truck dray rates at the inland terminal to move the box between Stockton and the ultimate origin and destination.

Short Haul Rail Between the Port of Oakland and Reno/Fernley Region

Currently, there is no short line rail service to connect the Bay Area to the Central Valley or the Reno/Fernley region. As part of separate studies, freight stakeholders have expressed interest in developing an intermodal rail service between the Port of Oakland and inland destinations such as Reno and Fernley in Nevada.

A 2013 study of the potentials for short haul rail services between Nevada and the US West Coast seaports has proved that Nevada's business environment can provide a desirable foundation for businesses can take development and growth. The state's proximity to California and other western region markets makes it a good candidate for goods distribution from both Northern and Southern Nevada. Between 100 to 150

[57] According to the Association of American Railroads, rail rates have increased by more than 30 percent between 2000 and 2017.

containers were moved between Reno and the Port of Oakland by trucks each day. This demand can be translated into 3 to 5 trains per week between the Port and an inland freight logistics facility in Reno.[58]

Also, a comparison of the rail and trucking rates between Reno and the Port of Oakland suggests that the concept could be feasible depending on a range of critical factors such as buy-in from and coordination with the Class I railroads, as well as the active involvement of the Port and state transportation agencies. Figure 5-21 shows the estimated rates for truck and rail shipments between Reno/Fernley and Port of Oakland. As the table shows, the rail rates between Oakland and Reno/Fernley are significantly lower than trucking rates. Meanwhile, the current trucking rates between Stockton and Reno/Fernley prove that draying cargo from Reno/Fernley to the Port of Stockton for shipment by the M-580 barge would not be financially viable.

Figure 5-21: Truck and Rail Costs Between Oakland, CA and Reno, NV

Trucking Rates ($/roundtrip)	Short Haul Revenue per Container
Between Oakland, CA and Reno/Sparks, NV: $950 - $1,150	Between Oakland, CA and Reno/Sparks, NV: $460
Between Stockton, CA and Reno/Sparks, NV: $850 - $1,050	

Source: CPCS consultation with stakeholders, December 2020; Tioga Group STB Waybill data analysis, 2016.
Note: Truck rates include chassis, fuel, and bridge/toll costs. The rail revenue per unit is estimated for distances ranging from 150 to 250 miles.

5.4 Underground Automated Freight System in Stockton or West Sacramento

Underground Freight Transportation (UFT) systems are widely used in Europe, where port terminal capacity is limited and demand is high. In UFT systems, containers are transferred between docks and ports' adjacent logistics hubs. The containers move automatically, using an electro-mechanical haulage cable that is running through a tunnel and pulls the container on rails.[59]

This concept is currently being examined by ROOT Utility Network LLC in Northern California, in the areas adjacent to Port of Stockton[60] and Port of West Sacramento. A future underground freight connection in the Northern San Joaquin Valley can improve the quality of life in the neighborhoods near ports, as large trucks will not have to move overweight containers around.

Other potential benefits include congestion mitigation, road safety improvements, and enabling the integration of new technologies (i.e., blockchain for tracking cargo movements). The estimated cost of container handling with UTF would be around $100 to $200 per container.[61]

[58] RCG, Nevada Inland Ports Viability and Funding Study, 2012: https://rcg1.com/wp-content/uploads/2013/05/Final-Nevada-Inland-Port-Report2.pdf
[59] Denys Website, Underground Container Mover, accessed February 2021: https://www.denys.com/en/projecten/underground-container-mover
[60] Rough and Ready Island and Roberts Island are option being examined as of February 2021.
[61] CPCS Consultation with Tony Wessling and Konstantin Miatchine, 2020.

6 | Barge Service Governance, Funding, and Implementation Options

Key Chapter Takeaway

This chapter discusses the barge governance options, using Port of Norfolk, VA and Port of Fernandina, FL as case studies. Recommended M-580 governance and service implementation steps include understanding the available funding for the project, identifying the potential shippers and the market for barge service, and investigating the potential market dynamics and shifts.

6.1 Barge Governance Options

6.1.1 Previous M-580 Barge Service

The previous barge service was initially operated entirely by the barge operator. They managed the marketing, day-to-day operations, logistics, coordination with dockside labor, and customer service. After a short period in which significant losses accrued, the Port of Stockton took over the service and operated it until the service terminated.

6.1.2 Future Barge Service Governance Options

From a governance perspective, it is ideal that the operator of a future M-580 service is the barge operator. This operating structure aligns the success of the barge operations with the entity that will financially gain the most from its success. For example, the barge operator will be incentivized to attract new customers, retain existing customers, reduce unnecessary costs, address logistical issues experienced by shippers and receivers, and adjust the barge operations to meet the real-time needs of customers.

If a renewed M-580 service were to be subsidized, then careful attention needs to be made to ensure that incentives are properly aligned. A subsidy paid to the barge operator would set up the potential for the barge operator to not operate as efficiently as possible.

A more effective subsidy structure would likely be a subsidy paid directly to the customer (either the shipper, receiver, or a logistics firm). This would retain the alignment with the barge operator and the barge operations. However, a subsidy to customers would mask the true level of demand for the barge services. Therefore, it will be critical for the subsidy provider to closely monitor how demand levels change based on the level of subsidy and operating characteristics.

Joint Port and Terminal Administration

Virginia's port facilities are administered jointly by Virginia Port Authority (VPA) and Virginia International Terminals (VIT). Until 2013, the VPA and VIT operated under their own administrative and governance structures. VIT is responsible for managing, operating, and maintaining VPA's terminals, including setting the conditions for the use of the terminals, performing sales and marketing functions, and taking responsibility for customer relations. VPA retains responsibility for terminal security and safety, improvements to facilities and infrastructure, advertising and public relations, and economic and business development. There is the potential for their roles and responsibilities to become duplicative.

While the two entities remained legally separate, in 2013, VPA's and VIT's respective boards implemented several changes, which created more unified governance and administrative structure. Port users reported that stability in leadership and operations positively contributes to port performance.

The six terminals that are overseen by VPA are APM Terminal (APMT), Newport News Marine Terminal (NNMT), Norfolk International Terminals (NIT), Portsmouth Marine Terminal (PMT), the Virginia Inland Port (VIP), and the Port of Richmond. These terminals primarily handle containerized and breakbulk cargo. The VIP is an inland rail terminal in northwestern Virginia. The Port of Richmond handles cargo shipped via a barge service to and from the seaport terminals.

Virginia also offers a barge and rail usage credit that is unique among East Coast states. This credit allows qualifying shippers that elect to transport their goods via rail or barge instead of truck to claim a credit against their corporate income taxes.[62] Credit is $25 per TEU, 16 tons of noncontainerized cargo, or one unit of roll-on/roll-off cargo in excess of the number of containers shipped by barge or rail by the taxpayer during the immediately preceding taxable year.[63]

Case Study: Port of Richmond Barge Service

USDOT appropriated nearly $200,000 for the James River barge connecting Norfolk and Hampton Roads to Richmond, Virginia. The funds will be used to purchase a 40-foot generator power pack to handle refrigerated containers, a gearbox for a second barge, and four twist-lock bins. The port will contribute another $47,460. Between January and November 2019, volumes rose 19% year over year to more than 34,000 containers, according to the Virginia Port Authority. On a fiscal year basis, the Virginia Ports Authority estimates 20 to 25% growth between July 1, 2019, and June 30, 2020. The Richmond barge service runs six days per week and transit times are equal to intermodal rail.[64]

Private Barge Operator

Case Study: Fernandina Beach Barge Service

2019 -Worldwide Terminals Fernandina, the port's commercial operator, is seeking a "maritime highway" designation for an ocean route parallel to Interstate 95 that is run through the Maritime Administration, an agency of the U.S. Department of Transportation.

2020- USDOT also issued a $1.3 million grant for a proposed barge service between Fernandina, Florida, and other US Southeast ports. Last August, the USDOT granted the port of Fernandina access to the M-95, a marine traffic lane in the Atlantic reserved for commercial traffic, by classifying its proposed barge service as a "marine highway." The selling point is to remove trucks off I-95 between Charleston and northern Florida, a 250-mile one-way haul that would take a full day round trip and cost about $1,200. Even with the $1.3 million, however, there are logistical challenges to overcome. Port officials in South Carolina and Georgia must find berth space amid the weekly strings with post-Panamax vessels becoming common. There are also questions about whether shippers will save enough money to warrant the extra transit time and handling that comes with barge service. The Port of Fernandina, though, has customers who already use the

[62] Joint Legislative Audit and Review Commission, Review of the Virginia Port Authority's Competitiveness, Funding, and Governance, 2013.
[63] Port of Virginia Website: https://www.portofvirginia.com/our-customers/economic-development/tax-incentives/
[64] Ari Ashe, Barge services in Florida, Virginia get USDOT funds, January 2020, Journal of Commerce.

port for other container services. The port handles about 10,000 TEU per year, with two of its core customers being Westrock Co. and Rayonier Advanced Materials, which both operate factories on Amelia Island. [65]

6.2 Proposed M-580 Barge Service Implementation Steps

There are three primary next steps to consider to continue the work towards developing a barge service:

1) Understanding the available funding to subsidize the project.
2) Assembling commitments from individual shippers willing to dedicate cargo volumes to a barge service.
3) Monitoring the freight system for potential shifts in market dynamics.

6.2.1 Understanding the Available Funding to Subsidize the Project

As mentioned in Section 3, the barge operations will likely require several millions of dollars of subsidies over several years until a breakeven operation status occurs. Funding of the barge operations can come from regional and state transportation agency funding sources that are applicable to freight projects across the state, such as the Trade Corridor Enhancement Program (TCEP).

Various local, regional, and state transportation agency funding sources can be applicable to re-launching the M-580 barge service in the short and long-term. Example sources include the Trade Corridors Enhancement Plan (TCEP),[66] California Air Resources Board's Low Carbon Transportation and Community Air Protection Programs,[67] and the FAST Act's Congestion Mitigation and Air Quality Improvement (CMAQ) Program.[68] Several other funding sources can also be available for the M-580 re-launch as there are several stakeholders that will benefit from the barge operations. Additional funding sources are included in Appendix B. Figure 6-1 lists some of the primary beneficiaries of an M-580 barge service.

Figure 6-1: M-580 Stakeholders and Benefits of Barge Service

Stakeholders	The Benefit of Barge Service	Additional Impacts
Port of Stockton	Traffic increase, land development at their facility	Localized impacts from additional trucks near the ports (criteria pollutants, noise)
Port of West Sacramento	Traffic increase	Localized impacts from additional trucks near the ports (criteria pollutants, noise)
Port of Oakland	Traffic reduction at the truck gate	Significant space and logistical constraints at port terminals is a challenge for overall operations, not attracting any new business for the port
Port of Redwood City	Traffic increase, land development at their facility	Localized impacts from additional trucks near the ports (criteria pollutants, noise)

65 Ari Ashe, Barge services in Florida, Virginia get US DOT funds, January 2020, Journal of Commerce.

66 Caltrans, Trade Corridor Enhancement Program, accessed February 2021. https://catc.ca.gov/programs/sb1/trade-corridor-enhancement-program#:~:text=The%20purpose%20of%20the%20Trade,Mobility%20Plan%2C%20and%20along%20other

67 CARB, California Climate Investments Funded Programs, accessed February 2021.

68 Information on Fixing America's Surface Transportation Act or "FAST Act" program can be found at: https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm

Stakeholders	The Benefit of Barge Service	Additional Impacts
Terminal Operators OAK	None	Significant logistical conflicts with existing traffic
Terminal Operators (STO, WS, and RW)	New business	Potential logistics conflicts with existing traffic
Barge Operator	New business	Depending on governance and funding structures, there are potential financial losses that can occur
Ocean Carriers	Reduce emissions and carbon footprint	Adding minimal new traffic, additional logistical challenges
Shippers	Reduce Costs	Additional travel time incurred, increased logistical requirements
Trucking Companies	Reduce medium-haul truck trips with two truck drayage trips, which are easier to staff	Some reduction in truck VMT due to diversion may reduce truck revenue overall
Caltrans, CARB	Progress towards sustainability goals, reduced need to add capacity, and lower maintenance costs	May require significant subsidy with Caltrans taking the lead
Local Communities	Business attraction and retention, reduction in congestion, and environmental impacts of truck activity	Localized impacts from additional trucks near the ports (criteria pollutants, noise)

Source: CPCS

6.2.2 Assembling commitments from individual shippers willing to dedicate cargo volumes to a barge service

We have found through shipper interviews that the M-580 barge service can offer significant transport cost savings and there are individual customers that are willing and excited to utilize a barge service. A future additional step of outreach would be to expand the base of potential customers that are interviewed. Then, for each potential customer, specify the amount of cargo that would be dedicated to the service and secure these commitments through a formal document such as a Memorandum of Understanding.

Ideally, this process would involve hundreds of potential customer interviews to get commitments on a sufficient number of containers (or trailers for RoRo) that would use the barge service under an initial set of conditions. This would minimize the ramp up process that we assumed as part of the financial modeling, thereby reducing the amount of subsidy needed in the initial years of operation. Additionally, these commitments can be presented to the potential funding sources mentioned in Section 6.2.1 as a proof of interest by customers and part of the negotiating process to obtain the needed amount subsidy to from a range of sources.

6.2.3 Monitoring the freight system for potential shifts in market dynamics

The stated preference survey confirmed that shippers that are not willing to utilize a barge service under current conditions would be willing to utilize the service under a different set of operating conditions in the future. Some of the factors that may increase demand for a barge service include:

- A significant increase in truck rates to ship goods between the Port of Oakland and West Sacramento or the Stockton region. Higher truck rates can result from increased congestion in the I-580 and I-80 corridors or from dramatically higher diesel fuel prices.

- A significant decrease in the costs to purchase or lease barges.
- A decrease in labor rates for workers moving containers to and from the barges.
- Increased delay at container terminals at the Port of Oakland.
- An increase in the amount of agricultural exports generated in the rural regions surrounding Sacramento and Stockton.
- An increase in the amount of exports moving between the Port of Oakland and Sacramento or the northern Central Valley.
- Changes in truck size and weight regulations to move goods to and from the Port of Stockton and the Port of West Sacramento.

Stakeholders interested in operating the barge service can utilize this study's optimization model to estimate the level of demand that is generated under different freight market scenarios as they arise. Under future scenarios, there is the possibility that a lower level of subsidies are needed. As the subsidies needed approach the level of subsidy that is realistic based on the work conducted in Section 6.2.1, a restarting of the barge service could be reconsidered.

6.3 Final Considerations on Alternative Modes in I-580 and I-80 Corridors

This study has identified that there are many positive benefits of operating a barge service or rail service to relieve truck track in the I-580 and I-80 corridors. These benefits include reduced fuel consumption, lower emissions, a reduction in congestion, less pavement damage/maintenance, and potentially more efficient logistics operations such as a reduction in empty container miles.

However, the financial analysis in this study indicates that a significant subsidy is needed to initiate a barge or rail service at this time and that it would need to be sustained at a high level for a significant period of time before the service would turn a profit. Additionally, the subsidy would need to be perceived as guaranteed in the freight community to instill confidence that the service will be reliable over a long period of time, thereby making it worthwhile to make the changes in operations needed to shift freight modes.

Based on the continued public and private sector interest in developing modal alternatives in this corridor, there should be continued periodic reviews to determine if changes in the funding environment, customer interest, and overall freight market dynamics converge to create a dynamic that can sustain a barge or rail service option in this corridor.

Appendix A: Expanded OD Matrix

Origin\Destination	Alameda Co.-Oakland Subarea	Alameda Co.-East Bay	Alameda Co.-South	Contra Costa Co.-West	Contra Costa Co.-East	Sacramento Co.-Southeast	Sacramento Co.-West	San Joaquin Co.-South	San Joaquin Co.-North
Alameda-Oakland Subarea	35,656	26,867	13,090	29,095	26,000	2,402	3,561	7,769	6,923
Alameda-East Bay	37,841	35,919	22,971	19,255	21,853	2,726	3,529	10,962	9,199
Alameda-South	17,349	22,482	31,768	11,688	16,186	4,448	4,867	16,381	12,366
Contra Costa-West	61,405	16,295	9,156	17,824	34,448	2,501	3,351	6,595	6,283
Contra Costa-East	43,647	19,115	15,759	23,939	72,492	5,034	5,850	13,871	15,985
Sacramento-East	3,902	3,667	5,090	3,598	6,221	34,443	141,113	8,002	12,630
Sacramento-West	5,027	4,277	5,145	4,424	6,734	133,871	629,521	6,937	10,873
San Francisco-South	47,502	30,883	18,430	18,357	31,861	4,290	6,244	10,841	10,371
San Francisco-North	32,641	17,203	12,085	15,198	16,889	3,337	3,978	8,379	8,071
San Joaquin-South	11,732	16,391	24,253	9,906	23,648	8,933	9,396	22,667	20,222
San Joaquin-North	9,812	9,763	11,997	7,773	15,722	12,313	11,814	14,855	33,179
San Mateo-South	11,716	15,292	13,037	8,045	10,116	3,864	4,259	7,770	7,353
San Mateo-North	29,941	31,943	22,716	15,297	23,350	4,536	6,498	10,455	10,133
Solano-West	13,246	10,978	10,032	11,214	17,494	6,445	8,386	8,214	11,797
Solano-East	8,419	7,316	7,295	7,521	10,848	7,483	9,381	6,590	7,755
Stanislaus	8,945	8,736	14,391	7,531	13,563	11,665	12,781	23,321	19,532
Yolo	5,169	5,328	6,212	5,280	7,870	16,190	41,218	7,676	9,310
Oakland Int. Gateway	3,162	3,168	3,174	3,180	3,186	3,192	3,198	3,216	3,222
Richmond	3,348	3,354	3,360	3,366	3,372	3,378	3,384	3,402	3,408
Lathrop	3,534	3,540	3,546	3,552	3,558	3,564	3,570	3,588	3,594
Stockton	3,720	3,726	3,732	3,738	3,744	3,750	3,756	3,774	3,780
Port of San Francisco	5,163	6,972	7,186	4,716	6,451	4,167	4,430	4,320	4,321
Port of Redwood City	4,647	5,536	5,551	4,501	5,631	4,242	4,376	4,349	4,353
Port of Oakland	17,807	21,855	25,321	11,825	18,428	6,497	9,164	5,843	6,413
Port of Richmond	5,945	6,563	9,713	29,416	9,496	4,744	5,209	4,939	4,879
Port of Stockton	4,650	4,656	4,663	4,668	4,674	4,680	4,686	4,709	4,715
Port of West Sacramento	5,475	6,503	7,584	6,513	8,200	6,162	8,069	9,949	8,201

Origin\Destination	San Francisco Co.-South	San Francisco Co.-North	Stanislaus Co.	Yolo Co.	San Mateo Co.-South	San Mateo Co.-North
Alameda-Oakland Subarea	33,241	40,333	3,597	2,660	10,433	24,537
Alameda-East Bay	27,396	20,993	5,268	2,727	16,445	25,488
Alameda-South	17,085	14,193	11,163	3,671	14,593	18,120
Contra Costa-West	19,664	18,046	4,061	2,787	7,083	16,650
Contra Costa-East	25,727	20,662	9,323	4,817	11,047	21,169
Sacramento-East	3,964	3,417	11,321	14,782	3,112	3,940
Sacramento-West	5,226	4,313	9,636	37,748	3,580	5,081
San Francisco-South	274,415	148,451	6,583	4,465	17,989	66,958
San Francisco-North	77,758	60,798	4,742	3,602	13,560	27,108
San Joaquin-South	15,729	12,679	29,243	5,892	9,738	15,665
San Joaquin-North	10,593	9,585	22,045	7,469	7,853	10,991
San Mateo-South	14,964	14,193	6,415	3,876	12,488	35,700
San Mateo-North	81,193	41,047	7,685	4,430	51,999	148,650
Solano-West	13,897	11,817	7,801	7,237	8,300	10,927
Solano-East	8,435	7,800	8,461	9,176	6,237	7,568
Stanislaus	9,010	7,322	349,362	8,173	7,598	10,171
Yolo	5,459	5,273	10,199	20,326	4,895	5,492
Oakland Int. Gateway	3,204	3,210	3,252	3,258	3,228	3,234
Richmond	3,390	3,396	3,438	3,444	3,414	3,420
Lathrop	3,576	3,582	3,624	3,630	3,600	3,606
Stockton	3,762	3,768	3,810	3,816	3,786	3,792
Port of San Francisco	5,196	5,107	4,102	4,111	5,310	5,298
Port of Redwood City	4,877	4,852	4,212	4,235	4,772	4,847
Port of Oakland	14,193	12,361	5,464	5,514	12,611	17,560
Port of Richmond	5,167	5,161	4,686	4,678	5,398	8,193
Port of Stockton	4,692	4,698	4,748	4,746	4,716	4,722
Port of West Sacramento	5,714	7,301	6,219	6,168	5,620	6,685

Origin\Destination	Port of San Francisco	Port of Redwood City	Port of Oakland	Port of Richmond	Port of Stockton	Port of West Sacramento	Oakland International Gateway	Richmond Rail Terminal	Lathrop Rail Terminal	Stockton Rail Terminal

Alameda-Oakland Subarea	201	1,754	15,484	1,637	150	156	102	108	114	120
Alameda-East Bay	332	1,017	6,457	845	336	342	288	294	300	306
Alameda-South	535	8,543	39,551	5,945	522	528	474	480	486	492
Contra Costa-West	690	805	2,763	26,209	708	714	660	666	672	678
Contra Costa-East	892	2,353	12,996	113,347	894	900	846	852	858	864
Sacramento-East	1,056	1,157	1,797	1,141	1,080	1,213	1,032	1,038	1,044	1,050
Sacramento-West	1,244	1,408	2,978	1,374	1,266	1,650	1,218	1,224	1,230	1,236
San Francisco-South	1,431	1,525	2,630	1,512	1,452	1,458	1,404	1,410	1,416	1,422
San Francisco-North	1,627	2,629	9,841	2,321	1,638	1,644	1,590	1,596	1,602	1,608
San Joaquin-South	1,806	1,812	3,680	1,841	1,824	1,830	1,776	1,782	1,788	1,794
San Joaquin-North	1,991	1,994	3,855	2,020	2,010	2,016	1,962	1,968	1,974	1,980
San Mateo-South	2,177	3,377	6,092	3,005	2,196	2,202	2,148	2,154	2,160	2,166
San Mateo-North	2,507	3,681	18,396	4,264	2,382	2,388	2,334	2,340	2,346	2,352
Solano-West	2,556	2,648	6,715	31,305	2,568	2,574	2,520	2,526	2,532	2,538
Solano-East	2,764	2,970	18,735	3,268	2,754	2,760	2,706	2,712	2,718	2,724
Stanislaus	2,918	2,924	3,834	2,941	2,940	2,946	2,892	2,898	2,904	2,910
Yolo	3,103	3,159	4,241	3,166	3,126	3,271	3,078	3,084	3,090	3,096
Oakland Int. Gateway	3,288	3,294	3,300	3,306	3,312	3,318	3,264	3,270	3,276	3,282
Richmond	3,474	3,480	3,486	3,492	3,498	3,504	3,450	3,456	3,462	3,468
Lathrop	3,660	3,666	3,672	3,678	3,684	3,690	3,636	3,642	3,648	3,654
Stockton	3,846	3,852	3,858	3,864	3,870	3,876	3,822	3,828	3,834	3,840
Port of San Francisco	4,032	4,038	4,044	4,050	4,056	4,062	4,008	4,014	4,020	4,026
Port of Redwood City	4,218	4,224	4,230	4,236	4,242	4,248	4,194	4,200	4,206	4,212
Port of Oakland	4,404	4,410	4,416	4,422	4,428	4,434	4,380	4,386	4,392	4,398
Port of Richmond	4,590	4,596	4,602	4,608	4,614	4,620	4,566	4,572	4,578	4,584
Port of Stockton	4,776	4,782	4,788	4,794	4,800	4,806	4,752	4,758	4,764	4,770
Port of West Sacramento	4,962	4,968	4,974	4,980	4,986	4,992	4,938	4,944	4,950	4,956

Appendix B: Potential Funding Sources

Senate Bills 1 and 103 (SB 1 and SB 103) Trade Corridor Enhancement Program (TCEP)

SB 1 TCEP Provisions

SB 1 created the Road Maintenance and Rehabilitation Program to address deferred maintenance on state and local roadway systems throughout the State through a combination of fuel taxes and license and registration fees. SB1 increased State gas tax by $0.12 per gallon for gasoline and $0.20 per gallon for diesel fuel and included an inflation adjustment factor. The Bill increased vehicle license fees by $25 to $175 based on the value of the vehicle and also adjusts for inflation.

Recognizing that the State is aiming for more EV registrations, the bill also created a new $100 increase in vehicle license fees for zero-emission vehicles starting in 2020 with an inflation adjustment factor. SB1 provides an annual set-aside of $200 million for self-help counties, defined as counties with adopted transportation sales tax measures and/or established development impact fee programs. Fifty percent of the revenue generated by the $0.20 per gallon diesel fuel tax will be deposited into the newly created Trade Corridor Enhancement Account to expend on corridor-based freight projects resulting in estimated 10-year funding of $3 billion. Furthermore, SB1 created a $30 million annual Advanced Mitigation Program to protect natural resources and accelerate project delivery.[69]

SB 103 TCEP Provisions

SB 103 deleted references to the Trade Corridor Infrastructure Fund (TCIF), revised the TCIF requirements and applied the revised TCIF requirements to the Trade Corridor Enhancement Account. SB 103 also mandates the California Transportation Commission (CTC) to allocate 60% of the available funds to projects nominated by regional transportation agencies and local agencies, with the remaining 40% to be allocated to projects nominated by Caltrans.[70]

Congestion Mitigation and Air Quality Improvement (CMAQ) Program

In 1991, Congress passed the Intermodal Surface Transportation Efficiency Act-the ISTEA, which built on the Clean Air Act and emphasized a multi-modal transportation focus, paving the way for greater focus on environmental programs.[71] Part of this approach was the newly authorized Congestion Mitigation and Air Quality Improvement (CMAQ) Program, which provides a flexible funding source for State and local governments to fund transportation projects and programs that reduce mobile source emissions to help meet the requirements of the Clean Air Act.[72]

Administered by FHWA, the CMAQ program has been reauthorized under every successive Transportation Bill up to and including the FAST Act in 2015. Projects that receive funding through CMAQ must be included

[69] Caltrans, Trade Corridor Enhancement Program Draft Guidelines, 2020.

[70] Ibid.

[71] FHWA, CMAQ Program Website, accessed February 2021: https://www.fhwa.dot.gov/environment/air_quality/cmaq/

[72]FHWA, National Coalition on Truck Parking: Funding, Finance, and Regulations Working Group - Emissions Reduction Grant Programs Fact Sheet, 2020.

in an MPO's current transportation plan and transportation improvement program (TIP) or the current State transportation improvement program (STIP) in areas without an MPO.[73]

Carl Moyer Program

This program was established by two legislative bills, Senate Bill 1107 (SB 1107) and Assembly Bill 923 (AB 923), to reduce emissions of Nitrogen Oxides (NOx), Particulate Matter (PM), and Reactive Organic Gases (ROG) from heavy-duty trucks, cargo handling equipment, locomotives, ocean-going vessels, and refrigerated truck units. On December 3, 2004, the South Coast AQMD passed a resolution adopting a $2 vehicle registration fee to supplement funding for this program in Southern California.

Below are the specific project categories identified for funding under the South Coast AQMD 2020 CMP solicitation.

Infrastructure

Infrastructure to fuel or power a covered source under the CMP, such as on-road heavy-duty vehicles, cargo handling equipment, and marine vessels. Eligible infrastructure projects include, but are not limited to:

- Battery charging stations: New, conversion of existing, and expansion to existing battery charging stations for heavy-duty vehicles and cargo handling equipment
- Alternative Fuel Station: New conversion of existing or expansion of existing hydrogen or natural gas fueling station for heavy-duty vehicles and cargo handling equipment
- Shore Power: Shore-side electrification for projects not subject to CARB's shore power regulation. This funding is limited to port authorities, terminal operators, and ocean-going vessel owners.

Heavy Duty Trucks

Eligible project types include vehicle replacement and repower/conversion projects; on-road retrofit projects will be considered on a case-by-case basis. The proposed vehicle must be in the same weight class as the existing vehicle (LHD, MHD, or HHD). The engine must be certified to the applicable heavy-duty intended service class as shown on the engine certification Executive Order[74]. However, the following cases may be allowed: 1) MHD engines may be installed in HHD vehicles with GVWR up to 36,300 lbs. (10 percent higher than 33,000 lbs. GVWR) with written warranty verification by engine and chassis manufacturer, or 2) HHD engines may be installed in MHD vehicles if necessary for vocational purposes but only if the GVWR is within 10 percent of the HHD intended service class (i.e., GVWR of 29,701 lbs. or greater).

Off-Road Equipment

Off-road equipment refers to marine vessels, locomotives, construction equipment, agricultural equipment, and cargo handling equipment. The funding allows for engine repower, retrofits, and replacements.

Engine repowers are primarily repowers of diesel engines to reduce NOx and PM emissions. Gas- and natural-gas-powered engines that are converted to cleaner diesel are not eligible for funding. Engine retrofits that involve the installation of a CARB-verified diesel emission control device, such as particulate filters and diesel oxidation catalysts, are eligible for funding. Retrofit projects that control PM_{10} must use

[73] Ibid

[74] California Air Resource Board, On-Road New Vehicle & Engine Certification Program. Accessed on January 2021: https://ww3.arb.ca.gov/msprog/onroad/cert/cert.php#3

the highest level, technically feasible technology available for the equipment being retrofitted, which is defined as a device that achieves the highest level of PM_{10} reductions (Level 3 - 85 percent) and the highest level of NOx reductions. To be eligible for equipment replacement funding, the replacement equipment (new or used) must have a certified engine that complies with the current emission standard (Tier 4 Final) or zero-emission technology, and the equipment being replaced must be older, fully functional at the time of the purchase, and then scrapped.

Marine Engine Repower

Marine vessels not subject to the in-use compliance requirements of CARB's Commercial Harbor Craft Regulation, such as fishing vessels, pilot boats, and workboats, are eligible for funding under the Carl Moyer Program (CMP). Vessels subject to the in-use compliance requirements of CARB's Commercial Harbor Craft (CHC) regulation (i.e., barge, crew/supply, dredge, excursion, ferry, towboat, and tugboats) are also eligible as long as the vessel is fully compliant with the CHC Regulation (i.e., engines meet Tier 2 standards). Based on the vessel's operation, the newer engine's emissions must be surplus to the currently required U.S. EPA marine engine emission standard (i.e., Tier 3, Tier 4, etc.).

Shore Power

Shore Power Projects within port locations must be surplus to CARB's At-Berth Regulation and approved on a case-by-case basis. Limited CMP funding opportunities remain for shore power projects due to the applicability of CARB's At-Berth Regulation. Applicants must submit their CARB-approved Initial Terminal Plan to document compliance with CARB's Shore Power regulation. The proposed project must provide emission reductions that are surplus to regulatory requirements. Projects not subject to CARB's regulation are eligible.

There are very limited CMP funding opportunities for Class 1 freight railroads, and such projects are selected on a case-by-case basis and must be approved by CARB. Class 3 freight railroads and passenger railroads are not subject to any CARB fleet regulations; therefore, they are eligible for CMP funding. All new locomotives and replacement engines must be certified to Tier 4 standards to be eligible for CMP funding. There are currently three types of locomotive projects that are eligible for CMP funding:

1. Locomotive replacement (the reuse and/or recycling of the baseline chassis is allowed if the baseline engine is destroyed)
2. U.S. EPA-certified engine remanufacture kit or repower
3. Head-end power (HEP) unit (apply as an off-road engine project)
4. Locomotive project activity must be based upon fuel consumption.

Cargo Handling Equipment

Propulsion engines greater than 25 horsepower on mobile off-road equipment are eligible for CMP funding, with limitations. Off-road heavy-duty equipment/engines include but are not limited to construction equipment, agricultural tractors, marine engines, shore power, and locomotive equipment.

Cargo Handling Equipment (CHE) Electrification

Cargo handling equipment fleets must be fully compliant with CARB's Regulation for Cargo Handling Equipment at Ports and Intermodal Rail Yards[75] in order to be eligible for CMP funding. Applicants must provide a copy of their most recent CARB Compliance Plan to document compliance with the regulation.

Existing diesel-powered RTG cranes or diesel-powered CHE (i.e., yard trucks, lifts, etc.) operating at a seaport, intermodal railyard, or freight facility are eligible for CMP funding to offset costs to electrify this equipment. Projects utilizing regulatory extensions are not eligible for funding.

CHE Electrification – RTG Cranes

The CMP allows funding to convert or replace existing diesel-powered RTG cranes to zero-emission power systems. Eligible costs may include the purchase of a new crane or installation of a zero-emission engine, necessary parts for an existing RTG crane, including directly related vehicle modifications, and infrastructure to supply electrical power, utility construction, and costs associated with increasing the capacity of electrical power to the crane. Ineligible costs include design, engineering, consulting, environmental review, legal fees, permits, licenses, and associated fees, taxes, metered costs, insurance, operation, maintenance, and repair. Projects are evaluated on a case-by-case basis.

CHE Electrification – Other

The CMP allows funding to convert or replace an existing CHE with a zero-emission propulsion system. Eligible costs may include the purchase of a zero-emission unit. Ineligible costs include license, registration, taxes (other than federal excise and sales tax), insurance, operation, maintenance, and repair. Projects are evaluated on a case-by-case basis.

Maximum Funding

Maximum funding is 85 percent when repowering to a zero-emission system and 80 percent for complete equipment replacement. In addition to these maximum funding levels, all projects must not exceed the cost-effectiveness limits as specified in the 2017 Carl Moyer Program Guidelines.

AB 617 Community Air Protection Program (CAPP)

Assembly Bill 617, the Community Air Protection Program, established funding for community-based plans to address the impacts of non-mobile freight generators within designated environmental justice communities. In 2018 and again in 2019, $245 million was authorized each year for projects pursuant to AB 617, including the establishment of funding for Community Emissions Reductions Plans (CERPs). SB 856 also provided supplemental funding for the Carl Moyer programs, Proposition 1-B TCEP, zero-emissions charging infrastructure for trucks, and other stationary source projects that met specific criteria. From 2017-2019, AQMD received nearly $300 million for these programs. Funding becomes available in the spring of each year.

[75] California Air Resource Board, Cargo Handling Equipment Regulation to Transition to Zero-Emission, Accessed January 2021: https://ww2.arb.ca.gov/our-work/programs/cargo-handling-equipment

California Cap and Trade Programs

This program funds projects that improve air quality and reduce greenhouse gas emissions. Most of these programs focus on non-freight activities; however, some of the programs and funding are beneficial to reducing freight-generated emissions.

Clean Truck Vouchers

The On-Road Heavy-Duty Voucher Incentive Program (VIP) provides funding opportunities for fleet owners with ten or fewer vehicles to quickly replace their older heavy-duty diesel or alternative fuel vehicles. Air Districts have the discretion to set certain local eligibility requirements based upon local priorities. Fleet owners may be eligible for funding to replace the existing vehicle(s) to be scrapped. The goal of the voucher program is to scrap and replace older, higher polluting vehicles earlier than would have been expected through normal fleet turnover or by regulation. Fleet owners that operate vehicles with 2009 or older model-year diesel or alternative fuel engines may be eligible for funding towards the purchase of a replacement vehicle that has a 2013 or newer engine.

Maritime Administration Funding Opportunities

The funding opportunities provided by the Maritime Administration (MARAD) can be used to support the re-launch of the M-580 barge service. This programs are discussed in the following:

Marine Highway Program

The US Marine Highway Program promotes he use of the navigable waters to reduce land side congestion, improve air quality, and mitigate the impacts of freight activities on communities. Calls for eligible projects are published by the Federal Register approximately every 2-years, and designated projects receive preferential treatment from the MARAD, possible funding assistance, and other support services.

Small Shipyard Grants

This program provides financial support for projects that make capital and related improvements and provide workforce training for marine vessels and associated industries. Small Shipyard Grants are capped at 75% of the project's total cost and are available to facilities with fewer than 1,200 employees.

Construction Reserve Fund

The Construction Reserve Fund (CRF) provides financial assistance through tax deferral benefits to U.S.-flag operators. Eligible parties include entities involved in domestic trade between US ports and with possessions located within the coastwise laws and along the inland waterways, as well as fishing vessel owners and operators.

Capital Construction Fund

American-flag vessel operators are eligible to apply for the Capital Construction Fund (CCF) program. CCF aims to provide this entities with a competitive advantage over foreign-flag operators, for the construction and replacement of their vessels.

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