Improving Environmental Justice and Mobility in Southeast Los Angeles

June 2022

A Research Report from the Pacific Southwest Region University Transportation Center

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PSR Pacific Southwest Region UTC
University Transportation Center

CSTACC
Climate Smart Transportation and Communities Consortium

METRANS Transportation Center
USC | CSULB

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. PSR-18-SP91-Final Report	**2. Government Accession No.** N/A	**3. Recipient's Catalog No.** N/A	
4. Title and Subtitle Improving Environmental Justice and Mobility in Southeast Los Angeles, Final Report		**5. Report Date** June 30, 2022	
		6. Performing Organization Code N/A	
7. Author(s) Genevieve Giuliano, Marlon Boarnet, Miguel Jaller, Wilma Franco, Robert Binder, Sue Dexter, Jiawen Fang, David Flores Moctezuma, Anmol Pahwa, Marely Randazzo, Bonnie Wang		**8. Performing Organization Report No.** TBD	
9. Performing Organization Name and Address METRANS Transportation Center University of Southern California University Park Campus, RGL 216 Los Angeles, CA 90089-0626		**10. Work Unit No.** N/A	
		11. Contract or Grant No. CCRP0017	
12. Sponsoring Agency Name and Address State of California Office of Planning and Research/California Strategic Growth Council Subcontract to University of California, Davis 1850 Research Park Drive, suite 300 Davis, CA 95618		**13. Type of Report and Period Covered** Final report (10/1/18 – 3/31/21)	
		14. Sponsoring Agency Code	
15. Supplementary Notes https://www.metrans.org/research/improving-environmental-justice-and-mobility-in-southeast-los-angeles-executive-summary			
16. Abstract This case study is part of the Climate Smart Transportation and Communities Consortium (CSTACC), case studies that were conducted in various locations throughout the state to analyze environmental justice issues in low income, communities of color. This study took place in southeast Los Angeles County in partnership with the Southeast Los Angeles Collaborative (SELAC), a non-profit community-based umbrella organization representing 8 cities and several unincorporated areas. The case study has two parts. The first part examines impacts of heavy duty trucks and finds the main problems to be traffic safety and particulate emissions. An analysis of regional freight traffic reveals that current and planned regulations to achieve zero emission truck targets will significantly reduce truck-related emissions. A local analysis showed higher than average truck involved crashes and safety hot spots. Local traffic management strategies are recommended to increase safety. The second part examines public transit job accessibility. Transit accessibility depends on both service level and access to bus stops. Reductions in service that took place as a result of the pandemic greatly reduced job access. Recommendations include exploring bike share and car share options to reduce travel times to and from bus stops, and restoring service to pre-pandemic levels.			
17. Key Words Environmental justice, heavy trucks, public transportation		**18. Distribution Statement** No restrictions.	
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 128	**22. Price** N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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About the Pacific Southwest Region University Transportation Center

The Pacific Southwest Region University Transportation Center (UTC) is the Region 9 University Transportation Center funded under the US Department of Transportation's University Transportation Centers Program. Established in 2016, the Pacific Southwest Region UTC (PSR) is led by the University of Southern California and includes seven partners: Long Beach State University; University of California, Davis; University of California, Irvine; University of California, Los Angeles; University of Hawaii; Northern Arizona University; Pima Community College.

The Pacific Southwest Region UTC conducts an integrated, multidisciplinary program of research, education and technology transfer aimed at *improving the mobility of people and goods throughout the region.* Our program is organized around four themes: 1) technology to address transportation problems and improve mobility; 2) improving mobility for vulnerable populations; 3) Improving resilience and protecting the environment; and 4) managing mobility in high growth areas.

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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated in the interest of information exchange. The report is funded, partially or entirely, by a grant from the U.S. Department of Transportation's University Transportation Centers Program. However, the U.S. Government assumes no liability for the contents or use thereof.

Disclosure

Principal Investigator, Co-Principal Investigators, others, conducted this research titled, "Improving Environmental Justice and Mobility in Southeast Los Angeles," at University of Southern California. The research took place from10/1/18 to 3/31/21 and was funded by a subcontract from University of California, Davis in the amount of $422,500. Funding was provided by the California Strategic Growth Council. The research was conducted as part of the Pacific Southwest Region University Transportation Center research program.

Acknowledgements

This research was funded by the California Strategic Growth Council under the grant, Climate Smart Transportation and Communities Consortium (CSTACC). The CSTACC was led by University of California, Davis and includes USC, UCLA, UC Berkeley, UC Irvine, and UC Riverside. We gratefully acknowledge the participation of the Southeast Los Angeles Collaborative, Pat Brown Institute at California State University, Los Angeles, focus group participants, and project Advisory Committee members. Regional transportation modeling data provided by the Southern California Association of Governments is gratefully acknowledged.

Abstract

This case study is part of the Climate Smart Transportation and Communities Consortium (CSTACC), case studies that were conducted in various locations throughout the state to analyze environmental justice issues in low income, communities of color. This study took place in southeast Los Angeles County in partnership with the Southeast Los Angeles Collaborative (SELAC), a non-profit community-based umbrella organization representing 8 cities and several unincorporated areas. The case study has two parts. The first part examines impacts of heavy duty trucks and finds the main problems to be traffic safety and particulate emissions. An analysis of regional freight traffic reveals that current and planned regulations to achieve zero emission truck targets will significantly reduce truck-related emissions. A local analysis showed higher than average truck involved crashes and safety hot spots. Local traffic management strategies are recommended to increase safety. The second part examines public transit job accessibility. Transit accessibility depends on both service level and access to bus stops. Reductions in service that took place as a result of the pandemic greatly reduced job access. Recommendations include exploring bike share and car share options to reduce travel times to and from bus stops, and restoring service to pre-pandemic levels.

Improving Environmental Justice and Mobility in Southeast Los Angeles

Short Executive Summary

The full Executive Summary for this project is published as a separate document available at https://www.metrans.org/assets/research/psr-18-sp91_giuliano_final-report.pdf. Here we summarize the main findings and recommendations of the research.

As part of the Climate Smart Transportation and Communities Consortium (CSTACC), case studies were conducted in various locations throughout the state to analyze environmental justice issues in low income, communities of color. This case study took place in southeast Los Angeles County in partnership with the Southeast Los Angeles Collaborative (SELAC), a community-based umbrella organization representing 11 cities and several unincorporated areas. SELAC participated in the study design, analysis, and policy recommendations.

A previous study of transportation in the SELA area revealed two main problems: extensive truck traffic and relatively limited transit service. This project builds on the previous research and conducts a comprehensive analysis of both truck traffic and public transit.

Summary of Findings: Freight Analysis

We conducted two levels of analysis, one on regional truck traffic and one on local truck traffic. Findings are as follows:

- *Truck traffic in the SELA area is a mix of through traffic and SELA generated traffic*. The SELA area accounts for about 10% of all regional trips and serves as a pass through for an additional 11% of regional trips, yielding roughly 210,000 truck trips per day, much higher than the County average.
- *Air pollution and crashes are the major impacts of truck traffic*. As a proxy for air pollution we use the intensity of truck traffic, truck volume per day per square mile. The average truck volume density in SELA is approximately 40,000 trucks/day/sq. mile compared to the regional volume density of approximately 25,500 trucks/day/sq. mile.
- *Air pollution is best addressed at the regional level*. Existing California regulations and zero emission vehicle targets will result in substantial reductions in CO2, NOX, PM 2.5 and SOX despite an estimated nearly 50% increase in truck VMT by 2040. If more ambitious targets are achieved and other decarbonization strategies implemented, emissions would increase further. As a major generator of truck traffic, the SELA area will reap large localized benefits from these reductions.

- *Truck related traffic safety is a serious problem.* Our crash analysis reveals that SELA has a higher rate of truck incidents on a square mile basis and higher fatalities as a percentage of the total than either the City of LA or the county. Significant spatial clusters of arterial accidents were found in heavy truck traffic areas. The top three causes of street truck collisions are unsafe speed, crossing the right way of another vehicle, and improper turning.

- *Solving safety problems requires highly localized solutions.* A hotspot analysis revealed specific high risk locations. Field observation showed these locations have unique problems, such as poor visibility or complex intersection geometry.

Freight Analysis Recommendations

The successful implementation of vehicle technology-related and other operational strategies included in current regulations will generate large regional environmental benefits. To achieve success, continuous programs that offer adequate incentives (monetary and non-monetary) are needed to help during the transition and to foster an equitable distribution of benefits. The technical limitations of ZEV trucks related to load capacities and ranges will have to be addressed, and major investments in fueling infrastructure will be required.

Local pollution hotspots in SELA can be mitigated by accelerating the transition to zero and near zero emission trucks operating within SELA. Charging stations should be considered in the I-5 corridor, the Carson area warehousing cluster, and the Alameda Street industrial corridor. Low emission zones may be considered to promote use of cleaner vehicles in these areas. There is potential for the SELA region to participate in demonstration projects related to these policy and technology implementations

Local truck safety hotspots should be evaluated for operational changes. Our hotspot analysis revealed specific problem areas with higher than average truck crashes and exposure to residential areas and schools. To improve upon pedestrian and traffic safety specific operational and geometric improvements are recommended for the Alameda Street corridor, by potentially eliminating the Alameda Street Auxiliary or one-waying the auxiliary, and along the Firestone Boulevard corridor by updating traffic signal timings along the corridor and along major cross-street corridors to minimize truck traffic diversions onto side-streets and Southern Avenue. It is recommended that the remaining hotspots be similarly evaluated.

Geofencing should be considered to reduce truck traffic in residential areas. To further minimize localized pollution impacts in the interim period, geofencing policies should be implemented to keep heavy duty trucks out of residential neighborhoods. In some cases trucks deviate routes to save time. Geofencing would also have the additional benefit of pedestrian and traffic safety in these neighborhoods.

SELA Collaborative should partner with local municipalities to achieve traffic safety changes. Our hot spot analysis showed that each safety problem is unique. Operational improvements have the potential to reduce risk, and these charges are largely under the jurisdiction of municipalities.

Summary of Findings: Transit Service

The transit service analysis has two parts: a comparison of transit accessibility to jobs under different transit service scenarios, and an analysis of transit service quality. Findings are as follows:

- *Increasing the speed of access to bus stops yields the greatest improvement in job access.* Scenarios where access to and from bus stops was by car or bicycle increased access by 182% and 65% respectively. In contrast, reducing all headways of routes in the SELA area increase access by 31%.
- *The planned West Santa Ana Branch (WSAB) light rail line will have limited effect on transit job access.* The planned WSAB will provide modest improvements in job access for the communities where stations will be located.
- *A docked bikeshare service in selected areas would increase access to high frequency routes.* A case study of communities within SELA showed that strategic placement of docked bikeshare facilities could bring a large share of population to within 10 minutes of a high frequency route.
- *The service reductions implemented in response to COVID reduced job access.* Service reductions, mainly in the form of longer headways and shortened service hours, reduced job access in the SELA area by 19%.
- *A small survey of SELA residents suggests transit service quality could be improved.* Survey results showed that 59% of respondents have seen a bus drive by without stopping. Of those, 45% said there was still room on the bus, but the bus did not stop. A large LA Metro on-board survey showed more positive perceptions.

Transit Service Policy Recommendations

L.A. Metro should expand their on-demand shuttle pilot in the SELA region. Los Angeles Metro launched an on-demand shuttle service, called Metro Micro, in October of 2020. The shared ride pilot service has expanded to five pilot areas with four more launching in 2021. Of those, the Watts-Willowbrook area serves the central part of the SELA region. We recommend that L.A. Metro prioritize expansion of Metro-Micro into other parts of the SELA region. Funds will likely be available from federal and state stimulus and pandemic recovery programs.

L.A. Metro should work with cities and partner entities to bring a robust bikeshare program and bicycle infrastructure to the SELA region. The best location for a bikeshare pilot should be examined in collaboration with the community, but we note that the job concentrations and existing high frequency bus lines in the northern part of the SELA region suggest that a promising early opportunity for docked bikeshare focused on station access would be in the northern part of SELA. Successful bikeshare programs require supportive infrastructure, including separated (Class IV) bikeways or cycle tracks. Traffic safety is an important issue in SELA – a point reinforced by the freight focus groups' comments about traffic safety related to truck travel through the region. We recommend that a bikeshare program include development of a network of bicycle lanes – ideally separated and protected from traffic – to allow safe travel.

Prioritize bus frequency improvements in the SELA region. Based on our analysis, we recommend that Metro prioritize studying and implementing frequency improvements in the SELA region as part of their restoration of service with the waning of the COVID-19 pandemic.

Continue to focus on improved transit service. Given the differences between our survey and the LA Metro on-board surveys, we recommend that L.A. Metro supplement their on-board surveys with focus groups organized in collaboration with SELA community groups. The SELA Collaborative can provide links to community groups in the SELA region.

Plan for first-last mile access to future West Santa Ana Branch light rail stations. Our analysis demonstrates the importance of first-last mile connections to West Santa Ana Branch stations. Those first-last mile connections can make the West Santa Ana Branch a valuable access tool for the entire SELA region. We recommend that SELA cities, regional and West Santa Ana Branch planning bodies, and L.A. Metro collaborate to prioritize robust bicycle and shuttle access to West Santa Ana Branch stations.

Restore the COVID-related service reductions at the earliest opportunity. Restoring transit service to pre-pandemic levels is an important first step in improving job accessibility. Understanding that service restoration depends on demand and budgets, we recommend that L.A. Metro move to reverse the pandemic transit service reductions as soon as feasible.

Summary of Recommendations for Implementation

The overall goal of this research is to move some recommendations to implementation. To accomplish this, we make the following recommendations:

- Communicate study results to the larger SELA community through a community open meetings, media and print communications.
- Promote clean truck pilot programs and demos in the SELA region, as well as EV infrastructure investment
- Work with cities to promote specific intersection improvements and other operational strategies to improve traffic and pedestrian safety
- Work with LA Metro to further explore service issues
- Explore Metro Micro on-demand service and bikeshare solutions as opportunities for further study.

Chapter One: Introduction

1.1 Introduction

Transportation is the largest source of greenhouse gas (GHG), criteria, and toxic diesel particulate emissions in California (California Air Resources Board, 2021a). Transportation systems harm the environment in countless other ways, including vehicle-related pollutants in storm-water run-off and fragmentation of wildlife habitat by highways. Despite considerable progress, transportation-related environmental impacts remain substantial and fall disproportionately on the most vulnerable populations. The challenge for California is to reduce these impacts while meeting the mobility needs of society, fostering healthy and equitable communities, and supporting economic growth. The Climate Smart Transportation and Communities Consortium (CSTACC) – led by University of California, Davis (UCD) and including UC Los Angeles (UCLA), UC Riverside (UCR), UC Berkeley, UC Irvine, and the University of Southern California (USC) was funded by the California Strategic Growth Council to address these challenges.

The CSTACC's research program is organized around five areas with equity and policy engagement serving as cross-cutting themes throughout. The areas are innovative mobility, electrification, public transit, land use and active transportation, and goods movement. The research program includes two types of projects: regional case studies that address specific concerns, and statewide initiatives that build on the case studies and inform state level climate and equity policy.

This report presents research results from one of the regional case studies, the Southeast Los Angeles Initiative. The case study builds on previous research (Giuliano, Kang, Yuan and Hutson, 2018) that performed a comprehensive analysis of the transportation assets and deficiencies within the Southeast Los Angeles area. Two major transportation challenges were identified: heavy truck traffic and its associated impacts, and limited public transit service. The study recommended in-depth studies of both that would identify policies and strategies for improvements. The CSTACC grant provided the opportunity to conduct these in-depth studies.

The prior research established partnerships between USC, the Pat Brown Institute (PBI), and the Southeast Los Angeles Collaborative (SELAC). The Pat Brown Institute, a research center at California State University, Los Angeles, has worked with community organizations in Southeast Los Angeles to foster political participation and greater visibility of the area's problems. PBI provided support to SELAC and facilitated its growth. SELAC is a community-based umbrella organization representing 8 cities and several unincorporated areas. Its members are representatives of NGOs and local governments. The research reported here was conducted as a collaborative process, with SELAC participating in the design, analysis, and policy recommendations.

1.1.1 Research Purpose

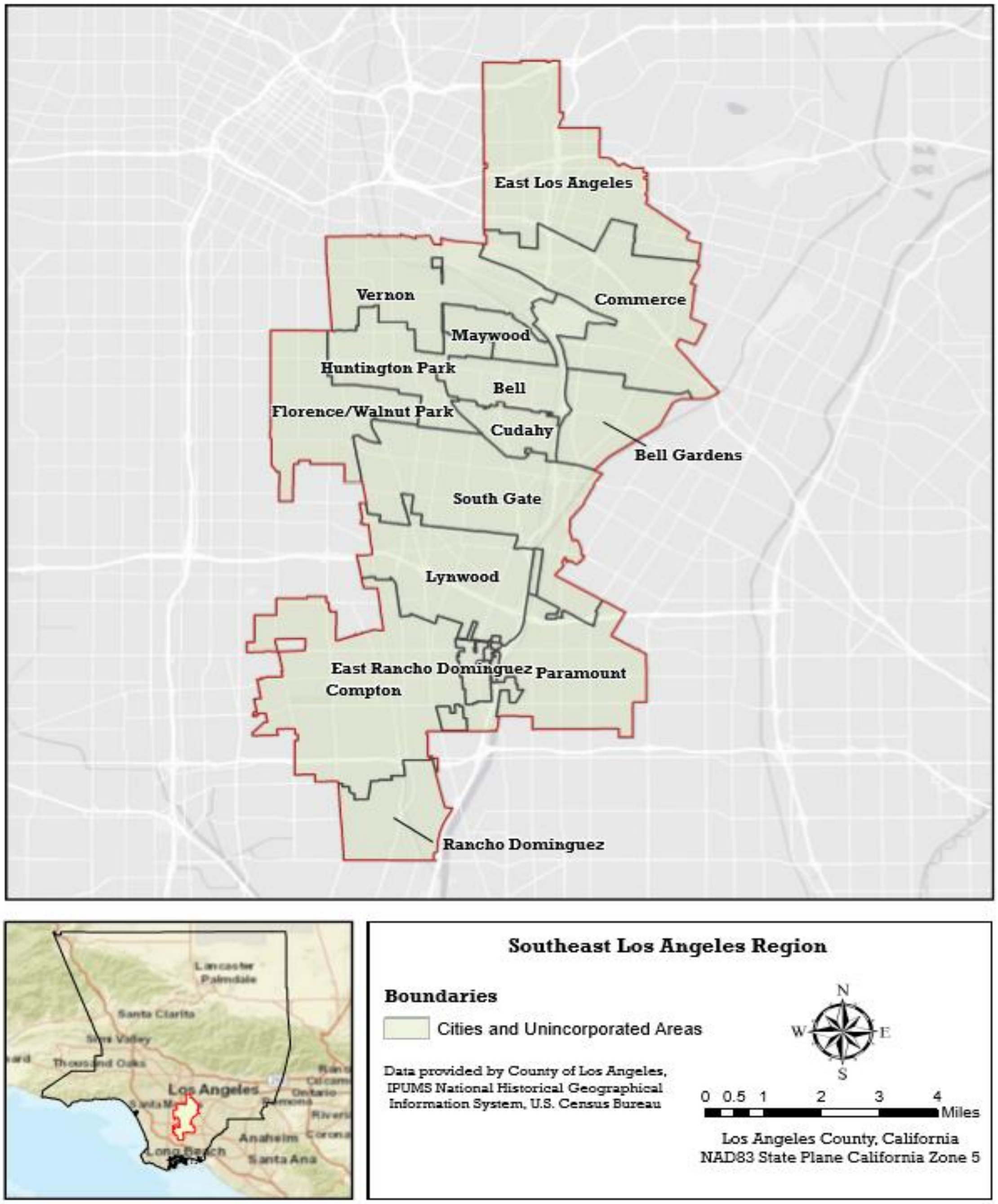
This research has three objectives. First, we use a participatory research model to engage community members directly in the research process. Participatory research is based on evidence that solving local problems requires a deep understanding of the nature of the problem and community consensus on how best to solve the problem. Our prior work with PBI and SELAC established a level of trust that allowed us to fully engage the community. Our objective was to identify solutions that the community would endorse and pursue through the policy process.

Second, we conduct in-depth analysis to understand 1) the nature and extent of truck-related problems, and 2) the quality and performance of transit service within the SELA area. In the case of truck related problems, we examine traffic volume, emissions, and truck safety. In the case of transit, we examine job accessibility via the transit system relative to the private vehicle. Third, with our community partners, we develop specific recommendations to address these problems. Community engagement is facilitated through the partnership with SELAC, focus groups, and a project advisory committee.

1.1.2 The SELA area

The SELA area is a classic example of communities of color being disproportionately burdened by transportation-related environmental externalities while experiencing limited mobility and accessibility. The SELA area is located south and east of downtown Los Angeles. See Figure 1-1. It includes the following municipalities: Bell; Bell Gardens; Commerce; Compton; Cudahy; Huntington Park; Lynwood; Maywood; Paramount; South Gate; and Vernon. It also includes the unincorporated areas of East Los Angeles; Florence/Walnut Park; Rancho Dominguez; and East Compton (East Rancho Dominguez).

Figure 1-1: SELA area map with cities and unincorporated areas



The SELA area is about 64 square miles and has a population of about 738,000 per 2019 American Community Survey (ACS) data. Table 1-1 gives some basic demographic data for the SELA area and Los Angeles County. It can be seen that the SELA area is far denser than the county as a whole: it accounts for 7% of the population but has just 1.6% of the county's area.[1] SELA is a majority minority area; the

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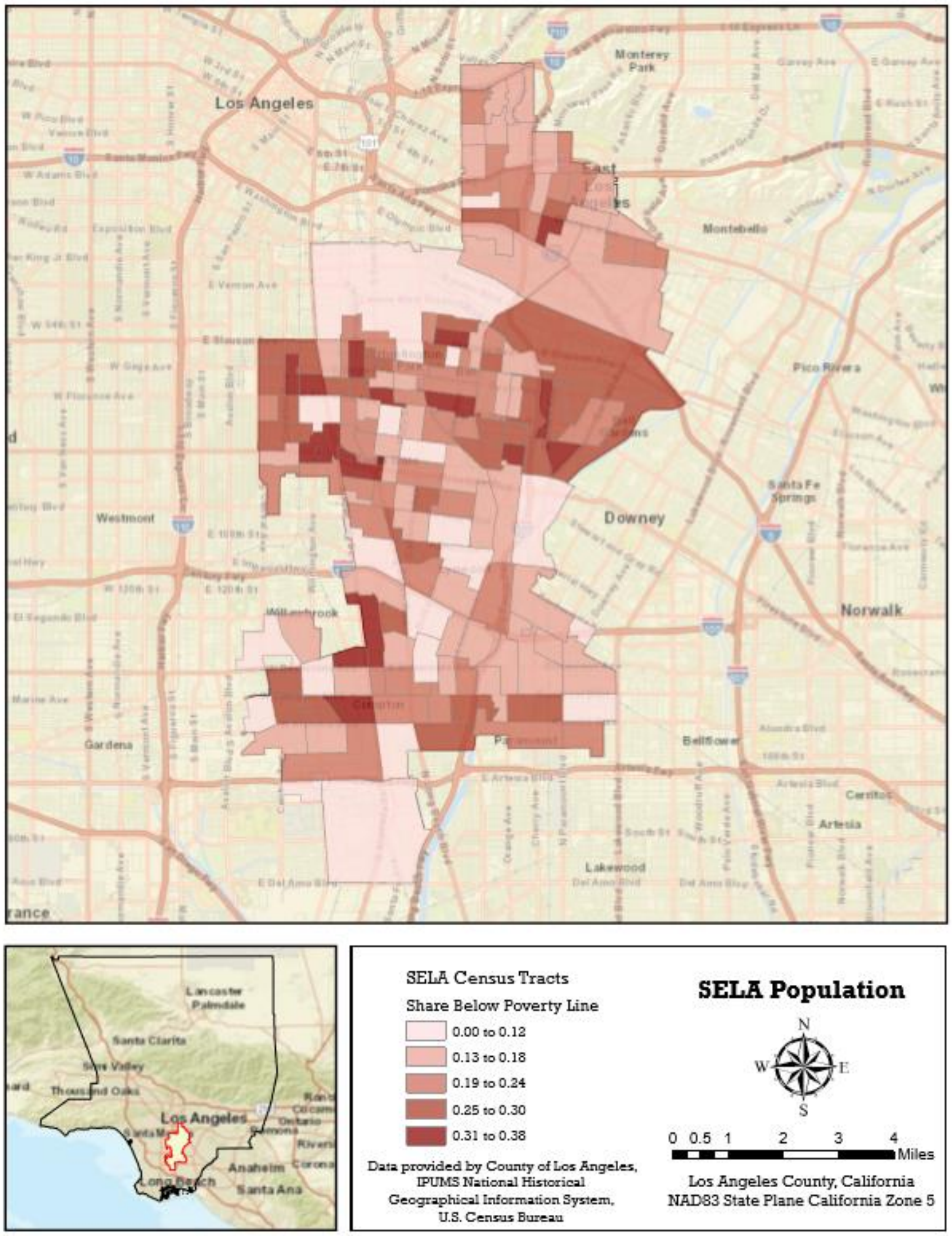
[1] Based on all of Los Angeles County except Catalina Island, so includes non-urban areas of the county.

population is overwhelmingly Hispanic or Latinx. The next largest share is African-American. Per capita income in SELA is lower than that of the County population, and the share of households in poverty is higher than the County average. Poverty patterns are not uniform. The highest levels of poverty are located in a west-east corridor from Florence/Walnut through Bell, Cudahy, Bell Gardens and the southern portion of Commerce. A second cluster is centered around Compton. See Figure 1-2.

Table 1-1: Demographics, SELA and LA County

	SELA	LA County
Area (sq mi)	65	3,953
Share	1.63%	100%
Population	737,648	10,077,403
Share	7.3%	100%
Population density	11,399	2,549
Share Hispanic	89%	48%
Share African-American	7%	8%
Share Asian	1%	14%
Share Non-Hispanic White	2%	26%
Share Other	1%	3%
Per capita income	$16,408.86	$34,170.18
Share households in poverty	20%	15%

Figure 1-2: Share households in poverty



Data provided by County of Los Angeles, IPUMS National Historical Geographical Information System, U.S. Census Bureau

Given the household income levels and population density of SELA, one would expect relatively higher rates of transit use. However, the SELA numbers are very similar to the overall County of Los Angeles numbers. See Table 1-2. For example. the percentage of households with no car in the region is 8.52%, only slightly below 8.81% for the county as a whole. The SELA region share of households with 1-car only is 29.8% compared to the county average of 33.5%. With regard to the journey to work, use of private vehicle is about the same in SELA as the county, but the carpool share is higher as expected. Transit mode share is only slightly higher, possibly reflecting limited transit access in the area.

Table 1-2: Travel characteristics in SELA

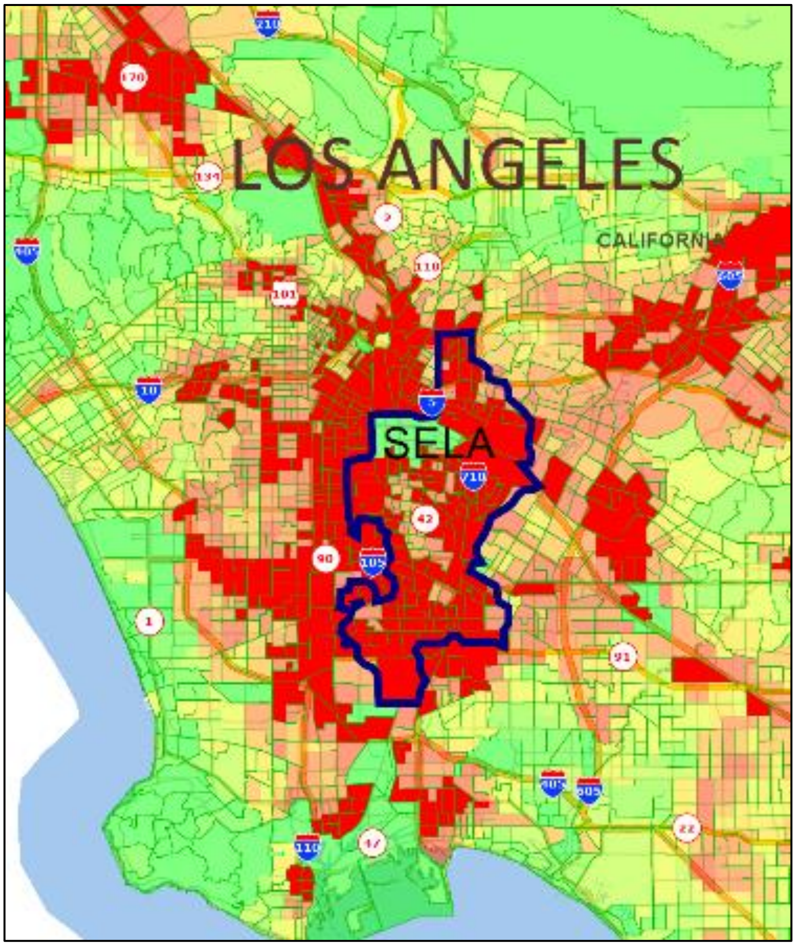
	SELA	LA County
Car ownership		
Share households with no car	8.52%	8.81%
Share households with 1 car	29.82%	33.54%
Share households with 2 or more cars	33.60%	35.33%
Journey to work mode share		
Drive alone	73.33%	74.00%
Carpool	13.14%	9.48%
Public transit	6.47%	5.81%
Walk	2.57%	2.69%
Bike	0.60%	0.77%
Other	1.17%	1.14%

Source: 2019 ACS

The SELA area experiences high levels of air pollution. CalEnviroScreen rates 85% of the census tracts making up the SELA area as high pollution and high population burden. The area straddles the I-710 freeway, a major truck corridor for port traffic, includes the I-5 industrial corridor and large concentrations of warehousing and distribution along its western border and in the southern portion. Heavy truck traffic generates higher emissions of NOX and diesel particulates.

According to SB 535 designations, most of the communities in the area are classified as disadvantaged communities (CalEnviroScreen score over the 90th percentile; California Office of Environmental Health Hazard Assessment, 2021). That is, these communities experience high burden on indicators falling in four broad groups: exposure, environmental effects, sensitive populations and socioeconomic factors.

Figure 1-3: CalEnviroScreen designations for SELA area



1.2 Community Planning and Participation

Although the SELA Project is focused on research and not directly on the planning process, the first part of this section begins with a brief review of some major concepts related to community participation in planning. It then provides a discussion of the emergence of the environmental justice movement, including federal and California programs to identify through databases and maps the environmental burdens of communities, as well as their connection to climate justice and how the State of California has addressed these issues. A brief review of community-based participatory action research and how the SELA Project incorporates this approach follows. The second part of this section describes the participatory approach of the SELA Project.

1.2.1 Community Participation in Planning and Policy

Community participation in planning has a decades-long history. Davidoff (1965) in several influential articles in the 1960s argued for planners to become advocates for disenfranchised communities. Arnstein’s 1969 article on the ladder of citizen participation argued that most community participation in planning decisions could be classified as forms of tokenism. In the influential Brookings study of urban democracy (Berry et al. 1993: 54-55), the authors provided a framework for gauging public involvement in government through determining the breadth and depth of participation—breadth referring to the opportunity of every community member to participate at every stage of the policy making process, and depth to the extent to which those who participate have the opportunity to determine the final policy outcome through the participation process. Innes and Boorhees (2004: 430) argued for collaborative participation in many sectors, for dialogue that relies on "an informed citizenry and responsive bureaucracy." They note that disadvantaged groups "often need technical assistance so they can have an equal voice with the more experienced and better funded interest groups."

This brief review of several major contributions to the community participation literature makes clear that this literature is focused on decision-making processes in planning and policy, and not directly on community participation in research.

1.2.2 The Environmental Justice Movement

Urban environments have been spatially segregated by income and other characteristics throughout modern, if not all, history. Injustices at the urban scale are expressed spatially, with concentrations of poor and minority populations in areas with poorer urban services, infrastructures, and the built environment, in addition to their greater proximity to active hazardous facilities and polluting industrial sites, and waste facilities--repositories of toxic or hazardous materials. The environmental justice (EJ) movement in the U.S. started in the 1980s, focused on the unfair siting or distribution of environmental harms in low-income and racial/ethnic minority neighborhoods and urban areas in the United States (Bullard 1996; Bullard and Johnson 2000; Boyce and Pastor 2013; California OEHHA 2020). The connection between environmental justice and climate justice has been well-developed (Bulkeley et al. 2013; Schlosberg and Collins 2014), since most polluting industrial sites emit GHGs and contribute to climate change.

1.2.3 The Importance of the Spatial-Demographic Distribution of Environmental Vulnerabilities for Climate Justice

At the national or at the urban scale, we cannot discuss climate justice as it relates to climate mitigation, since justice has an essential distributive aspect, without knowing the existing siting of carbon-emitting industries and infrastructures, and the associated distribution of carbon emissions and related environmental harms at the relevant geographic scales.

At the urban scale, in the context of climate change mitigation, mapping the distribution of land uses and infrastructures with associated carbon/GHGs/toxic releases, and of populations with greater sensitivity to carbon and related emissions is an essential step in assessing existing environmental injustices. Once the spatial distribution of exposures of current populations to carbon emissions and related toxics is available, discussions of how to address such carbon-based economic injustices can become more grounded.

In the US, the Clinton administration's Executive Order on Environmental Justice (1994), under pressure from the emerging environmental justice movement in the US, began to recognize and develop ways to respond to such injustices. In the 2010s, as part of this effort, the Environmental Protection Agency began to develop a national spatial analysis of toxic and other noxious sites, and a publicly accessible geographic database identifying a wide set of environmentally noxious uses at the census block scale, which was released to the public in 2015 (EPA 2019).

About the same time, the California Environmental Protection Agency began developing its environmental justice screening tool, CalEnviroScreen, a geographic database, with maps and databases available to the public that identify a set of environmental harms and vulnerable populations to such pollutants (children, and other sensitive populations, etc.) by census tract (a neighborhood scale classification, which ranges from 2,500 to 8,000 persons). CalEnviroScreen is increasingly used in the State to redress environmental injustices. Of particular interest to climate justice is the increasing use of California's cap and trade funds for programs aimed to improve the most environmentally burdened census tracts in the state. State laws in 2010s required that at least 35% of the funds be used to benefit the most disadvantaged census tracts in the state (CARB 2019a), and recent state reports indicate that more than 50 percent of cap-and-trade proceeds have benefitted populations in such tracts (CARB 2019b).

California's climate change programs, in particular, the environmental justice screening tool, and legislation requiring investment of cap-and-trade proceeds for the benefits of most environmentally burdened neighborhoods in the state are models for delivering climate justice, as well as for monitoring the results of climate mitigation or adaptation programs applicable at urban and metropolitan scales.

1.2.4 Community-Based Participatory Action Research

A strong partnership between the EJ community and Community-Based Participatory Action Research (CBPAR) emerged early on in the 1990s (Bacon et al. 2013). Principles of community-based participatory action research include: community partners influencing research agendas; providing input on research findings; and developing long-term relationships (Wallerstein et al., 2018; Wallerstein and Minkler 2002). This approach has been most influential in the public health field (Wallerstein et al. 2018). The South East Los Angeles (SELA) research project benefitted from prior research and collaboration between the research team at University of Southern California and the SELA Collaborative that led to the current project (Guiliano et al. 2018; Yuan 2018). Through this previous research, which provided a profile of the communities in SELA and identified major issues facing the communities, the SELA research project responded to environmental justice concerns in the SELA region, and incorporated a strong participatory action research approach, which, through the SELA Collaborative, included a consortium of South East Los Angeles community institutions.

1.2.5 Community Participation in the Project

Our research was structured around community engagement. The research project is the second research collaboration between USC researchers at METRANS, the SELA Collaborative (SELAC) and the Pat Brown Institute for Public Affairs (PBI) at CalState LA (Giuliano et al. 2018). The SELA Collaborative is a network of a dozen organizations across the SELA region, including youth, medical, educational, environmental justice organizations. PBI has a long-standing partnership with the SELA Collaborative. Both the SELA Collaborative and PBI were participants in the project meetings with the USC researchers, which were held on a monthly or bimonthly basis. Meetings were in person until March 2020; meetings moved to virtual through the remainder of the project due to the COVID-19 pandemic restrictions. Progress on research and outreach were discussed and decided at the meetings, and SELAC and PBI participants provided advice and input on research, findings, as well as ongoing and future outreach. The research team and SELAC planned the focus group questions and facilitated the focus groups by recruiting residents, developing the format for the groups, conducting the focus groups, and providing summaries. The researchers did not participate but attended the focus groups.

Project Advisory Committee (PAC)

The PAC for the Project was organized in the summer of 2019, and the first meeting was held on 8/28/2019. Due to the COVID-19 epidemic, two other meetings on 5/14/2020 and on 9/24/2020 were held via zoom. The PAC was composed of officials from the following organizations: Pat Brown Institute; East Yard Communities for Environmental Justice; Communities for a Better Environment; Los Angeles Clean Tech Incubator; Human Services Association; TreePeople; AltaMed; Gateway Cities COG; LA Metro; Caltrans; Supervisor Solis's Office; and Ports. During these meetings, the USC researchers and SELAC directors presented the research objectives, steps, and findings and sought comments/recommendations. Table 1-3 lists membership and affiliations.

Table 1-3: SELA project Advisory Committee membership

Raphael Sonenshein	Executive Director, Pat Brown Institute at CalState LA
Alessandro Negrete	Development and Communications, East Yard Communities for Environmental Justice
Xugo Lujan	SELA Community Organizer, Communities for a Better Environment
Jose Hernandez	Community Engagement Manager, Los Angeles Clean Tech Incubator
Leticia Chacon	Chief Executive Officer, Human Services Association
Cindy Montanez	CEO, TreePeople
Berenice Constant	Vice President of Government Relations, AltaMed
Nancy Pfeffer	Executive Director, Gateway Cities COG
William Ridder	Senior Executive Officer, Los Angeles METRO
Barbara Marquez	Los Angeles, Deputy Director for Sustainability, Caltrans
Martin Reyes	Transportation Deputy, L.A. County Supervisor Solis's Office
Efrain Escobedo	V.P. of Education and Immigration, California Community Foundation
Allison Yoh	Director of Transportation Planning, Port of Long Beach

Transportation Equity and Environmental Justice (TEEJ) Working Group

The Climate Smart Communities Consortium, the larger research project of which the SELA Regional Initiative is a part, established the TEEJ Working Group to focus on equity and environmental justice issues across the communities where the case studies were being conducted. The TEEJ working group was composed of members of the research teams and was geared to provide guidance and generate ideas on active research projects in the research consortium. The Executive Director of SELAC, Wilma Franco or the Associate Director, Cynthia Cortez, represented this research project at several meetings of the TEEJ Working Group, and reported back to the project.

Direct Outreach to the SELA Community

Direct outreach to SELA community members was facilitated by SELAC through focus groups and a transit survey. The original research called for three sets of focus groups. Due to the COVID-19 epidemic only the first set were held in person. Two focus groups were held in October of 2019, one focused on freight issues and the other on transit issues impacting the communities in SELA. The focus groups were facilitated by SELAC. Both were held in English and Spanish, with a translator who switched languages as the conversation moved from one language to another.

The first set elicited community perceptions and concerns about freight impacts and transit service respectively. They were intended to help us define the problems to be examined. These focus group meetings changed the course of the research. The freight focus group revealed that safety was the primary concern related to truck traffic. Focus group members related personal experiences of truck involved crashes (including pedestrian deaths), expressed fear of driving near trucks. and cited examples of dangerous driving by trucks. While air pollution and its impacts were also discussed, it became clear that the freight study would have to include safety.

The transit focus group revealed that transit service problems went beyond limited service or long travel times. Focus group members described buses not stopping even when not full, personal safety concerns at stops and while traveling on buses, threatening or offensive behavior of other passengers, and lack of cleanliness. Accordingly, the transit analysis was expanded to include safety and quality considerations.

A second set of focus groups was scheduled for the middle of the project and intended to present our research findings and receive guidance on possible solutions to pursue. By the middle of the project the COVID restrictions were in effect, preventing any type of in-person meeting. Rather than attempt a bi-lingual virtual event at a time when the community was suffering serious effects from the pandemic, we canceled the second round of focus groups and held an additional meeting of the Advisory Committee instead. When it became apparent that restrictions would not be lifted before the end of the project, we decided to hold the final set of focus groups virtually.

On November 17 and November 19, 2020, SELAC facilitated bilingual Zoom focus meetings with SELA residents to present major findings of the research and obtain feedback. 13 persons participated in the freight focus group and 15 in the public transit focus group. The focus groups were initiated with a Powerpoint presentation in Spanish (with an English translation available).

1.3 Organization of Report

The remainder of this report is organized as follows. Chapters 2 and 3 present the freight analysis. Chapter 2 presents a region level analysis that models emissions reductions under various scenarios. Chapter 3 presents a SELA level analysis that includes a summary of focus group concerns, analysis of local traffic and safety impacts, and case studies of two “hot spots” identified in the analysis. Chapters 4 and 5 present the transit analysis. Chapter 4 presents an analysis of transit job access and uses a transit modeling tool to examine different scenarios to improve job access. Chapter 5 discusses perceptions of transit as elicited from the focus group and a small community survey. Chapter 6 presents a summary of findings and policy recommendations.

Chapter Two: Mitigating Freight Impacts at the Regional Level

2.1 Introduction

The volume of trucks moving through SELA is related to global supply chains and goods movement flows beyond the reach of municipal, regional, and even state-level governments. Rather than accept the current conditions as inexorable, the scale of the global market underscores that local action is urgently required to mitigate these detrimental impacts on SELA. This chapter identifies and evaluates strategies for reducing pollution impacts of heavy duty trucks at the regional level. Any reduction in pollution would greatly benefit the SELA area because of the large volume of truck traffic that traverses the area.

The chapter begins with some background information on the local ports and industry dynamics. The second section introduces methodology and data. The following sections describe scenarios to be tested, results, and conclusions.

2.1.1 The San Pedro Bay Ports

The ports of LA and Long Beach are the first and third-largest container ports in the US, making the San Pedro Bay complex the largest in the country by a healthy margin. 17.3 million TEUs pass through the harbor each year, loaded onto trucks, trains, and ships for distribution throughout the nation and world (Port of LA-LB Statistics). From sea onto land, freight pours into SELA, bound for transloading facilities and warehouses located throughout the region. Most notably, Hobart Railyard, the major intermodal hub home to BNSF rail, is situated on the northern edge of the SELA region just south of Downtown Los Angeles. Resulting from these land use patterns and proximity to the ports, trucks flow through SELA at a higher rate than any other region in California. Limited on-dock rail infrastructure, the low cost of truck shipping, and the growing need for responsive supply chains have depressed rail's volume share and kept total volume well below potential capacity (Interview with Kerry Cartwright, 2020).

In recent years, a diversifying manufacturing base, Panama and Suez Canal expansions, federal trade policy, improved Canadian shipping routes, and the COVID-19 Pandemic have all influenced goods movement flow and made the Ports of LA and Long Beach more "regional ports"— i.e., less of a gateway to Mid-Western and Eastern markets (Interview with Bill Mongelluzzo, 2020). More regionally bound freight means distribution methods less suitable for rail and more congruous with the reduced cost and increased flexibility of trucks. Given the population growth expected in the region in the upcoming decades, this dynamic represents a profound threat to SELA communities and public health.

2.1.2 Global Market Dynamics

China is the world's leading manufacturer and Trans-Pacific trade comprises a vital component of the American economy. Given its relative proximity to Chinese manufacturing and shipping hubs, the Southern California region represents the closest point of entry for Chinese goods. This spatial relationship along with strategic infrastructural investment and naturally deep harbors, has helped the Ports of LA-LB achieve dramatic growth and attain preeminent shipping volumes (Mongelluzzo, 2020).

Even before COVID, production had been moving away from China to Southeast Asia to take advantage of more favorable market conditions (i.e., cheaper labor and relaxed regulations). This trend accelerated during 2020, as the pandemic has demonstrated that over-relying on a single nation for production is a national security hazard. The Trump Administration further incentivized these shifts, implementing tariffs on Chinese imports and motivating Beneficial Cargo Owners (BCOs) to import goods and materials from elsewhere. These new manufacturers are located further from LA, making East Coast ports more attractive for entry to US markets.

Canal expansions in Panama and Egypt have accelerated these shipping trends, reducing shipping times from Asia to the East Coast. The Panama Canal expansion project, completed in 2016, effectively doubled canal capacity with an additional set of locks. The Suez Canal Corridor Area Project, completed in 2015, added a second shipping lane, allowing for ships to more easily pass in either direction. These renovations have shortened shipping routes eastbound and westbound out of Asia, making the East Coast ports even more viable relative to LA and Long Beach.

Additionally, western Canada's ports are increasingly eating into San Pedro Bay's market share. While more distant from Asian manufacturing hubs than Southern California, the Ports of Prince Rupert and Vancouver are serviced by Canada's public rail companies. CN Rail, Canada's largest public rail operator, connects the ports to Canadian markets as well as Chicago, Memphis, St. Louis, and New Orleans among other cities. As a public entity, Canadian rail has the incentive to accommodate the positive externalities of goods movement in its pricing structure, effectively undercutting America's private BNSF and Union Pacific companies, who are more motivated by net profits than national market share.

Lastly, while volume share is trending away from Southern California, total volume is increasing year-over-year (ACTA). SCAG estimates that the regional population will grow by 3.7 million by 2045 (Connect SoCal, 2020). Against the backdrop of a more regionally focused shipping industry, this growth implies increasing truck flows and costs imposed on the SELA region. As such, mitigating the impacts of these trucks remains the most impactful and viable methods of harm reduction available to local governments.

2.1.3 Regional Traffic and the SELA Area

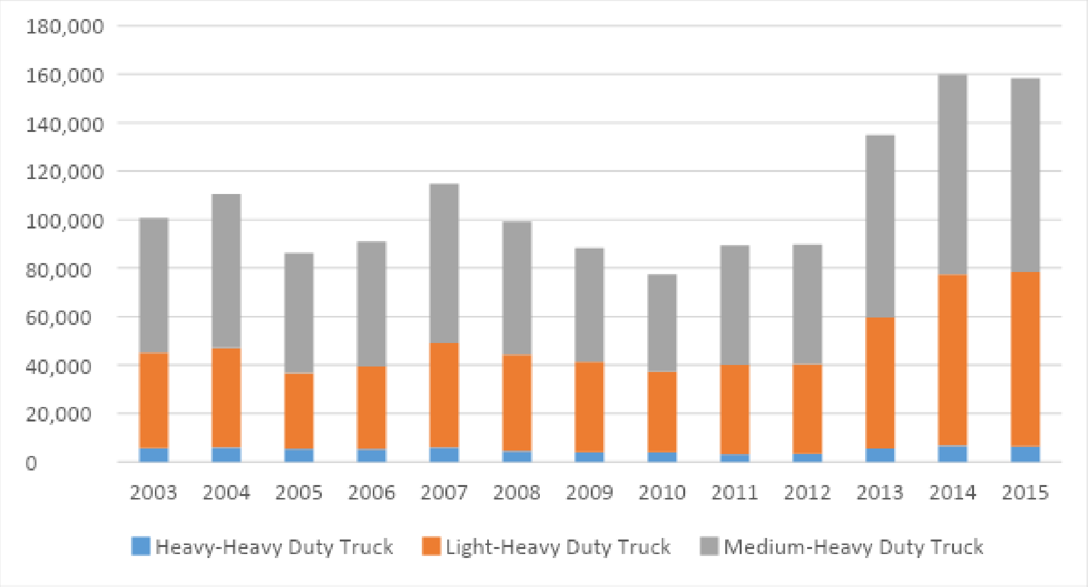
Overall, the SCAG region serves as an international trade gateway with the most active seaports in the country, has a large network of freight facilities, a robust manufacturing industry, and considering the large population, is also a significant consumption market. The related freight activity has had positive implications for a vibrant economy, though, at the expense of social and environmental consequences. The SELA area, in particular, is impacted by major truck corridors such (e.g., I-710, I-5, 105).

Southern California has received great attention from researchers to analyze changes in freight patterns because the South Coast air basin is in chronic non-attainment for both State and Federal air quality thresholds. Truck vehicle miles traveled on regional highways in the region are expected to increase 80% by 2035 (Ambrose et al., 2021). Moreover, the region has experienced recent changes in freight distribution. For example, there have been changes in the location, size and quantities of freight facilities such as warehouses and distribution centers, and freight flows have shifted in terms of concentration, and the share of vehicles types used. Figure 2-1 shows, for a sample of weigh-in-motion (WIM) stations along key highways in the region, the changes in total average daily volumes. Overall, there is an increase in overall traffic along these highways, with a significant increase in smaller heavy duty-trucks (WIM classes 5-7), and larger semi-trailers (classes 8-10) during the last decade (Rivera-Royero et al., 2021).

Moreover, the SELA communities face disproportionate impacts from trucks and goods movements due to high truck volumes, truck traffic associated with manufacturing and warehousing, major freight facilities located close to residences, and trucks traveling through residential areas.

The study followed a multi-pronged approach including a macro analysis of truck activity in the area, development and implementation of improvement scenarios, and quantitative analyses. The methodology is discussed next.

Figure 2-1: Average Daily Volume share vs. Time for Heavy-, Medium-, and Light-heavy duty trucks a sample of WIM stations



2.2 Methodology

To evaluate the impact of improvement strategies the team:

1. Evaluate simulated freight flows from the SCAG regional travel demand model (2012 model validation) outputs for the years 2012, 2020, 2030, 2035 and 2040;
2. Developed an emissions simulator based on emission rates as a function of travel speeds (see APPENDIX A for description); and,
3. Developed and implemented a set of scenarios.

2.2.1 Freight Flows from the SCAG Regional Travel Demand Model

The study used the 2012 calibrated SCAG's regional travel demand model. SCAG uses the model to forecast travel behavior for the Southern California region, as part of their cooperative planning, governmental coordination and reporting requirements (Southern California Association of Governments, 2008). Moreover, SCAG's is mandated to plan and implement a Regional Transportation Plan/Sustainable Communities Strategies (RTP/SCS), Federal Transportation Improvement Program (FTIP), Transportation Control Measures (TCMs), and other transportation strategies.

The model is a trip-based model (recently updated to an activity-based model), which includes passenger trips, as well as a heavy-duty truck (HDT) model. The modeling geographic scope includes the six counties in SCAG, as well as external trip zones (40) and special generators. In total, the model estimates trips for 4,109 Tier 1 internal zones (or 11,267 contained Tier 2 zones). The model also contains a Tier 3 detailed zoning system.

This study uses the outputs of the HDT model to evaluate a number of improvement scenarios. The HDT model includes various elements: internal and external HDT trips, port HDT trips and intermodal HDT trips. In terms of vehicle types, the model aggregates trips into three weight classes: light-heavy (8,500 to 14,000 lbs), medium-heavy (14,001-33,000 lbs), and heavy-heavy duty trucks (>33,000 lbs). The external trips represent those trips originating or destined to/from an external zone (connecting the SCAG region with the rest state and the nation). The internal trip component focuses on the intraregional trips, based on generation rates for industries/land uses. Special generators include the port and intermodal rail facilities, with emphasis on transloading trips and repositioning movements.

The model generates Origin-Destination (OD) tables for various Time of Day (ToD) periods, and conducts traffic assignment for trucks and light-duty vehicles. Table 2-1 describes the five ToD periods, and the total link volumes for the 3 vehicle types.

Table 2-1: HDT time of day total link volumes

	Light-heavy duty (LT)	Medium-heavy duty (MT)	Heavy-heavy duty (HT)	Sub-total
AM	129,328	108,059	285,033	522,420
PM	142,940	95,727	389,723	628,390
MD	275,577	256,091	686,128	1,217,796
EVE	30,463	19,257	138,197	187,917
NT	83,321	89,976	485,213	658,510
Sub-total	661,629	569,110	1,984,294	

Table 2-2 shows the daily composition of the heavy-duty vehicle fleet considering the vehicle type. The midday period exhibits the largest daily share (see part a); and heavy-heavy duty trucks the largest share of vehicles for any given time period. Comparing the simulated results with the traffic census data, the model seems to overestimate the flows using heavy-heavy duty truck trips.

Table 2-2: Daily flow composition

a) Share of flows per time of day by vehicle type

	Light-heavy duty	Medium-heavy duty	Heavy-heavy duty
AM	19.5%	19.0%	14.4%
PM	21.6%	16.8%	19.6%
MD	41.7%	45.0%	34.6%
EVE	4.6%	3.4%	7.0%
NT	12.6%	15.8%	24.5%

b) Share of flows per vehicle type for each time of day period

AM	25%	21%	55%
PM	23%	15%	62%
MD	23%	21%	56%
EVE	26%	10%	74%
NT	13%	14%	74%

Table 2-3 shows the estimated average speeds in the SCAG and SELA areas for the three truck types across the various time periods. The results show that the lowest speeds due to congestion happen mostly during the PM peak periods of the day. Compared to the night period, when system speeds are the highest, the PM peak exhibits a reduction of speeds by about 40%. Additionally, compared to the entire SCAG region, speeds are between 20-25% lower in the SELA area.

Table 2-3: Average speeds in the SCAG and SELA areas

a) Light-heavy duty (LT)

	AM	PM	MD	EVE	NT
SELA	32.24	29.21	35.07	41.50	47.48
SCAG	40.06	38.00	44.97	50.32	54.22

b) Medium-heavy duty (MT)

	AM	PM	MD	EVE	NT
SELA	32.32	29.45	34.82	41.30	47.07
SCAG	39.67	37.68	44.40	50.00	53.78

c) Heavy-heavy duty (HT)

	AM	PM	MD	EVE	NT
SELA	35.15	32.02	37.98	45.26	51.73
SCAG	44.57	42.46	50.26	56.21	60.41

2.3 Development and Definition of Evaluation Scenarios

In this work, the team concentrated on the development of a number of scenarios to represent improvement strategies. These strategies concentrate on the adoption of newer vehicle technologies, and potential operational/demand changes. The scenarios are discussed next:

1. **Business as Usual (BAU)**. This scenario considers the system modeling results from the SCAG model for 2012, 2020, 2030, 2035 and 2040. Considering that the system was validated for the 2012 time period, the comparative analyses use 2012 as the reference point. For the estimation of emissions,

the BAU model assumes the emission forecast from the California Air Resources Board (CARB) for the modeling years. The team synthesized the emission rates from EMFAC for each of the simulation years (California Air Resources Board, 2021b). These emissions were based on the projects before the enactment of the Advanced Clean Truck (ACT) rule or new executive orders and legislations that mandated the acceleration of new vehicle technology adoption, and new emission standards.

2. **Adoption and penetration of Zero-Emission Vehicles (ZEVs)**. A series of scenarios assumed the adoption and penetration of different ZEVs. In particular, the scenarios assume the incremental penetration of Battery Electric Vehicles (BEVs) at different rates and for different vehicle types, the spatial concentration of the penetration, and also a longer term goal for decarbonization that accounts for the introduction of new policies such as the ACT.
    1. Incremental Penetration of BEVs. This scenario assumes a 10, 20, 30, 40, 50% share of BEVs for light- (LT) and medium-heavy (MT) duty for model year 2030. Moreover, the team proportionally adjusted other vehicle fuel type shares.
    2. HT + Highway proxy inside SELA. This scenario is a particular more aggressive scenario of BEV penetration for 2040. This scenario considers a 75% BEV share for light- and medium-heavy duty trucks, and 50% for heavy-heavy (HT) duty trucks. However, the scenario only considers the HT changes along the main corridors and highways inside the SELA area in 2040.
    3. As part of a project to develop strategies for transport system decarbonization by 2045, funded by the Environmental Protection Agency (EPA), and led by UC Davis, researchers have developed fleet turnover projects using existing policies and other assumptions about fleet composition and vehicle survival rates (Brown et al., 2021). In this study (scenario 1b), the authors used the most recent fleet composition projections for the various planning years. The team used the fleet composition forecast for 2045 to estimate the changes in emissions for SCAG and SELA.
3. **Operational improvements and spatial analyses**. These scenarios include assumptions about the ability to foster a behavioral change in the system to shift truck traffic in the temporal and spatial dimensions. For temporal changes, the study assumes the implementation of an off-hour freight operations program. Additionally, based on the team's work to develop an eco-routing and geofencing modeling tool, the team evaluated the implications of geofencing the SELA area.
    a. Off-hour operations. These scenarios consider the following shifts (the team conducted proportional adjustments to the flows when re-estimating the traffic). It is important to mention that this scenario does not capture the full impacts of an off-hour program because the authors did not incorporate the behaviors and decisions into the analyses. That is, the scenarios only transfer traffic from one time period to another. It does not include route and destination choices. Nor does the model include any system feedback.
        1. 10-30% truck traffic shift from the AM to the EVE period;
        2. 10-30% truck traffic shift from the MD to the EVE period;
        3. 10-30% truck traffic shift from the AM and MD periods to the EVE period; and,
        4. 10-30% truck traffic shift from the AM and MD periods to the EVE and NT periods.
    b. Geofencing SELA. The team had developed a multi-class traffic assignment model to estimate the potential impacts of different routing assumptions (Jaller et al., 2021). The team used the model to estimate the system impacts when geofencing the SELA area. In this case, geofencing implies charging an additional social cost fee to the traffic traveling inside the SELA region. The fee and model evaluate the impacts of the selection of specific emissions and pollutants.

2.4 Scenario Evaluation

The reader is referred to APPENDIX B for summary results for the various scenarios.

2.4.1 Scenario 1. Business as Usual (BAU)

The team used the SCAG simulation outputs for the years 2012, 2020, 2030, 2035 and 2040 as the baseline and BAU scenarios. Specifically, the estimates use the daily flows per network link (at the model's resulting assigned speed) to calculate the total emissions for the various scenarios based on the composite vehicle type and speed-bin rates. Figure 2-2 and Figure 2-3 show the expected changes in emissions during the future simulated years (including 2020). Figure 2-2 shows the contribution of such emissions from each of the truck types and compares the share of heavy-duty (HDT) vehicles in the traffic. As shown, existing policies and strategies have reduced the GHG emissions, and for some criteria pollutants significant drops are planned. Interestingly, these strategies are expected to achieve significant reductions (~60-90%) for PM and NOx, even when VMT is expected to double in the next 20 years.

Figure 2-2: Changes in CO2 (left) and PM 2.5 (right) emissions in the next 20 years

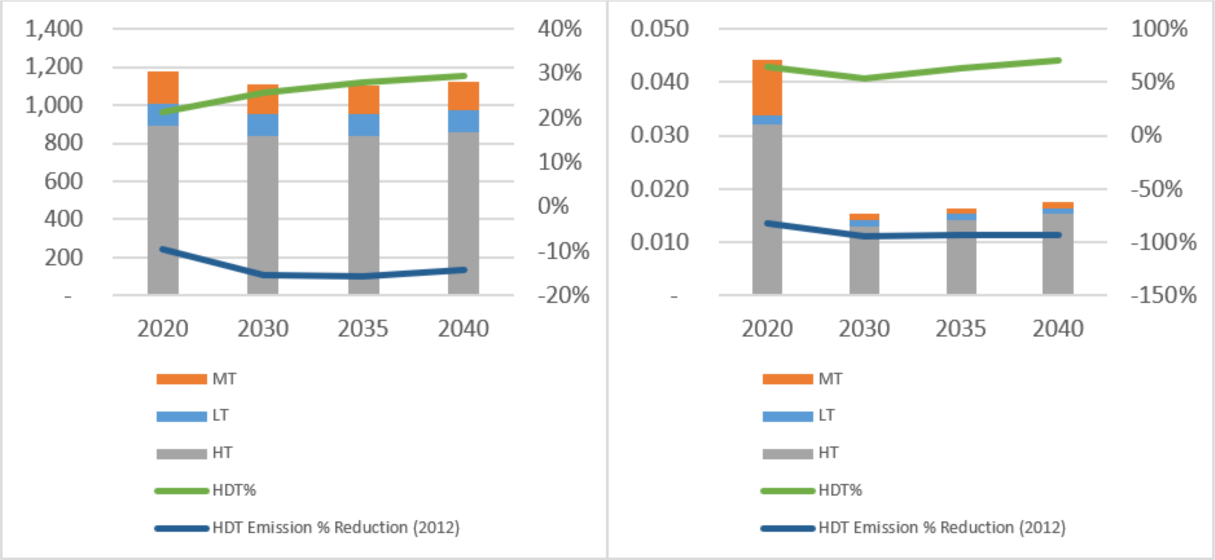
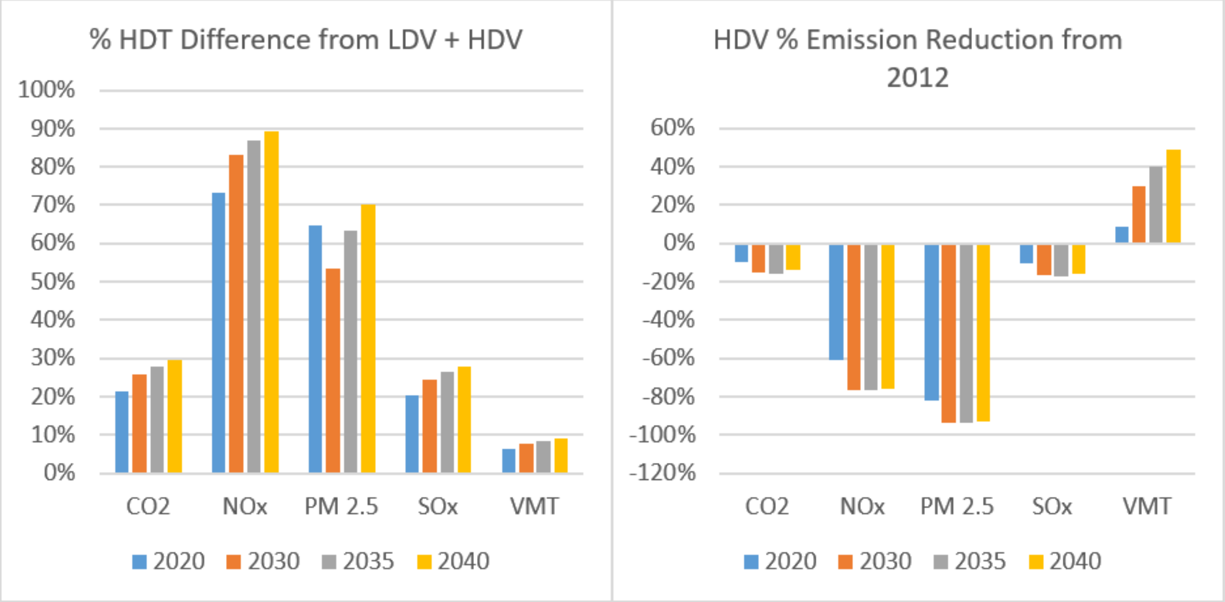


Figure 2-3: Expected changes across all emissions between 2020 and 2040



2.4.2 Scenario 2. Zero Emission Vehicles

In terms of vehicle technologies, the California Sustainable Freight Action Plan (CSFAP) proposed, back in 2016 (California Governor's Office, 2016), the goal of improving freight efficiency by reducing the overall emissions generated by the system, and the introduction of zero and near-zero emission vehicle technologies. Other state regulations have provided incentives to foster the use of these technologies and the associated infrastructure. More recently, the Air Resources Board approved the Advanced Clean Truck (ACT) rule which mandates that a percentage of new truck sales have to be zero emissions. ACT provides aggressive sales targets that could be above 50% for specific vehicle types by 2030, and increase significantly thereafter (see Table 2-4). However, considering the vehicle turnover rates, diesel trucks will continue to be the dominant vehicle type and full fleet renewal may net be achieved until 2050-2070.

Table 2-4: ACT Rule Manufacturer ZEV Sales Requirements

Model year	Class 2b-3	Class 4-8	Class 7-8 Tractors
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035+	55%	75%	40%

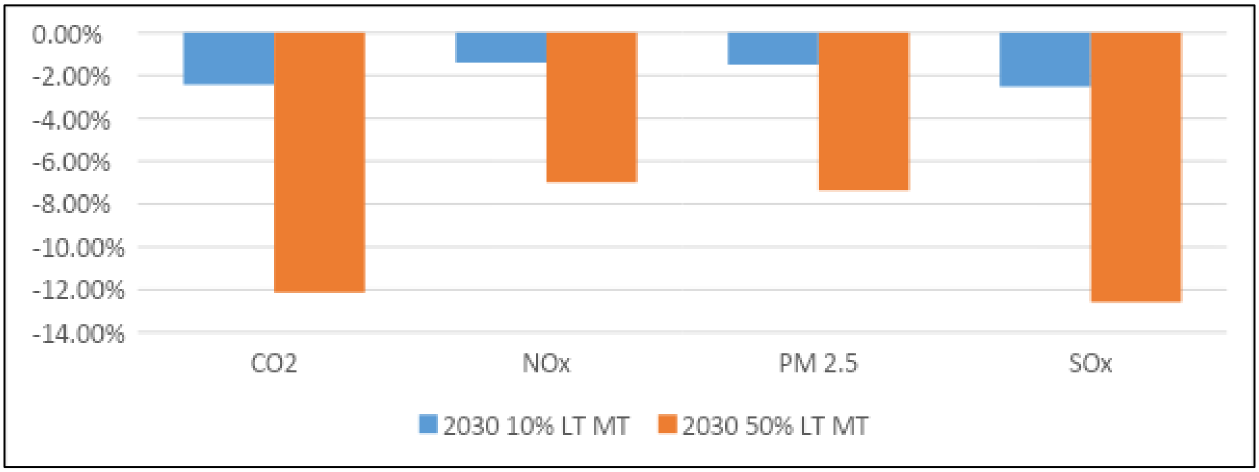
Considering the uncertainties about the implementation of the rule (at the moment, the rule limits to new vehicle sales, and discussions about a purchase mandate are just starting), the team evaluates the penetration of zero-emission vehicles (only considering battery electric vehicles or BEVs, and not fuel-cell vehicles) in two main approaches: incremental penetration of BEVs, and decarbonization scenario.

Incremental Penetration of ZEVs (Scenario 2a)

These scenarios consider different BEV fleet shares for the year 2030. These increments include: 10, 20, 30, 40, 50% BEVs for light- (LT) and medium-heavy (MT) duty for year 2030. And a scenario for 2040 in which, 75% for light and medium, and 50% for heavy-heavy (HT) duty trucks are BEVs. The team proportionally adjusted other vehicle fuel type shares. Due to the lack of emission rates information in EMFAC regarding some of the fuel technologies, the team adjusted various vehicle fuel type shares. It is important to mention that their shares represent about 3% of the total fleet, thus it is expected that the changes do not significantly impact the results. In Scenario 1a, the authors use EMFAC's fleet composition.

In this scenario, the reductions for NOx and PM2.5 are about half of the reductions in CO, CO2 and SOx (see Figure 2-4 for a comparison of results in SELA). Whilst the scenarios assume up to a 50% BEV share of the fleet, the emissions reductions are much smaller because the emissions contribution from LT and MT trucks is significantly lower than the emissions generated by the HT trucks in the region. For 2030, these scenarios did not include heavy-heavy duty trucks. On the contrary, the last scenario assumes a 75% share of LT and MT, and 50% for HTs. In this case, emissions reductions are in excess of 50%. These results are important for 2 main reasons: 1) achieving larger reductions requires affecting a smaller number of HT vehicles, which travel longer distances within the region; however, 2) achieving cost and technical specification for HT vehicles from BEVs is more difficult because of the interactions between range, cost, and battery weights, among other critical factors. Nevertheless, new and old vehicle manufacturers have made recent claims about new vehicle options to hit the market, and more and more States will follow California to push to electrify trucks and buses. It is expected that these pressures will foster not only rapid and new development, but also fleet adoption.

Figure 2-4: Scenario 2a. Battery Electric Trucks (SELA 2030)



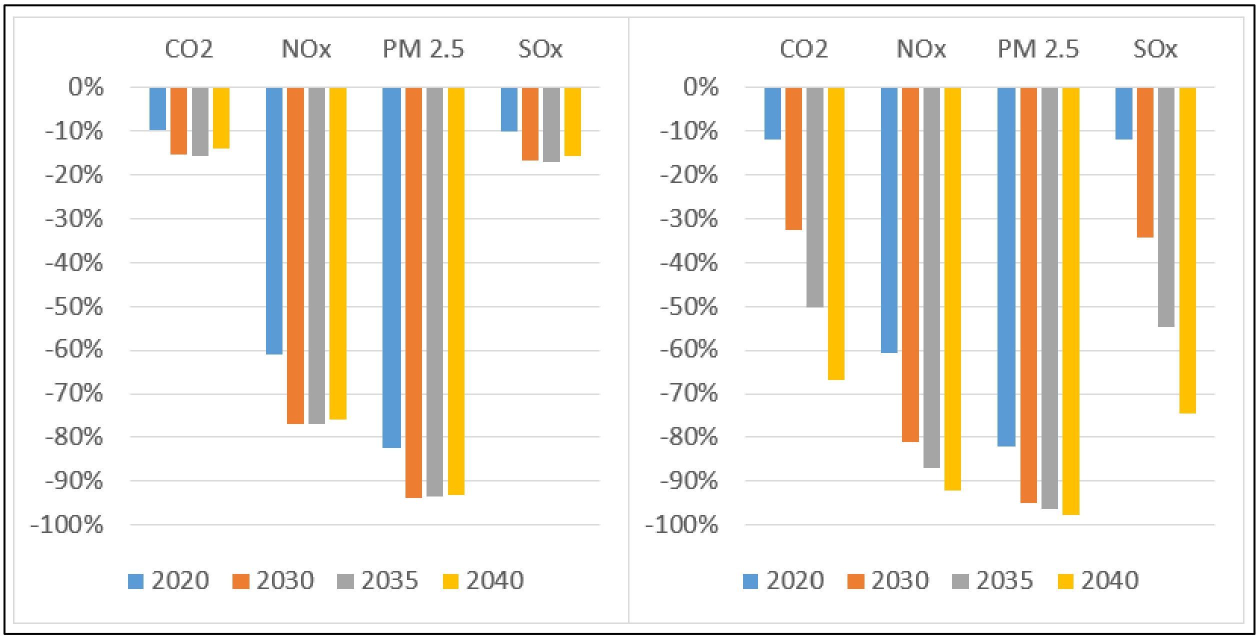
HT + Highway inside SELA (Scenario 2b)

The next scenario quantified the changes along the main infrastructure inside SELA. The results show that, the estimated reductions experienced along the major infrastructure are about a third of the reductions throughout the entire SELA area.

Decarbonization Scenario (Scenario 2c)

In this scenario (2c), the authors used the most recent fleet composition projections for the various planning years resulting from the 2045 decarbonization project. The scenario results (see Figure 2-5) consider new vehicle technology transitions, and currently adopted regulations (e.g., ACT).

Figure 2-5: Comparison between BAU (left) and Scenario 2c (right) Emission Reductions from 2012



This scenario shows that by 2030, emissions reductions could be around 20%, and reaching reductions up to 70% by 2040. These are significant emissions reductions towards decarbonization plans across the state. The results are consistent between SELA and the overall SCAG region. It is important to recognize that it will be harder to reduce emissions further. Besides significantly reducing on-road emissions, it will be necessary to improve freight system efficiency to achieve additional gains by improving processes and freight operations.

2.4.3 Scenario 3. Operational Improvements and Spatial Analyses

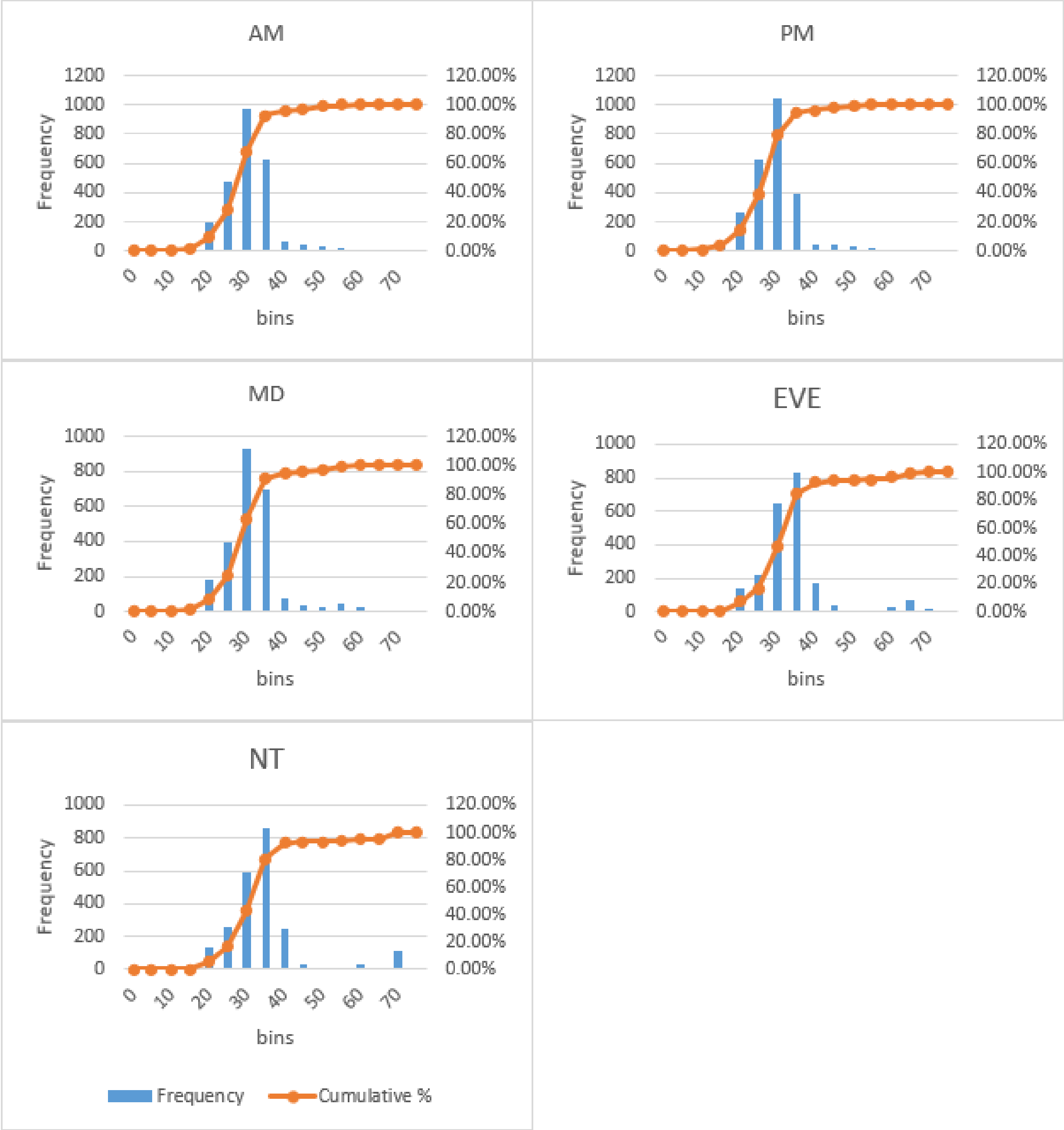
Off-hour Transport (Scenario 3a)

Off-hour delivery operations have seen their application in both short-haul and last-mile deliveries. For example, the Ports of Los Angeles and Long Beach, implemented the PierPASS program back in 2005, to address issues related to safety, congestion, and air quality. The program provided additional shifts at the international container terminals. To incentivize the use of the additional off-peak shifts, and to help cover the costs of operating the shifts, a Traffic Mitigation Fee (TMF) was implemented to peak movements between 3 a.m. and 6 p.m. Overall, the program shifted about 48 million truck trips from the peak hours. For last-mile deliveries, off-hour delivery programs have been pilot tested or implemented in various cities in the U.S. and abroad (e.g., Europa and Latin America), achieving emission reductions and increasing freight efficiency during the documented implementations. Therefore, the authors considered the evaluation of the potential impacts of additional shifts to off-hours of the existing flows in the BAU. It is important to mention that these approximate first-order analyses rely on simulation outputs from the baseline. The improvement effects during the peak-hours due to reductions in truck traffic to the overall impacts are underestimated as the results do not account for network improvements from flow reductions. Similarly, there are limitations during the off-hour estimates, as the results do not account for the potential reductions in level of service once the traffic shifts. Nevertheless, the results of analyzing shifts can indicate the potential of this measure and the need to conduct additional research.

The team used the TOD truck distributions in the SCAG model as the reference point from Table 2-1, and generated a number of scenarios that assume truck traffic shifts from peak hours to off-hour periods. The scenarios assume constant shift for the three types of trucks and are modeled for the year 2020.

See APPENDIX B for the results of the various simulated shifts in truck traffic to the evening and night periods. Considering the limitations in the evaluation process previously mentioned, the results only show very minor improvements (except for PM 2.5). Despite these results, it is important to consider the benefits from shifting traffic in space and time. Off-hour deliveries type programs have generated significant improvements when implemented. Moreover, when models have been developed to explicitly simulate the impacts of such programs, the results are significantly positive**.** To identify further impacts from the simulations in this scenario, the authors analyzed the system vehicle speeds in the various time periods. Figure 2-6 shows the histograms and cumulative distribution of link-speeds. The analysis of the speeds show that in the AM peak, average speeds are 28.08 mph, 26.52 mph in the PM peak, and 28.88 mph, 31.39 and 32.33 mph in the midday, evening and night time periods, respectively.

Figure 2-6: Summary of Speed Profiles in the Region for the Various Time Periods



Based on these average speeds, the authors estimated the potential emission reductions by analyzing the impact of speed improvements (as found in off-hour delivery project implementations). Considering an average of 5 mph and 10 mph speed improvements on the network because of the shifts in truck traffic to the less congested time periods, Table 2-5 shows the potential emissions reductions. The impacts could be between 5% and 30% for GHGs, and between 15% and 35% for NOx, among other improvements. Nevertheless, the development of detailed models would allow for the accurate estimation of these impacts.

Table 2-5: Speed Improvement Impacts on Emissions

		CO2	CO	NOx	TOG	ROG	N2O	CH4	PM10	PM2.5	SOx
5 mph	LT	-5%	-9%	5%	-15%	-15%	-1%	-16%	-11%	-11%	-5%
	MT	-9%	-12%	-11%	-18%	-18%	-9%	-18%	-5%	-5%	-9%
	HT	-7%	-21%	-12%	-22%	-22%	-7%	-24%	-5%	-5%	-7%
10 mph	LT	-8%	-12%	12%	-23%	-23%	-3%	-24%	-17%	-17%	-8%
	MT	-15%	-18%	-19%	-30%	-30%	-16%	-29%	-5%	-5%	-15%
	HT	-15%	-36%	-25%	-37%	-36%	-15%	-42%	-4%	-4%	-15%

Geo-fencing Simulation in the SELA Region (Scenario 3b)

The team used the multi-class generalized cost traffic assignment model previously developed to conduct further analysis in the SELA region, and complement the results in (Jaller et al., 2021). Overall, the model considers different types of vehicles (e.g., LDA/LM or light-duty, and HDT heavy-duty). In terms of costs, the model includes four main types of costs: *i)* distance ($/mile); *ii)* time ($/hr), *iii)* distance, time and energy (fuel in $/liter), and *iv)* emission factor (criteria pollutants or GHGs in $/kg). Table 2-6 shows examples of the costs for the various factors.

Table 2-6: Emission and Fuel Costs

Parameter	Vehicle	Cost
Fuel consumption		
FC	LDA	\$0.994/liter [a]
	HDT	\$1.051/liter [a]
Criteria Pollutants (CPs)		
CO	LDA / HDT	\$0.199/kg [b]
NO_x	LDA / HDT	\$79.28/kg [b]
PM	LDA / HDT	\$649.2/kg [b]
Green-House Gases (GHGs)		
CH_4	LDA / HDT	\$1.781/kg [c]
CO_2	LDA / HDT	\$0.068/kg [c]
ROG	LDA / HDT	\$4.925/kg [b]

Results from constrained OLS accounting for continuously differentiable, monotonically non-decreasing, and strictly positive properties of the generalized cost function.

[a] AAA Gas Prices (n.d.)

[b] Caltrans (2017)

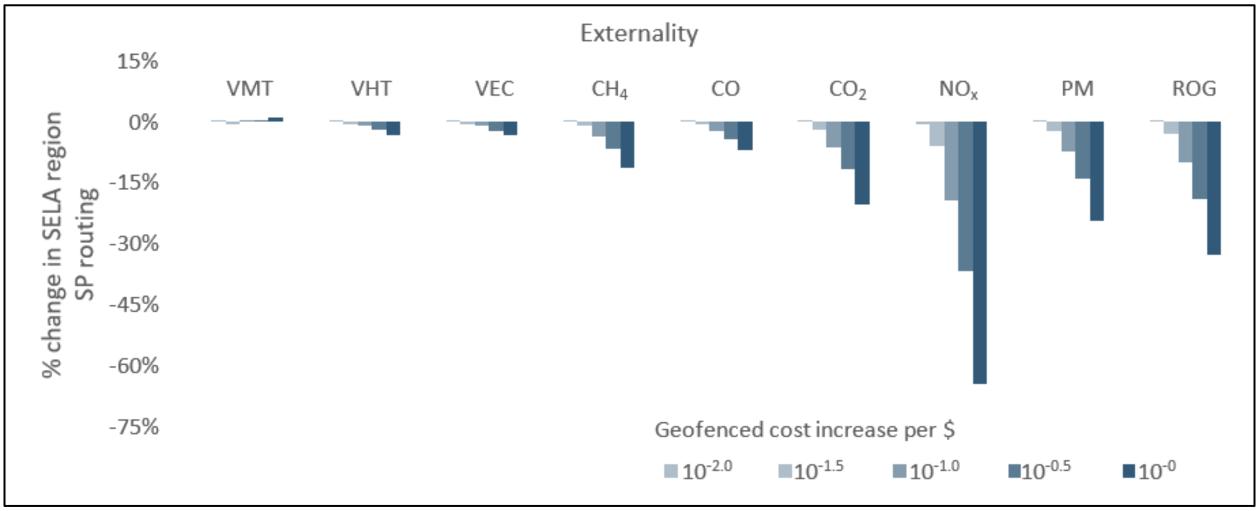
[c] Environmental Protection Agency (EPA) (2019)

Consistent with the previous analyses, the work uses the OD matrices from the SCAG model as a reference; however, in this case, the study performs a multi-class traffic assignment considering LDA and HDT. The emission factors are the average from EMFAC for the various vehicle types in the specific vehicle category. The study establishes the base case by finding the equilibrium under the following scenarios (in all scenarios LDA vehicles are routed under time based equilibrium):

1) Distance as base case (SP routing). Under this scenario, HDT vehicles are routed so as to find equilibrium based on distance costs for the base case. Afterwards, HDTs are routed using all of the other factors as objectives (e.g., VHT, VCE, PM, etc.).
2) Time as base case (FP routing). Similar to before but now the base case refers to vehicles routed using time as an equilibrium objective.
3) Distance, time and energy as base (LCP routing).

Afterwards, the study geofenced the SELA region within SCAG. In doing so, the authors increased the cost for the specific factors inside the geofenced area (with cost remaining unchanged elsewhere). It is important to acknowledge that preliminary analyses found that the emissions costs (externalities) are very small compared to the (direct/internalized) time, distance and energy costs; thus, private operators may not have a strong incentive to minimize such externalities as the additional internal costs (VMT, VHT, or VCE) could be larger than the costs reductions in externalities. Consequently, the study conducted sensitivity analyses about the change in such costs. Figure 2-7, Figure 2-8, and Figure 2-9 show the percent change in the various factors under different cost changes. For example, a 10^{-0} cost increase refers to the increased cost based on the initial costs from Table 2-6, i.e., base_cost*($1+10^{-0}$) = base_cost * 2, and a 10^{-5} increase is a 1.00001 multiplier of the cost.

Figure 2-7: Changes using Distance Based (SP) Routing as Reference



The results show significant reductions in some of the criteria pollutants compared to the GHG factors at different levels of the cost increase. The scenarios only show cost increases up to 100% from the base cost. At these extreme levels, the reduction in externalities could be between 60-80% for NOx, and up to ~25% for other pollutants. These reductions in externalities are only associated with modest increases in VMT, VHT, or VEC.

Moreover, the team analyzed the potential unintended consequences of the geofence. Whilst there were increases in some factors in other locations throughout SCAG, they were not concentrated on any specific location, thus not creating a disproportionate impact elsewhere.

Figure 2-8: Changes using Time Based (FP) Routing as Reference

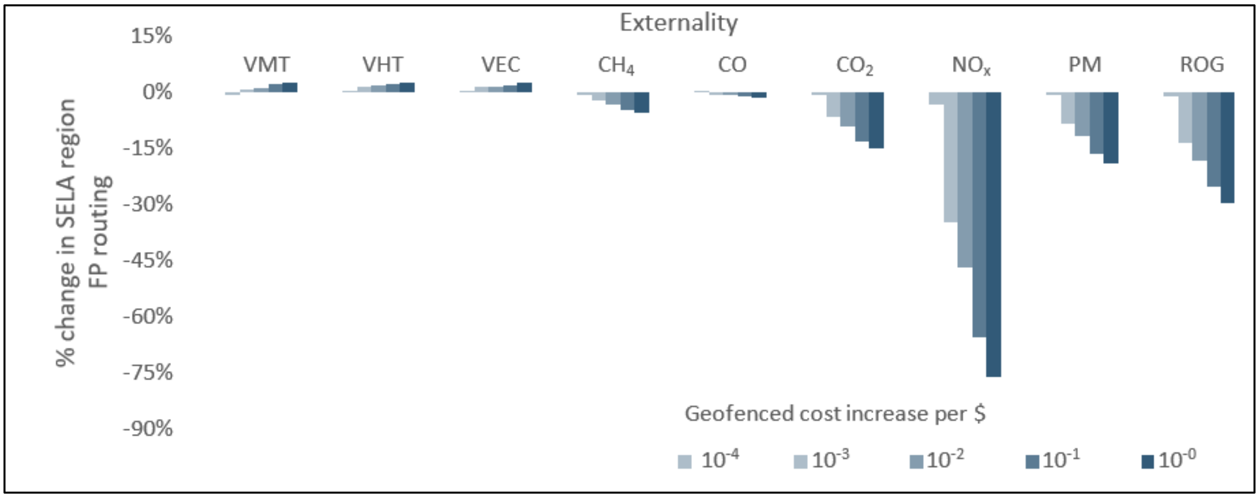
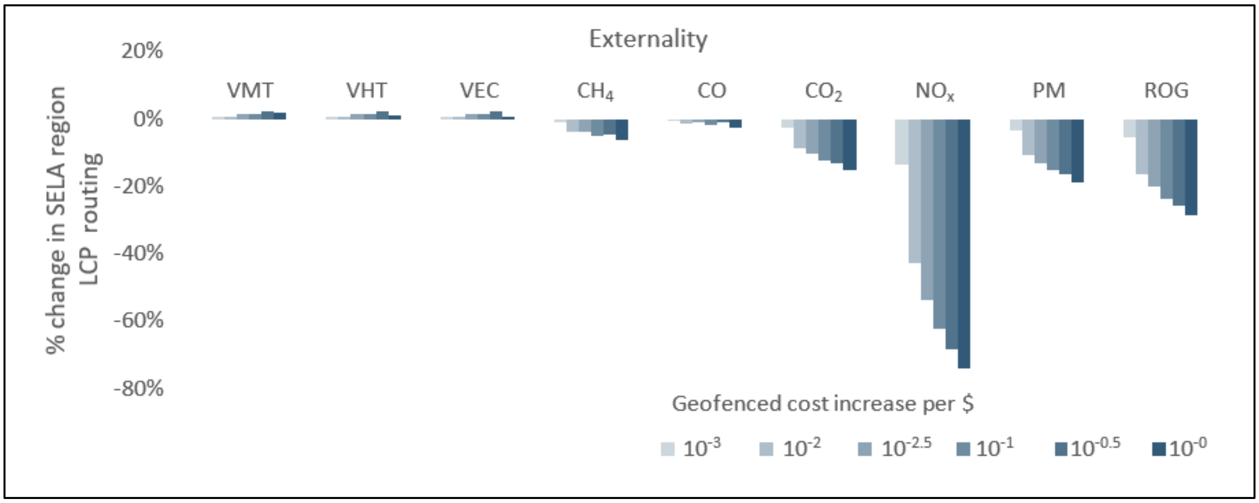


Figure 2-9: Changes using Distance, Time and Energy Based (LCP) Routing as Reference



2.5 Discussion

This study quantified the potential reductions in emissions in SELA from the implementation of vehicle technology related and other operational strategies. Additionally, the work evaluated the changes in emissions for the region resulting from ongoing regulations targeted at incentivizing the adoption and use of such vehicle technologies. Overall, there results show that:

1. There will be significant reductions in overall emissions from ongoing efforts such as AB-32, LCFS, On-road heavy duty diesel vehicle in-use regulation, Clean Air Action Plan, and the CSFAP, among others. This was shown with the reductions evidenced through Scenario 1.

2. Recent aggressive policies such as the ACT rule will have further benefits. The results from Scenario 2a and 2c show:
    - 30% + reductions in CO2
    - 90% + reductions in PM 2.5

3. The successful implementation of these strategies:
    - Requires uniform penetration across all vocations, and industries;
    - The use of continuous programs that offer incentives (monetary and non-monetary) to help during the transition and to foster an equitable distribution of benefits;
    - Overcoming technical limitations of ZEVs related to load capacities, and ranges, for specific vocations.
4. While most of the strategies are based on vehicle technologies with significant reductions in emissions, and potential health benefits, the truth is that ZEVs do not necessarily contribute to improving safety or reducing other non-emission externalities.
    - VMT will almost double in the next 20-30 years.
    - The SELA community prioritized safety over air quality.
5. Geofencing could reduce externalities inside SELA under large pollution charge scenarios for Diesel trucks [Scenario 3b]
    - ~60-80% reductions for NOx, and up to ~25% for other pollutants;
    - These reductions modestly increase VMT, VHT, or fuel consumption, inside the region, and do not generate disproportionate impacts outside the geofence.
6. Other scenarios [Scenario 3a] showed modest improvements in emissions by off-hour programs; however, there were limitations to fully assess the impacts of such programs.

Chapter Three: Mitigating Local Impacts of Freight

3.1 Introduction

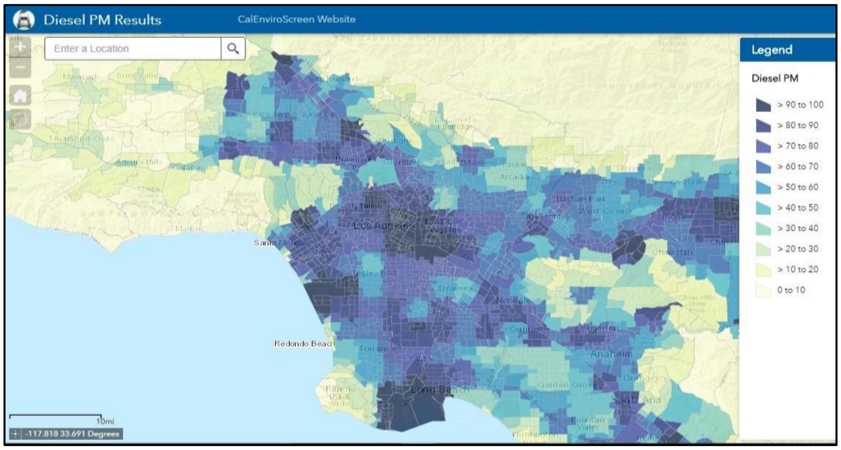
Chapter Two presented a region level analysis of truck traffic and showed how existing and planned regulations will affect the SELA area. This chapter takes a more disaggregated approach and examines the localized impacts of heavy duty truck traffic within the SELA area. We summarize community perceptions, then present a brief analysis of truck traffic within SELA. We then conduct an analysis of the safety impacts of heavy trucks. We conduct a hot spot analysis that identifies 5 priority locations for truck safety improvements. We then conduct a traffic simulation to test options for safety improvements at one of the priority locations.

3.1.1 Freight Activities in and around the SELA Area

SELA has large pockets of residential areas impacted by the volume of freight activity. Not only is SELA a central hub for Los Angeles based freight (warehouse-to-retail and direct-to-consumer delivery), it is also a major hub for international and nation-wide trade. The largest import facility in the US – the twin ports of Long Beach and Los Angeles – are located directly south. The Hobart intermodal train facility for BNSF is located in the northeast corner of the SELA area. The volume of freight traffic is estimated at 14,000 – 20,000 heavy-duty trucks per day on the I-710, I-5, I-10, I-105, and SR-91 freeways. (Port Statistics - Port of Long Beach," n.d.; "The Port of Los Angeles | TEU Statistics (Container Counts)," n.d.) These trucks emit fine particulates and other toxins into the environment creating numerous health risks for the people living and working in SELA. When inhaled over a period of time, diesel particulate matter (PM) can cause cardiovascular and pulmonary disease, asthma, and lung cancer (Office of Environmental Health Hazard Assessment, 2021).

A diesel particulate matter (PM) map (Figure 3-1) of Los Angeles shows that 80% of the SELA area is heavily impacted with PM values greater than 70 kg/day. The heaviest concentrations in navy blue are found at the ports and downtown Los Angeles/Hobart, followed by slightly lower concentrations along the major transportation corridors in and surrounding SELA.

Figure 3-1: **Diesel particulate matter (kg/day) indicator map of Los Angeles region from CalEnviroScreen4.0.** *("Draft CalEnviroScreen 4.0," n.d.)*



3.2 Community Perceptions of Truck Traffic

The freight research team had originally intended to focus on reducing health and environmental impacts of heavy truck traffic. It was assumed that the top priority of SELA residents would be environmental concerns, but this turned out not to be the case. A focus group held in October 2019 revealed that truck-related safety was a greater concern. The focus group facilitator began with pictures of trucks and asked what came to mind with the pictures. See Figure 3-2. The focus group revealed that safety was the primary concern related to truck traffic. Participants spoke about the overwhelming presence of trucks on streets causing anxiety and fear, especially about truck visibility to other cars or pedestrians. Participants related personal experiences of truck involved crashes (including pedestrian deaths), expressed fear of driving near trucks. and cited examples of dangerous driving by trucks. Others related how they avoided driving near trucks and cautioned family members not to travel on certain roads. Residents were weary of the vast numbers of trucks in areas where children walked to and from school. While air pollution and its impacts were also discussed, it became clear that the freight study would have to include safety. The research was restructured accordingly.

Figure 3-2: Focus Group perceptions

What comes to mind when you see this?

Fear-Safety-Accidents-Pedestrians at risk-Noise

Stories
- Truck jumped a curb
- Trucks on residential streets
- I don't drive where there are lots of trucks
- Children at risk walking to school

3.3 Truck traffic in SELA

A reasonable proxy for truck-related air pollution is the intensity of truck traffic within SELA. For the freight volume analyses, data from the SCAG travel demand model were used. The spatial units of the SCAG model are the Traffic Analysis Zone (TAZ), which are roughly the size of census tracts. There are 216 TAZs within and intersecting the SELA area, and 4,109 TAZs across the entire region. The data includes the origin-destination trip table, the input, and the 'loaded' network volumes following the equilibrium run of the model. The 'loaded' network refers to the estimated/projected volumes along each link in the model and is aggregated by time of day (AM, Midday, PM, Evening, Night). We sum network volumes for all times of day to generate 24-hour volumes for a typical weekday.

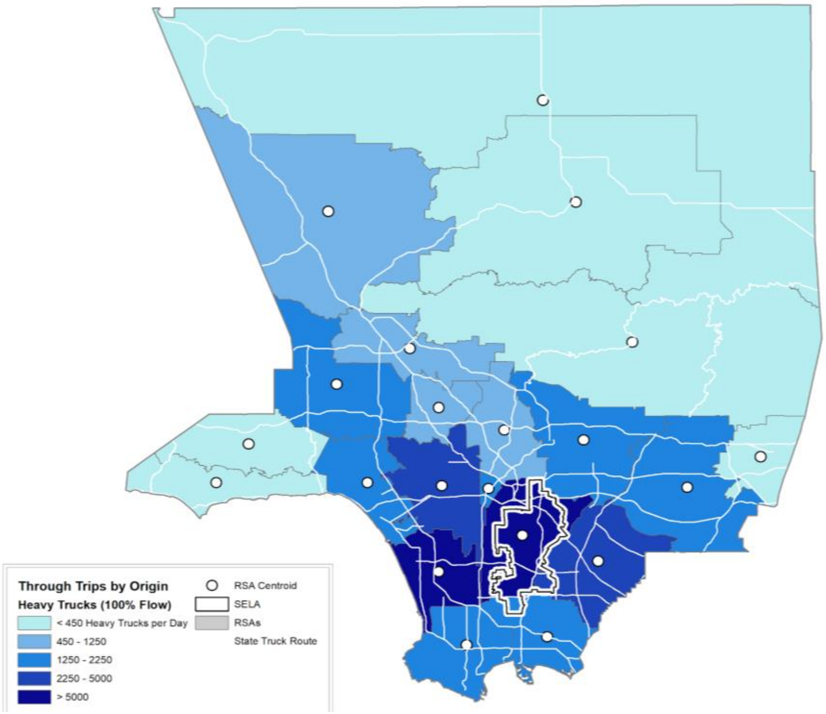
We examine truck traffic in two ways. First we look at the source of traffic: is most of the truck traffic serving freight activities within SELA, or is it mostly through traffic? Second, we look at where truck traffic is concentrated within SELA. Because many of the TAZs in the SELA area are traversed by freeways of through-trip freight volumes, we analyze truck traffic patterns in SELA both with and without freeways.

3.3.1 Sources of Traffic within SELA

Truck traffic associated with freight activities within SELA have some benefit attached, as they represent jobs and economic activity. Through trips generate only costs in the form of local pollution and health impacts. We use the SCAG data to identify three categories of truck trips: trips with both origin and destination within SEKA, trips with either origin or destination within SELA, and trips through SELA. The SCAG truck origin-destination allows to easily identify the first two categories of trips. However, we do not have data on the route or path of individual trips or O-D pairs.

To estimate through traffic we aggregated the O-D matrix to Regional Statistical Areas (RSA) for all TAZs outside of the SELA area. Linear desire lines from the centroid of each RSA to the centroid of every other RSA was then generated using 'Transportation' package coding in R. Each desire line, representing a trip from one RSA to another, was assigned the flow volume from origin RSA to destination RSA. Given the grid-like pattern of truck routes in the Los Angeles region we assume that desire lines adequately represent the general travel patterns of freight. The resulting desire lines were intersected with the SELA region using ArcGIS, yielding the projected through volumes caused by regional freight patterns. Figure 3-3 maps the sources of through traffic. SELA is crisscrossed by 4 east-west freeways (SR 60, I-10, I-105, and SR-91) and two north-south freeways (I-5 and I-710) making it a major draw for through traffic. Much of the through traffic is coming from nearby RSAs that have a lot of freight-related activity (e.g. manufacturing, warehousing, transportation).

Figure 3-3: Through trips by RSA of origin



Our method for estimating through trips is an approximation; some trips may use parallel facilities just outside the SELA borders. We therefore estimate through trips with 3 alternative assumptions: for a desire line that traverses SELA 100%, 80% and 60% of the estimated flow travels through SELA. Results are given in Table 3-1.

When considering freight travel happening only within SELA, that is, trips that both begin (origin) and end (destination) within SELA, the total trips across all three truck categories account for about 2% of all regional trips. This was expected to be the lowest number in the analysis due to the short distance of these types of trips. Within the model, a major assumption that was found to be utilized was that origin trips and destination trips for each TAZ are in equilibrium—the number of origin trips equal the number of destination trips; the number of trips generated equal the number of trips attracted. This assumption is highly unlikely to be true, but it is necessary as the formula estimating freight trips are partially based on the employment number in the manufacturing, warehousing, and distribution job categories. Because of this assumption, the number of truck trips that originate in SELA are in equilibrium with the number of truck trips that end in SELA. Together, the share of regional origin and destination trips in SELA are 7.7%. Depending on our alternative assumptions, somewhere between 6.7 and 11% of all the region's truck trips travel through the SELA area. Adding all categories together we get a range of 16 to 20% of all regional truck trips beginning, ending, or traveling through the area, or over 200,000 truck trips per day.

Table 3-1: Share of truck trips in SELA area

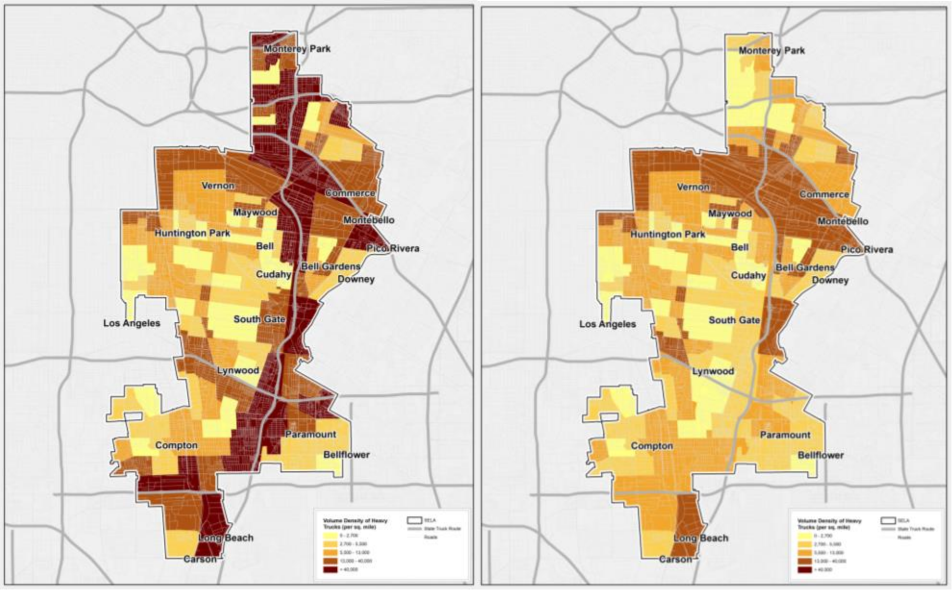
Trip Sum Type	All Trucks	Percent Regional Trips
O-Ds Within SELA Trips	17,727	1.89%
SELA Origin Trips	36,123	3.85%
SELA Destination Trips	36,110	3.85%
Trips Through SELA (100% of Estimated Flow)	104,839	11.17%
Trips Through SELA (80% of Estimated Flow)	83,871	8.94%
Trips Through SELA (60% of Estimated Flow)	62,903	6.70%
All Regional Trips	938,381	100.00%

We compared truck activity in the SELA area to Los Angeles County to determine whether SELA truck traffic is disproportional. We computed truck volume density: truck trips per day per square mile of area for both. The average truck volume density in SELA including freeways is approximately 40,000 trucks/day/sq. mile compared to the regional volume density of approximately 25,500 trucks/day/sq. mile. The average truck volume density in SELA without freeways is approximately 14,000 trucks/day/sq. mile compared to the regional volume density of approximately 9,000 trucks/day/sq. mile. Clearly the SELA area is disproportionately impacted by a higher average volume density than the region with or without freeway volumes.

3.3.2 Truck Traffic within SELA

We also calculated truck volume density for the TAZs within SELA. See Figure 3-4a and b. The color scale is the same for both map so can be directly compared. The I-710 corridor stands out (Fig 3=4a); it has the highest share of heavy truck traffic among all of the region's freeways. Other concentrations follow the I-5, I-105, and SR 91. When we remove the freeway traffic the main truck trip generators are revealed: the I-5 industrial zone that includes Hobart Yards, along the I-710 to the east of Southgate, and near the border with Long Beach to the south, the latter being major warehouse zones. Finally there is some concentration along Alameda street which has significant manufacturing and warehouse activity. The key findings from our truck traffic analysis are that the SELA area experiences a disproportionate share of the region's truck traffic, much of the traffic is through traffic due to the many freeways crossing the area, and there are clear concentrations of truck activity within SELA.

Figure 3-4 a and b: Truck volume density with freeway traffic (a), without freeway traffic (b)



3.4 Truck Related Traffic Safety

Given the findings from our first focus group we conducted a crash analysis to determine whether truck-related crashes are disproportionately high in the SELA area and to identify and evaluate safety hot spots. The crash analysis used four years of data (2015-2018) from the Transportation Injury Mapping System (TIMS), which consolidates Statewide Integrated Traffic Records System (SWITRS) crash data collected by the California Highway Patrol. Both highway and street crash data are included. Truck-pedestrian, truck-other vehicle, and truck-property records were extracted from the database. The analysis is restricted to heavy duty trucks (class 7 or higher). Table 3-2 gives SELA crash rates vs City of LA and LA County. SELA has a higher rate of truck incidents on a square mile basis and higher fatalities as a percentage of the total than the other areas (data not available to calculate crashes per miles traveled).

Table 3-2: Heavy duty truck involved crashes 2015-2018

	SELA Area	City of Los Angeles	Los Angeles County
Total Crashes	743	2,674	7,935
Crashes Per Sq.Mi	11.4	5.7	2.0
Total Fatalities	24	62	232
Fatalities/Crash	3.2%	2.3%	2.9%

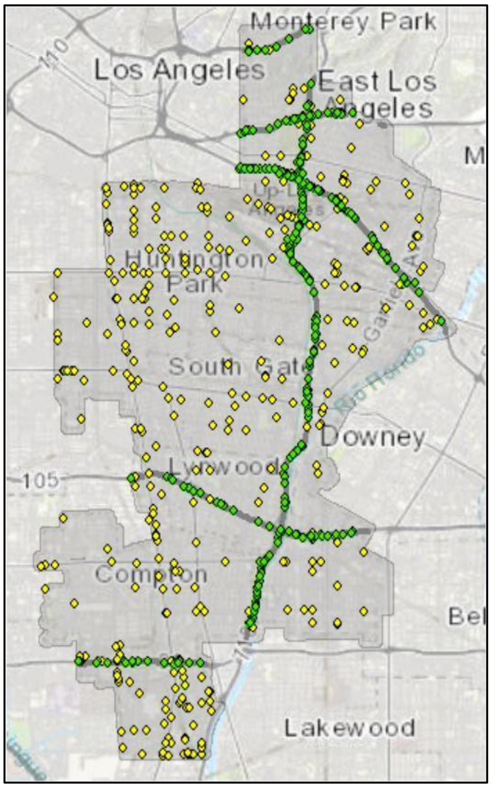
3.4.1 Geography of Crashes

All crashes in SELA are shown in Figure 3-5 including both freeway and non-freeway incidents. A total of 743 crashes were recorded in 2015-2018. More crashes occurred on the arterials (55% of total) than on the freeways (45%) For this analysis, we use the term freeway and highway interchangeably. A freeway is defined by ramp access and grade separation that allows drivers to pass through junctions without stopping. In the SELA area, highways include Interstates 710, 5, and 105, and State Routes 91 and 60. Ramps and highway interchanges are considered a part of this network, so any crashes on these road structures are deemed “highway.” Non-separated State Routes (like CA 47, Alameda Street) are not classified as highways since they do not have controlled access. Freeway crashes are rather evenly distributed along all the freeways. The northern portion of the I-710 and intersections with I-5 and I-10 have the greatest concentration. This area is one of the most congested bottlenecks in the system.

Arterial crashes are concentrated along Alameda street on the west side of SELA, in the warehouse district in the south, and along major arterials in manufacturing and warehousing areas to the north. As will be further discussed below, Alameda street has particularly problematic geometrics.

Highway and non-highway crashes show similar but not identical patterns. Street crashes tend to be deadlier overall. Speed is the #1 cause of crashes on both road types, but slightly less people are injured per accident on highways than non-highways (1.25 versus 1.29 people per crash). Total fatalities as a percent of crashes are 2.3% on highways and 3.9% streets (3.2% overall).

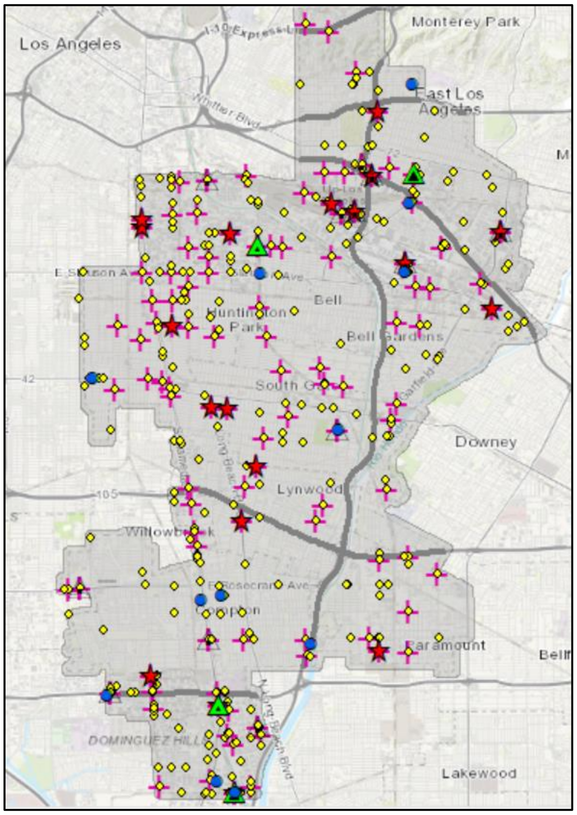
Figure 3-5: Location of heavy-duty truck crashes 2015-2018



ArcMap by Environmental Systems Research Institute, Inc.

To better reflect the local experience with trucks, we eliminate crashes on freeways and examine crashes on arterials. Figure 3-6 maps these crashes by type (fatal or severe, pedestrian involved), frequency (number of crashes in same location), and location (intersection or other). Of these crashes, 31% occur at intersections, and 12 locations have more than one crash recorded. Figure 3-7 give the heat density map for the same data. Statistically significant spatial clusters of arterial truck crashes (darker blue sections) are located in the City of Rancho Dominguez, BNSF intermodal yard, the I-5 and I-710 interchange areas, and Alameda Street.

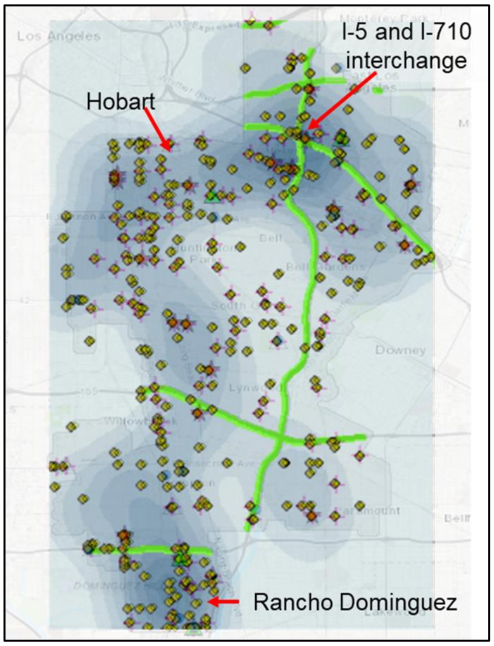
Figure 3-6: Heavy-duty truck crashes (excluding freeways) by frequency and type



★	Fatal or severe crashes
●	Pedestrians involved
✚	Crash at intersection
△	2 crashes at same location
▲	3 crashes at same location
▲	4 crashes at same location
●	All other street crashes

ArcMap by Environmental Systems Research Institute, Inc.

Figure 3-7: Heat map of heavy-duty truck crashes (excluding freeways)

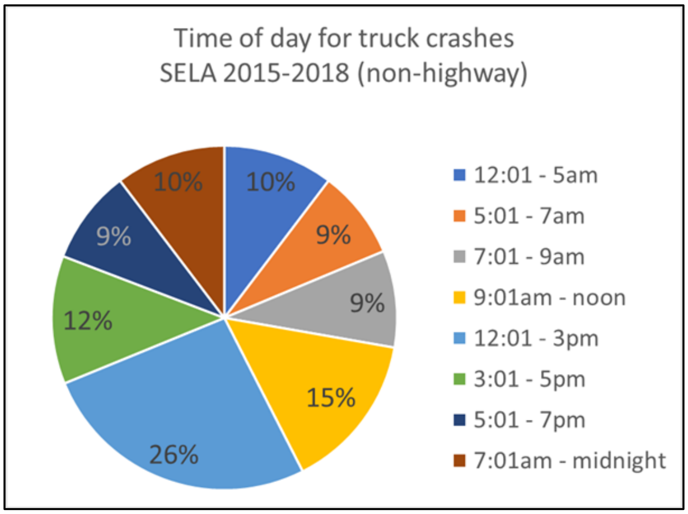


ArcMap by Environmental Systems Research Institute, Inc.

3.4.2 Characteristics of Crashes

As expected, crashes happen during the week (82%) much more often than the weekend (18%) since that is when truck volume is heaviest due to business operating hours. As shown in Figure 3-8 over 50% of crashes occur during regular business hours with most occurring in the afternoon between noon and 3 pm (26%) when children are getting out of school. Surprisingly, 10% of crashes occur between midnight and 5 am when traffic is very light.

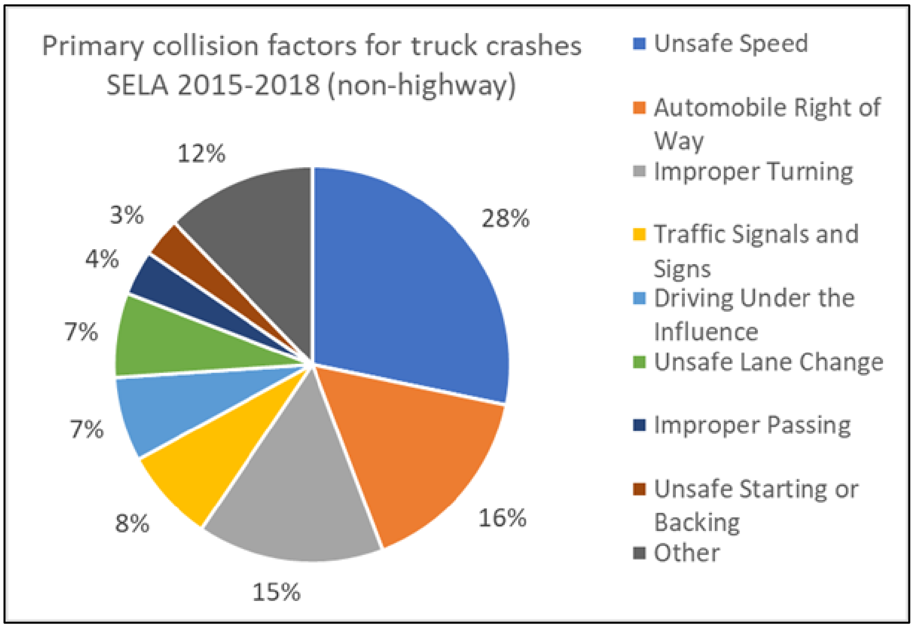
Figure 3-8: Share of non-highway truck crashes by time of day



Fatal crashes are rare events; a total of 16 fatalities were recorded over the 4 year period. Injuries ranged from 113 to 147 annually. A small number of crashes involved pedestrians (25 of 407, 6%) but made up 38% of the fatal crashes. Of these pedestrian accidents, 42% occurred at legal intersections. Causes of truck crashes can shed light on potential remediation strategies. For truck collisions, unsafe speed was the top reason for crashes followed by crossing the right way of another vehicle and improper turning. Combined, these account for 59% of all accidents. See Figure 3-9.

The data provide insight into where crashes are taking place, when, and why. The next step is to physically canvas specific neighborhoods and observe truck behavior to recommend mitigation strategies. This process is described in the next section.

Figure 3-9: Share of primary collision factors, non-highway crashes



3.5 Hotspot Analysis: A Spatial Evaluation of Truck Crash Data, Freight Volume, and Land Use in SELA

We extend our crash analysis by considering not only the frequency and distribution of crashes but also risk or vulnerability. For example, all else equal, streets with high pedestrian traffic may be at higher risk for pedestrian crashes. Streets with school crossings pose a greater hazard for children traveling to school. We wanted to identify particularly dangerous locations to recommend mitigation efforts for both localized air quality and traffic safety issues. Three separate analyses were completed first—each utilizing a different theory for what factors were important to both the community and the key stakeholders in SELA. Initially, these three separate analyses were to be compared only, but in the end were combined into a comprehensive analysis considering all factors and concerns found in initial analyses and from community engagement.

3.5.1 Identifying Hot Spots

The first analysis took an approach that only considered traffic crashes, prioritizing community concerns of traffic and pedestrian safety over air quality concerns. The main findings are as described in the previous section. One-third of the crashes occurred at intersections, while twelve different locations had multiple crashes—likely due to multiple factors of heavy traffic congestion and geometric design issues. However, looking at crashes gives an incomplete picture of risk. We don't know the root causes of the crashes.

The second analysis considered crashes along arterial corridors throughout the SELA area to understand how corridors function rather than singular intersections. By considering corridors, it was possible to understand how land uses and traffic operations may increase or decrease the prevalence of traffic crashes. The top ten corridors by number of crashes were identified. See Table 3-3. The Alameda Street corridor had the most crashes of any other corridor in SELA, with 24 crashes during the 4 year period. The corridor with the next highest number was Firestone Boulevard with 17 crashes. Atlantic Avenue and Sante Fe Avenue followed with 16 crashes. The results of this analysis, not surprisingly, would align closely with the final comprehensive hot spot analysis since land uses tend to align with corridor type.

Table 3-3: Top ten crash arterial corridors

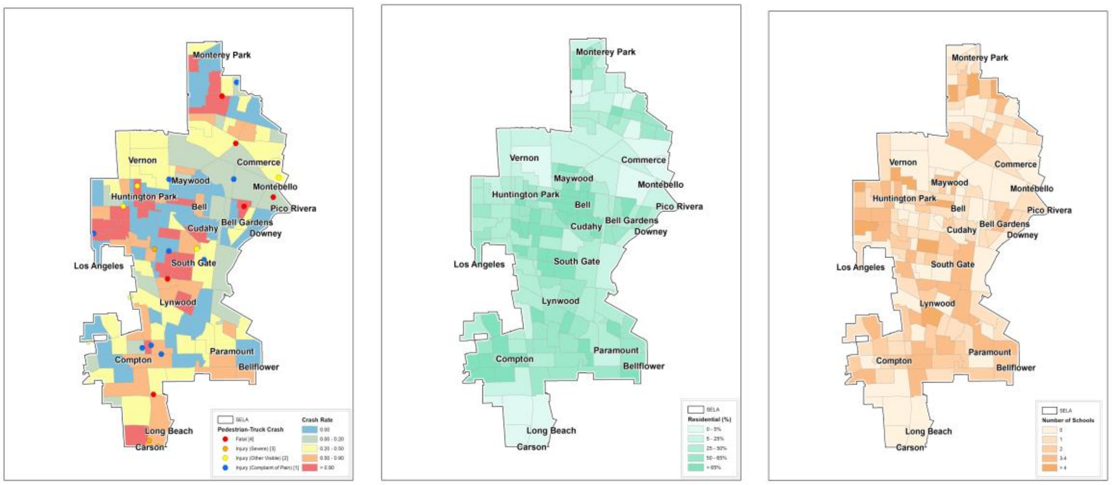
Street	No.of crashes
Alameda St.	24
Route 42 (Firestone Blvd.)	17
Atlantic Ave.	16
Santa Fe Ave.	16
Garfield Ave.	13
Artesia Blvd.	12
Gage Ave.	10
Slauson Ave.	9
Washington Blvd.	9
Route 47 (Alameda St.)	7

The third analysis utilized a set of evaluation criteria and mapping at the TAZ geography. The set of evaluation criteria is meant to address the needs of the community as expressed during the community engagement process while also addressing the goals of this study. There are eight different evaluation criteria used in the final scoring for each TAZ:

1. Freight volume density
2. Crashes per 1 million HDTs
3. Number of severe crashes
4. Number of pedestrian related crashes
5. Share of residential land use/all land use
6. Share of commercial land use/all land use
7. Share of public space land use/all land use
8. Number of schools

Each of the evaluation criteria is scored on a quintile scale. Examples of how the criteria are scored and mapped are shown in Figure 3-10 a-c.

Figure 3-10 a, b, c: Evaluation criteria

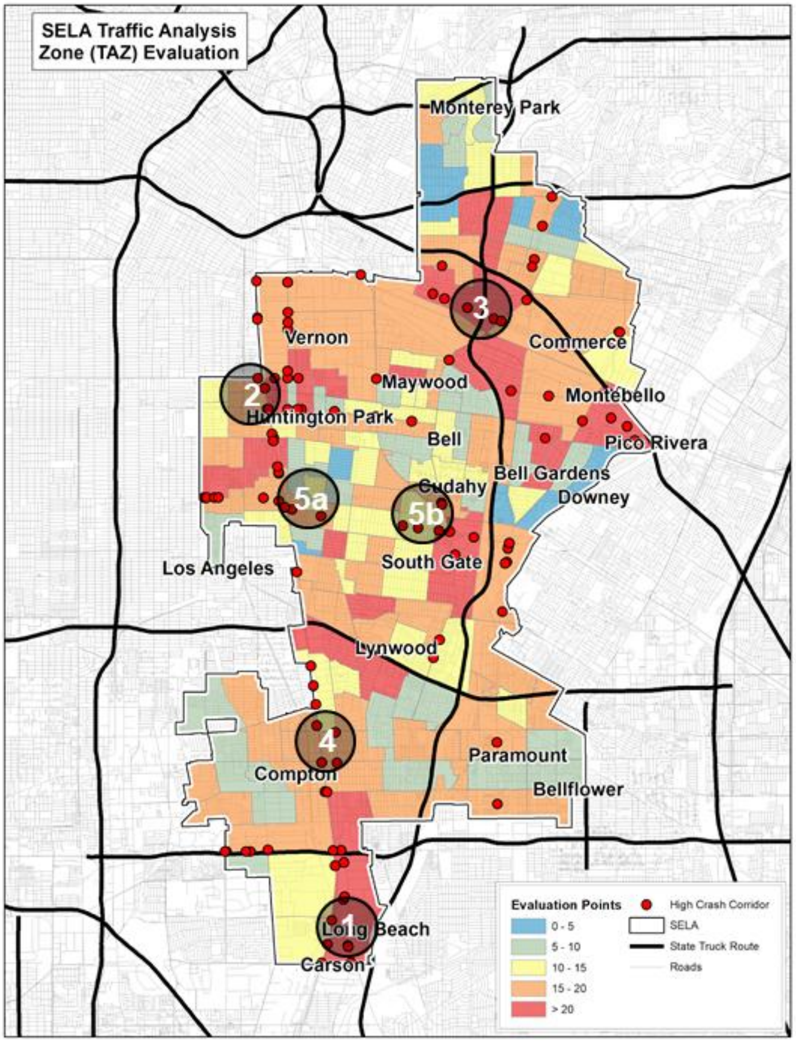


a-crash rate b residential % c schools

Scoring maps for the eight criteria were overlaid with one another and cumulative scores were generated. The result is shown in Figure 3-11. Areas of particular interest with the highest points are shown in rose and light orange with high crash corridors indicated with red dots. These recommendations are meant to address more localized problems, specifically regarding traffic and pedestrian safety—as identified by the community as a need in the community engagement/focus group process. Six locations were identified as hotspots for further consideration and study for localized recommendations. These are the numbered locations in Figure 3-11. Each of the locations have specific characteristics that set them apart from the others and relate to the issues identified in the criteria The six observation locations are:

1. Santa Fe Ave & Del Amo Blvd (Intersection & Mixed-Use)
2. Alameda St. corridor (Mixed-Use Corridor & Mixed-Use/Schools)
3. Washington from Atlantic Blvd. to Downey Rd. (Freight Corridor & Mixed-Use)
4. Elm St. & Santa Fe Ave. (Intersection & Residential/Schools)
5. a) Firestone Blvd. near Russell Elementary (Mixed-Use Corridor & Mixed-Use/Schools)
   b) Southern Ave. from Long Beach Blvd. to San Carlos Ave. (Mixed-Use Corridor & Residential/Schools

Figure 3-11: Risk map and identified hot spots



ArcMap by Environmental Systems Research Institute, Inc.

3.5.2 Field Observations and Results

Field observations of the six locations were conducted over a period of several weekdays in early July 2020. Because of COVID-19 restrictions in force at the time, field observation was mostly via car. Highlights of the field observations are described below.

Santa Fe Avenue and Del Amo Blvd. (1), Figure 3-12 a and b

- A double right turn lane from northbound Santa Fe to eastbound Del Amo has a turn signal. A restaurant on the corner partially blocks the view of eastbound Del Amo Blvd. on approach. Observer noticed numerous instances of trucks beginning a turn on a yellow light and not completing the turn until the light was solidly red. The turn is quite tight for large trucks. Vehicles stopped in the left turn lane on Del Amo are at risk of being hit by trucks making the northbound Santa Fe to eastbound Del Amo turn. There were only a few pedestrians at the intersection although a Metro station is on the northeast corner.

- Right turn from westbound Del Amo to northbound Santa Fe does not have a dedicated turn light; NE corner is parking for Metro station. Observed trucks sailing through yellow to red. Less of a problem with turn radius.
- Potential remediation: longer yellow lights. Elimination of Del Amo left turn would not be feasible given the traffic.

Figure 3-12 a and b:

a) Google map image of Santa Fe (east/west) and Del Amo (north/south).
b) Photo of northbound Santa Fe Ave intersection at Del amo Blvd.; double right turn lane has dedicated light. Photograph by S. Dexter.

Alameda Street corridor (2)

We examine five locations in the Alameda Street corridor.

Alameda Street and 55th Street (Figure 3-13)

- The corridor is lined with mixed use and commercial properties on the west side and subterranean Alameda Corridor train tracks on the east side.
- The width of the street does not always allow for parking, but when it does, parking is tight.
- Many small perpendicular streets have heavy truck traffic. Trucks have a hard time making right turns onto Alameda. There are limited dedicated left turn lanes.
- Businesses abut sidewalk. Many buildings have solid walls up to the corner which severely limits visibility for turning from side streets onto Alameda.
- In some areas, long distances between signals allows vehicles the opportunity to reach speeds higher than posted.
- General poor street appearance (rubbish, weeds, graffiti). Some areas worse than others.
- Potential remediation: mirrors showing oncoming traffic, no turn on red (if signal).

Figure 3-13 a and b: Photos of Alameda Street heading southbound at 55th Street

Photographs by S. Dexter.

Vista Industria at Alameda (Figure 3-14)

- Double parked trucks waiting for entry at Schneider Logistics/CNR International at the end of street blocking street access. Truck backing up almost hit a legally parked car.
- Trucks and passenger vehicles making U-turns on Alameda heading southbound, with oncoming traffic traveling at a high speed (+45 MPH as posted). Alameda is barely wide enough for large truck U-turns. Alameda Street is a California highway (State Route 47) and in some circumstances U-turns are illegal on highways; whether or not it is illegal at this location is unknown.
- Observed a truck making a left turn from Vista Industria to southbound Alameda into oncoming traffic where approaching vehicles needed to slow down to avoid an accident.
- Speed limit posted on Alameda near Del Amo is difficult to see.
- Potential remediation: no double parking/idling on Vista Industria, no left turn from Vista Industria, no U turn on Alameda at Vista Industria, and more visible speed limit signage on Alameda.

Figure 3-14 a and b:

a) Google map image of Vista Industria (east/west) and Alameda on far left (north/south).
b) Photo of eastbound Vista Industria. Photograph by S. Dexter.

N Tamarind Ave at E Mealy St.; E Mealy St. and Alameda (near 124th) (Figure 3-15)

- Tamarind is one short block west of Alameda. It is flanked by a Corning Roofing Factory to the west and small businesses on the east. This area has a concentration of businesses catering to the repair of large trucks. Immediately south of the plant is a residential area with single family homes.
- Long row of idling trucks (counted 14 in total) on Tamarind, some double parked. Many parked motorhomes on the street as well.
- General street appearance was very poor (rubbish everywhere).
- Large trucks parked on Alameda bumper to bumper block visibility of oncoming traffic from Mealy. There is no light at Mealy; turns from Mealy onto Alameda either right or left are done blind.
- Potential remediation: mirrors showing oncoming traffic, no truck idling on side streets within 100 feet of a residential area.

Figure 3-15 a and b:

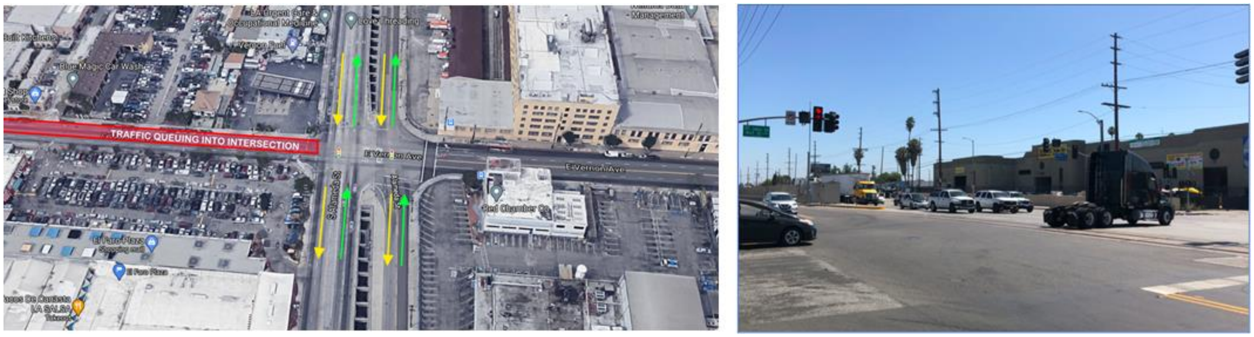
a) Google map image of Tamarind (center north/south) flanked by Alameda (far right north/south).
b) Photo of southbound Tamarind with idling trucks; Corning factory on right. Residential area one block south. Photograph by S. Dexter.

Alameda and E. Vernon Ave. (Figure 3-16)

- Directly west on E. Vernon is a metro station. Trains cause traffic to back up into multiple intersections at Vernon and Alameda.
- Two-way streets (divided by the Alameda Corridor) cause additional confusion and safety concerns.
- Potential remediation: Signal timing to avoid queuing from Long Beach and metro; study how to reconfigure the street.

Figure 3-16 a and b:

a) Google map image of Alameda (north/south) and E. Vernon Ave. (east/west).
b) Photo from Alameda Street intersection showing the multiple two-way streets separated by the Alameda Corridor underground railroad tracks. Photograph by M. Randazzo.



Alameda and Alondra (no photograph)

- Small businesses with no parking on Alameda; many have shallow driveways from Alameda. Customers park in driveways blocking the sidewalk and sticking out onto the street. Some cars park half on the sidewalk/half on the road.
- Potential remediation: signage that illegal parking includes blocking sidewalk access.

Washington from Atlantic Blvd. to Downey Rd. (3)

- Heavily used freight corridor providing access to/egress from Hobart Railyard and the I-710 Freeway.
- Few intersections along the corridor. Those that did exist were "T" intersections, which increase speeding.
- Wide street and limited sidewalk activity can encourage speeding.
- Potential remediation: lower speed limit to decrease truck speeds.

Figure 3-17: Washington Blvd northbound

Photograph by M Randazzo.

Elm Street and Santa Fe Avenue (4)

- Residential neighborhood with tree lined streets. Elm Street is not a truck route. Trucks observed on Elm are probably seeking to access Rosecrans, a major truck route. Rosecrans is constructed as a flyover at Alameda, with no ramps to connect Alameda. Trucks cannot turn eastbound (or westbound) onto Rosecrans. Therefore trucks take the next street (Elm) to Santa Fe and then rejoin Rosecrans.
- Elm is very narrow from Alameda to Santa Fe. At Santa Fe, there is no traffic signal. Intersection cross traffic on Santa Fe is moving well.
- Corner of Pearl and Elm has dense foliage which blocks the turning view.
- Potential remediation: implement "geofencing" to keep heavy duty trucks off residential streets; no truck access signage in these residential neighborhoods.

Figure 3-18 a, b, and c: Alameda and Elm Streets

a) Google map image of Rosecrans (east/west) and Alameda corridor (north/south); residential neighborhoods immediately southeast of intersection.
b) Rosecrans flyover viewed from Alameda
c) Elm Street heading eastbound (between Alameda and Santa Fe). Photographs by S. Dexter.

Firestone & Hooper near Russell Elementary (5a)

- Wide street with parking and bike lanes. Heavy pedestrian traffic in the area. Did not observe many trucks. (School was not in session due to the summer holiday/pandemic.)
- From Compton to Hooper, the median has a metal fence and a speed meter which was not active.
- Mixed use area (apartments, commercial, single-family homes on interior streets).
- Observed several illegal U-turns of passenger vehicles at the point where the median stopped and before the intersection.
- Potential remediation: continue median to intersection with fence.

Figure 3-19 a and b: Firestone and Hooper

a) Google map image of Firestone (east/west) and Hooper (left side north/south).
b) Eastbound Firestone median starts in front of Russell Elementary where illegal U-turns were observed. Photographs by S. Dexter.

Southern Ave. from Long Beach Blvd. to San Carlos Ave. (5b)

- Secondary road with substantially less volume than parallel Firestone Boulevard.
- Bike/pedestrian path along street's northern edge.
- Potential remediation: restrict truck traffic to Firestone Boulevard to prevent route diversions onto
- Southern Avenue.

Figure 3-20 a and b: Southern Avenue

a) Aerial image from Google Maps.
b) Southern Ave facing west. Photograph by M Randazzo

We reviewed our hotspot field observations with SELAC members and at the final focus group. SELAC and focus group members familiar with the various locations found our observations to be consistent with theirs. For example, both the truck queuing observed on Tamarind Ave and the illegal U turns observed near Russell Elementary were identified as regular occurrences. It was agreed that Alameda street is a particular problem where there are two bi-directional roads on either side of the Alameda Corridor trench.

3.5.3 Simulation Analysis of Case Study Hotspot

The last step in our safety analysis was to conduct a case study of one location using a traffic simulation model. From the initial group of six, we selected two locations for in-depth study: Alameda Street from Washington Boulevard to Slauson Avenue, and Firestone Boulevard and Southern Avenue. Of the two locations, Alameda Street is far more complex, with multiple intersections, two-way roads on either side of the Alameda Corridor trench, and queuing from a nearby LA Metro Blue Line station. While we were able to obtain sufficient traffic signal timing data from the field, we were unable to obtain sufficient traffic volume data at each of the intersections along the Alameda Street study corridor to model it.. We therefore present a descriptive analysis of the Alameda Street case and a simulation analysis of the Southern Ave case. The problem is trucks diverting to Southern Ave apparently to avoid traffic on Firestone. However, Southern Ave is not a designated truck route. On the south side there are apartment buildings and churches; on the north side is a pedestrian trail, open space, and bike path. Our proposed mitigation strategy is the prohibition of heavy trucks on Southern Ave via signage and eventually geofencing.

Our results provide examples of solutions to specific traffic safety problems and are intended to provide guidance. Given limited access to data, the lack of real-world calibration, and the shortcomings of modeling in general (Binder et. al., 2019), are best used as guidance toward developing solutions and not the only argument for pursuing these proposed solutions.

Case Study 1

Case Study 1 was meant to examine existing traffic flows and potential intersection and corridor reconfigurations along Alameda Street and the parallel Alameda Street Auxiliary from East Slauson Avenue through Washington Boulevard to Interstate 10. The main issues observed, and discussed with the community, along the Alameda Corridor is that there are several key activity centers generating pedestrian volume, but with few pedestrian facility enhancements in the area, and the traffic operations cause congestion and confusion for drivers. Also, being a major regional freight corridor, along with the Alameda rail corridor between the two parallel roads, the unsafe conditions are enhanced for pedestrians and drivers.

In Figure 3-16a, a note is made of the traffic queuing into Alameda Street and Vernon Avenue due to Metro’s A-Line Light Rail Line to the west of the intersection. The parallel roads on either side of the rail trench create unsafe turning movements as left turns require vehicles to cross traffic in two directions. Pedestrians must traverse two separate arterials plus the trench in order to cross the street. To begin addressing these concerns, it is possible to make traffic flow and operational adjustments along the corridor which a traffic micro-simulation model can be used to analyze. Unfortunately, simulation modeling was not possible due to lack of intersection movement data. There are two “build” scenarios that should be explored. Build

Scenario 1 would create one-way streets on each side of the trench and use crossover intersections, much like the existing junction north of Vernon Avenue, to the south of Slauson Avenue. Build Scenario 2 would eliminate access to through traffic on one side of the trench, reducing function to that of a service road. This would simplify left turns and make it safer and easier for pedestrians to cross the street.

Case Study 2

We use the PTV VISUM traffic simulation software. VISUM is a mesoscopic simulation model; it simulates platoons of vehicles moving through a network. Road segments are represented by links usable for specified modes of transport (Heyken Soares et al., 2021). Links are composed of two separate network objects, one for each travel direction. Each of these objects can have different attribute values, such as the allowed speed and capacity in terms of the number of vehicles. Nodes at the beginning and endpoints of each link define the positions of intersections and junctions in the network. Turning movement permissions can be defined in the properties of the nodes. We use OpenStreetMap as the primary source for building the local street network. We use the SCAG model network for areas outside the SELA area.

VISUM also requires a set of travel demands to be served during the simulation period. Per standard practice, travel demand is aggregated at the level of zones ($Z = \{z_1, z_2, \ldots, z_i\}$) and given in the form of an origin-destination (O-D) matrix. The VISUM network is loaded with demand generated from the SCAG Origin-Destination (OD) matrices. The SCAG model distinguishes between vehicle types in the demand; therefore, these tables were aggregated to the RSA and TAZ geographies to be used in the VISUM model for each vehicle type. The demand tables are by vehicle type, as well as by time period of the day. STATA software was used to aggregate these tables from the primary source data and into the long-table format required for VISUM. For this scenario model, we use the AM peak (7 to 10 AM) as our period of analysis. The set of tables generated represented demand movements from RSA to RSA, RSA to TAZ within SELA, TAZ within SELA to RSA, and TAZ to TAZ within SELA. Each RSA and TAZ had an ID in the VISUM model, so these tables were then combined into four tables for each vehicle type.

During data analysis there was a specific crash identified which occurred between a truck and a pedestrian that resulted in a fatality. This incident would not have been expected to occur along Southern Avenue, as it is not a truck route, and has a paved trail that runs parallel to it. Truck diversion is likely happening elsewhere within SELA as well, so the strategies tested in this modeling could be reproducible. Figure 3-20 shows Southern Avenue east of Long Beach Boulevard, part of the study area south of Firestone Boulevard. The corridors under study run from Long Beach Boulevard to Atlantic Avenue to the east. The intersection of Firestone Boulevard and Atlantic Avenue is considered to be an intersection of significance in this modeling effort due to observed congestion at the intersection.

As noted above, our objective is to eliminate trucks traveling on Southern Ave. We model three scenarios. Scenario 1 is the base case, with trucks allowed on Southern Ave. Note that because we do not have traffic count data for specific streets this is the base case for simulations and not necessarily reflective of actual conditions. Scenario 2 removes all trucks from Southern Ave and forces them to other routes. Scenario 3 is the same as 2, but with the addition of intersection improvements at Atlantic

Ave. If the reason for trucks choosing Southern is congestion at the Atlantic intersection, improving the intersection should help bring truck traffic back onto Firestone.

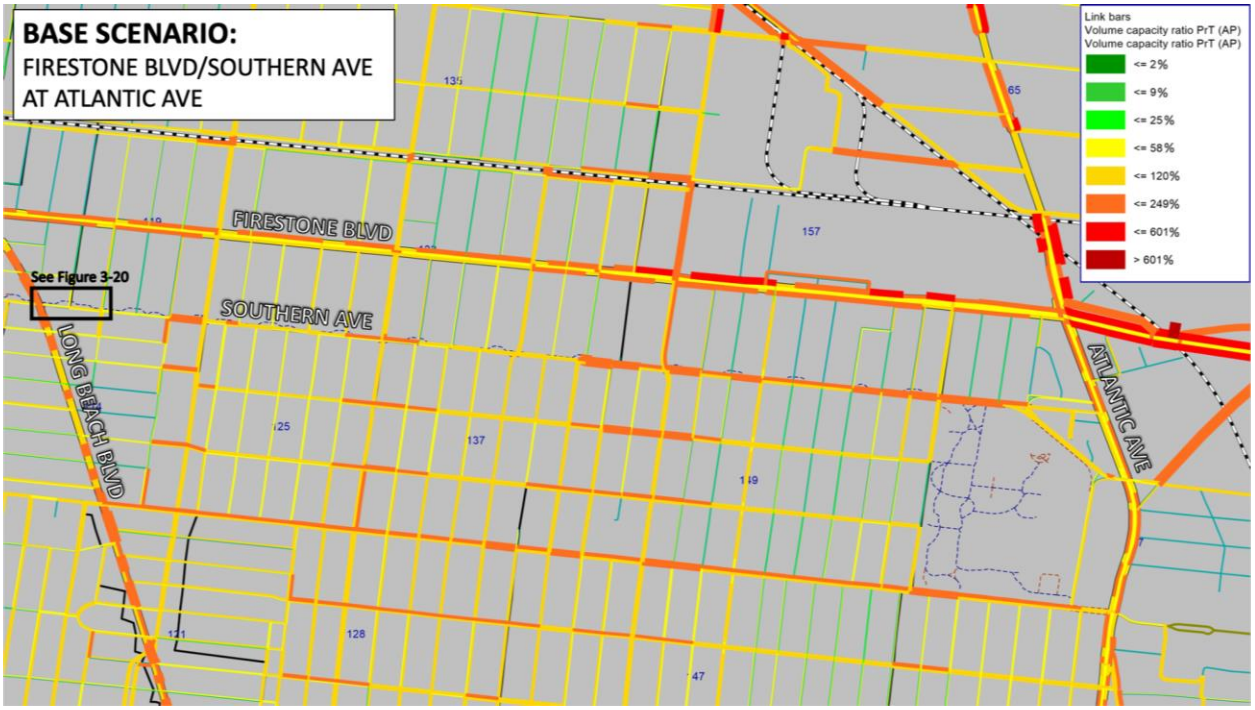
We evaluate results based on VMT for passenger vehicles and trucks and how VMT changes across the scenarios. See Table 3-4. The table shows that there are very few heavy trucks using Firestone or Southern and consequently there is little impact from eliminating trucks on Southern. Compared to the base case, car VMT shifts slightly to Southern in Scenario 1 and slightly to Firestone in Scenario 2 for both directional flows. Eliminating trucks on Southern has almost no effect because so few are traveling on Southern in the base case. There is only a 0.1% change in the percentage of heavy trucks from 1.1% in the base model to 1.2% in Scenario 1, and another 0.1% change in the percentage of heavy trucks from 1.2% in Scenario 1 to 1.3% in Scenario 2.

Table 3-4: Vehicle Miles Travel – Firestone Blvd & Southern Ave (by scenario; by direction)

Model	Arterial	Car Vehicle Miles Traveled (EB)	Car Vehicle Miles Traveled (WB)	Truck Vehicle Miles Traveled (EB)	Truck Vehicle Miles Traveled (WB)	Total Vehicle Miles Traveled (EB)	Total Vehicle Miles Traveled (WB)	Percent Heavy Trucks (EB+WB)
Base	Firestone	5,709.1	6,247.5	82.3	56.5	5,877.8	6,355.6	1.1%
	Southern	1,133.2	1,566.1	23.8	27.1	1,182.0	1,627.2	1.8%
Scenario 1	Firestone	5,632.6	6,218.1	90.4	57.7	5,799.3	6,332.9	1.2%
	Southern	1,200.9	1,683.6	0.4	0.3	1,213.4	1,705.9	0.0%
Scenario 2	Firestone	5,796.6	6,361.7	98.7	63.1	5,988.9	6,482.8	1.3%
	Southern	1,150.8	1,545.7	0.2	0.4	1,166.3	1,567.7	0.0%

We also use the vehicle-to-capacity (v/c) ratio and get similar results. Truck traffic is a very small share of overall vehicles in the study area, hence changes to these operations will do little to change traffic conditions in the area. Figure 3-21 shows the v/c ratio results in the baseline scenario. The uncalibrated model generated higher V/C ratios (over 3) than is expected to be occuring during the AM peak hours, but the trends in traffic conditions with heavy congestion along the main arterials are what is to be expected.

Figure 3-21: Baseline Scenario V/C Ratio Results



These challenges are highlighted more specifically in each of the scenarios modeled. Freight traffic continues to use Firestone Blvd with Southern Ave closed to freight traffic as seen by a volume increase in Scenario 1 model. Further, the Scenario 2 model also shows this increase, but this is more likely due to induced demand from the intersection and capacity Improvements implemented in the model at Atlantic Ave. The capacity improvements input into the model show a substantial decrease in the V/C ratio on the links entering and exiting the Firestone Boulevard and Atlantic Avenue intersection.

Figure 3-22: Scenario 1 V/C Ratio Results

Figure 3-23: Scenario 2 V/C Ratio Results

Our modeling analysis shows that there would be little impact on traffic conditions by prohibiting trucks on Southern Ave. However, the safety benefits for local residents would be potentially large. Congestion along Firestone Blvd at Atlantic Ave is the most likely cause of truck drivers making this decision. We expect that trucks using local streets to avoid congestion is not unique to Southern Ave but rather is likely occurring elsewhere in SELA. Our case studies are likely examples of similar problems in the SELA area, aligning with what we heard from the focus group, that freight drivers are diverting away from major arterial congestion onto residential collectors and local streets. The model strengthens the argument for geofencing and for geometric mitigations that limit the ability of trucks to enter major residential areas. Our results also suggest that scenario modeling is an effective tool for examining the types of local transportation problems we identified in our field study. Model results strengthen the evidence and may incentivize the public and policymakers to work toward developing mitigation efforts.

3.6 Findings and Conclusions on Truck Impacts in SELA

Our results may be summarized as follows. First, Truck traffic in the SELA area is a mix of through traffic and SELA generated traffic. The SELA area accounts for about 10% of all regional trips and serves as a pass through for an additional 11% of regional trips, yielding roughly 210,000 truck trips per day, much higher than the County average. The average truck volume density in SELA is approximately 40,000 trucks/day/sq. mile compared to the regional volume density of approximately 25,500 trucks/day/sq. mile. The disproportionately high exposure to truck traffic within SELA is consistent with observed high levels of air pollution and noise.

Second, Truck related traffic safety is a serious problem. Our crash analysis reveals that SELA has a higher rate of truck incidents on a square mile basis and higher fatalities as a percentage of the total than either the City of LA or the county. Significant spatial clusters of arterial accidents were found in heavy truck traffic areas. The top three causes of street truck collisions are unsafe speed, crossing the right way of another vehicle, and improper turning. Our spatial analysis of the crash data suggested the presence of hot spots. We developed a multicriteria method to identify hot spots and conducted field studies of six of them. We present a case study analysis of the effects of prohibiting trucks from one residential street.

3.7 Recommendations

Our findings lead to some policy recommendations. First, Local pollution hotspots in SELA can be mitigated by accelerating the transition to zero and near zero emission trucks operating within SELA. Charging stations should be considered in the I-5 corridor, the Carson area warehousing cluster, and the Alameda Street industrial corridor. Low emission zones may be considered to promote use of cleaner vehicles in these areas. There is potential for the SELA region to participate in demonstration projects related to these policy and technology implementations

Second, Local truck safety hotspots should be further evaluated for operational changes. Our hotspot analysis revealed specific problem areas with higher-than-average truck crashes and exposure to residential areas and schools. Third, to reduce both pollution and safety impacts, geofencing policies should be considered to keep heavy duty trucks out of residential neighborhoods. In some cases, trucks deviate routes to save time. Geofencing would also have the additional benefit of pedestrian and traffic safety in these neighborhoods. We recognize that these operational changes are largely under the jurisdiction of municipalities. The next step for implementation is for the SELA Collaborative to work directly with the cities and county to achieve these changes.

Chapter Four: Improving Transit Job Accessibility

4.1 Introduction

This section describes how well the transit system connects the SELA region to jobs. Job access is becoming a standard measure of transit and transportation system performance. We use what is becoming a common measure of job access - the number of jobs that can be reached in a transit trip within set travel times of 30 or 60 minutes. See, e.g., Owen and Levinson (2014) for early examples of this approach. We use this approach to then simulate how job access changes for several possible changes in the transit network. We examined headway changes, the addition of the in-planning West Santa Ana Branch (WSAB) light rail line, and improved first-last mile access to transit stations. We find that the largest job access increase results from improved first-last mile access to stations.

The job access scenario analysis was envisioned as the central focus of the transit access research, but we adjusted the research in two ways based on evolving circumstances and the needs of the SELA community. Our early focus groups with the SELA community revealed that the cleanliness, timeliness, and service quality of the transit system were perceived as being as important as the connectivity of the transit network. We adjusted the research to add a small service-quality survey and we also summarized insights from L.A. Metro rider surveys to add insights that respond to those community concerns. In March of 2020, the still unfolding COVID-19 pandemic reached the U.S. and Metro, like virtually all large transit operators, had to reduce service. We added an assessment of the impact of those COVID pandemic changes on transit access.

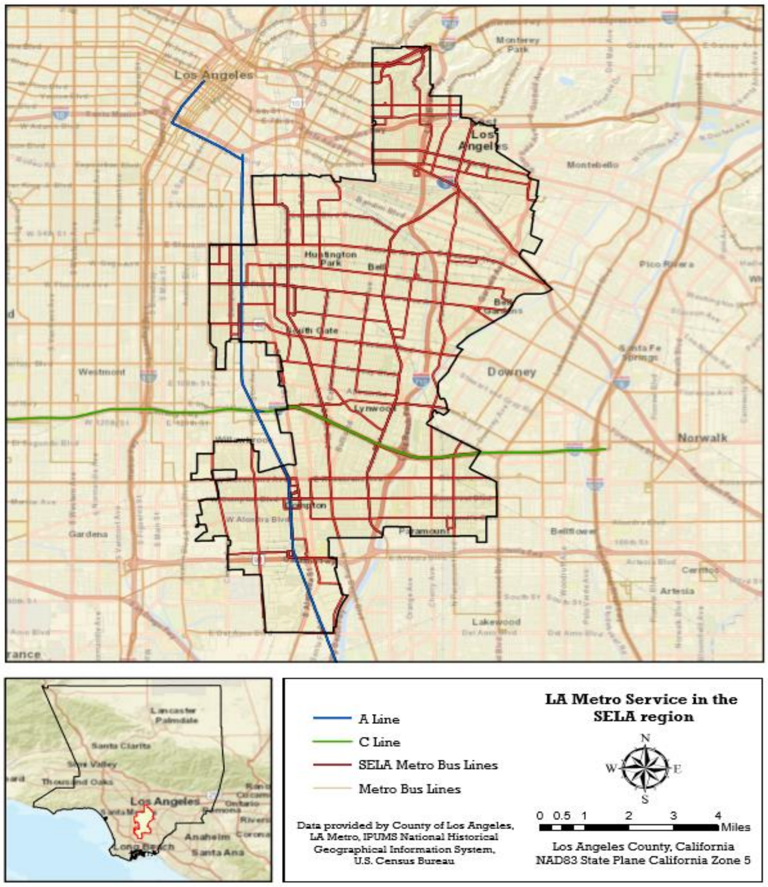
We start with a description of the pre-pandemic L.A. Metro transit network in the SELA region. Then we describe our access measure and the results of different scenarios that model how changes in the transit system will change job access. We follow that with a case study of a proposed bike-share model to improve first-last mile job access in two SELA locations. In the next Chapter, we summarize survey and focus group data. The recommendations that flow from our analysis are in Chapter 6.

4.2 Pre-COVID Public Transit Network

The major public transit supplier in the region is the Los Angeles Metro Transportation Agency (L.A. Metro). Other smaller municipal public transit agencies operate in the region. For the most part, these municipal public transit agencies serve as regional connectors to L.A. Metro transit routes. Local municipal operators are not included in this report; they account for a small portion of the region's transit service.

As of 2020, LA Metro operated 165 bus routes (directly operated and contracted), 4 Light Rail, and two subway Lines in the entire L.A. County service area. L.A. Metro operates 44 bus lines and 2 Metro Light Rail Lines (Lines A and C; formerly known as the Blue Line and the Green Line) in the SELA region. There is a total of 13,978 Metro bus stops in the L.A. County service area. A total of 1,515 bus stops fall within the SELA region, and there are 5 light rail stations for Line A and one light rail station for the C Line in the SELA region's west and south sections. Approximately 31% of the system's total bus lines, with a 26% distance coverage operate in the SELA region. The Metro bus lines are shown in red in Figure 4-1. As Figure 4-1 shows, the rail transit lines serve the edges rather than the core of the SELA region. SELA is heavily dependent on the bus network.

Figure 4-1: Bus and rail transit lines in SELA region



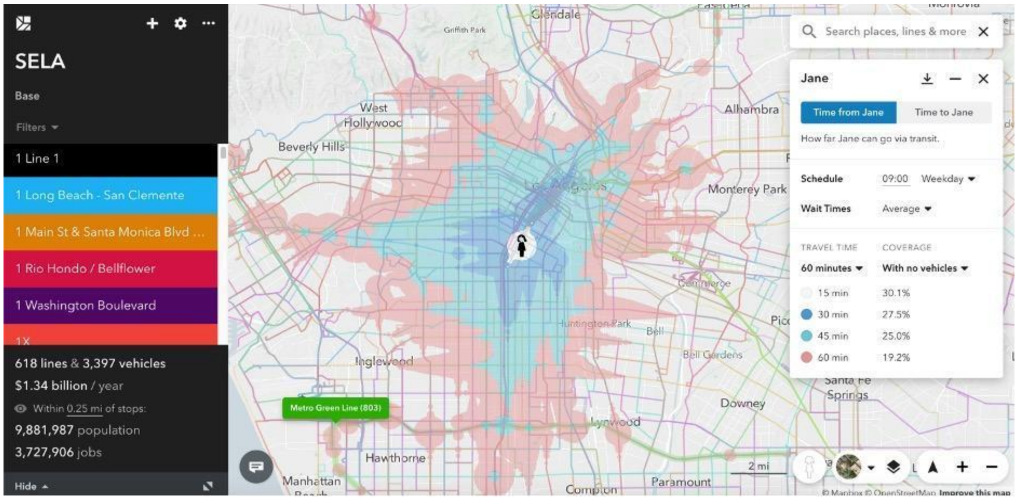
4.3 Purpose

The objective of this section is to simulate how changes to the bus transit network in Southeast Los Angeles (SELA) will change access to jobs that can be reached via transit. We focus on possible network changes that include headways, first/last-mile options (bikeshare or shuttles), the addition of the planned West Santa Ana Branch light rail, and the impact of both service and job changes due to the COVID-19 pandemic.

4.4 Methods and Data

Our simulation is conducted at the city level, where we use the number of jobs that can be reached from the geographic centroid of each SELA region city to represent the job access for residents living in this city. In a few cases we use unincorporated areas, and we refer to all city/unincorporated areas as study areas. We use two sets of tools for the simulation: Remix and ArcGIS. Remix is an online commercial transit access software tool, which includes General Transit Feed System (GTFS) data from transit authorities. In this project, we select transit lines that run through Los Angeles County. When a map is generated in Remix, the most recent GTFS data are used to draw the transit lines and once a map is built, the GTFS data in it remains static, so that users can save and reuse a particular scenario of interest. Possible edits to the system include point-and-click operations to: add/remove a new line; add or remove a stop; adjust a line's schedule; adjust the right of way on an existing line; and remove an existing line. Users can also change the parameters of the trip: departure time, wait times (average or actual), and walking network (radius or pedestrian network).

Figure 4-2: Remix demo map



1 Line 1
1 Long Beach - San Clemente
1 Main St & Santa Monica Blvd ...
1 Rio Hondo / Bellflower
1 Washington Boulevard
1X

618 lines & 3,397 vehicles
$1.34 billion / year
Within 0.25 mi of stops:
9,881,987 population
3,727,906 jobs

How far Jane can go via transit.

Schedule: 09:00 Weekday
Wait Times: Average

TRAVEL TIME	COVERAGE
60 minutes	With no vehicles
15 min	30.1%
30 min	27.5%
45 min	25.0%
60 min	19.2%

Figure 4-2 shows a sample Remix isochrone, centered in Southeast Los Angeles. From the location of the icon at the center of the Figure 2, the colored areas, from white to dark blue to light blue to pink, show respectively the area where a transit rider could travel in 15, 30, 45, and 60 minutes. Those areas are called isochrones. The travel areas are calculated in Remix and can be downloaded as ArcGIS-supported files (shapefiles). The isochrone will then be imported into ArcGIS as the transit access layer, which we overlayed with a job distribution map. The jobs data are from the Census LODES Workplace Area Characteristics (WAC) file for 2017 at the block level, the most recent available at the time of this research.

We developed several scenarios with various types of modifications to the transit network, to examine how those changes would affect the transit job access. The scenarios are listed below:

- **<u>Baseline</u>**: The L.A. Metro bus network as it existed in March 2019, which is the most updated version available in Remix Platform, plus all the transit lines that run through LA County available in Remix Platform. The number of lines in total is 618.
- **<u>10-minute headway</u>** (**<u>system-wide)</u>**: This scenario keeps all the lines in the baseline scenario but modifies the baseline Metro route schedule by moving every bus line with greater than a 10-minute morning peak hour headway to a 10-minute headway.
- **<u>10-minute headway</u> (SELA region only)**: This scenario keeps all the lines in baseline, but ***only*** modifies bus lines that cross the SELA region, and for those bus lines, any line with greater than a 10-minute morning peak hour headway is changed to a 10-minute headway.
- **<u>COVID-19 scenario</u>**: This scenario considers the impacts of both service changes and economic shocks caused by the pandemic. The service changes are based on the updated schedule posted by LA Metro in April 2020. The economic (job opportunity) changes are calculated based on the 'Current Employment Statistics' dataset downloaded from the

California Employment Development Department to estimate how the early months of the pandemic changed the county's employment surface and hence transit access.[2]

- **Add West Santa Ana Branch (WSAB) Light Rail**: This scenario adds the West Santa Ana Branch Light Rail (still in planning stages) which will run through the region, starting from Downtown Los Angeles and then going south to Bellflower and beyond.
- **First/Last-Mile options**: This scenario considers new first/last-mile options including bike sharing programs, ridesharing services (Uber/Lyft), scooters, or shuttles. With these services, people can get to the nearest transit stops faster than walking. The optimal way to model this scenario is to adjust the default station access/egress speed in Remix to match the speed of bicycling/scootering or driving, but at the time of this research Remix did not provide such a function. To address this issue, we assumed a bicycle or automobile/shuttle travel speed and then estimated how that faster station access/egress mode would translate to travel time savings. We then assumed the travel time savings would be used in route on buses or trains, allowing a rider to travel further in the same net travel time (and hence have access to more job opportunities). With those assumptions, we used ArcGIS's Buffering Tool to approximate the additional distance people could travel in this scenario. See the detailed method description in Appendix C

All scenarios were run based on the following assumptions:

- Departure time: 9am Weekday (morning peak)
- Wait time: average (1/2 headway) for all the scenarios except for WSAB which used actual (based on real timetable as represented in Remix)
- Travel mode for accessing to/egressing from transit stops: walking (except for First/Last-mile options), the speed of which is approximated at 3 miles per hour.

The results are presented in Table 4-1(all transit system and access/egress changes unrelated to the COVID-19 pandemic and the impact of the transit system changes related to the pandemic) and Tables 4-2 and 4-3 (decomposition of changes in transit service and jobs related to the COVID-19 pandemic into the access changes due to the April 2020 Metro service schedule changes and the separate effect of the estimated late Spring 2020 job losses.)

4.5 Findings

Table 4-1 summarizes job access changes within 30-minute travel time isochrones in the scenarios described above. Figure 4-3 illustrates how the 30-minute isochrone for each scenario differs. Figure 4-3 illustrates that moving from the baseline scenario to the lower headway scenarios increases the range of transit travel within 30 minutes, with an even larger increase for the scenarios that modify first/last mile station access-egress speed. The pattern of isochrone and job access changes varies across the SELA region, depending on the pre-existing transit network and how modifications to that network from specific starting points change the isochrone shape, and depending on the pattern of job locations in the region. We will examine scenarios centered on specific cities later in this section. Figure 4-4 shows the

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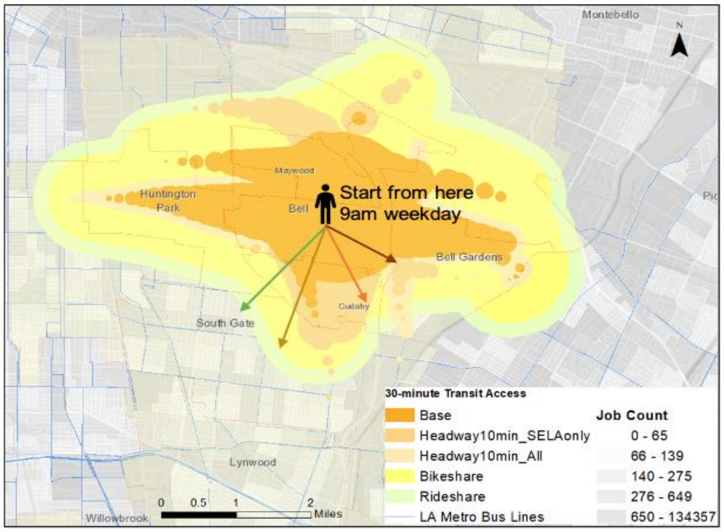
[2] See https://data.edd.ca.gov/Industry-Information-/Current-Employment-Statistics-CES-/r4zm-kdcg for the California Employment Development Department (EDD) data and see Appendix B of this section for the method to calculate changes in the 2017 LODES WAC data based on the California EDD data.

baseline level of transit job access in the SELA region. Generally, the northern part of the region - closer to job-rich downtown and served by higher frequency lines - has better baseline job access.

Figure 4-3: Example of 30-minute transit access (City of Bell)



On average, bikeshare travel speeds to/from stations would increase job access approximately 65% over baseline, while shuttles or rideshare (car travel speed) access/egress would increase job access approximately 182% over baseline. (See the population weighted average row in Table 4-1.) The next most effective option, in terms of increasing job access, is reducing the headways of buses to 10 minutes, either for buses that only run through SELA region (31% increase over baseline) or for all the LA Metro buses in the system (34% increase). As is to be expected, the greatest impact for SELA residents is frequency increases that are within the SELA region. Adding the new light rail line, the West Santa Ana Branch, is not as effective in increasing job access, only bringing about a 2.2% job access increase over baseline. This is likely due to several factors. The West Santa Ana Branch stations are often in the southern part of the region, where job access is lower, and the northern stations are near the already high access locations in the northern part of SELA. Access/egress to rail stations is particularly important, and our West Santa Ana Branch scenario did not include changes in access/egress beyond the default of walking access/egress - which might be less realistic for rail stations than for bus stops. The 30-minute isochrone, while strongly correlated with 60-minute isochrones (which we also tested), might be less likely to reflect access increases over longer trips that are most suited to rail. Improving the SELA region’s connections to the county’s rail system is an important objective that can yield more benefits as the system continues to expand. Yet the basic message remains: Focusing on station access/egress and higher frequency bus travel is the best option for improving job access in SELA.

Table 4-1 also shows the net change in job access that resulted from the transit system changes implemented by L.A. Metro in the early stages of the COVID-19 pandemic. Unlike the other hypothetical scenarios, the column “COVID-19” in Table 4-1 models the change in job access that resulted from the frequency reductions in the network. The “COVID-19” column in Table 4-1 is an observed impact, rather than a scenario. The impact of COVID-19 on transit job access is discussed in more detail later in this section. We estimate that, on average, about 19% of the baseline transit job access was lost due to the early (circa April-June, 2020) COVID-19 L.A. Metro system changes.

Figure 4-4: The 30-minute transit job access (city level)

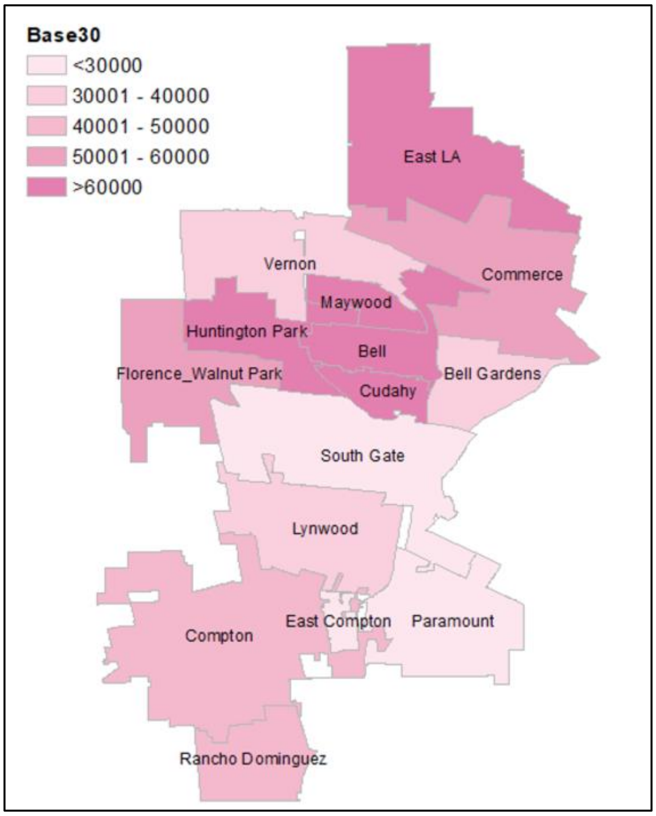


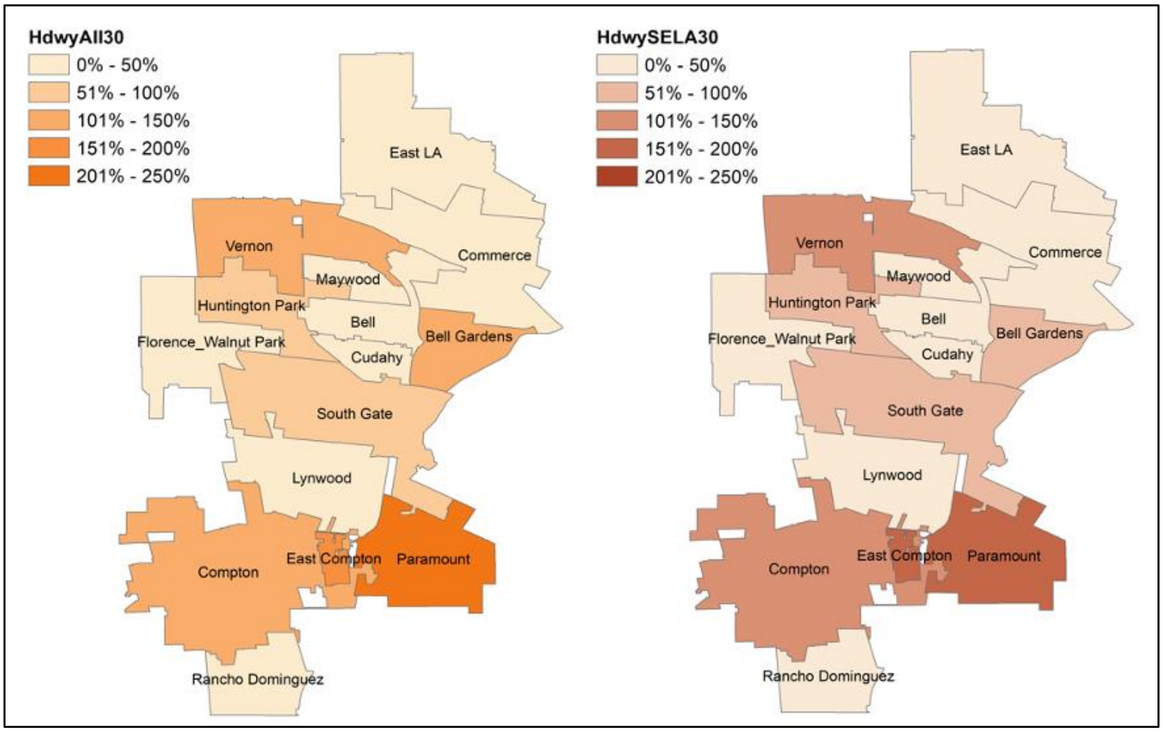
Table 4-1: Summary of results (30 minute isochrones, transit network changes only)

Scenario	Base 9am	Headway -SELA		Headway -All		COVID-19 April 2020 service changes		Add WSAB Rail		First-Last Mile Driving		First-Last Mile Biking	
City	Jobs+	Jobs + *	Jobs + %	Jobs +	Jobs + %	Jobs +	Jobs + %	Jobs +	Jobs + %	Jobs +	Jobs + %	Jobs +	Jobs + %
Bell	66,822	6,701	10%	23841	36%	-17207	-26%	6008	7.9%	143192	214%	50347	75%
Bell Gardens	37,087	29,804	80%	45821	124%	-830	-2%	2361	5.4%	154016	415%	40155	108%
Commerce	52,360	16,927	32%	16927	32%	-3234	-6%	0	0.0%	425454	813%	202297	386%
Compton	42,823	43,840	102%	45362	106%	0	0%	0	0.0%	111940	261%	39208	92%
Cudahy	61,437	21,552	35%	22509	37%	-1651	-3%	5340	14.5%	102772	167%	26206	43%
East Compton	29,460	55,630	189%	56461	192%	0	0%	0	0.0%	99548	338%	37701	128%
East LA	383,546	34,717	9%	38091	10%	-75407	-20%	0	0.0%	422146	110%	142628	37%
Florence-Walnut Park	56,074	8,971	16%	9072	16%	-29652	-53%	2777	3.7%	129607	231%	48676	87%
Huntington Park	63,534	34,407	54%	38272	60%	-13895	-22%	12899	13.2%	97001	153%	26775	42%
Lynwood	34,204	5,605	16%	5605	16%	-14774	-43%	0	0.0%	139854	409%	54099	158%
Maywood	112,116	23,006	21%	23774	21%	-17719	-16%	5798	6.1%	156266	139%	37623	34%
Paramount	24,202	47,627	197%	52146	215%	0	0%	2022	5.3%	53030	219%	23977	99%
Rancho Dominguez	47,423	0	0%	0	0%	0	0%	0	0.0%	51354	108%	9287	20%
South Gate	28,152	16,390	58%	16390	58%	-5672	-20%	0	0.0%	52852	188%	24485	87%
Vernon	36,669	52,256	143%	52559	143%	1204	3%	0	0.0%	93455	255%	26646	73%
Unweighted Average	**71,727**	**26,496**	**37%**	**29,789**	**42%**	**-11,922**	**-17%**	**2480**	**2.8%**	**148,832**	**207%**	**52,674**	**73%**
Weighted Average *	**85,850**	**26,216**	**31%**	**29,263**	**34%**	**-16,633**	**-19%**	**2,338**	**2.2%**	**156,573**	**182%**	**56,075**	**65%**
Notes:	**"Jobs +":** Additional Jobs Beyond Baseline **"Jobs + %":** Percent change from Baseline **Weighted average:** weighted by city population aggregated from block group level population data (Census 2018)														

4.5.1 Headway Changes

Figure 4-5 shows the pattern of job access changes, relative to baseline, in the fifteen SELA study locations. The left panel maps the percentage job access change over baseline from taking all L.A. Metro headways to a maximum of 10 minutes (key "HdwayAll30") and the right panel shows the percentage job access change over baseline from moving only SELA headways to a maximum of 10 minutes (key "HdwaySELA30".) From the left panel, it is clear that system-wide headway reductions produce the greatest job access percentage gains in the southern and central parts of the region - locations that are generally less well connected by transit to the broader Los Angeles area. Changing headways only for lines that pass through SELA produces a similar effect. The City of Paramount, which had the lowest transit job access at baseline (Table 4-1), sees its job access almost triple (SELA only changes) or more (systemwide changes) when headway is reduced (i.e., when frequency is increased).

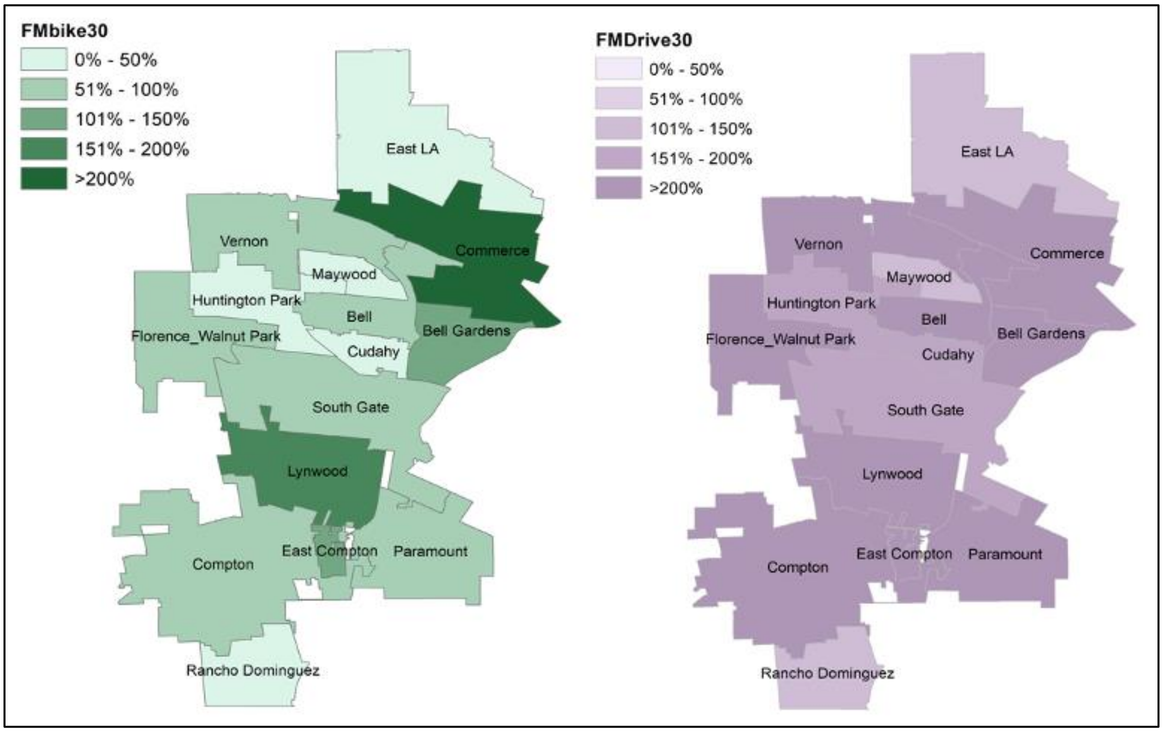
Figure 4-5: The percentage of increase in job access after headways being decreased to 10 minutes during peak hours on weekdays



4.5.2 First/Last Mile Options

Figure 4-6 shows the percentage increase in transit job access, over baseline, from moving station access/egress speeds to approximate speeds of bicycling (left side of Figure 4-6) and driving (which can also reflect shuttle or share-ride access/egress, right side of Figure 4-6) Appendix C contains a description of how job access is calculated for the biking and driving first-last mile access/egress scenarios. Both scenarios show that Commerce, Lynwood, and Bell Gardens are the top three cities with the greatest percentage increase from the first-last mile access/egress scenarios. Note that transit job access improvements from increasing station access/egress speed are more notable in the northern part of the SELA region when compared with the frequency (headway) scenarios.

Figure 4-6: The Percentage of increase in job access with bikeshare or rideshare options



4.5.3 COVID-19 Effects

The onset of the COVID-19 pandemic in March of 2020 had a large impact on transit operations. Transit agencies had no choice but reduce their service frequency, and at the same time employment opportunities dropped due to the pandemic-related job losses. Both effects played out rapidly - over timeframes of weeks and months. In this section, we will examine the impacts of the transit service changes and the economic recession on transit job access in the SELA region. Details for these scenarios are available in Appendix D.

(1) Transit Service

Starting from April 2020, L.A. Metro updated their transit schedule as a response to the stay-at-home COVID-19 pandemic policy. The changes greatly decreased the service frequency, including but not limited to:

- 104 lines running every day of the week on regular Sunday schedule,
- 22 lines running on Monday through Friday on an hourly schedule,
- 15 lines running only Monday through Friday on modified weekday schedule,
- 14 lines suspended, and
- 29 lines running nightly Owl service on Sunday

We modified the updated bus schedule information in the Remix Platform to reflect L.A. Metro's April 2020 schedule frequencies and re-ran the simulation with the same parameters (i.e., 9 a.m. weekday with walking speed station access/egress and wait times at half the new April 2020 headway) to see how the pandemic-related transit service changes impacted transit job access. The results, shown in Table 4-2, indicate variation across the SELA study areas. Table 4-2 shows the baseline transit job access, for 30- and 60-minute travel time isochrones, and then the change from baseline that resulted from the April 2020 L.A. Metro service changes.

On average, the SELA region saw a decline in job access of 19% from baseline. That ranged from a 53 percent job access reduction in Florence/Walnut Park to a 43 percent reduction in Lynwood to no change in Compton, East Compton, Paramount, and Rancho Dominguez (all at the 30-minute travel time isochrone.) While the pattern is not perfect, the lower access study areas and cities generally had a smaller decrease in access following the April 2020 service changes, likely because they already had poor access (i.e., lower frequencies.)

Table 4-2: Job access decrease due to transit service changes in the context of COVID-19 pandemic

City Name	Job Access Baseline		Job Access Changes Compared to Baseline (Feb 2019)			
	60-minute Travel Time	30-minute Time	60-minute Travel Time		30-minute Travel Time	
	Job Count	Job Count	Job Change	% of Change	Job Change	% of Change
Bell	335,094	66,822	-67,830	-20%	-17,207	-26%
Bell Gardens	321,022	37,087	-27,738	-9%	-830	-2%
Commerce	893,344	52,360	-56,900	-6%	-3234	-6%
Compton	408,932	42,823	-31,917	-8%	0	0%
Cudahy	335,790	61,437	-19,614	-6%	-1651	-3%
East Compton	412,995	29,460	-95,394	-23%	0	0%
East LA	1,380,849	383,546	-197,325	-14%	-75,407	-20%
Florence_Walnut Park	852,933	56,074	-118,753	-14%	-29,652	-53%
Huntington Park	704,466	63,534	-84,722	-12%	-13,895	-22%
Lynwood	970,598	34,204	-337,074	-35%	-14,774	-43%
Maywood	832,355	112,116	-152,011	-18%	-17,719	-16%
Paramount	189,593	24,202	-16,452	-9%	0	0%
Rancho Dominguez	194,584	47,423	-262	-1%	0	0%
South Gate	416,026	28,152	-169,912	-41%	-5,672	-20%
Vernon	583,322	36,669	-67089	-12%	-1204	-3%
Average (weighted)	**651,770**	**85,850**	**-115,867**	**-18%**	**-16,633**	**-19%**

4.5.4 Job shocks

In addition to transit service changes, the change in the geography of available jobs also changes job access. We used the most recently available census block level employment data from the Census LODES data set. Yet modeling the impact of COVID-related job losses and gains (some sectors gained jobs during the spring-summer 2020 COVID recession) was important in understanding transit job access changes in the SELA region. We modeled the job loss by gathering data on Los Angeles County employment, by industry sector, monthly from February to July, 2020 from the California Employment Development Department (EDD). We calculated sector-by-sector changes, for Los Angeles county, from February through May and from February through July, and then applied those industry sector changes to the 2017 block-level LODES jobs data. This required that we cross-walk the California EDD (which uses their own unique CES codes) to the NAICS codes used by the census. We used U.S. Bureau of Labor Statistics documentation for the cross-walk from CES to NAICS codes.

We found that employment generally fell to its lowest point in May 2020 and slightly rebounded by July 2020. As one might have expected, service industries tended to be hardest hit, with nearly 50% drops in employment in sectors such as food service, whereas several other sectors suffered less than 10% job loss, and the finance sector actually grew during this time. Table 4-3 summarizes the resulting transit job access changes in May and July compared to the pre-COVID baseline scenario. The percentage decrease in job access is almost evenly distributed across cities, ranging from 11 to 13 percent in May, and from 8 to 10 percent in July. Note that these access changes are not from changes in transit service (the results in Table 4-3 hold transit service at the pre-COVID baseline) but rather are solely from the pattern of estimated job losses in the county, translated from the county level to the LODES data based in changes within industry sectors.

Table 4-3: Job access decrease due to economic recession in the context of COVID-19 pandemic

City Name	Job Access Change in May Compared to Baseline				Job Access Change in July Compared to Baseline			
	60-minute Travel Time		30-minute Travel Time		60 minute-Travel Time		30-minute Travel Time	
	Job Change	% of Change	Job Change	% of Change	Job Change	% of Change	Job Change	% of Change
Bell	-43,088	-13%	-8,587	-13%	-28,153	-8%	-5,662	-8%
Bell Gardens	-40,617	-13%	-5,317	-14%	-26,511	-8%	-3,586	-10%
Commerce	-112,294	-13%	-6,881	-13%	-75,837	-8%	-4,431	-8%
Compton	-53,540	-13%	-4,995	-12%	-35,463	-9%	-3,244	-8%
Cudahy	-43,484	-13%	-8,084	-13%	-28,429	-8%	-5,303	-9%
East Compton	-54,233	-13%	-3,387	-11%	-35,681	-9%	-2,220	-8%
East LA	-188,431	-14%	-43,085	-11%	-131,417	-10%	-28,894	-8%
Florence_Walnut Park	-105,549	-12%	-6,679	-12%	-70,387	-8%	-4,225	-8%
Huntington Park	-78,574	-11%	-8,498	-13%	-51,458	-7%	-5,574	-9%
Lynwood	-118,217	-12%	-3,905	-11%	-78,690	-8%	-2,510	-7%
Maywood	-97,749	-12%	-14,409	-13%	-64,711	-8%	-9,300	-8%
Paramount	-25,214	-13%	-2,889	-12%	-16,645	-9%	-1,890	-8%
Rancho Dominguez	-25,275	-13%	-5,505	-12%	-16,862	-9%	-3,717	-8%
South Gate	-54,886	-13%	-3,675	-13%	-35,938	-9%	-2,371	-8%
Vernon	-65,025	-11%	-3,923	-11%	-43,160	-7%	-2,457	-7%
Average (weighted)	**-73,745**	**-13%**	**-8,655**	**-12%**	**-49,289**	**-8%**	**-5,692**	**-8%**

4.5.5 Transit Service Change + Job Shocks

In Table 4-4 we consider both types of disruptions together - the April 2020 L.A. Metro service change and the estimated census block level job changes, February to May or February to July 2020. Table 4-4 shows the net transit job access changes from both effects, in May 2020 and July 2020 based on the two different employment change time windows.

Table 4-4: Job access decrease due to transit service change and economic recession in the context of COVID-19 pandemic

City Name	Job Access Change in May Compared to Baseline				Job Access Change in July Compared to Baseline			
	60 min. Travel Time		30 min. Travel Time		60 min. Travel Time		30 min. Travel Time	
	Job Change	% of Change	Job Change	% of Change	Job Change	% of Change	Job Change	% of Change
Bell	-102,599	-31%	-23,432	-35%	-90,645	-27%	-21,323	-32%
Bell Gardens	-64,746	-20%	-6,021	-16%	-51,813	-16%	-4,331	-12%
Commerce	-161,056	-18%	-9,716	-19%	-127,262	-14%	-7,404	-14%
Compton	-81,142	-20%	-4,995	-12%	-64,527	-16%	-3,243	-8%
Cudahy	-60,650	-18%	-9,519	-15%	-46,420	-14%	-6,809	-11%
East Compton	-135,400	-33%	-3,387	-11%	-121,733	-29%	-2,219	-8%
East LA	-360,714	-26%	-105,828	-28%	-310,865	-23%	-95,553	-25%
Florence_Walnut Park	-207,790	-24%	-33,123	-59%	-178,305	-21%	-31,889	-57%
Huntington Park	-154,867	-22%	-19,863	-31%	-131,264	-19%	-17,777	-28%
Lynwood	-422,789	-44%	-17,367	-51%	-393,872	-41%	-16,493	-48%
Maywood	-232,448	-28%	-29,836	-27%	-205,268	-25%	-25,555	-23%
Paramount	-39,539	-21%	-2,889	-12%	-31,672	-17%	-1,890	-8%
Rancho Dominguez	-25,543	-13%	-5,504	-12%	-17,137	-9%	-3,716	-8%
South Gate	-201,417	-48%	-8,588	-31%	-190,426	-46%	-7,554	-27%
Vernon	-124,898	-21%	-3,012	-8%	-105,398	-18%	-1,455	-4%
Average (weighted)	**-184,693**	**-28%**	**-24,349**	**-28%**	**-162,105**	**-24%**	**-21,701**	**-25%**

4.6 Bikeshare Case Study

Because improving first-last mile station access had the largest impact on transit job access, we studied the potential for a docked bikeshare program in two of our study locations – East Los Angeles and Maywood. Both East Los Angeles and Maywood are in the more well connected, job-rich area of the north and north-center part of the SELA region. They have the two highest 30-minute baseline transit job access measures (Table 4-1.) East Los Angeles has the second largest magnitude job access gain in the 30-minute bikeshare scenario. Maywood had a large magnitude bikeshare gain, but in percentage terms Maywood's bikeshare gain was the 2nd lowest of the 15 student locations, at a 34 percent increase – still importantly large. The East Los Angeles and Maywood case study areas are shown in the map in Figure 4-7. The population density and transit stop locations with less the 10-minute peak hour frequency (i.e., less than 5-minute average wait-time at the stop) are shown in Figure 4-8.

Figure 4-7: East Los Angeles and Maywood case study areas, in the context of the SELA region

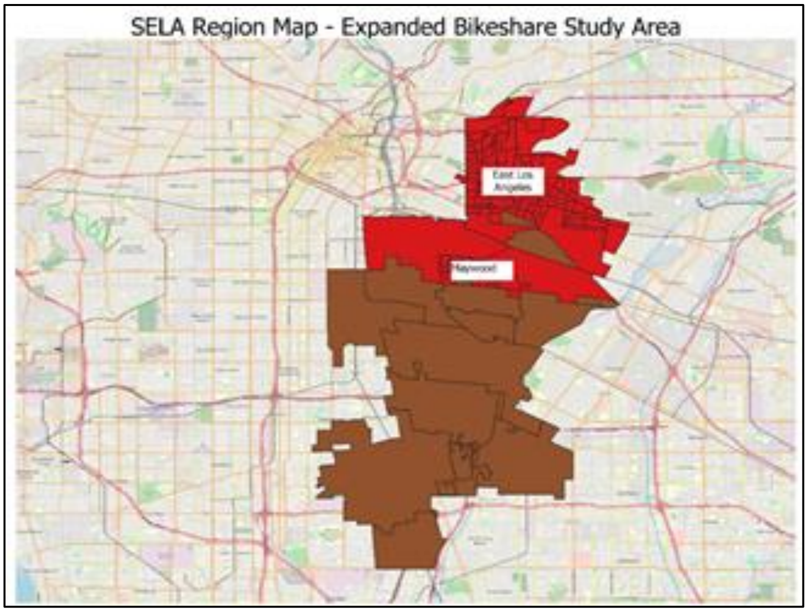
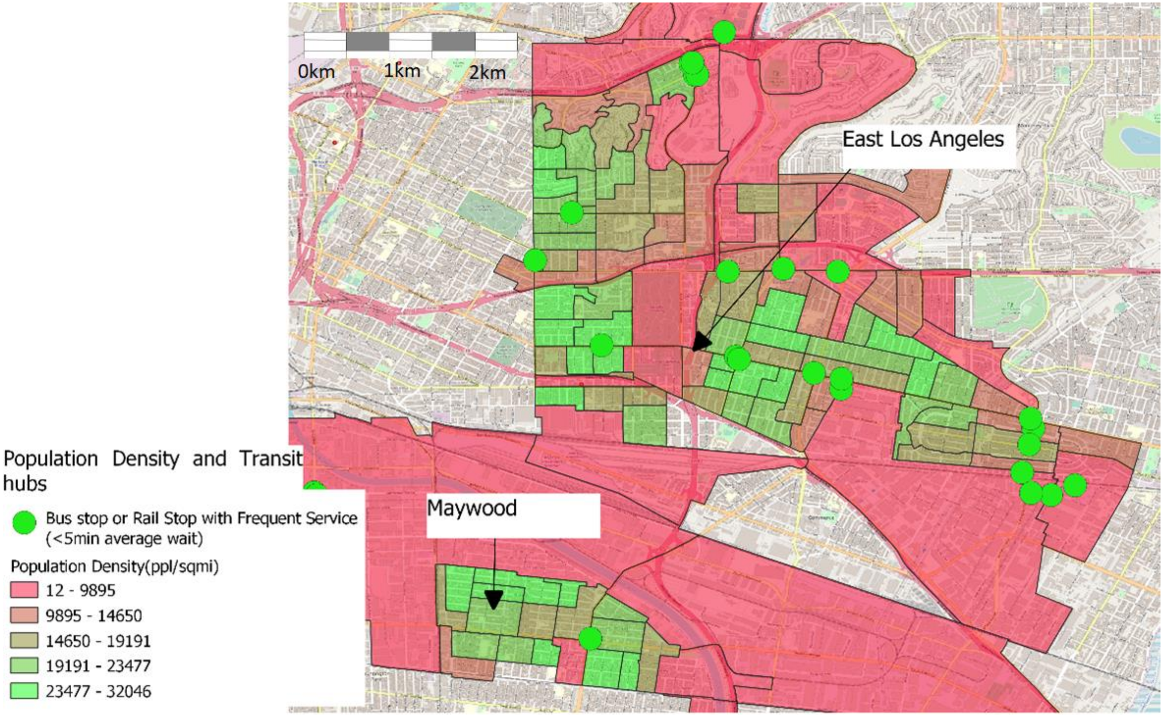


Figure 4-8: Population density and locations of high frequency transit stops in East Los Angeles and Maywood Case study areas



To motivate the potential for bikeshare in these two case study areas, we modeled the travel time to the nearest high frequency (less than or equal to 10-minute peak headway) transit hub by walking (3 mph) and by bicycling (10 mph). We used straight-line travel distances, which will overstate walking and bicycling access, but the comparison across the two access/egress modes is informative. The results are in Figure 4-9 and Figure 4-10. Moving transit access from walking to bicycling speed puts large portions of the case study areas within a 5-minute straight-line trip to the nearest high frequency transit stop.

Figure 4-9: Travel time to nearest transit hub, walking speed

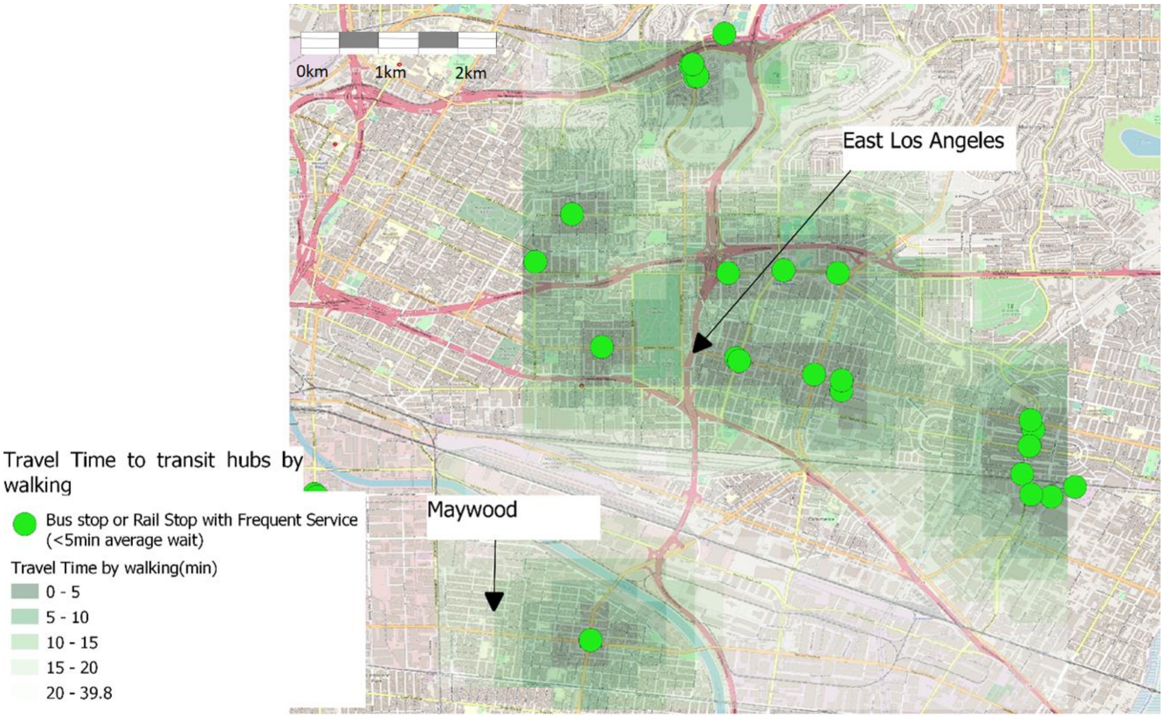
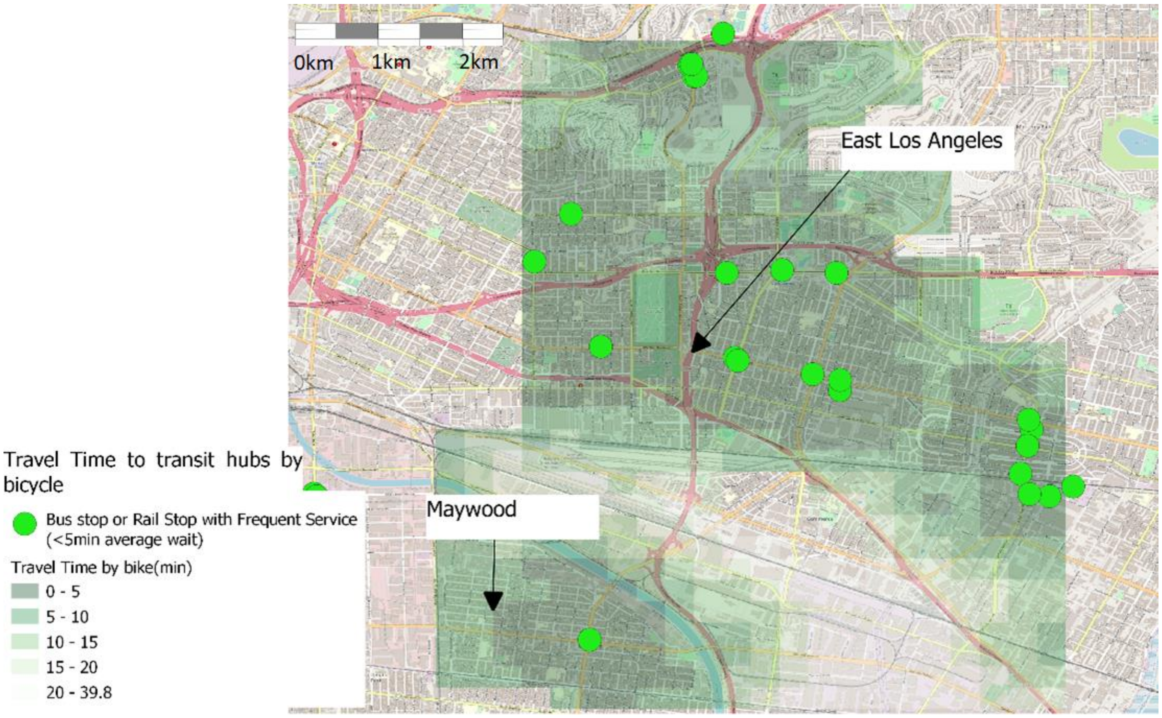


Figure 4-10: travel time to nearest transit hub, bicycling speed



We next assessed possible locations for a docked bikeshare program in the case study areas. We divided the two cases study areas into 300 by 300-meter grid cells, and used a formula based on data from New York City's Citi Bike program to select bikeshare locations within those grid cells. Data for Citi Bike ridership in October 2019 were drawn for Brooklyn, and census and Open Street Map (OSM) data were used to calculate correlates of Citi Bike station location ridership. Regression analysis yielded the formulae shown below, for four factors: population density, park space nearby, bike lanes, and distance to transit. For each 300x300 meter grid cell, locations at 50-meter intervals on a street were examined using the formulae shown below. For each possible location, the values for density, park/public space square footage, bike lanes, and distance to transit were drawn from a surrounding 300-meter catchment area. Based on the Brooklyn regression analysis, the regressions for density, park/public space, bike lanes, and distance to transit are shown below.

- Density (d): Trips per month = 0.0538*population density + 673
- Park/public space Square footage (p): Trips per month = 0.005*park space size (in square meters)
- Bike Lanes in Area (b): Trips per month = 181*number of bike lanes
- Distance to Transit (t): Trips per month = -367.3*ln (distance to transit hub) + 3404.5, where transit hub is nearest transit stop with less than 10-minute peak-hour frequency

The final score was determined by adding d+b+p+t = final score for the station. Note that the regressions above are not used to predict bikeshare trips per month. Instead, the equations, based on regression analyses for Brooklyn, are used to get an ordinal ranking of possible bikeshare locations.
In each 300x300 meter grid cell, the location with the highest score was chosen as a bikeshare location. That yielded 310 total possible bikeshare locations in the two case study areas. From among those 310 possible bikeshare locations, we focus on the locations in the top 25th percentile of d+b+p+t scores – 78 possible bikeshare locations. As expected, this "top 25%" network formed mostly a cohesive region. The location of the top 25% bikeshare locations is shown in Figure 4-11. The "top 25%" bikeshare locations can importantly improve travel time to high frequency transit stations, as shown in Figure 4-12.

Figure 4-11: Location of the top 25% highest score bikeshare locations, East Los Angeles and Maywood

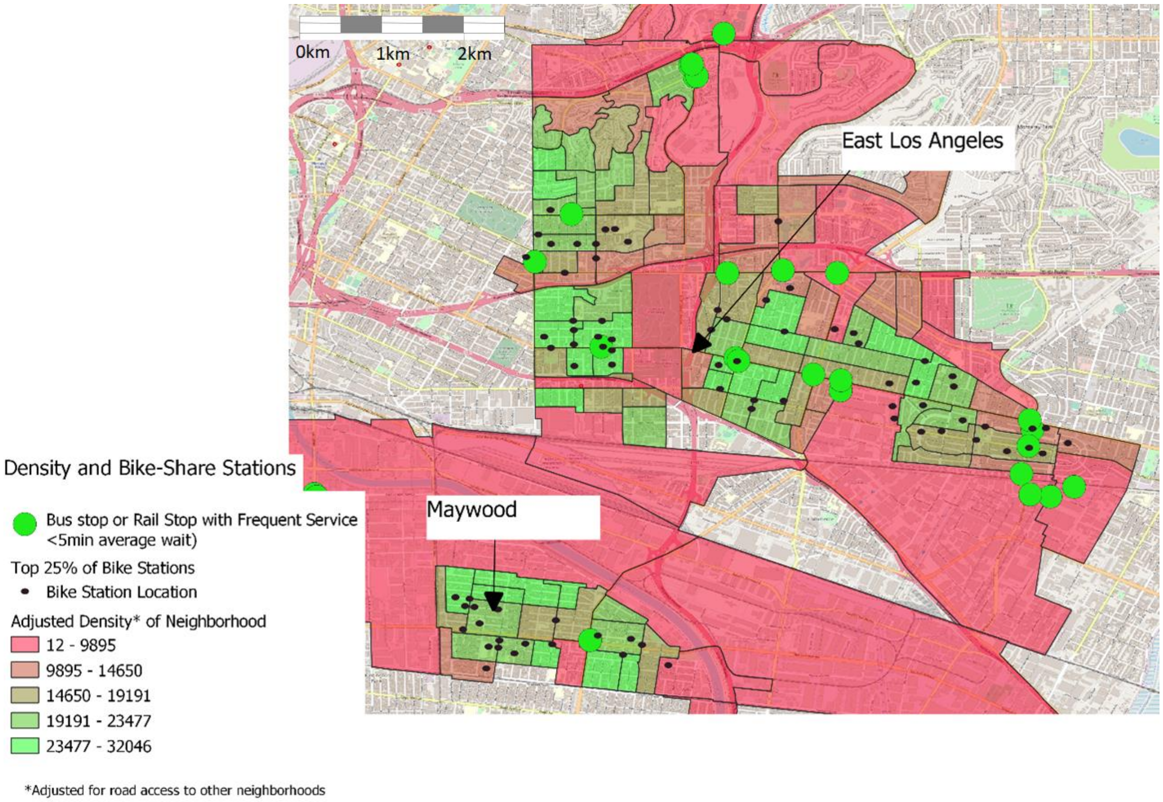
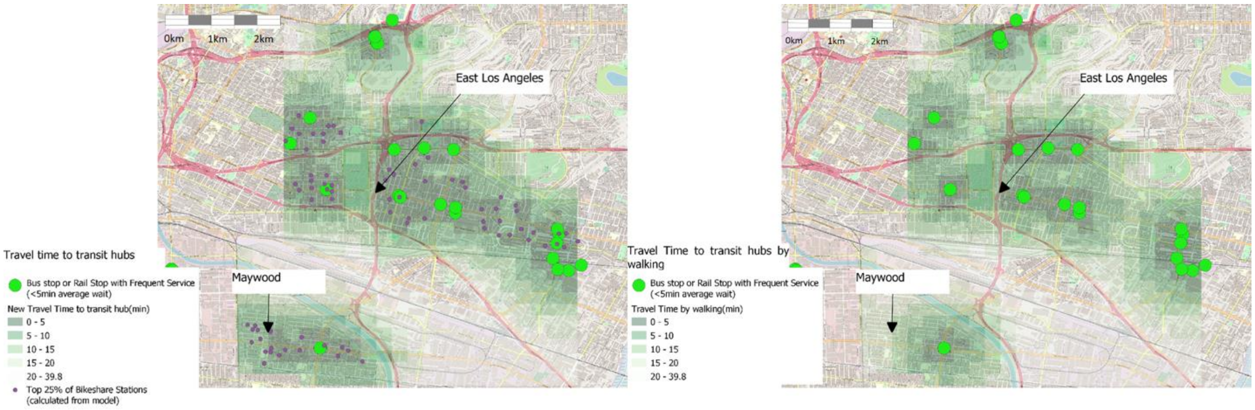


Figure 4-12: Travel time to high frequency transit stop, with bikeshare, left, without bikeshare, on right



In Table 4-5, we quantify the number of people within five and ten minutes of high frequency transit stops (less than 10-minute peak headway), by walking and by bikeshare assuming that the “top 25%” or all 310 bikeshare locations are active in East Los Angeles and Maywood. Implementing the “top 25%” of the bikeshare locations will bring approximately two-thirds of the case study area’s population within 10-minutes straight-line (via bikeshare) of high frequency transit. Implementing all 310 bikeshare locations will bring over 85 percent of the population of East Los Angeles and Maywood within 10 minutes straight-line of a high frequency transit station. Of course, not everyone will or is able to use docked bikeshare, and so these access estimates will overstate the improvement in access. Still, it is striking that the docked bikeshare has the potential to greatly increase the access to and hence the effectiveness of the transit system in the case study areas.

Table 4-5: Population within 5 and 10 minutes of high frequency transit, walking and docked bikeshare, East Los Angeles and Maywood

Category	No Bike-share System (walking station access/egress)	Top 25% of Bikeshare Locations	All 310 Bikeshare Station Locations
Population within 5-minute commute to frequent transit	34,716	52,342	103,800
Population within 10-minute commute to frequent transit	87,869	105,987	138,103
Total Population of Case Study Area	159,243		

4.7 Recommendations

The two most notable findings from this research are the importance of first-last mile access to stations and the potential for bicycle or car travel as a transit access extender. Among the scenarios studied, bringing all SELA transit lines to 10-minute or less peak weekday headways will increase job access, on average, 31 percent in the SELA region; increasing access/egress speeds to/from stations to bicycle speed increases SELA job access by 65 percent; increasing access/egress speeds to/from stations to driving speed increases SELA job access by 182%. Changing the speed of first-last mile station access has great potential. Given that, our top two recommendations relate to improving first-last mile station access in the SELA region.

- L.A. Metro should expand their on-demand shuttle pilot in the SELA region. Los Angeles Metro launched an on-demand shuttle service, called Metro Micro, in October of 2020. The shared ride pilot service has expanded to five pilot areas with four more launching in 2021. Of those, the Watts-Willowbrook area serves the central part of the SELA region. The service allows users to schedule a shared ride, on small shuttle vehicles, at an introductory rate of a dollar per ride. Metro Micro provides rides within local service areas during designated service hours, currently 5 a.m. to 11 p.m. in the Watts-Willowbrook service area.

We recommend that L.A. Metro prioritize expansion of Metro-Micro into other parts of the SELA region. Our simulations show that every one of the fifteen SELA study areas can more than double their job access if riders can access stations at driving speeds. Particularly attractive locations for an expansion of Metro-Micro are Commerce in the northern part of the SELA region (a projected 813 percent transit job access increase from driving speed first-last mile access), Bell Gardens (a projected 415 percent transit job access increase from driving speed first-last mile access) and Lynwood (a projected 409 percent transit job access increase from driving speed first-last mile access.) (See Table 1 for details on these results.) Funds will likely be available from federal and state stimulus and pandemic recovery programs, and an expansion of frequent or on-demand shuttles that improve access to transit stations in the SELA region should be a priority.

- L.A. Metro should work with cities and partner entities to bring a robust bikeshare program and bicycle infrastructure to the SELA region. Our analysis shows that placing 78 bikeshare stations in East Los Angeles and Maywood can put approximately one-third of those areas' residents within five minutes of high frequency transit (peak headway 10-minutes or less). We recommend that Metro prioritize a bikeshare program in the SELA region. The best location for a bikeshare pilot should be examined in collaboration with the community, but we note that the job concentrations and existing high frequency bus lines in the northern part of the SELA region suggest that a promising early opportunity for docked bikeshare focused on station access would be in the northern part of SELA.

Successful bikeshare programs require supportive infrastructure, including separated (Class IV) bikeways or cycle tracks. Traffic safety is an important issue in SELA – a point reinforced by the freight focus groups' comments about traffic safety related to truck travel through the region. We recommend that a bikeshare program include development of a network of bicycle lanes – ideally separated and protected from traffic – to allow safe travel.

Note that both of the above recommendations will help bring first-last mile station access in the SELA region to bicycle or car speed. Our simulations modeled bicycle and station car speeds both inside and outside SELA, and we note that first-last mile improvements only within SELA will not deliver the full job access increases listed in Table 4-1. Yet even if one assumed that the first-last mile job access improvements shown in Table 4-1 would be cut in half from programs that only improve access at origin stations within SELA – certainly an underestimate given that some trips are wholly within SELA – half of Table 1's first-last mile improvements would still deliver important job access gains.

We suggest additional recommendations, shown below.

- **Prioritize bus frequency improvements in the SELA region.** Our simulations show that moving every bus and rail line that traverses the SELA region to a 10-minute or less weekday peak frequency would increase transit job access during that service time by 31 percent. The same frequency increase – 10-minute or less headways systemwide – will increase transit job access in the SELA region by 34 percent. This illustrates how important frequency improvements, even when implemented only on the lines that traverse SELA, can be. We are not recommending that every line in the region be moved to a 10-minute or less headway. However, based on our analysis, we recommend that Metro prioritize studying and implementing frequency improvements in the SELA region as part of their restoration of service with the waning of the COVID-19 pandemic.

- Plan for first-last mile access to future West Santa Ana Branch light rail stations. Our simulations showed only modest job access improvements from the West Santa Ana Branch light rail line, averaging a 2.2 percent job access increase across the SELA region. We caution that this result understates the importance of the West Santa Ana Branch line. Unlike the other scenarios studied, the West Santa Ana Branch line is spatially focused in parts of the SELA region, and so a focus on a SELA average will understate the importance of the line in the cities that have proposed stations. Note that Table 4-1 shows that the West Santa Ana Branch will yield a transit job access increase of 14.5 percent in Cudahy and 13.2 in Huntington Park. In our discussions with L.A. Metro staff, they noted that the GIS-based job access analysis that we conducted does not use the criteria of a Federal Transit Administration (FTA) analysis and cannot demonstrate the value of the West Santa Ana Branch relative to FTA criteria. We agree. In our discussions with stakeholders in the SELA region, we heard enthusiasm for the West Santa Ana Branch, which will improve SELA's connections to regional rail. Our analysis demonstrates the importance of first-last mile connections to West Santa Ana Branch stations. Those first-last mile connections can make the West Santa Ana Branch a valuable access tool for the entire SELA region. We recommend that SELA cities, regional and West Santa Ana Branch planning bodies, and L.A. Metro collaborate to prioritize robust bicycle and shuttle access to West Santa Ana Branch stations.

- Restore the COVID-related service reductions at the earliest opportunity. Our simulations showed that the April 2020 service reductions required by the COVID-19 pandemic decreased transit job access in SELA by, on average, 19 percent. Restoring the service to pre-pandemic levels is an important first step. We do not recommend that bus and rail service be restored to exactly the pre-pandemic timetable. The details of timetables and service frequency and location are for L.A. Metro to determine. Our recommendation is that L.A. Metro move to reverse the pandemic transit service reductions as soon as feasible.

Chapter Five: Transit Service Quality

5.1 Introduction

The first community focus group, in October of 2019, revealed that the SELA community was more concerned about service quality issues than job access. Following the evolving transit access literature (e.g. Wachs and Kumagai, 1973; Levinson and Wu, 2020), we had planned to focus on job access as the key performance measure for the transit system. The results of that analysis were summarized in Chapter 4. Yet in the first focus group, residents spoke often about other concerns. One focus group participant mentioned that a bus would sometimes fail to stop at the bus stop, even when the bus was not full. Other participants echoed that concern. Participants spoke about a lack of cleanliness on the bus, or about feeling unwelcome or harassed by other riders. Overall, the most common concern from the October 2019 focus group was service quality broadly construed. More traditional metrics, including on-time performance, arrival frequency, or access to jobs were not mentioned as commonly in the focus group. The service quality concerns that surfaced in the first focus group centered on the cleanliness of the busses, a fear of harassment from other passengers and disappointment that drivers were not able to bring a higher sense of safety in those situations, and concerns that drivers failed to stop even when there was room on the bus.

We modified our study design to include a short survey to gather more information about these concerns. We initially planned an intercept survey of passengers near bus stops, but the pandemic had begun by the time of our planned mid-March 2020 survey launch. We pivoted the survey to an online social media survey. The results, and supplemental analysis of separate and larger Metro on-board surveys of riders, are described in this chapter.

5.2 Survey

In response to focus group comments, we designed a survey to gather insights from local residents and help us understand transit service in the SELA neighborhood. We partnered with the Southeast Los Angeles (SELA) Collaborative for survey design and distribution. The SELA Collaborative is a local non-profit organization that works on improving civic engagement in the nearby 11 communities including Bell, Bell Gardens, Cudahy, Florence-Firestone, Huntington Park, Lynwood, Maywood, South Gate, Vernon and Walnut Park. The bus service survey was created on Survey Monkey, an online survey platform. The survey was distributed through SELA Collaborative's email contacts and social media (Twitter, Instagram, and Facebook). Flyers are also distributed at the local YMCAs. The distribution dates were from April 10, 2020 to July 31, 2020. We received a total of 77 responses with 80% of respondents living in the SELA region.

5.2.1 Survey Results

Results, shown below, show that 59% (35) of respondents have seen bus drive by without stopping. Of those, 45% (14) said there was still room on the bus, but the bus did not stop.

<u>Detailed Results</u>

1) Reliability

Figure 5-1: Bus survey results: When waiting at the bus stop, have you ever seen the bus drive by without stopping?

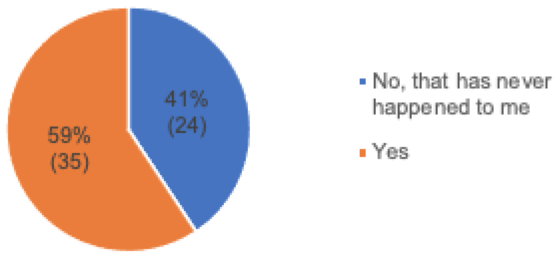


Figure 5-2: Bus survey results: Why did the bus not stop?

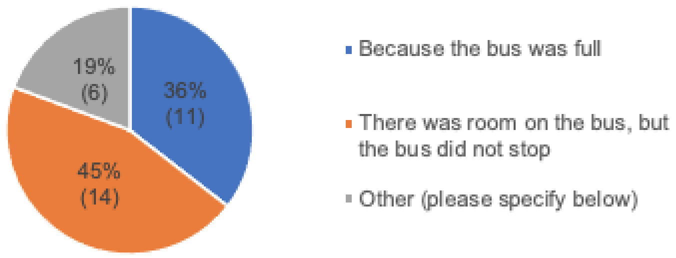
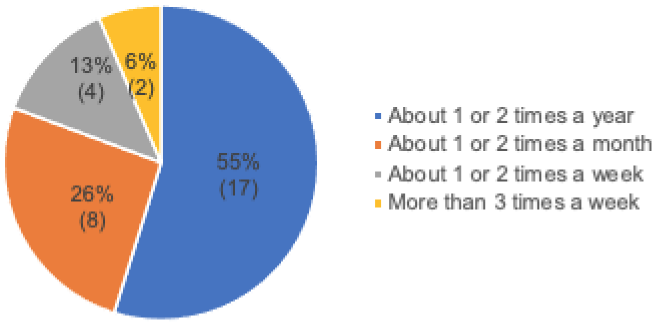


Figure 5-3: Bus survey results: How often have you seen the bus not stop when waiting at the bus stop?



2) Safety and Cleanliness

Figure 5-4: Bus survey results: I feel safe on the bus

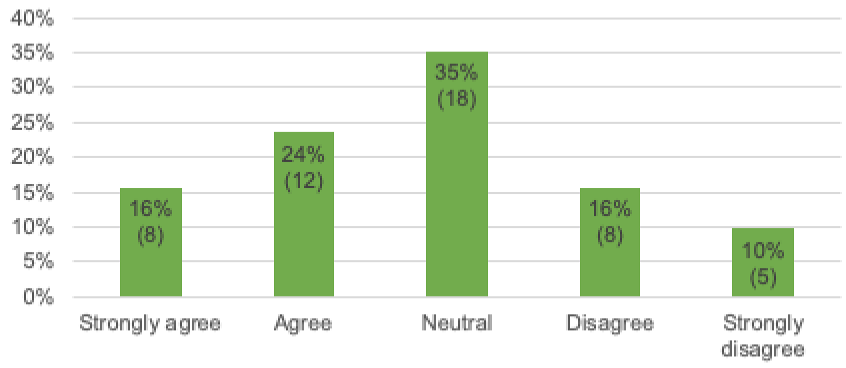


Figure 5-5: Bus survey results: I feel that the bus is clean

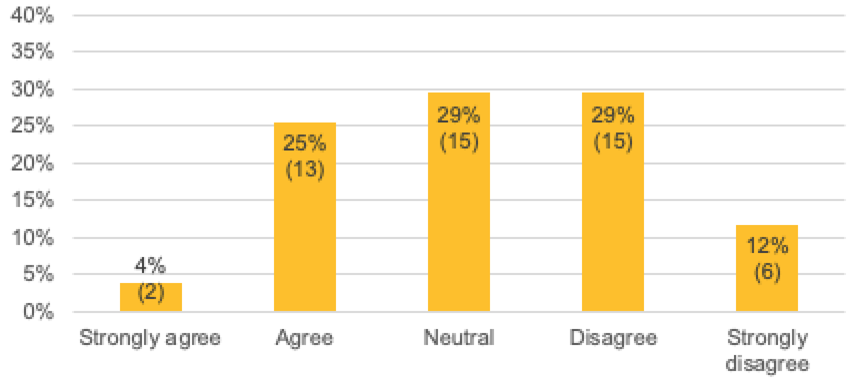
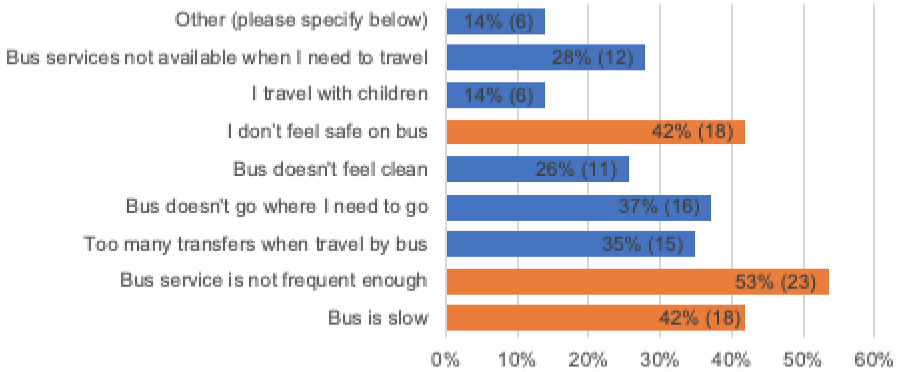


Figure 5-6: Bus survey results: The reasons why I don't use bus services are: (Please check all that apply)



The sample size for the survey is small (n=77) and the representativeness of the survey sample is limited by the necessity for social media distribution during the pandemic. For those reasons, we view the responses as suggestive but not definitive. The survey echoed the concerns from the focus groups. Among survey respondents, 59 percent reported having seen a bus fail to stop, and among those respondents 45 percent reported that the bus had room but failed to make a stop. In discussions with L.A. Metro, staff noted that the bus might have been out of service but the survey respondent did not notice or did not recall that sign. We agree, but we note that the perception reflected in the survey responses suggests at a minimum a lack of confidence in bus service quality. Among survey respondents, 41 percent did not agree that the bus was clean. These results echoed the results from the focus group, with cleanliness and a general concern about service quality being the most common concerns in both the focus group and the pilot survey.

We compared the results of our small pilot survey with results from L.A. Metro's onboard rider survey, conducted October through November, 2019. Metro's onboard survey had 10,652 respondents. We selected responses from bus lines that went through the Gateway Cities governance council area, which includes an area that goes beyond SELA but also includes the SELA study communities of Bell, Bell Gardens, Commerce, Compton, Cudahy, Huntington Park, Lynwood, Maywood, Paramount, South Gate, and Vernon.

The results of Metro's onboard survey differed from our social media pilot survey. The L.A. Metro survey found that 85% of respondents in the Gateway Cities feel safe while waiting for and riding on the bus, and that more than 80% of the respondents agreed that the bus and bus station areas are clean. Results from the L.A. Metro survey are shown in Table 5-1, Table 5-2, and Table 5-3 below.

Table 5-1: Satisfaction, from L.A. Metro 2019 on-board survey, Gateway Cities lines

Q. Generally speaking, I am satisfied with Metro Bus/Rail service		**Valid Percent**
Valid	Strongly Agree	52.5%
	Agree	38.6%
	Disagree	5.2%
	Strongly Disagree	3.6%
	Total	100.0%

Table 5-2: Sense of safety, from L.A. Metro 2019 on-board survey, Gateway Cities lines

		Q. I feel safe while waiting for THIS bus/train	**Q. I feel safe while riding THIS bus/train**
		Valid Percent	**Valid Percent**
Valid	Strongly Agree	46.3%	52.0%
	Agree	40.3%	39.5%
	Disagree	10.5%	6.2%
	Strongly Disagree	3.0%	2.2%
	Total	100.0%	100.0%

Table 5-3: Perception of cleanliness, from L.A. Metro 2019 on-board survey, Gateway Cities lines

		Q. THIS bus/train is generally clean	Q. THIS bus's/train's stops/stations are generally clean
		Valid Percent	Valid Percent
Valid	Strongly Agree	48.0%	40.1%
	Agree	40.5%	38.7%
	Disagree	8.8%	15.8%
	Strongly Disagree	2.8%	5.4%
	Total	100.0%	100.0%

The L.A. Metro on-board had a larger sample, drawn from riders. Due to the COVID-19 pandemic, our pilot survey was circulated via social media. We note the different sampling methods. While the Metro survey indicated a high level of satisfaction, our focus group results were more consistent with our pilot survey, indicating concerns about the perceived safety and cleanliness of the busses and bus stops in SELA.

Our focus group participants highlighted their concerns about the safety, cleanliness, and reliability of L.A. Metro bus lines. Their comments were provided without prompting in the focus groups. L.A. Metro's on-board survey data from 2019 did not reflect the same magnitude of service quality concern. Some of the concerns that surfaced in focus groups might differ from Metro's on-board survey due to the open-ended nature of focus group discussion.

5.3 Recommendations

- Continue to focus on improved transit service. We recommend that L.A. Metro supplement their on-board surveys with focus groups organized in collaboration with SELA community groups. The SELA Collaborative can provide links to community groups in the SELA region. We recommend that L.A. Metro use both focus groups and surveys in an ongoing basis to improve the rider experience on transit. L.A. Metro has made important strides in this direction recently, launching a 2019 study on the experience of women who ride transit (https://thesource.metro.net/2019/09/19/metro-releases-understanding-how-women-travel-report/.) That can provide a foundation for future studies on service quality.

Chapter Six: Conclusions and Policy Recommendations

Our research shows that the SELA community experiences serious impacts from freight activity within and around the area. Not only does the SELA area contain several major freight generators, it is also a pass through area for regional freight traffic. The result is a disproportionate share of all truck traffic within the area.

6.1 Recent Developments in Air Quality Regulation

To meet federally mandated air quality standards, the South Coast region must reduce NOx emissions by 45% by 2023, and 55% by 2031, against 2017 emission baselines (Proposed Warehouse Indirect Source Rule community meeting, 2/17/21). To accomplish this substantial reduction, the SCAQMD is developing Facility-Based Mobile Source Measures (FBMSMs), that aim to curb emissions associated with goods movement, regulating warehouses, airports, new or redevelopment projects, marine ports, and railyard/intermodal facilities (Air Quality Management Plan, 2016). Mobility is a heavy contributor to regional air pollution: according to 2019 data, 82% of regional smog came from mobile sources vs. 18% from stationary sources, i.e., trucks as opposed to factories (Warehouse ISR meeting, 2/17/21). Typically, CARB owns sole regulatory authority over vehicle-based emissions, while AQMDs have authority over all other sources unrelated to mobility (PR 2305 Draft Staff Report). However, the state Health and Safety Code 40716 grants AQMDs broad control to regulate “indirect and areawide sources in order to meet state ambient air quality standards” (PR 2305 Draft Staff Report, p. 18). Given the substantial emissions reductions required by federal standards, there is an unequivocal need for expanded air quality mitigation measures in the South Coast region.

For the SELA region, the most relevant of these FBMSMs is the Warehouse Indirect Source Rule (ISR). The need to focus on warehouses is acute: communities within ½-mile of a warehouse experience a pollution burden in the 80th percentile, compared with 61st in the overall SCAQMD (Warehouse ISR meeting, 2/17/21). As described in Proposed Rules 2305 and 316, Warehouse ISRs apply to all warehouses larger than 100,000 square feet and implement a points-based system of compliance. Called Warehouse Actions and Investments to Reduce Emissions (WAIRE) points, warehouse owners and operators must meet yearly points targets via a host of options. As proposed, warehouses can earn WAIRE points via mitigation fees funding projects in nearby communities, and custom, facility based WAIRE plans (PR 2305 Draft Staff Report). Phasing in over three years, the Warehouse ISR also introduces mandatory reporting requirements covering facility operations as well as administrative fees, to be paid to the SCAQMD for administrative costs (PR 2305 Draft Staff Report).

According to SCAQMD projections, the Warehouse ISR projects NOx reductions of 2.5 to 4 tons per day—representing a 10-15% reduction in baseline NOx emissions, with similar forecasts for diesel particulate matter (Warehouse ISR meeting, 2/17/21). There are numerous public health benefits associated with the Warehouse ISR, which projects to avoid 42-49 premature deaths, 700 asthma attacks, and 2,500-3,000 lost workdays per year: a public health benefit of ~$3.5 billion over ten years (Warehouse ISR meeting, 2/17/21). However, despite its meaningful projected contribution, the Warehouse ISR will not enable the South Coast region to achieve federal compliance alone given expected 45-55% reduction thresholds. Additional FBMSMs such as the Railyard and Intermodal Facility ISR are also of importance to SELA. However, there is no current information available regarding the progress or details of these regulations.

6.2 Summary of Freight Policy Recommendations

The successful implementation of vehicle technology-related and other operational strategies included in current regulations will generate large regional environmental benefits. To achieve success, continuous programs that offer adequate incentives (monetary and non-monetary) are needed to help during the transition and to foster an equitable distribution of benefits. The technical limitations of ZEV trucks related to load capacities and ranges will have to be addressed, and major investments in fueling infrastructure will be required.

Local pollution hotspots in SELA can be mitigated by accelerating the transition to zero and near zero emission trucks operating within SELA. Charging stations should be considered in the I-5 corridor, the Carson area warehousing cluster, and the Alameda Street industrial corridor. Low emission zones may be considered to promote use of cleaner vehicles in these areas. There is potential for the SELA region to participate in demonstration projects related to these policy and technology implementations.

Local truck safety hotspots should be evaluated for operational changes. Our hotspot analysis revealed specific problem areas with higher than average truck crashes and exposure to residential areas and schools. To improve upon pedestrian and traffic safety specific operational and geometric improvements are recommended for the Alameda Street corridor, by potentially eliminating the Alameda Street Auxiliary or one-waying the auxiliary, and along the Firestone Boulevard corridor by updating traffic signal timings along the corridor and along major cross-street corridors to minimize truck traffic diversions onto side-streets and Southern Avenue. It is recommended that the remaining hotspots be similarly evaluated.

Geofencing should be considered to reduce truck traffic in residential areas. To further minimize localized pollution impacts in the interim period, geofencing policies should be implemented to keep heavy duty trucks out of residential neighborhoods. In some cases trucks deviate routes to save time. Geofencing would also have the additional benefit of pedestrian and traffic safety in these neighborhoods.

SELA Collaborative should partner with local municipalities to achieve traffic safety changes. Our hot spot analysis showed that each safety problem is unique. Operational improvements have the potential to reduce risk, and these charges are largely under the jurisdiction of municipalities.

6.3 Policy Recommendations for Transit Access

L.A. Metro should expand their on-demand shuttle pilot in the SELA region. Los Angeles Metro launched an on-demand shuttle service, called Metro Micro, in October of 2020. The shared ride pilot service has expanded to five pilot areas with four more launching in 2021. Of those, the Watts-Willowbrook area serves the central part of the SELA region. The service allows users to schedule a shared ride, on small shuttle vehicles, at an introductory rate of a dollar per ride. Metro Micro provides rides within local service areas during designated service hours, currently 5 a.m. to 11 p.m. in the Watts-Willowbrook service area.

We recommend that L.A. Metro prioritize expansion of Metro-Micro into other parts of the SELA region. Our simulations show that every one of the fifteen SELA study areas can more than double their job access if riders can access stations at driving speeds. Particularly attractive locations for an expansion of Metro-Micro are Commerce in the northern part of the SELA region, Bell Gardens and Lynwood (see Chapter 2 for details on these results.) Funds could likely be available from federal and state stimulus and pandemic recovery programs, among other possible funding sources.

L.A. Metro should work with cities and partner entities to bring a robust bikeshare program and bicycle infrastructure to the SELA region. The best location for a bikeshare pilot should be examined in collaboration with the community, but we note that the job concentrations and existing high frequency bus lines in the northern part of the SELA region suggest that a promising early opportunity for docked bikeshare focused on station access would be in the northern part of SELA.

Successful bikeshare programs require supportive infrastructure, including separated (Class IV) bikeways or cycle tracks. Traffic safety is an important issue in SELA – a point reinforced by this study's findings about traffic safety related to truck travel through the region. We recommend that a bikeshare program include development of a network of bicycle lanes – ideally separated and protected from traffic – to allow safe travel.

These recommendations will help bring first-last mile station access in the SELA region to bicycle or car speed. First-last mile improvements only within SELA will not deliver the full job access increases from the scenarios in Chapter 2. Yet even if one assumed that the first-last mile job access improvements that we modeled would be cut in half from programs that only improve access at origin stations within SELA – certainly an underestimate given that some trips are wholly within SELA – half of the modeled first-last mile improvements would still deliver important job access gains.

Prioritize bus frequency improvements in the SELA region. Based on our analysis, we recommend that Metro prioritize studying and implementing frequency improvements in the SELA region as part of their restoration of service with the waning of the COVID-19 pandemic.

Continue to focus on improved transit service. Our focus group participants highlighted their concerns about the safety, cleanliness, and reliability of L.A. Metro bus lines. They mentioned concerns about the quality of transit service more often than they discussed job access. Given the differences from L.A. Metro on-board surveys, we recommend that L.A. Metro supplement their on-board surveys with focus groups organized in collaboration with SELA community groups. The SELA Collaborative can provide links to community groups in the SELA region.

Plan for first-last mile access to future West Santa Ana Branch light rail stations. Our analysis demonstrates the importance of first-last mile connections to West Santa Ana Branch stations. Those first-last mile connections can make the West Santa Ana Branch a valuable access tool for the entire SELA region. We recommend that SELA cities, regional and West Santa Ana Branch planning bodies, and L.A. Metro collaborate to prioritize robust bicycle and shuttle access to West Santa Ana Branch stations.

Restore the COVID-related service reductions at the earliest opportunity. Restoring transit service to pre-pandemic levels is an important first step in improving job accessibility. Understanding that service restoration depends on demand and budgets, we recommend that L.A. Metro move to reverse the pandemic transit service reductions as soon as feasible.

6.4 Summary of Recommendations for Implementation

The overall goal of this research is to move some recommendations to implementation. To accomplish this, we make the following recommendations:

- Communicate study results to the larger SELA community through a community open meetings, media and print communications.
- Promote clean truck pilot programs and demos in the SELA region, as well as EV infrastructure investment
- Work with cities to promote specific intersection improvements and other operational strategies to improve traffic and pedestrian safety
- Work with LA Metro to further explore service issues
- Explore Metro Micro on-demand service and bikeshare solutions as opportunities for further study.

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Data Management Plan

Products of Research

Many data sources were used in this study.

Data sets:

CalEnviroScreen 4.0, available at https://oehha.ca.gov/calenviroscreen/report/draft-calenviroscreen-40
American Community Survey, various years, available from US Census
Southern California Association of Governments regional transportation model output, 2012 model year
Traffic Injury Monitoring System data, 2015-2018
US Census LEHD Origin-Destination data (LODES), 2017
California Employment Development Department employment data, various years

Original data collected:

Focus groups transcripts
Field observation data on safety hot spots
Transit service quality survey

Table DMP-1: Data sources, format and content, access and sharing

Data	Source	Format & content	Access & sharing
CalEnviroScreen 4.0	California Office of Environment Health and Hazard Assessment	Visualization tool measuring vulnerability to environmental hazards	Available to public via OEHHA website
American Community Survey	US Census	Rolling population survey of US households; downloadable files in csv	Available to public via US Census ACS website
Regional transportation model output, 2012	Southern California Association of Governments	TransCad software files	Available by request to SCAG
Traffic Injury Monitoring System	UC Berkeley	Annual data on all traffic crashes in California' downloadable csv files	Available to public via UC Berkeley SafeTREC website
LEHD Origin-Destination data, 2017	US Census	Journey to work origin and destination data, including workplace area characteristics; downloadable csv files	Available to public via US Census LEHD website
California EDD employment data	California Employment Development Department	Annual employment data; downloadable csv files	Available to public via California EDD website

OpenStreetMap	OpenStreetMap.org	Open source street network data; interactive mapping service; downloadable via api	Available to public via OpenStreetMap website
Focus group transcripts	Research team	Text files of focus group discussions	Confidential information, not available to public
Field observation of safety hot spots	Research team	Notes and photos of hot spot areas summarized in this report	Publicly available in Chapter 2 of this report
Transit service quality survey	Research team	77 survey responses compiled in excel spreadsheet	Available by request from research team

Data Access and Sharing

Individuals will be able to access the transit service quality data through Dryad and should contact the co-principal investigator (Dr. Marlon Boarnet) prior to accessing the data. The data should not be hosted in other locations and should only use the Dryad repository. Users of the data should reference the system providers, and the data repository in Dryad. The DOI for the data is: XXXX. SCAG data is retained by SCAG and available only by request to SCAG. Focus group data is confidential and cannot be shared. All other data sources are available via public websites.

Reuse and Redistribution

Dr. Genevieve Giuliano and the other co-authors of the work hold the intellectual property rights to the data collected in this research. Data will not be able to be transferred to other data archives besides the ones approved by the PI. The data, with the limitations described above, can be used by anyone with proper referencing to the authors.

Appendix A: Vehicle Emissions Simulator Based on ARB's EMFAC Model

EMission FACtor (EMFAC) is an emission factors model developed by the Air Resources Board to estimate the official emissions inventories of on-road mobile sources in California (California Air Resources Board, 2021b). EMFAC provides aggregated and disaggregated emission factors for combinations of vehicle types, vehicle year, season, region, network speeds, fuel types, and model year. The team used the vehicle type definitions in the SCAG model, as well as EMFAC to identify a set of emission rates to be used in the analyses. Considering that SCAG uses 3 types of vehicles that include different categories in EMFAC, the team estimated composite emission rates based on the weighted (by EMFAC VMT estimates) composition of the fleet, per fuel type, and model year (see Table A-1 for EMFAC vehicle types). The model does not include much information about alternative fuels, and lacks data on natural gas vehicles.

Table A-1: EMFAC 2012 fleet composition by vehicle and fuel type

EMFAC Vehicle Definition		2012 VMT composition			
		Gasoline	Diesel	Nat. Gas	Electric
LDA	Passenger Cars	99%	0%	0%	0%
LDT1	Light-Duty Trucks (GVWR <6000 lbs/ ETW <= 3750 lbs)	100%	0%	0%	0%
LDT2	Light-Duty Trucks (GVWR <6000 lbs/ETW >3751lbs)	100%	0%	0%	0%
MDV	Medium-Duty Trucks (GVWR 6000-8500 lbs)	100%	0%	0%	0%
Composite	All - LM	100%	0%	0%	0%
LHDT1	Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs)	66%	34%	0%	0%
LHDT2	Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs)	48%	52%	0%	0%
Composite	Combined - LT	63%	37%	0%	0%
MHDT	Medium-Heavy-Duty Truck - MT	17%	83%	0%	0%
HHDT	Heavy-Heavy-Duty Truck - HT	1%	99%	1%	0%

Based on these vehicle types, the team generated composite emissions rates per 5-mph speed bins for the various modeling years (see Table A-2 for an example of the 2012 emission rate estimates). Moreover, Figure 4 graphically represents these emissions rates for the three vehicle types. The emissions rates include GHGs and criteria pollutants. Specifically, they consider CO2, CO, NOx, N2O, CH4, PM10, PM2.5, and SOx.

Table A-2: 2012 emission rates (grs/mile)

A-2a: Light trucks

Speed	ROG	TOG	CO	Nox	SOx	CO2	CH4	PM10	PM2.5	N2O
5	0.5826	0.7568	4.9993	1.9707	0.0174	1782.23	0.0765	0.0588	0.056	0.1068
10	0.4096	0.5311	3.98	1.9837	0.0143	1468.50	0.0528	0.0414	0.0395	0.0925
15	0.282	0.3662	3.1357	2.0046	0.0111	1132.17	0.0365	0.0301	0.0287	0.0671
20	0.2028	0.2639	2.572	2.0434	0.0092	946.984	0.0265	0.0229	0.0219	0.0587
25	0.1563	0.2031	2.1901	2.0953	0.008	817.274	0.0202	0.0182	0.0174	0.053
30	0.1273	0.1651	1.9331	2.164	0.0071	729.071	0.0163	0.0151	0.0144	0.0488
35	0.1089	0.141	1.7666	2.2389	0.0067	689.676	0.0138	0.0131	0.0125	0.048
40	0.0985	0.1274	1.683	2.3252	0.0065	667.815	0.0124	0.012	0.0114	0.0466
45	0.0928	0.1198	1.6421	2.4036	0.0065	664.079	0.0115	0.0114	0.0109	0.0454
50	0.0918	0.1184	1.668	2.4917	0.0067	686.335	0.0114	0.0114	0.0108	0.0467
55	0.0955	0.1232	1.7752	2.5958	0.007	714.658	0.0118	0.0118	0.0113	0.0483
60	0.1027	0.1322	1.9498	2.6772	0.0072	737.421	0.0126	0.0128	0.0123	0.0492
65	0.1209	0.1559	2.3762	2.8372	0.0074	756.148	0.0149	0.0148	0.0141	0.0507
70	0.1373	0.177	2.7452	3.0267	0.0074	757.971	0.017	0.0164	0.0156	0.0518

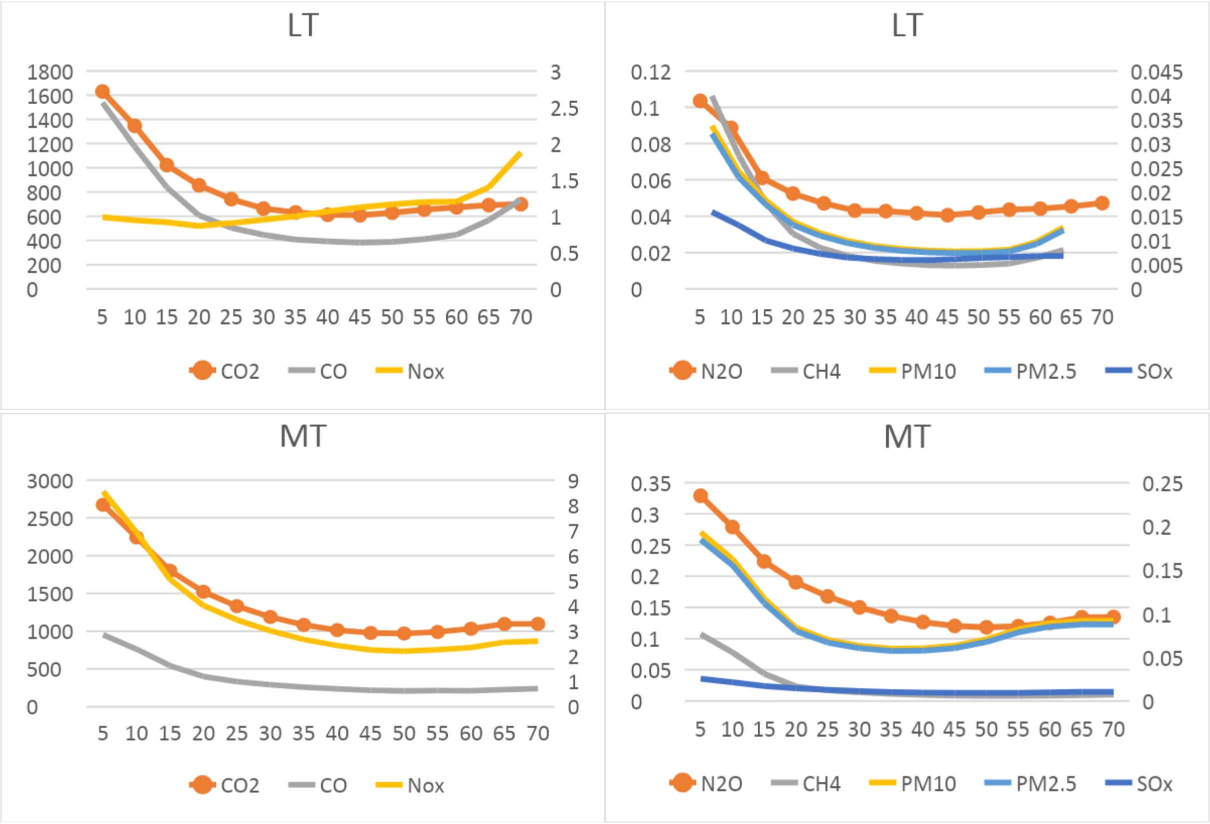
A2b: medium trucks

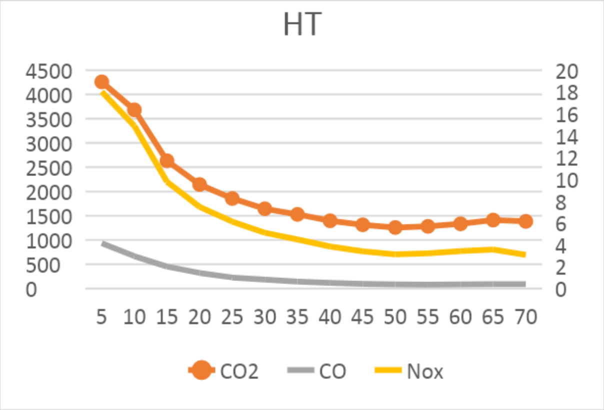
5	4.897	5.6503	9.1299	17.591	0.0262	2743.51	0.2698	0.9351	0.8946	0.3386
10	3.7387	4.305	7.6631	14.785	0.0228	2395.37	0.2014	0.797	0.7625	0.3028
15	2.0215	2.334	5.773	10.695	0.0187	1964.93	0.1128	0.5556	0.5315	0.2499
20	1.0013	1.1631	4.4798	8.4419	0.0156	1638.17	0.06	0.3867	0.37	0.2097
25	0.7271	0.845	3.7893	7.7092	0.0138	1451.67	0.0439	0.3164	0.3027	0.1882
30	0.5969	0.6932	3.3418	7.279	0.0127	1335.01	0.0358	0.2777	0.2657	0.1751
35	0.4975	0.5778	2.9969	6.9473	0.0119	1249.55	0.0299	0.2519	0.241	0.1646
40	0.4286	0.4981	2.7618	6.7253	0.0114	1191.34	0.026	0.2402	0.2298	0.1565
45	0.3807	0.4427	2.5606	6.5407	0.011	1155.77	0.0233	0.2388	0.2285	0.1505
50	0.3605	0.4194	2.4638	6.4787	0.0109	1140.41	0.0222	0.2513	0.2405	0.1468
55	0.3727	0.4339	2.5498	6.583	0.0109	1142.46	0.0232	0.2802	0.268	0.1458
60	0.3852	0.4486	2.6218	6.6431	0.011	1156.75	0.0242	0.2969	0.2841	0.1466
65	0.4117	0.4809	3.0916	6.8224	0.0112	1176.1	0.0271	0.3045	0.2913	0.1493
70	0.4344	0.5092	3.646	6.9134	0.0113	1179.49	0.0299	0.3134	0.2998	0.1503

A2c: Heavy trucks

5	3.2928	3.9246	6.96	27.385	0.0469	5007.65	0.3211	0.4009	0.3836	0.7826
10	2.9382	3.4802	6.1775	24.282	0.0426	4550.52	0.2668	0.4356	0.4167	0.7118
15	2.5207	2.9529	6.2721	17.379	0.0289	3085.38	0.1973	0.5264	0.5036	0.4826
20	1.6516	1.9325	6.1303	15.421	0.0225	2411.37	0.1271	0.5936	0.5679	0.3773
25	1.2087	1.4147	4.8442	13.516	0.0202	2160.61	0.0934	0.4374	0.4184	0.3384
30	0.9841	1.1502	4.1795	12.659	0.0185	1982.08	0.0744	0.3873	0.3705	0.3106
35	0.7727	0.9029	3.505	12.132	0.0181	1934.01	0.0582	0.3396	0.3249	0.3032
40	0.6498	0.758	3.1056	11.483	0.0168	1797.00	0.0477	0.3253	0.3113	0.2817
45	0.5694	0.663	2.8259	11.059	0.0159	1703.18	0.0406	0.329	0.3148	0.2669
50	0.5476	0.6357	2.7396	10.938	0.0151	1619.01	0.0372	0.3626	0.3469	0.2536
55	0.5136	0.5971	2.561	10.435	0.0147	1579.71	0.0356	0.3799	0.3634	0.2474
60	0.5591	0.649	2.7037	10.917	0.0149	1590.72	0.0379	0.425	0.4066	0.249
65	0.5972	0.6928	2.9951	11.233	0.0151	1614.35	0.0399	0.456	0.4363	0.2528
70	0.5623	0.6542	3.1006	10.491	0.015	1610.78	0.0389	0.44	0.421	0.2525

Figure A-1: Emission rates (grams/mile) by speed for vehicle types




HT
4500
4000
3500
3000
2500
2000
1500
1000
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0
20
18
16
14
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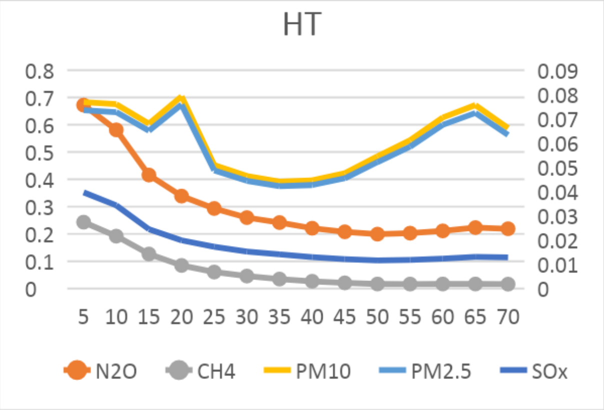
10
8
6
4
2
0
5 10 15 20 25 30 35 40 45 50 55 60 65 70
CO2
CO
Nox


HT
0.8
0.7
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0.5
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0.09
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0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
5 10 15 20 25 30 35 40 45 50 55 60 65 70
N2O
CH4
PM10
PM2.5
SOx

Appendix B: Truck Scenario Results

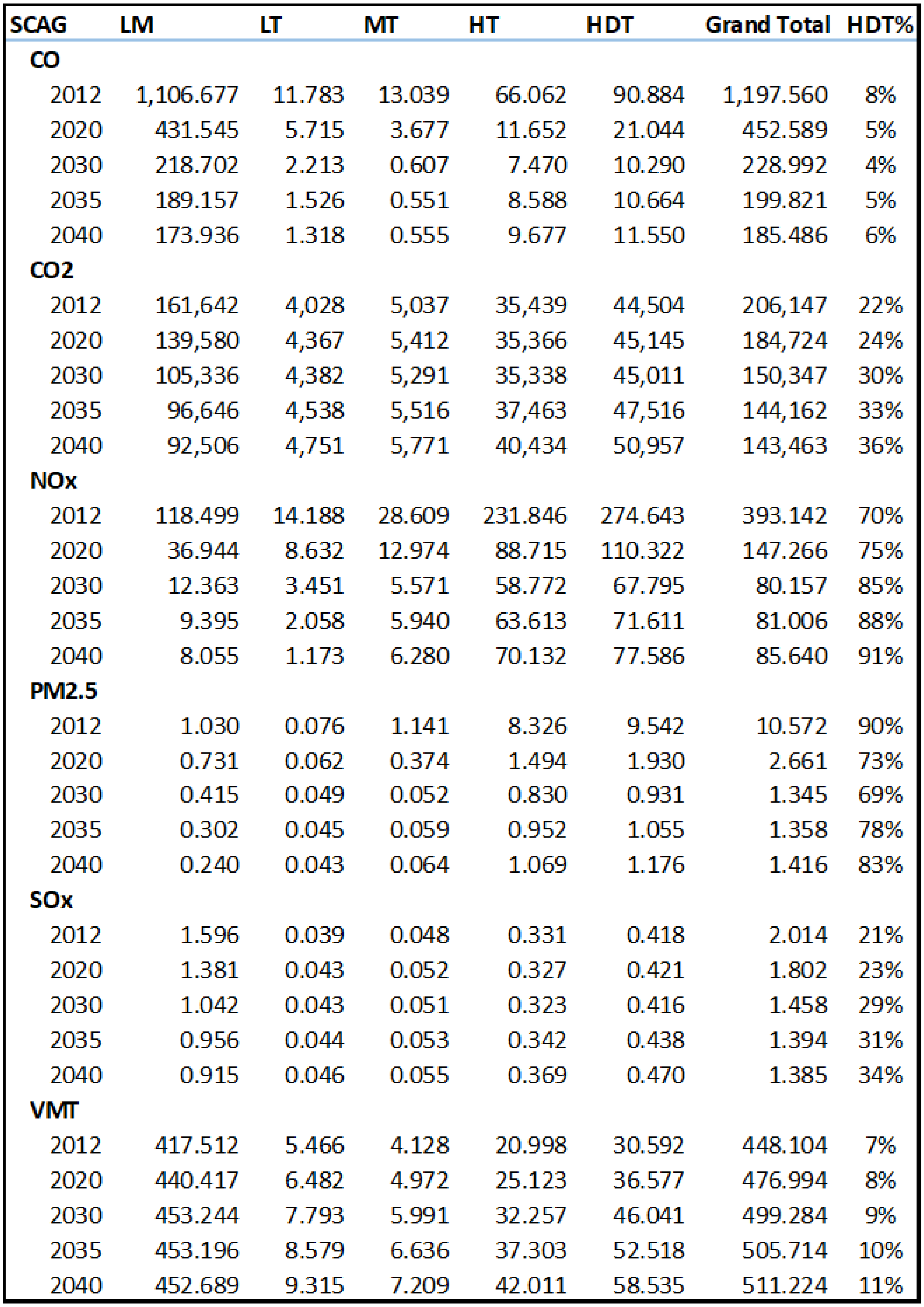
Table B-1a and Table B-1b summarize the results for VMT and emissions for the SCAG region and SELA for the BAU scenario, showing the disproportionate emissions impacts from trucks. In the table, LM refers to light-duty vehicles.

Table B-2 (a and b) show the results of the ZEV penetration scenarios in Scenario 2a. The results show that by year 2030, the percent increase in BEVs trucks in the fleet of LT and MT trucks could decrease overall emissions between 1% and 13%.

Table B-3 shows the results for the different pollutants for scenario 2b, while Table B-4 (a and b) show the results for Scenario 2c

Table B-5 (a and b) show the results of the various simulated shifts in truck traffic to the evening and night periods (scenario 3a).

Table B-1a: Daily VMT and emissions results for 2012, 2020, 2030, 2035 and 2040 for SCAG



SCAG	LM	LT	MT	HT	HDT	Grand Total	HDT%
CO							
2012	1,106.677	11.783	13.039	66.062	90.884	1,197.560	8%
2020	431.545	5.715	3.677	11.652	21.044	452.589	5%
2030	218.702	2.213	0.607	7.470	10.290	228.992	4%
2035	189.157	1.526	0.551	8.588	10.664	199.821	5%
2040	173.936	1.318	0.555	9.677	11.550	185.486	6%
CO2							
2012	161,642	4,028	5,037	35,439	44,504	206,147	22%
2020	139,580	4,367	5,412	35,366	45,145	184,724	24%
2030	105,336	4,382	5,291	35,338	45,011	150,347	30%
2035	96,646	4,538	5,516	37,463	47,516	144,162	33%
2040	92,506	4,751	5,771	40,434	50,957	143,463	36%
NOx							
2012	118.499	14.188	28.609	231.846	274.643	393.142	70%
2020	36.944	8.632	12.974	88.715	110.322	147.266	75%
2030	12.363	3.451	5.571	58.772	67.795	80.157	85%
2035	9.395	2.058	5.940	63.613	71.611	81.006	88%
2040	8.055	1.173	6.280	70.132	77.586	85.640	91%
PM2.5							
2012	1.030	0.076	1.141	8.326	9.542	10.572	90%
2020	0.731	0.062	0.374	1.494	1.930	2.661	73%
2030	0.415	0.049	0.052	0.830	0.931	1.345	69%
2035	0.302	0.045	0.059	0.952	1.055	1.358	78%
2040	0.240	0.043	0.064	1.069	1.176	1.416	83%
SOx							
2012	1.596	0.039	0.048	0.331	0.418	2.014	21%
2020	1.381	0.043	0.052	0.327	0.421	1.802	23%
2030	1.042	0.043	0.051	0.323	0.416	1.458	29%
2035	0.956	0.044	0.053	0.342	0.438	1.394	31%
2040	0.915	0.046	0.055	0.369	0.470	1.385	34%
VMT							
2012	417.512	5.466	4.128	20.998	30.592	448.104	7%
2020	440.417	6.482	4.972	25.123	36.577	476.994	8%
2030	453.244	7.793	5.991	32.257	46.041	499.284	9%
2035	453.196	8.579	6.636	37.303	52.518	505.714	10%
2040	452.689	9.315	7.209	42.011	58.535	511.224	11%

CO, CO2, Nox, PM2.5, Sox in Metric tons; VMT in million miles

Table B-1b: Daily VMT and emissions results for 2012, 2020, 2030, 2035 and 2040 for SELA

SELA	LM	LT	MT	HT	HDT	Grand Total	HDT%
CO							
2012	38.102	0.311	0.430	1.898	2.638	40.740	6%
2020	14.342	0.137	0.121	0.349	0.607	14.949	4%
2030	7.148	0.055	0.020	0.206	0.282	7.430	4%
2035	6.035	0.041	0.017	0.224	0.283	6.318	4%
2040	5.485	0.037	0.017	0.243	0.297	5.782	5%
CO2							
2012	5,335	117	175	1,014	1,306	6,641	20%
2020	4,357	120	172	889	1,180	5,537	21%
2030	3,188	113	155	838	1,106	4,294	26%
2035	2,850	111	151	839	1,101	3,951	28%
2040	2,694	112	150	860	1,122	3,816	29%
NOx							
2012	3.837	0.373	0.971	6.576	7.920	11.757	67%
2020	1.133	0.194	0.421	2.482	3.097	4.230	73%
2030	0.372	0.067	0.189	1.578	1.835	2.207	83%
2035	0.277	0.038	0.192	1.612	1.842	2.119	87%
2040	0.235	0.022	0.196	1.706	1.924	2.159	89%
PM2.5							
2012	0.035	0.002	0.037	0.211	0.250	0.286	88%
2020	0.024	0.002	0.010	0.032	0.044	0.069	65%
2030	0.013	0.001	0.001	0.013	0.015	0.029	53%
2035	0.010	0.001	0.001	0.014	0.016	0.026	63%
2040	0.007	0.001	0.001	0.015	0.017	0.025	70%
SOx							
2012	0.053	0.001	0.002	0.009	0.012	0.065	19%
2020	0.043	0.001	0.002	0.008	0.011	0.054	20%
2030	0.032	0.001	0.001	0.008	0.010	0.042	25%
2035	0.028	0.001	0.001	0.008	0.010	0.038	27%
2040	0.027	0.001	0.001	0.008	0.010	0.037	28%
VMT							
2012	13.820	0.159	0.137	0.565	0.862	14.682	6%
2020	13.703	0.178	0.153	0.603	0.935	14.637	6%
2030	13.609	0.203	0.172	0.743	1.118	14.727	8%
2035	13.243	0.211	0.179	0.819	1.208	14.451	8%
2040	13.065	0.219	0.184	0.883	1.286	14.351	9%

CO, CO2, Nox, PM2.5, Sox in Metric tons; VMT in million miles

Table B-2a: Results of battery electric vehicle penetration for 2030 and 2040 (scenario 2a SCAG)

		SCAG				
	Scenario	**LT**	**MT**	**HT**	**Sub-total**	**% Change**
CO	2030 BAU	2.213	0.607	7.470	10.290	
	2030 10% LT MT	1.991	0.547	7.470	10.008	-2.74%
	2030 20% LT MT	1.770	0.486	7.470	9.726	-5.48%
	2030 30% LT MT	1.549	0.425	7.470	9.444	-8.22%
	2030 40% LT MT	1.328	0.364	7.470	9.162	-10.96%
	2030 50% LT MT	1.106	0.304	7.470	8.880	-13.70%
	2040 BAU	1.318	0.555	9.677	11.550	
	2040 75% LT MT, 50% HT	0.329	0.139	4.839	5.307	-54.05%
CO2	2030 BAU	4,382	5,291	35,338	45,011	
	2030 10% LT MT	3,944	4,762	35,338	44,044	-2.15%
	2030 20% LT MT	3,506	4,233	35,338	43,076	-4.30%
	2030 30% LT MT	3,068	3,703	35,338	42,109	-6.45%
	2030 40% LT MT	2,629	3,174	35,338	41,142	-8.60%
	2030 50% LT MT	2,191	2,645	35,338	40,174	-10.75%
	2040 BAU	4,751	5,771	40,434	50,957	
	2040 75% LT MT, 50% HT	1,188	1,443	20,217	22,848	-55.16%
Nox	2030 BAU	3.451	5.571	58.772	67.795	
	2030 10% LT MT	3.106	5.014	58.772	66.892	-1.33%
	2030 20% LT MT	2.761	4.457	58.772	65.990	-2.66%
	2030 30% LT MT	2.416	3.900	58.772	65.088	-3.99%
	2030 40% LT MT	2.071	3.343	58.772	64.186	-5.32%
	2030 50% LT MT	1.726	2.786	58.772	63.283	-6.65%
	2040 BAU	1.173	6.280	70.132	77.586	
	2040 75% LT MT, 50% HT	0.293	1.570	35.066	36.929	-52.40%
PM2.5	2030 BAU	0.049	0.052	0.830	0.931	
	2030 10% LT MT	0.044	0.046	0.830	0.921	-1.08%
	2030 20% LT MT	0.039	0.041	0.830	0.911	-2.15%
	2030 30% LT MT	0.034	0.036	0.830	0.901	-3.23%
	2030 40% LT MT	0.029	0.031	0.830	0.891	-4.31%
	2030 50% LT MT	0.024	0.026	0.830	0.880	-5.39%
	2040 BAU	0.043	0.064	1.069	1.176	
	2040 75% LT MT, 50% HT	0.011	0.016	0.535	0.561	-52.27%
SOx	2030 BAU	0.043	0.051	0.323	0.416	
	2030 10% LT MT	0.038	0.045	0.323	0.407	-2.24%
	2030 20% LT MT	0.034	0.040	0.323	0.398	-4.47%
	2030 30% LT MT	0.030	0.035	0.323	0.388	-6.71%
	2030 40% LT MT	0.026	0.030	0.323	0.379	-8.94%
	2030 50% LT MT	0.021	0.025	0.323	0.370	-11.18%
	2040 BAU	0.046	0.055	0.369	0.470	
	2040 75% LT MT, 50% HT	0.012	0.014	0.184	0.210	-55.38%

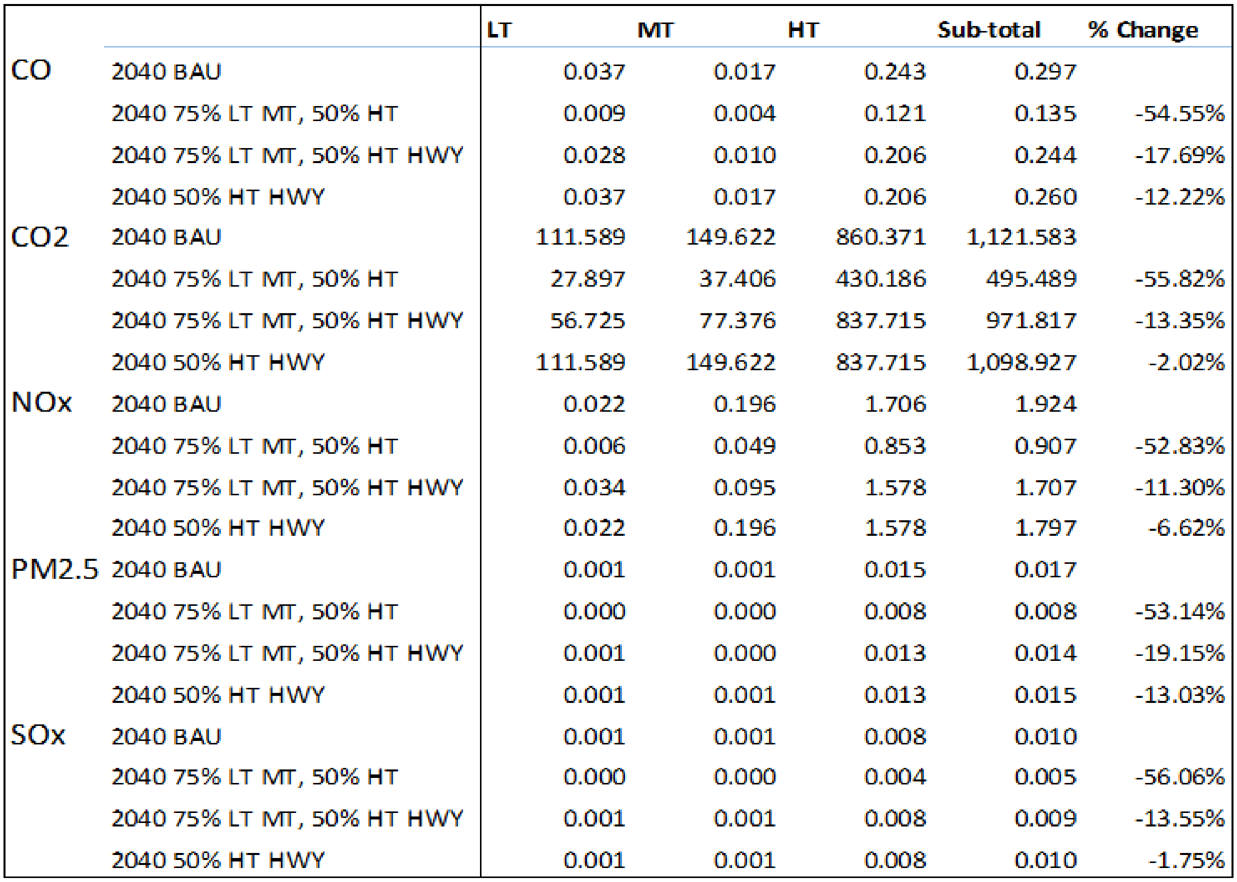
CO, CO2, Nox, PM2.5, Sox in Metric tons

Table B-2b: Results of battery electric vehicle penetration for 2030 and 2040 (scenario 2a SELA)

		SELA				
	Scenario	**LT**	**MT**	**HT**	**Sub-total**	**% Change**
CO	2030 BAU	0.055	0.020	0.206	0.282	
	2030 10% LT MT	0.050	0.018	0.206	0.274	-2.68%
	2030 20% LT MT	0.044	0.016	0.206	0.267	-5.36%
	2030 30% LT MT	0.039	0.014	0.206	0.259	-8.04%
	2030 40% LT MT	0.033	0.012	0.206	0.252	-10.72%
	2030 50% LT MT	0.028	0.010	0.206	0.244	-13.40%
	2040 BAU	0.037	0.017	0.243	0.297	
	2040 75% LT MT, 50% HT	0.009	0.004	0.121	0.135	-54.55%
CO2	2030 BAU	113	155	838	1,106	
	2030 10% LT MT	102	139	838	1,079	-2.43%
	2030 20% LT MT	91	124	838	1,052	-4.85%
	2030 30% LT MT	79	108	838	1,025	-7.28%
	2030 40% LT MT	68	93	838	999	-9.70%
	2030 50% LT MT	57	77	838	972	-12.13%
	2040 BAU	112	150	860	1,122	
	2040 75% LT MT, 50% HT	28	37	430	495	-55.82%
Nox	2030 BAU	0.067	0.189	1.578	1.835	
	2030 10% LT MT	0.060	0.170	1.578	1.809	-1.40%
	2030 20% LT MT	0.054	0.151	1.578	1.784	-2.79%
	2030 30% LT MT	0.047	0.132	1.578	1.758	-4.19%
	2030 40% LT MT	0.040	0.113	1.578	1.732	-5.59%
	2030 50% LT MT	0.034	0.095	1.578	1.707	-6.98%
	2040 BAU	0.022	0.196	1.706	1.924	
	2040 75% LT MT, 50% HT	0.006	0.049	0.853	0.907	-52.83%
PM2.5	2030 BAU	0.001	0.001	0.013	0.015	
	2030 10% LT MT	0.001	0.001	0.013	0.015	-1.48%
	2030 20% LT MT	0.001	0.001	0.013	0.015	-2.96%
	2030 30% LT MT	0.001	0.001	0.013	0.015	-4.43%
	2030 40% LT MT	0.001	0.001	0.013	0.014	-5.91%
	2030 50% LT MT	0.001	0.000	0.013	0.014	-7.39%
	2040 BAU	0.001	0.001	0.015	0.017	
	2040 75% LT MT, 50% HT	0.000	0.000	0.008	0.008	-53.14%
SOx	2030 BAU	0.001	0.001	0.008	0.010	
	2030 10% LT MT	0.001	0.001	0.008	0.010	-2.52%
	2030 20% LT MT	0.001	0.001	0.008	0.010	-5.04%
	2030 30% LT MT	0.001	0.001	0.008	0.009	-7.56%
	2030 40% LT MT	0.001	0.001	0.008	0.009	-10.08%
	2030 50% LT MT	0.001	0.001	0.008	0.009	-12.60%
	2040 BAU	0.001	0.001	0.008	0.010	
	2040 75% LT MT, 50% HT	0.000	0.000	0.004	0.005	-56.06%

CO, CO2, Nox, PM2.5, Sox in Metric tons

Table B-3: Summary results of BEV penetration for 2030 and 2040 inside SELA (scenario 2b)



		LT	MT	HT	Sub-total	% Change
CO	2040 BAU	0.037	0.017	0.243	0.297	
	2040 75% LT MT, 50% HT	0.009	0.004	0.121	0.135	-54.55%
	2040 75% LT MT, 50% HT HWY	0.028	0.010	0.206	0.244	-17.69%
	2040 50% HT HWY	0.037	0.017	0.206	0.260	-12.22%
CO2	2040 BAU	111.589	149.622	860.371	1,121.583	
	2040 75% LT MT, 50% HT	27.897	37.406	430.186	495.489	-55.82%
	2040 75% LT MT, 50% HT HWY	56.725	77.376	837.715	971.817	-13.35%
	2040 50% HT HWY	111.589	149.622	837.715	1,098.927	-2.02%
NOx	2040 BAU	0.022	0.196	1.706	1.924	
	2040 75% LT MT, 50% HT	0.006	0.049	0.853	0.907	-52.83%
	2040 75% LT MT, 50% HT HWY	0.034	0.095	1.578	1.707	-11.30%
	2040 50% HT HWY	0.022	0.196	1.578	1.797	-6.62%
PM2.5	2040 BAU	0.001	0.001	0.015	0.017	
	2040 75% LT MT, 50% HT	0.000	0.000	0.008	0.008	-53.14%
	2040 75% LT MT, 50% HT HWY	0.001	0.000	0.013	0.014	-19.15%
	2040 50% HT HWY	0.001	0.001	0.013	0.015	-13.03%
SOx	2040 BAU	0.001	0.001	0.008	0.010	
	2040 75% LT MT, 50% HT	0.000	0.000	0.004	0.005	-56.06%
	2040 75% LT MT, 50% HT HWY	0.001	0.001	0.008	0.009	-13.55%
	2040 50% HT HWY	0.001	0.001	0.008	0.010	-1.75%

Table B-4a: Summary results from scenario 2c (SCAG)

		SCAG					
		LT	MT	HT	Sub-total	BAU	%Change
CO	2012	10.618	11.264	51.707	73.589	90.884	-19%
	2020	5.060	3.414	10.234	18.707	21.044	-11%
	2030	1.733	0.440	6.153	8.326	10.290	-19%
	2035	0.920	0.274	8.175	9.370	10.664	-12%
	2040	0.463	0.152	10.582	11.197	11.550	-3%
CO2	2012	3,816	4,888	35,361	44,065	44,504	-1%
	2020	3,974	5,150	34,970	44,094	45,145	-2%
	2030	3,125	3,957	28,802	35,884	45,011	-20%
	2035	2,248	2,825	23,062	28,136	47,516	-41%
	2040	1,316	1,616	16,887	19,818	50,957	-61%
NOx	2012	17.623	29.559	232.092	279.275	274.643	2%
	2020	10.950	12.640	88.425	112.016	110.322	2%
	2030	3.562	4.285	47.516	55.363	67.795	-18%
	2035	1.505	3.193	35.998	40.695	71.611	-43%
	2040	0.484	1.876	22.561	24.921	77.586	-68%
PM2.5	2012	0.096	1.194	8.376	9.666	9.542	1%
	2020	0.081	0.366	1.497	1.943	1.930	1%
	2030	0.051	0.040	0.671	0.761	0.931	-18%
	2035	0.033	0.032	0.534	0.599	1.055	-43%
	2040	0.018	0.019	0.338	0.375	1.176	-68%
SOx	2012	0.037	0.046	0.329	0.412	0.418	-1%
	2020	0.038	0.049	0.327	0.415	0.421	-1%
	2030	0.030	0.038	0.261	0.329	0.416	-21%
	2035	0.022	0.027	0.191	0.239	0.438	-45%
	2040	0.013	0.015	0.115	0.143	0.470	-70%

CO, CO2, NOx, Sox, and PM2.5 in Metric tons

Table B-4a: Summary results from scenario 2c (SELA)

		SELA					
		LT	MT	HT	Sub-total	BAU	%Change
CO	2012	0.277	0.379	1.581	2.238	2.638	-15%
	2020	0.118	0.113	0.315	0.546	0.607	-10%
	2030	0.043	0.015	0.173	0.231	0.282	-18%
	2035	0.025	0.009	0.235	0.269	0.283	-5%
	2040	0.013	0.005	0.309	0.327	0.297	10%
CO2	2012	111	170	1,013	1,294	1,306	-1%
	2020	109	164	879	1,151	1,180	-2%
	2030	81	116	683	880	1,106	-20%
	2035	55	77	517	650	1,101	-41%
	2040	31	42	362	435	1,122	-61%
NOx	2012	0.462	1.004	6.590	8.056	7.920	2%
	2020	0.244	0.410	2.475	3.130	3.097	1%
	2030	0.068	0.146	1.276	1.490	1.835	-19%
	2035	0.028	0.103	0.912	1.043	1.842	-43%
	2040	0.009	0.059	0.548	0.616	1.924	-68%
PM2.5	2012	0.003	0.039	0.212	0.254	0.250	1%
	2020	0.002	0.010	0.032	0.045	0.044	1%
	2030	0.001	0.001	0.011	0.013	0.015	-18%
	2035	0.001	0.001	0.008	0.009	0.016	-43%
	2040	0.000	0.000	0.005	0.006	0.017	-68%
SOx	2012	0.001	0.002	0.009	0.012	0.012	-1%
	2020	0.001	0.002	0.008	0.011	0.011	-2%
	2030	0.001	0.001	0.006	0.008	0.010	-21%
	2035	0.001	0.001	0.004	0.006	0.010	-46%
	2040	0.000	0.000	0.002	0.003	0.010	-70%

CO, CO2, NOx, Sox, and PM2.5 in Metric tons

Table B-5a: Summary results for off-hour scenarios (scenario 3a - SCAG)

		SCAG				
		LT	MT	HT	Sub-total	%Change
CO	BAU	5.715	3.677	11.652	21.044	
	10% from AM to EVE	5.726	3.673	11.622	21.022	-0.11%
	20% from AM to EVE	5.738	3.670	11.593	21.000	-0.21%
	30% from AM to EVE	5.749	3.666	11.563	20.978	-0.32%
	10% from MD to EVE	5.740	3.676	11.638	21.055	0.05%
	20% from MD to EVE	5.765	3.676	11.624	21.065	0.10%
	30% from MD to EVE	5.790	3.675	11.610	21.076	0.15%
	10% from AM + MD to EVE	5.751	3.673	11.608	21.033	-0.06%
	20% from AM + MD to EVE	5.788	3.669	11.565	21.021	-0.11%
	30% from AM + MD to EVE	5.824	3.665	11.521	21.009	-0.17%
	10% from AM + MD to EVE + NT	5.772	3.675	11.608	21.055	0.05%
	20% from AM + MD to EVE + NT	5.829	3.673	11.564	21.066	0.10%
	30% from AM + MD to EVE + NT	5.886	3.671	11.519	21.077	0.15%
CO2	BAU	4,366.728	5,412.021	35,366.069	45,144.817	
	10% from AM to EVE	4,366.921	5,410.411	35,350.144	45,127.475	-0.04%
	20% from AM to EVE	4,367.113	5,408.801	35,334.219	45,110.133	-0.08%
	30% from AM to EVE	4,367.306	5,407.191	35,318.294	45,092.792	-0.12%
	10% from MD to EVE	4,368.812	5,414.094	35,372.480	45,155.387	0.02%
	20% from MD to EVE	4,370.897	5,416.167	35,378.892	45,165.957	0.05%
	30% from MD to EVE	4,372.982	5,418.241	35,385.304	45,176.526	0.07%
	10% from AM + MD to EVE	4,369.005	5,412.484	35,356.556	45,138.045	-0.02%
	20% from AM + MD to EVE	4,371.283	5,412.948	35,347.043	45,131.273	-0.03%
	30% from AM + MD to EVE	4,373.560	5,413.411	35,337.530	45,124.501	-0.05%
	10% from AM + MD to EVE + NT	4,370.072	5,413.611	35,356.492	45,140.175	-0.01%
	20% from AM + MD to EVE + NT	4,373.416	5,415.201	35,346.915	45,135.532	-0.02%
	30% from AM + MD to EVE + NT	4,376.760	5,416.791	35,337.338	45,130.889	-0.03%
NOx	BAU	8.632	12.974	88.715	110.322	
	10% from AM to EVE	8.654	12.967	88.581	110.202	-0.11%
	20% from AM to EVE	8.675	12.960	88.448	110.082	-0.22%
	30% from AM to EVE	8.696	12.952	88.314	109.962	-0.33%
	10% from MD to EVE	8.667	12.979	88.636	110.283	-0.04%
	20% from MD to EVE	8.703	12.984	88.557	110.243	-0.07%
	30% from MD to EVE	8.738	12.988	88.477	110.203	-0.11%
	10% from AM + MD to EVE	8.689	12.972	88.502	110.163	-0.14%
	20% from AM + MD to EVE	8.745	12.969	88.289	110.003	-0.29%
	30% from AM + MD to EVE	8.802	12.966	88.076	109.843	-0.43%
	10% from AM + MD to EVE + NT	8.721	12.976	88.420	110.118	-0.19%
	20% from AM + MD to EVE + NT	8.810	12.978	88.125	109.914	-0.37%
	30% from AM + MD to EVE + NT	8.899	12.980	87.831	109.709	-0.56%

Table B-5b: Summary results for off-hour scenarios (scenario 3a - SELA)

				SELA		
		LT	**MT**	**HT**	**Sub-total**	**%Change**
CO	BAU	0.137	0.121	0.349	0.607	
	10% from AM to EVE	0.137	0.121	0.348	0.606	-0.21%
	20% from AM to EVE	0.137	0.121	0.347	0.605	-0.41%
	30% from AM to EVE	0.137	0.121	0.345	0.603	-0.62%
	10% from MD to EVE	0.137	0.121	0.348	0.606	-0.20%
	20% from MD to EVE	0.138	0.121	0.346	0.605	-0.41%
	30% from MD to EVE	0.138	0.121	0.345	0.603	-0.61%
	10% from AM + MD to EVE	0.137	0.121	0.346	0.605	-0.41%
	20% from AM + MD to EVE	0.138	0.120	0.344	0.602	-0.82%
	30% from AM + MD to EVE	0.139	0.120	0.341	0.600	-1.23%
	10% from AM + MD to EVE + NT	0.138	0.121	0.346	0.605	-0.33%
	20% from AM + MD to EVE + NT	0.139	0.120	0.343	0.603	-0.67%
	30% from AM + MD to EVE + NT	0.141	0.120	0.340	0.601	-1.00%
CO2	BAU	119.695	171.751	888.557	1,180.003	
	10% from AM to EVE	119.667	171.635	887.954	1,179.256	-0.06%
	20% from AM to EVE	119.639	171.519	887.351	1,178.509	-0.13%
	30% from AM to EVE	119.611	171.403	886.749	1,177.762	-0.19%
	10% from MD to EVE	119.695	171.653	888.161	1,179.509	-0.04%
	20% from MD to EVE	119.695	171.556	887.765	1,179.016	-0.08%
	30% from MD to EVE	119.696	171.458	887.369	1,178.523	-0.13%
	10% from AM + MD to EVE	119.667	171.537	887.558	1,178.763	-0.11%
	20% from AM + MD to EVE	119.639	171.324	886.559	1,177.522	-0.21%
	30% from AM + MD to EVE	119.611	171.110	885.561	1,176.282	-0.32%
	10% from AM + MD to EVE + NT	119.724	171.554	887.355	1,178.633	-0.12%
	20% from AM + MD to EVE + NT	119.753	171.356	886.154	1,177.264	-0.23%
	30% from AM + MD to EVE + NT	119.782	171.159	884.953	1,175.895	-0.35%
NOx	BAU	0.194	0.421	2.482	3.097	
	10% from AM to EVE	0.195	0.420	2.478	3.093	-0.14%
	20% from AM to EVE	0.195	0.420	2.473	3.088	-0.28%
	30% from AM to EVE	0.196	0.419	2.469	3.084	-0.42%
	10% from MD to EVE	0.195	0.420	2.477	3.092	-0.15%
	20% from MD to EVE	0.196	0.420	2.472	3.088	-0.30%
	30% from MD to EVE	0.197	0.419	2.467	3.083	-0.45%
	10% from AM + MD to EVE	0.196	0.420	2.473	3.088	-0.29%
	20% from AM + MD to EVE	0.197	0.419	2.463	3.079	-0.58%
	30% from AM + MD to EVE	0.198	0.418	2.454	3.070	-0.87%
	10% from AM + MD to EVE + NT	0.197	0.420	2.469	3.085	-0.38%
	20% from AM + MD to EVE + NT	0.199	0.419	2.455	3.073	-0.76%
	30% from AM + MD to EVE + NT	0.202	0.418	2.442	3.062	-1.13%

Appendix C: First/last-Mile Options Scenario Methodology

In this appendix we describe the methodology for the scenario which shows how first/last mile options (bikeshare, rideshare, stations cars, etc) can shorten access or egress time, and then increase job access compared to walking. Given the constraints of Remix platform which only provide *walking* as the mode for first/last mile access, we calculated the equivalent isochrones for biking/ridesharing based on the results from Boarnet et al. (2017)'s research. Boarnet et al. modeled travel time via transit, from and to the centroid of census tracts in San Diego County, and results are shown in Figure C-1 below.

Figure C-1: Travel speed information extracted from Table 4 of Boarnet et al. (2017)

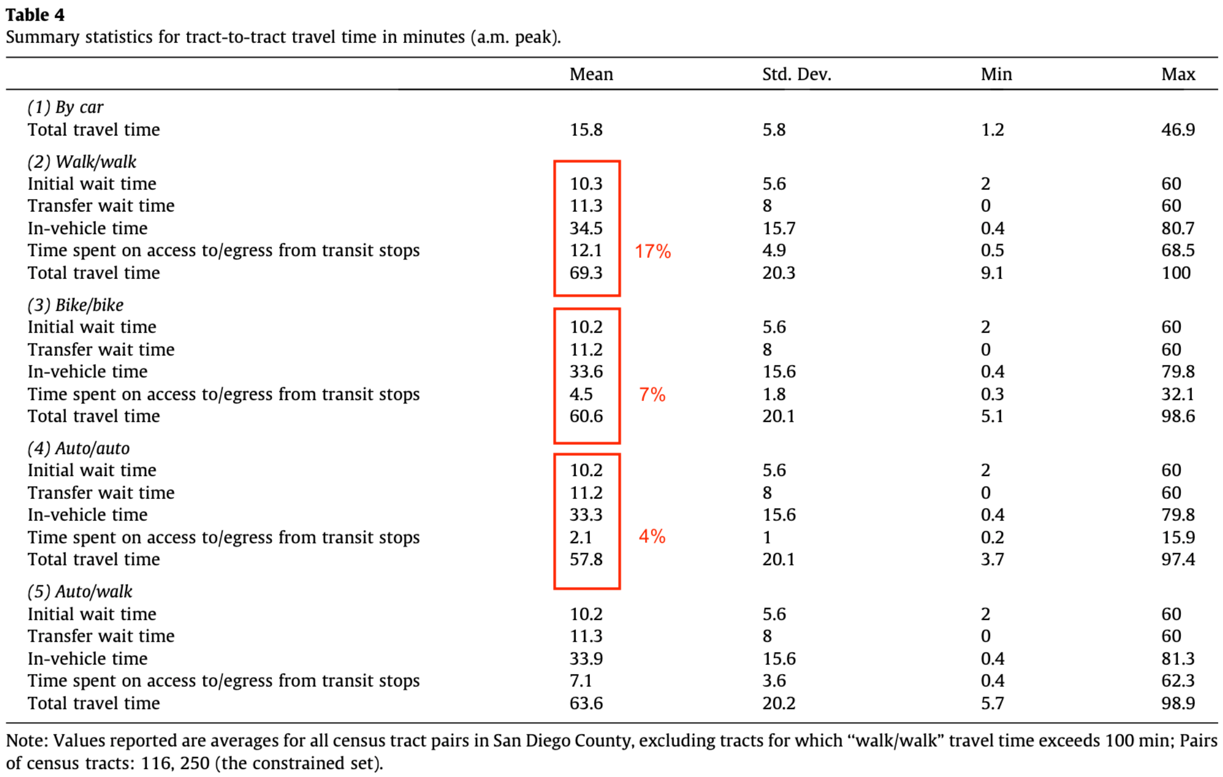


Table 4
Summary statistics for tract-to-tract travel time in minutes (a.m. peak).

	Mean		Std. Dev.	Min	Max
(1) By car					
Total travel time	15.8		5.8	1.2	46.9
(2) Walk/walk					
Initial wait time	10.3		5.6	2	60
Transfer wait time	11.3		8	0	60
In-vehicle time	34.5		15.7	0.4	80.7
Time spent on access to/egress from transit stops	12.1	17%	4.9	0.5	68.5
Total travel time	69.3		20.3	9.1	100
(3) Bike/bike					
Initial wait time	10.2		5.6	2	60
Transfer wait time	11.2		8	0	60
In-vehicle time	33.6		15.6	0.4	79.8
Time spent on access to/egress from transit stops	4.5	7%	1.8	0.3	32.1
Total travel time	60.6		20.1	5.1	98.6
(4) Auto/auto					
Initial wait time	10.2		5.6	2	60
Transfer wait time	11.2		8	0	60
In-vehicle time	33.3		15.6	0.4	79.8
Time spent on access to/egress from transit stops	2.1	4%	1	0.2	15.9
Total travel time	57.8		20.1	3.7	97.4
(5) Auto/walk					
Initial wait time	10.2		5.6	2	60
Transfer wait time	11.3		8	0	60
In-vehicle time	33.9		15.6	0.4	81.3
Time spent on access to/egress from transit stops	7.1		3.6	0.4	62.3
Total travel time	63.6		20.2	5.7	98.9

Note: Values reported are averages for all census tract pairs in San Diego County, excluding tracts for which "walk/walk" travel time exceeds 100 min; Pairs of census tracts: 116, 250 (the constrained set).

Step 1: Compare Speeds of Different Travel Mode

According to the results of this paper (see Figure C- 1 and Table C-1), walking to/from transit stations takes 17% of the total travel time in the San Diego case study from Boarnet et al. (2017), while biking to/from transit stations only takes 7% of the total travel time, and driving to/from transit stations only takes 4% of the total travel time, on average. Based on the data in Figure Apdx A.1, we can get a rough estimate of the relative speed of walking, biking and ridesharing: $V_{bike} = 2.7 V_{walk}$; $V_{auto} = 5.8 V_{walk}$. We assume that the time saved between origins and transit stations can be spent on either ***all on buses or trains (upper bound)***, or ***proportionally on vehicles and wait time (average)***, which enable residents to travel farther and access more jobs.

Table C-1: Information summarized from Boarnet et al. (2017) as cited in Figure A-1

From the paper:	Walk/walk		Bike/Bike		Auto/Auto	
Initial wait time (min)	10.3	15%	10.2	17%	10.2	18%
Transfer wait time (min)	11.3	16%	11.2	18%	11.2	19%
In-vehicle time (min)	34.5	50%	33.6	55%	33.3	58%
Time spent on access to/egress from transit stops (min)	12.1	17%	4.5	7%	2.1	4%
Total travel time (min)	**69.3**		**60.6**		**57.8**	
Travel Speed (compared to walking speed)	**1**		**2.7**		**5.8**	

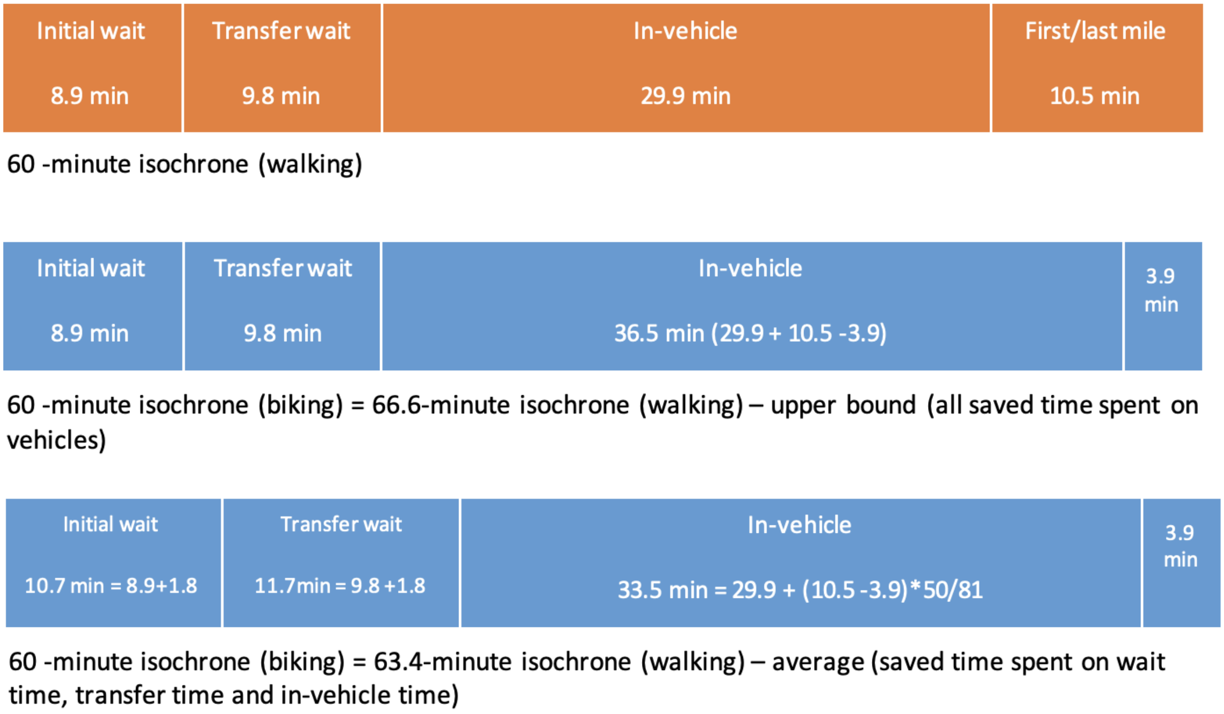
Step 2: Distribute Saved Time

For example (see the illustration in Figure C-2), in a base case, a traveler access can to/egress from transit stops only by walking, and the total travel time is 60 minutes, then the time spent on access to/egress from transit stops is about 60*17% = 10.5 minutes. If he/she switched to biking, only 10.5/2.7 = 3.9 minutes would be taken, and there is 6.6 minutes saved. If the saved time is only used on buses/trains (wait time remains unchanged), then the 60 -minute isochrone of access range by biking will be equivalent as a 66.6-minute isochrone of access range by walking. (This requires assuming that the final 6.6 minutes of a trip travels at the same average speed as earlier links, in all directions. We believe such an assumption is likely close to reality in most cases.) However, if the time saved is split proportionally between wait time and on-vehicle time, then the additional time spent on buses or trains would be only 3.3 minutes, which results in an equivalent 63.3-minute isochrone of access range by walking. Note that differences with what are shown in C-2 are due to rounding error.

Step 3: Calculate Additional Distance Generated by Saved Time

Given the speeds of biking and driving, as well as the additional time a travel can spend on vehicles, we calculate the additional distance one can travel in each scenario: biking upper bound (max), biking average, driving upper bound (max), and driving average (see Table C-2, columns in red text). For example, for a 30-minute trip, if we switch from walking to biking for station access, we can go farther by 0.6 mile on average, and 0.9 mile on maximum. If we switch from walking to driving for station access, we can go farther by 0.8 mile on average, and 1.2 mile on maximum. Once we get these numbers, we can then use buffering tools in ArcGIS to map out the isochrones for First/Last-Mile Options scenario. This method leads to the additional distance isochrones shown in Table C-2. In that table, "max mile" assumes that the entire saved access/egress time is in-vehicle, while "avg mile" assumes that the saved access/egress time is distributed proportionately across in-vehicle and waiting/transfer time. We use the "max mile" and "avg mile" times for the 30 minute and 60 minute walking isochrones, and Table C-2 shows how those are expanded for assumed bicycle and car first-last mile access/egress.

Figure C-2: Distributing saved time



60 -minute isochrone (walking)

60 -minute isochrone (biking) = 66.6-minute isochrone (walking) – upper bound (all saved time spent on vehicles)

60 -minute isochrone (biking) = 63.4-minute isochrone (walking) – average (saved time spent on wait time, transfer time and in-vehicle time)

Table C-2: Additional distance generated by saved time

Walking	**Biking**				**Auto**			
Min	Max Min	Max Mile	Ave Min	Ave Mile	Max Min	Max Mile	Ave Min	Ave Mile
0	0	0.0	0	0.0	0	0.0	0	0.0
5	6	0.2	5	0.1	6	0.2	5	0.1
10	11	0.3	11	0.2	11	0.4	11	0.3
15	17	0.5	16	0.3	17	0.6	16	0.4
20	22	0.6	21	0.4	23	0.8	22	0.5
25	28	0.8	27	0.5	29	1.0	27	0.6
30	**33**	**0.9**	**32**	**0.6**	**34**	**1.2**	**33**	**0.8**
35	39	1.1	37	0.7	40	1.4	38	0.9
40	44	1.2	43	0.8	46	1.6	44	1.0
45	50	1.4	48	0.9	51	1.8	49	1.2
50	55	1.6	53	1.0	57	2.0	54	1.3
55	61	1.7	59	1.1	63	2.2	60	1.4
60	**66**	**1.9**	**64**	**1.2**	**68**	**2.4**	**65**	**1.5**

Step 4: Map the isochrones in ArcGIS

The Buffering Tool in ArcGIS can create buffer polygons around input features to a specified distance, which in this case, is the additional distance one can travel with first/last-mile options, as we calculated in Step 3. We chose to use the ***average*** mileage from Table Apdx A.2 for the buffer, making the more conservative assumption that time saved by bikeshare or shuttles will not only be spent in transit vehicles, but also be spent on wait time and transfer time during the transit trip.

Appendix D: Covid Job Shock Scenario Methodology

The SELA team has been using 2017 data from the US Census Bureau for calculation of employment statistics in LA County. In order to answer questions about the impact of covid-19 on these jobs numbers in 2020, we found data and documentation from the California Employment Development Department which provided information on monthly employment trends by sector in our study area and Bureau of Labor Statistics documentation which allowed us to match the two data sources. We found that while employment generally fell to its lowest point in May 2020 and then slightly rebounded, there was noticeable variation in the strength of the trend among sectors. We detail our data sources, methods, and results below.

Data

We obtained the original LODES data from the US Census Bureau site for LEHD Origin-Destination Employment Data. Options ‘LODES7,’ ‘California,’ and ‘Workplace Area Characteristics (WAC),’ were selected on the web page, and file ‘ca_wac_S000_JT00_2017.csv.gz’ was downloaded and extracted. For monthly California employment by industry, the ‘Current Employment Statistics’ dataset was downloaded from the California Employment Development Department. A crosswalk tabulation was prepared by hand from Bureau of Labor Statistics documentation, described in detail below.

Table D-1: EDD-LODES Cross-walk

CNS	NAICS code (LODES)	CES series (EDD)	NAICS description	NAICS sub-categories not included	COVID Adjustment Factor (May)	COVID Adjustment Factor (July)
1	11	N/A	Agriculture, Forestry, Fishing and Hunting	N/A	.84*	.88*
2	21	N/A	Mining, Quarrying, and Oil and Gas Extraction	N/A	.84*	.88*
3	22	N/A	Utilities	N/A	.84*	.88*
4	23	20-236000, 20-237000, 20-238000	Construction		.93	.96
5	31-33	32-311000, 32-312000, 32-313000, 32-314000,	Manufacturing	316 - Leather and Allied Product Manufacturing	.91	.95

		32-315000, 31-321000, 32-322000, 32-323000, 32-324000, 32-325000, 32-326000, 31-327000, 31-331000, 31-332000, 31-333000, 31-334000, 31-335000, 31-336000, 31-337000, 31-339000				
6	42	41-000000	Wholesale Trade		.92	.95
7	44-45	42-441000, 42-442000, 42-443000, 42-444000, 42-445000, 42-446000, 42-447000, 42-448000, 42-451000, 42-452000, 42-453000, 42-454000	Retail Trade		.84	.91
8	48-49	43-481000, 43-482000, 43-483000, 43-484000, 43-485000, 43-486000, 43-488000, 43-492000, 43-493000	Transportation and Warehousing	487 - Scenic and Sightseeing Transportation 491 - Postal Service	.89	.93
9	51	50-000000	Information		.72	.75
10	52	55-520000	Finance and Insurance		1.02	1.03

11	53	55-530000	Real Estate and Rental and Leasing		.89	.93
12	54	60-540000	Professional, Scientific, and Technical Services		.89	.92
13	55	60-550000	Management of Companies and Enterprises		.92	.95
14	56	60-560000	Administrative and Support and Waste Management and Remediation Services		.88	.90
15	61	N/A	Educational Services	N/A	.84*	.88*
16	62	65-620000	Health Care and Social Assistance		.91	.94
17	71	70-710000	Arts, Entertainment, and Recreation		.56	.73
18	72	70-720000	Accommodation and Food Services		.58	.70
19	81	80-811000, 80-812000, 80-813000	Other Services [except Public Administration]	814 - Private Households	.71	.79
20	92	N/A	Public Administration	N/A	.84*	.88*

*Multiplied by countywide factor rather than industry-specific factor

Methods

The method for adjusting 2017 LODES data by the changes observed during the covid-19 pandemic is described in this section. As shown in Table Apdx B 1, we used the rows 'CNS01' through 'CNS20' in the LODES dataset. Each of those twenty rows represents an industry sector, and when all columns are added together, they equal column 'C000' which represents total employment for the row. Each row in the LODES dataset represents one census block. EDD data is different since it is tabulated at the county level, and each row represents total employment in a sector or subsector for a given month.

Additionally, LODES data uses NAICS industry classifications while EDD data uses CES industry codes (see Table D-1). In order to estimate a proportion change for each industry sector in our LODES data, we calculated the observed proportion change in 2020 EDD data in the corresponding industry sector(s) and multiplied each census block level observation in LODES data by that proportion change. The proportions were calculated by dividing the July 2020 jobs number from EDD by the February 2020 jobs number, for Los Angeles County. For example, CNS03 = 43220000 'Utilities' (CES) = 22 'Utilities' (NAICS). If the number of Utilities jobs in February was 100,000 in EDD data and 80,000 in July, 80,000/100,000 = .8, so every block-level observation for the 'Utilities' column in LODES (named CNS03) would be multiplied by .8 in order to adjust for covid-19 job losses. Please see Table Apdx B 2 for more detail.

The same operation was performed in order to adjust for both February -> May job changes, and February -> July job changes, producing two different covid-adjusted LODES datasets.

Table D-2: Covid-Adjustment of LODES Data by EDD

EDD Industry Code (NAICS Code)	2017 Total Emp.* LA County (LODES)	July 2017 Total Emp. LA County (EDD)	Feb 2020 Total Emp. LA County (EDD)	May 2020 Total Emp. LA County (EDD)	July 2020 Total Emp. LA County (EDD)	Prop.** Change (EDD) Feb-May	Prop. Change (EDD) Feb-July	LODES Adjusted by EDD Feb-May	LODES Adjusted by EDD Feb-July
C000	4,594,534	3,906,600	4,087,200	3,432,000	3,610,100	0.84	0.88	3,836,782	4,065,826
CNS01 (11)	5,994	0	0	0	0	0.84	0.88	5,033	5,294
CNS02 (21)	2,114	0	0	0	0	0.84	0.88	1,775	1,867
CNS03 (22)	28,966	11,500	12,200	12,300	12,500	0.84	0.88	24,323	25,585
CNS04 (23)	143,442	141,300	152,600	141,900	146,000	0.93	0.96	133,384	137,238
CNS05 (31-33)	352,617	327,200	313,700	284,900	297,600	0.91	0.95	320,244	334,520
CNS06 (42)	240,578	221,500	218,700	200,800	207,000	0.92	0.95	220,887	227,708
CNS07 (44-45)	445,805	420,900	415,800	348,200	377,500	0.84	0.91	373,327	404,741
CNS08 (48-49)	191,786	177,300	198,400	176,000	184,700	0.89	0.93	170,133	178,543
CNS09 (51)	316,370	204,900	241,000	174,700	180,000	0.72	0.75	229,335	236,293
CNS10 (52)	153,242	137,700	137,500	140,100	141,400	1.02	1.03	156,140	157,589
CNS11 (53)	88,140	85,300	87,500	77,900	81,300	0.89	0.93	78,470	81,895
CNS12 (54)	310,647	283,900	308,800	274,500	284,200	0.89	0.92	276,142	285,900
CNS13 (55)	66,010	62,400	62,900	57,900	59,500	0.92	0.95	60,763	62,442
CNS14 (56)	300,072	269,100	276,000	242,000	249,400	0.88	0.9	263,107	271,152
CNS15 (61)	379,262	113,200	147,600	132,600	122,300	0.84	0.88	318,464	334,991
CNS16 (62)	718,846	673,600	717,500	653,100	677,800	0.91	0.94	654,325	679,072
CNS17 (71)	105,338	92,700	96,200	53,400	70,600	0.56	0.73	58,472	77,306

*Emp. Stands for Employment

**Prop. Stands for Proportion

Notes

Originally, 12 of our 20 sectors directly matched from their original CES industry classification to the corresponding NAICS classification. However, we found in the NAICS handbook that all 3-digit subcategories will equal the corresponding 2-digit category when added together. For example, NAICS categories 811, 812, 813, and 814 can be added together to equal NAICS category 81. Using this method, we were able to calculate 5 of the 8 missing categories. In certain cases, we were missing one of the NAICS subcategories in EDD data. Additionally, CNS 20 ('Public Administration') did not have a corresponding CES-NAICS match listed, but we assumed CES 90-920000 and NAICS 92 to match based on code structure (in all other cases, the non-zero numbers after the dash correspond to the matching NAICS number). For the final two missing categories (CNS 01 and CNS 02) we did not find any observations of these in EDD data. Please see Table Apdx B 1 for more detail.

Finally, even though CES and NAICS categories may match according to the crosswalk table, the two employment statistics are compiled by different agencies and may still not be a close match. We found that CNS 01, 02, 03, 15, and 20 were either not similar or not compatible between EDD and LODES data, so we multiplied the LODES numbers by county-wide averages instead of industry-specific county averages.

Figure D- 1: Total Employment EDD (LA County)

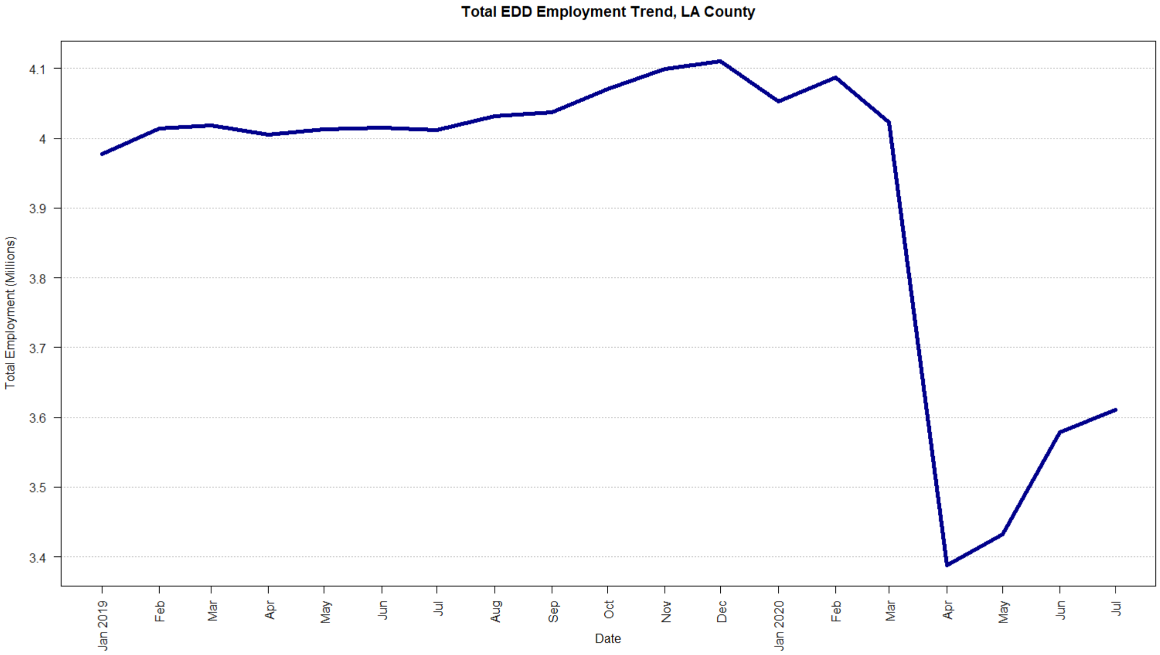


Figure D-2: Employment trend before and after COVID-19