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MTC REGIONAL GOODS MOVEMENT PLAN

Task 3C – Identify Gaps, Needs, Issues, and Opportunities

Draft Technical Memorandum

prepared for

Metropolitan Transportation Commission

prepared by

Cambridge Systematics, Inc.

with

AECOM
Transportation Analytics

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1.0 Introduction

This technical memorandum presents an analysis of the needs, gaps, deficiencies, and opportunities for the goods movement system in the San Francisco Bay Area. The needs assessment evaluates how well the system meets the vision and goals established for the regional goods movement system as part of the development of the regional goods movement plan.

The Vision for the Bay Area goods movement system is presented below.

> *The Goods Movement system will be safe and efficient, provide seamless connections to international and domestic markets to enhance economic competitiveness, create jobs, and promote innovation while reducing environmental impacts and improving local communities' quality of life.*

This vision is supported by Plan Goals that rely on collaboration with public and private sectors and community partners to maintain, operate, and invest in the goods movement system to:

- Reduce environmental and community impacts from goods movement operations to create healthy communities and a clean environment, and improve quality of life for those communities most impacted by goods movement;
- Provide safe, reliable, efficient, and well-maintained goods movement facilities;
- Promote innovative technology strategies to improve the efficiency of the goods movement system; and
- Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions; and
- Increase economic growth and prosperity that supports communities and businesses.

Each of these Plan Goals was selected to help the Metropolitan Transportation Commission (MTC) and its public and private partner stakeholders create plans that address the key issues in the region. When each of these goals is considered and ultimately realized, the goods movement system will meet the region's Vision.

This technical memorandum identifies gaps, needs, issues, and deficiencies for each of the major, multimodal goods movement corridors in the region as they relate to the goals. In an earlier technical memorandum[1], a group of eight multimodal corridors most critical for goods movement in the region was identified and these are the corridors that are analyzed in this technical memorandum. In addition, in a separate technical memorandum[2], a process was described for evaluating the condition of the goods movement system using performance measures related to each of the goals. Through the examination of trend information and other quantitative and qualitative data sources (such as stakeholder interviews), this document uses the performance measures to provide insight into which parts of the goods movement system are working well, as well as indicating weaker system components and where improvements should be considered. This report also identifies opportunities in the goods movement system that can be pursued through investments, policies, and programs. This needs assessment will provide the basis for developing strategies in the next phase of the planning process to address needs and pursue opportunities.

The evaluation of the goods movement system is organized in this technical memorandum around the major goods movement corridors as follows.

- **Section 1.0 – Introduction.** This includes an overview of the key needs and issues in the Bay Area, which sets the stage for corridor-level needs discussed in Section 2.0. In addition, this section also discusses key opportunities in the region that should be considered when addressing needs.
- **Section 2.0 – Goods Movement Corridor Assessment.** Detailed discussion around each multimodal corridor, named after their main highway component, include issues related to highway congestion/delay, reliability, safety, conditions, rail congestion/capacity issues, and rail access and safety issues, as well as other modal issues specific to each corridor.
  - Section 2.1 – Data and Methodology;
  - Section 2.2 – Interstate 880 (I-880) Corridor;
  - Section 2.3 – Interstate 80 (I-80) Corridor;
  - Section 2.4 – Interstate 580 (I-580) Corridor;
  - Section 2.5 – Interstate 680 (I-680) Corridor;
  - Section 2.6 –United States Route 101 (U.S. 101) Corridor;
  - Section 2.7 – State Route 12 (SR 12)/State Route 37 (SR 37) Corridor;

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[1] *MTC Goods Movement Plan: Infrastructure, Services, and Demographics/Freight Flow Trends.*

[2] *Alameda CTC and MTC Goods Movement Plans: Multimodal Performance Measures*.

  - Section 2.8 – State Route 152 (SR 152) Corridor; and
  - Section 2.9 – State Route 4 (SR 4) Corridor.
- **Section 3.0 – Cross-Cutting Issues.** These are issues that cross corridor and modal boundaries, and are important issues that affect the goods movement system in the Bay Area.

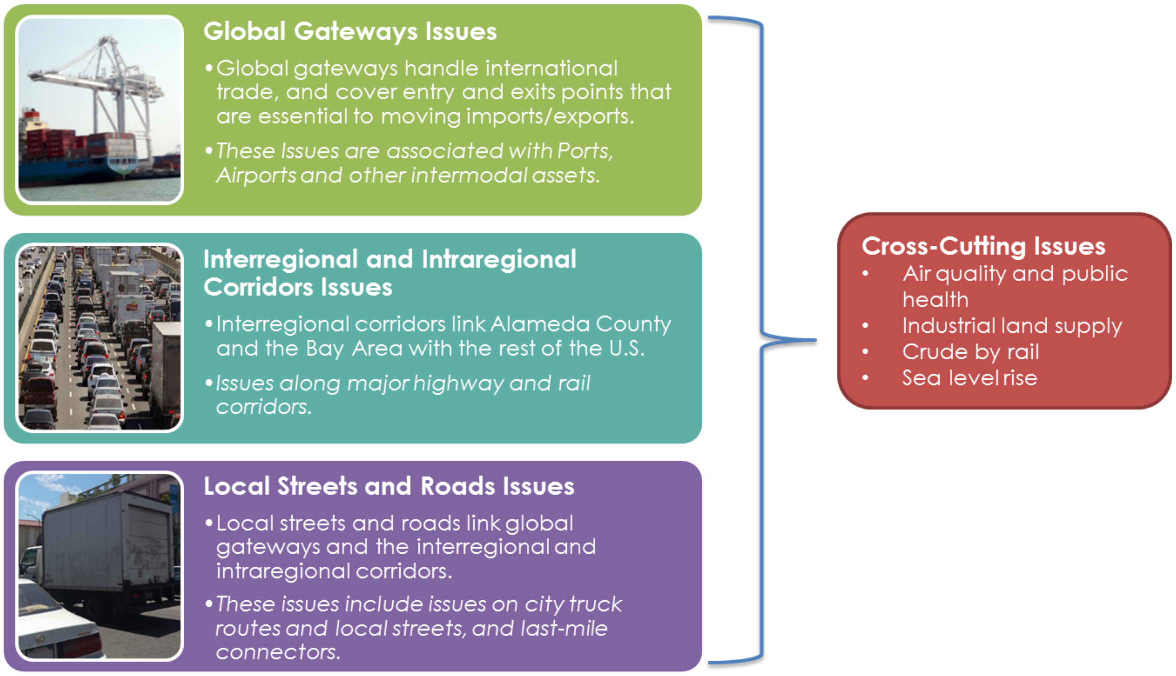
1.1 Summary of Needs and Issues in the Bay Area

Section 2.0 of this report presents an assessment of the needs of each of the eight major multimodal goods movement corridors in the region. In this section, the most pressing goods movement needs are summarized for the region as a whole. Throughout the regional goods movement plan technical reports, information about the goods movement system is often presented in terms of the functional elements of the goods movement system. These are illustrated in Figure 1.1 and include:

- **Interregional and Intraregional Corridors.** In this report, the interregional and intraregional corridor needs are presented by mode with separate sections describing needs for highways and needs for rail.
- **Global Gateways.** These are the region's seaports and airport. Needs are also presented by mode for this functional element.
- **Local Streets and Roads.** This is urban and rural goods delivery system and the last-mile connectors to major freight hubs. Local streets and roads needs are not presented at the regional scale. In a parallel goods movement planning effort, Alameda CTC has conducted an extensive analysis of local street and road issues in the County. Many of the issues identified through that effort have relevance all over the Bay Area and that needs assessment will provide valuable information about local street and road needs that can inform regional strategies in subsequent tasks related to developing the regional goods movement plan. Issues related to urban arterials and goods delivery are presented in the Cross-Cutting Needs section of this report.

In addition to the discussion of needs for each of the functional elements, there is a section of this report that addresses cross-cutting issues that cut across all of the functional elements. These issues include air quality and public health, industrial land supply and land use issues, climate change vulnerability, and a variety of other issues. Since these needs are already summarized for the region as a whole when they are presented later in the report (and are not presented by corridor), they are not included in this summary of regional needs.

Figure 1.1 Goods Movement Functions and Modes



The summary of regional goods movement needs follows in the next sections of the report.

1.1.1 Interregional and Intraregional Highway Corridor Needs

Congestion/Delay

As described in previous reports, most of the region's goods movement demand is satisfied by trucks operating on the region's major highway system, a system that is shared with passenger vehicles. Many of these corridors experience high levels of congestion during the peak commute periods and some experience congested conditions at selected locations throughout the day. While trucking companies try to avoid making pickups and deliveries during peak commute hours this is not always possible. Businesses that ship and receive goods often schedule their shipping activities during normal business hours and given the relatively long distances that some truckers must travel in the Bay Area (for example, from distribution centers in the San Joaquin Valley to Bay Area retailers and industries) trucks must often drive in congested conditions. This adds costs to goods movement, potentially affects regional competitiveness, and increases truck emissions.

Analysis of the impacts of congestion on regional trucking was conducted using data on truck speeds obtained from a regional database compiled by MTC. MTC had identified the locations with the highest levels of congestion in the regional system. For each of these locations, truck volumes were estimated using Caltrans truck counts. For each segment, the amount of delay was multiplied by the truck volumes to obtain an index that shows the relative levels of truck delay. The results are presented in Figure 1.2 for both the AM and PM peak periods. The freeway corridors with the highest levels of truck delay include:

- I-880 from I-238 to the Port of Oakland (AM peak period and less congested in PM peak period);
- SR 4 from Port Chicago to I-680 (AM peak period);
- U.S. 101 through San Jose, from I-880 to I-280 (AM peak period);
- I-80 from Oakland to Emeryville (PM peak period); and
- The Bay Bridge leaving San Francisco (PM peak period).

Of these locations, I–880 has the highest truck volumes, whereas the Bay Bridge has relatively low truck volumes but very high levels of overall congestion. Other locations with relatively high levels of truck delay include:

- U.S. 101 in Marin County from the Richmond-San Rafael Bridge (AM peak period);
- U.S. 101 through San Francisco (AM peak period);
- SR 4 east of Port Chicago (AM peak period);
- I-680 south of I-580 in Fremont and north of I-580 from Danville to Walnut Creek (PM peak period);
- U.S. 101 in the vicinity of San Francisco International Airport;
- I-580 in Livermore and Pleasanton (AM peak period and for short segments in the PM peak period);
- I-238 (AM peak period);
- I-880 south of I-238 into Fremont (AM peak period); and
- U.S. 101 south of I-280 to Santa Clara (AM peak period).

Of these locations, I-880 and I-580 have the highest truck volumes. I-680, while not generally thought of as one of the region's major truck routes, does carry volumes comparable to I-880 south of I-580/I-238 accessing the major industrial areas in Fremont. The significant amounts of truck delay in the region's industrial core areas (along I-880, U.S. 101, southern I-680, and SR 4) suggest that in order to continue to provide adequate truck service for the region's transforming industrial base and growing logistics cluster, and to provide access to the region's air cargo facilities and seaports, strategies will be needed to address this congestion or to identify opportunities for alternative modal services. The congestion on I-880 and I-580 is likely to continue to worsen with growth in international trade traffic linking shippers and distribution centers with the Port of Oakland. Agricultural shippers and wine producers in the North Bay with limited connections to the national interstate system and the region's seaports and airports will need to seek strategies to deal with truck delay on U.S. 101.

Travel Time Reliability

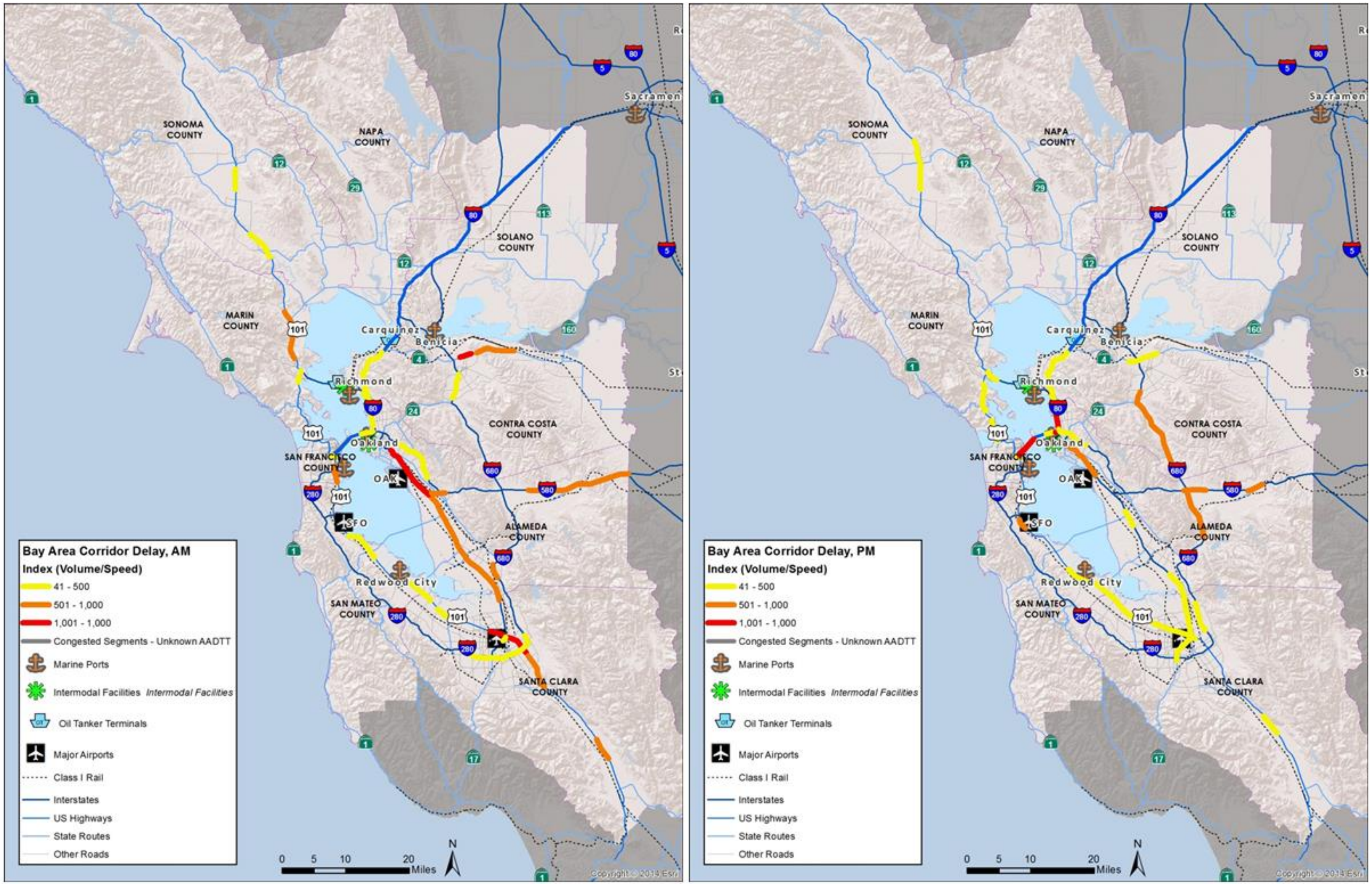
A second critical indicator of the goods movement performance of the interregiona/intraregional highway corridors is their reliability. Reliability is a measure of the variability in travel times from hour to hour and day to day. While recurrent congestion does create costs for shippers and carriers, unpredictable travel times can have even greater implications. Late deliveries can mean cutoff times for intermodal connections can be missed leading to significant delays and/or costs. Some shippers penalize carriers if they are not on-time. Thus, carriers must build extra time (and cost) into their pickup and delivery schedules in order to account for system unreliability.

Figure 1.3 provides a picture of system reliability weighted for the amount of truck traffic on each route. This provides an indication of the significance to goods movement of unreliability on these routes. The corridor segments with the poorest reliability weighted for high truck activity include:

- I-880 (through Hayward and Union City in the AM peak period and from Hayward to the Port of Oakland in the PM peak period);
- U.S. 101 from San Jose to Santa Clara (AM peak period); and
- I-580 from I-680 to I-205 (AM peak period).

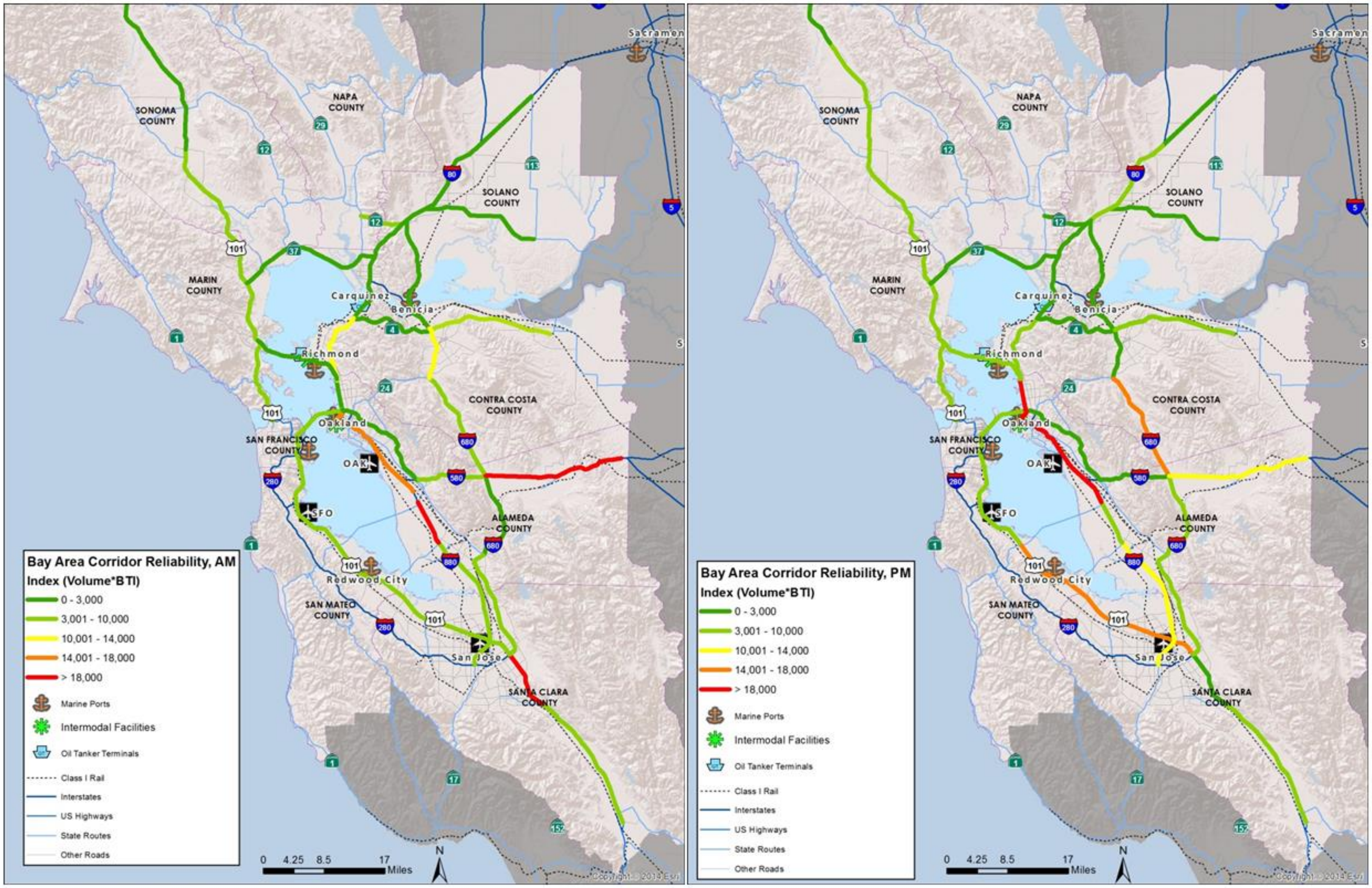
Portions of U.S. 101 on the Peninsula and I-680 north of I-580 also have poor reliability (weighted for truck activity) primarily in the PM peak period. The consequences of this unreliability are similar to the issues described for recurrent congestion. The fact that segments of the freeways accessing the region's primary cargo airports experience poor reliability in the PM peak period is a particular issue for e-commerce and modern retail distribution systems that are growing their facilities in the Bay Area. This could lead to missed cutoffs for air cargo shipments if not addressed or could result in higher shipping costs making the region less competitive as an e-commerce hub.

Figure 1.2 Bay Area Corridor Delay and Congested Segments



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Figure 1.3 Bay Area Corridor Segment Reliability



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Operational and Connectivity Issues

In addition to the previously mentioned congestion and reliability needs, the interregional and intraregional highway corridors in the Bay Area have deficiencies related to overall east-west connectivity and some additional locations besides those on the most congested segments that represent bottlenecks for trucks. Shippers throughout the Bay Area need to connect to the interstate system to reach domestic markets. There are two primary connections, I-80, which is a true cross-country truck route, and I-580, which connects to I-5 in the San Joaquin Valley and provides connections to I-40 in the south to make east-west connections. While both are important routes, I-580 carries the larger volume of trucks because I-80 is subject to winter closures where it traverses the Sierra Nevada mountains and because I-580 is also the primary connection to the San Joaquin Valley. San Joaquin Valley agricultural producers use the Bay Area seaports and airports to reach international markets; San Joaquin Valley distribution centers serve Bay Area consumer markets, and Class I railroad companies serving the Bay Area handle most of their domestic intermodal freight at San Joaquin Valley terminals and then truck the products to Bay Area customers via I-580. Clearly, alternative routes and alternative modes of transportation would be beneficial to create more options for the region.

There are three highway routes in particular that, if improved, could help relieve some of the I-580 truck traffic load:

1. **SR 12/SR 37.** Together, these roads could provide an alternative connection between the agricultural producers in the North Bay and the San Joaquin Valley and could provide a connection between North Bay wine producers and the inland distribution network. However, both roads would need improvements and upgrades to handle more traffic and would need improvements to bridges, such as the Rio Vista Bridge on SR 12 in Solano County. SR 37 is subject to event-related congestion and is also vulnerable to flooding and sea-level rise.

2. **SR 4.** This route serves the Northern Contra Costa County Waterfront, an area primed for industrial development and already the home to many of the region's oil refineries. While the highway has been upgraded with additional capacity over the last 20 years, it still lacks connectivity to the San Joaquin Valley for trucks in the east.

3. **SR 152.** This route already carries approximately 25 percent of the interregional east-west truck traffic in the region and could provide an important link between the agricultural shippers and food processors on the Central Coast and the San Joaquin Valley, But portions of the road are not suitable for trucks and will need to be upgraded if this route is to increase its role as and east-west trade corridor.

A longstanding truck bottleneck in the region that has been partially addressed in recent years is the I-680/SR 12/I-80 interchange in Solano County. This is a route with high volumes of truck traffic that is also impacted by the location of a truck weigh station at Cordelia. There is a multi-phase project to improve the interchange and provide for better operations and increased capacity. Some of these improvements have already been undertaken but the remaining phases need to be funded. Improvements have also been made to the truck weigh station in the eastbound direction and this has improved operations at the interchange. Similar improvements are needed for the weigh station on the westbound side of I-80.

Bridge and Pavement Condition

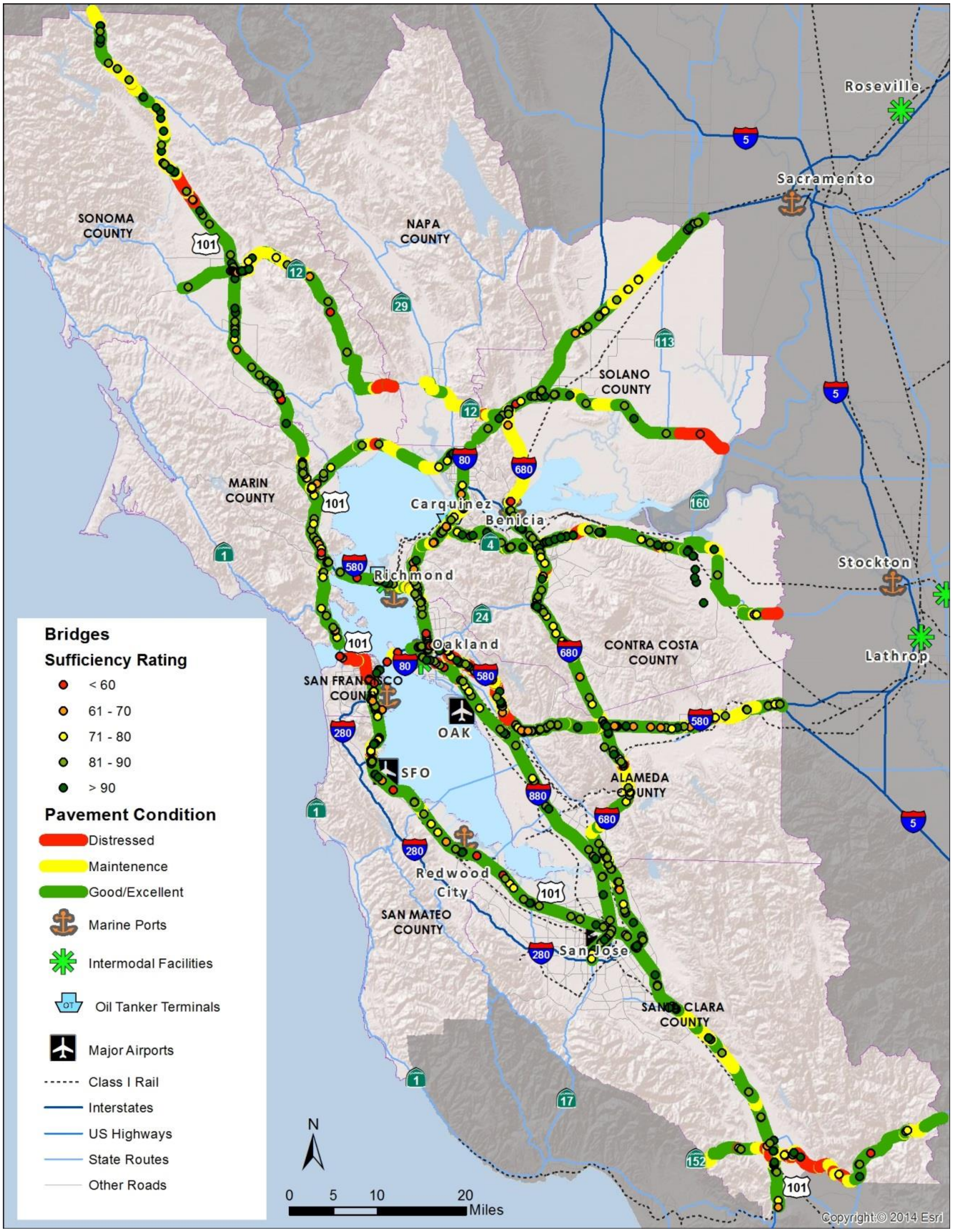
- U.S. 101 in Sonoma County (near Windsor);
- SR 12 and SR 37 in Napa and Solano Counties;
- SR 152 in Santa Clara County; and
- SR 4 in Contra Costa County (near Pittsburg).

Safety

Truck-involved crashes are a particular concern in interregional and intraregional corridors because they tend to be the most serious with higher probabilities of fatalities or serious injuries than the average crashes between two autos. In addition, truck-related incidents may involve spills of hazardous materials and are more likely to block multiple lanes of traffic, creating added incident-related congestion on already congested and unreliable freeways. These crashes often occur at interchanges where traffic is merging, particularly if the merge and weave sections are relatively short, ramp geometries were not designed with large trucks in mind, and where there are high truck volumes. There are a variety of operational and geometric improvements that can be made to reduce truck-involved crash rates.

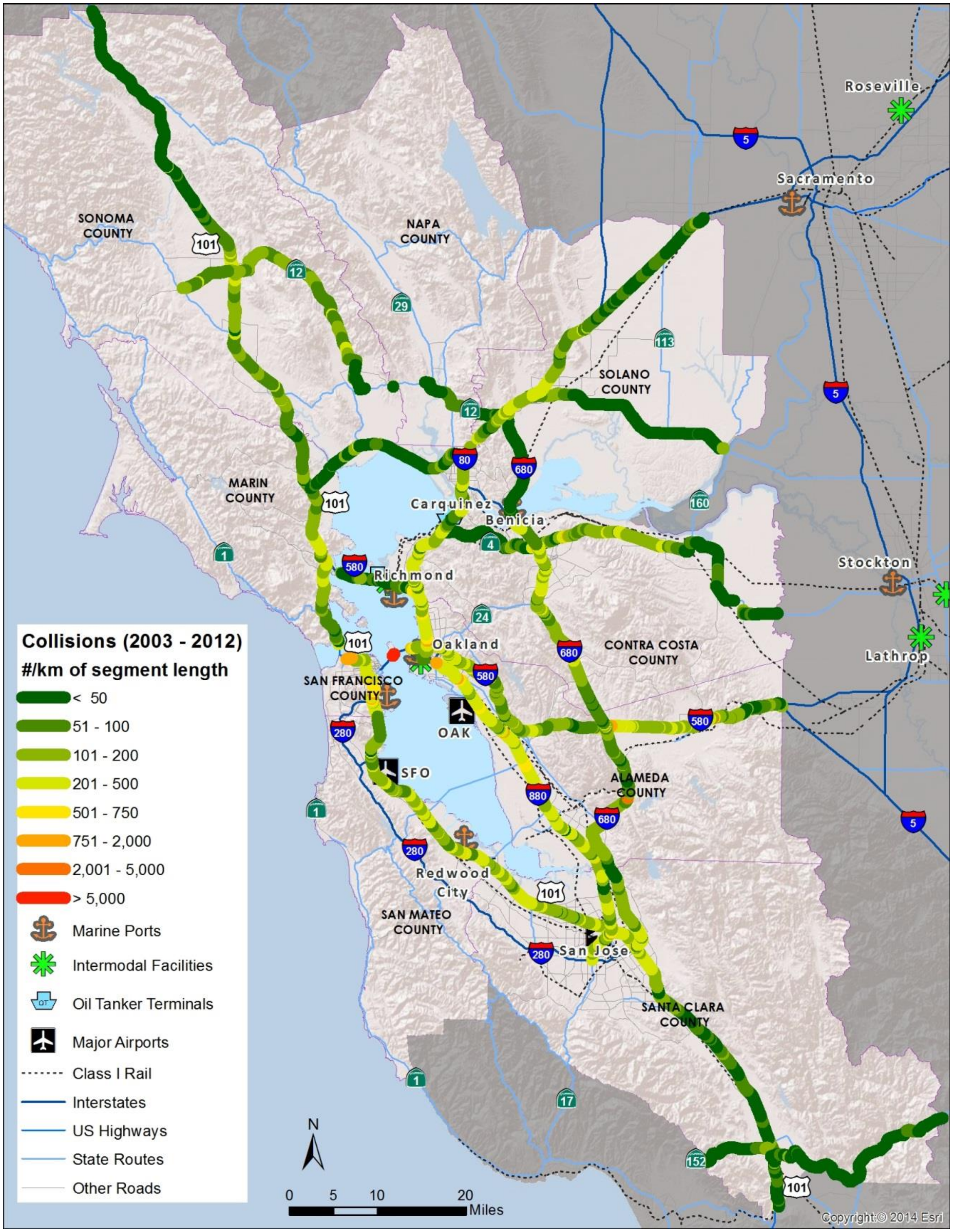
Figure 1.5 shows the locations of truck-involved crashes in the Bay Area. I-880 has the highest volume of truck-involved crashes in the region, followed by I-580 (with particularly high levels of crashes near the I-680 interchange), and I-80 (worst near the Bay Bridge approaches and between Oakland and Richmond). It should be noted that these are also areas with poor truck-weighted reliability illustrating the relationship between truck safety and freeway reliability.

Figure 1.4 Bay Area Corridor Bridge and Pavement Conditions



Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 1.5 Bay Area Corridor Truck –Involved Crashes



Source: SWITRS; Cambridge Systematics Analysis.

1.1.2 Interregional and Intraregional Rail Corridor Needs

In order to gain a complete appreciation of interregional rail needs in the Bay Area, it is useful to have an overview of how the freight rail system in the region functions. Most of the rail freight in the region is carried by the two Class I carriers in the western region – the Union Pacific Railroad (UP) and the BNSF Railway (BNSF). There are also several shortline railroads that deliver traffic from smaller volume shippers to the Class I railroads. The cargo carried by these railroads can be roughly classified in four main categories: 1) intermodal (usually carried in containers or trailers); 2) bulk (which can either be liquid bulk – such as oil—or dry bulk – such as minerals); 3) autos (loaded in special auto racks); and 4) manifest (a variety of typically industrial goods and from shippers who may generate small numbers of carloads that need to be aggregated with carloads from other shippers).

Both UP and BNSF handle intermodal cargo at rail terminals adjacent to the Port of Oakland (the UP Railport terminal and the Oakland Intermodal Gateway). For the most part, intermodal cargo handled at these terminals is international cargo, although UP handles small volumes of domestic cargo at Railport. The majority of domestic intermodal cargo that is destined for the Bay Area (or in the case of international imports that are being transloaded from smaller international containers to larger domestic containers for inland shipping) is trucked from and to the UP and BNSF intermodal terminals in the San Joaquin Valley. This creates truck traffic, mostly on I-580, going to and from these inland terminals that could be avoided if more domestic intermodal cargo could be handled in the Bay Area. This would be the case if UP undertook their planned expansion of the Railport terminal as part of the Oakland Army Base Phase 2 redevelopment.

Bulk rail cargo is handled primarily at the region's ports and there is an opportunity to substantially expand bulk exports through many of the region's seaports. Therefore, rail access for bulk trains to and from these ports is critical to realizing this opportunity. There continue to be a number of smaller industrial shippers who provide carloads to manifest trains and need access to the mainline from industrial spurs. These shippers are scattered throughout the region but there are concentrations near the Port of San Francisco, in Solano County, in the I-880 corridor in Alameda County, and along the Northern Waterfront in Contra Costa County. There are also agricultural shippers and wine producers in the North Bay that would use manifest services if they could make direct connections at their facilities, often through connections that would be provided by shortline railroads. Lastly, there is an increasing amount of crude oil coming to the region's refineries via rail. This issue is discussed in more detail in the Cross-Cutting Issues section of this report.

The regional rail system is shown in Figure 1.6. The UP operates on six different subdivisions in the Bay Area: Martinez Subdivision (Oakland –Emeryville – Richmond – Martinez -Sacramento); Oakland subdivision (Melrose/Oakland – Niles Junction – Lathrop/Stockton); Niles Subdivision

(Oakland – Niles Junction – Newark); Coast Subdivision (Oakland – San Jose – Gilroy); Tracy Subdivision (Martinez- Port Chicago – Lathrop); and the Caltrain Peninsula (owned by the Peninsula Corridor JPA). The BNSF Railway operates on one subdivision that it owns, the Tracy-Stockton Subdivision (Martinez – Port Chicago – Stockton) and on the UP Martinez Subdivision via trackage rights. The Capitol Corridor JPA currently runs passenger service on the Martinez Subdivision, the Coast Subdivision (San Jose to Newark), and the Niles Subdivision (Newark to Oakland). ACE runs commuter service on the Oakland Subdivision (Stockton to Newark) and the Coast Subdivision to San Jose. Caltrain runs service on the Peninsula.

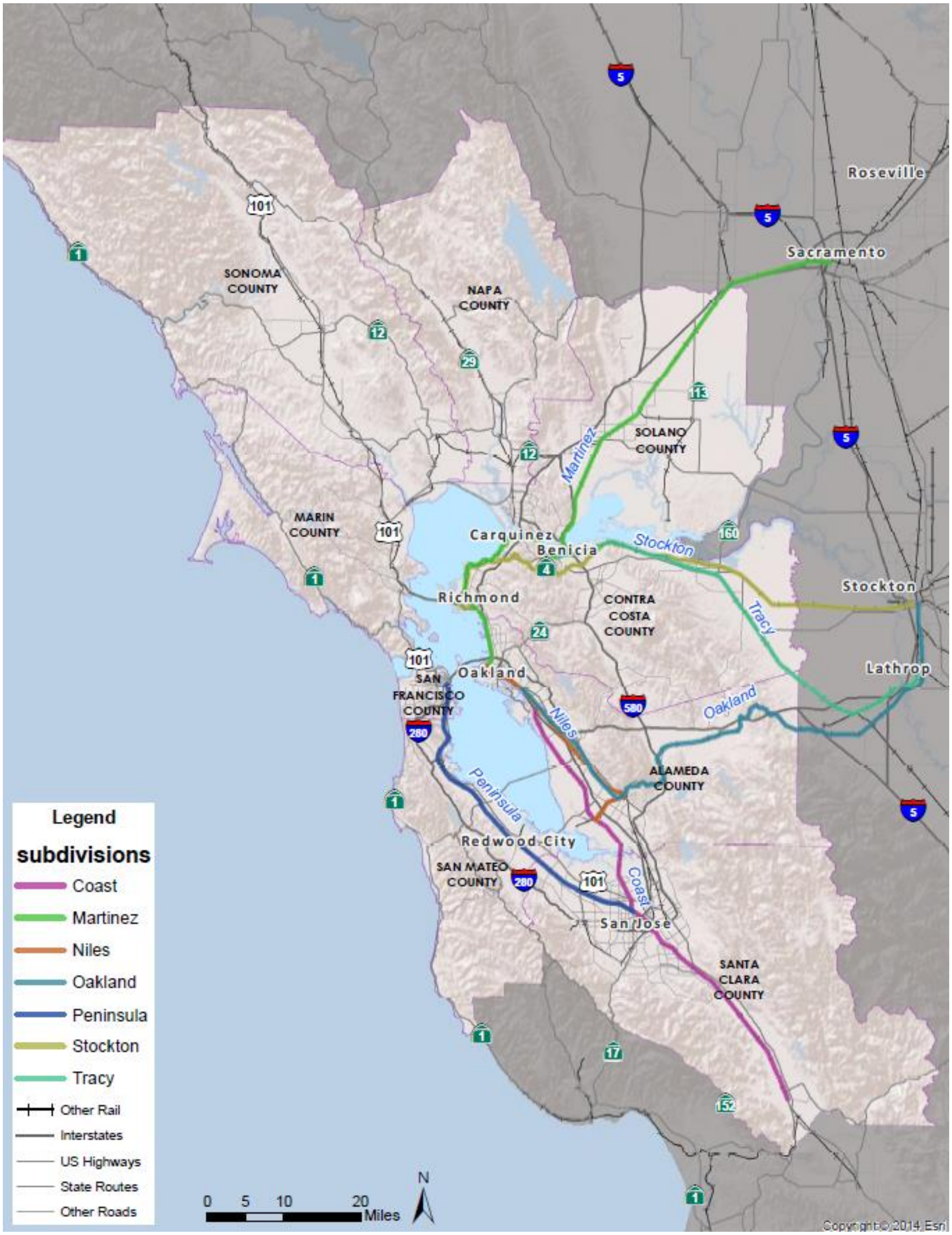
Viewing the Port of Oakland (including the new Oakland Army Base rail yards, the Oakland International Gateway (OIG), and the UP Railport intermodal terminal) as a major source of rail traffic and the center of the regional freight rail system, there are two major freight routes that access Oakland – the "northern" route via the Martinez Subdivision and the "southern" route which includes parallel routes along the UP Coast Subdivision, the Niles Subdivision, and the Oakland Subdivision. The southern route connects with the Oakland Subdivision route through Niles Canyon and the San Joaquin Valley. The importance of these two routes for designing freight rail strategies is that they can provide complementary capacity options that can be factored into any plans for increasing capacity for both freight and passenger services into/out of the Bay Area.

Because the southern route consists of three parallel lines, these also offer alternative approaches for accommodating future capacity needs and coordinating freight and passenger services. There are, however, some constraints to how these different lines can be used and connected, particularly given the connections that currently exist amongst the different lines.

The southern route is also important as a connection to the Ports of San Francisco and Redwood City, whereas the northern route is important for the Ports of Richmond and Benicia. The UP connections to the Port of San Francisco must also use the Peninsula Corridor creating some operational challenges for the Port and industrial shippers adjacent to the Port.

North Bay shippers who have an interest in connecting to the rail network could take advantage of increased service on the Northwestern Pacific (NWP) shortline that connects to the UP mainline but this may present capacity issues in the future (which are discussed later in this report).

Figure 1.6 Bay Area Class I Rail and Subdivisions



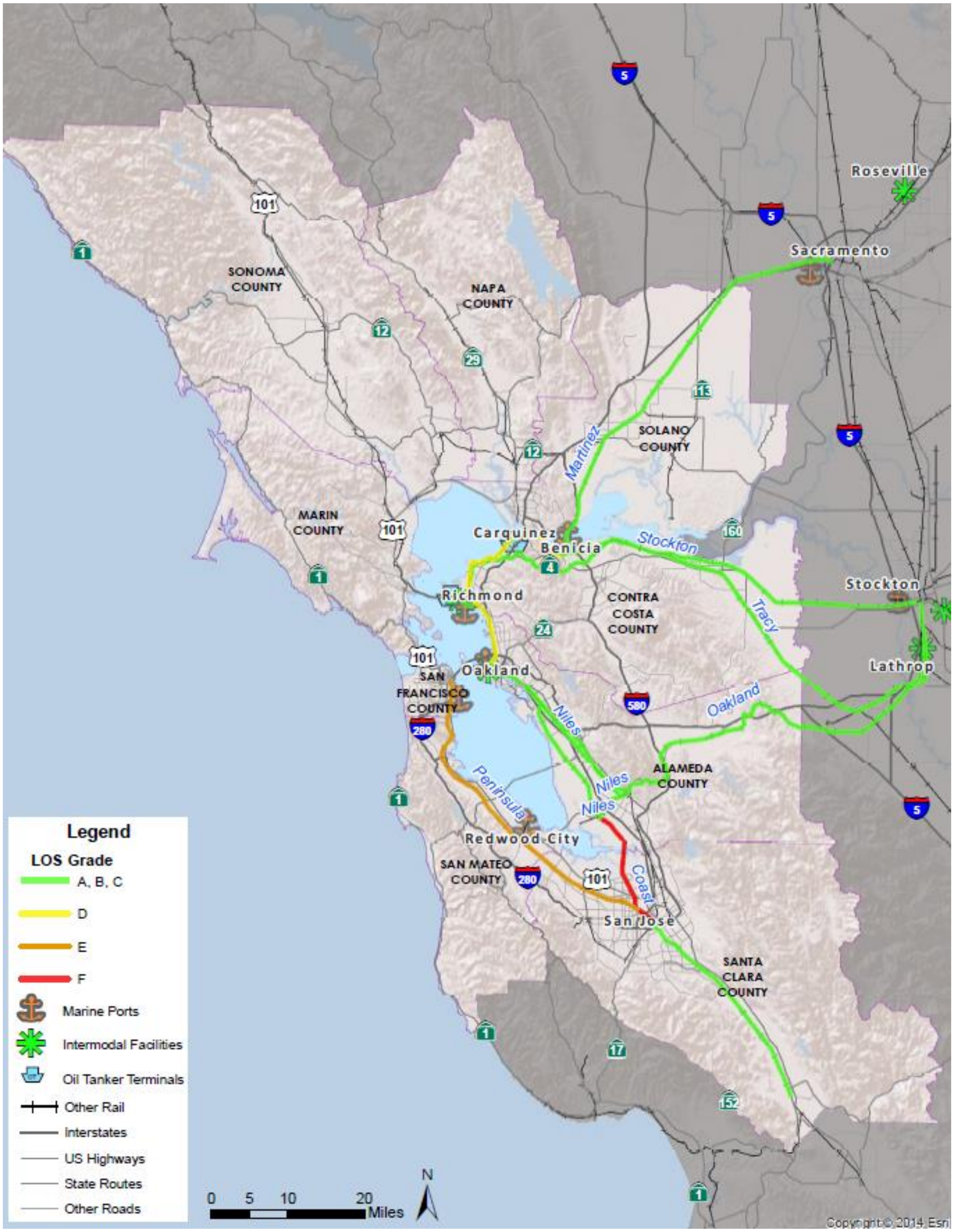
Source: AECOM and Cambridge Systematics.

Capacity Needs

Figure 1.7 and Figure 1.8 show the current and projected service conditions on the regional rail network. While rail planners do not typically refer to "level of service" (LOS) the way highway planners do, Cambridge Systematics introduced a concept of LOS as a measure of capacity utilization in a national capacity study for the Association of American Railroads and that capacity metric is used in this report to provide a convenient way of getting a high level view of capacity needs. As can be seen in the figure, the region generally has available capacity for growth in much of the rail system but this capacity will start getting tighter in the future, especially if the region's commuter rail services are allowed to grow as much as they would like. The Martinez Subdivision, particularly from Oakland to Richmond, is one of the busiest segments in Northern California and it is likely to experience significant capacity constraints if additional track and sidings are not added. Both UP and BNSF would like to expand their intermodal business going to and from the Port of Oakland and could potentially also increase domestic intermodal service at terminals being expanded at the Oakland Army Base. If capacity is very constrained, the UP does have the option of using the Oakland and Niles Subdivisions through Niles Canyon as a reliever route for intermodal traffic coming out of the Port of Oakland. However, it is more likely that they will use this southern route for bulk and manifest trains going not only to the Port of Oakland, but to industrial shippers in Central and Southern Alameda County and the Port of San Francisco. This combined growth in freight traffic along with passenger traffic is likely to put strains on both the Martinez Subdivision and the Oakland/Niles Subdivisions. To fully realize the benefits of increased rail terminal capacity that is being developed in Phase 1 of the Oakland Army Base redevelopment and to reduce auto and truck traffic on I-580, addressing capacity needs on the Oakland/Niles Subdivisions is critical.

The UP Coast Subdivision from Oakland to San Jose and the Caltrain Peninsula line are both likely to need additional capacity but primarily due to passenger train growth with spillover impacts on the freight users. Finally, with the full scale-up of commuter service on the Sonoma Marin Area Rapid Transit (SMART) service, capacity on the portion of the line that NWP operates on from Novato to Windsor is likely to be strained and would limit the ability of North Bay rail shippers to use this line (this is not shown on the map).

Figure 1.7 Bay Area Rail Existing Levels of Service



Source: AECOM and Cambridge Systematics.

Figure 1.8 Bay Area Rail 2020 Levels of Service

Source: AECOM and Cambridge Systematics.

Rail Operations and Access

There are a number of situations in the Bay Area where access to and from a major freight hub or where shippers are trying to access the mainline create operational and access issues. One example is the current access to the Port of Oakland rail terminals from the Martinez Subdivision. BNSF must cross through the UP intermodal terminal to access the OIG. In addition, capacity accessing the mainline is also limited for the UP. Rail improvements in this area are critically needed.

In Solano County there are a number of locations where switching operations necessary to access industrial customers are conducted on the UP mainline. This has the effect of reducing capacity and increasing travel times for both passenger and freight trains.

At the Port of San Francisco, Caltrain operations are causing constraints for port and unrelated industrial shippers. Operating windows for freight have been reduced considerably and this is affecting the ability of industrial shippers to use the service. The overhead catenary connections that are part of the Caltrain electrification have also imposed a height restriction on the freight trains. Clearly, this route could not be used for any double-stacked container operation.

As noted previously, there are a number of industrial shippers in the North Bay, Solano County, and the I-880 corridor that would like to use or expand their use of rail to meet transportation needs but the costs of building new industrial spurs is very high and beyond the financial capacity of many of these shippers. Some states provide industrial development grants and loans to rail-served industries and this type of approach might be beneficial in the Bay Area.

1.1.3 Global Gateway Needs – Ports

As described in previous technical memoranda, the Bay Area has a number of public and private ports that transport a wide range of different types of cargo. The Port of Oakland is the region's primary container port but it also handles bulk exports and sees opportunities to expand in both container and bulk cargo markets. The Port of Benicia handles auto traffic and bulk cargo. The Port of Richmond, which includes both public and private port facilities, handles a mix of auto and bulk cargo. Private port terminals serving the oil refineries along the Carquinez Strait are adjacent to the Ports of Richmond and Benicia. The Port of San Francisco handles bulk cargo and project cargo (large construction equipment) as does the Port of Redwood City. With proper investments, all of these markets have growth opportunities that can bring associated economic development to the Bay Area. Environmental and community impacts must be considered in assessing how best to take advantage of these growth opportunities and needs related to addressing these impacts in the context of growing port business are discussed in the cross-cutting issues section of this report.

Congestion and Capacity Needs

The greatest need for expanded marine terminal facilities at the region's ports is related to the opportunity to expand bulk exports and all of the ports have capacity needs that can be addressed through efficiency improvements and new terminal facilities but all also suffer from land constraints.

The Port of Oakland has sufficient container terminal capacity to realize most of its projected container demand growth. The biggest constraint for container market growth at the Port is related to intermodal terminal capacity and rail service. The Port will be able to increase both import and export business if it can attract more "first port of call" service from the ocean carriers that serve the port. This will require increased rail service. While some of this cargo is true "through" traffic that is only handled at the Port to change mode from ocean to rail, much of it involves value-added activity before the cargo is shipped by rail to its final destination. This value-added activity can provide jobs for Bay Area residents and new warehouse and logistics facilities that are being built as part of the Oakland Army Base (OAB) redevelopment will provide facilities for these value-added activities. The Port hopes that in the future about 40 percent of all cargo will be shipped by rail, as compared to about 25 percent today. Increasing container volumes and increasing rail share will put strains on the Port's existing rail facilities. An expanded intermodal facility, the Outer Harbor Intermodal Terminal (OHIT), is planned as part of the second phase of the redevelopment activities but is not fully funded. In addition, the UP also has discussed potential expansion of its Railport intermodal terminal. The OAB projects also include expansion of the bulk rail terminals and new cold storage facilities to give the Port more capacity to tap the growing bulk export market. Associated rail and road infrastructure will be required to support these facilities, some of which is already being planned and constructed.

The Port of Richmond public port recently expanded and re-configured its facilities to create an expanded space for auto shipments and finishing work on imported vehicles. At the present time this facility is operating at or near capacity. Business expansion and/or the ability to handle bulk exports at this facility would likely require land acquisition and could create land use issues in the adjacent community.

Both the Port of San Francisco and the Port of Redwood City have potential opportunities to expand bulk export business. In the future this may require expansion of bulk terminals.

Operations and Access Issues

The Port of Oakland regularly experiences delays and queuing of trucks at marine terminal gates that back onto local streets and occasionally to freeway ramps, creating safety concerns and impacts on local streets and roads. These issues are often related to the ability of the Port to process large ships that are now calling the Port with greater frequencies. The causes of the inefficiencies are complex and involve a mix of operational practices, labor practices, and the need for new gate monitoring technologies and re-design of circulation around the marine terminals.

A related issue involves delays and bottlenecking that occurs at the 7^{th} Street at-grade rail crossing. This crossing often sees slow moving trains that block truck access to the marine terminals and cause queues that can extend to the freeway. Elimination of this bottleneck would improve both rail and truck access to the terminals and reduce overall truck delays.

The Port of San Francisco also experiences rail access issues. Expansion of Caltrain service and the electrification of Caltrain have created some challenges for the Port and nearby rail users. Operating windows for freight have been reduced and this creates impacts on when shipments can be made. In addition, the addition of overhead catenary through tunnels has created height restrictions that could impact some cargo. As the Port has grown it has experienced rail delays on the Quint Street industrial spur that connects several port terminals to the Caltrain mainline. Last year, the Port received a Federal Rail Administration grant of $3,000,000 to upgrade the track to increase capacity and speeds on this spur that will improve operations.

1.1.4 Global Gateway Needs – Air Cargo

The three cargo airports in the Bay Area all share common needs, some of which are interlinked to one another, given the competitive environment of the air cargo industry. This section summarizes these needs. A more detailed discussion of air cargo needs for individual airports is presented later in this report in the sections describing corridor needs.

Airport Capacity and Congestion Challenges

The deficiencies of the region's air cargo system are tied to a lack of expansion potential and a legacy runway configuration that is not optimal for boosting total throughput. Construction of new runways at either SFO or OAK are not identified as priority projects in the 2011 *Regional Airport System Planning Analysis*[3], in part due to the large expense and constrained geography of the airfields. The focus instead is on serving future aviation demand using alternative options, including a redistribution of air passenger traffic from SFO to other regional airports to mitigate issues from growing passenger and air cargo traffic.

Although not as constrained as SFO, OAK also has challenges to growth. The airport's hourly capacity has been estimated between 54 to 85 takeoffs and landings an hour, about 420,000 to

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[3] Regional Airport Planning Committee (Metropolitan Transportation Commission, Bay Conservation and Development Commission, and Association of Bay Area Governments), *Regional Airport System Planning Analysis (RASPA), 2011 Update*.

450,000 annually.[4] The airport has significant challenges to meeting these projections, including airspace conflicts with SFO. Significant capacity issues at OAK occur with easterly winds and during inclement weather conditions, although weather-related capacity constraints at OAK are not as severe as they are at SFO.

Upcoming technological advancements in the FAA's air traffic control system are also projected to ease congestion and projected delays at the Bay Area airports, particularly at SFO due to its unique weather patterns and close spaced runways. NextGen, the FAA's next generation air traffic management system, will utilize satellites and enhanced aircraft avionics for precise navigation as well as other technologies and will significantly improve airspace and runway capacity in the United States.

Changing Demand for Air Cargo and Uncertain Growth. Over the past decades, air cargo has seen significant swings in both volumes and types of service offered. The 1980s and 1990s saw rapid growth in air cargo, particularly driven by increases in integrated express carriers (i.e., FedEx, UPS). However, the air cargo market has since matured and other modes have begun offering more competitive service, particularly trucking for domestic cargo and maritime for international cargo. Hence, since 2000 there has been consistent declines in overall air cargo tons. The growth of email and decline of traditional mail delivery and changing management practices have also contributed to the decline. From 2000 to 2007, air cargo shipments all over the Bay Area declined even faster than the national average at a decrease of 1.2 percent annually (OAK) and 6.1 percent annually (SFO).[5]

Although the trends leading to the decline in air tonnage will likely continue over the foreseeable future, the shift to high-value goods is leading to a resurging demand for air cargo for high-value shipments. In addition, the trend towards serving growing e-commerce demands from West Coast facilities (which provide for later cutoff times when orders are made from further east in the U.S. market) is leading to growing demand for air cargo services in the Bay Area and strong demand for warehouse space near the region's airports from third party logistics (3PL) providers serving e-commerce needs of major retailers. Air is the fastest growing mode, in terms of value, for importing goods into California. In 2012, more than $50 billion in shipments traveled by air to

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4 The number of takeoffs and landings presented in this reference is for both passenger and air cargo. It should be noted that a substantial amount of air cargo is transported in the bellies of passenger planes.

5 Regional Airport Planning Committee (Metropolitan Transportation Commission, Bay Conservation and Development Commission, and Association of Bay Area Governments), *Regional Airport System Planning Analysis (RASPA), 2011 Update*.

the Bay Area airports. The value of international cargo – both imports and exports – is expected to triple between 2012 and 2040.[6]

In 2014, the market for air cargo in the North American / Asian markets, the primary markets for Bay Area air cargo, appear to be cautiously optimistic. Growth in air freight for North American carriers grew 2.6 percent in April, at a relatively slow but increasing pace after a weak first quarter impacted by severe weather conditions. The International Air Transport Association (IATA) market reports indicate that the latest data shows a rebound in trade volumes and positive underlying growth trends, supporting stronger growth in overall trade and air freight demand in North America. However, the market for Asia Pacific carriers is mixed. After a strong year of growth in 2013, export volumes declined through early 2014, and the latest monthly growth rates, although relatively strong at 5.2 percent, are slower than in 2013. This slowing of growth is potentially caused by the continuing weakness in Chinese manufacturing, impacting regional economic performance and ultimately trade growth and air freight demand. These trade patterns have implications for the imports and exports moving through Bay Area airports, as shifting economies in the Pacific Rim will change the demand for consumer goods and other products, as well as impact the sourcing for goods and manufactured products traveling to local markets in the region.[7]

Imbalances in Air Cargo

There is a significant imbalance in the air cargo markets between SFO and OAK in terms of not only inbound versus outbound traffic, but also domestic versus international traffic. SFO retains the majority of international shipments, both inbound and outbound, while OAK primarily serves domestic traffic. Meanwhile, SJV remains primarily a passenger airport, serving only a small amount of cargo traffic.

Access Issues

Air shipping provides the fastest and generally most reliable mode of transport for long distance moves but it is also the most expensive mode of goods movement. Air cargo is often used for high value, lighter weight products such as many of the high-tech products and instrumentation produced and consumed in the Bay Area. E-commerce also relies heavily on air transport for next day and same day deliveries. However, for the air cargo system to work effectively, shippers must be able to make reliable connections so as not to miss cutoffs for air service (since these services are generally very time sensitive). Both of the region's principal cargo airports, SFO and

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6 FHWA FAF3, analysis by Cambridge Systematics.

7 International Air Transport Association (IATA) Air Freight Market Analysis, April 2014.

OAK, experience significant peak-hour congestion and reliability issues on the major truck routes leading to the airport (U.S. 101 and I-880), as well as on local access routes.

The corridor implications of the issues described in this regional summary of goods movement needs are presented in more detail in Section 2.0 of this report.

1.2 Opportunities for Bay Area

It is important to note that with proper investments and policies, Bay Area residents and businesses can realize greater benefits from the goods movement system than they do today. Technologies, operational strategies, and planning practices are available to ensure that these benefits can be realized while still providing the residents of the region – even those who live near major goods movement infrastructure – with a high quality of life and economic opportunity. Strategies to address the gaps and deficiencies identified in this report will be developed in the next phase of this plan development process. This section of the report describes opportunities that also should be the focus of strategies in the plan.

Many of these opportunities have a high degree of overlap. A well-crafted plan of investments and policies will be mutually reinforcing for many of the opportunities described below.

1.2.1 Opportunity #1. Goods Movement Systems to Support Emerging Industries

As discussed in Task 2D: Importance and Benefits of Goods Movement, more than 32 percent of jobs in the Bay Area are in economic sectors that represent nearly two-thirds of freight transportation spending in the region. These sectors include retail and wholesale trade, construction, and manufacturing (largely traditional industries). In addition, goods movement through Bay Area international trade gateways includes exports of substantial amounts of high-value agricultural products and electronics/precision instrumentation produced throughout Northern California.

While these sectors represent the bulk of freight transportation demand today, there are a host of emerging industries and opportunities that were mentioned by various stakeholders in the business community. Some of these emerging sectors include:

- **Biotech.** This includes biopharmaceutical research and production, biomedical equipment, and biomedical instrumentation. There are clusters of biotech industries emerging throughout the Bay Area. While much of the pharmaceutical component of this sector involves research and product development, with more of the manufacturing occurring overseas, precision instruments manufacturing is a Bay Area growth sector, providing jobs to highly skilled workers. In addition, this sector is synergetic with other precision instrument manufacturing businesses not allied to the biotech sector, as well as with the new clean energy technology development and manufacturing sectors. Biotech companies producing advanced medical products continue to expand their high-technology manufacturing facilities, creating demand for specialized and highly controlled goods movement. These industries ship small quantities of high-value products and rely on small trucks for pickup and delivery (usually integrated carriers, such as Federal Express and United Parcel Service) and use air shipping services extensively. Instrumentation manufacturers who are exporters also may ship through the Port of Oakland. Proximity to skilled workforce, specialized scientific facilities, and port and airport facilities are factors in location decisions that will affect goods movement routes for this industry sector. The greatest concentration of these companies in the region is in Alameda, San Mateo, and Santa Clara Counties, with a smaller cluster in Contra Costa County.

- **Artisanal food products.** With agricultural production areas and a strong consumer base for products nearby, the Bay Area is becoming an incubator for small artisanal food producers. This includes specialty foods and bakeries, small wineries, and craft breweries. Alameda County has had a strong tradition of food processing industry that has been eroded over time and Contra Costa County's Northern Waterfront also has a history as a producer of sugar and confectionary products. There are still active large food processors in Solano County and the region's wine producing region in the North Bay is world renowned. The North Bay also has a growing cluster of organic farms and dairies. Some of the region's older food processing plants are being adapted to modern food production techniques, and the region's remaining wholesale food markets represent an important link in the supply chain. In the older warehouse and manufacturing spaces in the Sunset, Mission, and Bayview neighborhoods of San Francisco small-scale manufacturing and artisanal food production startups are leading new industrial activity that has been encouraged by the City. Some of these businesses do outgrow their start-up facilities and move to other regions where they can acquire larger facilities at lower cost and with better access to national distribution networks. But for early stage producers, the Bay Area is a good location. Access to intraregional corridors for local distribution and to the airport will be important to the growth of these industries.

- **Clean energy and advanced transportation.** The Tesla factory in Fremont is the most visible player in this market in the Bay Area, but there are other producers of solar panels and plans for biofuel production that could turn into a growth opportunity for the region. For example, building on the region's strong core of petro-chemical industry infrastructure, biofuels production is one of the emerging industry clusters targeted for industrial development in Contra Costa County's Northern Waterfront. These products may be shipped by rail or truck or may use the Port of Oakland for export. While there is recent growth of crude by rail, this recommendation is not regarding crude by rail, but rather clean energy by rail. A discussion of needs and issues associated with crude by rail is provided in Section 3.5.

- **Advanced manufacturing for traditional industries.** Industries such as machinery production could experience a revival in the Bay Area as advanced manufacturing technologies make it possible to produce cost competitive products, taking advantage of proximity to the region's highly skilled technology workforce. In addition, smaller-scale prototypes or artisanal manufacturers also may take advantage of lower-cost, older industrial space that is still available in parts of the region. Goods movement demands of these industries will affect all of the functional elements of the Bay Area goods movement system and products and supplies will move mostly by truck.

While looking at the land use patterns along the region's major and minor truck routes, it is clear that there are several well-defined industrial corridors that present development opportunities that will require supporting infrastructure investment and protection of goods movement corridors. Examples include the I-880/I-80 corridor in Alameda County, the Contra Costa Northern Waterfront (SR 4 and I-80 corridor), portions of the I-80 corridor in Solano County (with Benicia industrial area being one of the few industrial parks nominated as a Priority Development Area), portions of the U.S. 101 corridor in South San Francisco, and remaining warehousing and light industrial corridors in San Jose. While land use planning is conducted by the cities individually, the goods movement planning process creates an opportunity for the cities to consider their joint economic development needs and to plan for preservation of these industrial corridors. The goods movement plan can support this effort by identifying infrastructure that preserves the viability of existing truck routes, and by providing guidance on how to effectively plan truck routes and manage truck traffic to improve efficiency while protecting residential neighborhoods. ABAG is beginning work on industrial land supply and policies in 2015.

1.2.2 Opportunity #2. E-commerce, Omni-Channel Retailing, and Advanced Retail Distribution Strategies

This opportunity involves both an opportunity and a challenge. The opportunity is related to providing facilities and infrastructure that can capitalize on the Bay Area's unique transportation assets and location to create a competitive advantage as a center of third-party logistics activity, integrated carrier hubs and major activity centers, and import- and export-oriented logistics facilities. As e-commerce expands and as retailers adopt advanced supply chain management strategies, West Coast locations – especially those located near international gateways, such as the Port of Oakland, San Francisco International Airport, and Oakland International Airport – will have a competitive advantage as distribution points for order fulfillment and reverse logistics. Importers and exporters will be looking for advanced warehousing and distribution facilities as will their third-party logistics (3PL) providers. The Oakland Army Base redevelopment and adjacent industrial and warehouse zones along the I-880 corridor stretching south to San Leandro will be ideal locations for these types of activities. There may also be demand for these types of facilities in Solano County, where industrial land is relatively less expensive and there are available sites for large high-cube warehouses that serve the needs of modern fulfillment centers. While certain types of warehousing and logistics centers will be highly automated and will provide more limited employment opportunities, certain types of "pick and pack" operations and value-added services will be more labor intensive and will provide higher skill-level job opportunities. To realize this opportunity, the region will need to continue to invest in its roadway and rail infrastructure in partnership with the private sector, and it will need to ensure that truck routes and truck services that support the local movement of goods amongst these facilities are planned and managed to reduce neighborhood impacts. MTC needs to work collaboratively with the Port of Oakland, 3PLs, regional agencies, and the Federal government to ensure that the region's airports can function effectively to meet future air cargo demands, particularly for international service.

E-commerce and advanced retail distribution strategies will impact the local truck route systems in the region and will require monitoring and adjusting truck routes and truck restrictions. The volume of smaller delivery trucks will continue to increase and their destinations will increasingly be in neighborhoods and commercial areas. Truck access, curbside management, and coordination of truck activity with other modal users will present challenges. MTC can help meet these challenges with guidance to the cities on how to plan truck routes and truck management strategies, and can provide supporting investments in technology that can more effectively manage truck operations to improve roadway utilization A collection of local truck route case studies are currently underway as part of the Alameda County Goods Movement Plan that parallels this effort. Best practices realized from those case studies will be integrated into this regional effort.

1.2.3 Opportunity #3. Bulk Export Growth and Expanded Rail Service Needs

The freight forecasts developed for this project show an increasing demand for bulk export movements through Bay Area seaports. This includes agricultural products; mineral ores; and waste, scrap, and recycled materials. Waste and scrap is one of the fastest growing export commodities in the Bay Area. There is a strong cluster of these industries in the East Bay, in both Alameda and Contra Costa County and these industries will use East Bay ports for export. The Port of Oakland and the City of Oakland already are working with developers to make investments in bulk terminal improvements, including modern cold storage facilities for agricultural shippers. The developers of the City's portion of the Oakland Army Base redevelopment and the owners of the Oakland Gateway Rail Enterprise (OGRE) shortline have been in negotiation with mineral producers in Utah and Nevada regarding potential exports through the Port of Oakland. Other ports in the Bay Area, including the Port of Richmond and the Port of San Francisco, also see opportunities for similar cargo. The most effective way to move this type of cargo to the ports is by rail, and there are railyard improvements at the OAB and the Port of San Francisco that will make this possible. Other Bay Area ports such as Richmond whose rail facilities have been more oriented to auto-trains are also likely to need improvements for bulk terminals if cargo opportunities continue to grow. The Knight Yard improvements at the OAB also will improve access to the yard and provide capacity to handle rail manifest traffic (i.e., the smaller shipments of a few carloads at a time in non-intermodal trains). This will create the opportunity for domestic shippers and international shippers of manufactured products to make greater use of the rail system by expanding railyard capacity within the Bay Area to handle this type of traffic.

In the recent past, the largest source of growth in rail markets has been in intermodal rail. The Port of Oakland and the Class I rail carriers (the Union Pacific Railroad and the BNSF Railway) have been planning for expanded intermodal service to the Port of Oakland based on the historically high rates of growth in containerized imports that were seen at all West Coast ports. Recent changes in the Pacific Rim trade lanes suggest a more modest rate of growth in international intermodal cargo from the Port (although the rates of growth will still be fairly robust). In addition to the international cargo, there also is an increasing demand for domestic intermodal cargo bringing products from the rest of the U.S. to the Bay Area, and allowing Bay Area manufacturers to take advantage of lower-cost, long-distance service by rail as compared to trucking. With current operations, most of that domestic intermodal traffic is handled at the intermodal terminals in the San Joaquin Valley (SJV). This creates truck traffic on I-580 as trucks bring the cargo from the SJV railyards into the Bay Area. With the OAB redevelopment, there is now an opportunity to bring some of those trains directly into Oakland and to distribute the product from there. The OAB Environmental Impact Report (EIR) suggests that at full buildout the additional throughput of domestic intermodal cargo that will be handled at the OAB could take more than 700 trucks a day off of I-580, though increases in rail and trucks in West Oakland are expected.

In order to accommodate this combined demand for international and domestic intermodal, bulk unit trains, and manifest trains, the UP has suggested that they will begin to use their existing rail lines somewhat differently than they do today. They will reserve as much capacity as is needed to handle their priority traffic (primarily intermodal) on the Martinez Subdivision (along I-80), and will bring bulk and manifest trains on the Oakland Subdivision (through the Altamont and Niles Canyon and on up to Oakland from the south). In order to accommodate this expanded demand for rail and to provide capacity to grow commuter rail services, public-private investment partnerships will be necessary to add new track, improve operations and remove bottlenecks, and address effects that increased rail traffic will have on communities through examination of quiet zones and grade separations at crossings. A number of these issues in Alameda County, Contra Costa County, and Solano County, which each has some of the largest components of the regional freight rail system, has been identified in this report.

There will also be an increasing need to coordinate growth in the region's commuter rail systems with the freight railroads and in some cases, to move operations to separate tracks. Creating separate tracks for passenger and freight traffic would require significant investments in rail infrastructure and agreement with both passenger agencies and freight operators, as well as communities along the routes. It also may require acquisition of new right-of-way which may not be feasible without significant impacts on communities. If passenger growth plans are fully realized, there will be growing capacity and operational conflicts between freight and passenger rail on the Martinez Subdivision, the Oakland Subdivision, and the Niles Subdivision. Conversion of Caltrain to electric operation and narrowing of operating windows for freight trains will impact the growth plans at the Port of San Francisco, which is primarily a bulk and project cargo port that will become increasingly reliant on rail to meet its growth targets.

1.2.4 Opportunity #4 – Goods Movement Workforce Development

Task 2d: Importance and Benefits of Goods Movement, have noted the potential for goods movement to contribute to greater job diversity. In 2012, there were approximately 102,000 people in the Bay Area who were employed in goods movement occupations that do not require a college degree.[8] These goods movement jobs represented approximately 14 percent of the Bay Area jobs for which a college degree is not required. Another way to look at the contribution that goods movement jobs make to job diversity is to examine the distribution of jobs by category using a system of occupational analysis developed by David Autor.[9] In his analysis, Autor identifies three tiers of occupations with Tier 2 being middle-skilled, middle-wage jobs. In California, these jobs pay an average hourly wage of $21.22 per hour[10] (Bay Area average wages for Tier 2 jobs are likely to be much higher than California average wages). Autor also noted that since the 1970s, Tier 2 jobs have been declining nationally due to the effects of automation and offshoring of manufacturing. This trend is also true of the Bay Area. In the East Bay, 76.9 percent of transportation and warehousing jobs are considered Tier 2, the second highest percentage of any industry cluster (behind construction).

Job growth in the 3PL and supply chain industries is expected to be robust across a variety of occupational categories, according to the 2015 Third Party Logistics Study[11], and the Bay Area has the necessary infrastructure and talent pool to tap this growth opportunity. Nationally, estimates show that 60 million people will leave the 3PL workforce with only 40 million to replace them. For many years, there has been concern in the industry over a growing shortage of truck drivers. The recent recession may have exacerbated this trend along with retirements of aging

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[8] San Francisco Bay Area Freight Mobility Study, Task 4: Benefits and Importance of Bay Area Freight Movements, Cambridge Systematics, prepared for Caltrans District 4, March 2014.

[9] The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, April 2010.

[10] Special Report on the East Bay Workforce, East Bay EDA, 2013.

[11] 2015 Third Party Logistics Study: The State of Logistics Outsourcing, Capgemini Consulting, Penn State University, Penske, and Korn Ferry.

drivers and new, stricter health and safety regulations. According to the American Trucking Association, 30,000 to 35,000 driver jobs go unfilled every year.

All of these trends suggest that with a strong workforce development program, the Bay Area has an important opportunity to enhance regional job diversity through growth in the goods movement sector.

These are some of the most significant opportunities that can be realized through a coordinated goods movement plan for the Bay Area. Other opportunities will be identified and evaluated in the next phase of the plan when strategies for the future are developed.

1.3 Stakeholders Issues Identification Process

The foundation for the detailed needs assessment that is presented in this plan was the identification of key goods movement issues by reaching out to affected stakeholders. The intent of this goods movement plan is to be actionable and focused on the needs of freight stakeholders and community members. As a result, an extensive engagement process was designed to allow stakeholders' voices be heard and incorporated into this plan. A variety of engagement techniques were used throughout the process aimed at gathering the most pertinent information required at different plan development stages. For example, for the needs assessment, stakeholder input was solicited in two main ways including the following.

- One-on-one interviews and small group meetings with stakeholders;
- A stakeholder roundtable meeting.

As this project is jointly conducted with the Alameda County Transportation Commission, additional information gathered with a more Alameda County focus also are included in this technical memorandum, where appropriate. More details on these two engagement processes are discussed below.

1.3.1 Interest Group Meetings

Early in the engagement process, interest groups were identified and one-on-one meetings and small group meetings were conducted. The interest groups included private-sector goods movement organizations (shippers, carriers and logistics service providers); businesses; environmental organizations; community and public health groups; and other key stakeholders from across Bay Area. The information gleaned from these stakeholders has been incorporated into this needs assessment. Table 1.1 provides a summary of the one-on-one interest group meetings done as part of this needs assessment and the corresponding key issues identified.

Table 1.1 Summary One-on-One Interest Group Outreach

Stakeholder Types	Stakeholder
Business Chambers and Commerce	East Bay Leadership Council, Bay Area Council, East Bay EDA, San Leandro Chamber of Commerce, Oakland Chamber of Commerce, Hispanic Chamber of Commerce, North Bay Leadership Council
Carrier	California Trucking Association (CTA)
Government Agencies	Bay Area Air Quality Management District
Government Agencies	Congestion Management Agencies for each of the nine Bay Area counties (Executive Directors, Planning Directors, Program Delivery staff)
Government Agencies	West Contra Costa Transportation Advisory Committee
Carrier	Federal Express, UPS
Maritime	California Capital and Investment Group
Maritime	Port of Oakland, Port of San Francisco, Port of Richmond
Aviation	Oakland International Airport
Public Health	Ditching Dirty Diesel Collaborative
Public Health	California Air Resources Board (CARB) Sustainable Freight Initiative, BAAQMD
Public Health	Contra Costa Health Department
Railroads	Union Pacific
Railroads	ACE and Capitol Corridor
Shippers/Receivers	East Bay Biomedical Manufacturing Network
Shippers/Receivers	East Bay Transportation and Logistics Partnership
Shippers/Receivers	Sonoma County Businesses
Trade Unions	Alameda Labor Council (including Teamsters, International Brotherhood of Electrical Workers)
Trade Unions	International Longshore and Warehouse Union (ILWU)

- Second, a roundtable was conducted in July 2014 to collect ideas of additional needs and issues important to various stakeholders and members of the public. The roundtable brought in more than 100 stakeholders from all levels of government and private businesses, as well as members of the public, over a one-half-day period. The roundtable included two panel discussions, as well as small group breakouts that allowed the collection of specific feedback. A second roundtable focused on community and environmental impacts of goods movement in the Bay Area was conducted in West Oakland in November 2014. Issues identified at this second roundtable are included in several sections of the cross-cutting needs assessment presented later in this report.

2.0 GOODS MOVEMENT CORRIDORS ASSESSMENT

Interregional and intraregional corridors form the backbone of the goods movement system and connect the local goods movement network to markets throughout Bay Area, the rest of the nation, and international markets via the global gateways. The goods moved on these corridors include products manufactured in the Bay Area, supplies for the manufacturers in the Bay Area, and consumer products supplying the Bay Area population. Highways and rail are the corridor arteries, performing both long haul and short haul freight movements. While trucks will continue to service the majority of demand, rail cargo (both intermodal and carload, and international and domestic cargo) is expected to experience high levels of growth, creating both challenges and opportunities. Ports, airports, and other intermodal facilities are important nodes linking the corridors to different markets, while performing other important functions. This section details the needs, issues and opportunities along each of the eight corridors. Appendix A contains the detailed data and methodology used for analyzing the key issues along each corridor.

2.1 The I-880 Corridor

2.1.1 Overview, Industry Drivers, Growth Trends

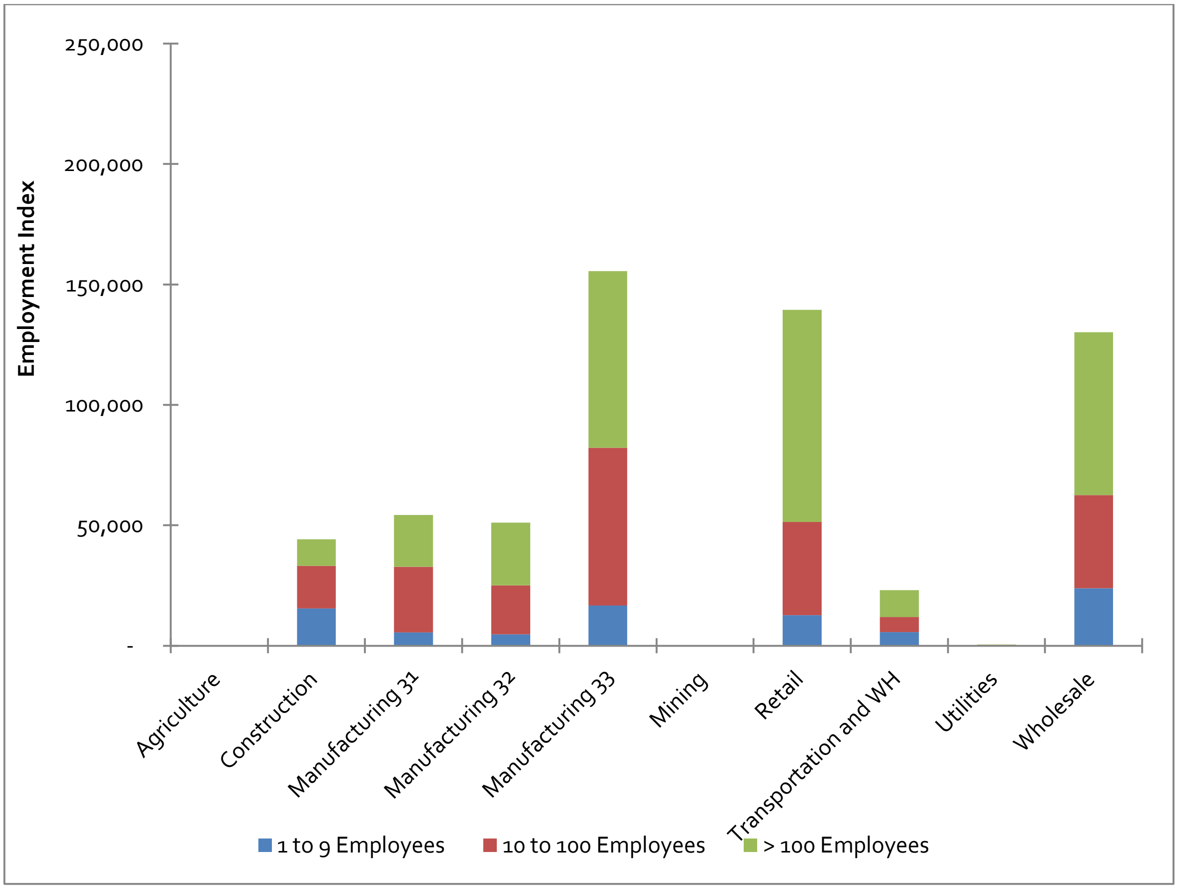
The I-880 corridor is the core north-south intraregional freight corridor that supports a variety of manufacturing, logistics and value-added industries in the East Bay from San Jose to Oakland. It is one of the most densely populated corridors in the region, with significant business and residential activity throughout the corridor. This corridor includes both the I-880 highway and multiple Union Pacific rail facilities along its length, two international airports (OAK and SJC), and the container terminal at the Port of Oakland. UP and BNSF both operate intermodal facilities adjacent to the Port of Oakland. I-880 also provides access to the interregional network of I-580/I-238, and for industrial areas along the I-880 corridor, as well as serving as the East Bay entry point for the three Transbay bridges: the Bay Bridge, the San Mateo Bridge, and the Dumbarton Bridge. The Port of Oakland and the City of Oakland are jointly planning multiple freight-related development projects on the former OAB, which could change rail utilization patterns and increase freight movements along the I-880 corridor. Several of the key pieces of goods movement infrastructure in the I-880 corridor are in low-lying areas that could be affected by sea level rise; this topic is discussed more fully in the Cross-Cutting Issues section. A summary of the corridor is shown in Table 2.1.

Table 2.1 I-880 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Alameda, Santa Clara	I-880	UP Rail Lines (Niles, Coast Subdivisions) Port of Oakland UP Railport, BNSF Oakland Intermodal Gateway (OIG) Oakland International Airport San Jose Mineta International Airport	Global Gateway, Interregional, Intraregional	Major North-South truck corridor supporting East Bay. One of the region's primary international gateway corridors and intermodal rail terminals. Major industrial corridor with much of the region's historic industrial core.

Along the corridor, heavy concentrations of manufacturing activities are found, especially along the west side. Metal, computer and electronics manufacturing dominate with an employment index of 155,000 employees, which is 60 percent of all manufacturing employment. Retail activities (employment index of 139,000) and wholesale activities (employment index of 130,000) also are heavily concentrated along the corridor. Figure 2.1 through Figure 2.4 display the industry profile along the corridor. The colors in the legend of Figure 2.1 represent the different size categories in terms of the number of employees.

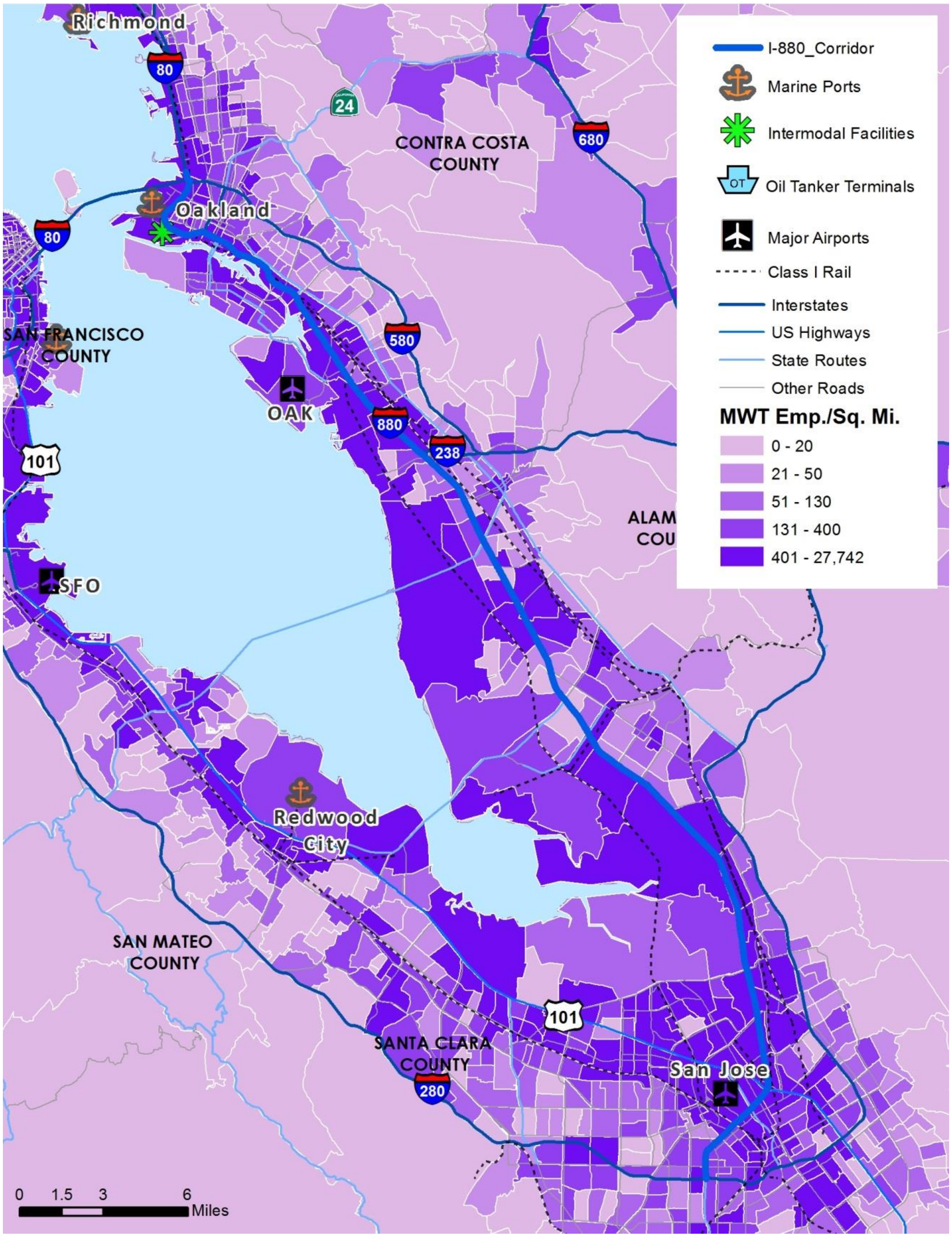
Figure 2.1 Employment Index for Goods Movement-Dependent Industries, I-880
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

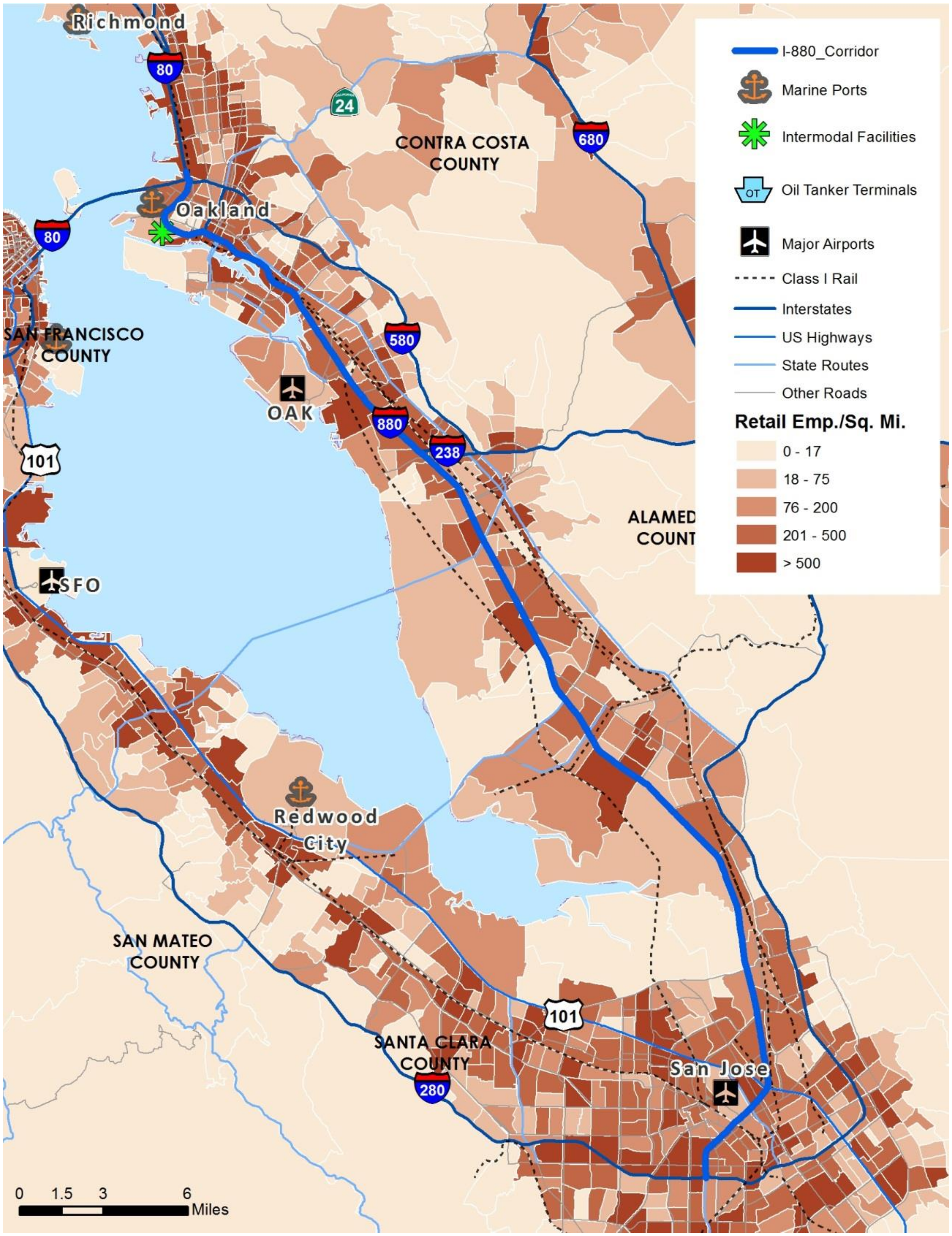
Figure 2.2 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along I-880



Source: MTC.

Note: Employment Density is in employees per square mile.

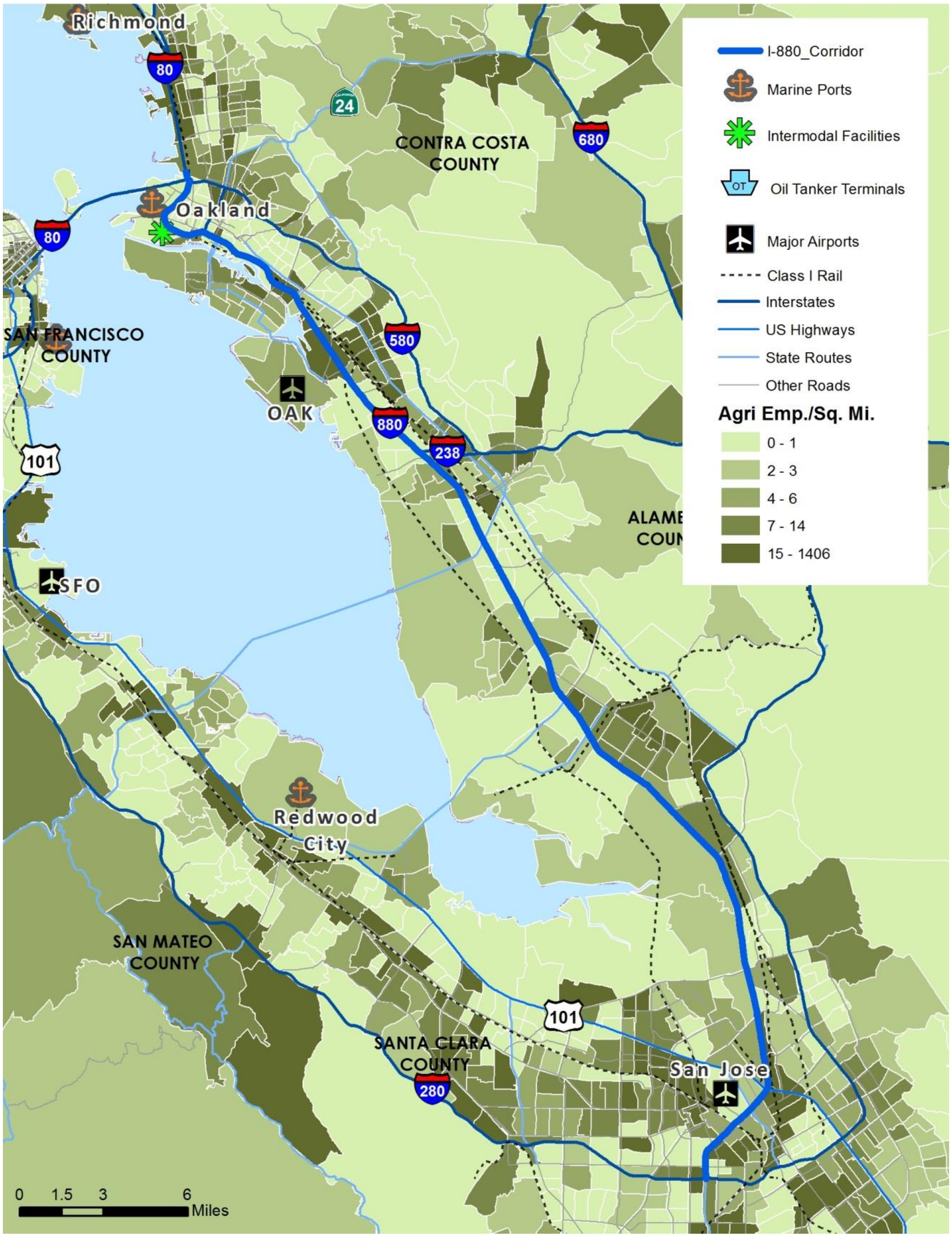
Figure 2.3 TAZ Level Employment Density in the Retail Sector along I-880



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.4 TAZ Level Employment Density in the Agriculture Sector along I-880



Source: MTC.

Note: Employment Density is in employees per square mile.

Growth trends in the I-880 corridor are influenced by activity at the Port of Oakland, by trends in how freight is handled after it leaves seaports and airports, and by the industrial activity occurring near the corridor. In terms of Port activity, imports and exports are growing for different reasons, with the former driven by resurgence in imports from Asia due to the economic recovery and consumer demand, and the latter driven by bulk exports, particularly agricultural products coming from the San Joaquin Valley.

Freight flows coming to and from the Port of Oakland are influenced by recent dynamic changes in logistics and supply chains. At the run-up to the economic downturn, trade throughput was at an all-time high and all cargo forecasts indicated that the growth would continue. The sudden decline in 2008 resulted in major changes to the logistics and supply chain industry. For instance, the industry implemented cost-saving measures, such as: increasing transloading (moving freight out of international containers to return containers more quickly and consolidate loads);; consolidating vessel calls (i.e., making fewer vessel calls at smaller ports and using larger ships to call larger ports); reducing marine terminal gate hours, reducing inventory holding; and implementing cargo handling systems to better manage, store and retrieve goods in warehouses, distribution centers, and intermodal marine and railroad terminals.

Trends in the retail environment—such as increased e-commerce overall and store-branded services that automatically deliver household consumables straight to residential customers on a set schedule—are also influencing how goods move out of the Port after being unloaded. In order to provide flexibility for onward movements, retailers are placing fulfillment centers on the West Coast. As a result, 3PLs are following suit, placing warehouses and distribution centers near sea ports and airports, instead of immediately transferring shipments to the interior of the country via truck or rail.

In terms of more local movements, small start-up manufacturers—especially newer artisanal food manufacturers—have been growing in the corridor and converting older industrial spaces for their use. In the process, these newer businesses create new demands for service and access in areas that had been less active in recent years. This can create conflicts with other nearby land uses, particularly where the renewed and new industrial activity is close to areas that have been converted to residential uses, often to take advantage of access to the transportation network.

2.1.2 Analysis

Overall, as one of the most freight intensive corridors in the Bay Area, the I-880 corridor faces significant performance challenges presently. Table 2.2 shows the corridor evaluation based on how well it performs in relation to the goals of the regional goods movement plan.

Table 2.2 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/Air Quality/Public Health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel Time Reliability	Buffer time index on freight (truck) routes	🔴	AM travel extremely unreliable on northern portion of the corridor, PM travel unreliable around Oakland and by San Jose
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	🔴	Highest number of truck crashes per lane mile among all corridors
		Crashes at at-grade rail crossings	🟡	High Street crossing in Oakland and Hesperian Boulevard crossing in San Leandro have high number of accidents with other modes (bikes, cars, pedestrians).
	Freight infrastructure conditions	Bridge conditions ratings	🟡	Average bridge rating sufficiency among all corridors, with rating of 83.33
		Freight (truck) highway and arterial routes pavement conditions ratings	🟢	Highest pavement ratings among all corridors, with 92% lane miles in good/excellent conditions
	Freight Resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system.	Use of Innovative Technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0
Preserve and strengthen an integrated and connected, multimodal	Travel time delay	Travel time delay on freight (truck) routes	🔴	Significant congestion in AM and PM peak periods, especially around Oakland

Goals	Measures	Metrics	Rating	Rating Explanation
goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions		Travel time delay on railways, terminals, ports, airports	●	UP Coast subdivision currently at LOS F from San Jose to Newark. Long wait times at Port of Oakland gate, and several delays at crossings affect port performance
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	●	There is some access issues at OIG as BNSF trains need to cross UP tracks. This causes significant roadway backup as well. This issue will be resolved through the OHIT project.
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	N/A	Evaluated in Section 3.0
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic Contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

Source:

a The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

Congestion/Delay

As discussed in the previous memo[12], the truck volumes on I-880 are the highest in the region. The top congested segments along I-880 are shown in Figure 2.5. In the AM period, almost the entire length of the freeway is congested, but the delay occurs in two distinct segments. The first runs northbound from the I-238 interchange to 16th Street in Oakland (Segment 20). This 9.4-mile section has average speeds barely above 17 mph, and includes a mix of commuters headed to jobs in San Francisco and downtown Oakland and heavy-truck traffic coming off of I-238 and

[12] *MTC Goods Movement Plan: Infrastructure, Services, and Demographics/Freight Flow Trends.*

headed to the Port of Oakland. The other congested segment is longer, running 20.7 miles southbound from I-238 to Dixon Landing Road (Segment 2). In this segment, average speeds are slightly higher at 18.2 mph. Traffic here is mostly a mix of commuter bound for Silicon Valley work locations and smaller delivery and maintenance trucks.

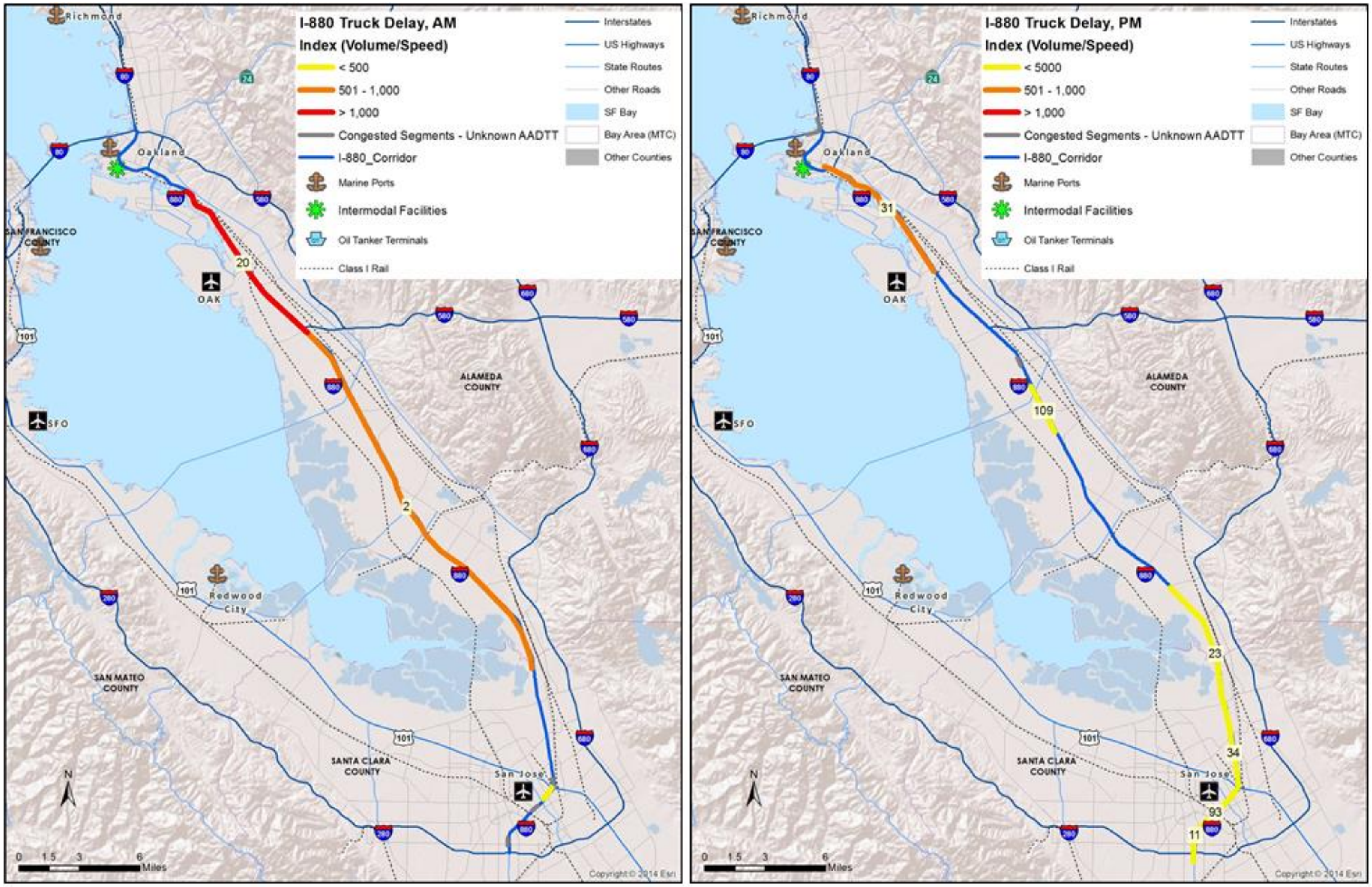
In the PM period, there is only one significantly congested area, running for 7.8 miles southbound from Adeline Street near the Port of Oakland to 98th Avenue (Segment 31). Congestion typically begins around 3:45 p.m. and extends until 6:45 p.m. Minor congestion can also be seen for all of the segments of I-880 in Santa Clara County.

Travel Time Reliability

The reliability index along I-880 is shown in Figure 2.6. In the AM period, the most unreliable segment is between the San Mateo and Dumbarton Bridges in the southbound direction, where the BTI is 1.82. This means that one would need to buffer 182 percent extra time to ensure on-time arrive 95 percent of the time. The portion from Bay Bridge to the San Mateo Bridge also has poor reliability.

In the PM period, truck reliability is worst along the segment from Bay Bridge to the San Mateo Bridge in both directions of travel. In addition, the southern portion of I-880 to San Jose also experiences high levels of unreliability especially going in the southbound direction.

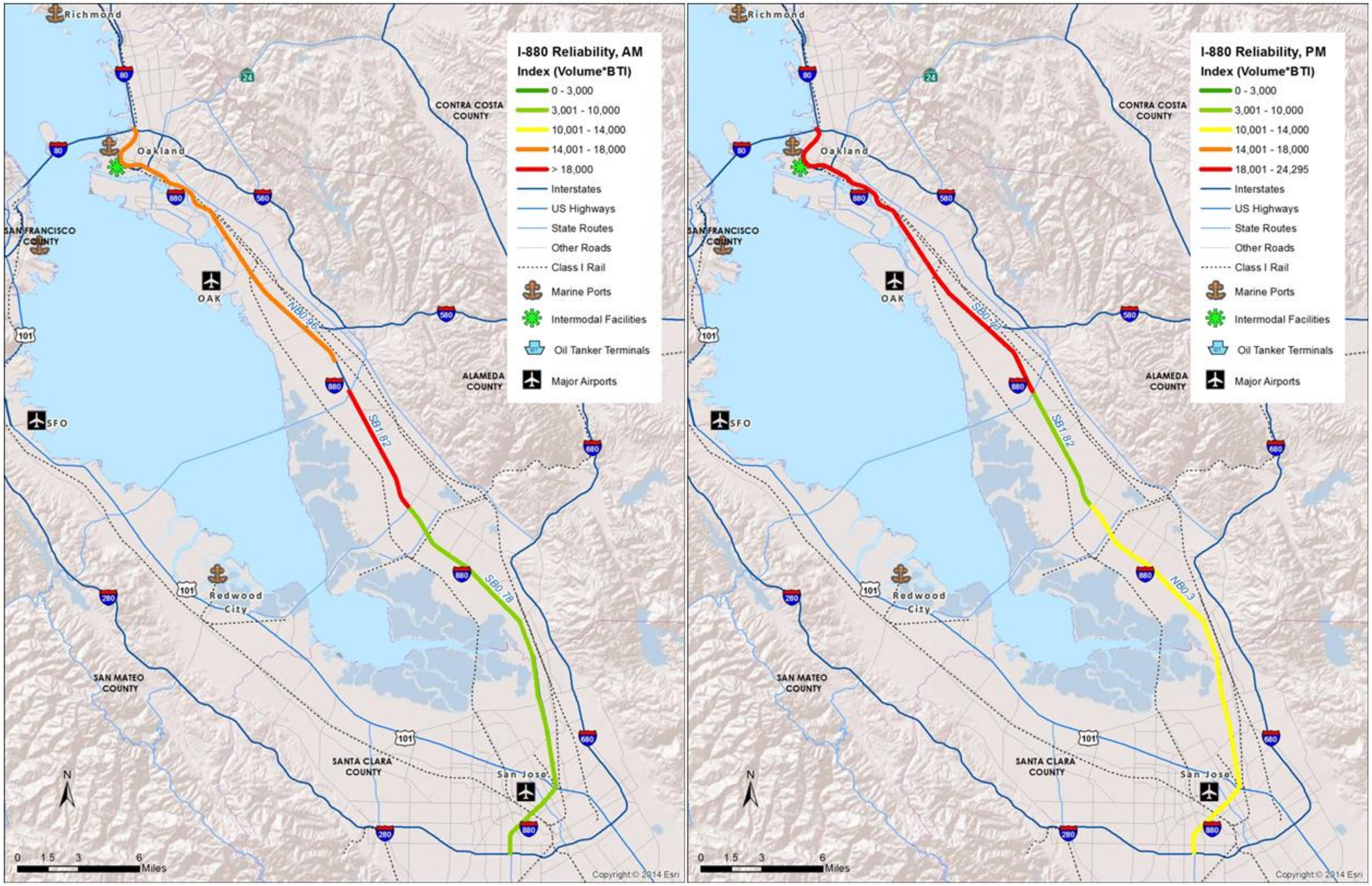
Figure 2.5 Truck Delay on Congested Segments along I-880, Peak Periods, 2013



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Figure 2.6 Reliability on Segments along I-880, Peak Periods, 2013



Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

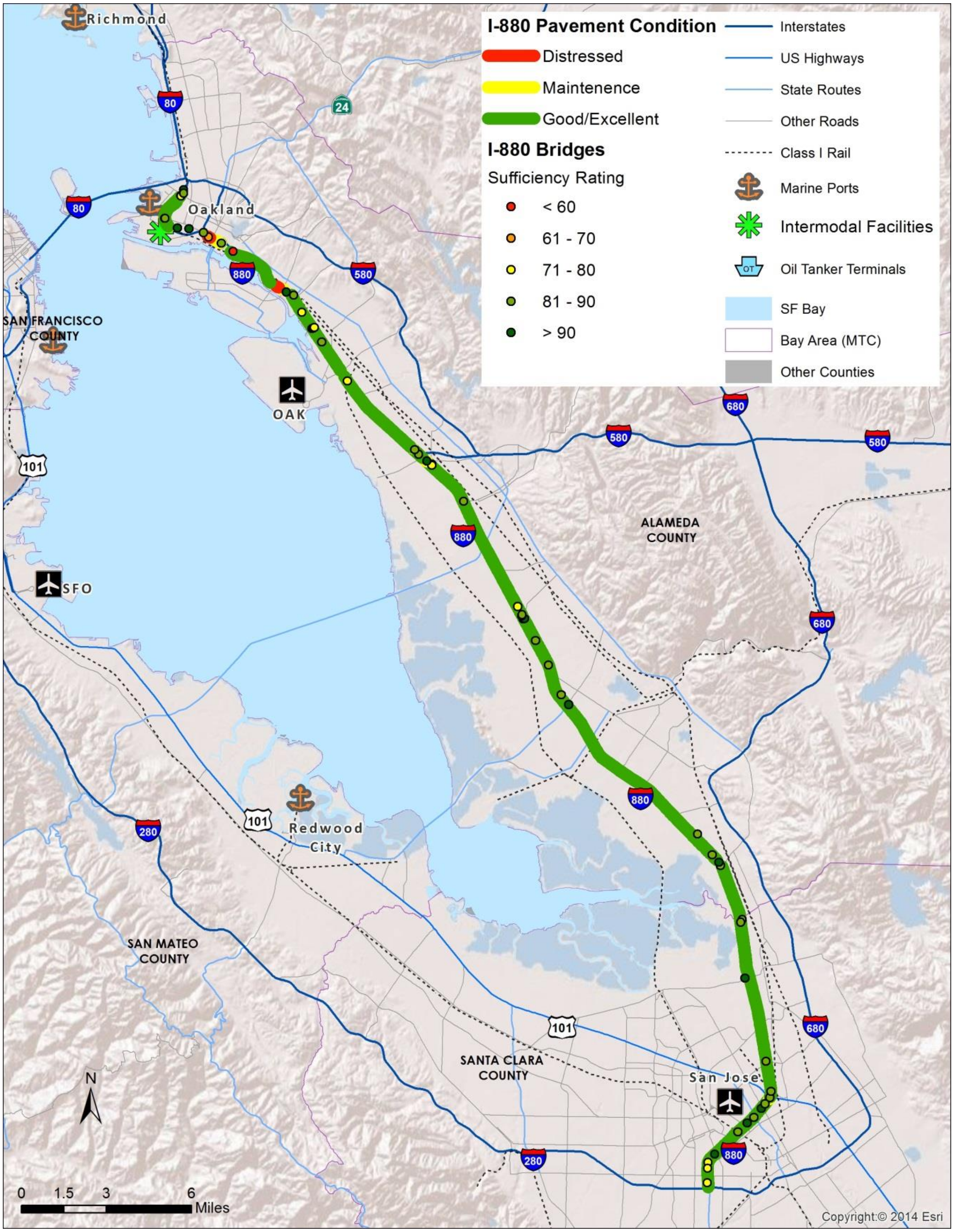
Pavement and Bridge Conditions

The I-880 corridor ranks fourth out of the 8 corridors in average bridge condition with a sufficiency rating at 83.33. While only 2 bridges have a rating below 50, only 67 of the 110 bridges along the corridor have a rating above 80. The I-880 corridor has the highest overall pavement rating among the corridors examined in this study. The overall weighted pavement score for I-880 is 2.9 out of 3 with 92 percent of all lane miles in good/excellent condition and only 2 percent in distressed condition. This result may be somewhat misleading as it reflects a high degree of recent investment Caltrans has made in repaving segments of I-880. Prior to this, the corridor had poor pavement condition, reflecting the high level of damage associated with high truck volumes. As Figure 2.7 shows, locations with poorer pavement conditions are in Oakland where it junctions with SR 24.

Safety

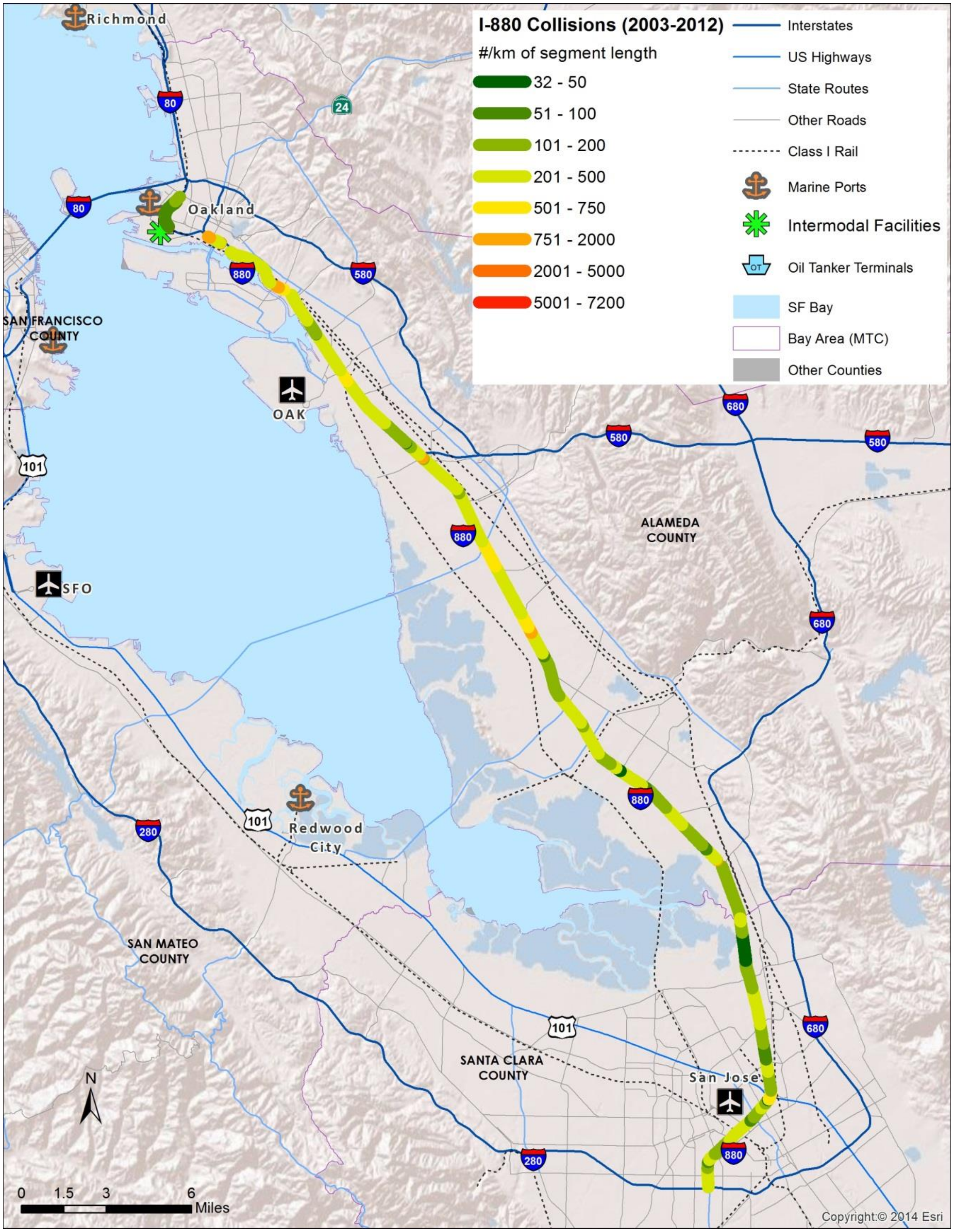
From 2003 to 2012, I-880 has the highest truck crash rate (per lane mile per year) among the study corridors at 2.76. Of the 889 collisions involving trucks that occurred along the corridor during this time period, 19 were fatal. A combination of factors could have contributed to this high crash rate, including the presence of many closely spaced interchanges along the corridor that create geometrical constraints that make merging and weaving difficult especially during peak hours of traffic. As Figure 2.8 shows, there does not seem to be a specific pattern to the locations with the highest crashes.

Figure 2.7 Pavement and Bridge Existing Conditions along I-880



Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.8 Truck Involved Crash Rates along I-880



Source: SWITRS; Cambridge Systematics Analysis.

Rail Needs Analysis

Mainline Congestion/Capacity

There are four UP rail subdivisions in the area of the I-880 corridor: Martinez, Oakland, Niles, and Coast. The Martinez Subdivision serves traffic headed away from the I-880 freeway, towards the I-80 Corridor and towards Sacramento. The busiest part of the Oakland Subdivision is located in the portion that follows the I-580 corridor to the San Joaquin Valley, so it is only discussed briefly here and more extensively covered in Section 2.4 below. The Niles and Coast subdivisions are discussed at length here in this section. Both share capacity with passenger services for at least a portion of their length from Oakland, running south along the I-880 corridor.

- **Niles Subdivision.** The Niles Subdivision is the legacy Southern Pacific (SP) route between Oakland and Niles Junction where it runs parallel to the legacy Western Pacific (WP) Oakland Subdivision (now owned by UP). The 30-mile route between Oakland and Newark has two main tracks and centralized track control (CTC) signaling[13]. This route hosts Capitol Corridor trains and supports speeds up to 79 mph for passenger trains and 60 mph for freight trains. BNSF has trackage rights between Oakland and Niles Junction. ACE regional rail trains use the segment between Newark and Niles Junction.

- **Coast Subdivision.** The Coast Subdivision is a combination of the former SP Mulford and Coast Lines. The Mulford Line ran from Oakland to San Jose via Newark. Amtrak's Coast Starlight travels the entire Coast Subdivision from Los Angeles to Oakland. A total of 20 Capitol Corridor and ACE trains use the segment between Newark and San Jose, which is mostly single track. Through freight trains operate on the segment between San Jose and Oakland, and freight service to customers is provided by local trains.

- **Oakland Subdivision**. The portion of the Oakland Subdivision in the I-880 corridor extends between Melrose in Oakland and Niles Junction in Fremont. It is basically a single track mainline with passing sidings controlled by a CTC system, and it runs parallel the Niles Subdivision along this section. The portion of the Oakland Subdivision between Union City and Oakland was relegated to secondary status after Union Pacific merged with Southern Pacific in 1996. UP chose to operate on SP's parallel route, the Mulford Line (now part of the Coast Subdivision, described above), instead of the Oakland Subdivision. The portion of the legacy WP route between Melrose in East Oakland and Magnolia in West Oakland has been

[13] CTC signaling is a form of controlling how trains move through a network of track. It consolidates train dispatching decisions that would otherwise be made by local dispatchers. By centralizing control, the host railroad is able to more efficiently and safely use its track and thus, can accommodate more trains per day than would be possible with localized signal controls.

abandoned. At the present time, the remainder of the northern portion between Melrose and Niles Junction is used only for local movements, and there is no through-train operation.

According to the California State Rail Plan, in 2025, overall freight rail demand is anticipated to grow moderately on the UP Niles line, especially the portion from San Jose to Fremont. Neither the Niles nor the Coast subdivisions are major freight routes today. However, there are several trends which could increase their use as freight routes in the future. First, as will be noted later, there could be future capacity constraints on the Martinez subdivision (see I-80 Corridor) due to growth in international and domestic intermodal trains and passenger trains that could cause UP to reroute some of its freight traffic to the Niles subdivision. Second, there are new sources of freight rail traffic that could come to the Bay Area as a result of growth in freight rail at the former Oakland Army Base. This traffic, which would likely be primarily bulk exports, might be routed on the Niles subdivision to avoid scheduling conflicts with passenger and premium freight rail services that will be operating on the Martinez subdivision. In addition to freight traffic growth, the Capitol Corridor has plans to increase the number of trains operating south of Oakland to San Jose. Finally, the Altamont Commuter Express (ACE) passenger service, which operates on the Niles subdivision once it transitions to the I-880 corridor, is hoping to expand its operation.

Available Rail Capacity. As described above, the existing railway infrastructure in the I-880 corridor is the rationalized remnants of several Class I railroads operating in the Bay Area. Increased demand for freight rail services and the desire to operate more passenger trains is constraining the ability of the existing railroads to support this growing demand. As demand approaches capacity, there will be increasing delays for all users of the system.

Table 2.3 illustrates the practical capacities of the rail lines in the I-880 corridor that support passenger trains, which are the most constrained portions of the freight system. The railroad subdivision and segments are identified as well as the number of main tracks and type of signaling. In instances where short segments of the rail line are either double or triple tracked, the lower average capacity was used to show the practical limitations of the rail line to support increased traffic volumes. Rail network simulation models would be required to determine the exact capacity of each line illustrated.

Table 2.3 Practical Capacity of Rail Lines in I-880 Corridor

Subdivision	From:	To:	Number of Main Tracks	Signaling	Average Capacity
UP Coast	San Jose	Newark	3/1[14]	CTC[15]	30
UP Coast	Newark	Oakland	1	ABS	18
UP Niles	Niles	Oakland	2/1	CTC	30
UP Oakland	Niles	Melrose	1	CTC	30

Source: Altamont Press, "California Region Timetable 20" March 2009.

Existing train volumes on these two lines are highlighted in Table 2.4. The table aggregates current average daily freight and scheduled passenger trains to obtain total daily trains.

Table 2.4 Average Daily Train Volumes in the I-880 Corridor

Subdivision	From:	To:	Class I Freight Railroads	Average Daily Freight	Daily Passenger Trains	Total Daily Trains
UP Coast	San Jose	Newark	UP	8	22	30
UP Coast	Newark	Oakland	UP	6	2	8
UP Niles	Niles	Oakland	UP	2	14	16
UP Oakland	Niles	Melrose	UP	1	0	1

Sources: Freight train counts based on 2008 UP train count data. Passenger train counts based on weekday published timetables for summer 2014.

Comparing train volumes (v) to practical capacity c) gives a sense of the potential for any line to be so congested that trains might be delayed. The v/c ratios for the railroad segments that support passenger services in the I-880 corridor are tabulated in Table 2.5, and described in the following paragraph.

[14] The split numbers indicates that along the track there are places with 3 tracks as well with single tracks. Same convention follows for other subdivisions.

[15] Centralized Traffic Control (CTC) is a form of railway signaling that consolidates traning routing decisions that were previously carried out by local signal operators.

Table 2.5 Rail Lines Level of Service in the I-880 Corridor

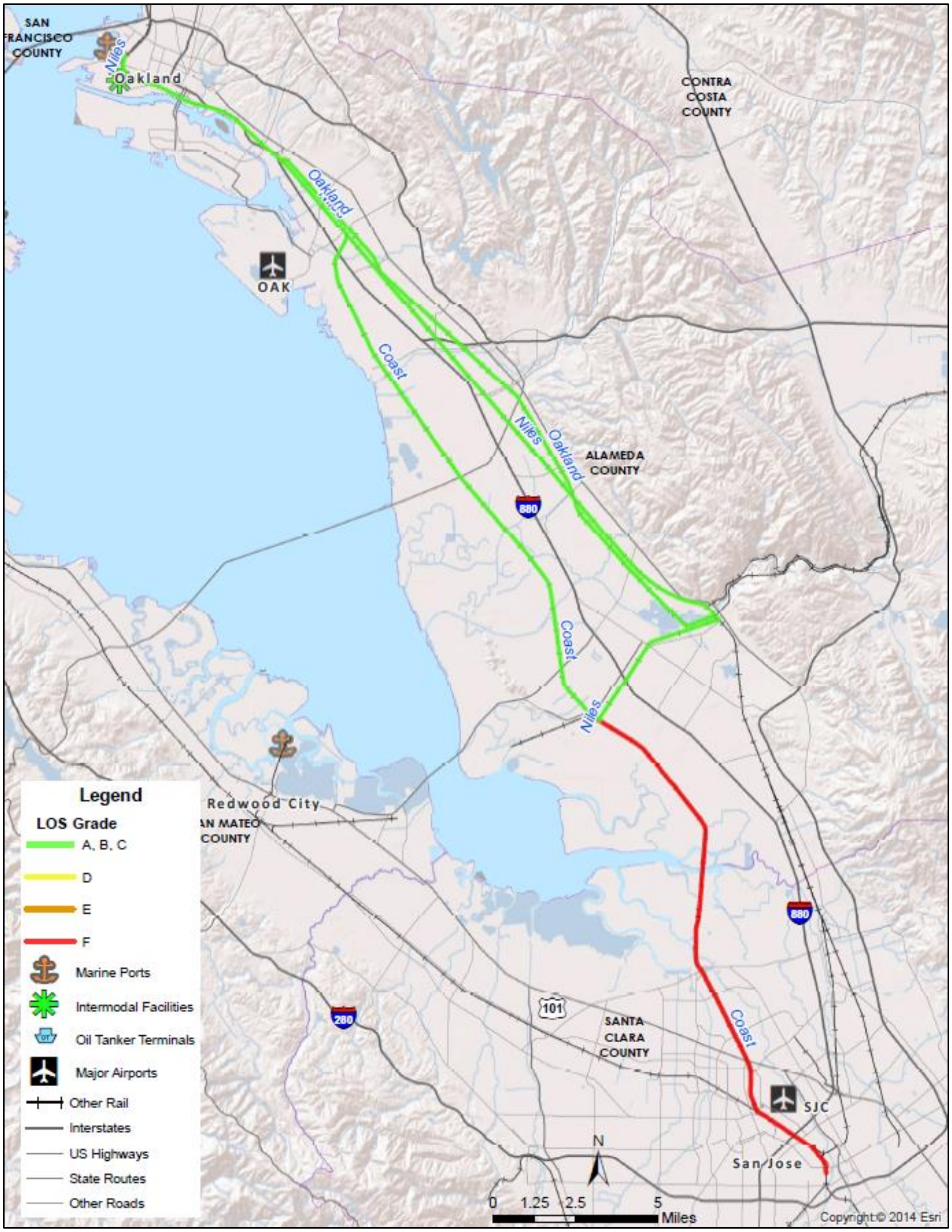
Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS[a]
UP Coast	San Jose	Newark	3/1	30	30	100%	F
UP Coast	Newark	Oakland	1	8	18	44%	C
UP Niles	Niles	Oakland	2/1	16	30	53%	C
UP Oakland	Niles	Melrose	1	1	30	0%	A

Source: AECOM and Cambridge Systematics calculations.

[a] Level of Service. LOS is ranked from A (best) to F (worst) using the ranges in Table 4.3 of the *National Rail Freight Infrastructure Capacity and Investment Study*, prepared by Cambridge Systematics for the Association of American Railroads, 2007.

The UP Coast Subdivision between San Jose and Santa Clara with three main tracks is operating at LOS A. However, the line drops down to single track at Great America through to Newark restricting the flow of train volumes and resulting in LOS F. The UP Niles Subdivision supports 14 Capitol Corridor daily trains between Oakland and Newark. This segment of the railroad network is operating at LOS C. The UP Oakland Subdivision in the I-880 Corridor is a parallel route the Niles Subdivision that is lightly used primarily for storage and switching. Figure 2.9 provides the existing LOS on the I-880 corridor rail lines in graphical format.

Figure 2.9 Existing LOS on I-880 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Forecast Rail Traffic. The 2013 California State Rail Plan[16] provided a wealth of information on rail movements; in particular it provided train volume estimates and forecasts. Freight train volumes were estimated by rail segment for 2020, 2025 and 2040, and by train service type (i.e., intermodal, automobiles, bulk, and general merchandise). In addition, passenger train forecasts were also available by segment up to 2025. Future train volumes reported in the State Rail Plan for rail segments in the I-880 corridor are indicated in Table 2.6.

Table 2.6 Future Train Volumes in the I-880 Corridor

			2020 Daily Train Volumes			2040 Daily Train Volumes		
Subdivision	**From:**	**To:**	**Freight**	**Passenger**	**Total**	**Freight**	**Passenger**	**Total**
UP Coast	San Jose	Newark	10	32	42	12	N/A	N/A
UP Coast	Newark	Oakland	8	2	10	N/A	N/A	N/A
UP Niles	Niles	Oakland	2	22	24	14	N/A	N/A
UP Oakland	Niles	Melrose	N/A	N/A	N/A	N/A	N/A	N/A

Source: California State Rail Plan, May 2013.

[a] Oakland Army Base Area Outer Harbor Intermodal Terminal Project Environmental Impact Report, August 2012.

One major driver of changes in rail volumes and flow patterns and reflected in these forecasts are the plans for the OAB redevelopment. When completed, the OAB will add a new intermodal terminal (OHIT), will add capacity at UP's Railport intermodal terminal, will add capacity at a new bulk terminal, and will add capacity for manifest trains. These terminals will serve a mix of intermodal, bulk, and manifest traffic that will come from both international and domestic sources. The UP also may change the way it uses its available mainline capacity connecting to these terminals. It is likely that the UP will carry its premium services (intermodal) on the Martinez Subdivision and the heavier bulk and manifest traffic on the Oakland and Niles Subdivisions accessing the Port of Oakland from the south.

Based on the EIR for the OAB project, by 2035, there will be about 10 additional intermodal trains per day based on the forecast for intermodal growth in and out of the Port of Oakland rail terminal expansion.[17] The apparent split in traffic will be about 6 trains from the OHIT and 4 from UP's Railport intermodal terminal. This growth in train volumes will impact LOS as indicated in Table 2.7. These forecasts, which are taken from the California State Rail Plan, provide growth

[16] AECOM with Cambridge Systematics, *California State Rail Plan*; California Department of Transportation, Rail Division; September 2013.

[17] Oakland Army Base Area Outer Harbor Intermodal Terminal Project Environmental Impact Report, August 2012.

rates that are generally consistent with the Oakland Army Base forecasts and the UP forecasts when both international and domestic traffic on the Martinez Subdivision are taken into account. What is different among all of these sources is the timing of the growth. The California Rail Plan forecasts show lower rates of growth for the period until 2020 and higher rates of growth from 2020 to 2040; whereas, the OAB forecasts anticipate a big bump up in traffic when the projects are brought on-line (by 2020) and a slowing of growth beyond 2020. The UP forecasts, which include nonintermodal traffic on the Martinez Subdivision, only extend to 2018 and have somewhat lower rates of growth than the OAB forecast in this period (reflecting a mix of international and slower growing domestic traffic).

The changes in capacity utilization and LOS are presented in Table 2.7.

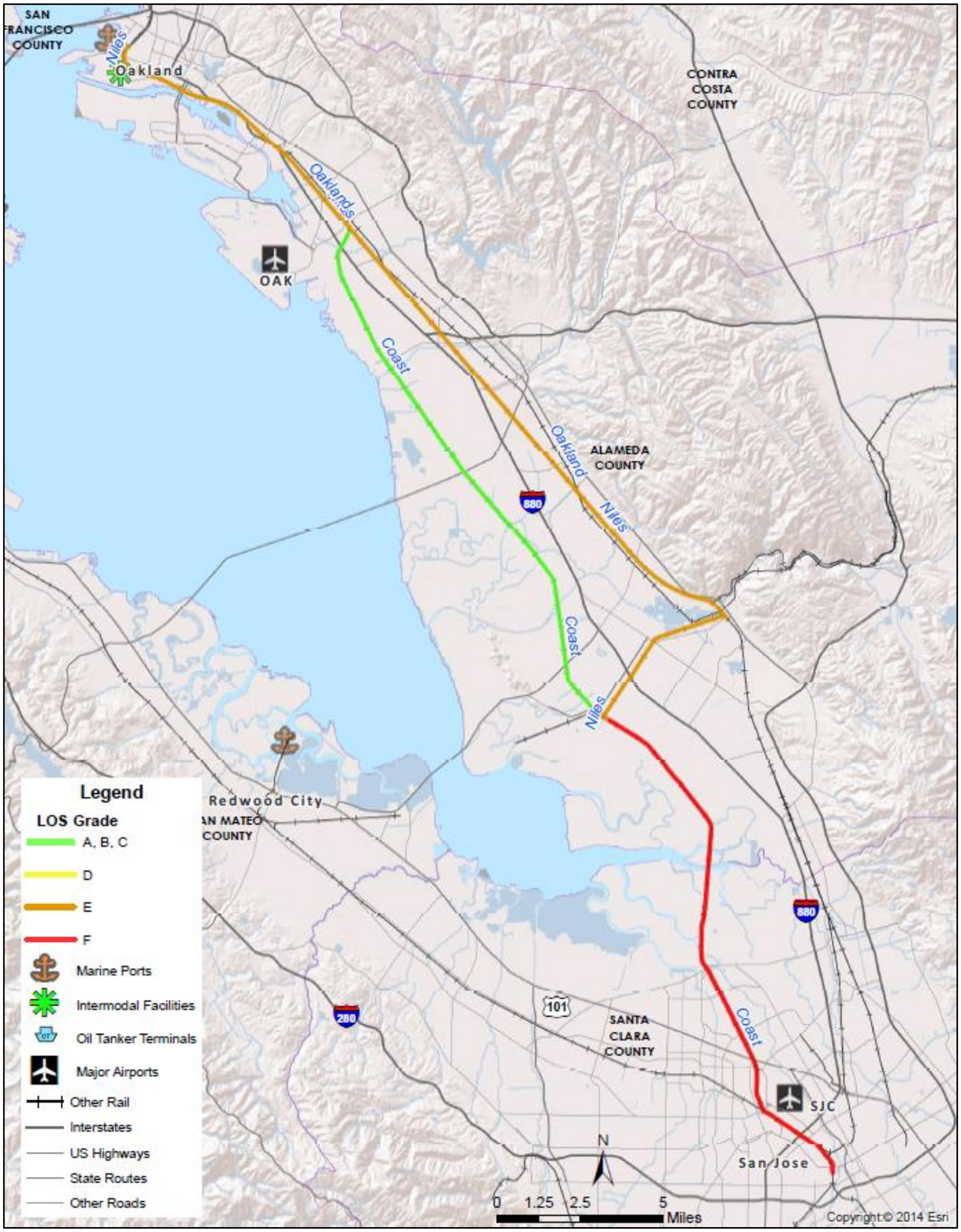
Table 2.7 Rail Lines 2020 Forecast Level of Service in the I-880 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Coast	San Jose	Newark	3/1	42	30	140%	F
UP Coast	Newark	Oakland	1	10	18	56%	C
UP Niles	Niles	Oakland	2/1	24	30	80%	D
UP Oakland	Niles	Melrose	1	N/A	N/A	N/A	N/A

Source: AECOM calculations.

As indicated, the planned future growth in train volumes for freight and passenger services degrades the overall network. The UP Coast Subdivision could degrade to LOS F. The Capitol Corridor Joint Powers Authority (CCJPA) is supporting several rail capacity projects to keep pace with growing demand for existing services. Third track and siding investments, signal improvements, and station expansions will allow for increased passenger service between San Jose – Oakland – Sacramento. The CCJPA envisions increasing top train speeds from the current 79 mph to 90 mph, where local conditions allow. In southern Alameda County, rail siding extensions, universal crossovers, and a double-track project near Industrial Parkway will address rail congestion in the Oakland to San Jose segment. Additional capacity analysis is currently underway by the UP to verify some of these passenger rail improvements. Figure 2.10 provides the 2020 LOS on the I-880 corridor rail lines in graphical format.

Figure 2.10 2020 LOS on I-880 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Rail Access and Operational Issues

Rail traffic in the I-880 Corridor is anchored by the Port of Oakland. The Port has two intermodal rail terminals to facilitate container traffic, UP's Railport and the BNSF OIG joint intermodal terminal. The construction of OIG in 2002 eliminated the 12-mile trip over local roads between the port and BNSF's former Richmond Intermodal Facility. However, there is a significant access bottleneck at OIG. In order to access the OIG, BNSF trains must cross through the UP terminal and cross UP tracks at-grade. This movement causes significant delays and operational issues for both railroads. The Port of Oakland is working to resolve this and other intermodal terminal capacity and access issues through – the OHIT project mentioned before.

In addition to the OHIT project, Railport may be expanded to meet future demand. As part of an analysis of future conditions, the OAB EIR indicates the potential to increase annual number of intermodal container lifts at Railport from about 386,000 annually in 2011 to 669,000 annual lifts in 2035. If this expansion of Railport does not take place and demand continued to grow, the additional demand would most likely be handled at nearby intermodal terminals in the San Joaquin Valley (UP's Lathrop Yard). Containers would be transferred to Bay Area customers by truck on I-580.

At-Grade Highway-Rail Crossing Safety and Delay Issues

The rail system interacts directly with the roadway system where roads cross railroad tracks at-grade. At-grade crossings introduce safety concerns and traffic delay issues to the overall transportation system. This section identifies the major at-grade crossings in the I-880 corridor and presents accident statistics and estimated traffic delay for these crossings. This data is used to rank the crossings and provide guidance for prioritizing grade separation projects.

The grade crossings studied in the I-880 corridor were drawn from those included in the 2013 Alameda CTC Congestion Management Plan (CMP). Also, the analysis focused only on crossings located along the mainline rail routes that carry passenger trains. The location and accident history of these crossings appears in Table 2.8.

Table 2.8 At-Grade Crossings Accidents on the Along the I-880 Rail Corridor

				Accident History (January 2004 – June 2014)			
City	Street	Crossing Number	Railroad	Number of Incidents	Fatal	Injury	Property Damage Only
Fremont	Fremont Boulevard	750039X	Union Pacific	0	0	0	0
Hayward	Tennyson Road	749774W	Union Pacific	0	0	0	0
Newark	Mowry Avenue	749946C	Union Pacific	1	0	0	1
Oakland	Broadway	749585A	Union Pacific	2	1	0	1
	23rd Avenue	749634U	Union Pacific	1	0	1	1
	High Street	749712Y	Union Pacific	5	0	0	5
San Leandro	Hesperian Boulevard	834229L	Union Pacific	5	3	1	1
	Davis Street	834250S	Union Pacific	1	1	0	0
Union City	Decoto Road	749781G	Union Pacific	0	0	0	0

Source: U.S. DOT Crossing Inventory.

Determining the at-grade crossings most in need of grade separation can be based on two factors: the frequency and severity of accidents and the amount of delay experienced by roadway traffic. As shown in Table 2.8, the Davis Street and Broadway crossings each had one fatal accident, and the Hesperian Boulevard crossing had three fatalities and an injury over the ten year period. In terms of traffic delay, Table 2.9 shows that the Hesperian crossing has the highest delay. This suggests that the crossings be ranked in the following order for consideration of grade separation:

- Hesperian Boulevard (because it has the most fatal accidents and the highest traffic delay);
- Davis Street (tie); and
- Broadway (tie).

Davis Street and Broadway are tied because each has one fatal accident and the same amount of delay. The remaining crossings (plus Davis Street and Broadway) all have the same amount of delay, so they can be ranked based on the number of accidents (all nonfatal):

- High Street (five accidents); and
- 29th Avenue (three accidents).

Table 2.9 At-Grade Crossings Hourly Traffic Delay

City	Street	Railroad	Traffic Delay (Vehicle Hours)		
			Freight	Passenger	Total
Fremont	Fremont Boulevard	Union Pacific	0.31	0.09	**0.40**
Hayward	Tennyson Road	Union Pacific	0.31	0.09	**0.40**
Newark	Mowry Avenue	Union Pacific	0.30	0.08	**0.38**
Oakland	Broadway	Union Pacific	0.31	0.09	**0.40**
	23rd Avenue	Union Pacific	0.31	0.09	**0.40**
	High Street	Union Pacific	0.31	0.09	**0.40**
San Leandro	Davis Street	Union Pacific	0.31	0.09	**0.40**
	Hesperian Boulevard	Union Pacific	0.38	0.11	**0.49**
Union City	Decoto Road	Union Pacific	0.31	0.09	**0.40**

Source: AECOM Calculations.

Port of Oakland Needs Analysis

Port Capacity

In 2013, the Port of Oakland handled 2.4 million TEUs and expects to continue to grow at a rate of two percent for the foreseeable future. As the Port pursues its growth strategy, it will be trying to build import volumes so that imports and exports stay roughly equivalent over time. To do this, there will need to be increased rail service for international intermodal cargo. While older logistics system supporting Pacific Rim trade often used the rail system as a land bridge from West Coast ports to the Midwest and East Coast with containers traveling in-tact (often referred to as inland point intermodal or IPI), a new strategy called "transloading" has been developing in which the cargo in international containers is unloaded and reloaded into larger domestic containers. Transloading helps international shippers save money by returning their smaller international containers right away, by allowing multiple shipments to be combined into a single container, and by allowing for loads to be recombined to new destinations after the ocean segment. The OAB Redevelopment plans include modern warehousing facilities that will provide space for transloading near the Port of Oakland.

Upon buildout of the OAB Project, throughput has been projected to grow to just more than 4 million TEUs by 2035. This is a significant reduction from prerecession forecasts that projected growth to more than 5 million TEUs in the same time period. Based on this revised future throughput forecast, the Port facilities were analyzed for future capacity. The analysis found that marine terminals have sufficient backland to accommodate the throughput, but the landside infrastructure (namely roadways and railways) posed potential constraints to growth. Prior analyses conducted in 2004, estimated that the Port roadways would only be able to accommodate 3.3 million to 3.9 million TEUs and the rail network would only be able to accommodate 2.5 million to 3.5 million TEUs per year. The Maritime Development Alternatives Study (MDAS 2004) further estimated that larger vessels with higher amounts of lifts per call would create congestion within the terminals. This is what we are witnessing today at the Port of Oakland. More recently, the new, larger vessels have required the Port to closely review berth availability, something that the MDAS identified would be an issue. Port volume has not grown as anticipated a decade ago, but many of the landside constraints identified in the MDAS are impacting the flow of goods today. Growing exports and the growing export market potential also requires more investigation.

To date, terminal operators have accommodated the larger vessels by eliminating truck chassis storage on the terminals. This increases the amount of land available to store containers and storage is further increased by stacking containers, something that can not be done if the containers are loaded directly onto a truck chassis. While the terminals have sufficient backland capacity for container storage, the terminal operators have not implemented adequate operational changes to address the cargo surges, such as more shifts or implementation of new technology to help manage the storage and retrieval of containers. As a result, truck queuing regularly extends as far north as Maritime Street/Wake Avenue/Engineer Road and northwest on Burma Road, as far west as I-880 on 7th Street, and from the south to Adeline Street and I-880. Truck turn times from the entrance gate to exit gate is more than 60 minutes for up to 50 percent of the trucks. Outside of the gates, trucks have been reportedly waiting two to four hours. Whereas, truckers were previously making three to four turns at the Port per day, they are now making two turns, which is exacerbating the trucker and chassis shortage issues. The MDAS suggested that this would occur once terminals began experiencing more than 1.000 lifts per vessel. On a regular basis, terminals are handling 1,200 lifts per vessel.

The Port of Oakland maintains berths with minimum 50-foot depths at 90 percent of its terminals. It is "Big Ship Ready," and regularly accommodates vessels in excess of 12,000 TEUs. Berth capacity, more so than depth, backland and transportation infrastructure, will limit the Port's ability to accommodate growth. The Port has the ability to accommodate larger vessels at several terminals, but the larger vessels require longer berths. Facilities that previously operated three berths are now accommodating larger vessels and only able to utilize two of their three berths.

Fleet conversion to larger vessels with greater container-carrying capacity was anticipated due to significant growth in trade from 2000 to 2006, but the speed at which this conversion has occurred has been faster than would have been expected in light of the slowing of trade growth that occurred after 2006. Vessel operating companies began ordering larger ships, known as the New Panamax and the Triple E classes, and retiring smaller vessels, and even during the 2009 recession, most had few options but to honor their purchases as the ships were already under construction. What is most interesting is the rate of scrapping of relatively young vessels (less than 20 years)[18]. The push for efficiency gains from fuel consumption and the related environmental benefits have prompted the industry to convert to larger vessels much more quickly than previously anticipated. This quick conversion is impacting port operations, including surges of goods as a large vessel offloads in one day the same amount that a terminal typically once handled over the course of two to three days. West Coast ports also are adjusting to the reality that carriers, through alliances and vessel-sharing arrangements, are concentrating their vessel calls at fewer ports and terminals. Shipping lines seek density; pushing more freight through fewer ports allows the carriers to use the capacity of their big ships more effectively and achieve the economies of scale inherent in the mega-ships.

Port Access

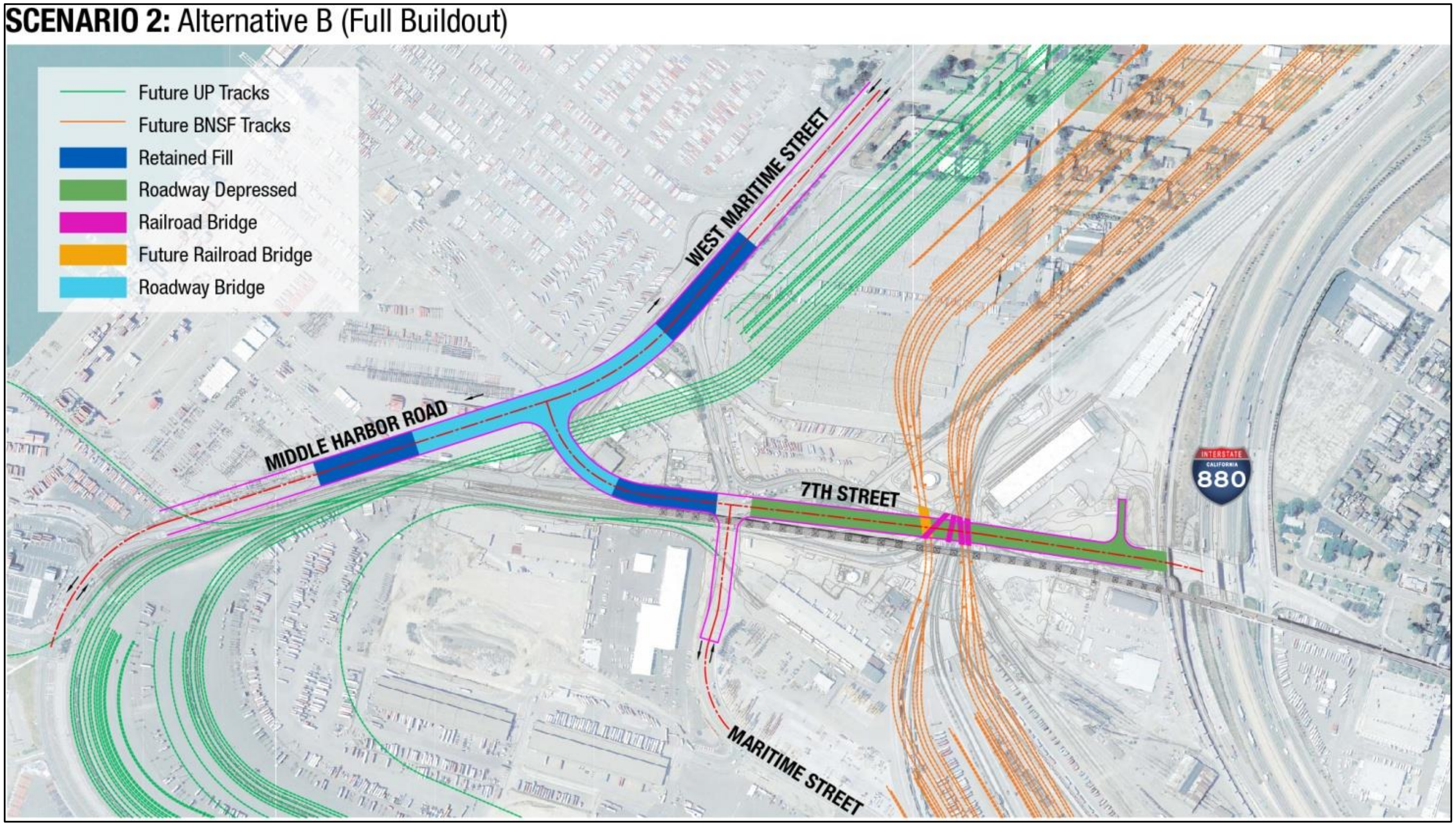
To evaluate port connectivity, the last-mile roadway connectors and rail connections into the rail yards and terminals at the Port of Oakland were examined for constraints to growth in the landside transportation connections. The most significant constraint, aside from long wait times at the gates, is the impact of at-grade crossings in the Port, specifically on Maritime Street where both at-grade crossings (one near 7th Street and the other near Middle Harbor Road) can simultaneously be blocked by one train. One train blocking both crossings temporarily eliminates access to the Joint Intermodal Terminal (JIT)/Oakland Intermodal Gateway (OIG) rail yard and several other uses along this segment of Maritime Street. A blockage of the at-grade crossing of Maritime Street near 7th Street also results in significant truck queues that can extend as far back as I-880. The proposed grade separation and roadway reconfiguration of 7th Street from Maritime Street to Navy Roadway, planned as part of the Oakland Army Base Redevelopment Project, would eliminate the at-grade crossing of Maritime Street near 7th Street. The preferred alternative is shown in Figure 2.11.

Another bottleneck, the 7th Street Union Pacific Railroad underpass, restricts travel flow due to narrow travel lanes and inadequate height clearance for some truck loads. Improvement of this underpass would not increase capacity, but would improve traffic flow, truck operations, and safety (also reflected in the figure above).

Overall, improvements in truck traffic operations within the Port through traffic management could help with managing queues, reducing intersection delay, and improving safety (i.e., eliminate blinking red signals that drivers regularly ignore).

[18] Danish Ship Finance, http://www.shipfinance.dk/en/SHIPPING-RESEARCH/~/media/Shipping-Market-Review/Shipping-Market-Review-April-2013.ashx.

Figure 2.11 Preferred OHIT 7th Street Grade Separation Alternative



Source: Port of Oakland, prepared by URS.

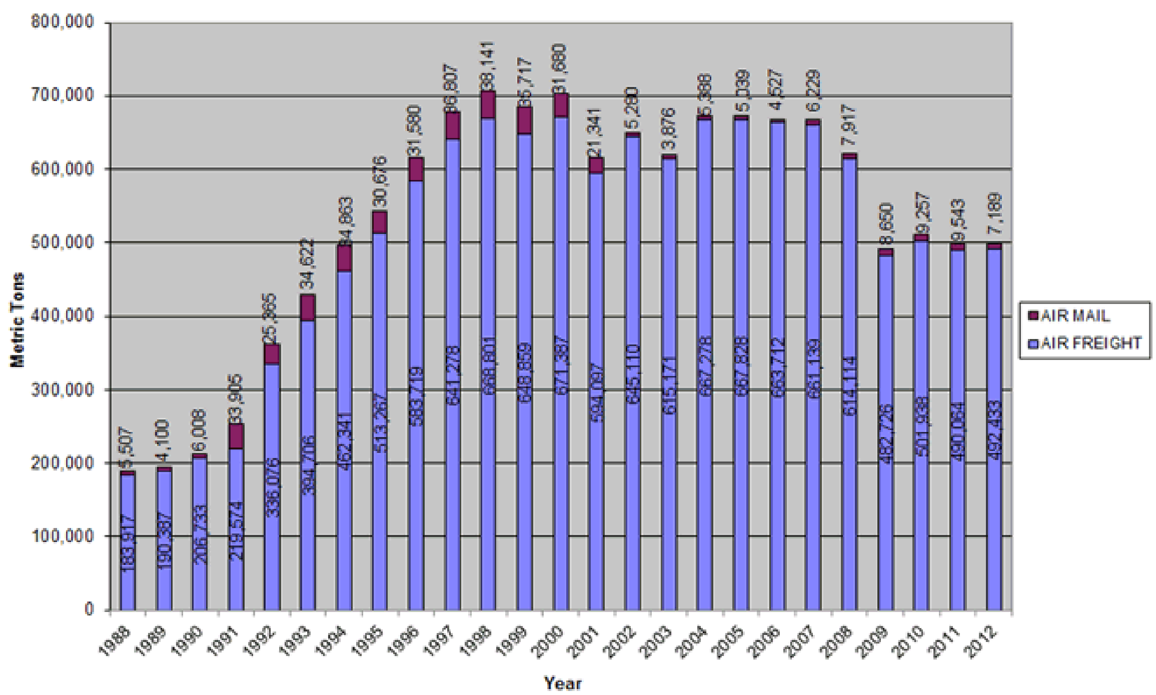
Airport Needs Analysis

Oakland international Airport

Almost all commercial operations at OAK are conducted in the South Field, and OAK's main runway, 12/30, is used for nearly all passenger and air cargo flights. OAK's North Field is primarily used by General Aviation and Air Taxi operators. This is in part due to a noise policy that discourages North Field jet departures to the west and arrivals from the west. Due to potentially significant noise impacts, the airport works to maintain a very high compliance rate with noise abatement procedures. In addition, home sound insulation programs are in place to mitigate impacts to area residents.

Primary air freight destinations from OAK are domestic, serving the West Coast as well as national cargo hubs such as Memphis (FedEx) and Louisville (UPS). The airport also handles significant international service to Pacific Rim nations. Air cargo volumes have overall been decreasing since the peak in the late 1990s, with a significant drop in 2009 due to the global recession. Since the end of the recession, OAK has not seen air cargo volumes return to prerecession levels (Figure 2.12). Recently some carriers such as Delta, U.S. Airways, and Norwegian Air, have begun accepting more belly cargo, and steady growth in this market is expected to continue.

Figure 2.12 Oakland International Airport Air Cargo Volumes



Source: Oakland International Airport, 2014.

Although air freight is growing slowly, recently, there is an ongoing and dramatic decline of electronics outbound shipments from OAK, primarily due to the changing computer market, with fewer goods being manufactured in the Bay Area and California in general. Shipments of electronics from OAK are projected to decrease from $24.5 billion in 2012 to 11 billion in 2040. Nevertheless, growth in inbound commodities, most notably precision instruments, manufactured goods and basic chemicals will offset much of this loss of demand and continue to require strong connections to the region's manufacturers and distributors. OAK is proximate to many of Alameda County's main freight routes providing connectivity yet also with challenges in terms of roadway condition and congestion. Airport Drive is 10 years old and needs to be rebuilt, and significant congestion exits on I-880, Davis Street, and other routes. Freight traffic to and from the airport contributes to roadway congestion, safety, environmental, and air quality issues, and particularly impacts surrounding communities.

Other challenges at OAK include land use and geographical constraints. The airport is located in a densely populated region that is primarily industrial but also includes a school and other residential infrastructure. Within the airport, terminal expansion and repaving projects are needed. Furthermore, due to the airport's proximity to the Bay, extreme flooding remains a threat. The levees around the airport are not sufficient to withstand a 100-year flood and need to be rebuilt at a cost of $45 million.

Mineta San Jose International Airport

Mineta San José International Airport (SJC) is the third major airport in the Bay Area region, and is the gateway to Silicon Valley. Located two nautical miles northwest of downtown San Jose, the airport is at the southern tip of the San Francisco Bay in Santa Clara County. SJC does not see nearly the volume of cargo traffic as the two other major Bay Area airports, and in 2011, SJC was ranked as the 74th largest air cargo airport in North America by the Airports Council International. Cargo service is available through seven freight airlines and three airlines offering belly cargo service. Both FedEx and UPS have cargo operations at San Jose.[19]

SJC has two main runways, which are parallel 11,000 foot runways and can handle up to 103 takeoffs and landings per hour, well above projected capacity for 2035. SJC has two main runways, which are parallel 11,000 foot runways and can handle up to 103 takeoffs and landings per hour, well above projected capacity for 2035. Unlike SFO, SJC has capacity to handle a number of additional flights, and regional plans have explored the goal of shifting traffic from

[19] Caltrans, *Freight Planning Fact Sheet*, *Mineta San Jose International Airport*, http://www.dot.ca.gov/hq/tpp/offices/ogm/air_cargo.html.

SFO to SJC and OAK in order to provide service to the region'.[20] Implementation of any redistribution, however, is extremely complex and has not been a strategy the airports have agreed to pursue. SJC has made efforts to increase utilization, including a renovation of terminal and airport facilities in 2010. Some increases in air cargo have been seen in recent years, and the airport reports about 42,000 tons moved in 2013. International operations, in particular, are expected to increase about one to two percent per year, according to analysis of FAF data, and supported by service being provided by international carriers to SJC, such as Nippon Airways which began service to Tokyo Narita in 2012.

On one hand, San Jose has significant advantages over its neighboring airports, in particular, due to better weather conditions. Unlike SFO, SJC is ranked among the top U.S. airports for on-time performance and lack of weather delays. Like its Bay Area neighbors, the SJC is faced with the challenges of its urban surroundings, including lack of expansion capacity, congestion on area roadways, and noise. Like many airports, SJC operates a "Fly Quiet" program, established in 2009 to influence airlines to operate as quietly as possible. Congestion and regional connectivity is particularly relevant for SJC, as the airport is located at a hub of connections to the Peninsula, East Bay, and South Bay. The airport is close to major highway connectors, including I-880, I-680, I-580, U.S. 101, SR 87, and SR 85. As described throughout this document, many of these roads experience significant congestion, especially during peak hours, which can lead to issues with trucks carrying air freight to and from the airport and local destinations.

2.2 The I-80 Corridor

2.2.1 Overview, Industry Drivers, and Growth Trends

I-80 is a major interregional freight corridor connecting the Bay Area to Sacramento and northern U.S. states. I-80 also performs functions as an intraregional corridor in Solano, Alameda and Contra Costa Counties, as well as along the San Francisco-Oakland Bay Bridge. In addition to the I-80 freeway, this corridor also contains the UP's Martinez Subdivision rail line and multiple marine terminals serving nearby oil refineries. The corridor also carries truck and/or rail traffic originating from two ports that are close by: the Port of Richmond, near I-580 (discussed below in Section 2.4), and the Port of Benicia, near I-680 (discussed below in Section 2.6). Several of the key pieces of goods movement infrastructure in the I-80 corridor are in low-lying areas that could be affected by sea level rise; this topic is discussed more fully in the Cross-Cutting Issues section. Table 2.10 summarizes the corridor.

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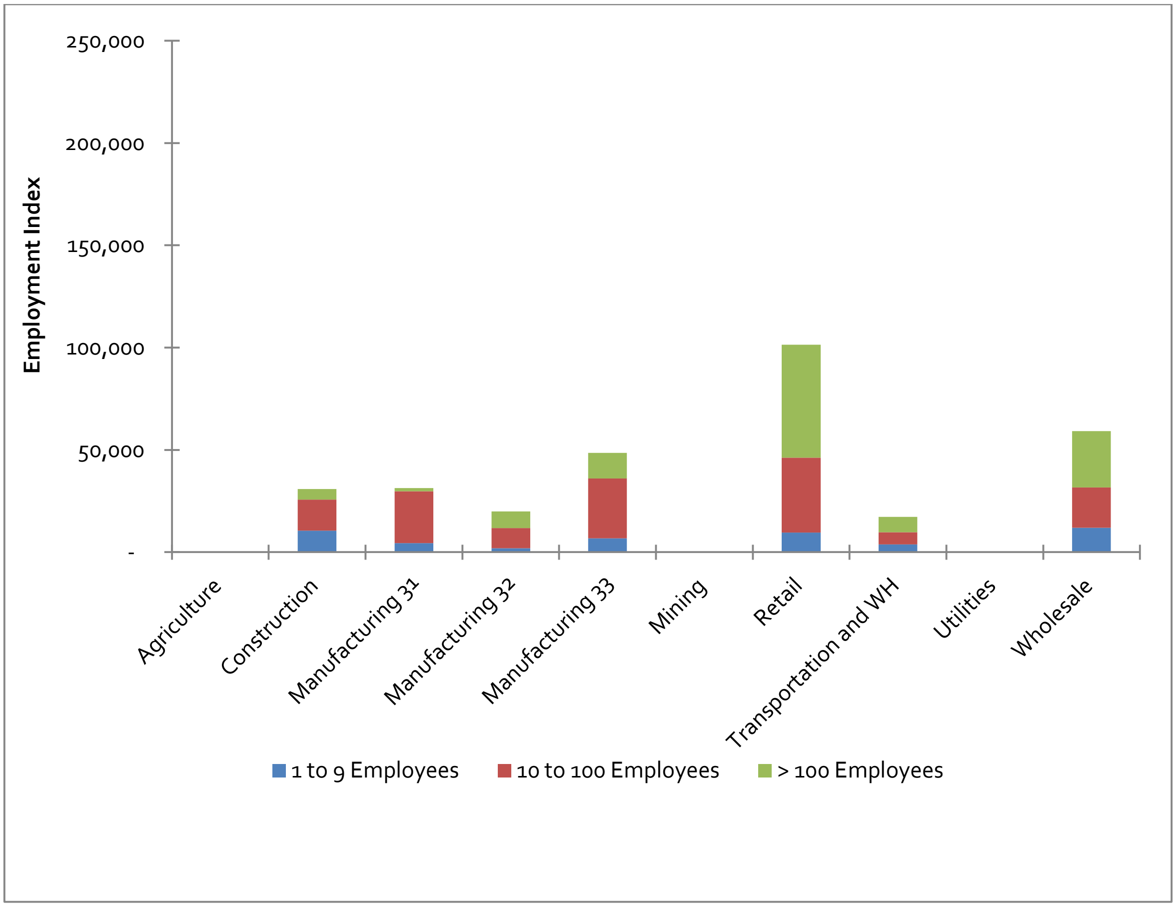
[20] Regional Airport Planning Committee (Metropolitan Transportation Commission, Bay Conservation and Development Commission, and Association of Bay Area Governments), *Regional Airport System Planning Analysis (RASPA), 2011 Update*.

Table 2.10 I-80 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
San Francisco, Alameda, Contra Costa, Solano, Napa	I-80 (Central Corridor)	UP Martinez Subdivision Port of Benicia Travis Air Force Base Cordelia Truck Scales Major interchange at I-80/I-680/SR 12	Interregional, Intraregional	Primary corridor connecting Bay Area to Sacramento and northern tier states across the U.S. Also connects Bay Area counties.

Along the corridor, manufacturing activities are found near Richmond, West Berkeley, and Vallejo, as well as Vacaville; and has a total employment index of nearly 100,000 employees. Since the corridor traverses major population centers and shopping centers, retail activities have a high share of goods dependent industry employment. Agriculture activities are more prominent going north along the corridor starting in Fairfield/Vacaville in Solano County. Figures 2.13 through Figure 2.16 display the industry profile along the corridor.

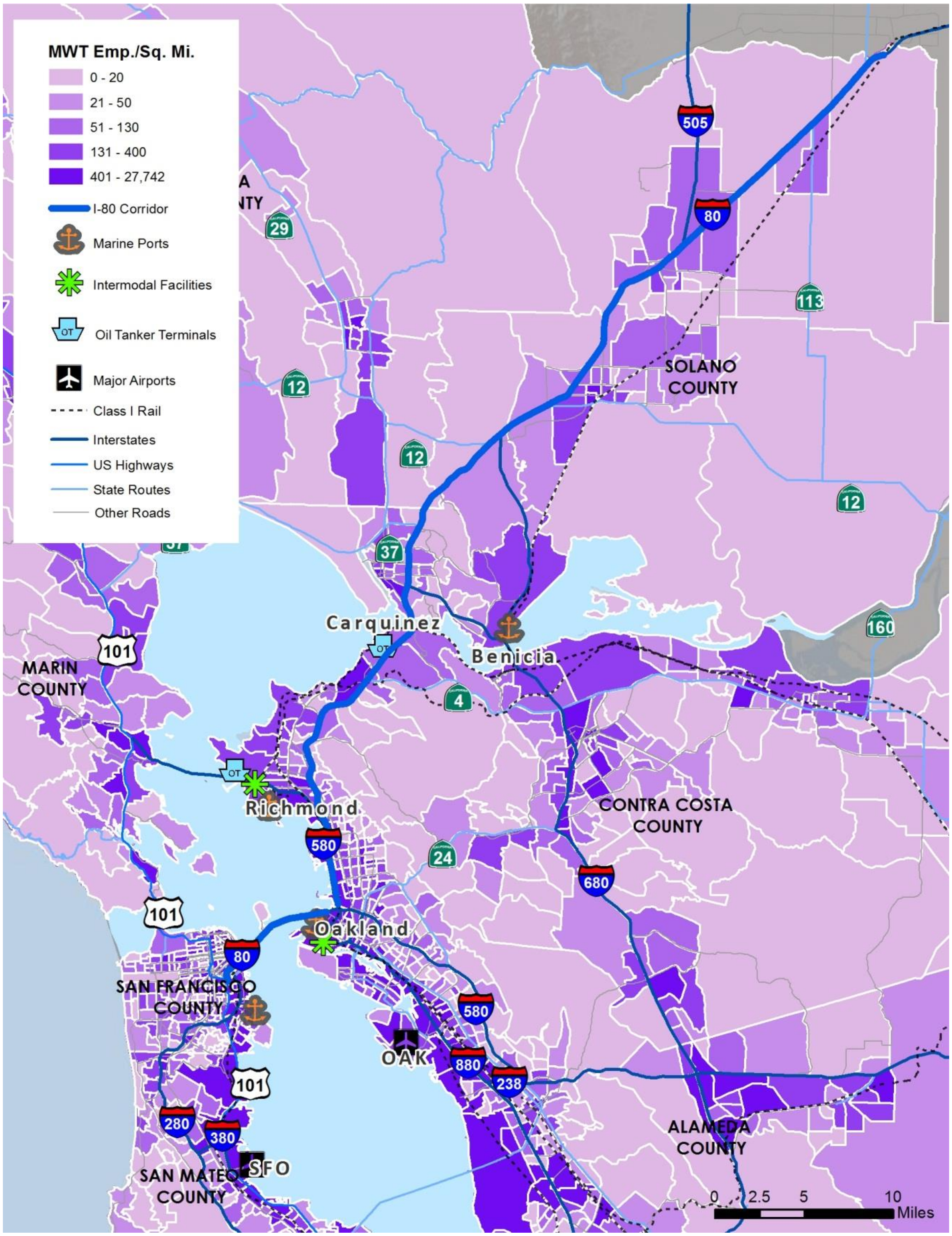
Figure 2.13 Employment Index for Goods Movement-Dependent Industries, I-80
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

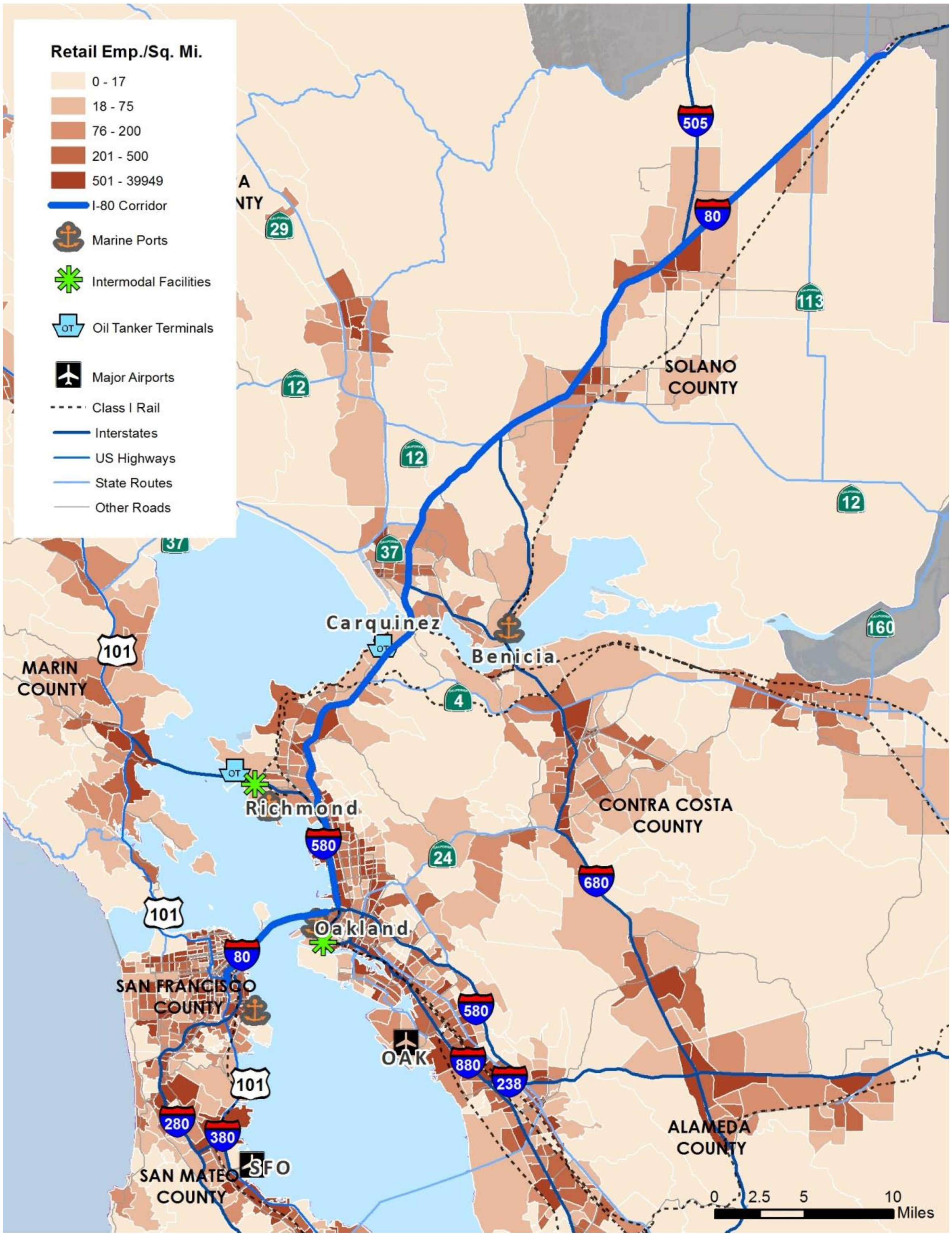
Figure 2.14 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along I-80



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.15 TAZ Level Employment Density in the Retail Sector along I-80



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.16 TAZ Level Employment Density in the Agriculture Sector along I-80

Source: MTC.

Note: Employment Density is in employees per square mile.

2.2.2 Analysis

The I-80 corridor has significant needs in several performance areas, including congestion, delay, and future rail capacity on the Martinez line. Table 2.11 summarizes the performance evaluation of the corridor.

Table 2.11 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/Air Quality/Public Health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel Time Reliability	Buffer time index on freight (truck) routes	🔴	AM travel unreliable from Albany to Berkeley, PM traffic generally unreliable, especially northbound from Bay Bridge
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	🔴	Third highest number of truck crashes per lane mile among all corridors
		Crashes at at-grade rail crossings	🟡	Market Ave in Richmond and Ferry Street in Martinez have high number of accidents
	Freight infrastructure conditions	Bridge conditions ratings	🟡	Average bridge rating sufficiency among all corridors, with rating of 82.3 out of 100
		Freight (truck) highway and arterial routes pavement conditions ratings	🟢	Second highest pavement ratings among all corridors, with 90% lane miles in good/excellent conditions
	Freight Resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system.	Use of Innovative Technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions	Travel time delay	Travel time delay on freight (truck) routes	●	Significant congestion in AM and PM peak periods, especially around the Bay Bridge and Carquinez Bridge following commuter traffic patterns. Significant operational? congestion issues at the I-80/I-680/SR 12 interchange
		Travel time delay on railways, terminals, ports, airports	●	UP Martinez subdivision has generally LOS C
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	●	There is some access issues at OIG as BNSF trains need to cross UP tracks. This causes significant roadway backup as well. This issue will be resolved through the OHIT project.
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	●	Passenger trains (Capitol Corridor) significant along corridor and desire to grow. Adding more trains will result in unstable conditions along the line
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic Contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

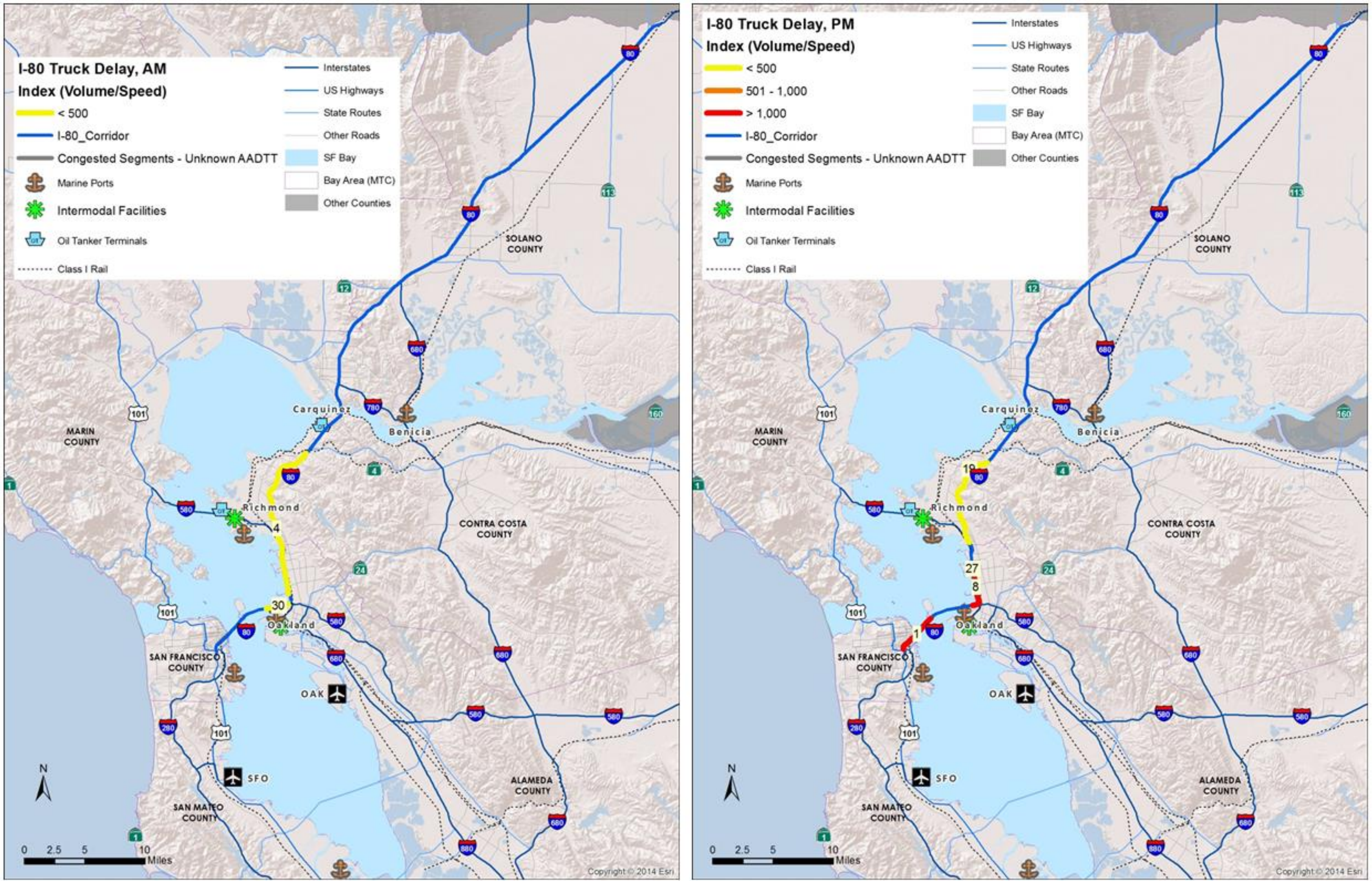
Congestion/Delay

As shown below in Figure 2.17, the majority of congestion and truck delay on I-80 occurs east of the Carquinez Bridge, in Contra Costa, Alameda, and San Francisco Counties. In the AM period, all of the congested segments run westbound, with two distinct portions. From SR 4 to Powell Street in Emeryville (Segment 4), a 13.6-mile section has average speeds of 15.6 mph from

6:35 a.m. to 10:20 a.m. This area has a high amount of total vehicle hours of delay (VHD), but speeds are high enough that the delay index is in the lowest quartile. A much shorter 1.9-mile portion runs from the I-580 merge to the Bay Bridge (Segment 30), has an average speed of 4.3 mph, the lowest average speed of any congested segment in the Bay Area.

In the PM period, congestion runs both eastbound and westbound. The highest amount of delay occurs for traffic leaving San Francisco, starting at the endpoint at U.S. 101 and continuing to Yerba Buena Island on the Bay Bridge (Segment 1). This 4.1-mile section of I-80 has average speeds of only 4.4 mph. The congestion on this segment spans the second longest amount of time of any part of the Bay Area highway system, running from 1:25 p.m. to 8:30 p.m. In addition, a 4.3-mile stretch running eastbound from West Grand Avenue in Oakland to Gilman Street in Berkeley (Segment 8) also produces a high amount of delay, in part because average speeds are only 8.8 mph. I-80 also has delay in the westbound direction from Gilman Street to the I-580 interchange (Segment 27). Though this segment runs in the noncommute direction, the traffic it carries is approaching the merge with I-580 westbound and I-880 southbound, both of which are filled with heavy commute flows, so congestion backs up through the interchange and onto the approaching freeways.

Figure 2.17 Truck Delay on Congested Segments along I-80, Peak Periods



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Travel Time Reliability

Truck reliability along the corridor is shown in Figure 2.18. In the AM peak, the corridor is generally quite reliable, with the exception of the westbound traffic from Albany to Berkeley area, destined for downtown Oakland/Bay Bridge. This section has a high BTI of 2.06, and a moderately high reliability index in the 10,000 to 14,000 range. In the PM period, the reliability is generally poorer with most commuters rushing to get home in the afternoon from city centers to suburbs in the north. Traffic is most unreliable from the McArthur Maze to I-580 going in the eastbound direction, with a BTI of 1.47, and reliability index in the highest range. Figure 2.18 show the reliability on segments along I-80.

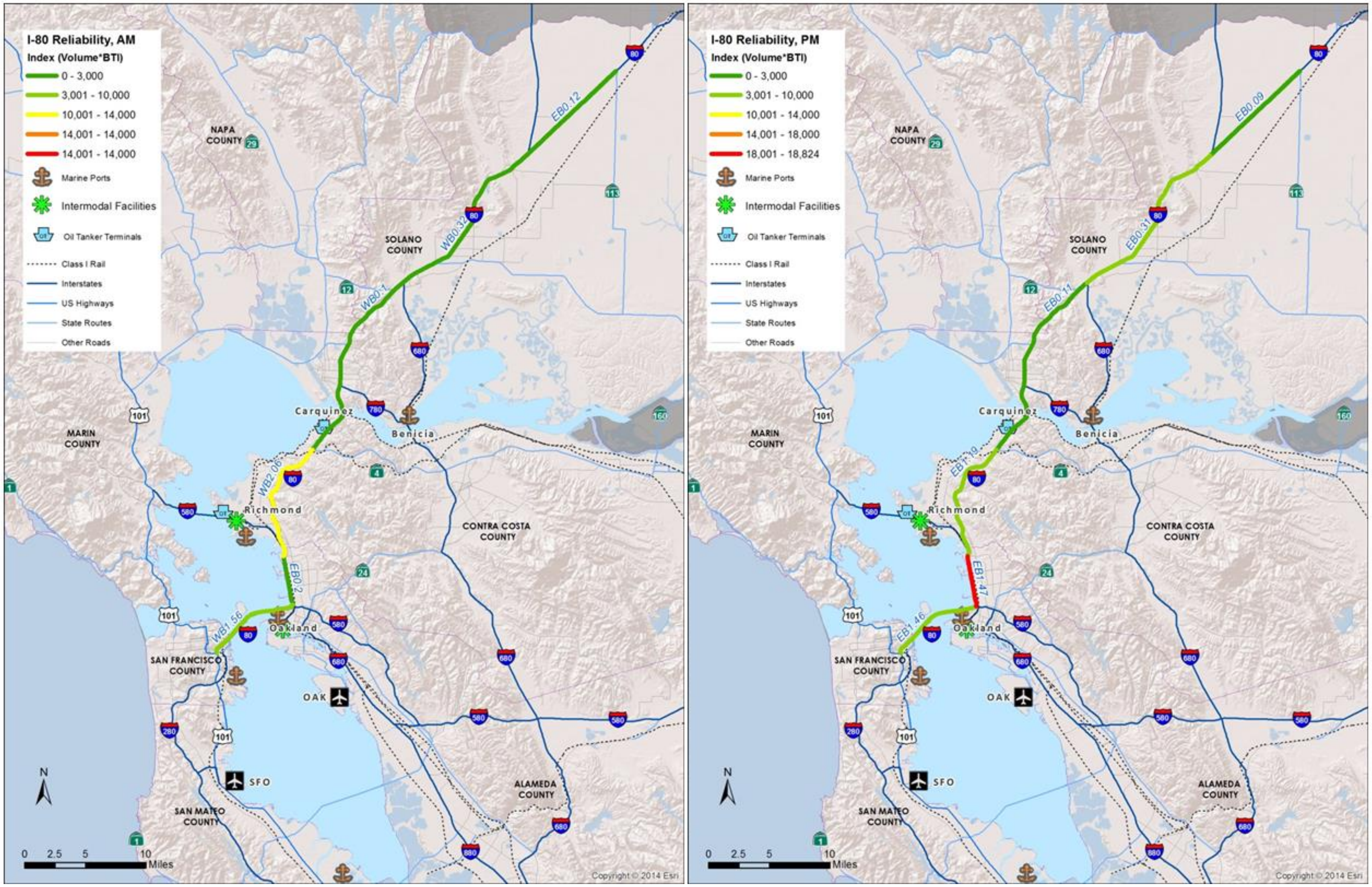
Pavement and Bridge Conditions

The average bridge sufficiency rating along the I-80 corridor is 82.3, ranking sixth among the 8 corridors. Of the 61 bridges along the corridor, 48 have a rating above 80 while 3 have a rating below 50. As Figure 2.19 shows, there is no discernable pattern as to the locations of the poorer bridges. I-80 has the second highest overall pavement rating among the 8 corridors with an overall weighted pavement score of 2.84 out of 3. The vast majority, 90 percent, of all lane miles is in good/excellent condition and only 6 percent are considered to be in distressed condition. As shown in Figure 2.19, pavement conditions are worst along some portions of the Bay Bridge, along Richmond, and also north in Solano County.

Safety

From 2003 to 2012, I-80 had the third highest truck crash per lane-mile rate among the study corridors at 1.56. Of the 793 collisions involving trucks that occurred along the corridor during this time period 36 were fatal. As Figure 2.20 shows, crash rates are highest along locations in the Bay Bridge, and also portions with heaviest traffic from Oakland to Richmond.

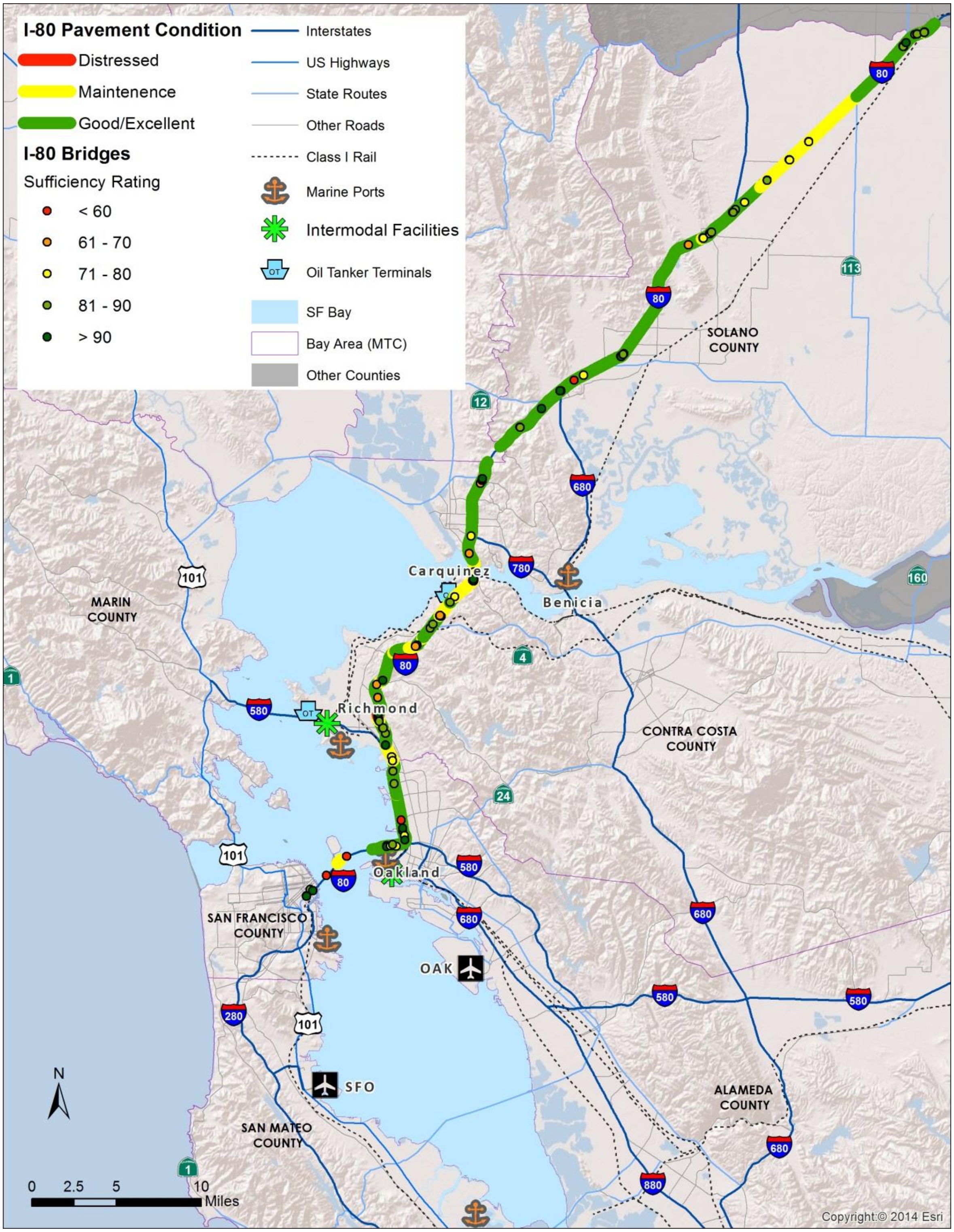
Figure 2.18 Reliability on Segments along I-80, Peak Periods, 2013



Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

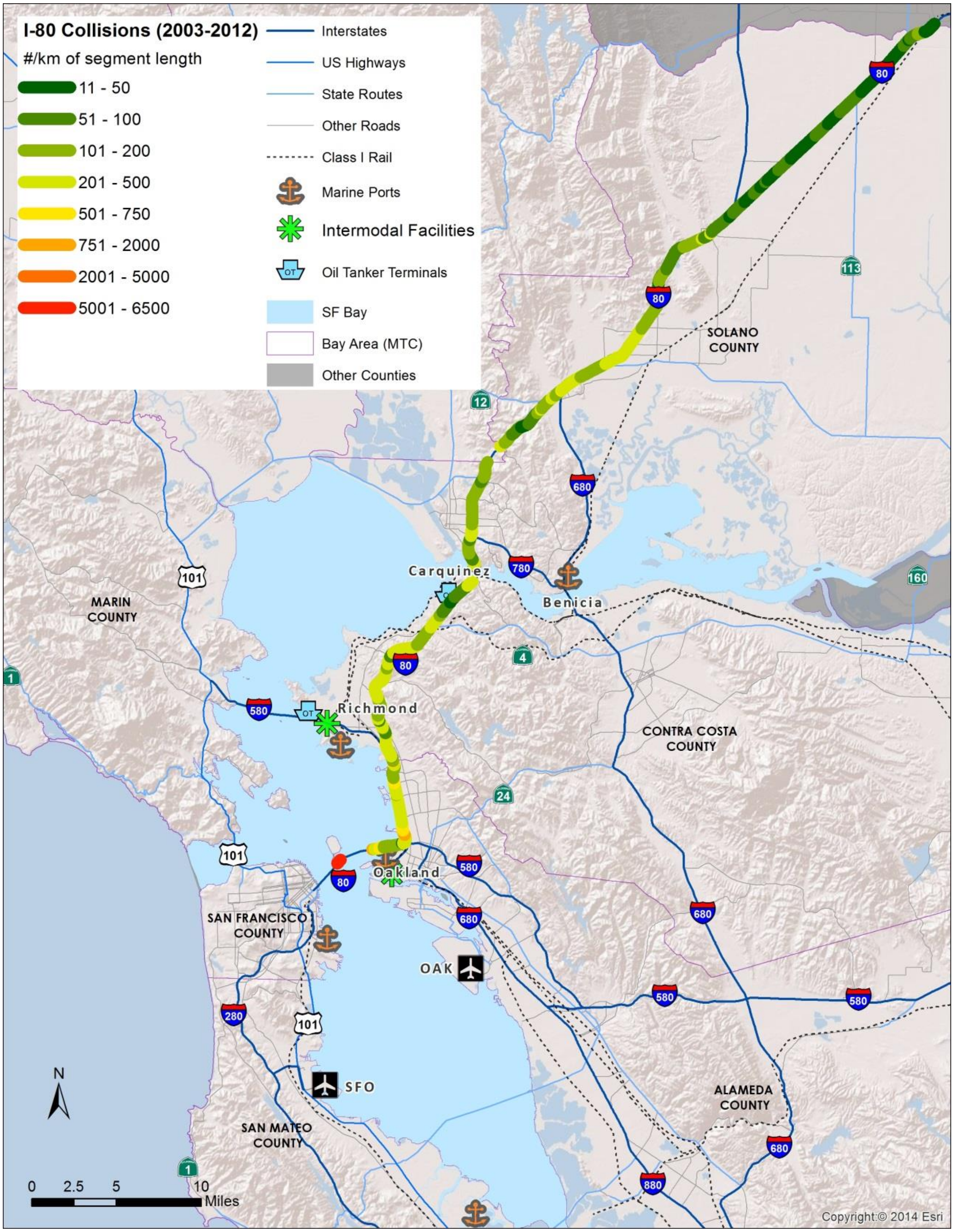
Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Figure 2.19 Pavement and Bridge Existing Conditions along I-80



Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.20 Truck Involved Crash Rates along I-80



Source: SWITRS; Cambridge Systematics Analysis.

Other Highway Needs

In addition to corridor level needs, the interchange of I-80, I-680, and nearby SR 12 has historically been one of the most operationally complex in the regional highway network. Constructed in the 60s, the junction of three major roads causes a very high amount of merging and weaving by all vehicles, particularly by freight trucks that must exit and pass through the Cordelia truck scale facility before continuing through the area. In addition, it is estimated that up to 1,450 vehicles divert from the NB I-680 to EB I-80 connector to alternate routes to by pass the congestion. This cut-through traffic creates a series of problems along local streets such as congestion on local roads, safety concerns, and accessibility issues for local properties and emergency vehicles.

Local and regional agencies recently partnered on a $98 million project to relocate and improve the eastbound scales, providing more inspection capacity (to reduce delay) and longer ramps (to improve truck queuing and merging). Now that this project is complete, a similar effort is envisioned for the scales that operate in the westbound direction[21].

In addition, in June 2014, construction of Phase I of the I-80/I-680/SR 12 Interchange, the Green Valley Interchange Project, began. This multiphase project is estimated to:[22]

- Reduce congestion through the I-80/I-680/SR 12 interchange complex;
- Reduce the amount of cut-through traffic on local roads;
- Encourage the use of high-occupancy vehicle lanes and ridesharing;
- Improve safety conditions;
- Accommodate current and future truck volumes on highways; and
- Facilitate adequate inspection and enforcement at truck scales.

[21] For more information, go to: http://www.sta.ca.gov/docManager/1000002352/Truck%20Scales%20Study%20-%20Final%20Report%202-16-2005.pdf.

[22] http://www.dot.ca.gov/dist4/documents/80_680_sr12_interch/final_environmental_impact_report_interstate_80_680_state_route_12_interchange_project_vol_1.pdf.

Rail Needs Analysis

Available Rail Capacity

The Martinez Subdivision is UP's principal gateway to the San Francisco Bay Area from the east, hosting both transcontinental traffic via the former Southern Pacific (SP) Overland Route and the former Western Pacific (WP) Feather River Route, as well as traffic from the Pacific Northwest. The Martinez Subdivision between Oakland and Martinez is one of the busiest segments of the northern California rail system. In addition to UP's own traffic, BNSF connects to the Port of Oakland via trackage rights on this portion of the Martinez Subdivision, and various state-supported intercity passenger services (San Joaquin, Capitol Corridor), and Amtrak's California Zephyr and Coast Starlight account for 44 weekday passenger train movements over this segment. Freight traffic on this line typically increased with the rerouting of port-related traffic from the Oakland Subdivision (Oakland to Stockton via Niles Junction) after UP gained access to this more direct route to Sacramento and points north and east as part of the SP acquisition in 1996.

Determining the capacity of a rail line depends on many factors, such and the number of main tracks and type of signaling. Table 2.12 illustrates these attributes and shows the computed practical capacities of the segments of the Martinez Subdivision in the I-80 corridor. In instances where short segments of the rail line are either double or triple tracked, the lower average capacity was used to show the practical limitations of the rail line to support increased traffic volumes. Rail network simulation models would be required to determine the exact capacity of each line illustrated.

Table 2.12 Practical Capacity of Rail Lines in the I-80 Corridor

Subdivision	From:	To:	Number of Main Tracks	Signaling	Average Capacity
UP Martinez	Sacramento	Martinez	3/2	CTC	75
	Martinez	Richmond	2	CTC	75
	Richmond	Emeryville	3/2	CTC	75
	Emeryville	Oakland	2	CTC	75

Source: Altamont Press, "California Region Timetable 20" March 2009.

Existing train volumes on the freight rail line in the I-80 corridor are highlighted in Table 2.13. The table aggregates current average daily freight and scheduled passenger trains to obtain total daily trains.

Table 2.13 Average Daily Train Volumes in the I-80 Corridor

Subdivision	From:	To:	Class I Freight Railroads	Average Daily Freight	Daily Passenger Trains	Total Daily Trains
UP Martinez	Sacramento	Martinez	UP	18	34	**52**
	Martinez	Richmond	UP/BNSF	18	42	**60**
	Richmond	Emeryville	UP/BNSF	17	42	**59**
	Emeryville	Oakland	UP/BNSF	17	40	**57**

Sources: Freight train counts based on 2010 BNSF and 2008 UP train count data. Passenger train counts based on weekday published timetables for summer 2014; and AECOM.

The v/c ratios for the railroad segments that support passenger services in the I-80 Corridor are tabulated in Table 2.14 and described below.

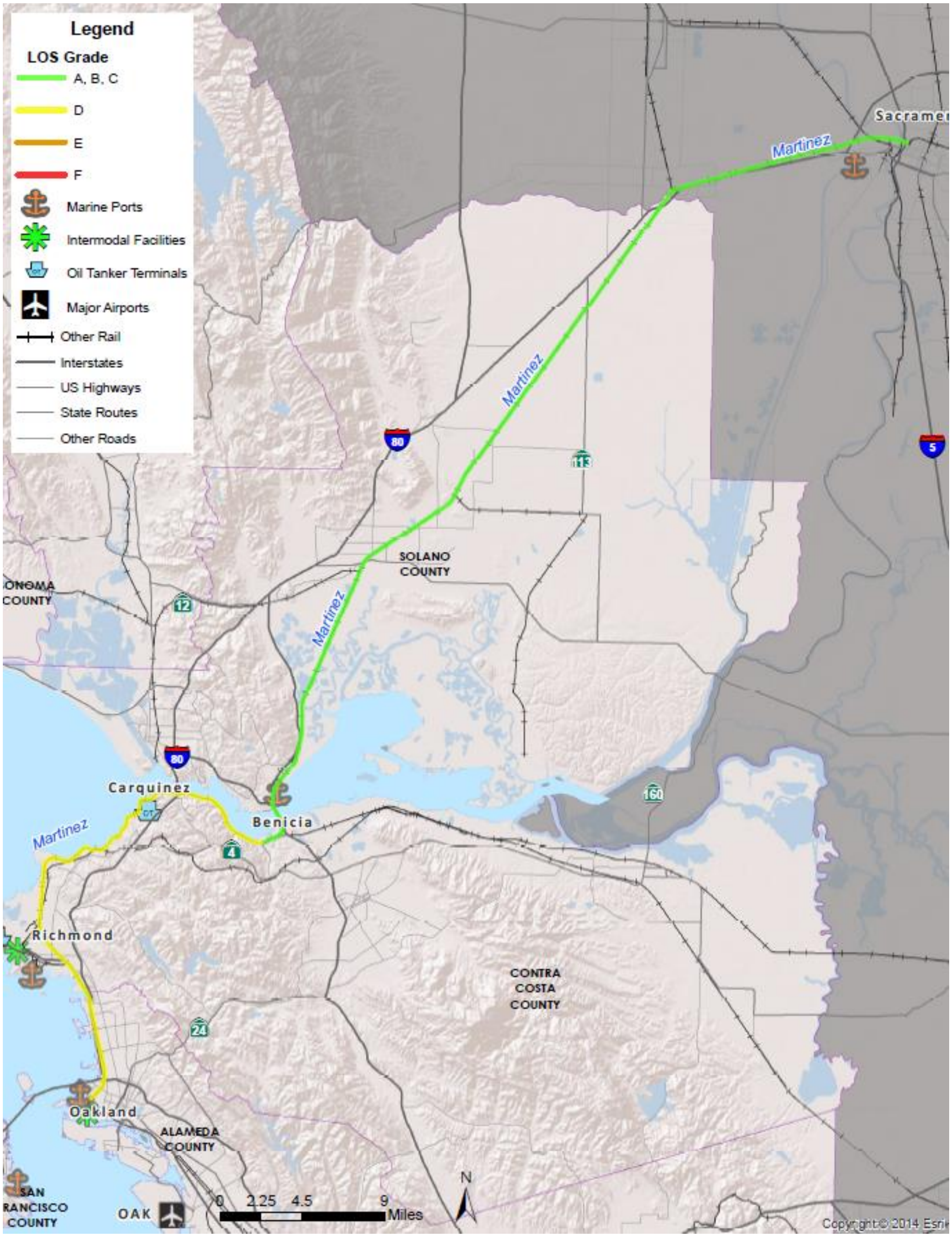
Table 2.14 Rail Lines Level of Service in the I-80 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Martinez	Sacramento	Martinez	3/2	52	75	69.3%	C
	Martinez	Richmond	2	60	75	80%	D
	Richmond	Emeryville	3/2	59	75	78.6%	D
	Emeryville	Oakland	2	57	75	76.0%	D

Source: AECOM calculations.

The UP Martinez Subdivision is currently at LOS C and D. Adding more trains to this segment of the network may result in unstable operating conditions seriously degrading on-time performance of freight service and Capitol Corridor passenger trains. Figure 2.21 provides the existing LOS on the I-80 corridor rail lines in graphical format.

Figure 2.21 Existing LOS on I-80 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Forecast Rail Traffic

The 2013 California State Rail Plan[23] provided a wealth of information on rail movements; in particular it provided train volume estimates and forecasts. Freight train volumes were estimated by rail segment for 2020, 2025 and 2040, and by train service type (i.e., intermodal, automobiles, bulk, and general merchandise). In addition, passenger train forecasts were also available by segment up to 2025. Future train volumes reported in the State Rail Plan for rail segments in the I-80 corridor are as indicated in Table 2.15.

Table 2.15 Future Train Volumes in the I-80 Corridor

			2020 Daily Train Volumes			2040 Daily Train Volumes		
Subdivision	**From:**	**To:**	**Freight**	**Passenger**	**Total**	**Freight**	**Passenger**	**Total**
UP Martinez	Sacramento	Martinez	22	34	56	36	N/A	**N/A**
	Martinez	Richmond	22	44	66	36	N/A	**N/A**
	Richmond	Emeryville	30	44	74	50	N/A	**N/A**
	Emeryville	Oakland	30	42	72	50	N/A	**N/A**

Source: California State Rail Plan, May 2013.

Based on the forecast train volumes in Table 2.16, it is possible to estimate future LOS ratings for each segment of the Martinez Subdivision along the I-80 corridor, as shown in Table 2.16 for the year 2020.

Table 2.16 Rail Lines 2020 Forecast Level of Service in the I-80 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Martinez	Sacramento	Martinez	3/2	56	75	74.7%	D
	Martinez	Richmond	2	66	75	88.0%	E
	Richmond	Emeryville	3/2	74	75	98.7%	E
	Emeryville	Oakland	2	72	75	96.0%	E

Source: AECOM calculations.

Additional freight and/or passenger traffic on the Martinez Subdivision beyond the levels forecast for 2020 would continue to degrade network performance. This is a double-track

[23] AECOM with Cambridge Systematics, *California State Rail Plan*, California Department of Transportation, Rail Division; September 2013.

segment with sufficient projected demand to require at least one additional track. A third track would also facilitate operational reliability.

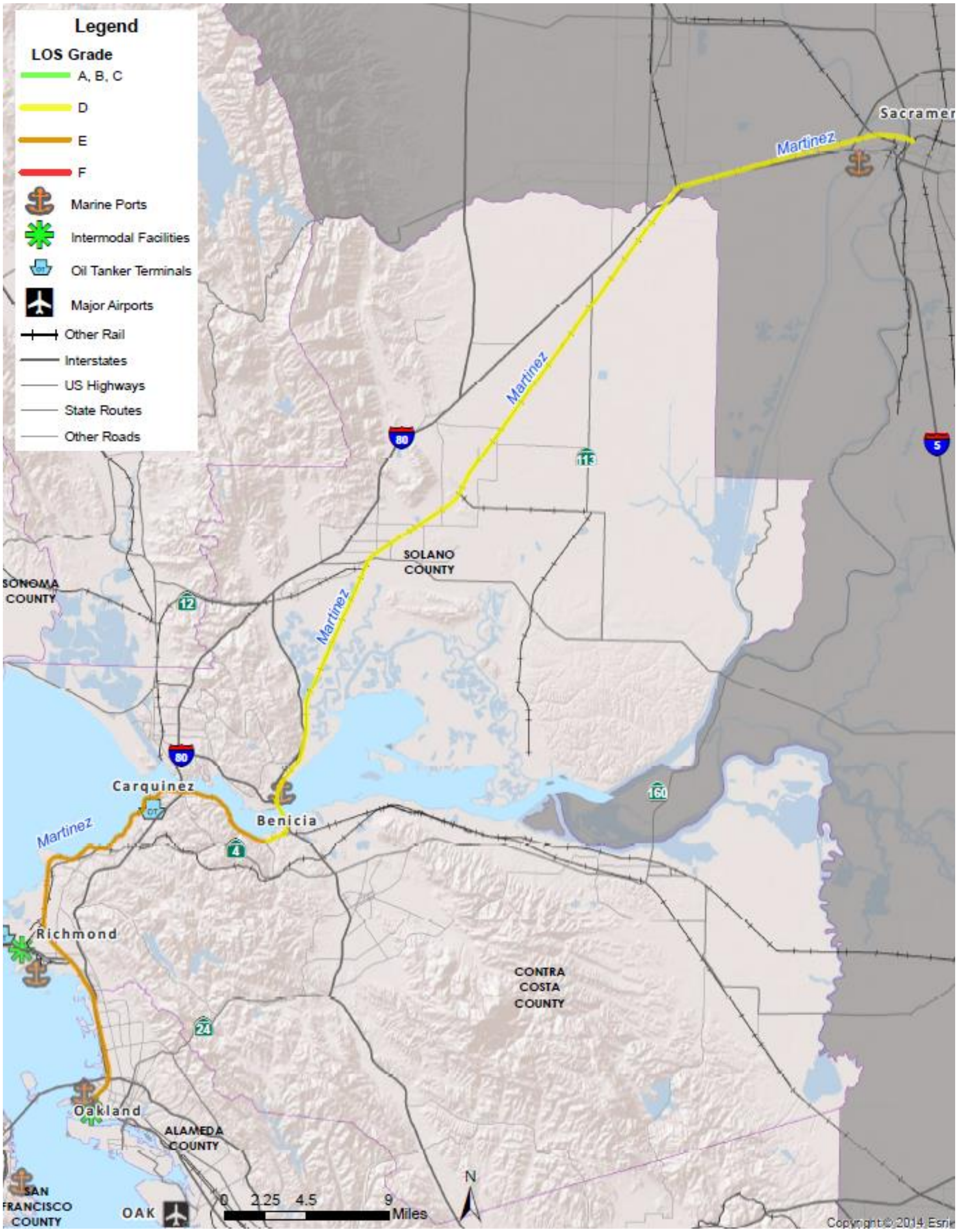
In recent years, most of the focus on the Martinez Subdivision has been on growth in international intermodal rail traffic and potential conflicts with expanded passenger rail services. More recently, there has been growth in movement of crude oil from Canada into the region's oil refineries along the northern Contra Costa waterfront and Benicia. 'New growth in Solano County could also come from other industrial sectors, such as: three vacant Fairfield industrial sites that could be reactivated and unincorporated areas near Dixon that could be developed for agricultural processing[24]. Another potential source of growth could be automobiles processed through the Port of Benicia, which is the Northern California domestic distribution hub for Ford, Chrysler, and Toyota.

'With its roots in petroleum and liquid bulk cargos, the Richmond port area has expanded its dry bulk and break-bulk handling capabilities and has increased its automobile processing facilities. Today, Richmond ranks first in liquid bulk and automobile tonnage among ports on San Francisco Bay. The Port of Oakland sees capacity issues on the Martinez Subdivision as an impediment to increased freight rail service and associated expansion of port activity. This could be exacerbated by the completion of work on Donner Summit, which has the potential to increase traffic on the UP's Overland route.

Figure 2.22 shows the 2020 LOSS along the rail lines in the corridor.

[24] Solano Rail Facilities Plan Update, Preliminary Draft, May 2014.

Figure 2.22 2020 LOS on I-80 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Rail Access and Operational Issues

Some of the most significant bottlenecks in the segment between Sacramento and Benicia are the several locations where switching operations happen on the main line, including Tolenas Industrial Park, Suisun Junction and Davis Station. Constraints at the Tolenas Industrial Park are expected to be addressed by the recently approved project to build a new passenger station and overcrossing at Peabody Road, but other bottlenecks still remain.[25]

Bottlenecks also occur in the segment between Richmond and Emeryville. BNSF shares tracks with UP between Richmond and Oakland. Currently, BNSF trains on the Stockton Subdivision swings west through Richmond to the BNSF rail yard on the west side of the city. Then, the BNSF tracks swing back east and traverse the length of Richmond from west to east. At a location called Stege, the BNSF tracks end at a connection to the UP Martinez Subdivision, which continues south into the Port of Oakland.

Trains using BNSF tracks through Richmond must travel at low train speeds that often result in blocking traffic at grade crossings for extended periods. The longer route and slow speeds increase the amount of time it takes BNSF trains to reach the Port of Oakland. The slow-moving BNSF trains accessing the Martinez Subdivision at Stege also impact Capitol Corridor and San Joaquin passenger and UP freight trains, reducing their on-time performance and reliability.

A new connector track between the BNSF and the UP tracks is under construction in the northern portion of Richmond to facilitate movement of trains between the two railroads and to avoid train movements through downtown Richmond. By substantially reducing the number of slow-moving intermodal trains in the center of the City, the connector will also relieve traffic congestion.

At-Grade Highway-Rail Crossing Safety and Delay Issues

This section identifies the major at-grade crossings on the UP Martinez Subdivision on the I-80 Corridor and presents accident statistics and estimated traffic delay for these crossings. The location and accident history of these crossings appears in Table 2.17.

Table 2.17 At-Grade Crossings Accidents on the I-80 Corridor

				Accident History (January 2004 – June 2014)			
City	Street	Crossing Number	Railroad	Number of Incidents	Fatal	Injury	Property Damage Only
Berkeley	Bancroft Way	751176H	Union Pacific	1	1	0	0

[25] Ibid.

City	Street	Crossing Number	Railroad	Accident History (January 2004 – June 2014) Number of Incidents	Fatal	Injury	Property Damage Only
	Gilman Street	751199P	Union Pacific	1	1	1	0
	Cedar Street	751183T	Union Pacific	0	0	0	0
	Hearst Street	751179D	Union Pacific	0	0	0	0
Richmond	Cutting Boulevard	751678U	Union Pacific	4	2	0	2
	Chesley Avenue	751691H	Union Pacific	3	2	1	1
	Market Avenue	751692P	Union Pacific	5	0	2	3
	Brookside Drive	751693W	Union Pacific	2	0	0	2
	Parr Boulevard	751694D	Union Pacific	No accident file			
Martinez	Berrellessa Street	751733S	Union Pacific	0	0	0	0
	Ferry Street	751734Y	Union Pacific	4	0	4	1
Benicia	Pierce Road	751494U	Union Pacific	1	0	18	3
Suisun City	Cordelia Road	751298M	Union Pacific	0	0	0	0
Fairfield	Sunset Avenue	751295S	Union Pacific	2	2	0	2
	East Tabor Avenue	751294K	Union Pacific	2	0	2	2
	Peabody Road	751292W	Union Pacific	1	0	0	1
	Cannon Road	751291P	Union Pacific	2	0	2	2
Elmira	Fry Road	751289N	Union Pacific	2	1	7	2
	Elmira Road	751288G	Union Pacific	1	0	0	0
	Hawkins Road	751260R	Union Pacific	0	0	0	0
	Lewis Road	751259W	Union Pacific	0	0	0	0
	Fox Road	751258P	Union Pacific	0	0	0	0
Emeryville	65th Street	751151M	Union Pacific	0	0	0	0
Dixon	Weber Road	751257H	Union Pacific	0	0	0	0
	Batavia Road	751256B	Union Pacific	0	0	0	0
	Midway Road	751255U	Union Pacific	2	1	0	2
	Pitt School Road	751254M	Union Pacific	1	0	0	1
	A Street	751253F	Union Pacific	0	0	0	0
	First Street	751250K	Union Pacific	0	0	0	0
	Vaughn Road	751249R	Union Pacific	0	0	0	0
	Pedrick Road	751248J	Union Pacific	0	0	0	0
	Robben Road	751247C	Union Pacific	1	1	0	0
	Tremont Road	751246V	Union Pacific	1	0	1	2
Davis	Old Davis Road	751241L	Union Pacific	0	0	0	0

Source: U.S. DOT Crossing Inventory.

The next step is to calculate delay experienced at these crossing locations. Traffic delay at at-grade crossings is customarily measured in terms of vehicle-hours of delay per day. The daily train volumes for freight and passenger trains, as presented above in Table 2.17, were used to calculate gate blockage time. Gate blockage time was combined with estimated traffic volumes in a formula to calculate vehicle hours of delay at each crossing. The results are shown in Table 2.18.

Table 2.18 At-Grade Crossings Hourly Traffic Delay

City	Street	Railroad	Subdivision	Traffic Delay (Vehicle Hours/Day)		
				Freight	Passenger	Total
Berkeley	Bancroft Way	Union Pacific	Martinez	0.91	0.21	**1.12**
Richmond	Cutting Boulevard	Union Pacific	Martinez	1.19	0.36	**1.55**
	Chesley Avenue	Union Pacific	Martinez	0.89	0.50	1.38
	Market Avenue	Union Pacific	Martinez	1.61	0.50	2.11
	Brookside Drive	Union Pacific	Martinez	1.85	0.00	1.85
	Parr Boulevard	Union Pacific	Martinez	1.17	0.00	1.17
Martinez	Berrellessa Street	Union Pacific	Martinez	1.21	0.50	1.70
	Ferry Street	Union Pacific	Martinez	1.21	0.50	1.70
Benicia	Pierce Road	Union Pacific	Martinez	0.00	0.23	0.23
Suisun City	Cordelia Road	Union Pacific	Martinez	1.56	0	1.56
Fairfield	Sunset Avenue	Union Pacific	Martinez	0.27	0.19	0.46
	East Tabor Avenue	Union Pacific	Martinez	1.56	0	1.56
	Peabody Road	Union Pacific	Martinez	0.68	0	0.68
	Cannon Road	Union Pacific	Martinez	1.56	0	1.56
Elmira	Fry Road	Union Pacific	Martinez	0.69	0	0.69
	Elmira Road	Union Pacific	Martinez	0.69	0	0.69
	Hawkins Road	Union Pacific	Martinez	0.69	0	0.69
	Lewis Road	Union Pacific	Martinez	0.68	0	0.68
	Fox Road	Union Pacific	Martinez	0.68	0	0.68
Dixon	Weber Road	Union Pacific	Martinez	0.69	0	0.69
	Batavia Road	Union Pacific	Martinez	0.69	0	0.69
	Midway Road	Union Pacific	Martinez	0.68	0	0.68
	Pitt School Road	Union Pacific	Martinez	0.69	0	0.69
	A Street	Union Pacific	Martinez	0.68	0	0.68
	First Street	Union Pacific	Martinez			
	Vaughn Road	Union Pacific	Martinez	0.68	0	0.68
	Pedrick Road	Union Pacific	Martinez	0.69	0	0.69
	Robben Road	Union Pacific	Martinez	0.69	0	0.69
	Tremont Road	Union Pacific	Martinez	0.68	0	0.68
Davis	Old Davis Road	Union Pacific	Martinez	0.69	0	0.69

Source: AECOM calculations.

Determining the at-grade crossings most in need of grade separation can be based on two factors: the frequency and severity of accidents and the amount of delay experienced by roadway traffic. The Cutting Boulevard, Chesley Avenue, and Sunset Avenue crossings each had two fatal accidents, and the Fry Road, Midway Road, and Robben Road crossings had one fatal accident each.

In terms of traffic delay, Table 2.18 shows that Market Avenue has the greatest delay, followed by Brookside Drive, Berrellessa Street, and Ferry Street. Among grade crossings in the corridor, little correlation is observed between crossings with higher accident rates and crossings with high traffic delay.

Focusing on crossings with high accident rates, this suggests that the crossings be ranked in the following order for consideration of grade separation, with those having multiple fatal accidents at highest priority:

- Chesley Avenue (because it had an injury accident in addition to the two fatal accidents);
- Cutting Boulevard (because it has the highest level of delay among the crossings with multiple fatal accidents); and
- Sunset Avenue.

Prioritization for grade separation would then be followed by the crossings with a single fatal accident:

- Fry Road (because it had an additional seven injury accidents);
- Midway Road (tie); and
- Robben Road (tie).

2.3 The I-580 Corridor

2.3.1 Overview, Industry Drivers, and Growth Trends

I-580 corridor is the most heavily used interregional truck corridor in the Bay Area with more than 20,000 trucks per day, and connects the Bay Area and I-880 with I-205 to distribution warehouses in northern San Joaquin Valley that serve the Bay Area and is the primary route for agriculture exporters in the San Joaquin Valley. Facilities providing connectivity on the corridor include the I-680 and I-238 freeways, a UP rail line (Oakland Subdivision), and the M-580 marine highway between the Port of Oakland and the Port of Stockton[26]. I-680 provides connectivity to the South Bay and up to the North Bay where it connects with I-80. The corridor also includes the Port of Richmond, a deepwater marine port with terminals managed by the Richmond Pacific Railroad (RPRC) and BNSF. As described in Task 2c: Infrastructure, Services, and Demographic/Freight Flow Trends, portions of the corridor from San Leandro to the Grand Avenue exit in Oakland are truck-restricted. Table 2.19 provides a corridor summary.

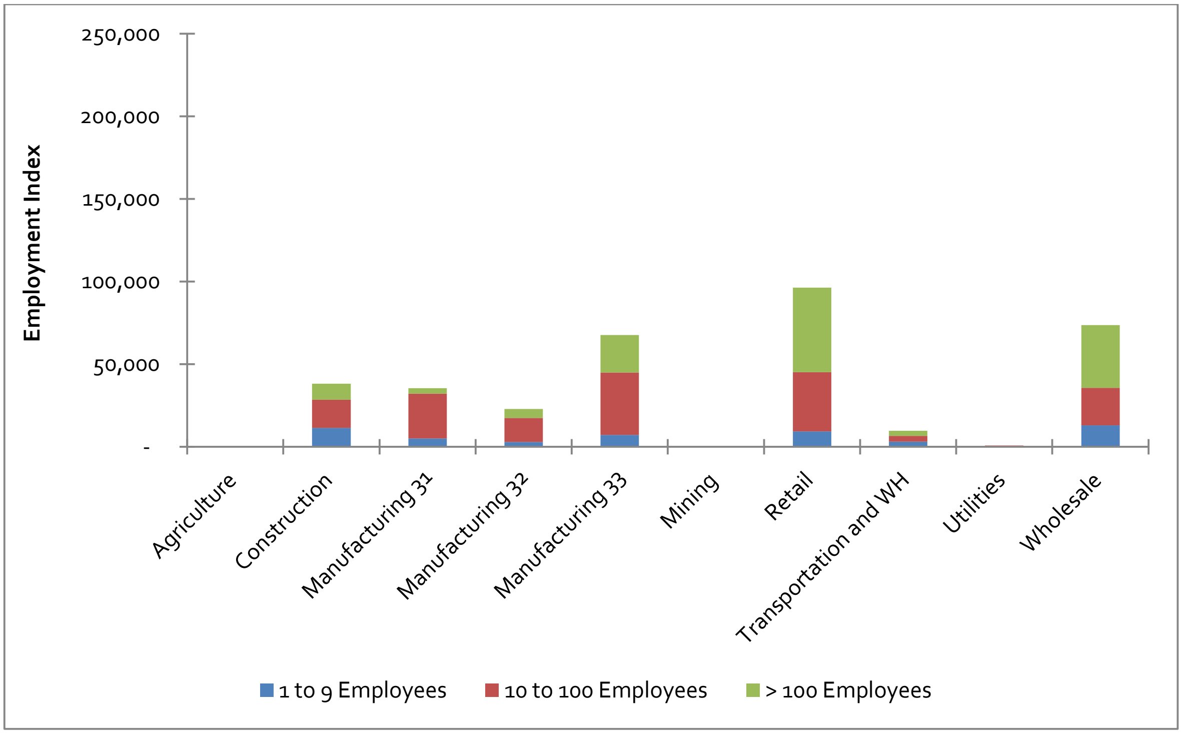
Table 2.19 I-580 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Contra Costa, Alameda	I-580/SR 238 (Altamont Corridor)	UP Oakland Subdivision, M580 Marine Highway, Port of Richmond	Interregional	Primary truck corridor connecting the Bay Area to the rest of the U.S.. Secondary freight rail line that is expected to grow increasingly important with expansion of rail terminal at the Oakland Army Base and crowding on the Martinez Subdivision.

Figure 2.23 through Figure 2.26 display the industry profile along the corridor. The corridor has a total manufacturing employment index of more than 125,800 employees, most of which are in metal, machinery and computer manufacturing. Along the corridor, manufacturing activities are found near the junction with I-680 in the urban areas of Pleasanton and Livermore. This likely includes a mixture of machinery and consumer products manufacturing. Very little manufacturing activity exists between I-680 and I-880. Because of the truck restriction along the northern portion of I-580, there is also little to no manufacturing activities that exist along that portion of the corridor. Employment in retail follows a similar pattern, with the exception of moderate levels of retail development along the truck restricted portion of the corridor, which connects suburban population centers. Finally, moderate levels of agriculture activity exist around the corridor. Figures 2.20 through Figure 2.24 display the industry profile along the corridor.

[26] The M-580 marine highway is currently not operational, as of January 2015.

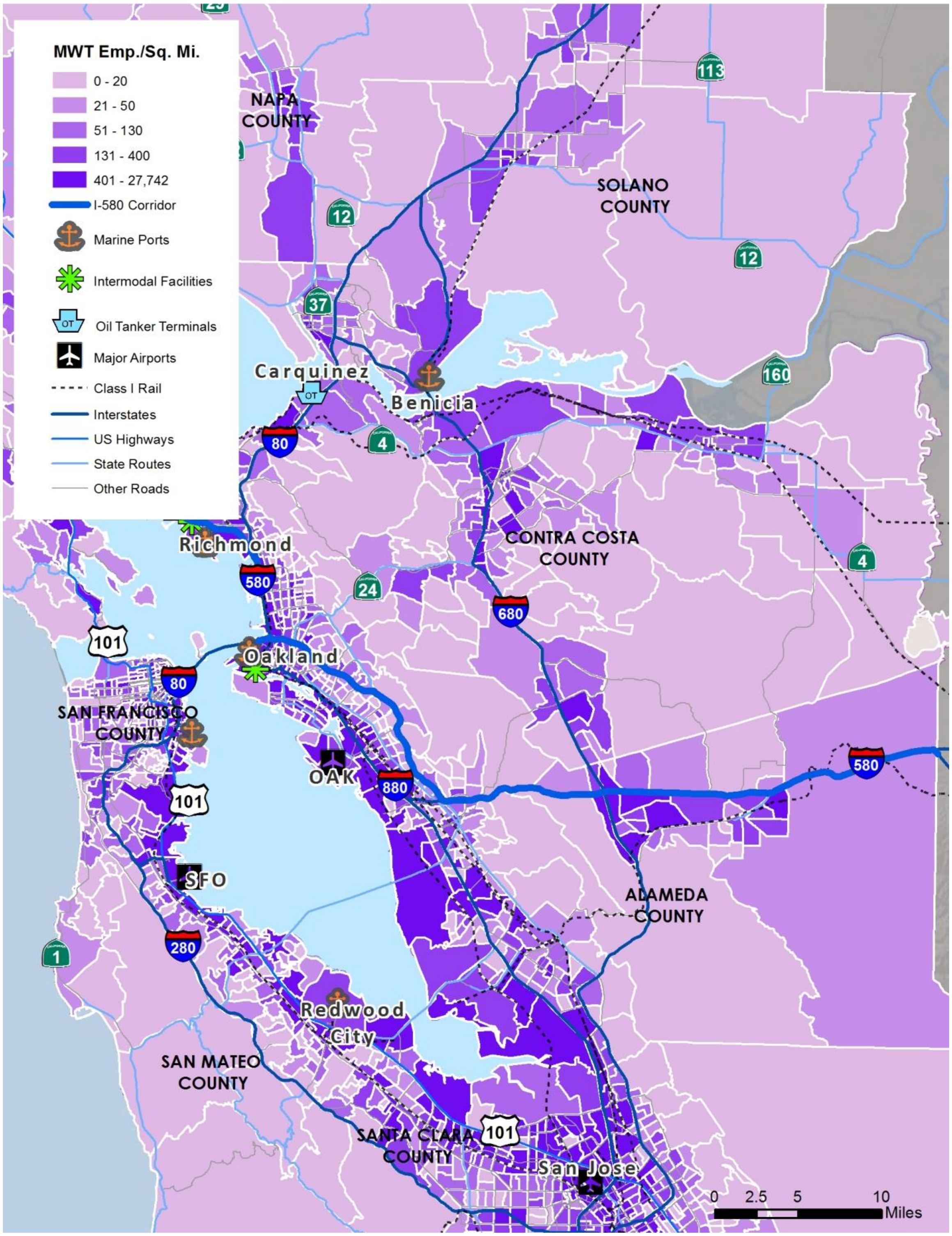
Figure 2.23 Employment Index for Goods Movement-Dependent Industries, I-580
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

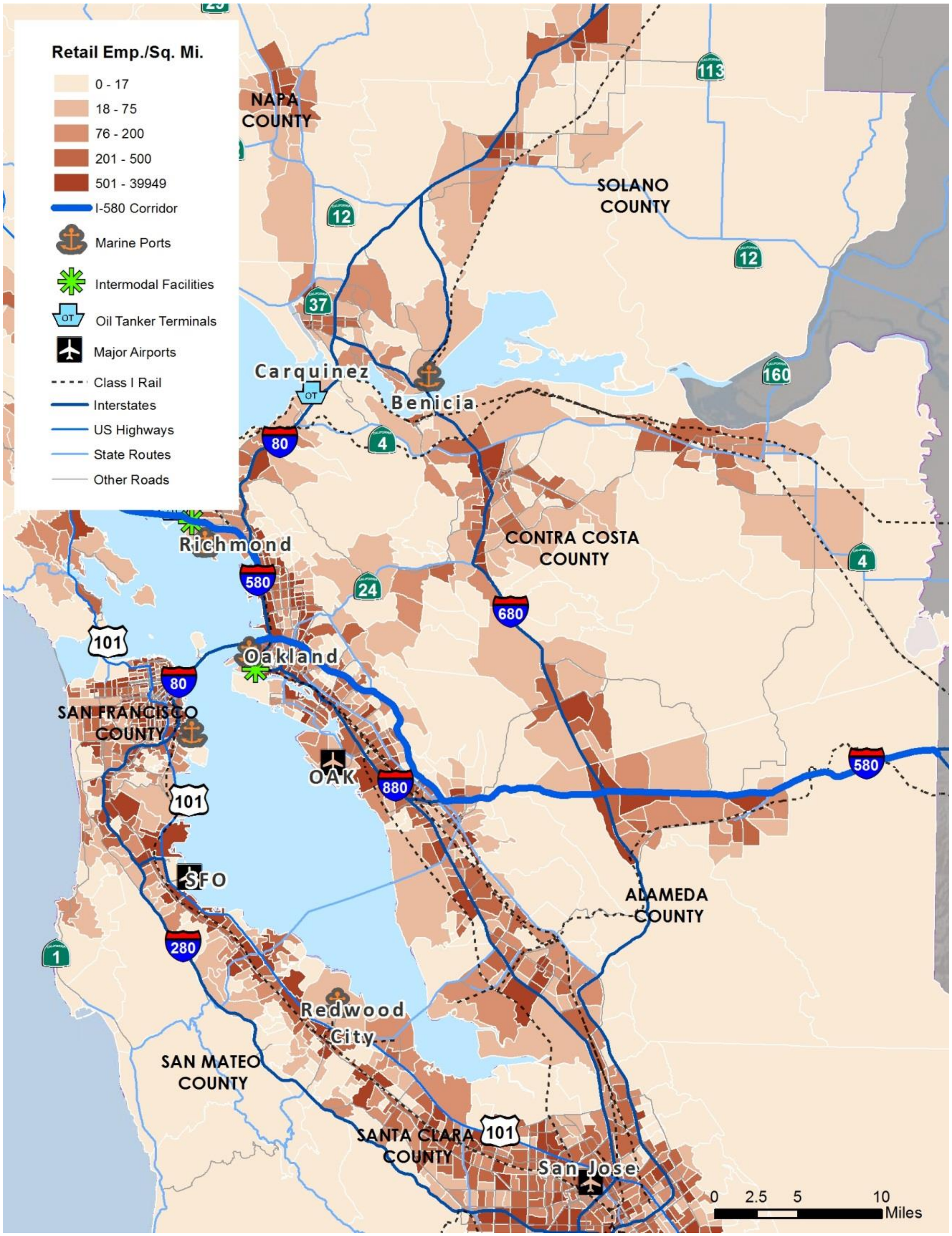
Figure 2.24 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along I-580



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.25 TAZ Level Employment Density in the Retail Sector along I-580



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.26 TAZ Level Employment Density in the Agriculture Sector along I-580

Source: MTC.

Note: Employment Density is in employees per square mile.

International intermodal cargo[27] by and large is loaded at the port and does not go by truck on I-580 (except a small amount that is transloaded to domestic containers and shipped out of intermodal facilities in the SJV). However, significant volumes of domestic truck traffic move on the corridor, given mountain passes on I-80. Domestic intermodal is typically inbound traffic and is unloaded in the SJV and trucked back in to Bay Area businesses and consumers using the corridor. Some of this traffic will be moved to expanded intermodal facilities directly at the OAB but overall domestic intermodal is going to grow and there will be expanded intermodal capacity in the Valley as well. Thus, domestic intermodal with trucking into the Bay Area is going to grow – just not as fast as it would if OAB didn't handle domestic intermodal. There also is a lot of construction-related traffic on I-580 providing construction material to residential and commercial projects in the region.

2.3.2 Analysis

The I-580 corridor's most significant issues are related to highway congestion in the Southern portion of the corridor from I-238 to Livermore. In addition, there are pavement condition needs on the northern portion of the corridor. It should be noted that the discussion regarding the I-580/80 East shore portion is entirely covered in Section 2.2 (I-80). Table 2.20 summarizes the corridor evaluation.

Table 2.20 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/air quality/public health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel Time Reliability	Buffer time index on freight (truck) routes	●	Poor reliability in the portion of the corridor from SJ County line to junction with I-680, WB in AM, and eastbound in PM period
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	●	Second highest number of truck crashes per lane-mile among all corridors.
		Crashes at at-grade rail crossings	N/A	N/A

[27] Cargo moved in international standard containers that can be transferred among rail, trucks and carrier vessels.

Goals	Measures	Metrics	Rating	Rating Explanation[a]
	Freight infrastructure conditions	Bridge conditions ratings	🟡	Second lowest bridge ratings among all corridors.
		Freight (truck) highway and arterial routes pavement conditions ratings	🔴	Second lowest pavement rating score, with 28% of lane miles in distressed conditions – most of which are located on the truck restricted portion of I-580
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system.	Use of innovative technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions	Travel time delay	Travel time delay on freight (truck) routes	🔴	Significant truck delay occurs near Livermore Valley. In the AM, delay is worst from SJ county line to Fallow Road. PM congestion worst near I-680 and by Livermore.
		Travel time delay on railways, terminals, ports, airports	🟢	Current LOS on Oakland Subdivision is A, though Niles Junction is a pinch point; At-grade crossings accessing Port of Richmond presents issues
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	🟢	ACE operations on Oakland subdivision currently have no capacity constraints, but may likely expand operations in the future
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic Contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

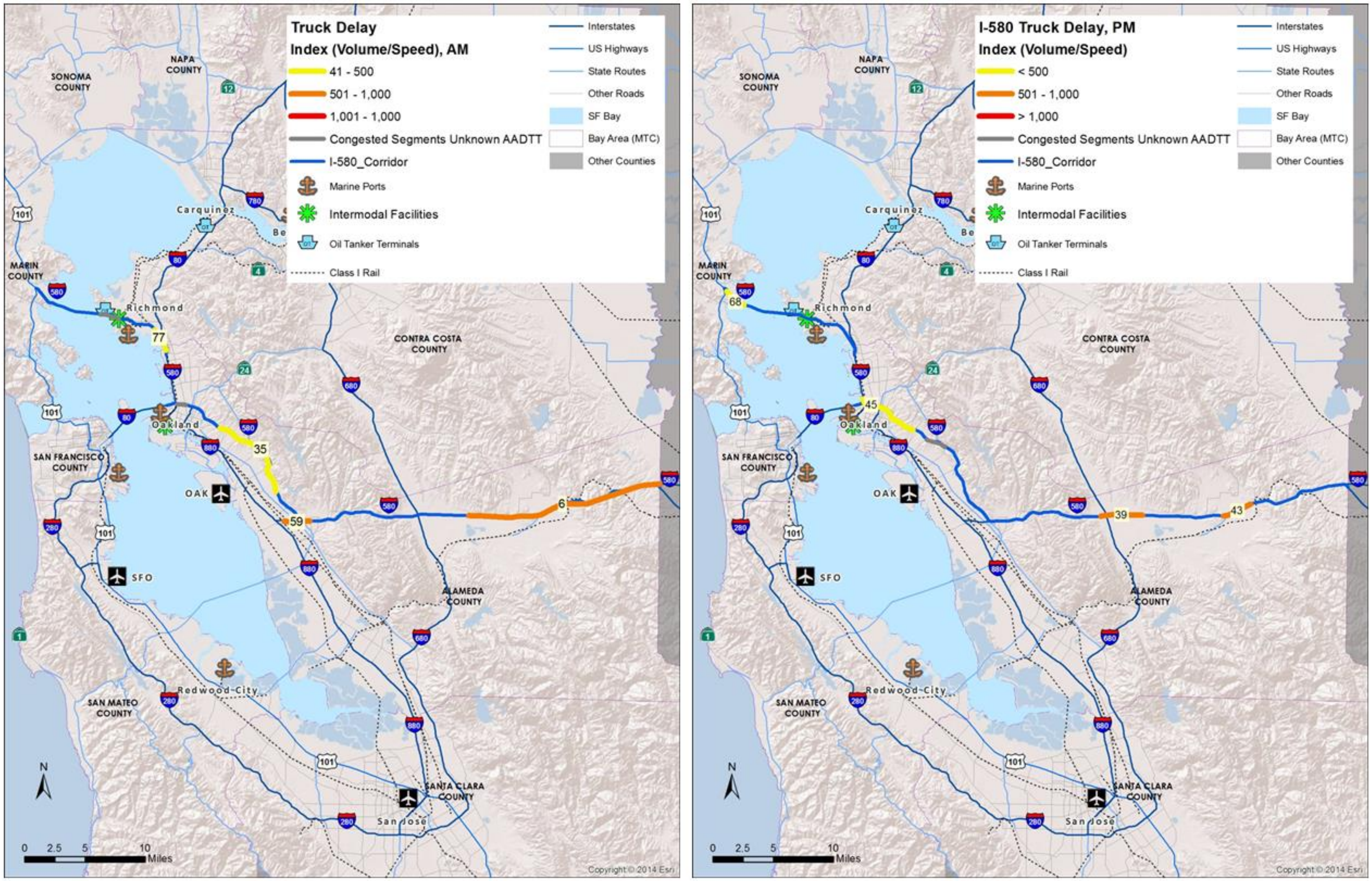
Congestion/Delay

Overall traffic volumes on I-580 are highest in major population centers such as Oakland and Dublin/Pleasanton. However, because of the truck prohibition on I-580 through Oakland, truck volumes are most significant on I-580 East between I-238 and I-205. In this segment, truck volume (2+ axles) can be as high as 20,000 a day, and heavy trucks (5+ axles) comprise the vast majority of those truck trips. The number of trucks between Emeryville and San Rafael is significantly less in comparison, with only about 5,000 trucks per day.

As illustrated in Figure 2.27, the most significant truck delay on I-580 occurs in the Livermore Valley, between the Dublin grade and the Altamont pass. In the AM period, the congestion runs westbound from the San Joaquin County line to Fallon Road (Segment 6). This 16.6-mile section typically flows at an average speed of less than 16 mph during the peak period. This traffic is composed of inbound commuters driving from Stockton, Tracy, and surrounding areas to jobs in the Bay Area plus heavy-truck traffic bound for the Port of Oakland and Bay Area retail deliveries. A short segment of westbound congestion occurs at the interchange of I-238 and I-580, running from Castro Valley Boulevard to I-880 (Segment 59). The 2.2-mile stretch has average speeds of 11.7 mph between 6:10 AM and 11:15 AM. The congestion and delay on this segment is more likely due to complex merging activity in the area, with heavy trucks merging from I-580 westbound to I-880 northbound while many commuters are traveling from I-580 eastbound to I-880 southbound.

The most significant truck delay during the PM period occur at two sections running eastbound for 3.5 miles from I-680 to Santa Rita Road (Segment 39) and for 2.5 miles from First Street to Greenville Road (Segment 43). The former has an average speed of 18.6 mph from 3:45 p.m. to 6:05 p.m. and the latter has an average speed of 13.4 mph between 3:15 p.m. and 6:45 p.m. As in the morning, much of this traffic is Bay Area commuters returning home and truck traffic headed back to the San Joaquin Valley.

Figure 2.27 Truck Delay on Congested Segments along I-580, Peak Periods



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Travel Time Reliability

Truck reliability along the corridor is shown in Figure 2.28. In the AM peak, truck reliability is worst along the most congested segments (i.e., the portion of I-580 from the San Joaquin County line to the junction with I-680, in the westbound direction). The BTI along that portion of the corridor is 1.88, which means that 188 percent extra time must be buffered in for truck trips traveling along that segment. This segment is also the most unreliable corridor in the PM peak period. However, the unreliability in the PM period occurs in the eastbound direction (with a BTI of 1.31), consistent with commuting patterns.

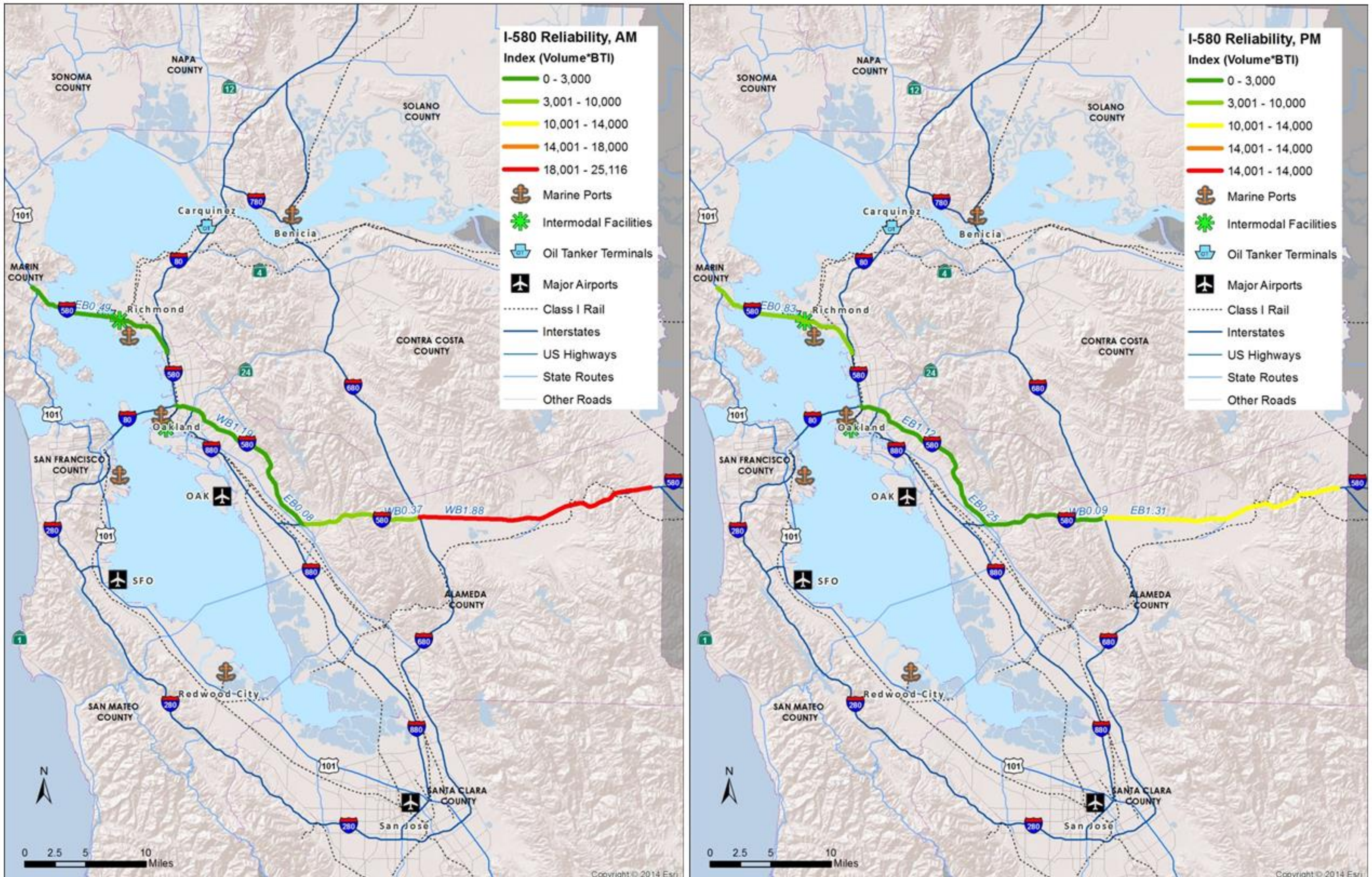
Pavement and Bridge Conditions

The I-580 corridor has the second lowest average bridge sufficiency rating at 82.28. Of the 136 bridges along this corridor, 93 have a rating in excess of 80 and 1 has a rating below 50. I-580 also has the second lowest weighted pavement score with 2.35 out of 3. This corridor has the second highest percentage of lane miles in distressed condition with only 63 percent of all lane miles are in good/excellent condition while 28 percent are considered to be in distressed condition. Figure 2.29 shows the bridge and pavement conditions along the corridor. While the bridge ratings show no discernable correlations with geography, a significant majority of the distressed lane-mileage on I-580 is located between the Maze and I-238. While much of this section is prohibited for use by large trucks, a large number of smaller trucks do use the facility.

Safety

The I-580 corridor has the second highest number of truck crashes per lane-mile among the study corridors at 1.6. From 2003 to 2012 there were 617 truck crashes along the corridor. Of these crashes 14 were fatal. Figure 2.30 shows the truck-involved crash rates along the corridor. The crash rates are highest near the interchange with I-680 (most likely due to interchange-involved merging and weaving), the portion of I-580 from the SR 13 split to the Maze, as well as the portions from Albany to Richmond, where it splits from I-80.

Figure 2.28 Reliability on Segments along I-580, Peak Periods, 2013



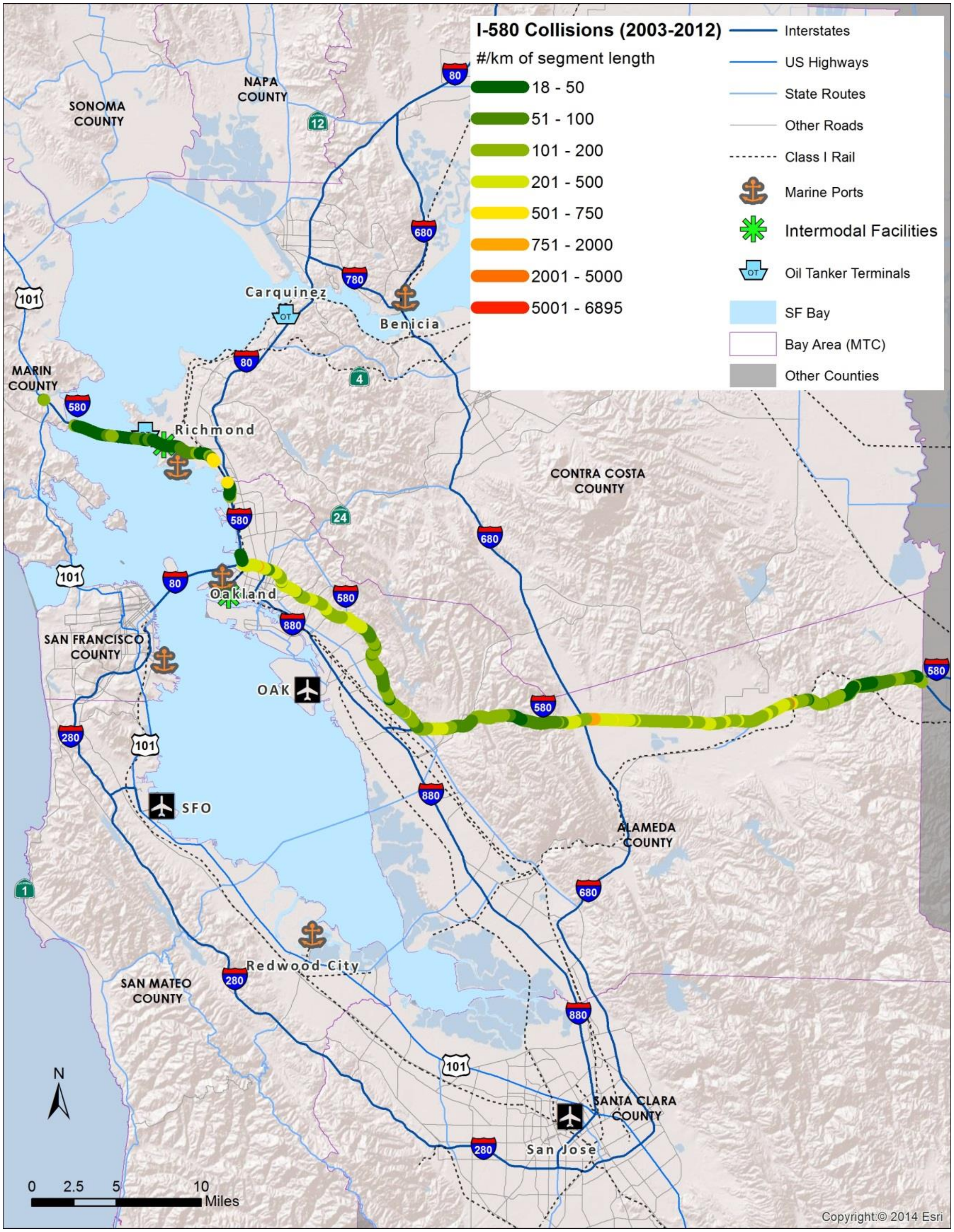
Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Figure 2.29 Pavement and Bridge Existing Conditions along I-580

Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.30 Truck Involved Crash Rates along I-580



Source: SWITRS; Cambridge Systematics Analysis.

Rail Needs Analysis

Mainline Congestion/Capacity

The original route of the first transcontinental railroad from Oakland to Sacramento was through the Niles Canyon and over the Altamont Pass to Lathrop, Stockton and Sacramento. This route was constructed by the Central Pacific, which eventually became part of the Southern Pacific Railroad (SP). The Western Pacific Railroad (WP) was a Class I railroad formed in 1903 in an attempt to break the near-monopoly the Southern Pacific had on rail service into Northern California. WP's Feather River Route directly competed with SP's portion of the original transcontinental railroad route for rail traffic between Oakland and Salt Lake City/Ogden, Utah. In 1982 the Western Pacific was acquired by the Union Pacific Railroad to provide access to Northern California. In 1996, Southern Pacific was merged into the Union Pacific.

After the merger with Southern Pacific, the legacy transcontinental Central Pacific route between Niles Junction and Tracy was abandoned in favor of the parallel WP route through Niles Canyon, todays Oakland Subdivision. Alameda County owns the historic Central Pacific right-of-way and leases it to the Niles Canyon Railway, which provides tourist rail services between Niles and Sunol.

The primary rail infrastructure in the I-580 Corridor is the UP Oakland Subdivision, which carries the primary east-west traffic moving between the Bay Area and the San Joaquin Valley. The portion of the Oakland Subdivision from Niles Junction to Lathrop is used by both UP freight trains and Altamont Corridor Express (ACE) commuter passenger trains. ACE trains leave the Oakland Subdivision at Niles Junction, operating on the Niles Subdivision to Newark and then south to San Jose on the Coast Subdivision. ACE service is now operating 8 trains each weekday. ACE has reached a tentative agreement with the UP to run up to 12 trains per day between Stockton and San Jose.

Traffic levels have actually decreased significantly on the Oakland Subdivision since UP acquired the SP in 1996. Much of the traffic that used to traverse the Oakland Subdivision between Sacramento, Stockton and Oakland, San Jose and Milpitas now takes the more direct, shorter route to Sacramento by utilizing the Martinez Subdivision.

According to the California State Rail Plan, in 2025, overall freight rail demand is anticipated to grow moderately on the UP Oakland line. There are, however, several trends which could increase freight volumes in the future. First, there could be future capacity constraints on the Martinez subdivision (see I-80 Corridor) due to growth in international and domestic intermodal trains and passenger trains that could cause UP to reroute some of its freight traffic to the Oakland subdivision. Second, there are new sources of freight rail traffic that could come to the Bay Area as a result of growth in freight rail at the former Oakland Army Base. This traffic, which would likely be primarily bulk exports, might be routed on the Oakland subdivision to avoid scheduling conflicts with passenger and premium freight rail services that will be operating on the Martinez subdivision. Finally, the Altamont Commuter Express (ACE) passenger service, which operates on the Oakland subdivision in the I-580 corridor, is hoping to expand its operation.

In a capacity study conducted in 2013 by UP as part of the Northern California Unified Service Concepts Analysis (a working group including UP and the passenger rail service providers), they reported freight train volumes of 10 train movements per day on the Oakland Subdivision between Lathrop and Niles. This volume appears high as compared to analysis of train demand from data on commodity movements in the Bay Area. The California State Rail plan estimated approximately 4 trains per day on this portion of the Oakland Subdivision. At Niles, the preferred freight route to Oakland switches to the Niles Subdivision to reach Newark where it switches to the Coast Subdivision. If the UP numbers represent more typical operations on the Oakland Subdivision, there could be a greater need for additional capacity on the portion of the subdivision from Lathrop to Niles than is indicated in this report.

Available Rail Capacity. As described above, the current train volumes on the Oakland Subdivision are not large, but may increase due to shifting rail utilization and/or added passenger service. Increased demand for freight rail services and the desire to operate more passenger trains could constrain the ability of the existing railroads to support this growing demand. As demand approaches capacity, there will be increasing delays for all users of the system.

Table 2.21 illustrates the practical capacity of the Oakland Subdivision. In locations where short segments of the rail line are either double or triple tracked, the lower average capacity was used to show the practical limitations of the rail line to support increased traffic volumes. Rail network simulation models would be required to determine the exact capacity of each line illustrated.

Table 2.21 Practical Capacity of Rail Lines in I-580 Corridor

Subdivision	From:	To:	Number of Main Tracks	Signaling	Average Capacity
UP Oakland	Niles Junction	Stockton	1	CTC	30

Source: Altamont Press, "California Region Timetable 20" March 2009.

Existing train volumes on this line are highlighted in Table 2.22. The table aggregates current average daily freight and scheduled passenger trains to obtain total daily trains.

Table 2.22 Average Daily Train Volumes in the I-580 Corridor

Subdivision	From:	To:	Class I Freight Railroads	Average Daily Freight	Daily Passenger Trains	Total Daily Trains
UP Oakland	Niles	Stockton	UP	4	8	12

Sources: Freight train counts based on 2010 BNSF and 2008 UP train count data. Passenger train counts based on weekday published timetables for summer 2014.

Comparing train volumes (v) to practical capacity c) gives a sense of the potential for any line to be so congested that trains might be delayed. The v/c ratio for the railroad segment in the I-580 corridor is tabulated in Table 2.23, and described in the following paragraph.

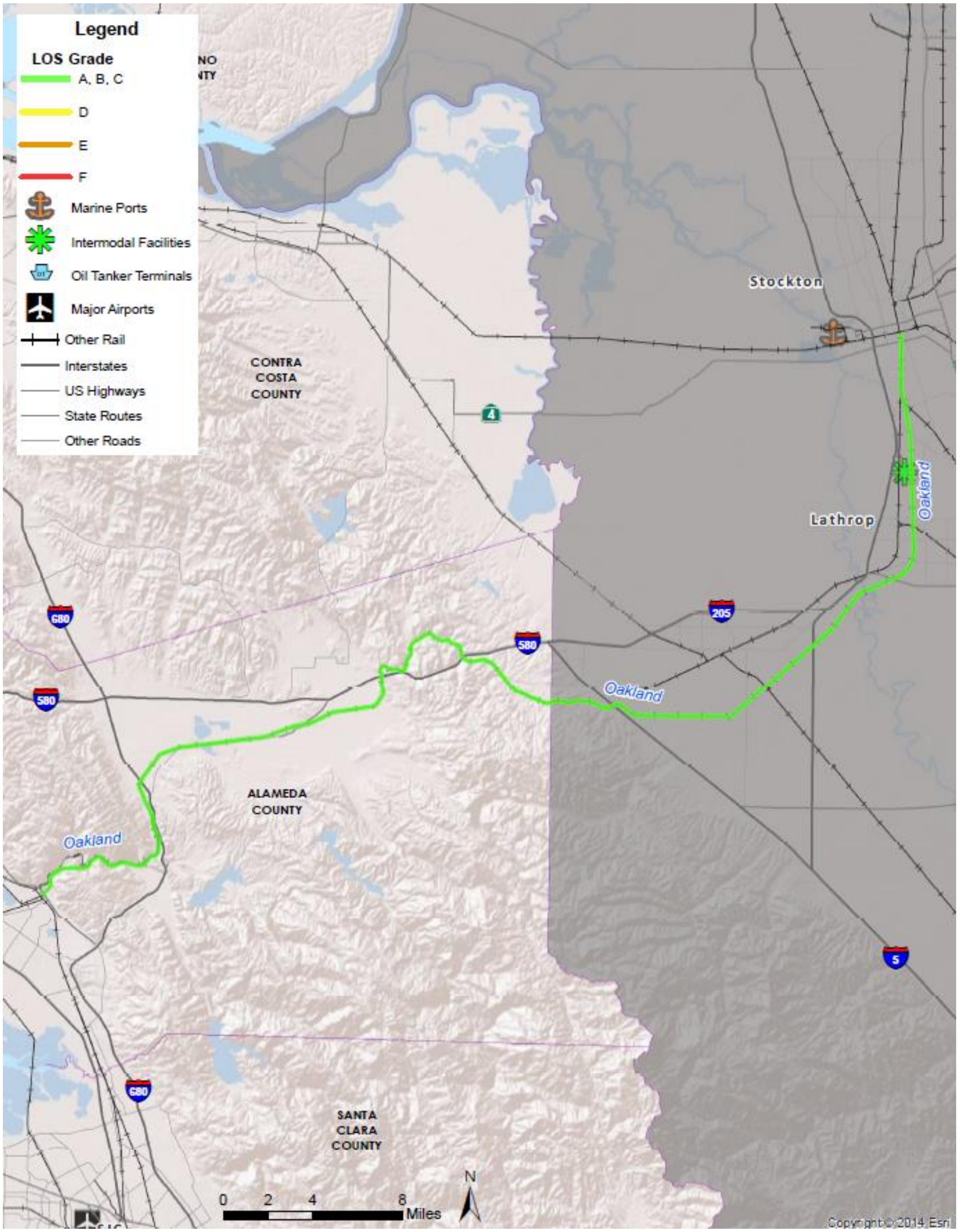
Table 2.23 Rail Lines Level of Service in the I-880 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Oakland	Niles	Stockton	1	12	30	40.0%	B

Source: AECOM calculations.

The Oakland Subdivision is a single track line that runs through Niles Canyon and over the Altamont Pass along the legacy WP Feather River Route. The line has many curves restricting speeds in some segments of the line to 30 mph or less. Pinch points exist in Lathrop where level crossings with other UP lines occur. The Oakland Subdivision is at LOS B. However, the level crossing and interlockings at Niles Junction and Lathrop restrict the flow of trains through this critical segment of the railroad network impeding the flow of trains. Figure 2.31 provides the existing LOS on the I-580 corridor rail lines in graphical format.

Figure 2.31 Existing LOS on I-580 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Forecast Rail Traffic. The 2013 California State Rail Plan[28] provided a wealth of information on rail movements; in particular it provided train volume estimates and forecasts. Freight train volumes were estimated by rail segment for 2020, 2025 and 2040, and by train service type (i.e., intermodal, automobiles, bulk, and general merchandise). In addition, passenger train forecasts were also available by segment up to 2025. Future train volumes reported in the State Rail Plan for the rail segment in the I-580 corridor are indicated in Table 2.24.

Table 2.24 Future Train Volumes in the I-580 Corridor

			2020 Daily Train Volumes			2040 Daily Train Volumes		
Subdivision	From:	To:	Freight	Passenger	Total	Freight	Passenger	Total
UP Oakland	Niles	Stockton	11[a]	12	23	15	N/A	N/A

Source: California State Rail Plan, May 2013.

[a] Oakland Army Base Area Outer Harbor Intermodal Terminal Project Environmental Impact Report, August 2012.

As mentioned above, one major driver of changes in rail volumes and flow patterns on the Oakland Subdivision are the plans for the Oakland Army Base (OAB) redevelopment. On the Oakland Subdivision, where it is assumed UP may carry its nonintermodal cargo coming from and going to the Port of Oakland, there is expected to be significant growth on the Niles to Stockton/Lathrop segment and this will impact capacity in this corridor. The changes in capacity utilization and LOS are presented in Table 2.25.

Table 2.25 Rail Lines 2020 Forecast Level of Service in the I-580 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Oakland	Niles	Stockton	1	23	30	77%	D

Source: AECOM calculations.

As indicated, the planned future growth in train volumes for freight and passenger services degrades the overall network. The UP Oakland Subdivision through Niles Canyon degrades to LOS D based on existing forecasts. I-In light of the congestion on the Martinez Subdivision, there is potential for UP to use the Oakland Subdivision as a reliever route, but there are likely investments that would be needed to resolve operational issues and specific capacity choke points along this route which is only lightly used for freight service today.

[28] AECOM with Cambridge Systematics, *California State Rail Plan*, California Department of Transportation, Rail Division, September 2013.

One approach for increasing capacity between Niles Junction and Stockton is reactivating the legacy transcontinental Central Pacific route through Niles Canyon. This route is currently used by the Niles Canyon Railway to provide tourist rail services between Niles and Sunol. Reactivating this route would provide parallel capacity to the Oakland Subdivision through the canyon, which could be used by additional freight and passenger trains. There are also possible strategies that could increase capacity on the existing Oakland Subdivision through the addition of sidings and potential changes and improvements to the existing track realignment. Significant investment in system capacity will be required to support forecast and planned service expansions. Any new service on the route will need to be part of a larger discussion of tradeoffs in the corridor given increasing volumes of passenger and freight trains and an already stressed highway system. Figure 2.32 provides the 2020 LOS on the I-580 corridor rail lines in graphical format.

Port of Richmond Needs Analysis

The Port of Richmond includes both public and private facilities. Private port facilities handle crude oil supplies to refineries and a variety of other liquid and solid bulk products. The public area of the port is almost exclusively auto-related. The public port is adjacent to and served by the BNSF auto yard. This yard brings imported autos from the Port to customers in the midwestern and eastern U.S. and receives domestically manufactured autos to be distributed to customers in the Bay Area. The Port recently expanded it's auto handling facilities to accommodate the needs of new tenants. The Port has two current tenants, Subaru and Honda, who use almost the entire auto handling capacity at the Port. Subaru's operation is entirely focused on imports whereas Honda also has facilities to receive domestically produced autos at the BNSF auto yard, making Richmond a major distribution point for Honda in Northern California. In addition to work unloading and loading autos, the Port also includes a manufacturing facility at which one of the tenants does auto finishing work prior to dealer delivery. All of these activities provide jobs for local residents.

The Port director believes that there is continued interest by other Asian auto manufacturers to import through the Port of Richmond to serve Northern California markets as well as northern Nevada and Utah. However, the Port faces land constraints that would make it difficult to expand. Many existing facilities on the site that have not been demolished or re-purposed have historic preservation status, limiting their potential for port uses and there is limited adjacent land in which the port could expand. There is potential through reconfiguration of the site to make modest expansions to capacity but these would be very limited. As a result, freight traffic volumes moving through the Port are expected to grow more slowly than they have in recent years.

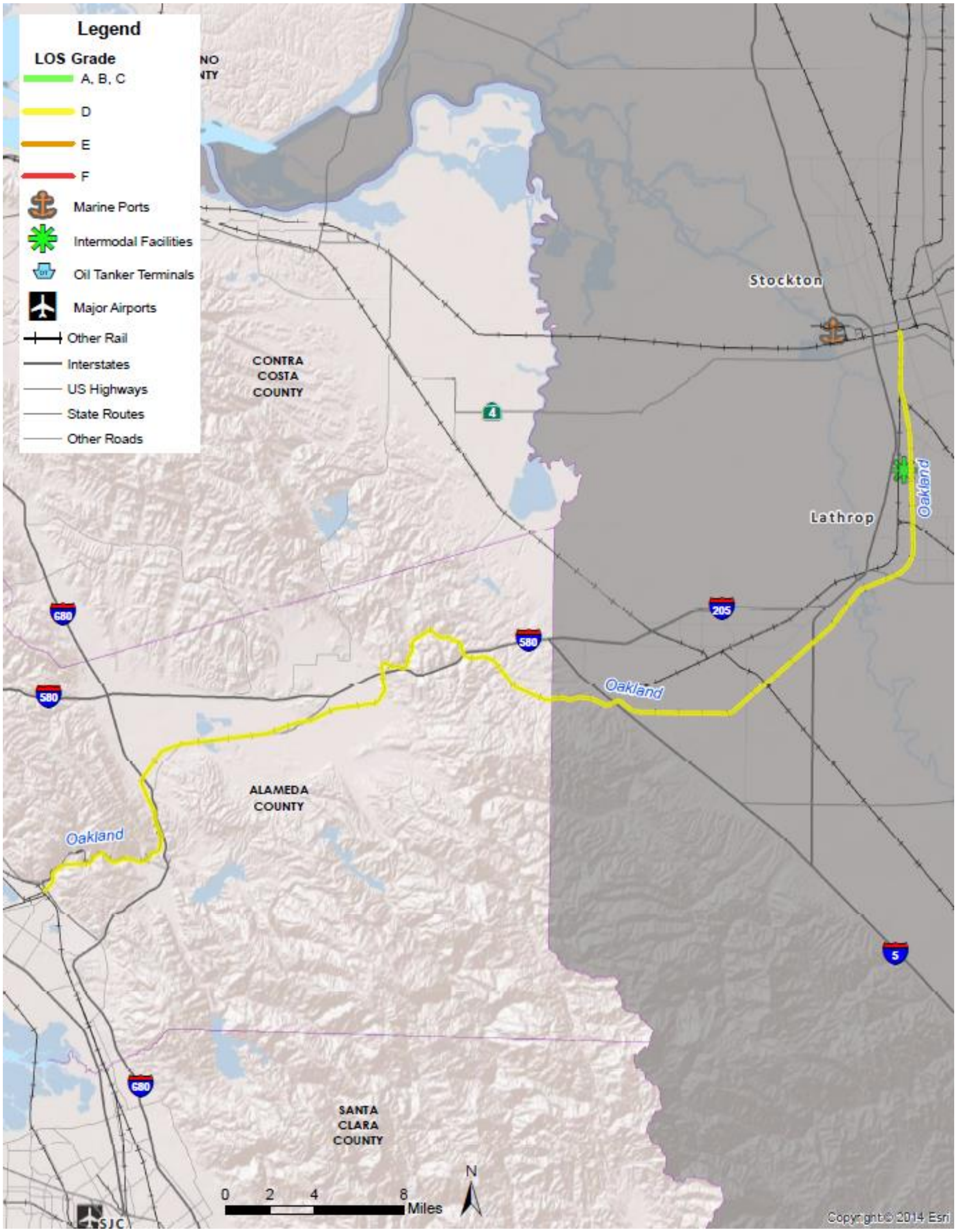
There is potential demand for increased movement of bulk exports through the Port of Richmond based on forecasts prepared for this study. However, in the current configuration, this expanded activity would need to be limited to the private port facilities if they have capacity. The director of the Port of Richmond has met with prospective Asian customers who do express interest in mineral exports and construction materials from the U.S. However, the Port of Richmond does not have the ability to handle this demand. There could also be community concerns related to expanded processing of bulk cargo that would need to be addressed.

There are two railroad crossings near the Port and the BNSF yard, at Cutting Blvd./Carlson Blvd. and Cutting Blvd. and Canal that cause significant delay for local residents. Because of its location near the entrance to the BNSF yard, the crossing at Cutting and Canal poses a particular problem as trains are moving very slowly as they enter the yard. While grade separating these crossings would provide little if any benefit to port and rail operations, they would reduce delays for residents and public safety vehicles and should be considered as part of any regional program to address at-grade crossings.

Dredging the shipping channels around the Port of Richmond continues to be a concern of the Port's stakeholders. Maintaining channel depth to handle increasingly large ships requires regular channel dredging. Dredging windows are limited in order to ensure that they do not interfere with the movements and spawning of the area's fish populations. Environmental windows are established by the National Marine Fishery and the U.S. Fish and Wildlife Services. If dredging work cannot be completed within the designated environmental windows, the regulations require a consultation process to continue dredging during restricted periods and these requests for extending work are often denied. The dredging windows tend to be 4-6 months in length meaning dredging equipment often sits idle for much of the year. This has the effect of raising dredging costs as equipment operators try to cover costs over a short period of time. Balancing the need to protect the Bay ecosystems and meeting the needs of the international trade industries is a continuing challenging that is being addressed through cooperative planning and management of the dredging programs.

Local stakeholders have identified areas in which the community is negatively impacted by goods movement activities. The area around Richmond Parkway includes a significant amount of vacant land that is currently being rezoned to include commercial activities. It is felt that this could be a good location for growth in goods movement infrastructure, because it would be close to the port. There are concerns about safety issues around the Richmond triangle, because this residential area is bounded on all sides by rail. If trains are on tracks that block roadways, it creates concerns for emergency response and evacuation, because the residents could potentially be blocked in.

Figure 2.32 2020 LOS on I-580 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

2.4 The U.S. 101 Corridor

2.4.1 Overview, Industry Drivers, Growth Trends

U.S. 101 is the main north-south corridor for distribution of products to the major population centers in Santa Clara, San Mateo, and San Francisco Counties in the South Bay and Peninsula, as well as the only north-south connector in the North Bay serving Marin and Sonoma Counties. Through connections with SR 37/I-680/I-580, U.S. 101 also is part of an intraregional network that connects to the interregional system for agricultural producers in the North Bay and serves population centers in Sonoma and Marin Counties. In addition to the U.S. 101 freeway, this corridor also includes the Port of San Francisco, the Port of Redwood City, San Francisco International Airport, a short-line railroad operating at the Port of San Francisco (the San Francisco Bay Railroad). The corridor also has two rail lines that are primarily intended for passenger use, but that sometimes carry freight: the Caltrain corridor on the Peninsula and the planned SMART service, which will partly operate on the former NWP rail line in Marin and Sonoma Counties. Several of the key pieces of goods movement infrastructure in the U.S. 101 Corridor are in low-lying areas that could be affected by sea level rise; this topic is discussed more fully in the Cross-Cutting Issues section. Truck growth in the future along the corridor will be driven by population growth as well as growth in agriculture activities in the North Bay. Note that the analysis in this section does not really account for U.S. 101 when it is a surface street in San Francisco. Table 2.26 shows a summary of the corridor.

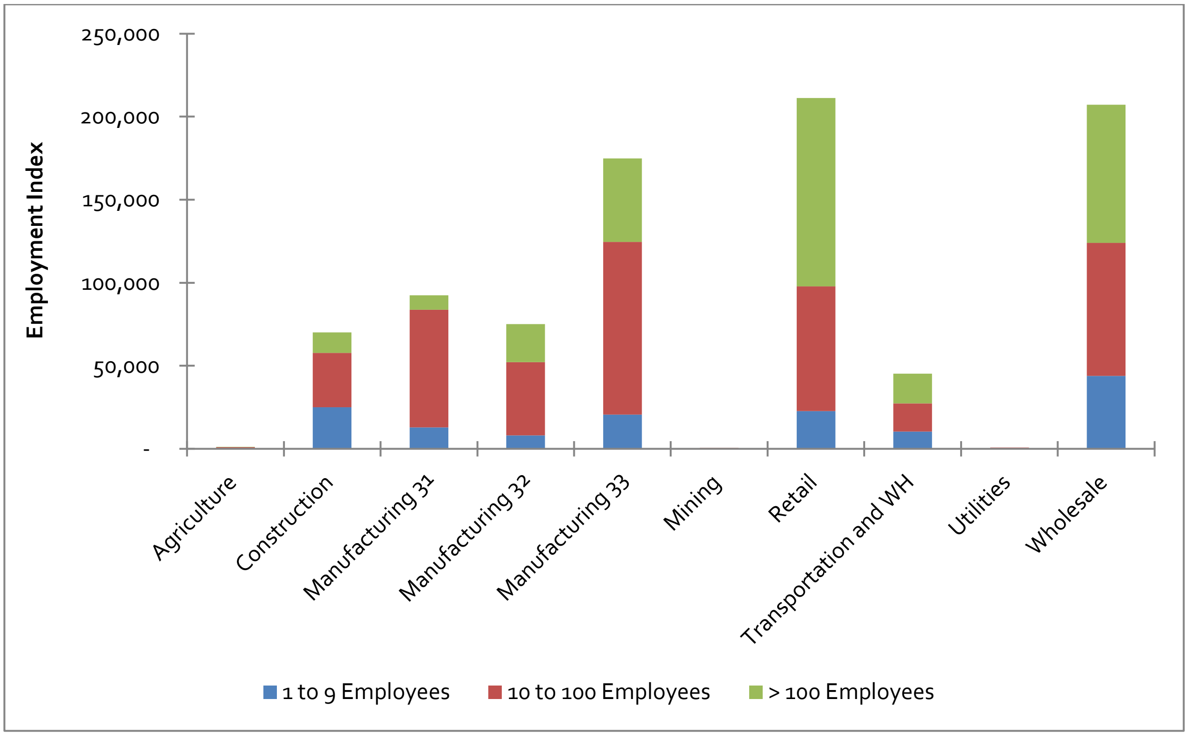
Table 2.26 U.S. 101 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Santa Clara, San Mateo, San Francisco, Marin, Sonoma	U.S. 101	San Francisco International Airport Port of San Francisco Port of Redwood City SMART rail on NWP line	Global Gateway, Interregional, Intraregional	Major goods movement corridor serving the Peninsula in the Bay Area. Connects agriculture shippers on North Bay (Sonoma), Central Coast, and North Coast with markets in Bay Area. Primary access to SFO.

Figure 2.33 through 2.36 below show the industry profile of the corridor. Since the U.S. 101 corridor traverses the entire region in the N-S direction, it is surrounded by significant goods movement activities. Manufacturing activities, mostly related to computer, electrical, and other metallic types of manufacturing are concentrated on the Peninsula. The manufacturing activities have an employment index of almost 350,000 employees, with more than one-half of that coming from computer and machinery manufacturing. Retail activities are most densely located along the major population centers along the corridor. Levels of wholesale sector employment

are on-par with retail activities. Finally, agricultural activities are concentrated in the North Bay in Sonoma County, and in the South Bay which extends to the Central Coast.

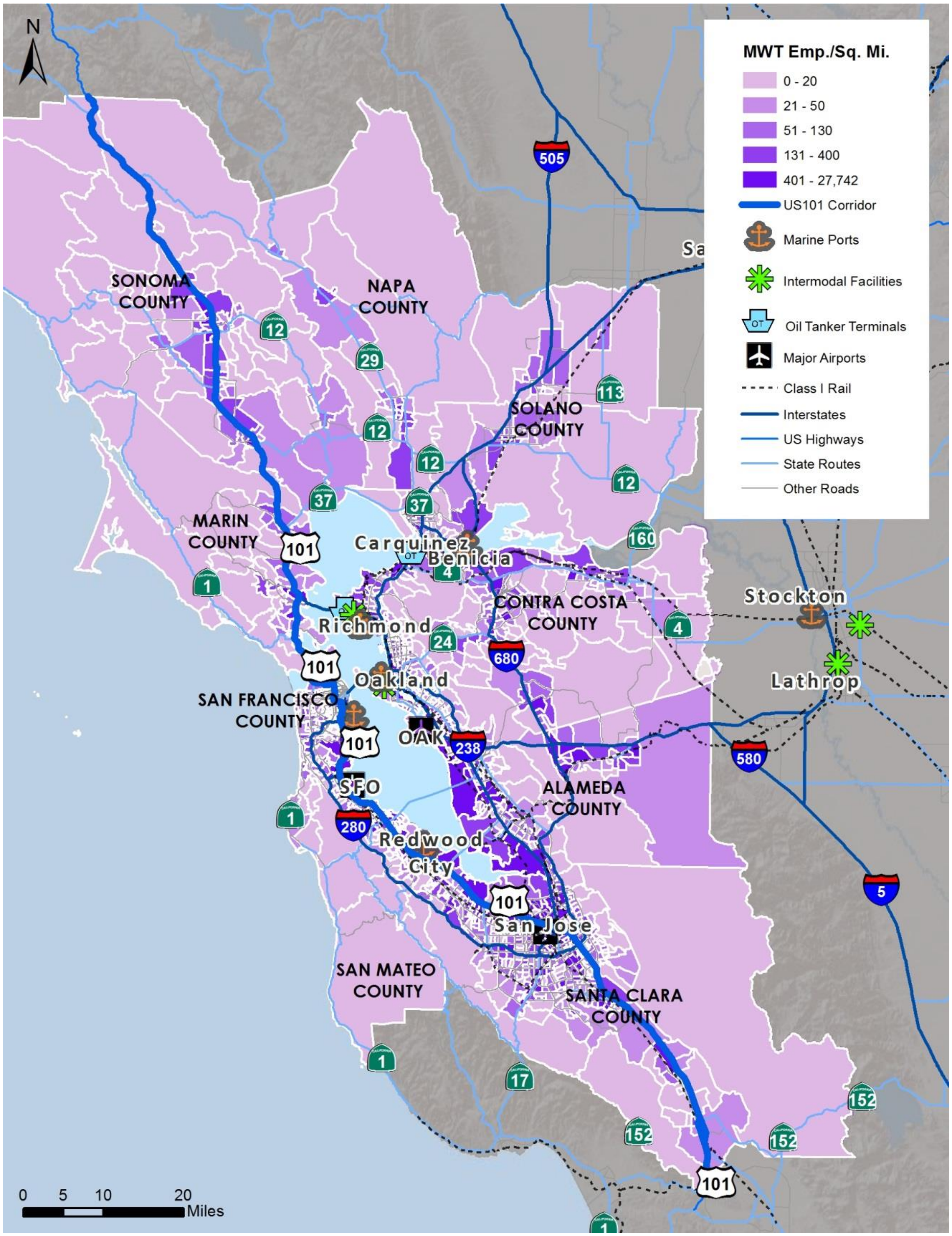
Figure 2.33 Employment Index for Goods Movement-Dependent Industries, U.S. 101
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

Figure 2.34 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along U.S. 101



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.35 TAZ Level Employment Density in the Retail Sector along U.S. 101

Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.36 TAZ Level Employment Density in the Agriculture Sectors along U.S. 101

Source: MTC.

Note: Employment Density is in employees per square mile.

2.4.2 Analysis

The major issues along the U.S. 101 corridor include congestion, safety and pavement conditions issues in urban centers of San Francisco. Trips within the corridor are often not served well because of lack of first and last mile access. Lack of freight rail capacity on the Peninsula also is a challenge for goods movement. Table 2.27 shows the corridor needs evaluation.

Table 2.27 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/air quality/public health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel time reliability	Buffer time index on freight (truck) routes	●	Overall truck travel is reliable with a few exceptions in the AM and PM period near San Jose and Redwood City
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	●	Lowest crash rates among all corridors. Portions with worst rates found in San Francisco
		Crashes at at-grade rail crossings	N/A	N/A
	Freight infrastructure conditions	Bridge conditions ratings	●	Worst bridge sufficiency ratings among the corridors, with a sufficiency rating of 82.12
		Freight (truck) highway and arterial routes pavement conditions ratings	●	Third best pavement scores, with 82% of pavement considered to be good/excellent. Segments of poor pavement conditions are found in San Francisco and north in Sonoma County
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system.	Use of Innovative Technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions	Travel time delay	Travel time delay on freight (truck) routes	🔴	Significant delay around key population centers that are used by commuters in Santa Clara and San Mateo Counties; specific congested hotspots in North Bay
		Travel time delay on railways, terminals, ports, airports	🟢	Support for additional passenger train needs along rail in the South Bay in Santa Clara County. Potential freight service on SMART.
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	🟡	Caltrain capacity, and physical constraints along Peninsula means very limited growth potential for freight rail along the line. HSR and Caltrain electrification can significantly impact freight rail service.
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic Contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

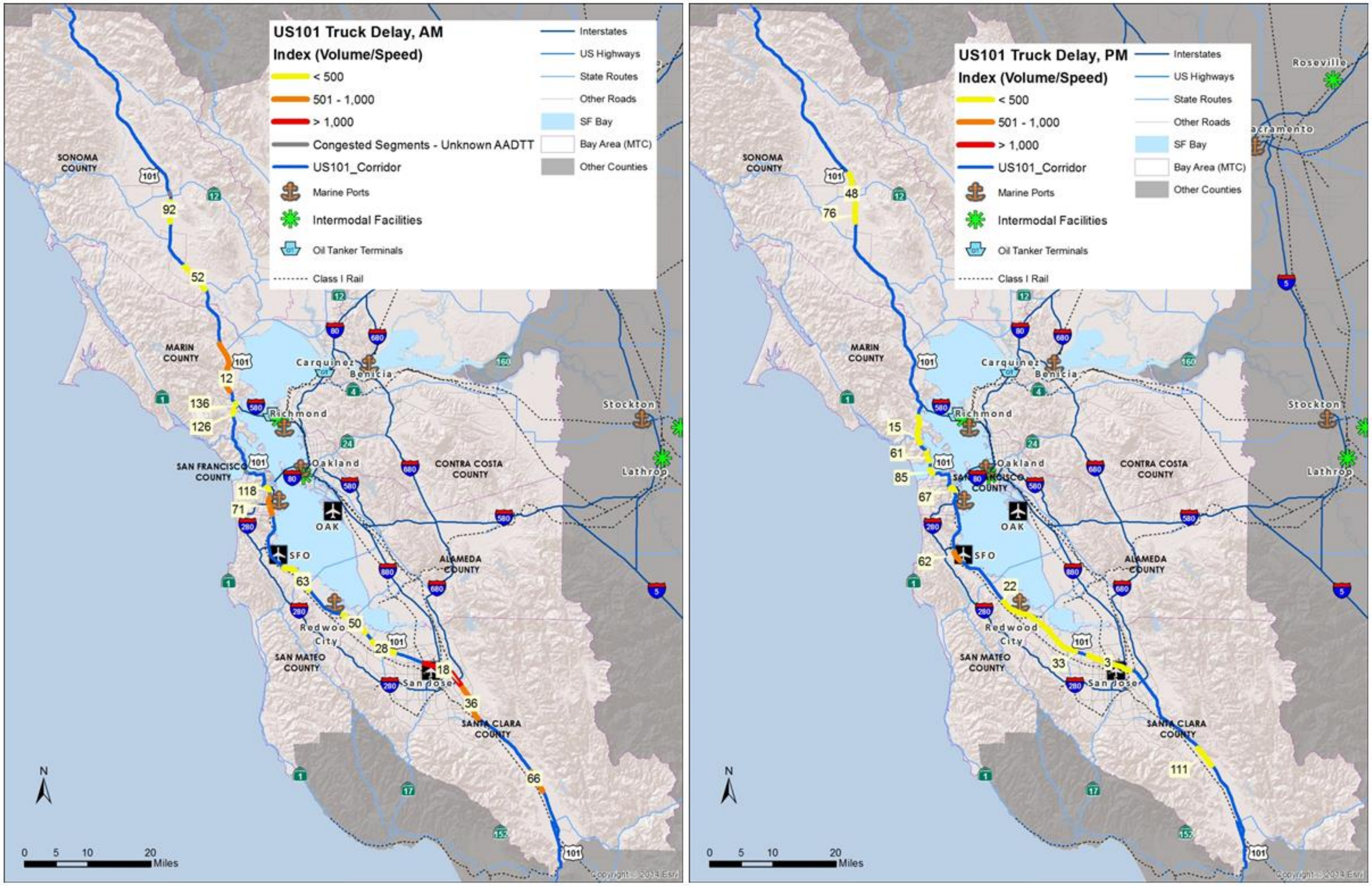
Congestion/Delay

Highway issues include significant truck delay around key population centers that are used by commuters in Santa Clara, and San Mateo Counties.

Figure 2.37 shows the most significant congested segments on U.S. 101, and their truck delays. In the AM period, the largest amount of delay occurs southbound in Marin County between Rowland Boulevard and N San Pedro Road (Segment 12). This is most likely commuter traffic headed to the County offices at the Civic Center and other nearby employment centers. The average speed on this 8.2-mile segment is 13.6 mph. The second congested area is a 2.7-mile segment that runs southbound in San Francisco between Cesar Chavez Street and Bayshore Boulevard (Segment 71). This area includes the junction with I-280, and traffic may be generated by the Port of San Francisco and employers located in South San Francisco. There are three highly congested segments in Santa Clara County, most of which are close to interchanges with other major freeways in the area. The first runs for 7 miles northbound from Story Road to Trimble Road (Segment 18). Congested conditions extend from 5:50 AM to 10:35 AM with typical average speeds of about 14 Mph. The second segment is the 5.5-mile section running northbound between Blossom Hill Road and Tully Road (Segment 36) and the third area is a 3.6-mile portion of northbound U.S. 101 between San Martin Avenue and Dunne Avenue (Segment 66). Given the very high auto mode-share for commute trips in Santa Clara County, it is likely that most of this congestion is due to work-related trips.

Most of the congestion on U.S. 101 in the PM period is less intense than the AM period, but there are several segments of note. First, the 1.7-mile section running southbound between San Bruno Avenue and Millbrae Avenue (Segment 62) has modest average speeds (17.7 mph) and a relatively short duration (3:35 p.m. to 6:25 p.m.). However, it occurs near the junction with I-380, and the very high traffic volumes make it the standout segment on the map below. Second, the 7.1-mile portion of U.S. 101 that extends from Fair Oaks Boulevard to Oakland Road in Santa Clara County (Segment 3) is the source of the third largest amount of total delay in the Bay Area during peak periods. Southbound traffic on this segment travels an average speed of about 7 mph from 2:45 p.m. to 8:05 p.m. Another section with very slow speeds is the portion of U.S. 101 that extends northbound from Donahue Street to north of Tamalpais Drive in Marin County (Segment 15). Traffic on this 4.5-mile segment travels about 10 miles per hour from 3:30 p.m. to 7:10 p.m. Finally, a segment from Hopper Avenue to Baker Avenue in Sonoma County has delays in the afternoon period, with average speeds of 17.5 mph.

Figure 2.37 Truck Delay on Congested Segments along U.S. 101, Peak Periods



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Travel Time Reliability

Truck reliability along the corridor is shown in Figure 2.38. In the AM period, the corridor overall offers a high level of truck reliability. However, the 10-mile long segment immediately south of San Jose is a notable exception. This segment has a high BTI of 1.96 in the northbound direction (as can be seen in Figure 2.38), nearly twice the BTI as the next worst segment. Commuter traffic to San Jose from the residential areas is likely to blame for this unreliability. In the PM period, the overall reliability of the corridor decreases slightly around the major population centers. The highest degree of unreliability is the stretch between the Dumbarton and San Mateo Bridges, with a northbound BTI of 1.80. Another segment immediate south to San Jose also have poor reliability. The results from this reliability analysis may be surprising, given the widely perceived congestion issues associated with U.S. 101. However, as this data shows, while congestion is a significant problem as discussed in the section above, this congestion is generally predictable.

Pavement and Bridge Conditions

U.S. 101 is the longest corridor examined in this study and it possesses the lowest average bridge sufficiency rating at 82.17. Of the 247 bridges along this corridor 168 have a rating above 80 with 6 rated below 50. Despite having the lowest average bridge rating, U.S. 101 has the third highest weighted pavement score with 2.74 out of 3. Of the corridors nearly 1,100 lane miles, 82 percent of the pavement are considered to be in good/excellent condition with only 8 percent considered distressed.

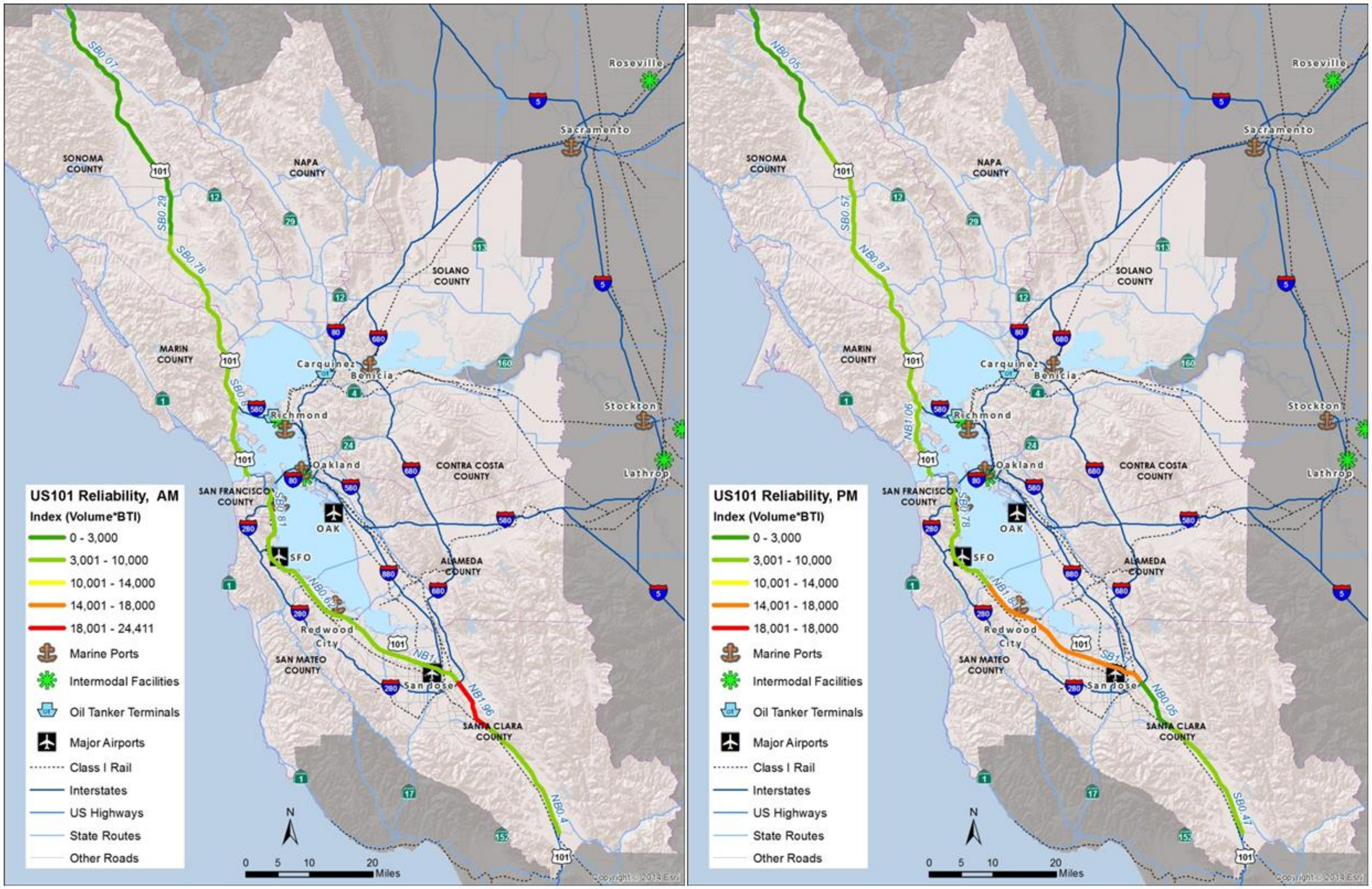
Figure 2.39 shows the pavement and bridge conditions along U.S. 101. Locations with the worst pavement conditions include the portions going through the city of San Francisco, which are heavily traversed city streets (Van Ness Ave and Lombard St). Portions of U.S. 101 going north in Sonoma County, especially near the town of Windsor also have poor pavement conditions.

Safety

The U.S. 101 corridor is tied for the lowest number of truck crashes per lane-mile among the study corridors at 0.84. Of the 916 crashes that occurred from 2003 to 2012, 21 were fatal.

Figure 2.40 shows the truck-involved crash rates along the corridor. Not surprisingly, the worst crash segment are located within San Francisco, where conflicts with other modes and poor pavement conditions present significant safety hazards.

Figure 2.38 Reliability on Segments along U.S. 101, Peak Periods, 2013



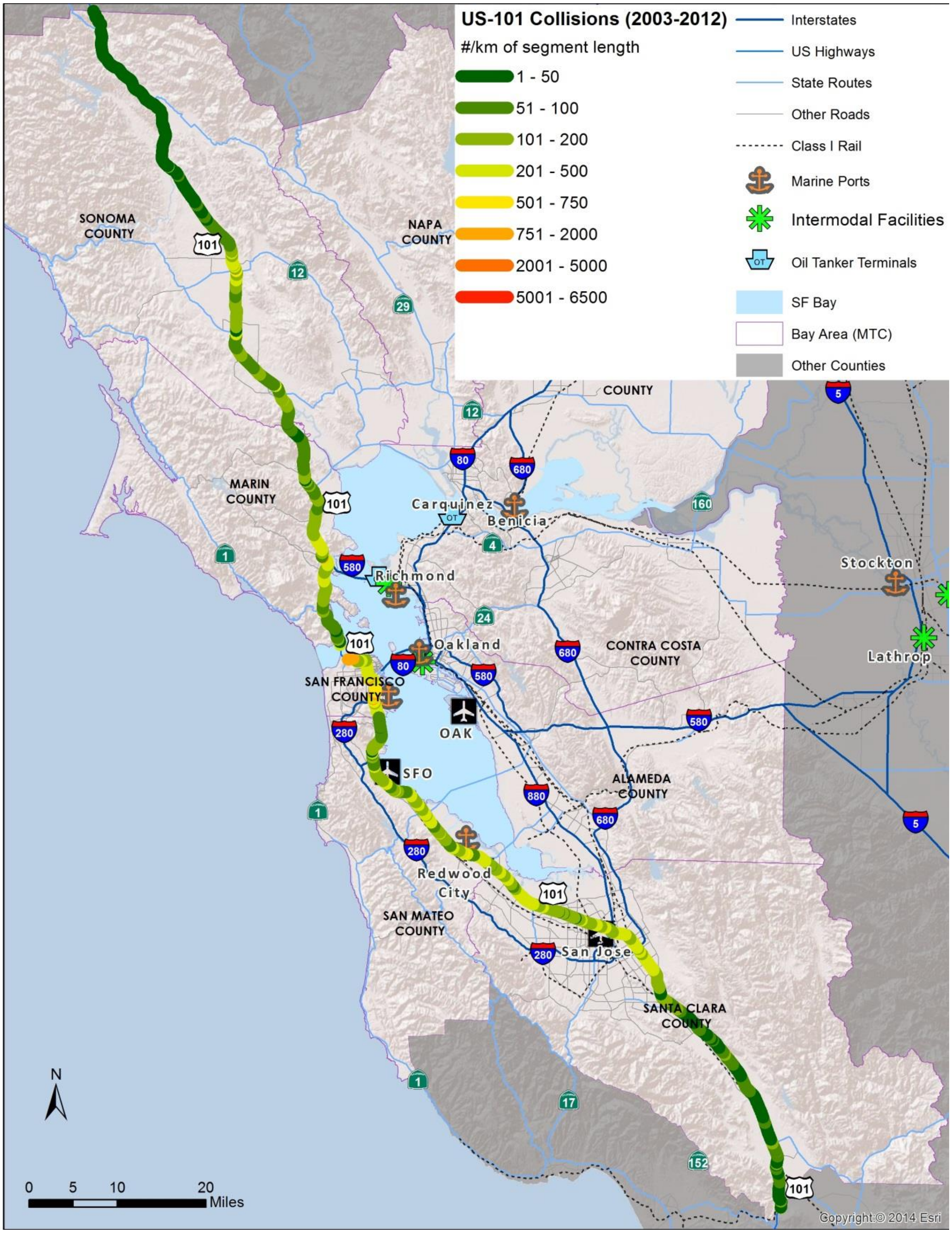
Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Figure 2.39 Pavement and Bridge Existing Conditions along U.S. 101

Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.40 Truck Involved Crash Rates along U.S. 101



Source: SWITRS; Cambridge Systematics Analysis.

Rail Needs Analysis

South Bay Rail

In Santa Clara County, the mainline rail corridor runs parallel to U.S. 101 and carries freight and some passenger trains (see discussion of Caltrain in the Peninsula Rail section below). The main issue in this corridor is the need to add track capacity to support additional passenger trains. A moderate level of freight moves on the UP Coast Subdivision between Central Coast points and San Jose, where it connects to the I-880 corridor. Amtrak's Coast Starlight also travels this segment, as do three round trip Caltrain trains between San Jose and Gilroy. Future plans for additional passenger service include an extension of Capitol Corridor service to Salinas and a new Coast Daylight train between San Francisco and Los Angeles. North of San Jose, Caltrain owns the tracks and UP provides freight service. Caltrain's commuter rail passenger service dominates in this segment.

Peninsula Rail

In San Francisco and San Mateo Counties, the Caltrain's Peninsula Subdivision runs parallel to U.S. 101 and carries both Caltrain passenger trains and a small amount of freight movements. Also, a short-line railroad called the San Francisco Bay Railroad facilitates freight movements to and from the Port of San Francisco. A spur off the Caltrain line also provides rail freight access to the Port of Redwood City. The main issues in this corridor stem from the need to upgrade infrastructure to handle the changing nature of both passenger and freight movements in the area.

On the mainline, passenger service dominates, and freight must fit in where slots permit. At the present time, freight trains face operational challenges because there are not enough storage tracks along the line. Due to low tunnel heights on older portions of the line, trains cannot carry double-stacked containers, auto racks, or high-cube refrigerator cars, which limits total freight throughput. There are two tunnels under Bayview Hill that have only 19 feet of clearance, but could be notched to provide improved clearances, depending on how the Caltrain electrification project is designed. The Quint Street lead also has clearance issues.

Further south, there is an opportunity to potentially raise clearance heights as part of the efforts to electrify the mainline and construct California High Speed Rail. In addition to the infrastructure requirements, a complex planning effort has been underway to develop a new operating plan that can support all types of rail traffic. One possibility is shifting Port traffic to overnight hours (midnight to 5:00 a.m.) when passenger trains are not running. Or, if FRA rules change, it is possible that heavy diesel trains and new EMU passenger trains can travel together on the same line during the daytime. The Caltrain line is one of the first in the nation to install a Positive Train Control (PTC) system, which is specifically designed to improve rail safety on busy lines. The presence of PTC could be a factor in receiving FRA approval for mixed operation during the daytime, which could provide additional opportunities to operate freight trains in the midday period.

North Bay Rail

In Marin and Sonoma Counties, construction is underway to develop the SMART passenger service on the former NWP rail line that runs parallel to U.S. 101. The enabling legislation for the new service transferred ownership of a portion of the NWP line to SMART, specifically the segments running from Healdsburg south to Novato and then east in the SR 37 corridor to the interchange with the California Northern Railroad (CFNR) at Lombard in Napa. That same legislation also granted the freight authority that operates in the area an exclusive perpetual easement to operate freight rail on the SMART-owned tracks.[29] FRA approval to operate freight service was granted, and the line reopened in June, 2011, transporting primarily agricultural and timber products between Brazos (near American Canyon) and Windsor.

The NWP would like to expand service to more customers in the area, but many agricultural and wine customers do not have a functional rail spur to provide last-mile connectivity. Adding team tracks in key locations may be one solution. In addition to this infrastructure barrier, rail car availability is very low right now, creating an obstacle to expansion even in locations where rail lines are fully operational. It should be noted that the NWP will benefit from the rebuilt tracks between Ignacio and Windsor provided by the SMART project, allowing NWP to operate at higher speeds and thereby reducing operating crew costs.

Available Rail Capacity

As described above, there are plans to operate more passenger trains in the U.S. 101 corridor. When combined with increased demand for freight rail services this desire is constraining the ability of the existing railroads to support this growing demand. As demand approaches capacity, there will be increasing delays for all users of the system.

Table 2.28 illustrates the practical capacities of the rail lines in the U.S. 101 corridor that support passenger trains, which are the most constrained portions of the freight system. The railroad subdivision and segments are identified, as well as the number of main tracks and type of signaling. In instances where short segments of the rail line are either double or quadruple tracked, the lower average capacity was used to show the practical limitations of the rail line to support increased traffic volumes. Rail network simulation models would be required to determine the exact capacity of each line illustrated. For rail in the North Bay, capacity

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[29] Whitepaper Number 14: Freight Trains and Passenger Trains, Sonoma Marin Rail Transit Authority, July 2008.

assessment is not possible because of lack of signaling information, though currently the SMART mainline subdivision is single tracked.

Table 2.28 Practical Capacity of Rail Lines in U.S. 101 Corridor

Subdivision	From:	To:	Number of Main Tracks	Signaling	Average Capacity
UP Coast	Gilroy	San Jose	2/1	CTC	30
Caltrain Peninsula	San Jose	San Francisco	4/2	CTC	100
SMART	Ignacio Wye	Windsor	1	N/A	N/A

Source: Altamont Press, "California Region Timetable 20" March 2009; Sonoma-Marin Area Rail Transit District. .

Existing train volumes on these lines are highlighted in Table 2.29. The table aggregates current average daily freight and scheduled passenger trains to obtain total daily trains.

Table 2.29 Average Daily Train Volumes in the U.S. 101 Corridor

Subdivision	From:	To:	Freight Railroads	Average Daily Freight	Daily Passenger Trains	Total Daily Trains
UP Coast	Gilroy	San Jose	UP	2	8	**10**
Caltrain Peninsula	San Jose	San Francisco	UP	6	87	**93**
SMART	Ignacio Wye	Windsor	NWP (old)	1	0	**1**

Sources: Coast Corridor Service Development Plan, May 2013, Peninsula Corridor Electrification Project DEIR, February 2014, Sonoma-Marin Area Rail Transit District. Passenger train counts based on weekday published timetables for summer 2014.

Comparing train volumes (v) to practical capacity (c) gives a sense of the potential for any line to be so congested that trains might be delayed. The v/c ratios for the railroad segments that support passenger services in the U.S. 101 corridor are tabulated in Table 2.30, and described in the following paragraph.

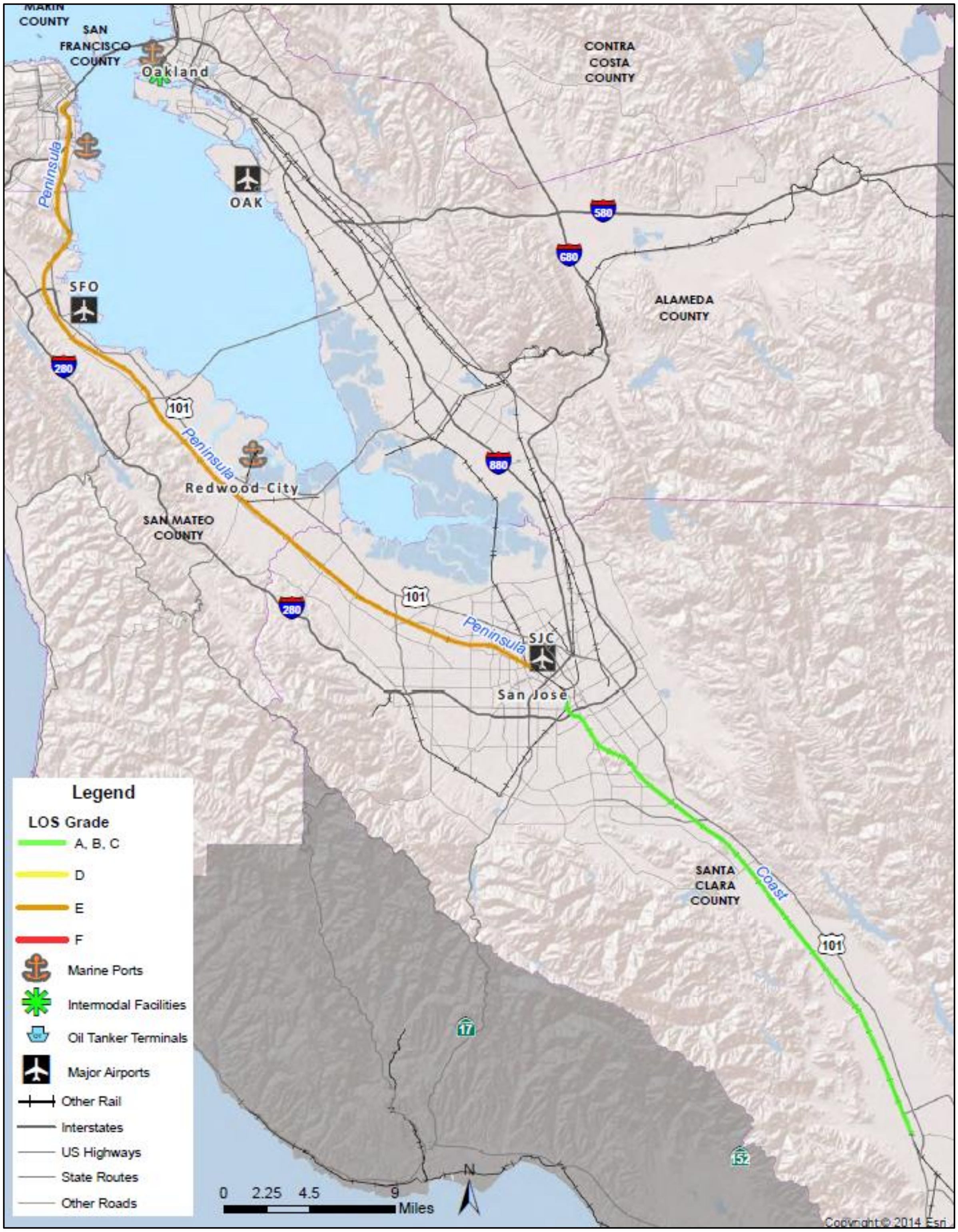
Table 2.30 Rail Lines Level of Service in the U.S. 101 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Coast	Gilroy	San Jose	2/1	10	30	33.0%	B
Caltrain Peninsula	San Jose	San Francisco	4/2	93	100	93.0%	E
SMART	Ignacio Wye	Windsor	1	1	N/A	N/A	N/A

Source: AECOM calculations; Sonoma-Marin Area Rail Transit District.

The single track section of the UP Coast Subdivision between Gilroy and Coyote is operating at LOS B. The subdivision is double tracked north of Coyote, providing extra capacity for future growth. The Caltrain line is operating at LOS E. Though the Caltrain line is double-tracked, the uniformity of train types (almost all passenger), schedule adherence, and availability of four track segments at Lawrence, Redwood City, and Bayshore allow it to operate very near capacity without significant delays. Figure 2.41 shows the existing LOS on the U.S. 101 corridor rail lines. Note, North Bay Rail is not included as the LOS is indeterminate. Given that there is only one train operating, it is reasonable to presume there are no capacity issues on the SMART line.

Figure 2.41 Existing LOS on U.S. 101 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

The Coast Corridor Service Development Plan, Caltrain Peninsula Corridor Electrification Project DEIR, and an informational flyer from the Transportation Agency for Monterey County provided information of train volume estimates and forecasts. Freight train volumes were estimated by rail segment for 2020 and 2040, and passenger train forecasts were also available. Future train volumes reported in these documents for rail segments in the U.S. 101 corridor are indicated in Table 2.31.

Table 2.31 Future Train Volumes in the U.S. 101 Corridor

			2020 Daily Train Volumes			2040 Daily Train Volumes		
Subdivision	From:	To:	Freight	Passenger	Total	Freight	Passenger	Total
UP Coast	Gilroy	San Jose	4	8	12	4	18	**22**
Caltrain Peninsula	San Jose	San Francisco	6	114	120	12	204	**216**
SMART	San Rafael	Sonoma County Airport	2	30	32	N/A	N/A	**N/A**

Source: Coast Corridor Service Development Plan, May 2013, Peninsula Corridor Electrification Project DEIR, February 2014, TAMC Capitol Corridor Extension Flyer, October 2014, Sonoma-Marin Area Rail Transit District.

Growth in freight traffic is expected to be steady but moderate. It is possible that bulk freight shipments to or from the Ports of San Francisco and Redwood City could increase substantially, which would significantly increase the number of carloads on the Caltrain line. This may not cause a large increase in the number of daily trains, but the bulk trains themselves would be longer and heavier.

The primary growth issue in the U.S. 101 corridor is the increasing number of passenger trains sharing the freight routes. While this growth appears manageable on the Coast Subdivision, it represents an increase of more than 100 percent on the Caltrain line by 2040. Most of this growth is attributable to the introduction of blended high-speed rail service between San Jose and San Francisco. The changes in capacity utilization and LOS are presented in Table 2.32.

As indicated, the planned future growth in train volumes for freight and passenger services degrades the overall network. The UP Coast Subdivision could degrade to LOS D, while the Caltrain line would drop to LOS F. Caltrain recently certified the FEIR for the Peninsula Corridor Electrification Project, which would install an electric power catenary system above the Caltrain tracks between San Jose and San Francisco. The FEIR concluded that the only significant impacts to freight rail that (possibly) cannot be mitigated are reduced vertical clearance at some points on the corridor which could constrain the size of future freight cars. To address the clearance issue Caltrain is undertaking an additional feasibility study on mitigation measures. Another potential concern of freight users was a reduction in freight operating hours, however, Caltrain has indicated that they will not reduce the operating hours for freight but that reduced vertical clearance at some points on the corridor could constrain the size of future freight cars. To address the clearance issue Caltrain will be doing an additional feasibility study on mitigation measures.

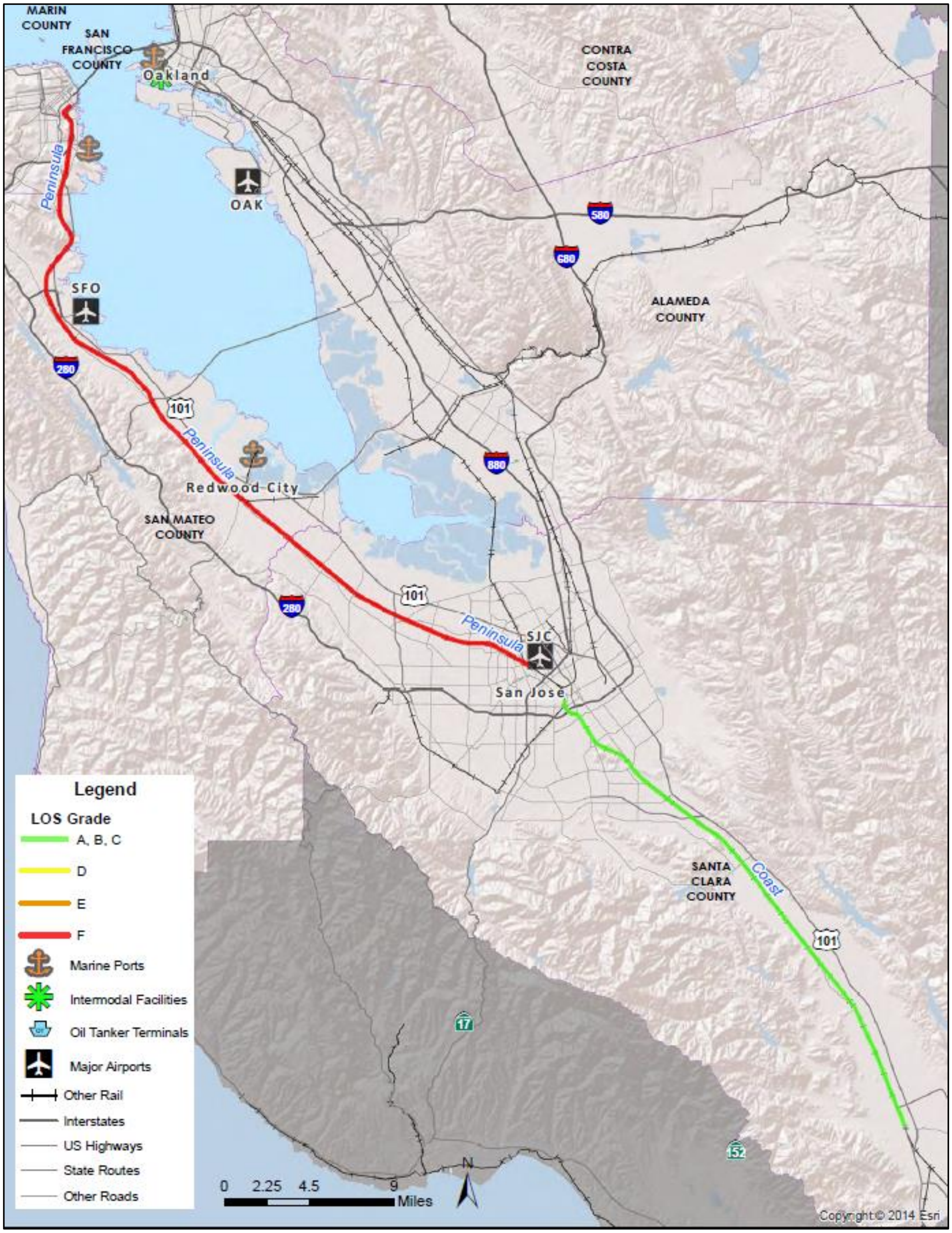
For the SMART corridor, by 2016 the commuter service will expand to San Rafael to Sonoma County Airport, and 30 one way passenger trips will be planned at the end of 2016. As the total trains on the line grows to 32 in 2016, the line will likely be capacity constrained. SMART has indicated that constraints on the mainline track from Novato to the north can be managed with additional sidings, spurs, and transload facilities. Figure 2.42 shows the 2020 LOS on U.S. 101 corridor rail lines.

Table 2.32 Rail Lines 2020 Forecast Level of Service in the U.S. 101 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
UP Coast	Gilroy	San Jose	2/1	22	30	73.3%	D
Caltrain Peninsula	San Jose	San Francisco	4/2	120	100	120.0%	F
SMART	San Rafael	Sonoma County Airport	1	32	N/A	N/A	N/A

Source: AECOM calculations, Sonoma-Marin Area Rail Transit District.

Figure 2.42 2020 LOS on U.S. 101 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Rail Access and Operational Issues

A particular pinch-point in the U.S. 101 corridor is the 3-mile segment located between San Jose and Santa Clara. Just north of the Santa Clara station, at a location called Control Point (CP) Coast, the UP Coast Subdivision branches to the east away from the Caltrain line and becomes part of the I-880 corridor. Between San Jose Diridon Station and CP Coast, the Coast Subdivision and Caltrain share what is mostly a three track segment. This is called the South Terminal Area, and it hosts through freights between the Central Coast and the East Bay, ACE commuter rail service, Capitol Corridor trains, Caltrain commuter rail service, and Amtrak's Coast Starlight. In the future, it may also host the new Coast Daylight service between San Francisco and San Jose, and eventually blended high-speed rail service. Studies of this segment are underway, and some capacity improvement projects are moving through the project development pipeline.[30]

The Caltrain Electrification Project includes replacement of Caltrain's current rolling stock with lightweight electric multiple unit (EMU) equipment. The FRA has given Caltrain a waiver to use EMU equipment, but the waiver requires temporal separation of freight traffic from the EMU rolling stock. Therefore, freight service on the Caltrain line would be limited to the hours of 12:00 a.m. to 5:00 a.m. Currently, freight operations generally occur between 8:00 p.m. and 5:00 a.m., with a few daytime operations. The new restrictions would reduce the capacity of the Caltrain line to handle freight traffic. However, the FRA is considering rule changes that may allow longer hours for freight operation.[31]

The California State Rail Plan noted that introduction of SMART commuter rail service between Windsor and San Rafael would constrain the ability of the NWP to provide freight service to customers along the line unless infrastructure improvements were made. Since the SMART route is primarily single track, passing sidings are necessary. Though the project is providing passing tracks for the passenger service, they may not be long enough to hold longer freight trains. In addition, short signal blocks in the vicinity of stations could also limit the length of freight trains. Overall, shared passenger and freight service will reduce the schedule flexibility currently enjoyed by the NWP. The freight trains will, however, benefit from the overall improvements to the line.

[30] Los Gatos Creek Bridge Replacement/South Terminal Phase III Project Draft Initial Study/Mitigated Negative Declaration, October 2013.

[31] Peninsula Corridor Electrification Project DEIR, February 2014.

Port of San Francisco Needs Analysis

The Port of San Francisco can see increased rail volumes with planned rail improvements to handle waste, bulk, and construction project cargo, but it will continue to be limited as a cargo port given landside and transportation access constraints.

The Port of San Francisco manages multiple waterfront facilities handling 10 different port industries including containerized cargo, a cruise-ship terminal, fishing, fish processing, and bulk commodities. The Port of San Francisco is the only active break-bulk port in the Bay Area. A major source of cargo at the port is construction material, including building materials and large construction equipment. With the city's recent construction boom, there have been increased demands at the Port. Garbage and recycling movements to and from the Port are also important, including some construction material recycling handled by Recology. Other break bulk products handled at the Port (at Pier 80) include: steel coil, pipe, rebar, steel plate, beams, project cargo, windmill parts, and materials for the Tesla auto factory in Fremont.

The nearest competitor for break bulk business is the Port of Stockton in the San Joaquin Valley. The Port of Stockton currently leases some of its land so that freight can be stored, including some construction steel products that are shipped to Stockton and then trucked back into the Bay Area for local projects. The Port of San Francisco would like to explore the leasing option locally to capture some of this business and reduce excess freight movements.

In the near term, the Port has plans to develop a bulk export terminal at Pier 96 to facilitate the export of up to 3 million tons of bulk product per year, including iron ore. This would be brand new business that could generate jobs and millions of dollars in new revenues to the Port. The Port plans to expand its rail infrastructure to facilitate the goods movement, including adding storage track and a loop track to facilitate efficient unloading and storage of unit trains.

Similarly, there may be an opportunity to export copper concentrate at Pier 80. In addition to last-mile rail access, mainline capacity may also need to be upgraded to handle these moves.

Port Access Issues. For trucks, last-mile access to Port's facilities happens on City streets, and constraints have emerged due to the City's efforts to build "complete streets" that accommodate all modes. Cesar Chavez is one of the most important arterials providing road access to the Port's busy Southern Waterfront area, but it was recently reduced by a lane to allow for a dedicated bus lane. Growth along the Embarcadero has led to conflicts with pedestrians and bicyclists. There are also potential issues with land uses and future development plans that could affect goods movement in the area. For example, a new NBA arena for the Golden State Warriors has been proposed at a location that is less transit accessible than the original proposal. This could lead to increased auto-access to the arena and added traffic congestion on the Port's key access routes.

In terms of rail access, the Port has 10,000 feet of track on its property with switching provided by San Francisco Bay Railroad. Currently, interchange with the UP mainline occurs in South San Francisco, but the Port recently received a $3 million FRA grant to upgrade its track to Class I standards that will allow UP trains to come further north. The Port is also planning $12 million to $15 million of improvements to add five additional parallel tracks and several loops on its property.

On a slightly larger scale, the Port of San Francisco is situated on a peninsula with only one rail line providing access to the national network. As further elaborated below, freight rail access is highly dependent on the operations of Caltrain passenger services. Maintenance of this access during and after Caltrain electrification and construction of High Speed Rail is a key concern for the Port.

Port of Redwood City Needs Analysis

The Port of Redwood City is a deepwater port with mean lower low water depth of 30 feet, and is located in San Mateo County between the Dumbarton Bridge and the San Mateo-Hayward Bridge. The Port handles mostly drybulk, neobulk, bulk, liquid, and specialized cargo. Land uses at the Port mainly consist of handling, processing, storage and transportation of imported construction materials, scrap metal exports, construction debris for recycling, and chemicals. Its key trading partners include China, Kora, Japan, Mexico, and Australia. The Port of Redwood City has seen growth as a niche port for bulk commodities, such as construction materials including aggregate. Projected growth in these materials over the next 25 years will place strain on existing facilities unless bulk terminal capacity is increased. Specifically, some of the major issues faced by the port include the need for channel dredging, which will be increasingly important given competition from ports with deeper channels. Poor truck access, lack of cargo diversification (lack of containerized cargo), and encroachment by adjacent land uses are some other issues.[32]

San Francisco International Airport Needs Analysis

SFO is one of the U.S.'s busiest international cargo airports, ranked as 11th in North America by the Airports Council International in 2011. Cargo service is available from 56 airlines, including 7 cargo-only airlines and 11 cargo facilities, which provide more than 1 million feet of cargo space. SFO has captured 40 percent of the Bay Area air cargo market, including 94 percent of the

[32] http://www.dot.ca.gov/hq/tpp/offices/ogm/CFMP/Dec2014/Appendices/Appendices/Appendix_B_Fact_Sheets/Dec2014/Appendix_B-4-7_PortRedwoodCity_121914.pdf#zoom=75.

international market, as of 2009, and is a major trade hub with Pacific Rim countries like South Korea, Japan, and Taiwan.[33]

Products shipped by air freight out of SFO include a high number of technology goods produced in the Bay Area, primarily electrical machinery, optics and instruments, and industrial machinery, according to WISER trade data analyzed as part of the report.[34]

SFO reported almost 325,000 metric tons (or 360,000 short tons) of cargo landing in 2013, a decrease of 3.4 percent from the previous year. However, international cargo, which represents two-thirds of the tonnage, increased slightly year over year at rate of 2.7 percent and is expected to grow at up to 4 percent annually until 2040. Due to its status as an export engine, connectivity to the SFO airport is particularly important to the Bay Area. Just off of U.S. 101, the airport also is closely reliant on I-280, SR 92, and SR 82 for regional connectivity. Exacerbated by being located within a peninsula, the truck portion of air freight contributes to regional roadway issues, such as roadway congestion, pavement damage, and environmental and safety concerns.

Congestion and airfield capacity is also a major issue at SFO. The effective capacity is limited both by closely spaced runways and by the frequency of inclement weather, principally fog, which leads to periodic delays and flight cancellations. In 2013, SFO airport ranked 28th out of major airports for on time arrivals. Accounting for the different weather conditions and runway use configurations, it is estimated that SFO's runways can handle between 460,000 and 485,000 annual aircraft takeoffs and landings, or about 61 to 100 arrivals and departures an hour. The preferred configuration is parallel arrivals on 28L and 28R with departures on 01L and 01R, as the approaches to 28L and 28R provide increased capacity, except in periods of low visibility and inclement weather. However, capacity is still substantially diminished during IFR and East flow conditions due to the close separation of the two preferred arrival runways.[35]

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[33] Caltrans, *Freight Planning Fact Sheet*, *San Francisco International Airport*, http://www.dot.ca.gov/hq/tpp/offices/ogm/air_cargo.html.

[34] Economic Development Research Group, *2013 Economic Impact Study of San Francisco International Airport*, prepared for the City and County of San Francisco and the San Francisco Airport Commission, available at: http://www.flysfo.com/media/facts-statistics.

[35] Caltrans, *Freight Planning Fact Sheet. San Francisco International Airport*, http://www.dot.ca.gov/hq/tpp/offices/ogm/air_cargo.html.

2.5 The I-680 Corridor

2.5.1 Overview, Industry Drivers, Growth Trends

The I-680 Corridor is an important intraregional corridor that provides north-south connections in the eastern East Bay and connects numerous other major goods movement corridors, including I-80, I-580, and I-880. The corridor connects the wine regions of the North Bay to the Central Valley via connections with I-580, and it provides a key link for general freight traffic between the San Joaquin Valley and the South Bay. In addition, the Port of Benicia in Solano County can be accessed via I-680 and I-80, as well as on-dock rail provided by UP that is connected to the Martinez subdivision. Additional detail about rail needs and opportunities on the Martinez subdivision is provided in Section 2.2, above.

The Benicia Industrial Park lies to the northeast of the residential areas of the City and includes the Valero oil refinery. The main exports are Valero's petroleum coke and the main imports are automobiles. The Port of Benicia is privately owned and operated by APS West Coast, Inc. AMPORTS, a leader in the vehicle-processing industry, operates the terminal facilities at Benicia. CODA Automotive, Inc. began assembly of all-electric cars on March 13, 2012, creating 50 new jobs at the AMPORTS facility.[36]

Fremont area industrial uses, anchored by the Tesla auto manufacturing plant, continue to create demand for deliveries of parts and materials, and the I-680 freeway provides an alternative connection that avoids congested vehicle traffic on I-880 and I-238/I-580.

Table 2.33 shows the summary of the corridor.

Table 2.33 I-680 Corridor Summary

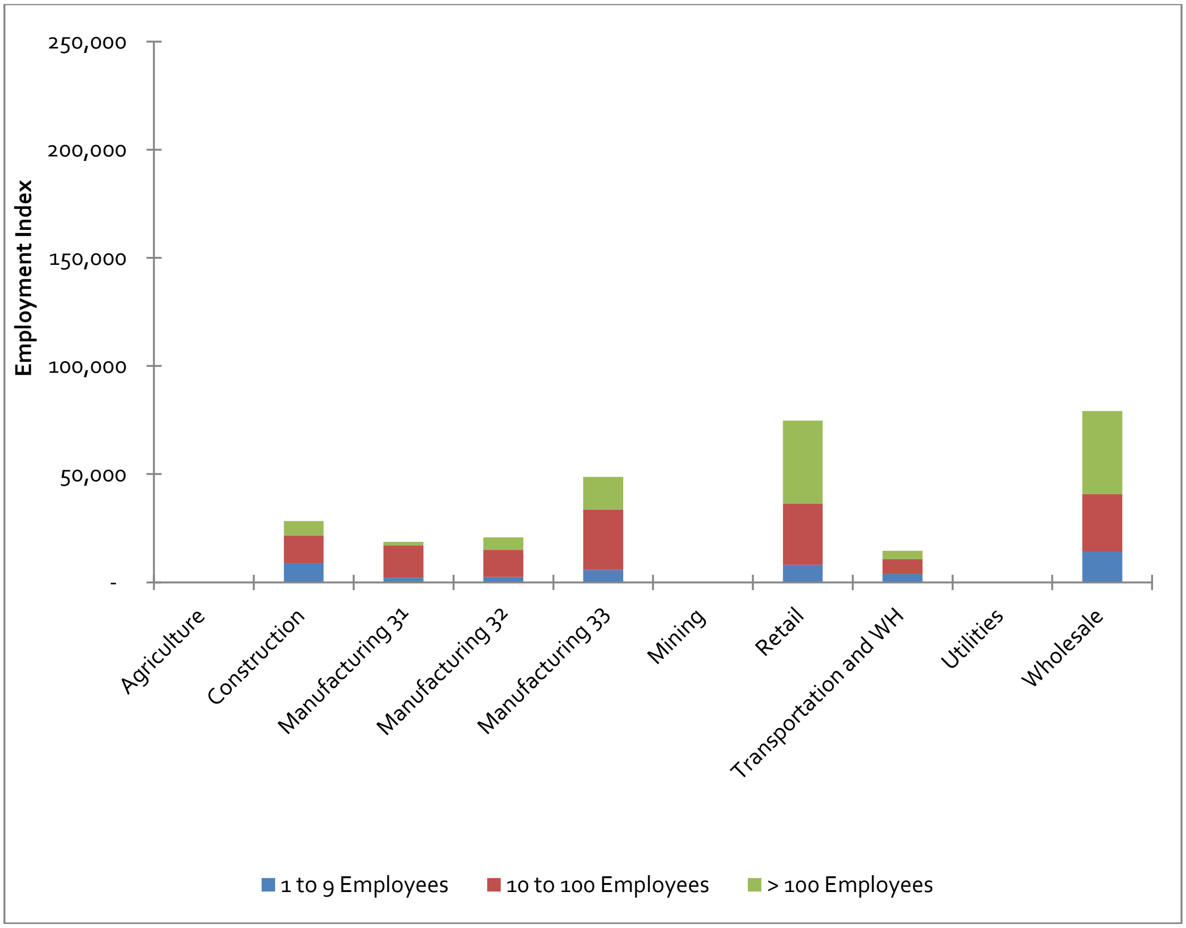
Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Santa Clara, Alameda, Contra Costa	I-680	Port of Benicia	Intraregional	Serves trucks moving from South Bay and Fremont and connecting to and from the warehouses in the San Joaquin Valley via connections with I-580.

Goods movement-dependent activities along the corridor are concentrated near Dublin/Pleasanton, and north of SR 24 from Walnut Creek to Benicia. Figures 2.43 through 2.46

[36] Caltrans District 4 Fact Sheet on Port of Benicia, available at: http://www.dot.ca.gov/hq/tpp/offices/ogm/fact_sheets_index.html (last retrieved on October 15, 2013).

show the industrial profile along the corridor. Manufacturing activbitie has an employment index of about 88,000, while wholesale and retail having employment indices of about 79,000 and 75,000.

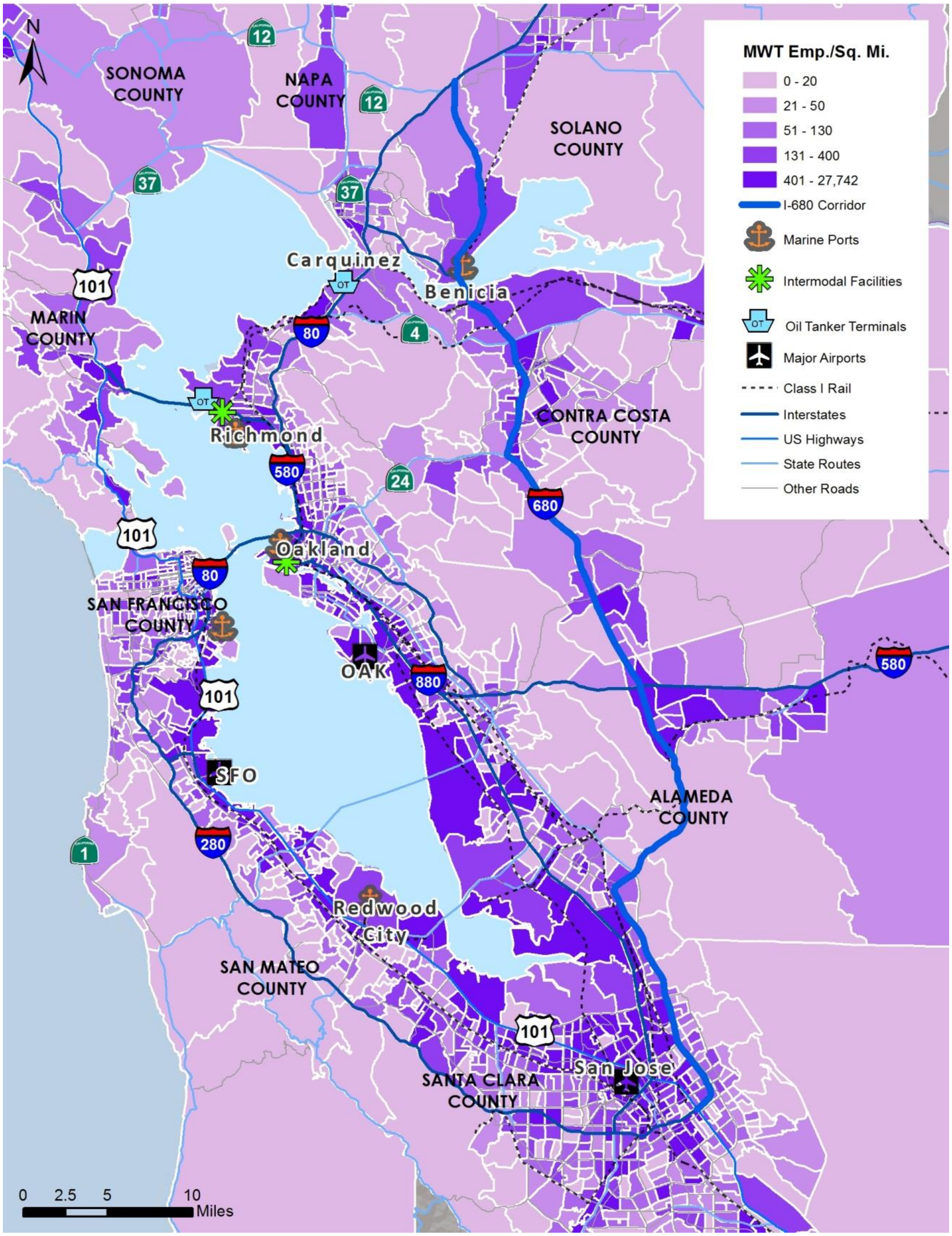
Figure 2.43 Employment Index for Goods Movement-Dependent Industries, I-680
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

Figure 2.44 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along I-680



Source: MTC.

Note: Employment Density is in employees per square mile

Figure 2.45 TAZ Level Employment Density in the Retail Sector along I-680

Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.46 TAZ Level Employment Density in the Agriculture Sectors along I-680

Source: MTC.

Note: Employment Density is in employees per square mile.

2.5.2 Analysis

Congestion delay is the most critical issue along the corridor, in addition to truck reliability. Table 2.34 summarizes the evaluation of the corridor.

Table 2.34 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/air quality/public health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel time reliability	Buffer time index on freight (truck) routes	🟡	Reliability is generally good, with the worst reliability experience from Walnut Creek to SR 4 in the AM, and Dublin to Walnut Creek in the PM
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	🟢	Second lowest truck involved crash rates among the corridors
		Crashes at at-grade rail crossings	N/A	N/A
	Freight infrastructure conditions	Bridge conditions ratings	🟢	Third highest bridge rating among corridors
		Freight (truck) highway and arterial routes pavement conditions ratings	🟡	Pavement conditions fourth out of 8 corridors, with 70% corridor in good/excellent condition
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system	Use of innovative technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and	Travel time delay	Travel time delay on freight (truck) routes	🔴	Significant delay in the PM period, particularly around Walnut Creek, and south of Dublin. I-680 from Bollinger Canyon to Treat and NB from SR 262 to SR 84 in the PM peak have high levels of delay.

Goals	Measures	Metrics	Rating	Rating Explanation[a]
access, and is coordinated with passenger transportation systems and local land use decisions		Travel time delay on railways, terminals, ports, airports	N/A	N/A
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	N/A
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	●	Caltrain capacity, and physical constraints along Peninsula means very limited growth potential for freight rail along the line. HSR and Caltrain electrification can significantly impact freight rail service.
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

Congestion/Delay

Heavy-truck traffic will increase moderately in the future, driven primarily by local and domestic markets, as well as imports and exports.

Growth in manufacturing activity in south Bay (e.g., Tesla Plant) also will place additional traffic on this corridor.

For 2012, total traffic volumes on I-680 are highest around the population centers of Walnut Creek, with more than 230,000 daily vehicles. Truck (3+-axle) volumes, on the other hand, are highest (around 8,000 trucks daily) near Pleasanton and Fremont, where there are clusters of industrial activity as well as connections to I-580. The vast majority of the truck traffic is made up of heavy trucks (5+ axles). However, south of I-580, there is a higher proportion of 2+ axle trucks on I-680 than on either I-580 or I-880.

Figure 2.47 shows the congested segments of I-680 and their corresponding truck delays. In the AM period, there is only one section with more than minor delay. Southbound I-680 is congested for 2.4 miles between Washington Boulevard and SR 262 (Segment 100). However, average speeds are close to 30 mph, and the congested period is less than 90 minutes, so total truck delay in this short segment is not excessive. In Contra Costa County, a 3.9-mile portion of southbound I-680 between Willow Pass Road and North Main Street (Segment 25) has moderate levels of truck delay.

Truck delay in the PM is more significant than the AM period, in particular two longer segments in the center of the corridor. Both are within the top 10 segments in the Bay Area for congestion. A 13.1-mile long portion of northbound I-680 have high truck delays between Bollinger Canyon Road and Treat Boulevard in Walnut Creek (Segment 5) from 3:30 p.m. to 7:00 p.m., and average speeds are approximately 19 mph. Further south, an 8.8-mile section between SR 262 and SR 84 (Segment 7) has high delays between 3:00 p.m. and 7:55 p.m., with average speeds below 9 mph.

Travel Time Reliability

Figure 2.48 shows the truck reliability along I-680. Truck reliability along the corridor is generally good in the AM period, with exception of the segment from Walnut Creek to the Junction with SR 4, where the southbound direction experiences a BTI of 1.53. In the PM period, the reliability is noticeably worse, with the most unreliable segment being a 15-mile stretch from Dublin to Walnut Creek, where the northbound direction has a BTI of 1.44.

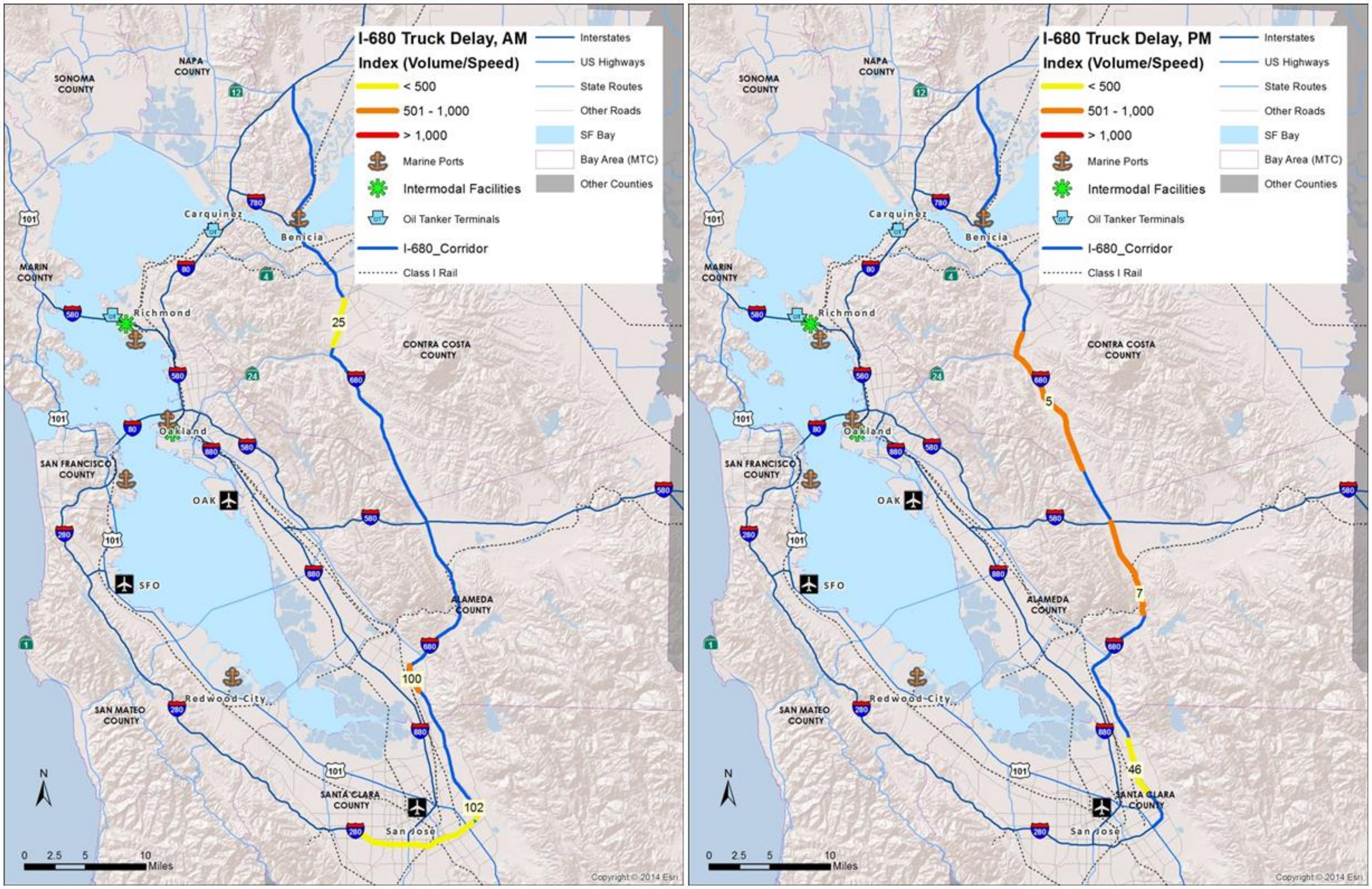
Pavement and Bridge Conditions

I-680 has the third highest average bridge rating at 84.07. Of the 122 bridges along the corridor, 99 of them have a rating above 80 and none have a rating below 50. I-680 is in the middle at fourth out of 8 in terms of weighted pavement score with a 2.59 out of 3. The percentage of lane miles considered to be in good/excellent condition is 70 percent, while 11 percent are considered to be distressed. The distressed rating is concentrated along a small portion of the corridor north of Walnut Creek. Figure 2.49 shows the pavement and bridge conditions along I-680. The corridor north of Benicia and south of Dublin have maintenance ratings.

Safety

The I-680 corridor has the second lowest truck crashes per lane mile among the corridors at 0.87. Of the 394 truck-involved crashes occurring along the corridor from 2003 to 2012, 12 were fatal. Figure 2.50 shows the truck involved crash rates along the corridor. Higher rates were observed from Walnut Creek to San Ramon, north of Dublin. A small portion of the corridor near the ‘bend" by Sunol has a higher than normal crash rate.

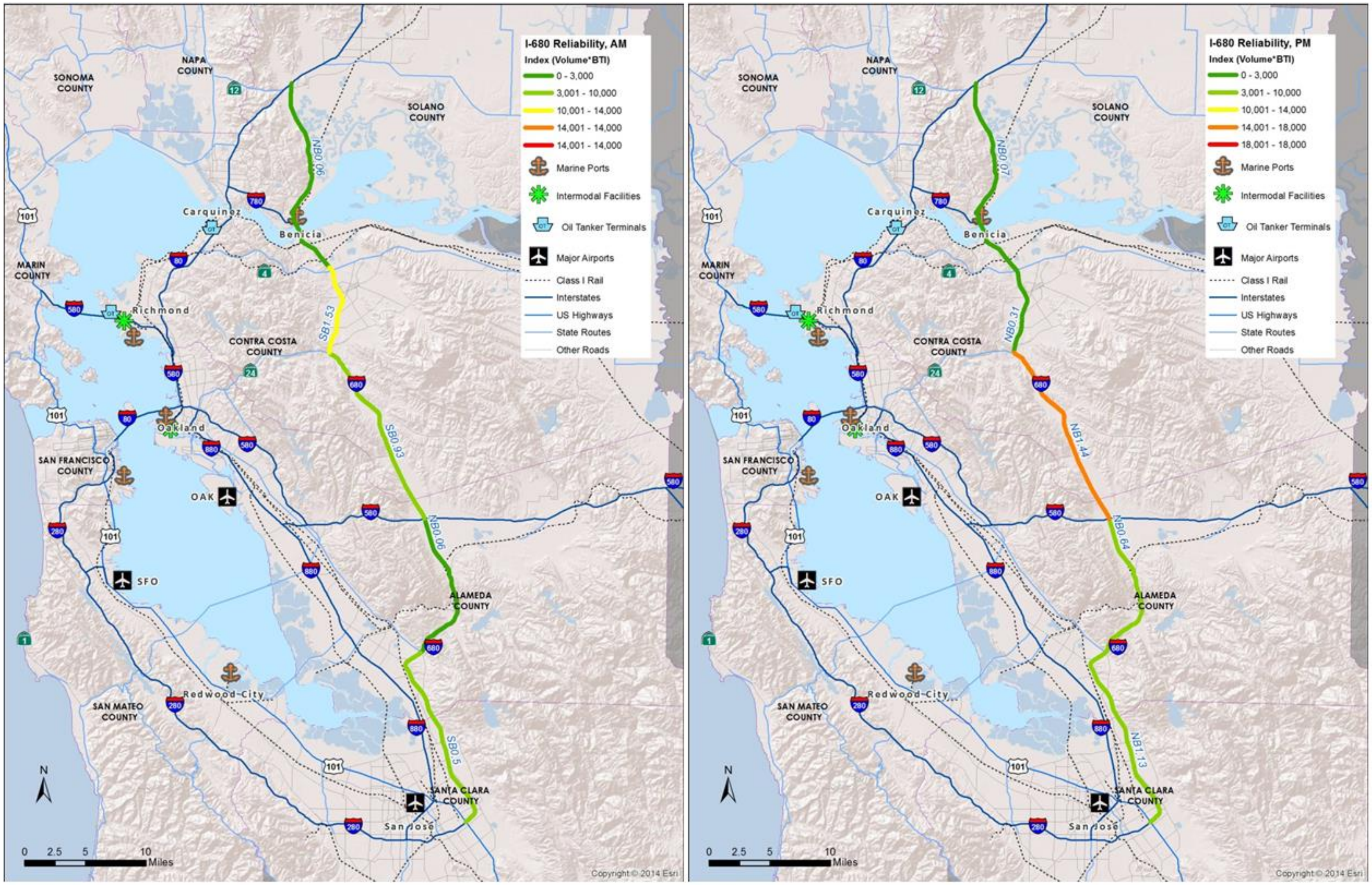
Figure 2.47 Truck Delay on Congested Segments along I-680, Peak Periods



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Figure 2.48 Reliability on Segments along I-680, Peak Periods, 2013



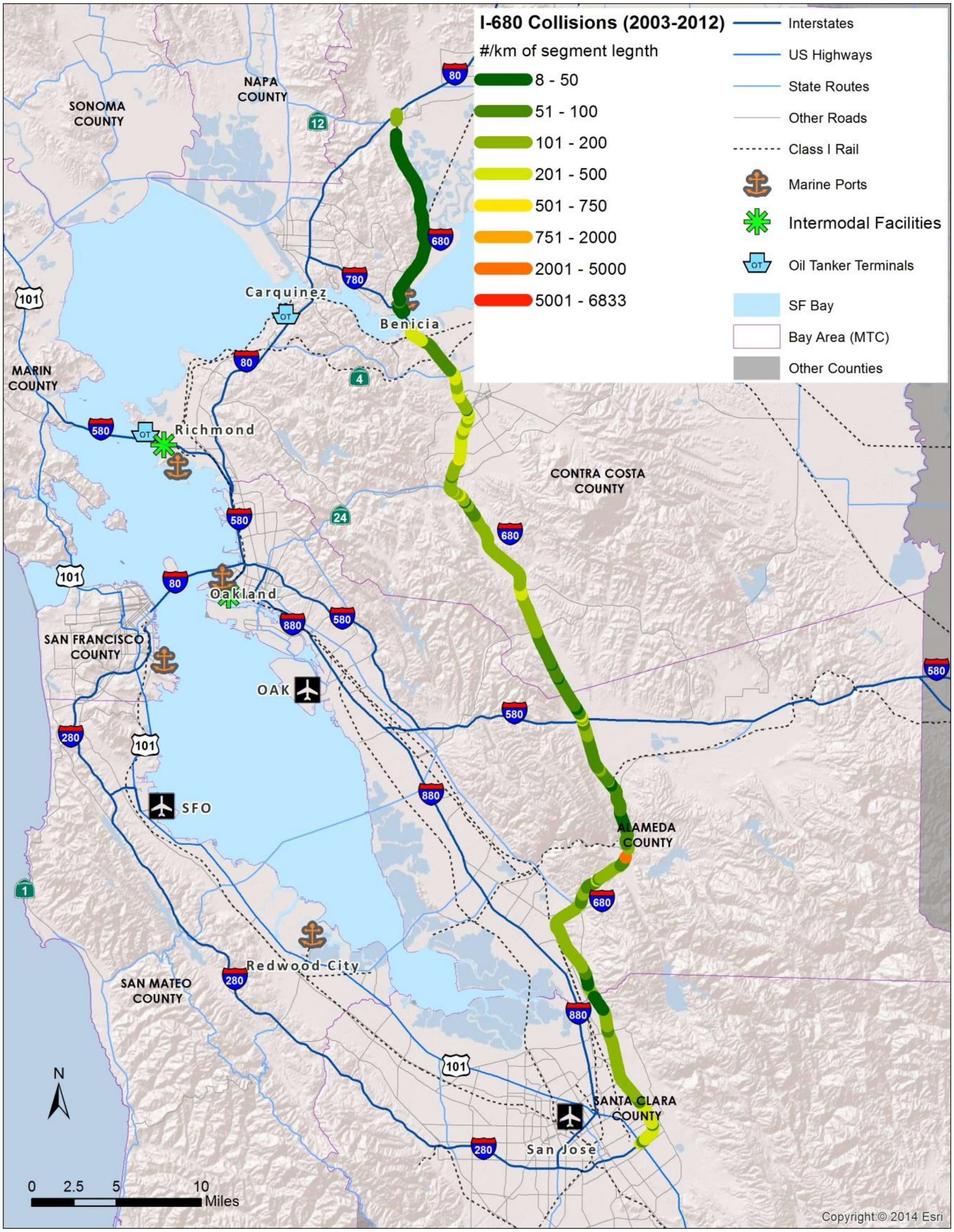
Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Figure 2.49 Pavement and Bridge Existing Conditions along I-680

Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.50 Truck Involved Crash Rates along U.S. 101



Source: SWITRS; Cambridge Systematics Analysis.

Port of Benicia Needs Analysis

The deep water Port of Benicia is located in Solano County on the northern bank of the Carquinez Strait. The Port is privately owned and operated by APS West Coast, Inc. Its major trading partners include Japan, South Korea, and Australia. The Port is about one mile from I-680, and UP railroad operates on-terminal rail service. The Port of Benicia is anticipated to have relatively slower rates of growth in both imports (mostly autos) and exports (primarily petroleum coke) as compared to historic rates of growth. Some of the major issues faced by the port include dredging needs to maintain ship channels, navigation channel restrictions and insufficient land area for container terminal development.[37] The City of Benicia recently applied to have the Port of Benicia Industrial Park designated as a Priority Development Area (PDA) within the region's housing and transportation plan called *Plan Bay Area*.

2.6 The SR 12/SR 37 Corridors

2.6.1 Overview, Industry Drivers, Growth Trends

The corridors of SR 12 and SR 37 are east-west corridor that serve agricultural shippers from Napa Valley, Solano County, and the Delta Region. Because they serve the same areas and industries, they are discussed together. The SR 12 Corridor is an east-west, mostly rural route that connects the North Bay to San Joaquin Valley. This two- to four-lane route is used to transport agricultural products from the Napa Valley, Solano County and the Delta region. SR 37 is a secondary corridor offering parallel connection to U.S. 101, west of I-80. A portion of the inactive NWP rail line parallels portions of SR 12 and SR 37 between Napa and Novato, and then extends further north along U.S. 101. A brief discussion of this rail line is provided above in Section 2.4. Several key pieces of infrastructure in this corridor are in low-lying areas that could be impacted by climate change; this issue is discussed more fully in the Cross-Cutting Issues section. Table 2.35 summarizes the corridor.

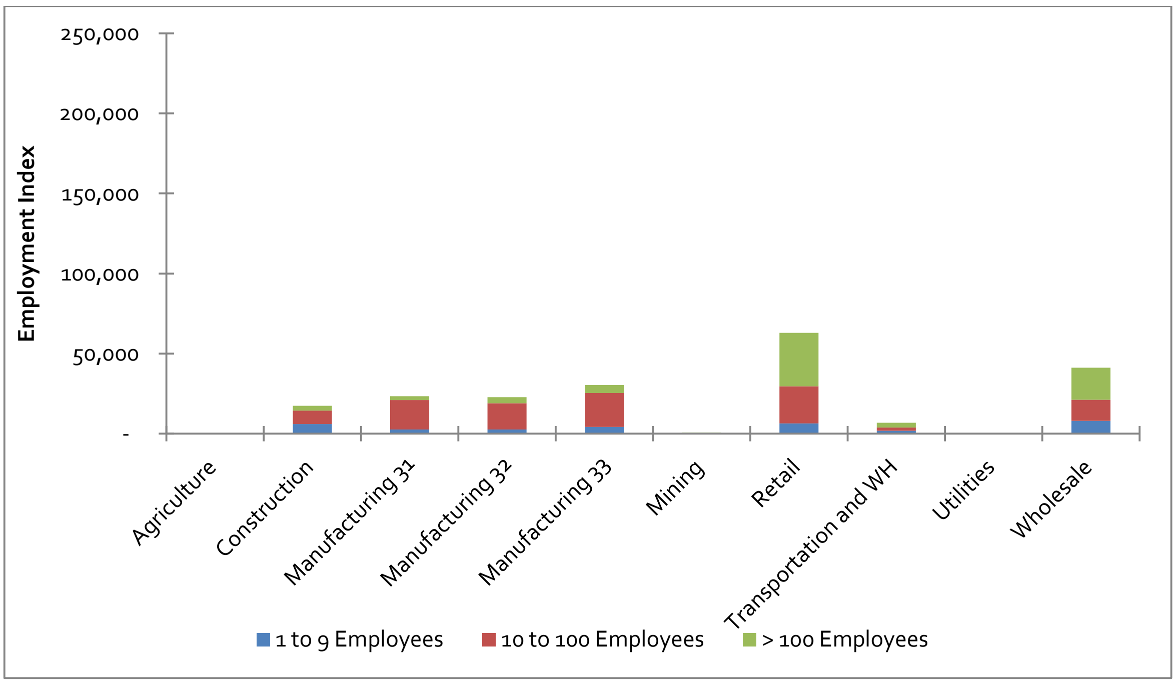
Table 2.35 SR 12/SR 37 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Sonoma, Napa, Solano	SR 12/37	NWP rail line	Interregional, Intraregional	Helps connect North Bay to the rest of the region and the San Joaquin Valley.

[37] http://www.dot.ca.gov/hq/tpp/offices/ogm/CFMP/Dec2014/Appendices/Appendices/Appendix_B_Fact_Sheets/Dec2014/Appendix_B-4-1_PortBenicia_090314.pdf#zoom=75.

Figures 2.51 to 2.57 show the industry profile of SR 12/SR 37. Along the corridors, retail activity is the most dominant, with an employment index of about 63,000. Total manufacturing activity has an employment index of about 76,000. In the area around SR 12, the dominant industry (by revenue) is food and beverage processing, making up about 20 percent of total economic activity.[38] This industrial segment depends heavily on the agricultural, ranching, and dairy goods produced in the wider surrounding area, resulting in significant local truck movements between these two segments of the economy.[39] As the region has emerged from the recession, jobs in agriculture and manufacturing in Solano County are flat or continuing to decline, while construction, wholesale trade, and retail trade are growing again.[40]

Figure 2.51 Employment Index for Goods Movement-Dependent Industries, SR 12/SR 37
Number of Employees, 2012



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[38] Highway 12 Corridor Economic Analysis, Solano Transportation Authority and Solano Economic Development Corporation, 2012.

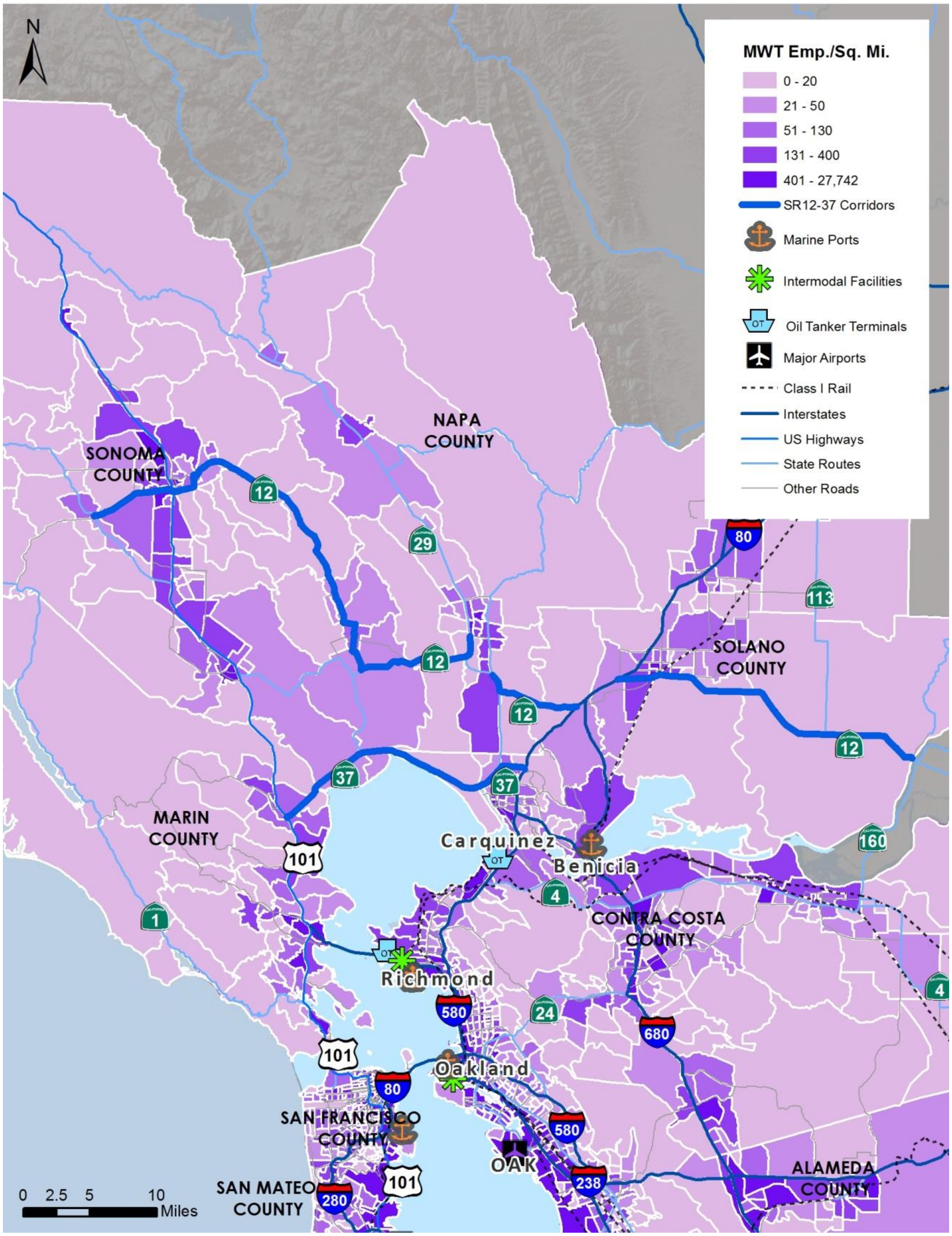
[39] Ibid.

[40] Solano County 2012 Index of Economic and Community Progress, Solano County Economic Development Corporation, 2013.

Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

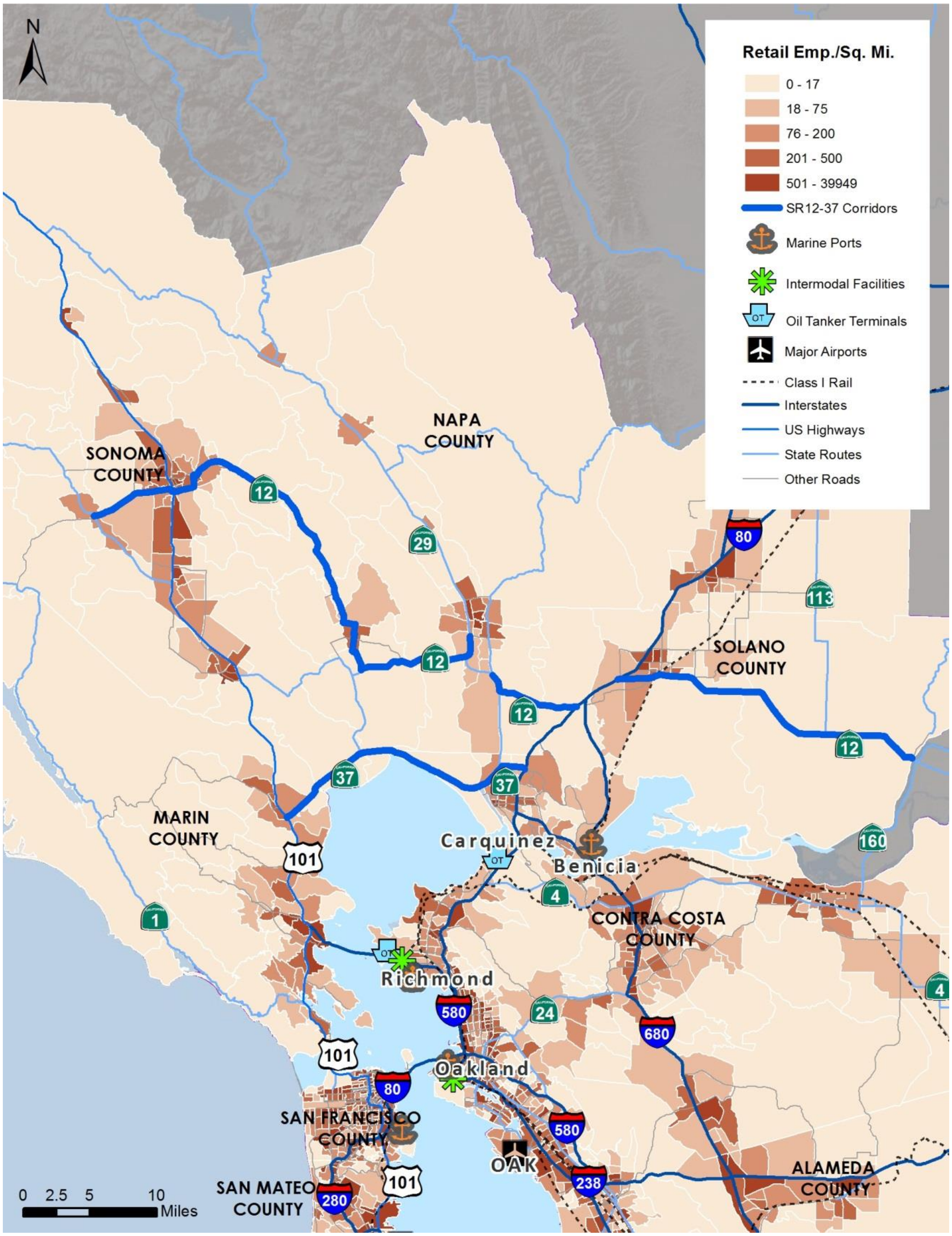
Figure 2.52 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along SR 12/SR 37



Source: MTC.

Note: Employment Density is in employees per square mile.

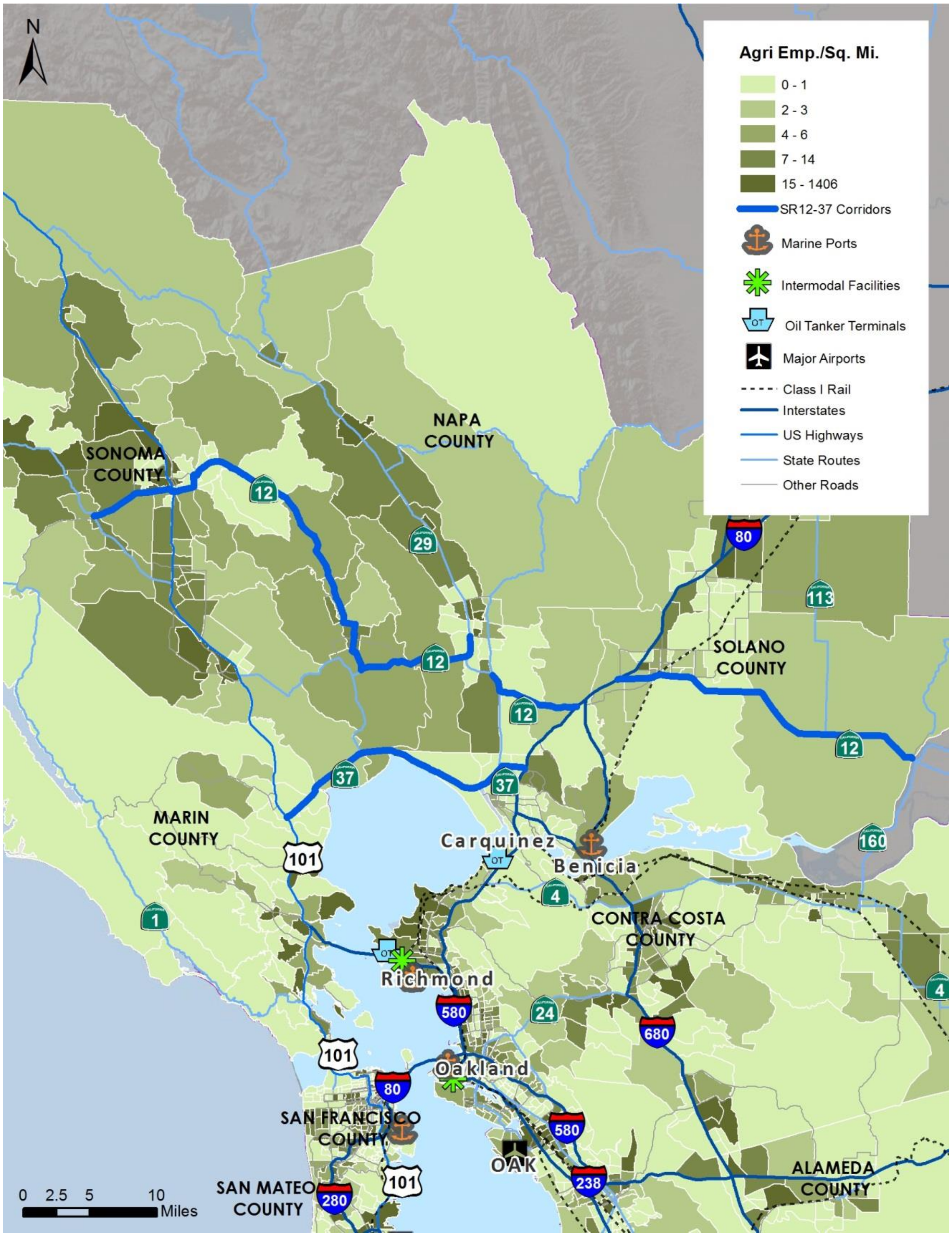
Figure 2.53 TAZ Level Employment Density in the Retail Sector along SR 12/SR 37



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.54 TAZ Level Employment Density in the Agriculture Sectors along SR 12/SR 37



Source: MTC.

Note: Employment Density is in employees per square mile.

2.6.2 Analysis

Overall traffic congestion, pavement and bridge conditions are some of the key operational and infrastructure issues along the corridor. Table 2.36 summarizes the evaluation of the corridor.

Table 2.36 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/Air Quality/Public Health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel time reliability	Buffer time index on freight (truck) routes		Generally high truck reliability along the corridor.
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)		Fourth out of all corridors in terms number of truck crashes per lane-mile among the corridors
		Crashes at at-grade rail crossings	N/A	N/A
	Freight infrastructure conditions	Bridge conditions ratings		Fifth in terms of bridge ratings among all corridors, problems with delay caused by draw bridges across waterways
		Freight (truck) highway and arterial routes pavement conditions ratings		Sixth in terms of pavement conditions rating among all corridors, with 20% in distressed condition
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system	Use of innovative technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and	Travel time delay	Travel time delay on freight (truck) routes		None of the region's most congested segments are on this corridor
		Travel time delay on railways, terminals, ports, airports	N/A	N/A

Goals	Measures	Metrics	Rating	Rating Explanation[a]
access, and is coordinated with passenger transportation systems and local land use decisions	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	N/A
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	N/A	N/A
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses.	Economic Contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

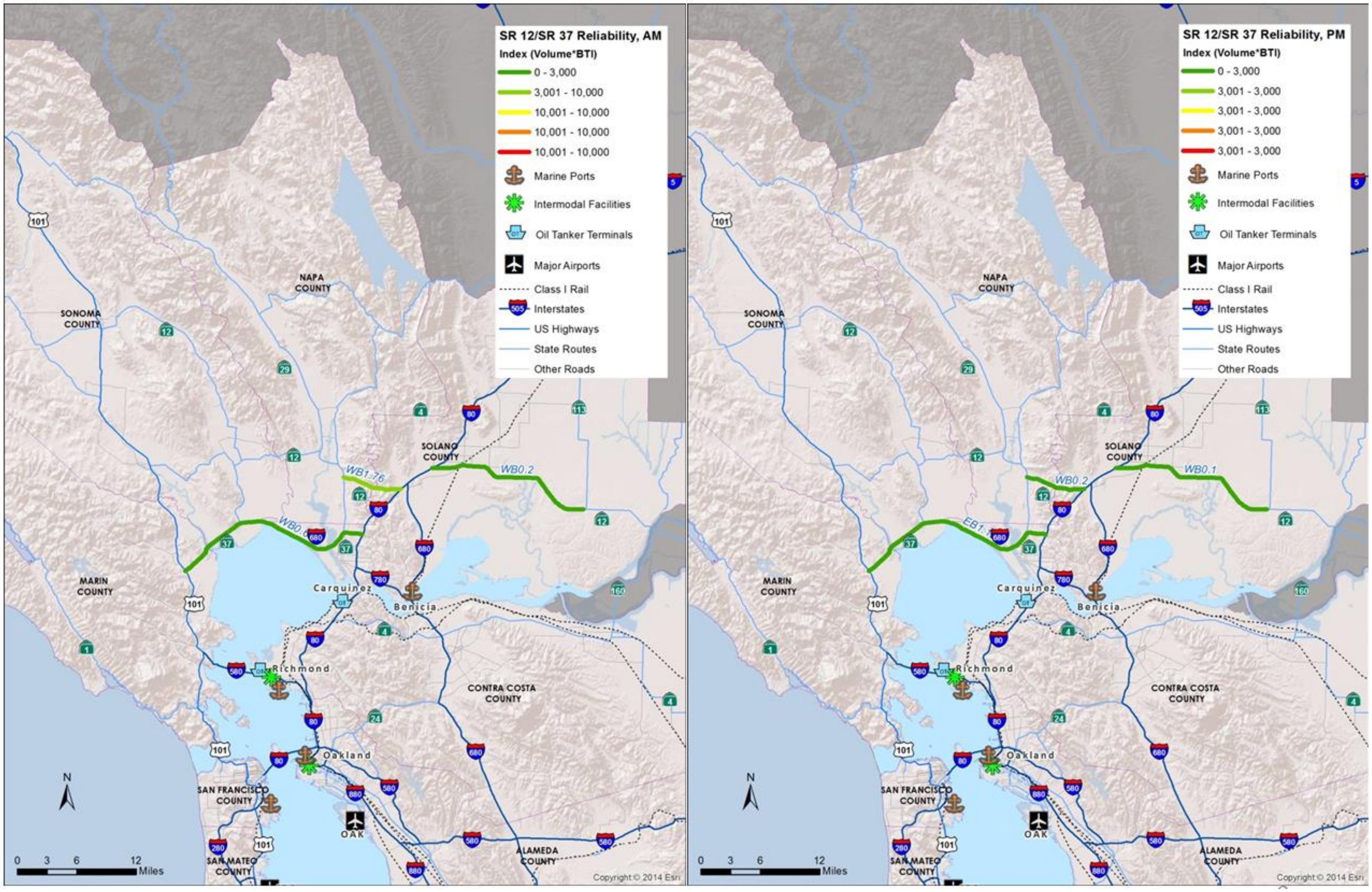
Congestion/Delay

The majority of the SR 12/ SR 37 corridor has modest truck volumes, with observed counts below 2,500 trucks per day (2+ axles) in 2012. However, two locations have much higher volumes. Over 5,500 trucks per day (2+ axles) traveled on SR 37 near the junctions with U.S. 101 and I-80, with the vast majority (4,500 per day) being 3+ axle trucks. Most of these are heavy trucks (5+ axles) used to transport agricultural products, particularly in Sonoma County. Though currently not a major interregional goods movement corridor, SR 12 has potential to become one because of its direct access to San Joaquin Valley. None of the top 139 congested segments in the Bay Area is on either corridors; however, this does not mean there are no congestion issues along the corridor. Stakeholders have cited SR 37 as having congestion problems during rush hours and special events.

Travel Time Reliability

Figure 2.55 shows the truck reliability along the corridors. Overall, the corridor has high reliability in both the AM and PM peak periods. A 6-mile segment between I-80 and SR 29 has a BTI of 1.76 in the westbound direction in the AM period, which shows significant unreliability for total traffic. However, due to relatively low volumes of truck traffic, that unreliability is small compared to the rest of the corridor.

Figure 2.55 Reliability on Segments along SR 12/SR 37, Peak Periods, 2013



Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Pavement and Bridge Conditions

The SR 12/SR 37 corridor is fifth out of the 8 corridors in average bridge rating but it should be noted that a portion of the corridor is in a more rural area. Of the 71 bridges along the corridor, 53 have a rating above 80 but 4 have a rating below 50, good for second most among the study corridors. In terms of weighted pavement score, SR 12/SR 37 ranks 6 out of 8 with 2.43 out of 3. The percentage of lane miles considered to be in good/excellent condition is 63 percent with 20 percent considered to be distressed. Figure 2.56 shows the conditions along the corridor.

Several of the bridges in the SR 12 corridor cross major waterways and must be raised to accommodate ship traffic, causing delays to waiting vehicles and pedestrians. For example, the Corridor System Management Plan (CSMP) for SR 12 points out that the delays at the Rio Vista Bridge can be as much as 25 minutes each time the bridge is raised.[41] At present, the bridge must be raised once or twice per week. However, if goods movement activity at the Port of Sacramento were to increase, the bridge might need to be raised 10 to 15 times per week.[42]

Safety

The SR 12/SR 37 corridor ranks fourth out of the 8 corridors in truck crashes per lane-mile with 1.11. Of the 247 truck-related crashes along the corridor from 2003 to 2012, 15 were fatal. Figure 2.57 shows the truck involved crash rates along U.S. 101.

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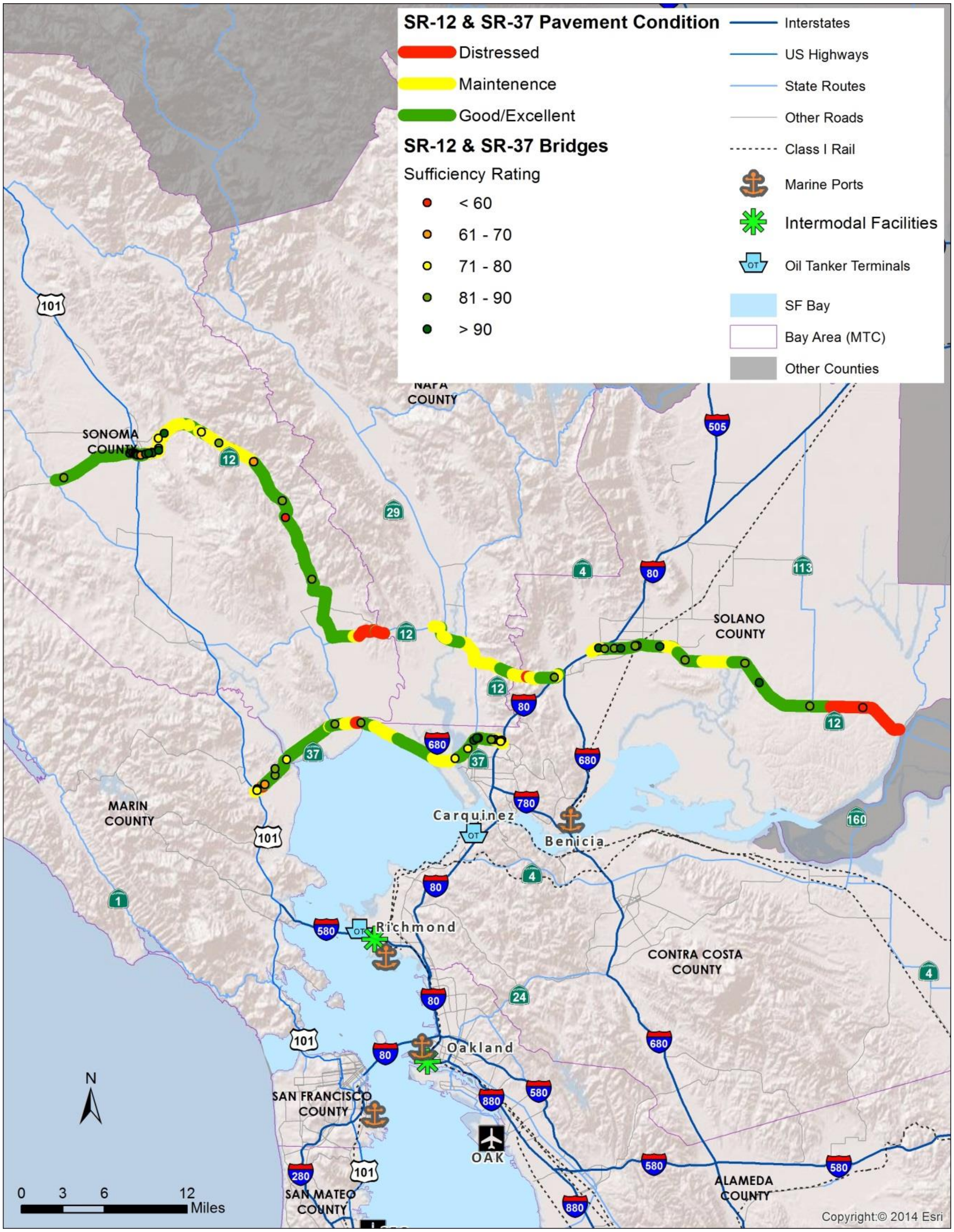
[41] State Route 12 Corridor System Management Plan, Caltrans, December 2010.

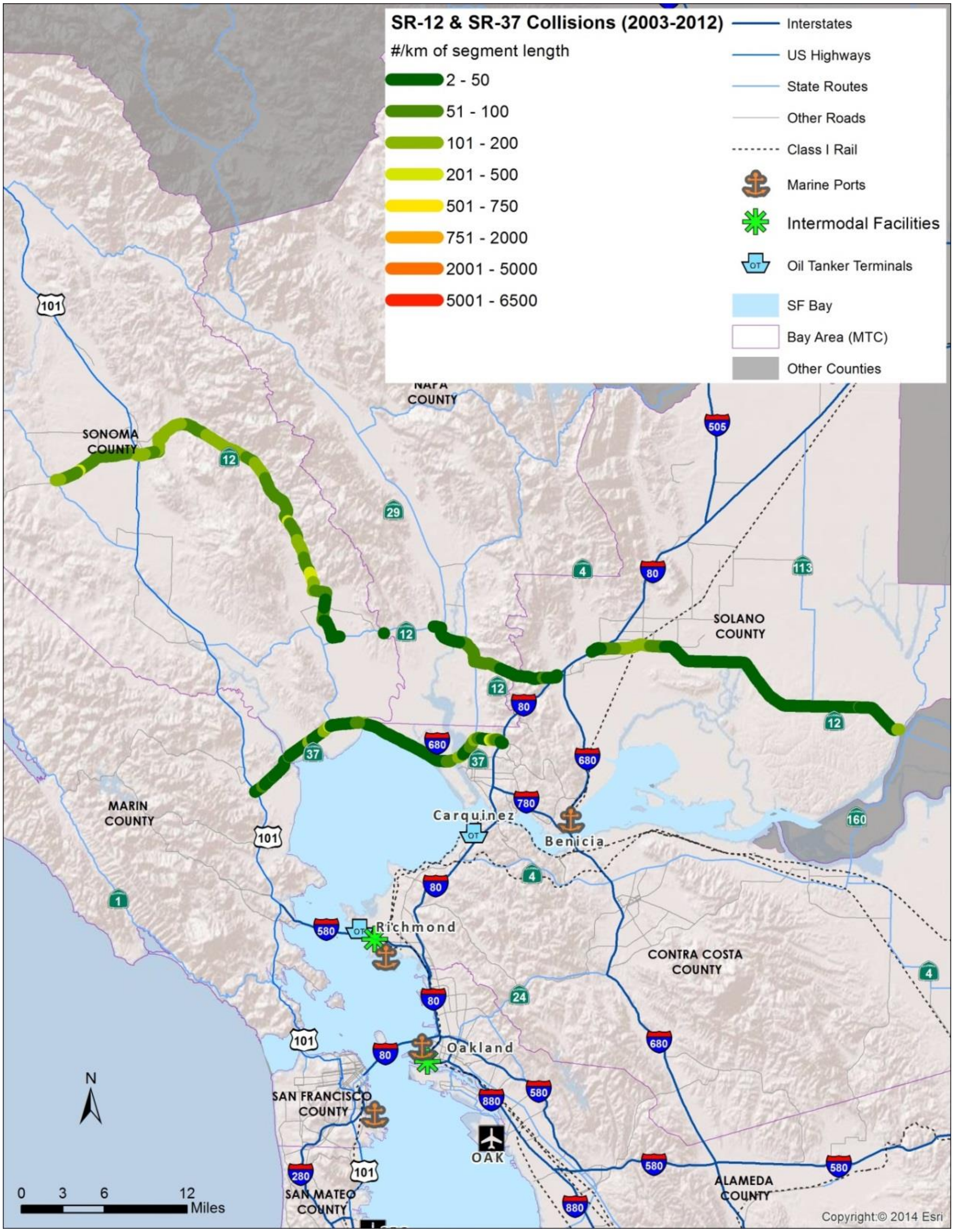
[42] Ibid.

Figure 2.56 Pavement and Bridge Existing Conditions along SR 12/SR 37



Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.57 Truck Involved Crash Rates along U.S. 101



Source: SWITRS; Cambridge Systematics Analysis.

Rail Needs Analysis

Many local shippers in the area are becoming frustrated with the highway congestion on SR 37 (and U.S. 101), and they have been investigating what it would take to transition their shipments to rail, especially agricultural and beverage producers who send and receive heavy loads. However, this option is limited by both infrastructure and operational issues. In particular, more rail spurs need to be rebuilt or added to provide last-mile connectivity, and railcar turnover needs to increase enough that railcar reservations are not cost-prohibitive. It will be important for planners to maintain sufficient freight capacity once SMART passenger trains begin operating on the NWP rail line. For additional information on the NWP and SMART line, please refer to discussions in Section 2.4.

2.7 The SR 152 Corridor

2.7.1 Overview, Industry Drivers, Growth Trends

The SR 152 Corridor is a major east-west corridor for interregional traffic connecting the South Bay, North Central Coast and Central Valley regions. Though only a relatively small portion of SR 152 is within the Bay Area, it offers an important connection to the Central Valley. SR 152 is the only continuous east-west route connecting SR 99 and U.S. 101, and provides a viable alternative to the heavily congested I-580/I-238/I-880 east-west corridor.[43] SR 152 has been designated as a Focus Route in Caltrans' Interregional Transportation Strategic Plan (ITSP).[44] Focus Routes are the highest priority for completion to minimum standards (usually expressway or freeway standards) in order to serve interregional trips and provide access to statewide gateways.

Nearly 50 percent of the State's $36 billion in agricultural production take place in counties along and adjacent to the SR 152 corridor. Table 2.37 provides a summary of the corridor.

Table 2.37 SR 152 Corridor Summary

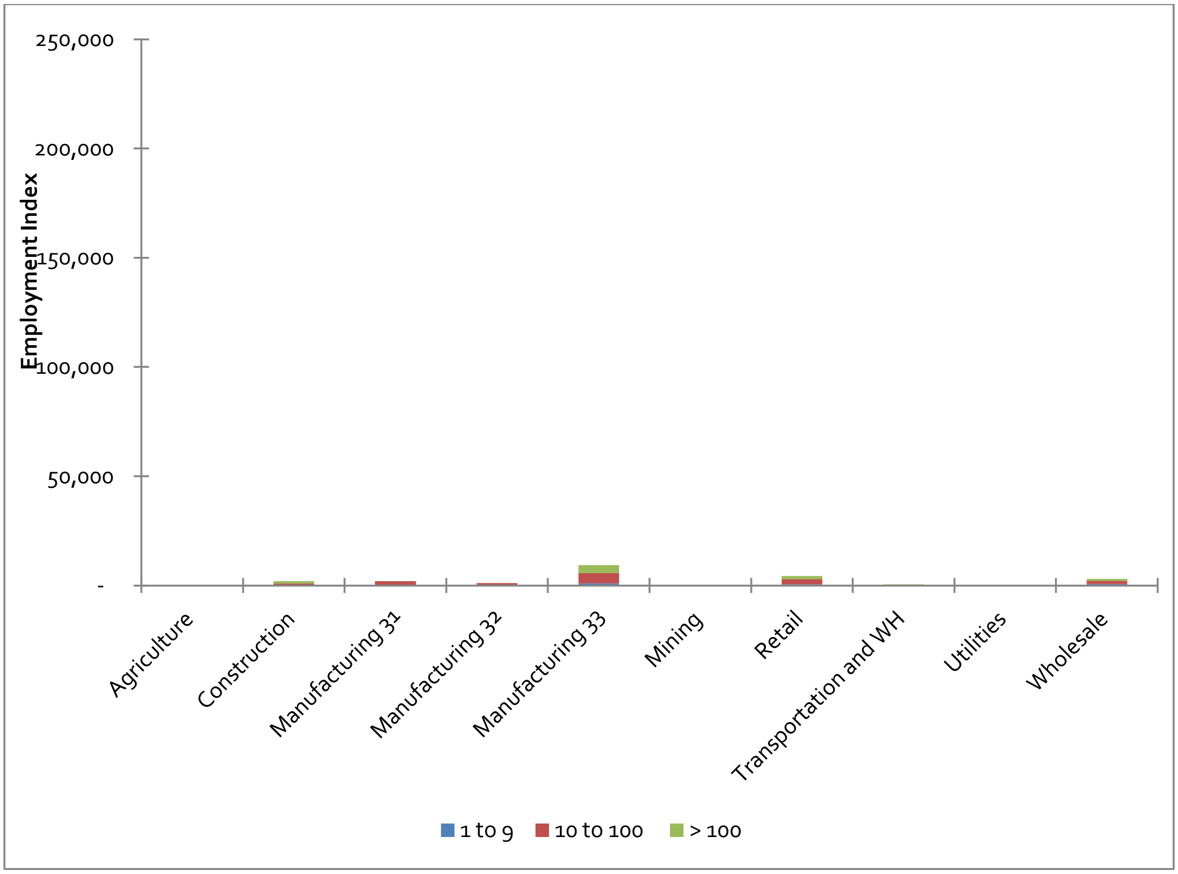
Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Santa Clara	SR 152		Interregional, Intraregional	Important connection providing link that connects the San Joaquin Valley to the coast. Selected as a Caltrans Focus Route in 2013.

[43] Route 152 Trade Corridor Summary Report, VTA, 2013.

[44] http://www.dot.ca.gov/hq/tpp/offices/oasp/ITSP_document_11_25_2013_rev1.pdf#zoom=75.

Figures 2.58 through 2.61 show the industry profile along SR 152. Note that since the corridor is much shorter as compared to other corridors in the region, the magnitude of the employment is much smaller compared to other corridors, as Figure 2.58 shows.

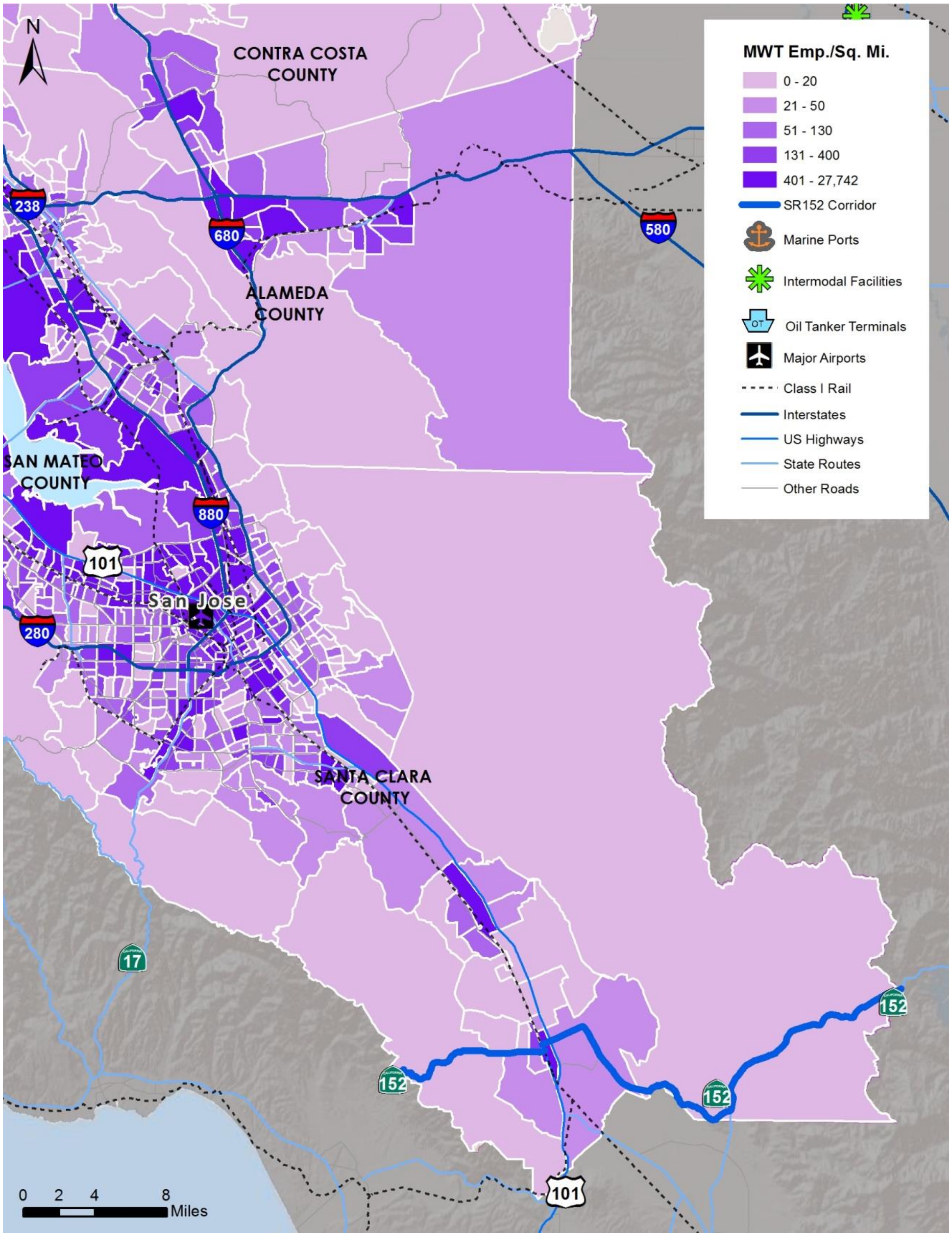
Figure 2.58 Employment Index for Goods Movement-Dependent Industries, SR 152
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

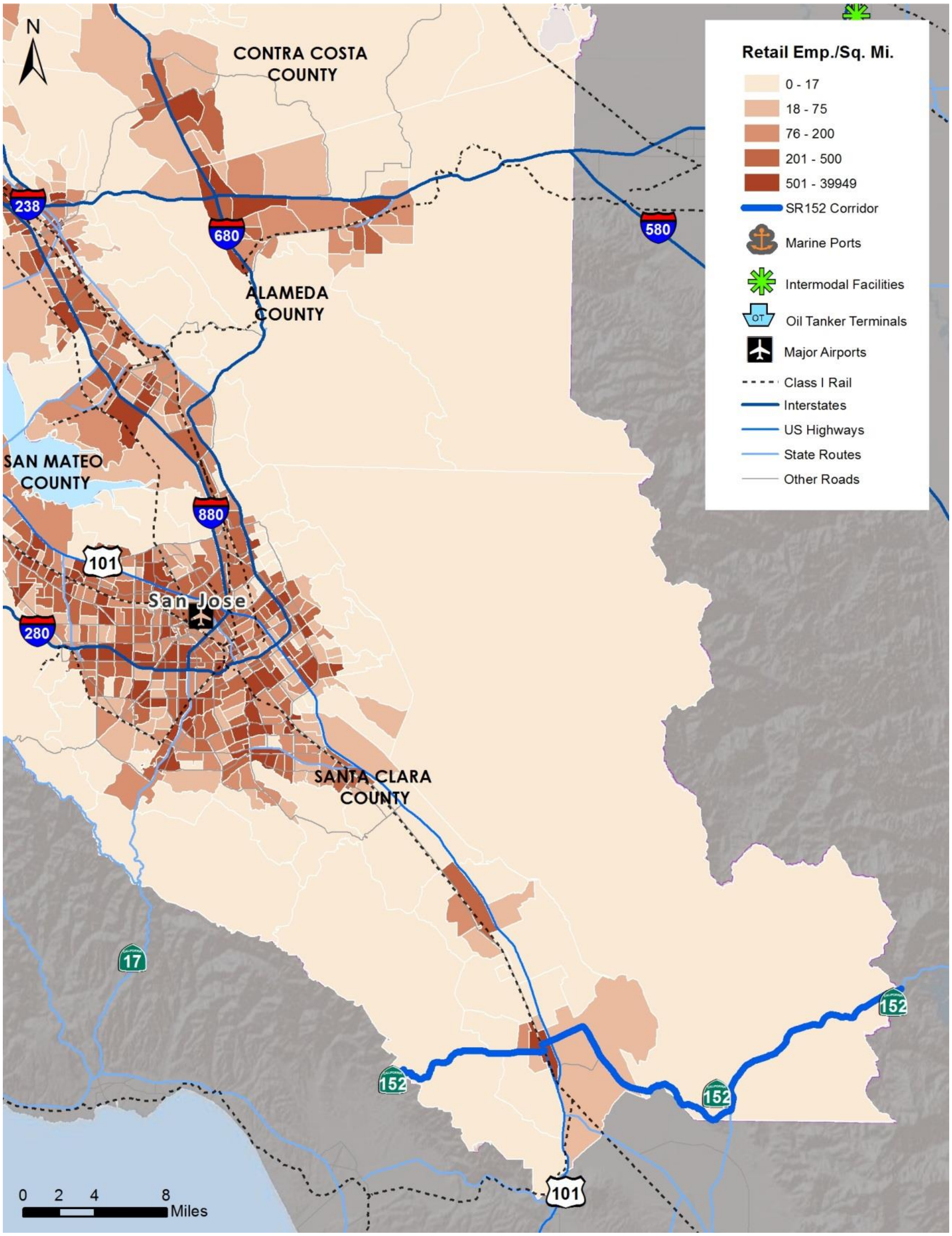
Figure 2.59 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along SR 152



Source: MTC.

Note: Employment Density is in employees per square mile.

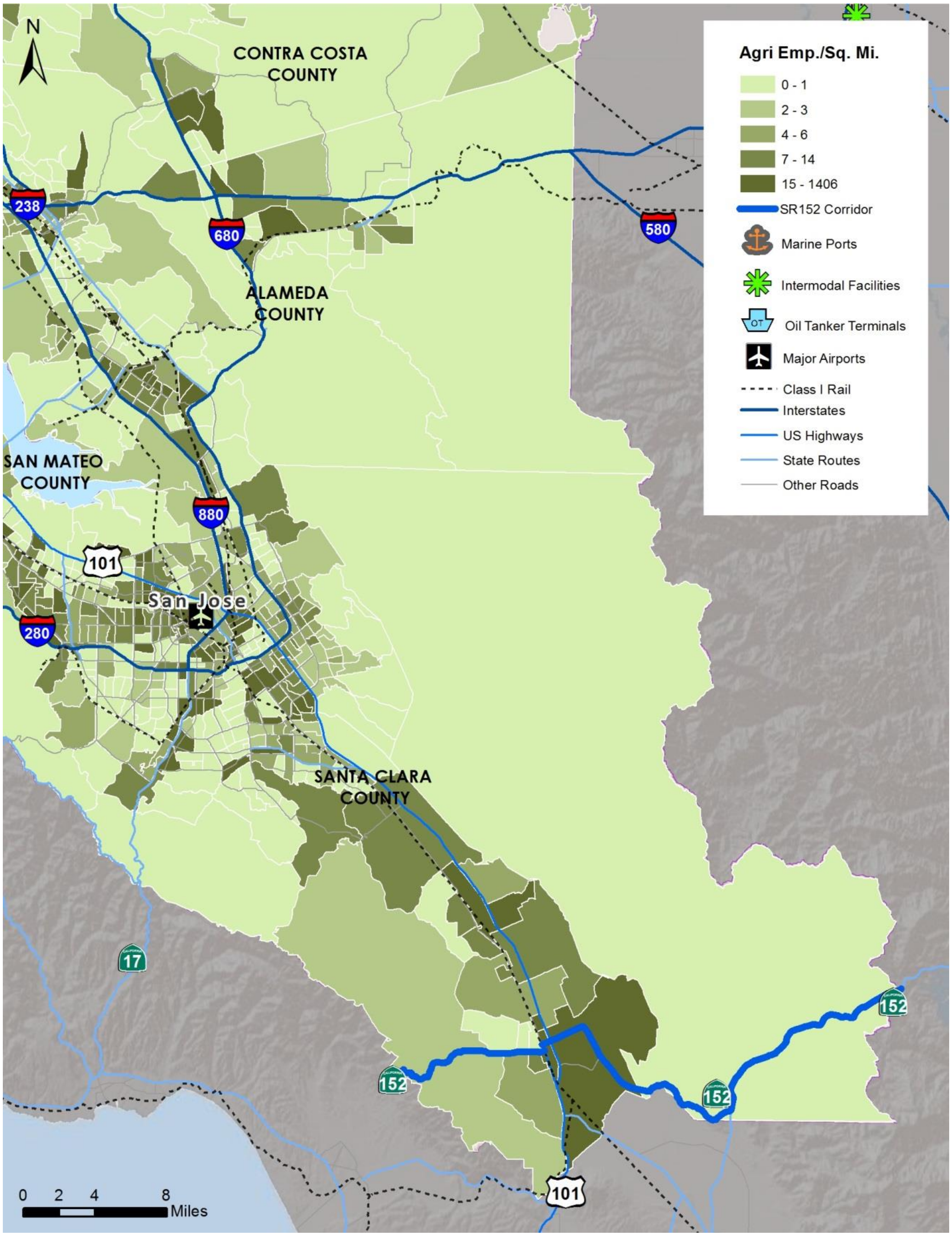
Figure 2.60 TAZ Level Employment Density in the Retail Sector along SR 152



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.61 TAZ Level Employment Density in the Agriculture Sectors along SR 152



Source: MTC.

Note: Employment Density is in employees per square mile.

2.7.2 Analysis

While the existing conditions on SR 152 within the study area does not show critical needs, with increased interregional role in the future, the conditions will likely worsen if not monitored. Table 2.38 shows the corridor evaluation.

Table 2.38 Corridor Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/air quality/public health	Tons of $PM_{2.5}$ emissions	N/A	Evaluated in Section 3.0
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	N/A	Evaluated in Section 3.0
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel time reliability	Buffer time index on freight (truck) routes	N/A	N/A
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	●	Ranked fifth in terms of truck involved crash rates among the corridors
		Crashes at at-grade rail crossings	N/A	N/A
	Freight infrastructure conditions	Bridge conditions ratings	●	Second highest bridge rating among corridors
		Freight (truck) highway and arterial routes pavement conditions ratings	●	Lowest weighted pavement score, with 30 % of corridor in distress condition (east of U.S. 101)
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	N/A	Evaluated in Section 3.0
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system	Use of innovative technologies	Use of ITS and innovative technologies, such as zero-emission technologies	N/A	Evaluated in Section 3.0

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions	Travel time delay	Travel time delay on freight (truck) routes	●	None of the region's most congested segments are on this corridor. However, corridor volumes expected to increase significantly as it gains more interregional significance.
		Travel time delay on railways, terminals, ports, airports	N/A	N/A
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	N/A	N/A
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 3.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	N/A	N/A
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	N/A	Evaluated in Section 3.0
Increase jobs and economic opportunities that support residents and businesses	Economic contribution	Jobs and output generated (including co-benefits of public health strategies)	N/A	Evaluated in Section 3.0

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

Highway Needs Analysis

Congestion/Delay

According to the Route 152 Corridor Study final report, by 2015, volumes along some portions of the whole SR 152 corridor are forecast to increase by more than 40 percent, and nearly double by 2035.[45] Truck percentages on portions of SR 152 within Santa Clara County are highest at the

[45] Route 152 Trade Corridor Summary Report, VTA, 2013.

junction with SR 156, with 4,512 trucks daily in 2012, making up almost 15 percent of total traffic. On a more interregional level, SR 152 currently carries about a quarter of all east-west truck movements in between the Bay Area and the Central Valley, and truck volumes along the corridor are expected to increase in the future.[46]

Portions of the corridor exhibit poor connectivity with the adjoining state highway system. West of the SR 152/SR 156 interchange, the route splits from a four-lane expressway type facility to the two-lane conventional highways of SR 152 and SR 156 before reaching U.S. 101. Rural, two-lane undivided highways are not capable of effectively and safely moving the traffic we see today or expect in the future. The resulting congestion causes some traffic to divert onto local roads such as Ferguson Road. A continuous four-lane freeway or expressway type facility would significantly improve system connectivity throughout the corridor.

Travel Time Reliability

Reliability cannot be determined along this corridor due to the lack of corridor-level INRIX data.

Pavement and Bridge Conditions

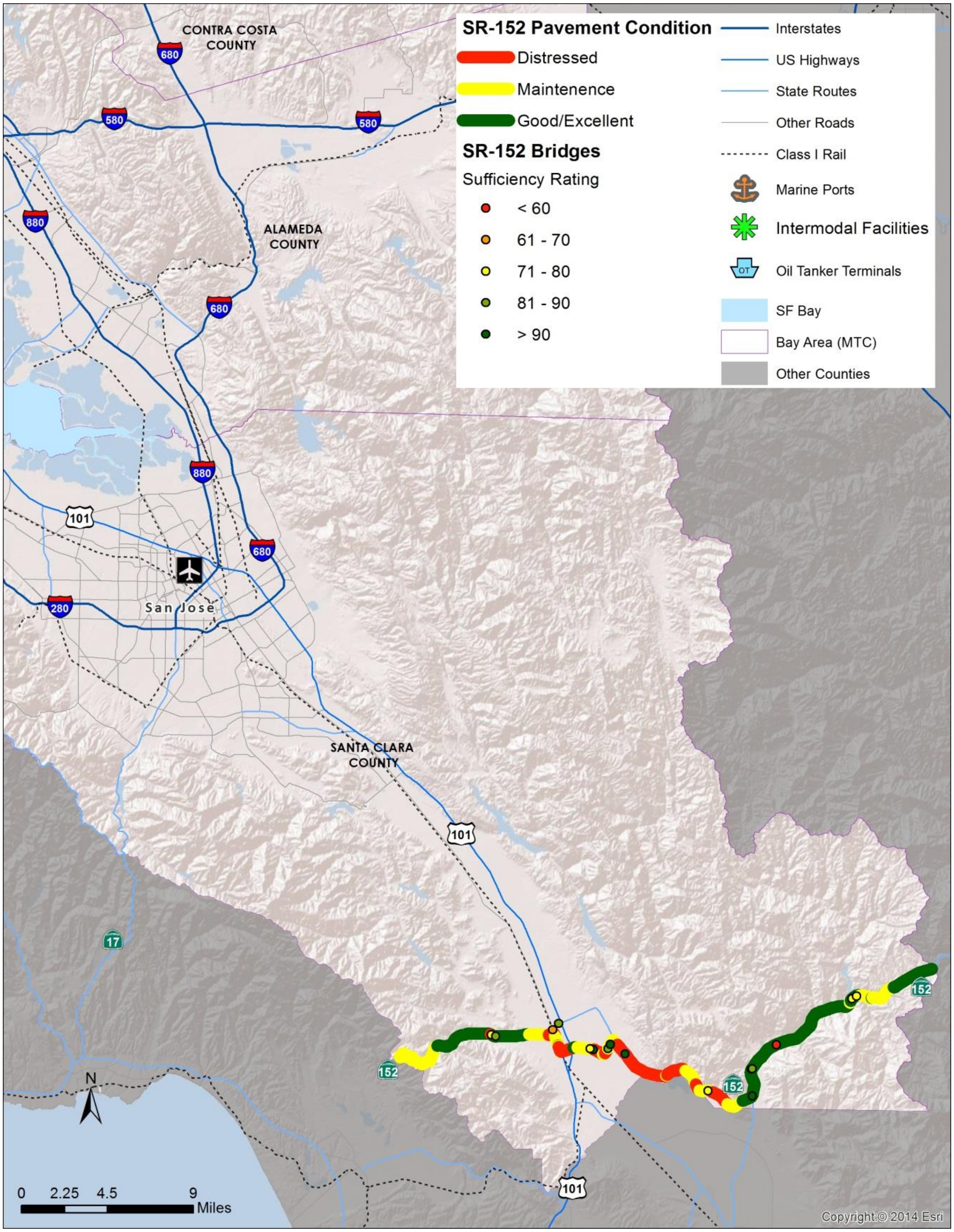
As shown in Figure 2.62, the SR 152 corridor has the second highest average bridge rating with a score of 88.64; it also has the fewest bridges with 27. Of the 27 bridges along the corridor, 21 have a rating above 80 and none has a rating below 50. Despite the high bridge score SR 152 has the lowest weighted pavement score with a 2.32 out of 3. The percentage of lane miles along this corridor considered to be in good/excellent condition is 62 percent, while 30 percent are considered to be distressed. This corridor has the highest percentage of distressed lane miles out of all the corridors, and this distressed portion is seen to be immediately east of U.S. 101.

Safety

The SR 152 corridor ranks fifth with 0.94 truck crashes per lane-mile from 2003 to 2012. Of the 94 crashes along the corridor during this time, 7 were fatal. Figure 2.63 shows the truck involved crash rates along the corridor, indicating slightly higher crash rates near the junction with U.S. 101.

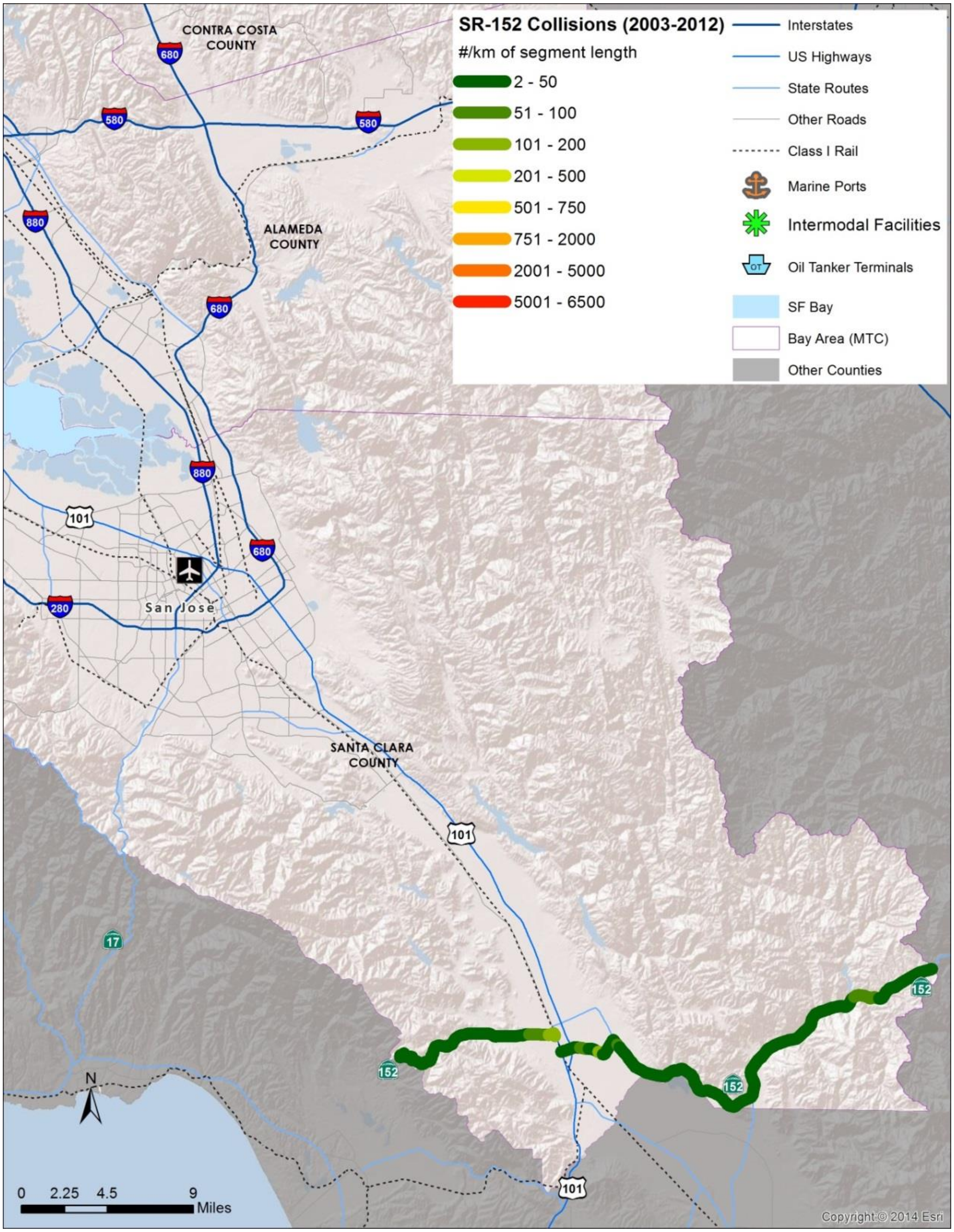
[46] Ibid.

Figure 2.62 Pavement and Bridge Existing Conditions along SR 152



Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.63 Truck Involved Crash Rates along SR 152



Source: SWITRS; Cambridge Systematics Analysis.

2.8 The SR 4 Corridor

2.8.1 Overview, Industry Drivers, Growth Trends

The SR 4 Corridor is an east-west route providing intraregional and interregional travel between the Central Valley and Bay Area for commuter and commercial traffic. The SR 4 corridor serves local and intercity truck traffic for surrounding communities and provides connections between the oil refineries and other industrial producers along the Contra Costa County Northern Waterfront with the rest of the intraregional network and customers in the Bay Area. SR 4 also provides connections to I-680 and I-80. This corridor includes the BNSF and UP rail lines from Stege/Port Chicago to Stockton, as well as the legacy UP Mococo line from Martinez to Lathrop, following similar alignments to the SR 4 corridor, connecting the Bay Area to the rest of the nation.

In terms of both freight flows and employment, the current industrial uses along the SR 4 corridor are dominated by petroleum refining and chemical processing. Three of the five oil refineries in the Bay Area are located in the corridor, and five chemical producers have large scale production facilities in the area. Much of the raw crude that is delivered to the area arrives on oil tanker ships, and so the continued maintenance of ship channel depths is a high priority for inbound flows. In addition, the UP rail line serving these refineries shares track with the popular Capitol Corridor passenger service, potentially leading to capacity issues for the outbound movements of both local freight and through traffic in the rail corridor.

Traditional large-scale manufacturing has historically been a strong focus in the corridor, particularly heavy products that are more economical to ship by sea or rail, such as metals and machine parts, construction materials, nonmetallic mineral products, and electronic and transportation equipment. Unfortunately, most of the industrial base in the area was built up nearly a century ago, and the cost of refurbishing aging and outdated infrastructure is high, which discourages new entrants in these sectors. The number of business establishments and total employment in these heavy industry sectors has been steadily declining over the past few decades, suggesting that this trend is unlikely to change in the near future.[47]

At the same time, there has been growth in smaller emerging clusters such as advanced manufacturing, life sciences, and clean technology, as well as food and beverage processing. These growth industries use smaller facilities and produce smaller volumes of higher-value freight than their area neighbors. These factors could make the newer industries more sensitive

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[47] Revitalizing Contra Costa's Northern Waterfront: How To Be Competitive in the 21st Century Global Economy, Contra Costa County Department of Conservation and Development, January 2014.

to concerns such as network access and travel time reliability than historical industries such as bulk products and commodities. In addition, smaller volumes of dis-aggregated freight are less attractive to marine and rail carriers; as these industries grow, the freight mode share could shift more towards truck transport than exists today, potentially exacerbating highway congestion.[48] Logistics facilities and 3PL services that support load consolidation could provide local businesses with multimodal flexibility and help to relieve roadway congestion.

In addition, connectivity to the east is also problematic. As will be discussed in the land use section, land use conflicts also are likely to happen as these industrial areas see rapid housing growth. Table 2.39 shows the corridor summary.

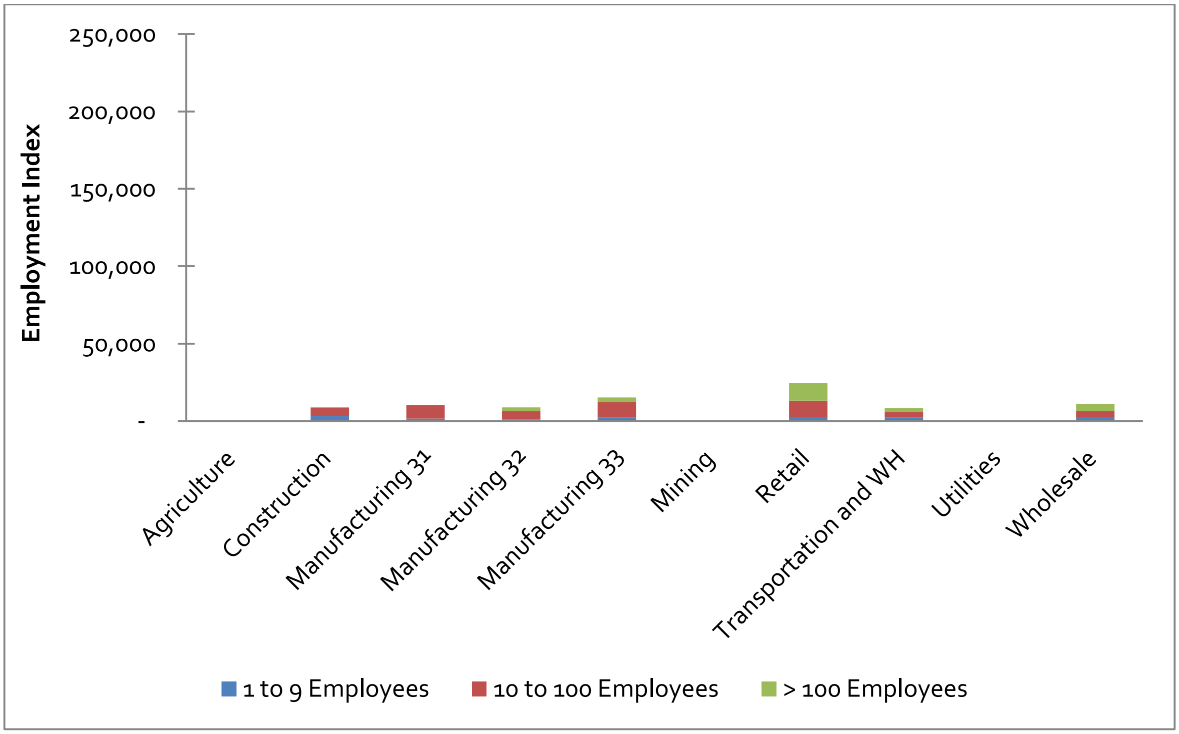
Table 2.39 SR 4 Corridor Summary

Counties in Bay Area	Corridor	Other Key Corridor Elements	Functions of the Corridor	Corridor Description
Contra Costa	SR 4	BNSF Route Stockton Subdivision (Transcon Line) UP line to Stockton	Intraregional, interregional	Serves refineries and diverse manufacturers in CCC, provides connections to Central Valley.

Because the corridor is relatively short compared to the other corridors, the general levels of employment are low. Manufacturing activities along the corridor are concentrated mostly along the northern water front following the corridor alignment. In addition, retail activities are concentrated in population centers including Concord, Pittsburgh and Antioch. There are also some concentrations of agricultural activities in these locations. Figures 2.64 through Figure 2.67 show the industry profile along SR 4.

[48] *Contra Costa Northern Waterfront Atlas*, Contra Costa County Department of Conservation and Development, January 2014.

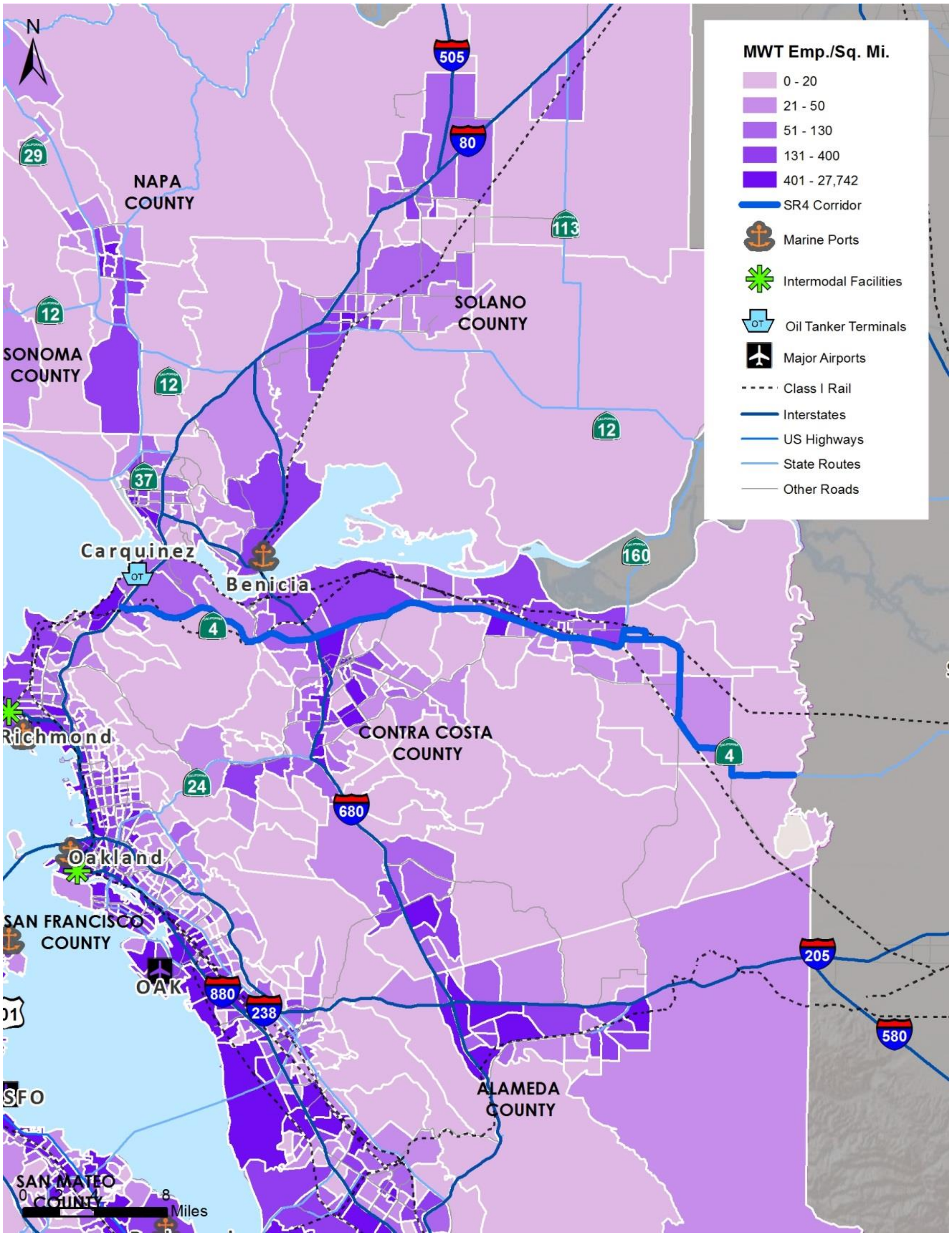
Figure 2.64 Employment Index for Goods Movement-Dependent Industries, SR 4
Number of Employees, 2012



Source: Zipcode Business Patterns Data, U.S. Census Bureau, 2012.

Note: Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical, plastics, rubber and other nonmetal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products, and all other miscellaneous manufacturing.

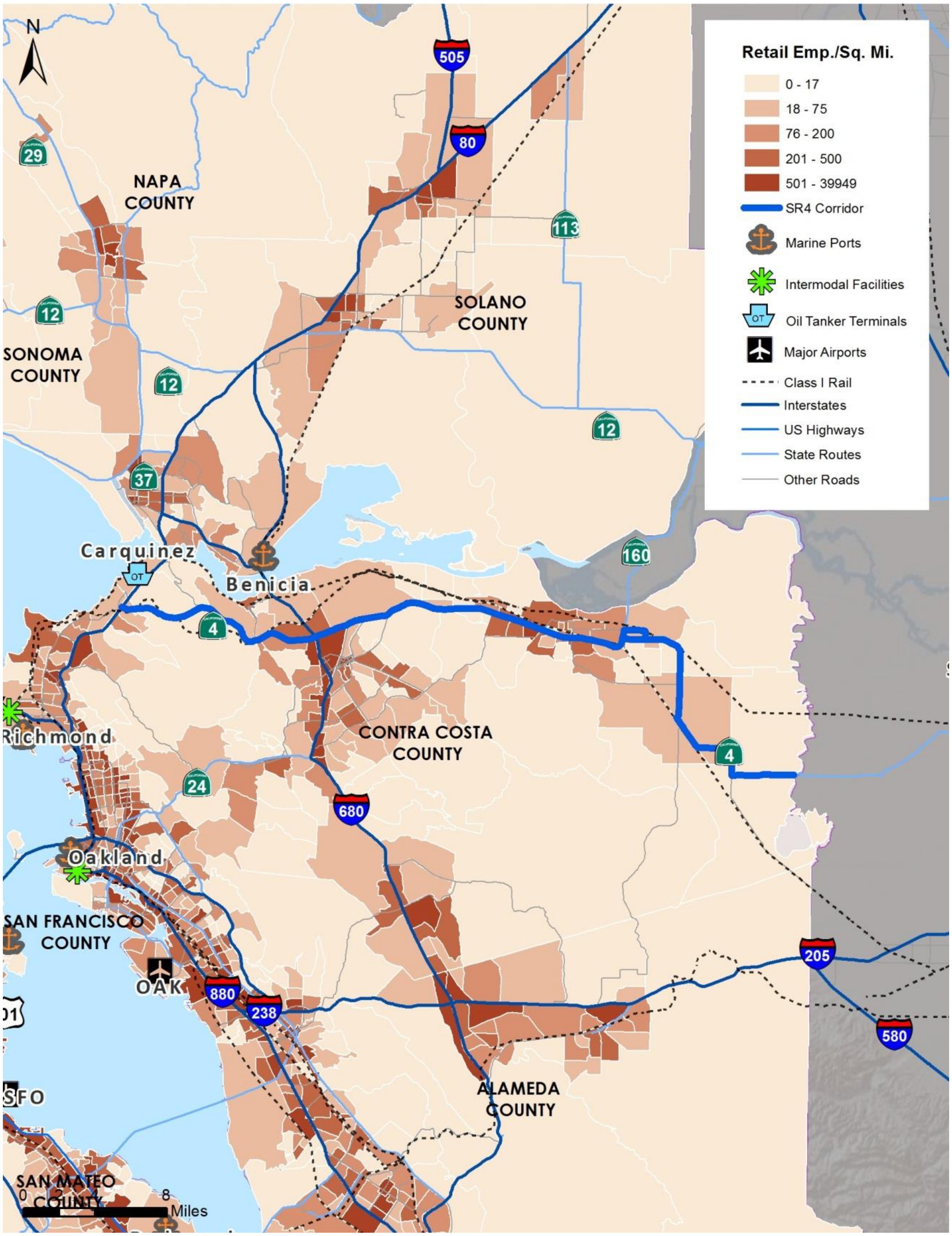
Figure 2.65 TAZ Level Employment Density in Manufacturing, Wholesale and Transportation Sectors along SR 4



Source: MTC.

Note: Employment Density is in employees per square mile.

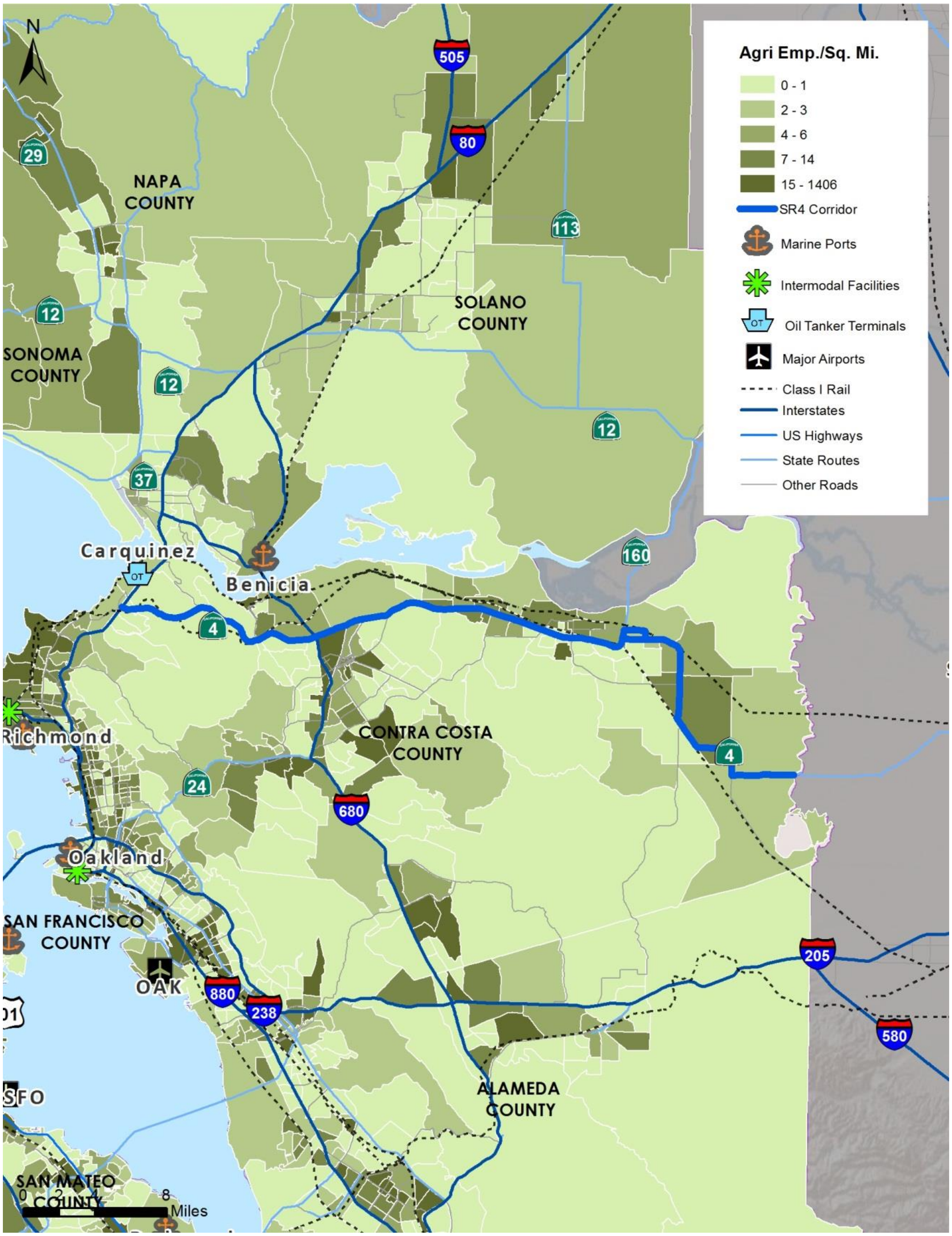
Figure 2.66 TAZ Level Employment Density in the Retail Sector along SR 4



Source: MTC.

Note: Employment Density is in employees per square mile.

Figure 2.67 TAZ Level Employment Density in the Agriculture Sectors along SR 4



Source: MTC.

Note: Employment Density is in employees per square mile.

2.8.2 Analysis

The major issues along SR 4 are related to the capacity constraints on the rail lines around the corridor, as well as truck delay and pavement conditions. It should be noted that major investments have been made recently in the corridor, including the widening of SR 4, and the extension of the BART passenger rail service to Antioch (eBART). Both projects will relieve traffic congestion on SR 4.[49] Table 2.40 summarizes the corridor evaluation.

Table 2.40 Corridor Evaluation

Goals	Measures	Metrics	Current Rating	Rating Explanation
Provide safe, reliable, efficient and well-maintained goods movement facilities.	Travel time reliability	Buffer time index on freight (truck) routes	🟢	Generally high truck reliability along the corridor.
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	🟢	Lowest number of truck crashes per lane-mile among the corridors.
		Crashes at at-grade rail crossings	🟢	Most crossings have not had a single incident in 10 years. The worst location, Fulton Shipyard Rd had two incidents.
	Freight Infrastructure conditions	Bridge conditions ratings	🟢	Highest rating among all corridors.
		Freight (truck) highway pavement conditions ratings	🟡	Second lowest pavement conditions rating among all corridors, with 15% in distressed condition.
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions.	Travel time delay	Travel time delay on freight (truck) routes	🟡	AM peak delay is found in two locations east of I-680. PM delay found at the junction with I-680.
		Travel time delay on railways, terminals, ports, airports	🟢	Currently train volumes do not present capacity issues.
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	🟡	Potential capacity constraints on shared passenger BNSF Stockton Subdivision in the future.

[49] http://www.bart.gov/about/projects/ecc.

Highway Needs Analysis

Congestion/Delay

Truck traffic volumes on SR 4 are most significant in the middle of the corridor. In 2012, nearly 7,500 2+ axle trucks per day were counted near Port Chicago and the interchange with I-680. Truck volumes on the eastern and western portions of the corridor are much lower, on the order of 1,000 2+ axle trucks per day. There are three portions of SR 4 with significant quantities of delay, as shown in Figure 2.68 below. In the AM peak, SR 4 is congested westbound for 6.1 miles between Railroad Avenue and Willow Pass Road (Segment 32) and for 4.6 miles between Hillcrest Avenue and Loveridge Road (Segment 17). The latter section has a very long time-span (from 5:10 a.m. to 10:50 a.m.), and average speeds are only 6.3 mph. The westbound section between Port Chicago Highway and Solano Way (Segment 113), stretches 1.9 miles, and has average speeds of nearly 7.28 mph. The total vehicle delay in this segment is very low, but because of the total volume at this location, the delay index is the highest of any SR 4 segment in either peak.

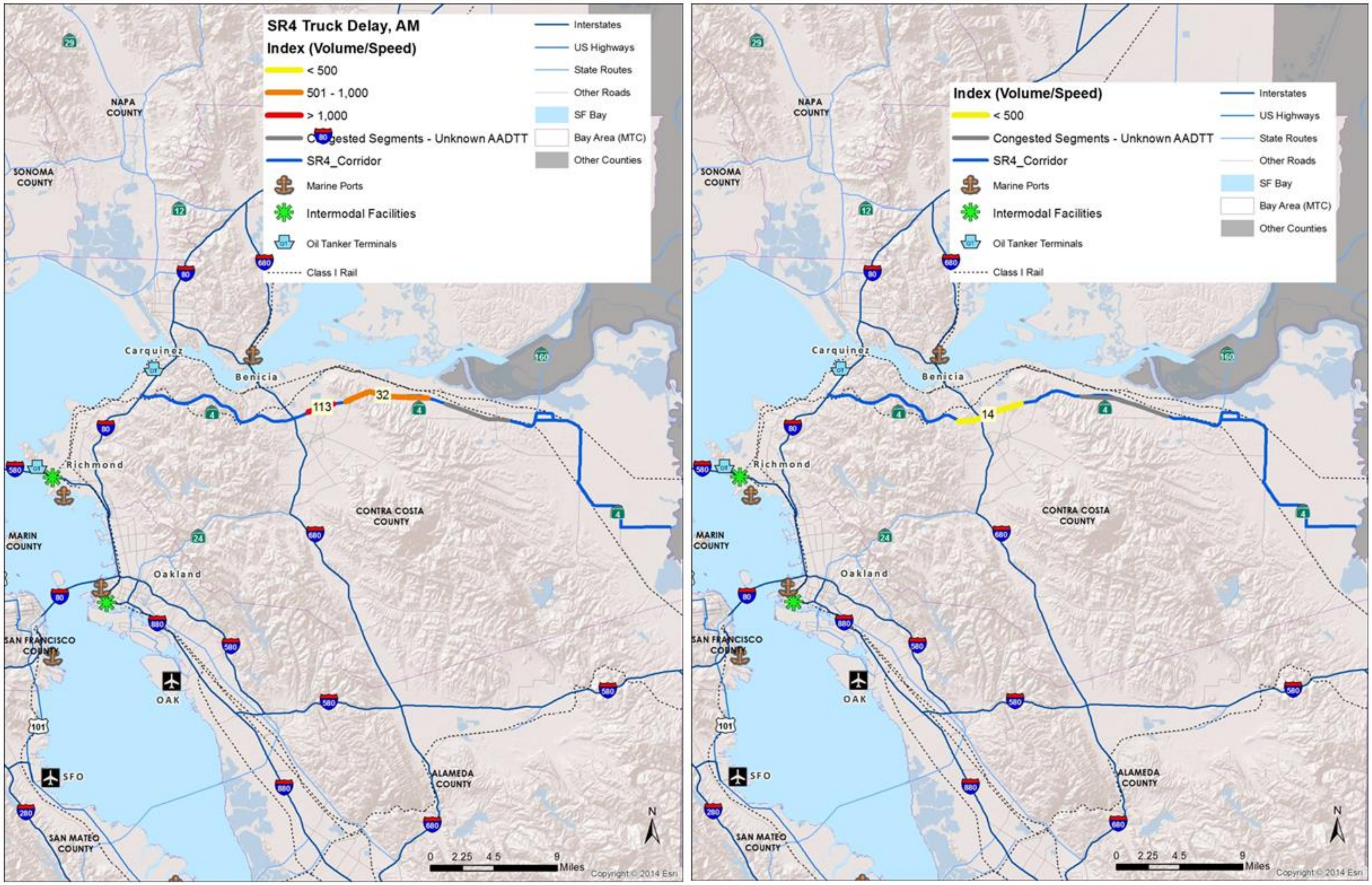
In the PM peak, the primary congestion location is eastbound between Bailey Road and Contra Loma Boulevard. This 6.3-mile portion of SR 4 experiences delays for the fourth longest time span of any congested segment in the Bay Area, extending from 1:35 p.m. to 8:25 p.m. Average speeds for this segment are about 7 mph.

The key findings of the SR 4 Corridor System Management Plan (CSMP) cite three causes for traffic conditions on this corridor. Specifically, the report says, "existing congestion along the SR 4 CSMP Corridor is the result of a lack of corridor-wide traffic management strategies, implementation of ITS, and segments with inadequate capacity and weave-merge sections."[50] The study specifically recommended implementation of ramp metering, the activation of existing ITS installations that are not currently fully operational, and the expansion of ITS technology elsewhere in the corridor.

The Northern Waterfront study has identified several locations where infrastructure and operational issues may be hindering efficient truck movements on SR 4 and local truck routes. Specific constraints include multiple locations with potential clearance issues, the need for truck climbing lanes and better geometry for weaving movements on portions of SR 4, an at-grade crossing, and ride quality issues in two locations.

[50] State Route 4 Corridor System Management Plan, Caltrans, October 2010.

Figure 2.68 Truck Delay on Congested Segments along SR 4, Peak Periods



Source: Congested Segments from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The numbers over the route indicates the ranking of the segment among the 139 most congested corridors in the region. Those shown in blue were not in the top 139 and do not have the same data available.

Travel Time Reliability

Truck travel reliability is generally high along the corridor, as shown in Figure 2.69. In the AM peak, the portion with lower reliability includes a 15-mile stretch east of I-680. In the PM peak period, there does not seem to be any reliability issues along the corridor.

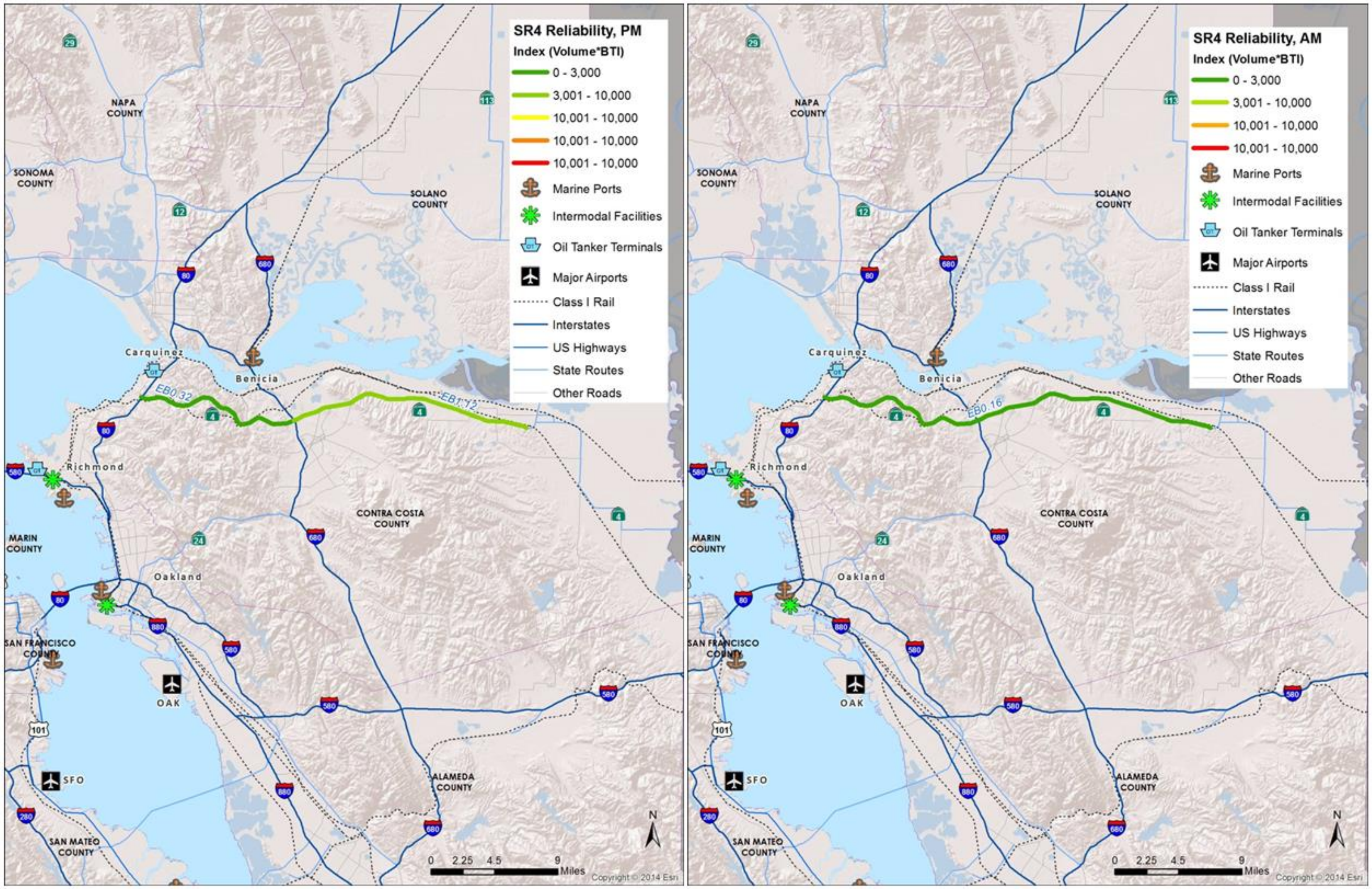
Pavement and Bridge Conditions

The SR 4 corridor has the highest average bridge sufficiency rating at 90.3. Out of the 75 bridges along the corridor, 67 have a rating above 80, and none is rated below 50. The SR 4 corridor is fifth in weighted pavement score with 2.48 out of 3. The percentage of lane miles considered to be in good/excellent condition along this corridor is the second lowest at 63 percent with 15 percent considered to be distressed. Figure 2.70 shows the pavement and bridge Conditions.

Safety

The SR 4 corridor is tied with U.S. 101 for the lowest number of truck crashes per lane-mile among the corridors in the study at 0.84. Of the 154 crashes involving trucks along this corridor from 2003 to 2012, 11 were fatal. Figure 2.71 shows the truck involved crash rates along the corridor.

Figure 2.69 Reliability on Segments along SR 4, Peak Periods, 2013



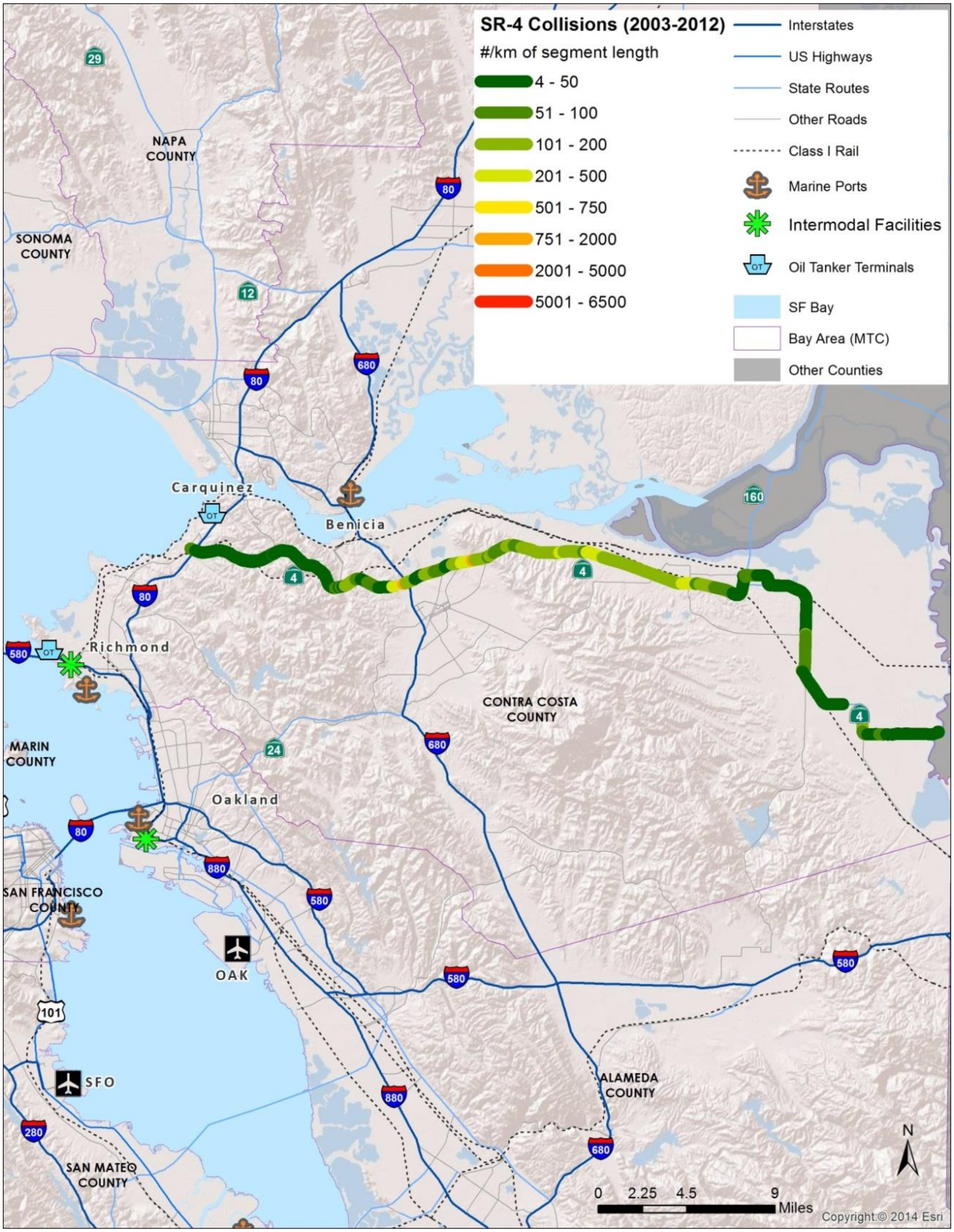
Source: BTI from INRIX 2013; Truck Volumes data from Caltrans Truck Counts, 2012; Analysis by Cambridge Systematics.

Note: The blue labels on segments indicate the direction as well as the BTI of the segment. Not all segments are labeled in all directions. In addition, for each segment, the reliability is shown for the direction with the worst reliability.

Figure 2.70 Pavement and Bridge Existing Conditions along SR 4

Source: Bridge Conditions Data from National Bridge Inventory, through MTC; Pavement Conditions Data from Caltrans, through MTC; Analysis by Cambridge Systematics.

Figure 2.71 Truck Involved Crash Rates along SR 152



Source: SWITRS; Cambridge Systematics Analysis.

Rail Needs Analysis

Two rail corridors run relatively parallel to SR 4. The BNSF route currently begins at Richmond, where BNSF maintains a major freight yard west of downtown. The route passes over the UP tracks one mile north of the Richmond BART station, and then generally parallels the UP line on a more inland alignment as far as Hercules. From Hercules, the BNSF route continues easterly through Franklin Canyon and southern Martinez before continuing east to Stockton across the San Joaquin Delta. This BNSF route was originally part of the Atchison, Topeka, and Santa Fe Railway (AT&SF) prior to a major rail merger with the Burlington Northern in 1995. The track configuration is single track with sidings, and employs an older Automatic Block Signal (ABS) system, which is less efficient than CTC.

In terms of rail traffic, the BNSF line to Stockton currently has around 10 freight trains and 8 passenger trains[51], which is expected to grow in the next 15 years. . BNSF's signaling system is outdated, and the line western portion travels through narrow ravines and on structures that are old; any additional service on this line will require infrastructure as well as capacity enhancing improvements. Bakken crude oil from North Dakota is part of the mix of increased crude-by-rail shipments into Contra Costa County, and this issue is discussed in more detail in Section 3.5.

The UP Tracy Subdivision (Mococo line) has not had any through train service on the route for decades, though the UP had considered reactivating the line as a reliever route to Lathrop in 2008 and has recently instituted tie renewal and grade-crossing improvements. The Tracy Subdivision consists of two main tracks between Martinez and Mococo and one main track from Mococo to Port Chicago. This segment of the UP Tracy Subdivision hosts 8 San Joaquin passenger trains daily and supports 79 mph passenger and 60 mph freight train service. This segment of the line is CTC signaled. From Port Chicago through to Tracy, the Tracy Subdivision is a single track line with track warrants. Speeds are restricted to 10 and 25 mph depending on line segment. UP currently is in the process of renewing the grade crossings on this line between Antioch and Brentwood and completed retying the line from Martinez to Somersville Road in Antioch last spring. UP also retied the line on the Tracy end up to Grant Line. If the line were needed in the future, potential community issues could include noise, emissions, safety at grade-crossings, and traffic congestion at crossings, among others.[52]

Available Rail Capacity. As described above, the current train volumes on the BNSF Stockton and UP Tracy Subdivisions are not large, but may increase due to shifting rail utilization and/or

[51] Sources: Freight train counts based on 2010 BNSF and 2008 UP train count data. Passenger train counts based on weekday published timetables for summer 2014.

[52] Staff Memorandum from Contra Costa Department of Conservation and Development, September 29, 2008, http://ca-contracostacounty.civicplus.com/DocumentCenter/Home/View/2686 (last retrieved November 16, 2014).

added passenger service. Increased demand for freight rail services and the desire to operate more passenger trains could constrain the ability of the existing railroads to support this growing demand. As demand approaches capacity, there will be increasing delays for all users of the system.

Table 2.41 illustrates the practical capacity of the BNSF Stockton and UP Tracy Subdivisions.

Table 2.41 Practical Capacity of Rail Lines in the SR 4 Corridor

Subdivision	From:	To:	Number of Main Tracks	Signaling	Average Capacity
BNSF Stockton	Richmond	Stockton	1	CTC	30
UP Tracy	Martinez	Port Chicago	1	CTC	30
UP Tracy	Port Chicago	Lathrop	1	TWC	15

Source: Altamont Press, "California Region Timetable 20" March 2009.

Existing train volumes on this line are highlighted in Table 2.42. The table aggregates current average daily freight and scheduled passenger trains to obtain total daily trains.

Table 2.42 Average Daily Train Volumes in the SR 4 Corridor

Subdivision	From:	To:	Class I Freight Railroads	Average Daily Freight	Daily Passenger Trains	Total Daily Trains
BNSF Stockton	Stockton	Port Chicago	BNSF	10	8	**18**
UP Tracy	Martinez	Port Chicago	UP	4	8	**12**
UP Tracy	Port Chicago	Lathrop	UP	0	0	**0**

Sources: Freight train counts based on 2010 BNSF and 2008 UP train count data. Passenger train counts based on weekday published timetables for summer 2014.

Comparing train volumes (v) to practical capacity c) gives a sense of the potential for any line to be so congested that trains might be delayed. The v/c ratio for the railroad segment in the SR 4 corridor is tabulated in Table 2.43.

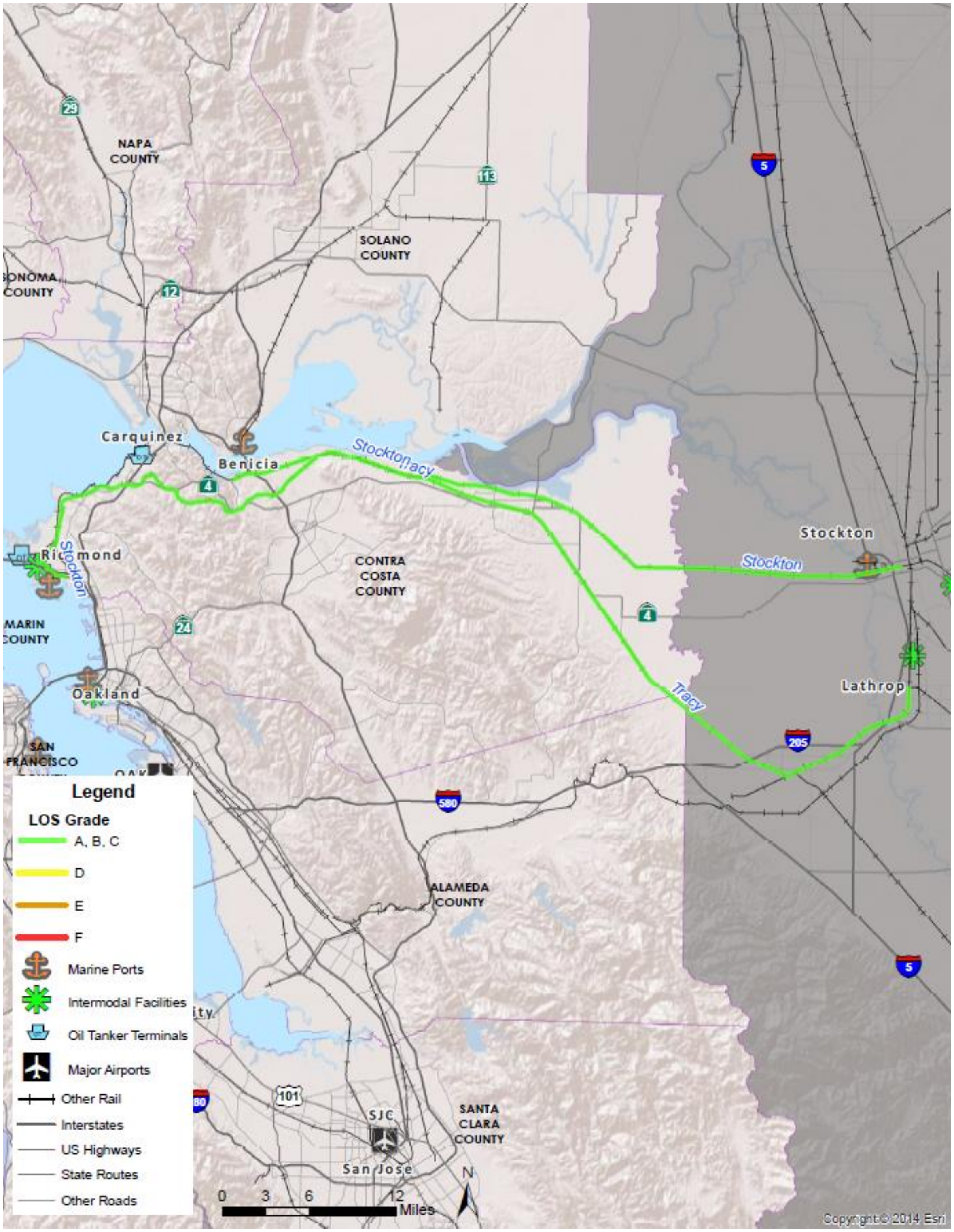
Table 2.43 Rail Lines Level of Service in the SR 4 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
BNSF Stockton	Richmond	Stockton	1	18	30	60.0%	C
UP Tracy	Martinez	Port Chicago	1	12	30	40.0%	B
UP Tracy	Port Chicago	Lathrop	1	0	15	0	A

Source: AECOM calculations.

Figure 2.72 provides the existing LOS on the SR 4 corridor rail lines in graphical format.

Figure 2.72 Existing LOS on SR 4 Corridor Rail Lines



Source: AECOM and Cambridge Systematics.

Forecast Rail Traffic. Future train volumes reported in the State Rail Plan for the rail segment in the SR 4 corridor are indicated in Table 2.44.

Table 2.44 Future Train Volumes in the SR 4 Corridor

			2020 Daily Train Volumes			2040 Daily Train Volumes		
Subdivision	From:	To:	Freight	Passenger	Total	Freight	Passenger	Total
BNSF Stockton	Richmond	Stockton	12	10	22	20	N/A	N/A
UP Tracy	Martinez	Port Chicago	N/A	N/A	N/A	N/A	N/A	N/A
UP Tracy	Port Chicago	Lathrop	N/A	N/A	N/A	N/A	N/A	N/A

Source: California State Rail Plan, May 2013.

The growth in traffic in both freight and potential passenger service will impact the BNSF Stockton Subdivision reducing the LOS from C to D, as shown in Table 2.45.

Table 2.45 Rail Lines 2020 Forecast Level of Service in the SR 4 Corridor

Subdivision	From:	To:	Number of Main Tracks	Total Daily Trains	Average Capacity	v/c Ratio	LOS
BNSF Stockton	Richmond	Stockton	1	22	30	73.3%	D

Source: AECOM calculations.

As indicated, the planned future growth in train volumes for freight and passenger services degrades the overall network.

Figure 2.73 provides the existing LOS on the SR 4 corridor rail lines in graphical format.

Figure 2.73 2020 LOS on SR 4 Corridor Rail Lines

Sources: AECOM and Cambridge Systematics.

At-Grade Highway-Rail Crossing Safety and Delay Issues

This section identifies the major at-grade crossings on the BNSF Stockton Subdivision in the SR 4 Corridor and presents accident statistics and estimated traffic delay for these crossings. The location and accident history of these crossings appears in Table 2.46.

Table 2.46 At-Grade Crossings Accidents on the SR 4 Corridor

				Accident History (January 2004 – June 2014)			
City	Street	Crossing Number	Railroad	Number of Incidents	Fatal	Injury	Property Damage Only
Port Chicago	Main Street	029773C	BNSF	0	0	0	0
Pittsburg	Mc Avoy Road	029768F	BNSF	1	1	0	0
Antioch	Loveridge Road	029732X	BNSF	0	0	0	0
	L Street	029698T	BNSF	1	1	0	0
	I Street	029697L	BNSF	1	0	0	1
	Fulton Shipyard Road	029693J	BNSF	2	1	0	1
	Minaker Drive	029685S	BNSF	0	0	0	0
	Viera Avenue	029677A	BNSF	0	0	0	0
	Big Break Road	029660W	BNSF	No accident file			
	Cypress Road	029654T	BNSF	1	0	0	1
	Sellers Avenue	029651X	BNSF	0	0	0	0
	Knightsen Avenue	029650R	BNSF	0	0	0	0
	Delta Road	029649W	BNSF	No accident file			
	Byron Highway	029647H	BNSF	No accident file			

Source: U.S. DOT Crossing Inventory.

The next step is to calculate delay experienced at these crossing locations. Traffic delay at at-grade crossings is customarily measured in terms of vehicle-hours of delay. Gate blockage times were combined with estimated traffic volumes in a formula to calculate vehicle hours of delay at each crossing. The results are shown in Table 2.47.

Table 2.47 At-Grade Crossings Hourly Traffic Delay

				Traffic Delay (Vehicle Hours/Day)		
City	Street	Railroad	Subdivision	Freight	Passenger	Total
Port Chicago	Main Street	BNSF	Stockton	2.10	0.09	2.19
Pittsburg	Mc Avoy Road	BNSF	Stockton	2.10	0.09	2.19
Antioch	Loveridge Road	BNSF	Stockton	1.33	0.06	1.38
	L Street	BNSF	Stockton	2.02	0.09	2.11
	I Street	BNSF	Stockton	1.37	0.09	1.46
	Fulton Shipyard Road	BNSF	Stockton	2.10	0.09	2.19
	Minaker Drive	BNSF	Stockton	2.10	0.09	2.19
	Viera Avenue	BNSF	Stockton	2.10	0.09	2.19
	Big Break Road	BNSF	Stockton	2.10	0.09	2.19
	Cypress Road	BNSF	Stockton	1.33	0.06	1.38
	Sellers Avenue	BNSF	Stockton	2.10	0.09	2.19
	Knightsen Avenue	BNSF	Stockton	2.10	0.09	2.19
	Delta Road	BNSF	Stockton	2.10	0.09	2.19
	Byron Highway	BNSF	Stockton	2.10	0.09	2.19

Source: AECOM calculations.

Determining the at-grade crossings most in need of grade separation can be based on two factors: the frequency and severity of accidents and the amount of delay experienced by roadway traffic. As shown in Table 2.46, the McAvoy Road, L Street, and Fulton Shipyard Road crossings each had a fatal accident. Cypress Road and I Street also had accidents, though nonfatal. With regard to traffic delay, Table 2.47 shows that the greatest level of traffic delay, 2.19 vehicle hours, has been calculated for several of the crossings, including those with fatal accidents.

Focusing on crossings with high accident rates, this suggests that the crossings be ranked in the following order for consideration of grade separation, with those having had fatal accidents at top priority:

- Fulton Shipyard Road (because it had an accident involving property damage in addition to a fatal accident, as well as the highest level of traffic delay);
- McAvoy Road (with the highest level of traffic delay); and
- L Street.

Prioritization for grade separation would then be followed by the crossings with nonfatal accidents:

- I Street (with a greater level of traffic delay); and
- Cypress Road (with somewhat less traffic delay).

3.0 Cross-Cutting Goods Movement Needs and Opportunities

There are a number of issues and needs that were identified through stakeholder outreach and initial analysis that are not specific to any particular corridor. These were analyzed and their impact on needs and deficiencies are described below. Many of these cross cutting issues will be the focus of programs and policies developed during the next phase of the study. The evaluation of cross-cutting issues and needs are summarized in Table 3.1.

Table 3.1 Cross-Cutting Needs Summary Evaluation

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Reduce and mitigate impacts from goods movement operations to create a healthy and clean environment, and support improved quality of life for those communities most burdened by goods movement	Emissions/air quality/public health	Tons of $PM_{2.5}$ emissions	🔴	$PM_{2.5}$ emission from freight levels have been decreasing steadily, though disproportionate impacts existing in certain communities.
	Equity	Freight impacts, such as light, noise pollution, safety, air pollution, and encroachment on communities	🔴	Freight operations, including increase transport of crude by rail contribute significantly to pollution in specific neighborhoods and create other health risks.
Provide safe, reliable, efficient, resilient, and well-maintained goods movement facilities and corridors	Travel time reliability	Buffer time index on freight (truck) routes	N/A	Evaluated in Section 2.0
	Freight-related crashes	Truck-involved crashes and crash rates (including crashes with bikes and pedestrians)	N/A	Evaluated in Section 2.0
		Crashes at at-grade rail crossings	N/A	Evaluated in Section 2.0
	Freight infrastructure conditions	Bridge conditions ratings	N/A	Evaluated in Section 2.0
		Freight (truck) highway and arterial routes pavement conditions ratings	N/A	Evaluated in Section 2.0
	Freight resiliency	Addresses freight system vulnerability to major service disruptions due to major natural or other events	🟢	There is moderate risk of vulnerability to freight infrastructure, especially highways and interchanges and rail infrastructure near the shoreline. Airport flooding and moderate flooding at Port of Oakland can be expected.
Promote innovative technology and policy strategies to improve the efficiency of the goods movement system.	Use of innovative technologies	Use of ITS and innovative technologies, such as zero-emission technologies	🟢	Emerging technologies are helping to reduce emissions significantly, though some areas are still at high risk.

Goals	Measures	Metrics	Rating	Rating Explanation[a]
Preserve and strengthen an integrated and connected, multimodal goods movement system that supports freight mobility and access, and is coordinated with passenger transportation systems and local land use decisions	Travel time delay	Travel time delay on freight (truck) routes	N/A	Evaluated in Section 2.0
		Travel time delay on railways, terminals, ports, airports	N/A	Evaluated in Section 2.0
	Multimodal connectivity and redundancy	Freight routes access from/to locations with significant freight activities	●	Congestion on local streets due to increasing amounts of local delivery traffic resulting in insufficient loading/unloading spaces and parking issues. Truck access to major freight facilities also limited or inadequate at various locations in the Bay Area.
		Access to rail lines, terminals, ports, and airports from/to locations with significant freight activities	N/A	Evaluated in Section 2.0
	Coordinate with passenger systems	Freight system element shared use with passenger system and addresses passenger/freight conflicts	●	Conflicts between trucks and buses along major bus routes, and planned BRT route in Oakland to San Leandro. In addition, complete streets concepts emphasize bike and pedestrian elements creates parking deficiencies for truck deliveries, especially in San Francisco. Bike and pedestrian facilities that cross industrial properties also create conflicts, near Port of Oakland, Port of Richmond and CCC Northern Waterfront.
	Compatibility with land use decisions	Locations and corridors with significant freight activities in proximity to noncompatible land uses currently and in the future	●	Existing shortage of industrial land will only be exacerbated in the future and create outward push of freight activities. Incompatible land uses also exacerbate illegal truck parking or trucks cutting through neighborhoods.
Increase jobs and economic opportunities that support residents and businesses.	Economic contribution	Jobs and output generated (including co-benefits of public health strategies)	●	A chronic lack of drivers, and also misconception of good paying jobs in freight is leading to a significant shortage of drivers, which may continue to be exacerbated in the future

[a] The current and future years are different depending on the particular issue. Please refer to each section for more detail.

3.1 Arterial Operations/Use of ITS technology/Urban Goods Delivery

One area of need for goods movement in the Bay Area that is difficult to analyze at the corridor level without more detailed, "micro" level analysis are needs associated with the urban goods movement system. The urban goods movement system in the Bay Area is the system of local streets and roads that are truck routes and that provide pickup and delivery access to residential and commercial areas. The urban goods movement system also includes last-mile connections to seaports, airports, rail terminals, and major industrial centers. There are a number of critical issues identified by stakeholders that are addressed below. Some of these issues were examined in more detail in a goods movement plan being developed for Alameda County Transportation Commission through a series of case studies. To the extent that this analysis is applicable to other situations throughout the Bay Area, the Alameda CTC analysis is referenced and examples of best practices and recommendations will be included in the regional plan.

3.1.1 Congestion and Operations on Arterials, Urban Truck Routes, and Rural Highways

Truck routes on local streets and roads play a critical role in the goods movement system. In urban areas, arterial highways are often designated as "through" truck routes and create corridors that supplement the freeway system for intercity goods movement within the Bay Area. These routes may actually provide an alternative to congested freeways at certain times of the day. In rural areas, state highways and county roads in the Bay Area are often high speed commuter routes that also provide access to truck-served uses such as agricultural producers and food processors (including the region's wineries). Many of these roads have been planned without considering the unique needs of the modern trucking industry.

Congestion on local streets and roads can be a particular issue for trucking, especially when the roads are signalized or have many stop signs. Heavy trucks require more time to accelerate and decelerate and if traffic signals are not timed properly, they can significantly inhibit the smooth flow of truck traffic. Trucks also create much higher levels of emissions when accelerating and idling and many and poorly timed signals can cause elevation of diesel emissions from heavy trucks. Congestion and delays on arterials may need to be addressed with spot widening, time of day capacity management (e.g., restricting parking, truck loading and unloading operations, bike access to certain times of day to enhance capacity during peak periods), or intelligent transportation (ITS) systems. ITS traveler information can coordinate freeway and arterial capacity and ramp activity to direct trucks to the best routes at any particular time and reduce delays. Smart arterial corridors can also include signal prioritization for trucks in heavily used industrial corridors.

The access needs of trucks on local streets and roads also must be considered. With increased use of 5+ axle trucks on local streets and roads, there is an increasing number of locations around the Bay Area where geometric constraints (such as inadequate turning radii) or lack of controlled access to major freight facilities can create safety concerns. Access issues are not exclusively an urban goods movement problem and are often found on more rural highways. As part of their goods movement planning effort, Alameda CTC included a case study along Tesla Road in Livermore, where truck access to wineries was an issue. This segment of Tesla Road is a 2-lane rural highway along which there are eight wineries. Aside from two signals at the ends of the corridor, traffic is controlled by side-street stop signs. The corridor functions as a high speed highway and is used by commuters to access I-580. The lack of left turn pockets and any traffic controls means that trucks experience significant operational challenges, often blocking the road turning into the wineries, creating congestion and safety concerns. This type of access issue is common in the more rural parts of the Bay Area and even in some of the smaller downtown areas.

Another growing issue in the urban goods movement system is the increasing amount of delivery traffic in busy downtown districts and in neighborhoods. The amount of truck traffic in areas where there has traditionally been more limited traffic is growing as a result of the increasing use of e-commerce as a way of making and fulfilling retail sales. This is resulting in insufficient loading and unloading spaces, double-parking or illegal parking of trucks, and encroachment of trucks in neighborhoods. This also creates conflicts between trucks and other users of the urban street system (see Modal Conflicts and Complete Streets in the following section). Many cities are beginning to experiment with a variety of strategies to address this issue including the development of package and parcel consolidation centers or local pickup/dropoff centers for urban parcel delivery, night-time delivery, and time of day street controls. This issue and some of the proposed solutions are described in more detail in the next section.

Figure 3.1 European Neighborhood Parcel Pickup and Delivery Center

Source: NACTO Webinar, Freight Considerations in World Class Street Design, Stacey Hodge, March 13, 2014

Figure 3.2 Change in Street Operations with Night-Time Delivery in New York City

Source: NACTO Webinar, Freight Considerations in World Class Street Design, Stacey Hodge, March 13, 2014

3.1.2 Modal Conflicts and Complete Streets

Another issue on the urban goods movement system is conflicts between trucks and other users of the urban street system. Many arterial truck routes are also high frequency bus routes and delivery trucks can block access to bus pullouts. Some transit operators in the Bay Area also report damage to bus shelters and signs from trucks making turns on streets with inadequate turning radii for heavy trucks. In Alameda County, AC Transit is currently planning to implement a bus rapid transit (BRT) line on International Boulevard in Oakland and San Leandro – a route that is also a major intercity truck route. The implementation of BRT will create limitations on certain turning movements. Similar issues may exist on the Muni system in San Francisco and in other transit systems developing BRT routes. It may be necessary to reconfigure truck routes and truck access from BRT corridors to ensure access by trucks to major pickup and delivery locations.

With the current emphasis on Complete Streets, there is a growing number of streets that has designated bike lanes and pedestrian pathways. In some cases, these uses are occurring on truck routes, creating safety issues and concerns. Trucks that must cross bike lanes to access on-street loading zones or that double-park due to lack of sufficient on-street parking for trucks can create particular hazards for bikes. Nonetheless, city planners must ensure adequate access to retail areas for truck deliveries. This was noted as a particular problem along the San Francisco Embarcadero by planners from the Port of San Francisco where pedestrian traffic has been emphasized, but often with adverse consequences on delivery trucks. There are also several bike and pedestrian pathways along the Bay that cross industrial properties or working waterfronts, where there is heavy-truck activity. This issue has been noted near Shoreline Park near the Port of Oakland, near the Port of Richmond, and along the Contra Costa County Northern Waterfront (where there are new plans being developed to encourage industrial development). Several different solutions have been used to address these issues in other cities, including barrier or grade separated bike and pedestrian trails and time-of-day use restrictions that try to limit conflicts by allocating street space for each user based on their general time-of-day use preferences.

3.1.3 Land Use Conflicts

A number of communities in the Bay Area report problems such as trucks cutting through neighborhoods on routes that have truck prohibitions, trucks parking illegally in neighborhoods, and various other issues around encroachment of trucks in neighborhoods. These issues are most likely to occur in cases where industrial areas border neighborhoods and where legal truck routes form boundaries between residential and industrial areas. If possible, future land use plans should try to create buffers between residential neighborhoods and truck-served land uses. This can be done be setting major truck generators further away from the street and buffering neighborhoods by putting small neighborhood commercial areas, parking lots, and barriers between the truck routes and the neighborhoods. Other land use restrictions that require uses such as fueling stations and truck services to obtain conditional use permits to locate in neighborhoods is another way to control the amount of trucks moving through residential neighborhoods. Sometimes these problems are a result of legacy land use decisions and there may be little that can be done to change the land use patterns. In these cases, making sure there is sufficient truck parking for both short stay activities (such as waiting for new dispatch instructions, fueling, or accessing food services) and overnight parking and prohibiting truck movements in residential neighborhoods may be necessary. These types of truck management strategies always should be accompanied by adequate services and access for trucks and enforcement.

A related land use issue is the encroachment of residential and commercial development along freight corridors. Even if appropriate buffers are provided between residential/commercial land uses and industrial land uses, when these buffers are not applied along heavily used truck routes and rail lines, the resulting conflicts can impact freight operations and/or public health and community quality of life. With growing demand fro residential and commercial development to serve population needs in the Bay Area, industrial land along freight corridors is experiencing conversion to higher value uses and often with proper buffer planning. New residents, employees, and patrons are then subjected to negative health affects and noise which could be avoided with proper planning protections. In addition, new residents often demand changes in the operations of trucking and rail in these freight corridors that can impact the freight users by reducing operating windows or requiring activity to occur in off peak periods when the costs to freight users of maintaining staff maybe higher.

3.2 Air Quality and Environmental Impacts

While Bay Area residents and businesses rely on goods movement to provide their day-to-day needs, this freight activity sometimes leads to unintended impacts that should be mitigated. Perhaps the most critical air quality and public health issues surrounding goods movement in the Bay Area are related to impacts of goods movement-related emissions on the health and safety of communities directly adjacent to major goods movement facilities and connecting infrastructure. These communities experience some of the highest exposure levels to pollution that causes asthma and other respiratory ailments, heart disease, and other health problems. Understanding air quality issues that arise from freight vehicle emissions and the resultant public health impacts is a critical step in determining appropriate mitigation activities, and is a component of this goods movement plan. This section explores the trends in emissions from freight sources in the Bay Area, and also the effect of these emissions on local communities. A significant portion of the discussion from this section is drawn from the recently completed report, Community Air Risk Evaluation Program Retrospective and Path Forward (2003 to 2013)[53] and the San Francisco Bay Area Freight Mobility Study conducted for Caltrans District 4.[54]

3.2.1 Emissions from Freight

California's air quality standards are the most stringent and health-protective in the nation, and are designed to provide additional protection for those segments of the population who are most sensitive to the effects of air pollution. Although the Bay Area does not yet attain all national and state standards for pollutants that cause health impacts, specifically particulate matter (PM), the Bay Area Air Quality Management District (BAAQMD) and the California Air Resources Board (CARB) are actively seeking to reduce emissions from key sources and significant achievements have been made in reducing these pollutants.[55]

Particulate Matter pollution is of utmost concern from a freight perspective because a significant portion of the PM pollution, especially $PM_{2.5}$[56] pollution, comes from freight. From July 2009 to December 2011 (as shown in Figure 3.3), during the peak $PM_{2.5}$ concentration period, freight transportation contributed to 17 percent of total $PM_{2.5}$ pollution in the Bay Area (13 percent from diesel vehicles, 2 percent from ships, 2 percent from aircraft/trains).

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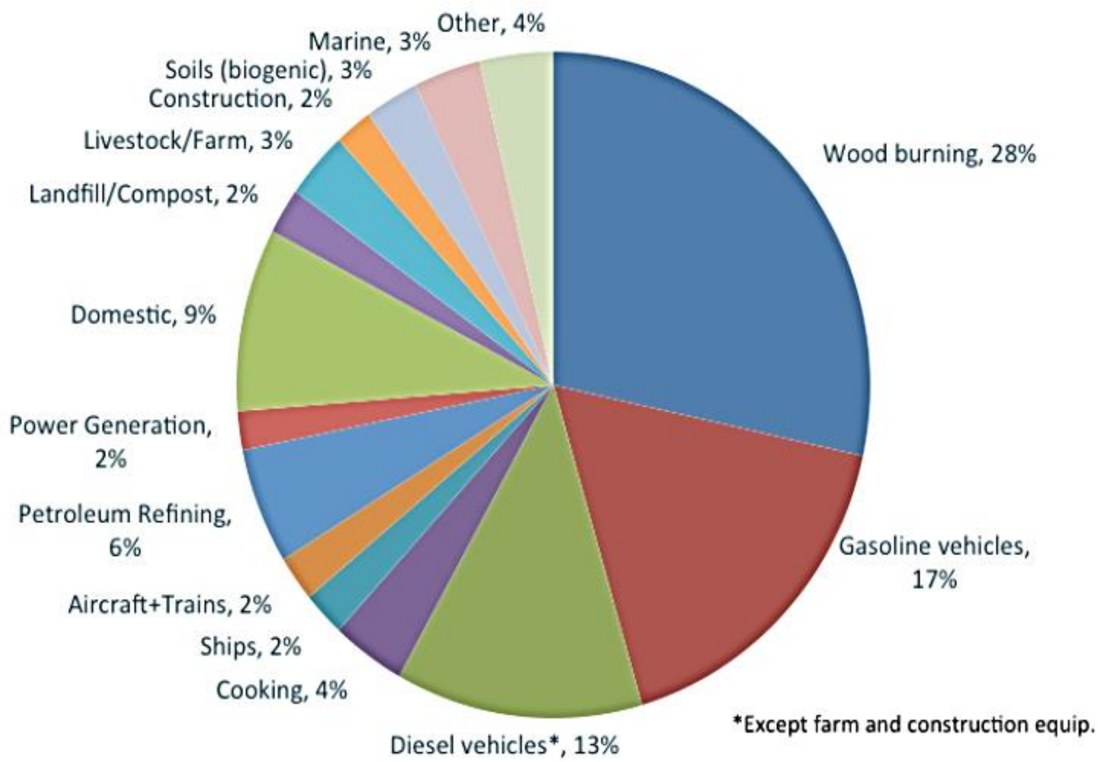
[53] Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 to 2013), BAAQMD, April 2014.

[54] San Francisco Bay Area Freight Mobility Study, Task 6: Freight Movement Impacts, prepared by Cambridge Systematics for the California Department of Transportation, District 4, March 2014.

[55] Bay Area Air Quality Management District (BAAQMD), http://www.baaqmd.gov/Divisions/Planning-and-Research/Particulate-Matter.aspx#dpm.

[56] $PM_{2.5}$ is fine particular matter and is believed to cause more significant health risk than PM_{10} (larger).

Figure 3.3 Estimated Source Contributions to Peak $PM_{2.5}$ Concentrations
July 2009 through December 2011



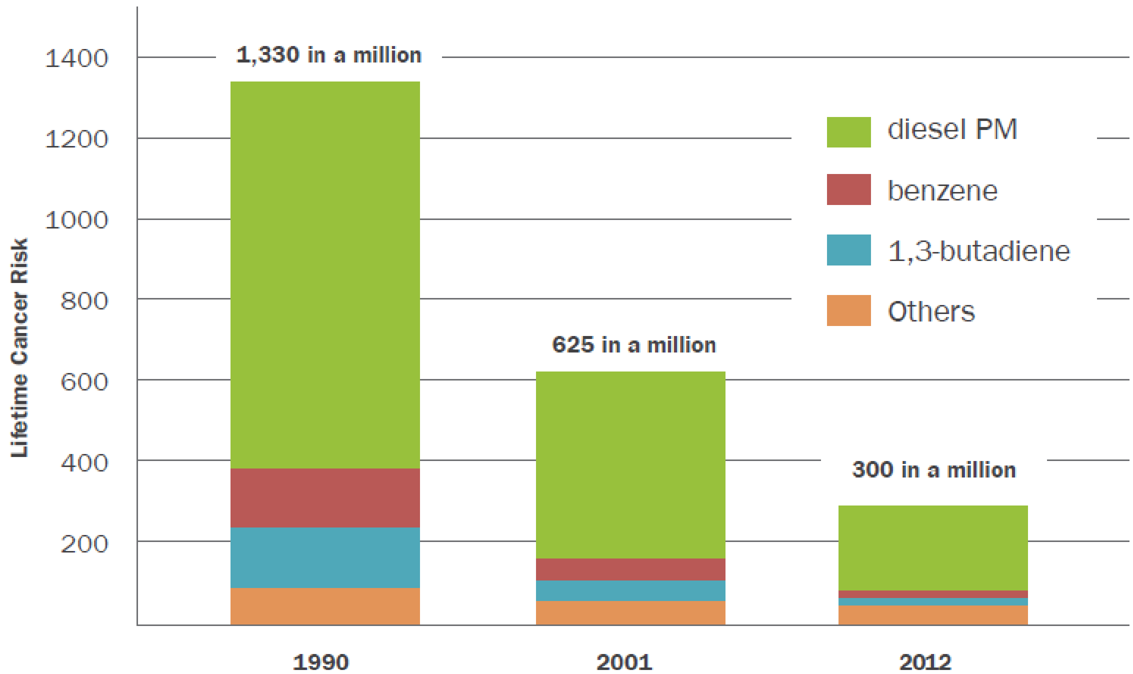
Source: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/PM%20Planning/ParticulatesMatter_Nov%207.ashx.

PM from diesel is also a significant contributor to cancer risk. BAAQMD staff estimated incremental cancer risk due to measured toxic air contaminants (TAC) in the Bay Area, of which diesel PM is the largest contributor. According to the most recent analysis (2012), the average regional cancer risk was about 300 per million. That is, for every million residents exposed for 70 years to current levels of TAC, 300 would be expected to develop cancer as a result of the exposure. Figure 3.4 shows that the region has seen a four-fold reduction in cancer risk due to air toxics over time: from 1,300 per million in 1990 to 300 per million in 2012. It also shows the relative contribution of certain specific air toxics to cancer risk. According to the analysis, more than 70 percent of the cancer risk related to air pollution in the Bay Area are due to diesel PM, and 90 percent of the total risk are due to three compounds: diesel PM, benzene, and 1,3-butadiene. All three of these compounds are emitted via fuel combustion.[57]

[57] Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 to 2013), BAAQMD, April 2014.

Proximity to roadways, particularly those with high volumes of truck traffic, is an important factor in evaluating health impacts, as adverse health effects from $PM_{2.5}$ have been documented within 1,000 feet of high-volume roadways, with the strongest effects within 300 feet.[58] Thus, local impacts can be much higher and fluctuate based on proximity, as discussed in Section 3.2.2.

Figure 3.4 Estimated Bay Area Lifetime Cancer Risk from Toxic Air Contaminants, Based on Air Pollution Measures



Source: Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 – 2013), BAAQMD, April 2014.

Predicting future trends of emissions is challenging, as many factors come into play such as changes in technology, emission standards, land use decisions and economic fluctuations. Considering current regulations, and assuming no additional regulations or policies will be adopted, $PM_{2.5}$ emissions from on- and off-road motor vehicles are expected to decline until 2020 due to aggressive regulations on diesel engines. These key regulations include regulations to reduce tailpipe emissions, regulations for cleaner fuels, restrictions on vehicle use, as well as grants and incentives to encourage emission reductions above regulatory requirements. A full list of current emissions regulations are discussed in a later section of this report. After 2020, vehicle emissions are expected to increase by less than one percent annually until 2030. This is in

[58] http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/PM%20Planning/ParticulatesMatter_Nov%207.ashx.

large part due to the lack of current regulations for the 2030 timeframe and uncertainty surrounding new technologies when looking out to 2030.

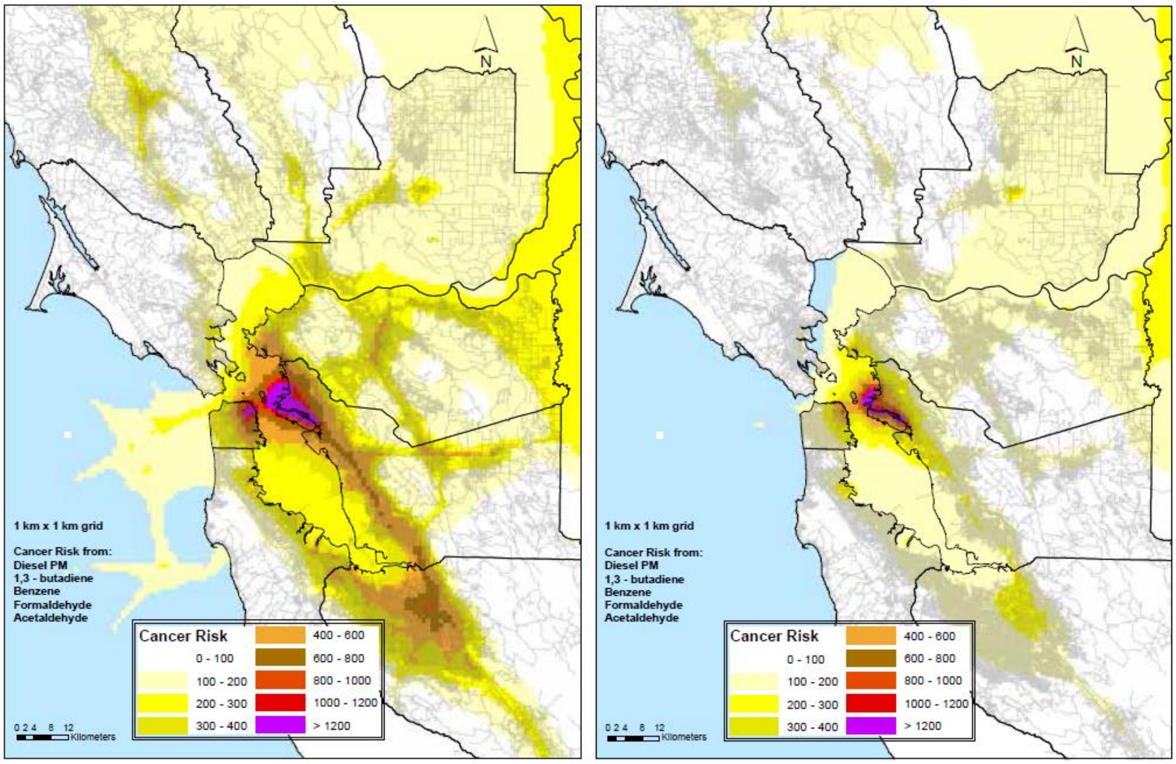
3.2.2 Localized Health Effects on Communities

Despite tremendous strides in air pollution reduction, some communities in the Bay Area experience higher pollution levels, and more adverse health effects, compared to their counterparts in other parts of the region. The underlying causes of this disparity are complex.

In 2004, BAAQMD launched the Community Air Risk Evaluation (CARE) program, a critical step toward reducing and eliminating health disparities linked to air quality. In 2006, emissions inventories for years 2005 and 2015 were input to a regional air quality model to predict concentrations of key toxic compounds and cancer risk associated with them. Some of the key findings from this work were that the simulated potential cancer risk from TAC is highest near major diesel PM sources, as shown in Figure 3.5. Another key finding is that cancer risk from TAC is dropping; modeled risk values were projected to drop by more than 50 percent between 2005 and 2015, when emissions inputs accounted for state diesel regulations and other reductions.[59] As shown in Figure 3.5, West and East Oakland continue to have a significantly higher risk than other parts of the Bay Area.

[59] Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 to 2013), BAAQMD, April 2014.

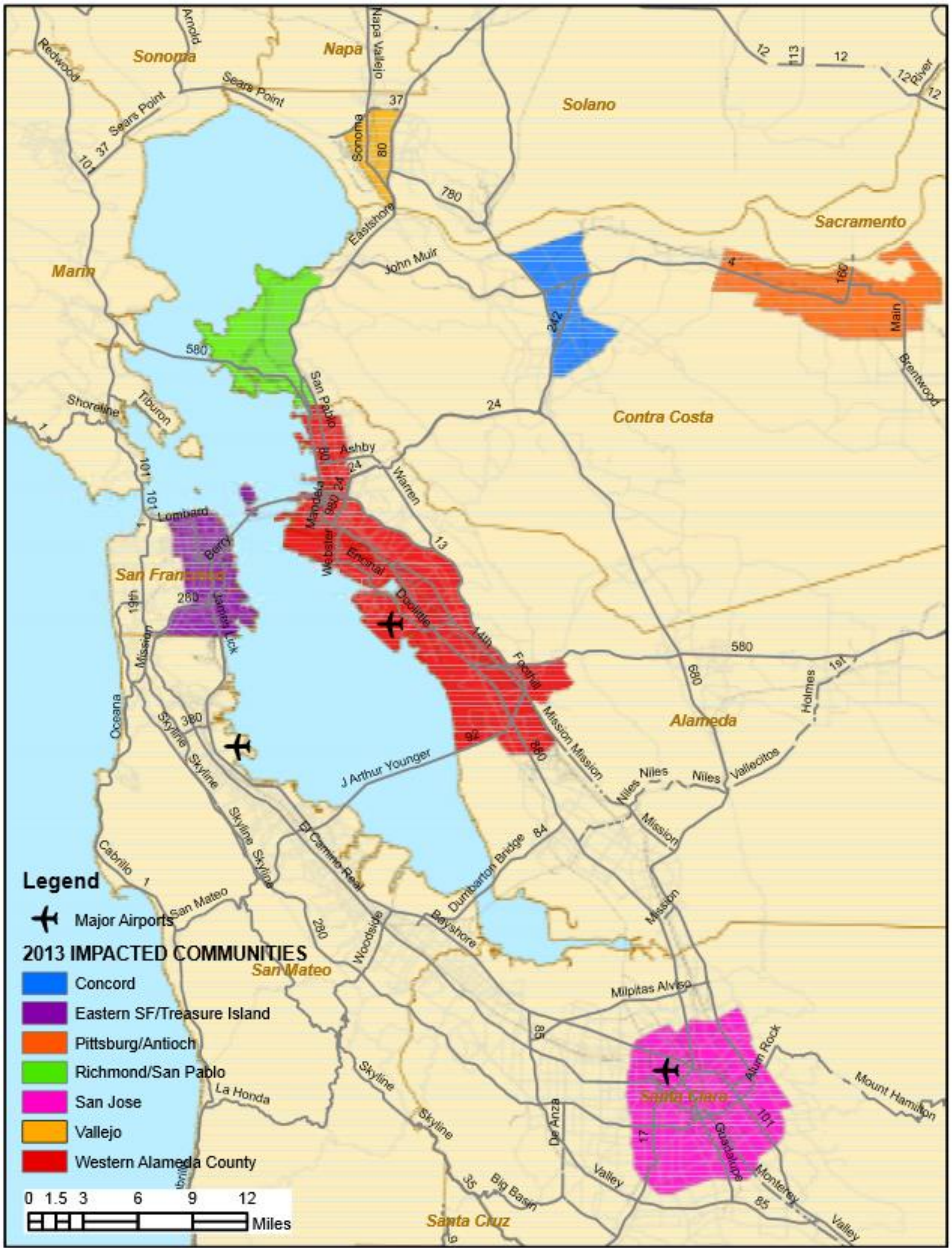
Figure 3.5 Potential Cancer Risk from Toxic Air Contaminants for the Bay Area in 2005 (Left) and 2015 (Right)



Source: Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 – 2013), BAAQMD, April 2014.

In 2009, for the first time, the BAAQMD mapped areas with relatively high levels of toxic air pollution and with people who are relatively more vulnerable to health impacts of air pollution. In 2014, the Air District updated its methodologies to include a wider range of pollutants with health effects and by directly estimating health effects on vulnerable populations. The impacted communities based on the 2014 updated methodology are shown in Figure 3.6. These areas have the highest pollution vulnerability index, where combined health impacts are predicted to be the greatest, which includes cancer risk, mortality rates, and health costs from air pollution.

Figure 3.6 Impacted Communities Based on the Updated Method



Source: Bay Area Air Quality Management District.

The Impacted areas included:

- Western Alameda County along the I-880 corridor,
- Eastern San Francisco/Treasure Island,
- San Jose,
- West Contra Costa County,
- Concord,
- Pittsburg and Antioch, and
- Vallejo.

These communities are located along major truck corridors, industrial areas and in some cases, nearby major freight hubs. These communities also have high concentrations of lower income residents. It should be noted that many of these communities also have other sources of air pollution that contribute to health risks and more analysis may be necessary to determine the degree to which goods movement is a major cause of health risks in these communities.

Looking at the two sets of maps does make clear that West Oakland is one part of the Bay Area that currently experiences high levels of health risk associated with diesel pollutants and even with significant reductions in these pollutants regionally, West Oakland will continue to experience relatively high levels of health risk. To a large degree, the health risks experienced in West Oakland can be traced to its proximity to the Port of Oakland, near-dock rail terminals, and the I-880 freeway. In 2006, CARB, in partnership with BAAQMD and the Port of Oakland, conducted a health risk assessment (HRA) for West Oakland[60] to estimate the public health risks from exposure to diesel PM. Three sources were considered including the Port of Oakland (maritime), UP rail yard and other sources around the West Oakland community. Emissions from each source were analyzed to evaluate the impacts of each on residents. The findings of the study were updated in 2008 and 2009 in partnership with the West Oakland Environmental Indicators project by using a truck survey.[61] Key results from this study are shown in Table 3.2 and Figure 3.7. The updated data that came from the truck survey indicated that overall health risk in West Oakland was lower than previously estimated but that the Port's contribution was greater than initially estimated.

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[60] http://www.arb.ca.gov/ch/communities/ra/westoakland/westoakland.htm.

[61] http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CARE%20Program/Documents/CARE_Retrospective_April2014.ashx.

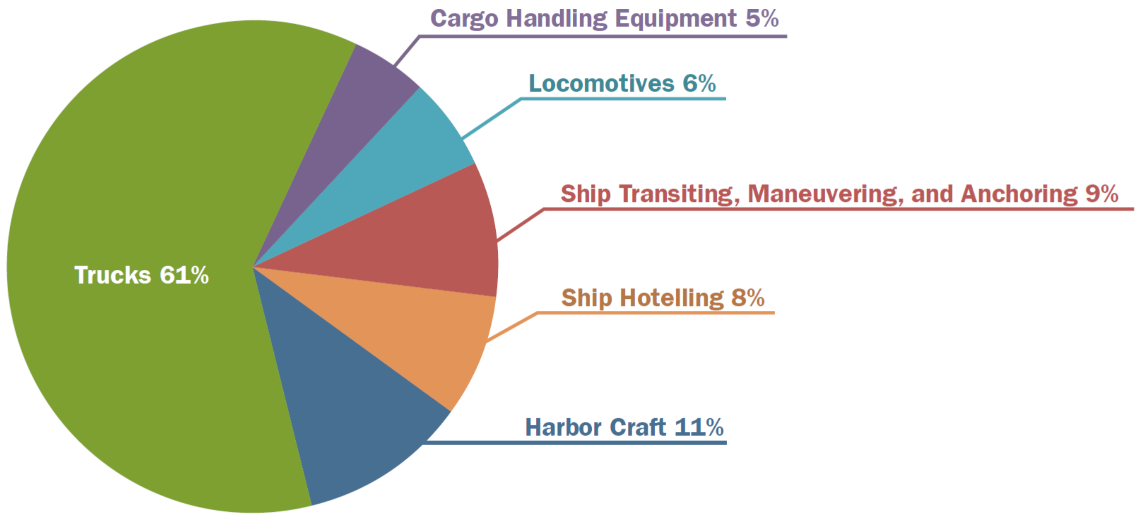
The Port's contribution to cancer risk is 29 percent according to the revised numbers in Table 3.2, with the vast majority of the rest contributed by other sources in and around West Oakland. This indicates that solutions that address local sources of pollution around West Oakland are important. More detailed discussions on this issue is included in the West Oakland Case Study of the Alameda County Goods Movement Plan as part of this project. On the other hand, there will continue to be a high level of focus on port-related emissions because the port is such a concentrated source of activity, which creates certain opportunities to demonstrate and implement solutions like zero-emission truck technologies. But solutions to this problem that place a disproportionate cost on the international trade industries could have impacts on the port's competitiveness without addressing the larger impact on the West Oakland community for nonport trucking on I-880. While CARB's upcoming in-use trucking rule will reduce emissions from all trucks, there is still likely to be a need to find ways to incentivize lower emission trucking technologies, improve operations to reduce truck VMT, and spread trucking activity to other roadways to reduce overall health risks.

Table 3.2 Average Potential Cancer Risk (per Million) in West Oakland by Source Areas in 2005, with Revisions Based on Truck Survey (2008 to 2009)

Source of Diesel Particulate Matter Emissions	Average Potential Cancer Risk (per Million) in West Oakland – Revised Based on Truck Survey	Average Potential Cancer Risk (per Million) in West Oakland – Based on HRA
Port of Oakland	250 (29%)	190 (16%)
Union Pacific	40 (5%)	40 (4%)
Other Sources in and around West Oakland	570 (66%)	950 (80%)
Total	**860 (100%)**	**1,180 (100%)**

Source: Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 to 2013), BAAQMD, April 2014.

Figure 3.7 Revised Based on Truck Survey: Apportionment of Total Cancer Risk in 2005 (in Percent) by Source Category from All Source Areas in West Oakland



Source: Improving Air Quality and Health in Bay Area Communities, Community Air Risk Evaluation Program Retrospective and Path Forward (2004 – 2013), BAAQMD, April 2014.

3.2.3 Current Programs and Regulations to Reduce Air Quality Impacts of Goods Movement

Air quality is regulated at the Federal, state, regional and local levels. In the case of transportation emission regulation, all vehicle emission standards and most fuel regulations are established at the Federal and state levels. Regional agencies, such as BAAQMD, are mainly responsible for distributing Federal and state air quality funds, as well as carrying out programs and adopting transportation control measures to comply with Federal and state regulations.

While there are many regulations that affect emissions from trucks, the one that will have the greatest impact is the 'CARB's On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation, which will be the main cause for the drop in NO_x and PM emissions in the immediate future. The regulation calls for phase-in of best available control technology for PM and NO_x between 2011 and 2023. By 2023, nearly all trucks and buses will need to have 2010 model-year engines or equivalent.

Table 3.3 provides a summary of all applicable regulations in California that control emissions from heavy-duty vehicles, locomotives, and ships. Some regulations will have significant impacts on truck emissions over time and cause a much faster turnover of trucks on the road than would otherwise occur in their absence. Locomotive regulations also are established by the U.S. EPA, and apply to both new and remanufactured locomotives. In addition to enforcing regulations, the California Air Resources Board (CARB) also helps develop voluntary agreement and funding programs (such as those for railroads) to further reach emission reduction goals.

Table 3.3 CARB Diesel Air Toxic Control Measures for Heavy-Duty Vehicles, Equipment and Ships

Pollutant	Impacts to Public Health/the Environment
Trucks and Buses	Since 2008, idling limited to 5 minutes
	By 2016, all trucks meet equivalent of 2007/2010 PM standard
	By 2023, all trucks meet equivalent of 2010 NO_x standard
Drayage Trucks	By 2010, pre-MY 1994 trucks banned
	By 2010, MY 1994-2003 trucks meet 2007/2010 PM standard
	By 2014, all trucks meet 2007/2010 PM and 2007 NO_x standard
	By 2023, all trucks meet 2010 NO_x standard
Public Fleet Vehicles	By 2012, all trucks meet equivalent of 2007/2010 PM standard
Garbage Trucks	By 2011, all vehicles have installed Best Available Control Technology (BACT)
Transit Buses	By 2003, met an NO_x fleet average of 4.8 g/bhp-hr
	By 2007, PM emissions reduced by 85% from 2002 baseline
	For fleets in the Bay Area with 200+ buses, 15% of new buses purchased from 2011-2026 must be zero emissions. (May be amended in 2012.)
Truck Refrigeration Units	By 2020, engines must meet Ultra-Low Emission standard
Locomotives	In 2007, begin using 15 ppm Sulfur fuel in California-based locomotives
	By 2008, conduct health risk assessments for major rail yards
	By 2009, install idling reduction devices on California-based locomotives
Construction Equipment	Since June 2008, idling limited to 5 minutes
	Between 2014 and 2023, fleets with more than 5,000 total hp must meet fleet average NO_x targets or turnover/replace 4.6-10% of fleet hp
	Between 2017 and 2023, fleets with 2,501 to 5,000 total hp must meet fleet average NO_x targets or turnover/replace 4.6-10% of fleet hp
	Between 2019 and 2029, fleets with less than 2,501 total hp must meet fleet average NO_x targets or turnover/replace 4.6-10% of fleet hp
Cargo Handling Equipment	By 2007, new equipment meets equivalent of Tier 4 off-road engine standards or 2007 PM/NO_x on-road engine standards
	By 2015, pre-2007 yard trucks meet equivalent of Tier 4 off-road engine standards or 2007 PM/NO_x on-road engine standards
	By 2017, all other pre-2007 equipment must meet equivalent of Tier 4 off-road engine standards or 2007 PM/NO_x on-road engine standards
Harbor Craft	Beginning in 2009, engines for new vessels or repowers meet Tier 2 or Tier 3 off-road standards; new ferries must be 85% below Tier 2 standards
	By 2016, pre-2000 engines meet Tier 2, 3, or 4 off-road standards
	By 2022, all engines must meet Tier 2, 3, or 4 off-road standards

Pollutant	Impacts to Public Health/the Environment
Ships	In 2009, ships began using Marine Diesel Oil (MDO) with 0.5% sulfur or Marine Gas Oil (MGO) with 1.5% sulfur. By august 2014, ships begin using MDO or MGO with 0.1% sulfur
	In 2014, 50% reduction in auxiliary engine use during 50% of visits by cruise and container ships (shore power)
	In 2017, 70% reduction in auxiliary engine use during 70% of visits by cruise and container ships (shore power)
	In 2020, 80% reduction in auxiliary engine use during 80% of visits by cruise and container ships (shore power)
Back-up Generators (BUG)	By 2008, PM emissions for BUGs reduced by 85% in new engines

Source: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/PM%20Planning/ParticulatesMatter_Nov%207.ashx.

Plans, Programs, and Incentives

To help reach air quality goals in a comprehensive manner, plans, programs and incentives have been adopted by the BAAQMD, MTC, and the Port of Oakland. These programs and plans are described below.

Bay Area 2010 Clean Air Plan

The Bay Area 2010 Clean Air Plan (CAP) provides a comprehensive plan to improve Bay Area air quality and protect public health, through implementation strategies that involve all pollutants. Specific measures pertinent to freight listed in the CAP under the three relevant control measure categories are presented below. The 2015 CAP is in development and is expected to be released and adopted in 2015.

Mobile Source Measures (MSM)[62]

MSM are measures that reduce emissions by accelerating the replacement of older, dirtier vehicles and equipment through programs such as the Air District's Vehicle Buy-Back and Smoking Vehicle Programs, and promoting advanced technology vehicles that reduce emissions of criteria pollutants and/or greenhouse gases. Specific measures that are most applicable to freight include:

- **MSM B-1 – Fleet Modernization for Medium and Heavy-Duty On-Road Vehicles.** This measure is designed to provide and encourage other organizations to provide incentives for the purchase of new trucks to meet CARB's 2010 emission standards for heavy-duty engines. Between 2010 and 2015, the BAAQMD will directly provide and/or work with other entities to

[62] http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/2010%20Clean%20Air%20Plan/Draft%202010%20CAP/Vol2_SectionB_MSMs.ashx.

provide incentives to accelerate the replacement of up to 5,000 heavy-duty on-road diesel engines in advance of requirements for the CARB in-use heavy-duty truck regulation (mentioned before).

Currently, this measure is partially being addressed by the Carl Moyer program, a state-level program that provides grant funding for cleaner-than-required engines and equipment administered by the BAAQMD.[63] Stakeholder interviews have indicated that many private sector entities in marine, trucking, and railroading businesses have benefitted from this program. For example, in 2010, Richmond Pacific Railroad and California Northern Railroad received Carl Moyer funds for purchasing locomotives. In year 2014 of the program (2013) alone, a total of 85 projects, or 112 engines are funded in the Bay Area at a cost of $5.4 million.[64]

- **MSM B-2 – Low NO_x Retrofits in Heavy-Duty On-Road Vehicles.** This measure is designed to reduce NO_x emissions from on-road heavy-duty vehicles. Between 2010 and 2015, the BAAQMD will provide incentives to install CARB-verified abatement equipment to reduce NO_x emissions from existing on-road heavy-duty truck engines. Emphasis is placed on bringing existing engines into early compliance with CARB's in-use truck regulation. The retrofit of heavy-duty diesel engines with NO_x abatement equipment is estimated to cost $30,000 per engine. BAAQMD staff anticipates that about 75 percent of the retrofits will occur between 2013 and 2015 as fleets prepare to comply with NO_x requirements in the CARB in-use truck engine regulation. It is anticipated that BAAQMD will make available up to $3 million to 5 million per year in incentives for the retrofit of existing trucks between 2010 and 2015. However, currently there is no identified dedicated funding for this program according to BAAQMD staff.

Transportation Control Measures (TCM)[65]

These are measures to reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling, or traffic congestion for the purpose of reducing motor vehicle emissions. Specific measures that are applicable to freight include:

- **TCM B-4 – Goods Movement Improvements and Emission Reduction Strategies.** This measure has reduced emissions associated with goods movement by investing in the Bay

[63] http://www.arb.ca.gov/msprog/moyer/moyer.htm (last accessed on September 19, 2013).

[64] http://www.baaqmd.gov/~/media/Files/Strategic%20Incentives/Carl%20Moyer/CMP%20Year%2014%20Projects.ashx.

[65] http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/2010%20Clean%20Air%20Plan/Draft%202010%20CAP/Vol2_SectionC_TCMs.ashx.

Area's trade corridors and by providing incentive funding for diesel equipment owners to purchase cleaner-than-required vehicles and equipment. This measure is funded by Proposition 1B, a $19.9 billion transportation infrastructure bond for California. Proposition 1B included a $2 billion Trade Corridors Improvement Fund (TCIF) to improve goods movement infrastructure statewide. In 2008, the State augmented the program to nearly $2.5 billion and programmed just more than $3 billion for high-priority goods movement projects. Proposition 1B also included $1 billion for a Goods Movement Emissions Reduction program. Nearly all of these funds have been expended with small amounts of savings from completed projects still being programmed.

- **Land Use and Local Impacts Measures (LUM)**. This is a new category of measures built on the Community Air Risk Evaluation (CARE) Program. It is designed to: 1) promote mixed-use, compact development to reduce motor vehicle travel and emissions, and 2) ensure that we plan for focused growth in a way that protects people from exposure to air pollution from stationary and mobile sources of emissions. Measures relevant for goods movement include LUM 1- Goods Movement, and LUM 5 – Reduce Health Risk in Impacted Communities.

Maritime Air Quality Improvement Program

For the Port of Oakland, its commitment to reducing air pollution can be seen from the development of the Maritime Air Quality Improvement Plan (MAQIP) in 2009, which set to achieve the emission reduction goals in Table 3.4. Based on the 2012 Port of Oakland Seaport Emissions Inventory[66], the Port has made major strides towards emissions reduction. In a more recent MAQIP Outcomes memorandum, it was noted that although container volumes have increased by a total of 3 percent between 2005 and 2012, overall diesel particulate matter (DPM) emissions have decreased by 70 percent for that same period. Of the overall 70-percent reduction, DPM emissions from drayage trucks have decreased from 16 tons in 2005 to 2 tons in 2012, which represents an 88 percent reduction. Similarly, DPM emissions from ocean-going vessels have decreased from 209 tons DPM in 2005 to 57 tons DPM in 2012, which represents a 72-percent reduction.[67] With continued progress and follow-through on MAQIP strategies, the Port should be able to fully achieve its air quality targets by 2020. Table 3.4 shows the progress made by the Port in terms of emissions reductions between 2005 and 2012.

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[66] http://www.portofoakland.com/pdf/environment/maqip_emissions_results.pdf.

[67] http://portofoakland.com/pdf/environment/maqip_outcomes_memo.pdf.

Table 3.4 Emission Changes for Port of Oakland, 2005 to 2012

Emission	Ocean-Going Vessels	Cargo-Handling Equipment	Harborcraft	Locomotives	Trucks	Overall Percentage Change 2005-2012
DPM	-72%	-63%	-30%	-77%	-88%	-70%
Co	-1%	-49%	14%	-81%	-67%	-33%
NO_x	4%	-46%	-32%	-75%	-60%	-15%
SO_x	-80%	-92%	-94%	-100%	-90%	-80%
ROG	50%	-33%	11%	-83%	-74%	1%

Source: http://www.portofoakland.com/pdf/environment/maqip_postcard.pdf.

Based on the Port's future projections, on and near-shore DPM emissions are expected to decrease from the 2005 baseline by 78 percent in 2015 and by 86 percent in 2020. These projected reductions are a direct result of the combined effect of regulatory deadlines, shore power implementation, and the use of cleaner ocean-going vessel fuel.[68] Since all of the heavy-duty trucks are required to have a 2010 model year engine or equivalent by 2023, we can expect that the complete fleet turnover will help reduce emissions significantly.

There have been some concerns raised about how continued growth in goods movement will impact pollution levels and health risks beyond 2023 when the CARB in-use diesel regulations for trucks will be fully implemented and when all of the provisions of the Port of Oakland's Maritime Air Quality Improvement Program are fully implemented. Forecasts of goods movement activity in the Bay Area prepared for this Plan suggest that growth in goods movement demand will be modest but could outpace auto VMT growth. In particular, international trade forecasts for the region, particularly if the ports in the region are successful in implementing their respective growth strategies, suggest significant growth potential for these sources. There are a variety of approaches that can be taken to accommodate this growth while continuing to reduce emissions or mitigating the impacts of this activity on communities. For example, there are opportunities to make significant reductions in emission levels from railroad operations through introduction of low or zero-emission technologies in intermodal terminals, use of low emission switcher locomotives, and acceleration of the adoption of Tier 4 locomotive technologies (Tier 4 locomotives represent the most stringent standard for locomotive emissions that will begin to take effect for new locomotive purchases beginning in 2015). With acceleration of the adoption of Tier 4 locomotives, shifting cargo movements from truck to rail could result in further overall emission reductions at the Port of Oakland. Truck activity will grow more slowly if the Port is

[68] Ibid.

successful in expanding its rail transport share from 21 percent today to 40 percent by 2035, as it plans to do through investments in new rail terminals at the Oakland Army Base. There also may be opportunities to reduce the growth in emissions while still achieving growth in goods movement activity by creating greater efficiencies in goods movement operations through the application of information technologies. These options will be further evaluated as part of the development of strategies for the regional goods movement plan.

3.3 Sea-level Rise and Vulnerability

The nine-county San Francisco Bay Area is home to approximately seven million people making the Bay one of the world's most urbanized estuaries. Climate change has the potential to dramatically impact the economy, environment and quality of life in the Bay Area. Sea-level rise (SLR) and changes in precipitation trends (including downpour and flooding) have the potential to damage critical infrastructure and severely disrupt goods movement. Sea-level rise is expected to cause permanent inundation in some areas, and cause more frequent inundation in others when combined with storm effects such as precipitation, storm surge, and wind waves. Changes to precipitation will impact rainfall experienced locally at goods movement asset sites – in the form of direct rainfall on the assets, and localized flooding in the area – and will impact regional riverine flooding.

In recent years, the San Francisco Bay Conservation and Development Commission (BCDC) has partnered with the National Oceanic and Atmospheric Administration Coastal Services Center to work with San Francisco Bay Area shoreline communities on planning for sea-level rise and other climate change-related impacts. The overall goal of these efforts is to increase the preparedness and resilience of Bay Area communities to sea-level rise and other climate change-related impacts while protecting ecosystem and community services. It involves evaluating potential shoreline impacts, vulnerabilities, and risks; identifying effective adaptation strategies; and developing and refining adaptation planning tools and resources that will be useful to communities throughout the Bay Area.

According to current projections, climate change will cause the Bay to rise 16 inches by midcentury and 55 inches by the end of the century.[69] This means that today's floods will be the future's high tides, and areas that currently flood every 10 to 20 years will flood much more

[69] Sea-Level Rise Task Force of the Coastal and Ocean Resources Working Group for the Climate Action Team (CO-CAT), 2010 (October), State of California Sea-Level Rise Interim Guidance Document, developed with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust, available: http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20100911/14.%20SLR/1011_COPC_SLR_Interim_Guidance.pdf.

frequently. Neighborhoods, businesses, and entire industries that currently exist on the shoreline will be subject to this flooding and the many other direct impacts that will result from it.

Large commercial and industrial areas are at risk of flooding, especially in San Francisco, Silicon Valley, and Oakland. Approximately 72 percent of each of the San Francisco and Oakland airports are at risk from a 16-inch sea level rise and about 93 percent of each is at risk from a 55-inch sea level rise, which could disrupt as many as 30 million airline passengers annually and approximately one million metric tons of cargo. Flooding of highway segments in the regional transportation network could disrupt the movement of goods from ports, which handled approximately 25 million metric tons of cargo in 2007 to 2008.[70] Other water-related industries would be similarly affected. Flooding of the rail system would be particularly serious, because multiple carriers share a single line in most locations around the Bay, with these mainlines often located along the shoreline.

3.3.1 Airports

Two international airports in the region, SFO and OAK are located on the Bay shoreline. These two airports provide linkages with international and domestic trading partners and serve as major hubs of the national and global air passenger system and air cargo network. SFO is the principal international air passenger gateway within the region

The two airports cover approximately 4,700 acres (7.3 square miles) along the shoreline of the Bay. Without any shoreline protection, more than 3,400 acres (5 square miles) or 72 percent of these designated lands would be potentially exposed to a 16-inch sea level rise while approximately 4,400 acres (6 square miles) or 93 percent of these designated lands would be potentially exposed to a 55-inch sea level rise.

At OAK, the perimeter dike serves as the flood protection system for the airport's South Field, including the main air carrier runway and passenger terminal facilities. The dike was constructed using dredged bay mud, sand, and gravel during the 1950s to 1970s. Two fuel lines are buried under the dike crest. As part of its Airport Perimeter Dike Improvement Project, the Port of Oakland plans to construct improvements to the dike, portions of which currently do not meet FEMA 100-year flood protection standards.[71] The Port estimates that the dike system protecting OAK can currently support approximately 36 inches of sea level rise at mean higher high water. Proposed dike improvements include, where necessary, raising the height of the dike, stabilizing

[70] Ibid.

[71] Port of Oakland, 2011, Container Statistics: Container History, http://www.portofoakland.com/maritime/facts_cargo.asp.

inboard slopes, protecting against seepage, and strengthening portions of the dike that are vulnerable to seismically-induced liquefaction.

SFO was built on landfill and has addressed runway subsidence through a regular program of repaving and overlay. A partial seawall protects the runways and reduces their exposure to flooding. In order to address the gaps remaining in the existing shoreline protection system, SFO has been coordinating with FEMA to certify its seawalls and update flood maps. SFO is investigating the issue of storm surge to determine whether additional seawall or levee heights are needed and whether existing drainage is sufficient. As sea level rises, raising levees or other adaptation measures will be necessary to protect runways from flooding. Detailed vulnerability assessments for the airports will need to consider existing shoreline protection, extreme tides, storm surge, wind-driven wave run up and other factors.

In addition to the airports themselves, access routes to the airports are vulnerable to impacts of sea level rise. SFO is linked to the highway transportation network via the U.S. 101 and also has direct BART passenger service. Segments of the U.S. 101 and the BART tracks near the airport are potentially exposed to a 16-inch sea level rise. OAK is linked to the region via the I-880 corridor, which is vulnerable to flooding near Port of Oakland, the Bay Bridge approach and along the segment of I-880 near the Coliseum.

3.3.2 Ports

There are five major ports in the Bay Area located at Oakland, Richmond, San Francisco, Redwood City and Benicia. Like the region's airports, the ports rely on the transportation network to move cargo and employees to and from the ports. The ports handle a variety of cargo types, including container cargo, dry bulk, break bulk, neo bulk and liquid bulk. Maritime cargo handled by these five ports was 19,114,199 metric tons in 2010, a 58-percent increase since 1994.[72]

Shoreline flooding and damage to Bay Area ports as a result of sea level rise would likely have a ripple effect through much of the West Coast economy. All of the region's ports are vulnerable in varying degrees to projected sea level rise. Collectively, 2,700 acres (4 square miles) of land is designated for port use. Approximately 100 acres (0.16 square mile) or four percent of land within the port areas are potentially exposed to a 16-inch sea level rise while approximately 500 acres (0.78 square mile) or 20 percent of land within the port areas are potentially exposed to a 55-inch sea level rise. Additionally, segments of the ground transportation network that make vital connections to the Port of Oakland are at greater risk of flooding. Several vulnerabilities

[72] BCDC 2011.

exist in the Martinez Subdivision, the major trade route in the region, which originates at the Port of Oakland, runs roughly parallel with I-80, and heads toward Sacramento and beyond.

3.3.3 Major Roadways and Highways

Because of their proximity to the Bay, many of the major roads and highways within the region may be significantly impacted by sea level rise and extreme flooding events. Approximately 99 miles of the major roads and highways within the region are potentially exposed to a 16-inch rise in Bay water levels and approximately 186 miles of major roads and highways are potentially exposed to a 55-inch rise. Interstate 880 along the eastern shoreline of the South Bay; U.S. 101 in Santa Clara, San Mateo, and Marin Counties; Highway 37 in the North Bay; I-680 in Solano County; and Highway 12 in Solano County include significant portions of roadway that are potentially exposed to flooding.

Many roads and highways will be subject to secondary impacts from sea level rise. For example, much of I-80 along the Berkeley and Albany shoreline is not directly subject to flooding due to the existing elevation of the roadway. However, erosion from increased storm activity can undermine existing protective and/or highway structures, which can substantially increase the cost of maintaining the highway. Other secondary impacts may occur where traffic from one impacted road is diverted onto another road. Increased construction activity that is necessary to make transportation infrastructure more resilient to sea level rise can cause more congestion and impact residential communities adjacent to roadways. Congestion causes delays in the movement of goods throughout the region and adds time to residents' already lengthy commutes. Finally, the supporting structures of many of the region's bridges may be susceptible to unanticipated, prolonged contact with corrosive salt water.

3.3.4 Rail Network

Approximately 70 miles of railroad are potentially exposed to flooding or permanent inundation with a sea level rise of 16 inches, while 105 miles are potentially exposed to a 55-inch sea level rise. The rail segments that are particularly vulnerable to flooding include the Union Pacific Martinez Subdivision where it passes through the Suisun Marsh and along the northern Contra Costa shoreline near Martinez, the Niles Subdivision along the shoreline in the East Bay, the Caltrain corridor on the Peninsula, and the Union Pacific Coast Subdivision in the South Bay. Because these rail segments are shared by multiple users and already experience congestion, flooding could paralyze rail service regionwide. The economic impacts of a systemwide rail failure would be staggering. Furthermore, protection of this infrastructure from sea level rise will also be costly and may require funds to be redirected from projects that address current pressures on the system.

Table 3.5 below provides a summary of shoreline vulnerabilities, providing an assessment of degree of sensitivity to climate change impacts, adaptive capacity, and overall vulnerability.

Table 3.5 Summary of Shoreline Vulnerabilities

Goods Movement Infrastructure	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Airports	Subsided runways at SFO. Difficulty moving goods on land from SFO & OAK.	Flooding of 72-93% of acreage for airport operations. Secondary impacts to ground movement of cargo and passengers from flooding of transportation network.	High – Airports are critical to the regional economy. They are especially sensitive to primary and secondary impacts of flooding.	High – Shoreline protection for runways and upgrading important ground transportation is costly, but would likely be a high regional priority.	Medium-High
Ports	Difficulty moving goods via highways and rail.	Moderate flooding of ports (4-20% of total acreage). Most flooding impacts regional goods movement.	Medium-High – Ports are central to the regional economy. Rail lines and highways essential to goods movement are sensitive to flooding.	Medium – Goods movement is central to port activities. Ports are unlikely to be burdened with the cost of transportation infrastructure.	Medium-High
Major Roads and Highways	Congested and in need of repairs.	Widespread flooding (99-186 miles), including key highways and interchanges.	High – Many highways are adjacent to the Bay and cross the Bay. Flooding projected on some key passenger and truck routes.	Medium – Current congestion and maintenance issues make costly adaptations difficult.	High
Rail	Congested with multiple users sharing single tracks.	Widespread flooding (70-105 miles of track), including key segments.	High – Rail lines carry passengers and freight, are located on low-lying lands and wetlands. Freight demand projected to grow.	Low – Current location of tracks limits options for expansion or modifications.	High

Source: Adapting to Rising Tides, and AECOM analysis.

To address the widespread flooding from storm activity and sea level rise, shoreline protection projects will be needed. Shoreline protection can be structural, natural, or a combination of both. Choosing the appropriate form of shoreline protection – one that both protects public safety and minimizes ecosystem impacts – is critically important. In the long term, the region needs to engage in an open and vigorous public dialogue to make the difficult decisions about what to protect, and where and what kind of new development is appropriate in vulnerable areas, and areas where further development should be avoided.

3.4 Industrial Land Shortage

Whether to support existing or emerging industry growth, changes in logistics patterns or macro-level growth in international and domestic trade, industrial land uses are needed to carry out freight and logistic activities. This is especially important as cities consider joint development needs and plan for various industrial corridors around the region. There is a continuing concern in Alameda County along the I-80 and I-880 corridors, along the Contra Costa Northern Waterfront (SR 4), and along the U.S. 101 corridor in proximity to San Francisco International Airport about a lack of consideration for industrial land needs and encroachment of residential development along existing goods movement corridors. This section offers a broad discussion of industrial land shortage. The Association of Bay Area Governments is beginning a regional analysis of industrial lands in 2015.

A 2008 Goods Movement/Land Use Study was carried out to further understand industrial land use issues and implications of trends and to identify the implication of land use decisions on the efficiency and cost of regional goods movement. The study determined that goods movement industries with demand for industrial land along the corridors are growing, and at the same time, industrial land use supply is declining. The growth trends in general are in agreement with the findings from this study.

The trends towards declining industrial land supply and increasing costs is driven by several key factors:[73]

- Market pressures for higher value uses, including residential, commercial and office/R&D developments in central areas.

- Land use policies that allow and/or encourage new uses in many industrial areas. Local land use plans and policies are allowing or encouraging redevelopment of industrial areas for higher intensity uses in many parts of the central corridors. In addition, regional efforts are

[73] Ibid.

encouraging a more compact development pattern with more growth in the central areas, often along or near the major goods movement corridors.

- Increasing land use conflicts as new development intensifies around industrial uses.

The potential effects of this reduced industrial land use supply will be an outward push and dispersion of industrial goods movement businesses, which will result in longer trips and have consequences that could lead to the displacement of jobs; increases of costs of goods, and increases in PM emissions and other air quality impacts. Since land use is controlled at the local level, there is an opportunity to take a regional approach to managing industrial land supply and goods movement, as well as initiatives to support industry's role in a more balanced approach to Smart Growth.[74]

3.5 Crude Oil by Rail

Over the last several years there has been growing concern nationally and in Bay Area communities over the potential for significant increases in the volume of crude oil shipped to refineries by rail. Since many of the California refineries are located in the Bay Area and the Central Coast along rail lines that run through major population centers, many of the cities along these rail lines have been looking for ways to either stop these oil shipments or to ensure greater oversight and emergency response support from the state and Federal governments, oil producers and refiners, and the Class I railroads who are transporting the oil.

To a large extent, the growth in rail shipments of crude oil reflect the changing geography of oil production with expanding production areas in the U.S. and Canada. As production of crude oil in California has declined, California refineries have increased the amount of oil imported into the State. Historically, much of this supply came by water and pipeline from Alaska and overseas producers. The shift in supplies to North America and the lack of connecting pipeline infrastructure connecting these new fields with California means that refiners have been looking for alternative transportation options and rail shipments have grown rapidly. According to the California Interagency Rail Safety Working Group, in 2012 only 0.3 percent of oil imported to California refineries was shipped by rail; this increased 506 percent by 2013, but still only accounted for approximately 1 percent of all crude imports. But the California Energy

[74] Ibid.

Commission projects that by 2016, crude shipments by rail could increase to 25 percent of California's crude oil imports.[75]

Much of the concern regarding increased shipments of crude oil by rail is focused on safety and environmental impacts. Incidents involving oil by rail in California increased from 3 in 2011 to 25 in 2013.[76] To date, these incidents have involved spills, most of which have resulted in relatively small volumes of oil being released. But one particularly high profile crash in Lac-Megántic, Quebec in which 47 people were killed, has raised serious questions about the risks associated with moving crude oil through major population centers, where a similar accident could have even more catastrophic impacts.

The accident in Quebec involved transportation of crude oil from the Bakken fields of North Dakota. This type of oil is particularly dangerous if not transported properly or if involved in an accident, because it is a more volatile form of crude than has been typically used. Much attention has been focused on Bakken crude but it is important to note that volumes of Bakken crude transported through the Bay Area may be much smaller than has been reported. According to the California Energy Commission, in June 2014, approximately 25 percent of crude oil imported to California came from North Dakota.[77] According to David Hackett, an energy industry analyst with Stillwater Associates (and reported in Bloomberg), "Refinery configuration in California is oriented toward heavy or medium sour crude, and the Canadian barrels, which are heavy and somewhat sour, are a better fit than the light Bakken barrels."[78] According to the same report, the peak monthly import of Canadian crude to California in 2013 was 11 times as high as the peak monthly import in 2012. Until there is better information about what types of crude are moving by rail in the Bay Area, it may be difficult to more precisely assess the specific risks to populations and the environment.

Railroad safety regulation occurs at the Federal level, and U.S. DOT has moved in cooperation with the Association of American Railroads to adopt new safety and operational practices through a voluntary program while DOT adopts new safety standards for tank cars. These actions include:

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75 Oil by Rail Safety in California, Preliminary Findings and Recommendations, State of California Interagency Rail Safety Working Group, Jun 10, 2014.

76 Ibid

77 "California senators ask DOT to expand crude by rail notifications," Curtis Tate, McClatchy, D.C., September 30, 2014.

78 "Oil-by-Rail Fuels Record U.S. Imports of Canadian Oil," Justin Mikulka, Desmogblog.com, October 16, 2014.

- Reduced speed for crude oil trains with older tank cars going through urban areas,
- Analyses to determine the safest routes for crude oil trains,
- Increased track inspections,
- Enhanced braking systems,
- Installation of wayside defective bearing detectors along tracks,
- Better emergency response plans, and
- Improved emergency response training.

The railroads have also stated their intent to work with communities through which oil trains move to address community concerns, although most communities feel more is needed.[79] In addition, the California Interagency Rail Safety Working Group made the following recommendations for the State:

- Increase the number of California Public Utilities Commission rail inspectors;
- Improve emergency preparedness and response programs;
- Request improved identifiers on tank placards for first responders;
- Request railroads to provide real-time shipment information to emergency responders;
- Request railroads provide more information to affected communities;
- Develop and post interactive oil by rail map;
- Request DOT to expedite phase out of older, riskier tank cars;
- Accelerate implementation of new accident prevention technology;
- Update California Public Utilities Commission incident reporting requirements;
- Request the railroads provide the State of California with broader accident an injury data;

[79] State of California Interagency Rail Safety Working Group, op. cit.

- Ensure compliance with industry voluntary agreement; and
- Ensure state agencies have adequate data.

Even with these actions at the state and Federal level, affected communities throughout the region have called on MTC to adopt a stronger position and many cities have adopted their own resolutions on crude by rail. The regional goods movement plan will examine what role, if any, would be appropriate for MTC to play in partnership with agencies that have jurisdiction over this issue.

Appendix A. Data and Methodology

This appendix synthesizes the outputs of multiple types of quantitative and qualitative analysis, which are standardized across all corridors to offer more useful comparisons.

Corridor-Level Industry Profile

Goods movement corridors carry both local traffic and pass-through traffic. While pass-through traffic may be explained by trends outside of the Bay Area, local traffic is inextricably linked to the industries that exist along each corridor. The corridors provide connection to/from markets and suppliers for the industries along the corridors. To understand what kinds of goods movement activities are around each corridor, we need to look at the businesses around each corridor at a disaggregate level. This has been done using two sources. The first source is Traffic Analysis Zone (TAZ) level employment data provided by MTC, for the year 2010. These data show the total employment in each TAZ for three aggregate goods movement industry sector, manufacturing/wholesale/transportation, retail, and agriculture. While this data source provides useful visual information about the spatial distribution of businesses, it does not provide much sector-level detail. To supplement this, another data source, the Zip code Business Pattern (ZBP) data for the year 2012 obtained from the U.S. Census Bureau, was used. This data source provides information about industries classified at the 6-digit, North American Industry Classification System (NAICS) level of detail for all of the zip codes in the Bay Area. The database also provides the number of establishments by size (number of employees). The data are presented by size category (i.e., each category represents a range of number of employees). A GIS spatial analysis was then performed to determine the zip codes associated with each corridor, and hence the NAICS[80]-based number of establishments in each employment size category along each corridor. Since the data do not provide the exact number of employees in each establishment, it is impossible to use the data to estimate the exact number of employees by NAICS sector in each zip code. However, it is possible to use the data to approximate the number of employees by sector in each zip code by multiplying the mid-point employment of each size range (e.g., if the size category were zero to four employees, the midpoint would be two employees) by the number of establishments in that size category. In order not to confuse this with actual employment, we refer to this as the employment index and it provides a reasonable representation of the relative number of employees by sector in each corridor. The results for 2-digit industry sectors are displayed in a chart for each corridor. It should be noted that the manufacturing sector is divided into three subsectors – Manufacturing 31 includes food, apparel, beverage manufacturing; Manufacturing 32 includes wood product, paper, chemical,

[80] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

plastics, rubber and other non-metal manufacturing; Manufacturing 33 includes metal, computer, machinery, transportation equipment, furniture products and all other miscellaneous manufacturing. Keeping these manufacturing sectors separate provides additional detail as to the types of manufacturing concentrated along each corridor.

3.5.1 Highway Network

Truck Congestion and Delay

Congestion on freeways remains one of the biggest issues in urban areas, and congestion delay leads to a host of impacts for communities, including pollution, lost time/productivity and other quality of life concerns. For the private sector, congestion drives up logistics costs and ultimately cuts into customer satisfaction and profits. To document the extent of the congestion issue as it affects trucking in the Bay Area, a congestion analysis was carried out to understand the locations/segments with the worst congestion delay on highways with the highest truck volumes.

Data were obtained from MTC that identified the top 139 congested segments in the Bay Area for 2013. The data used by MTC to identify these top congested segments was purchased from, INRIX, a private traffic data provider that collects data from a variety of sources (including probe vehicles and GPS data tracking devices) to determine average speeds for short periods of time and over short distances that can be average over many days to determine the speed profile of a road over time. The top congested segments are selected based on a combination of factors including average speed, length of time the segment experiences congestion, as well as total vehicle flows. From this dataset, the segments that are on the eight goods movement corridors were selected. To understand the impact of the congestion on trucks, data on average daily truck volumes were obtained from Caltrans (2012 data). While the ideal approach to conducting this analysis would have used hourly truck counts applied to average hourly speeds for the same hour (to calculate actual truck delay), hourly truck volume data were not available and an alternative approach was developed to get an indicator of relative levels of truck delay experienced on congested segments. By combining the two parameters (truck average annual daily traffic (AADT) and average speed during congested periods), a truck delay index was calculated (truck volume/average segment speed). This index in essence represents the severity of congestion felt by trucks along the segment. A high number corresponds to high truck volumes and low speed.

Travel Time Reliability

In addition to predicable, or recurring delay, travel reliability, which can be affected by unexpected events, such as incidents or weather, is even more important for goods movement. Motor carriers are held to very strict standards for on-time delivery by their customers. Being late can mean missing times when businesses are open or missing cutoff times for intermodal connections at ports, airports, and rail terminals. In order to avoid poor on-time performance, motor carriers must plan for the worst conditions and this can mean wasted time when conditions are not as bad as these worst case scenarios. Motor carriers are reducing this wasted time by using real-time traffic information and sophisticated dispatching programs, but it is impossible to adapt in real-time to all instances of unreliable travel times.

A useful measure of travel time reliability is the buffer time index (BTI). BTI expresses the amount of extra travel time needed to ensure an on-time arrival 95 percent of the time as a percentage of the average travel time. The BTI for each of the eight corridors was obtained from MTC's INRIX database for the year 2013. BTIs for each of the corridors are then joined with the Truck AADTs from Caltrans, for the year 2012. This resulted in the ability to calculate the reliability index, which is Truck AADT*BTI, which combines both metrics. A high reliability index means that the segment is highly unreliable for truck travel, and vice versa.

Highway Bridge and Pavement Conditions

The condition of infrastructure has a direct effect on the efficiency and cost of freight movement along a given corridor. Poor bridge and pavement conditions can cause trucks to drive more slowly to avoid damage to vehicles and in cases of very poor pavement condition, may cause damage to vehicles that increases costs of operations. Understanding which corridors, or sections of corridors, where pavement conditions have deteriorated, or bridges are in need of replacement, is crucial to maximizing the effectiveness of limited infrastructure improvement funding.

Freight infrastructure conditions were determined through an analysis of bridge and pavement data along each of the identified corridors. For each corridor the average bridge rating was calculated using the bridge sufficiency score provided in the National Bridge Inventory dataset for 2014. This average rating was used to compare the overall bridge conditions among corridors.

The pavement data used in the analysis was obtained from MTC (year 2012), and it was broken into segments of various lengths. Each segment was specific to a particular lane on the roadway. Every segment was assigned a pavement condition of either "Distressed," "Maintenance," or "Good/Excellent." In order to determine the overall pavement condition of each corridor a score of 1 was assigned to distressed segments, 2 to maintenance segments, and 3 to good/excellent segments. The number of lane miles in each pavement condition category was totaled for each corridor to determine the percentage of overall lane miles that fell into each category. Finally, the weighted average pavement condition for each corridor was calculated using the previously determined percentages. This average rating was used to compare the overall pavement conditions among corridors.

Truck-Involved Crashes and Safety

On the interregional and intraregional goods movement systems, trucks and passenger vehicles face unique safety challenges due to the high volumes of traffic and higher speed. Not surprisingly, many crashes occur near interchanges. These could be due to congestion and driver behavior (e.g., weaving, lane changing, etc.), as well as interchange geometry. Heavy trucks are slow to accelerate and decelerate and they also block the view of drivers in automobiles who must follow closely behind them in heavy traffic. If merge and weave sections at the interchanges are too short or ramps are spaced very close together, trucks may have a difficult time entering the traffic stream and autos may enter the traffic stream too abruptly for trucks to decelerate and avoid hitting the autos. There are a number of other operational characteristics of congested routes with heavy-truck traffic that can lead to safety hot spots.

Crashes on California highways are reported to the Statewide Integrated Traffic Records System (SWITRS) database, including many details about the conditions and outcomes of each incident. For this study, crashes that involved trucks were tabulated for each corridor. Crashes cause not only loss of life, but also incur significant societal costs. It is estimated that a death has an equivalent value of more than $1.4 million, and a nonfatal disabling injury has an equivalent value of $78,900 in 2012. This is significantly higher than the $8,900 per accident costs of a property damage-only crash.[81]

The truck-involved crashes for each corridor are normalized by lane-mile. To display the collisions data, the normalization used is per kilometer of roadway segment. A spatial join tool was used to associate each collision point with the dissolved roadway segment closest to it and report a count of collisions on each segment.

3.5.2 Rail Network

Delay on Mainlines

The first step in determining the level of delay on the rail network is to identify the practical capacity of each line. Determining the capacity of any particular rail line is complex. Rail line capacity is a function of a number of factors, including the number of tracks, the frequency and length of sidings, the capacity of the yards and terminals along a corridor to receive the traffic, type of control systems, geography, and the mix of train types, propulsion power, track speed, and individual railroad operating practices. Furthermore, it varies with changes in infrastructure and operating conditions.

[81] http://www.nsc.org/news_resources/injury_and_death_statistics/Pages/EstimatingtheCostsofUnintentionalInjuries.aspx.

Numerous approaches have been developed to evaluate railway capacity. Network simulation modeling is usually required by the track owners before any modifications are made. However, general rules have been developed by railroads to determine the theoretical and practical capacity of rail lines. Three variables are generally used to estimate the capacity of rail corridors: the number of tracks, the type of control system, and the mix of train types.

Typically, a corridor serving multiple train types will have a lower capacity than a corridor serving a single train type. For example, a railroad corridor with two tracks, a centralized traffic control (CTC) system, and a mix of merchandise/bulk trains, intermodal/auto trains, and passenger trains would typically operate at a capacity of about 75 trains per day. The same corridor, serving all intermodal trains, would typically operate at a capacity of about 100 trains per day.

Once the practical capacity is established, it can be compared with current or forecast volume to determine how crowded the facility is. While railroad capacity analysis does not typically use the concept of level of service (LOS) that is used in highway analysis, in a study conducted for the Association of American Railroads (AAR)[82], Cambridge Systematics developed an LOS indicator for railroads based on volume to capacity ratios (v/c) that is similar to the familiar highway congestion rating. Rail lines are graded A through F depending on how free-flowing traffic can be expected to run.

Part of the use of this calculation is to identify when freight and passenger users will need to coordinate to improve capacity or develop more efficient operational practices. The freight railroads have a need to protect their ability to deliver current and future freight volumes and have an inherent right to retain existing capacity for future freight growth. Adding more freight trains to the system will degrade on-time performance of passenger trains unless new capacity is added in the form of longer passing sidings, station dwell time takes place off the mainline, more crossovers are added and other infrastructure improvements are made to improve fluidity. This simply means that passenger train operators will need to partner with freight railroad hosts to invest in additional infrastructure to provide the needed capacity enhancements that allow rail line LOS to be at level C or better.

At-Grade Highway-Rail Crossing Delay and Safety

One additional delay issue is a concern at the places where roadways and rail lines meet: at-grade rail crossings. Traffic delay at these crossings is customarily measured in terms of vehicle-hours of delay (VHD) for the waiting vehicular traffic. Delay is a function of train volumes, train length and speed, and roadway traffic volumes. Data regarding the trains is used to estimate

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[82] *National Rail Freight Infrastructure Capacity and Investment Study*, prepared by Cambridge Systematics for the Association of American Railroads, September 2007.

gate blockage time, which is the amount of time that the crossing gates are down and stopping traffic. Longer and slower trains result in more gate blockage time, while shorter and faster trains cause less blockage time. The daily train volumes for freight and passenger trains in each corridor were used to calculate gate blockage time. Assumptions were made regarding typical train speed and length.[83]

Current traffic volume data at the crossings was not readily available. The FRA database includes daily traffic volumes, but these figures were at least 5 years old and in most cases 10 to 26 years old. Instead of using this old data, estimated traffic volumes were developed from information regarding the classification and number of lanes on each roadway. The Florida Department of Transportation has developed industry-standard estimates of roadway volumes based on classification and number of lanes.[84] These volume estimates are adjusted for California using Caltrans factors. Gate blockage time and traffic volumes are combined in a formula to calculate vehicle hours of delay at each crossing.

In addition, at-grade crossings introduce safety concerns to the overall transportation system. The FRA at-grade highway-rail crossing database was reviewed to identify all at-grade crossings that are on major streets and roads in each freight corridor. This measure does not include pedestrian or bicycle safety due to data limitations.

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[83] Freight train speed: 50 mph; freight train length: 4,000 feet; passenger train speed: 79 mph; passenger train length: 1,200 feet.

[84] Florida Tables – Table 1 – Generalized Annual Average Daily Volumes for Florida's Urbanized Area.