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Evaluating Benefits from Transportation Investments Aligned with the Climate Action Plan for Transportation Infrastructure (CAPTI)

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REPORT 23-43

EVALUATING BENEFITS FROM TRANSPORTATION INVESTMENTS ALIGNED WITH THE CLIMATE ACTION PLAN FOR TRANSPORTATION INFRASTRUCTURE (CAPTI)

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16. Abstract

Building upon two executive orders targeting the mitigation of greenhouse gas (GHG) emissions in California, the Climate Action Plan for Transportation Infrastructure (CAPTI) offers a comprehensive plan to work toward a more unified vision for transportation that prioritizes climate, health, and social equity. The purpose of this project was to help evaluate the benefits from transportation investments across the State of California. With support from Caltrans, the research team provided a holistic evaluation framework that involved an analysis of vehicle miles traveled (VMT) and emissions impacts, an economic impact analysis, and an equity analysis of transportation investments in California. Findings indicate that CAPTI has generally had a positive impact on California communities by helping align transportation investments with the state's climate and equity goals while continuing to generate significant economic activity through investments in transportation infrastructure. Decarbonizing transportation is an ambitious, yet achievable goal that requires a strong emphasis on alternative transportation modes to make transit and active transportation more accessible and appealing than driving. California should continue investing in transportation infrastructure in a manner that is equitable and significantly reduces VMT and emissions while creating quality jobs and positive economic impacts.

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ABSTRACT

Building upon two executive orders targeting the mitigation of greenhouse gas (GHG) emissions in California, the Climate Action Plan for Transportation Infrastructure (CAPTI) offers a comprehensive plan to work toward a more unified vision for transportation that prioritizes climate, health, and social equity. The purpose of this project was to help evaluate the benefits from transportation investments across the State of California. With support from Caltrans, the research team provided a holistic evaluation framework that involved an analysis of vehicle miles traveled (VMT) and emissions impacts, an economic impact analysis, and an equity analysis of transportation investments in California. Findings indicate that CAPTI has generally had a positive impact on California communities by helping align transportation investments with the state's climate and equity goals while continuing to generate significant economic activity through investments in transportation infrastructure. Decarbonizing transportation is an ambitious, yet achievable goal that requires a strong emphasis on alternative transportation modes to make transit and active transportation more accessible and appealing than driving. California should continue investing in transportation infrastructure in a manner that is equitable and significantly reduces VMT and emissions while creating quality jobs and positive economic impacts.

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Transportation and climate change are undeniably interrelated. Both in California and in the U.S., the transportation sector is the largest source of greenhouse gas (GHG) emissions across all sectors of the economy. On the other hand, climate change already impacts the transportation infrastructure and services, and by extension, the way we travel. New and expanded federal and state investment programs in transportation infrastructure offer a chance to transform mobility and build a more sustainable, equitable, and resilient system. The State of California spends approximately $30 billion on transportation investments each year. The California State Transportation Agency (CalSTA) adopted the Climate Action Plan for Transportation Infrastructure (CAPTI) in 2021 to help align transportation infrastructure decisions with the state's climate, health, and equity goals. The purpose of this project was to help evaluate benefits from transportation investments across the State of California.

STUDY METHODS

With support from Caltrans, the research team provided a holistic evaluation framework that involved three main phases: 1) an economic impact analysis, 2) an analysis of vehicle miles traveled (VMT) and emissions impacts, and 3) equity analysis of transportation investments in California. The first phase offers an economic impact analysis of California's transportation investments and seeks to understand if the policy changes enacted with CAPTI resulted in substantial differences in economic impact and job quality. The research team used IMPLAN—an Input-Output model—to estimate the economic impacts of all transportation investments across all seven state transportation investment programs. The second phase involved estimating and comparing the VMT, and consequently, emissions impact of CAPTI on these investment programs. The research team used qualitative and quantitative methods to develop a VMT rating method to examine whether the investment outputs, such as addition of new active transportation facilities, have a neutral, positive, or negative impact on VMT. Building upon these two phases, the third phase analyzes the distributional and equity impacts of various investment programs. The research team used spatial analysis and maps to examine how projects with various VMT ratings are distributed across the state and in relationship with disadvantaged communities.

FINDINGS

Overall, findings indicate that CAPTI has had a positive impact on California communities by helping align transportation investments with the state's climate and equity goals while continuing to generate significant economic activity through investments in transportation infrastructure. The adoption of CAPTI has resulted in an overall reduction of GHG emissions generated across the portfolio of programs, an increase in the number of investments that do not generate higher GHG emissions and other pollutants, and an increase in the number of investments that do not induce VMT. Investments approved after the adoption of CAPTI generated consistent economic impact across California as compared to previous rounds of investments. Also, policy changes enacted in the CAPTI process did not result in the diminution of job quality and did not alter the accessibility of jobs to California workers. This contradicts the popular belief that only certain types of infrastructure projects generate high-quality jobs (i.e., jobs with higher pay and benefits that often require skilled labor) for Californians. Lastly, equity considerations are at the center of CAPTI implementation. Newly updated guidelines incentivize enhanced community engagement, and the newly established Equity Advisory Committee weighs on funding recommendations. Transportation infrastructure investments are reaching disadvantaged communities and areas with the greatest need for mobility improvements.

POLICY AND PRACTICE RECOMMENDATIONS

- California should continue investing in transportation infrastructure in a manner that is equitable and reduces VMT and emissions, while creating quality jobs and positive economic impacts.

- California should streamline monitoring and evaluation of CAPTI by developing a standardized online dashboard that displays current investment data across all state investment programs. The dashboard can be used to examine the economic, VMT, and equity impacts of transportation investments across the state over time or during a specific period.

- Decarbonizing transportation is only achievable if stronger emphasis is put on investing more in alternative transportation modes to make transit and active transportation modes more accessible and more appealing than driving.

- All key aspects of equity—process, input, output, and outcome—should be considered for a comprehensive evaluation of CAPTI.

- Both horizontal and vertical equity are goals worth attaining in the CAPTI implementation process, but if tradeoffs are necessary between different equity objectives, the needs of disadvantaged communities should be prioritized.

- Transportation infrastructure planning can focus on equity of opportunity as a step toward equity of outcome (or vertical equity).

1. INTRODUCTION

Transportation and climate change are undeniably interrelated. Both in California and in the U.S., the transportation sector is the largest source of greenhouse gas (GHG) emissions across all sectors of the economy. On the other hand, climate change already impacts the transportation infrastructure and services, and by extension, the way we travel. In the most recent decade, we have witnessed many climate hazards disrupting transportation networks, stressing transportation infrastructure, posing serious safety risks for communities, and costing our economy billions of dollars each year. Given the significance of the relationship between transportation and climate change, the transportation sector is a key component of any plan to address the climate crisis.

Although curbing transportation emissions has proved difficult in the past decade, there are numerous opportunities to build and maintain a better transportation system. For example, through land use planning, we can enable people to take fewer trips for their daily needs, and drive shorter distances, take transit, bike, or walk to access jobs, services, and amenities. Simultaneously, we can invest in public transit, passenger rail, and active transportation infrastructure to improve mobility for all while reducing emissions. Also, we should decarbonize all modes of transportation through various pathways, such as improving fuel and system-wide efficiency, switching to low- or zero-emissions options, and implementing transportation demand management strategies. In sum, a holistic approach to addressing transportation needs and emissions requires a combination of strategies and using all available tools at our disposal.

New and expanded federal and state investment programs in transportation infrastructure offer a chance to transform mobility and build a more sustainable, equitable, and resilient system. The Bipartisan Infrastructure Law (BIL)—also known as the Infrastructure Investment and Jobs Act (IIJA)—includes roughly $1.2 trillion in spending that touches every sector of infrastructure, such as transportation, energy, water, and broadband. In addition to provisions related to traditional infrastructure components—such as highways, transit, and rail—BIL introduces entirely new programs to address gaps in the nation's infrastructure planning practices and funding mechanisms. For example, there is a new focus on resilience and rehabilitation of our natural resources and an emphasis on addressing climate change and inequities caused by historic infrastructure decisions. In California, the California State Transportation Agency (CalSTA), adopted the Climate Action Plan for Transportation Infrastructure in 2021 to help align transportation infrastructure decisions with the state's climate, health, and equity goals. CAPTI identifies a set of guiding principles and strategies to leverage approximately $5 billion in annual discretionary transportation infrastructure funding. These guiding principles emphasize the importance of investing in rail and transit networks, bicycle and pedestrian infrastructure, and zero-emission vehicle infrastructure, while simultaneously focusing on social and racial equity, environmental sustainability, and safety and community well-being.

Timely evaluation of large infrastructure investment plans offers a range of benefits, such as early detection of strengths and weaknesses, enhanced effectiveness, increased stakeholder and community engagement, improved decision-making, and increased innovation. Both BIL and CAPTI can potentially present an enormous generational shift in transportation planning; infrastructure project selection, scoping, and implementation; and climate mitigation and adaptation efforts. As such, a comprehensive evaluation of how these infrastructure investments can help meet our mobility needs, while simultaneously enhancing our economic competitiveness, responding to the causes and consequences of climate change, improving community well-being, health, safety, and establishing racial and social equity, is needed.

The purpose of this project was to help evaluate benefits from transportation investments across the State of California. With support from Caltrans, the research team provided a holistic evaluation framework that involved an analysis of vehicle miles traveled (VMT) impacts, an economic impact analysis, and equity analysis of transportation investments in California. The report also offers a set of recommendations for future infrastructure planning and decision-making.

2. ECONOMIC IMPACT ANALYSIS

The State of California spends approximately $30 billion on transportation investments each year. This funding comes from a variety of sources, including state taxes and fees, federal funding, and local government contributions.

The Climate Action Plan for Transportation Infrastructure (CAPTI) is a California State program that outlines strategies and actions to advance more sustainable, equitable, and healthy modes of transportation, such as walking, biking, transit, and rail, as well as accelerate the transition to zero-emission vehicle technology.

CAPTI was developed in response to Executive Orders N-19-19 and N-79-20 issued by Governor Gavin Newsom in 2019 and 2020, which call for California to achieve carbon neutrality by 2045 and transition to a 100% zero-emission vehicle fleet by 2035.

CAPTI provides a holistic framework that aligns the state's transportation infrastructure investments with its climate, health, and social equity goals, while also maintaining the commitment made in Senate Bill (SB) 1 to a fix-it-first approach to transportation. This means that priority will be given to investing in existing infrastructure to improve its condition and safety before building new infrastructure.

CAPTI outlines a number of specific strategies and actions, including:

- Increasing investments in public transportation, walking, and biking infrastructure
- Electrifying the state's vehicle fleet
- Reducing the need for travel by investing in smart growth and land use planning
- Making transportation more accessible and affordable for all Californians

CAPTI is still in its early stages of implementation, but it has the potential to transform California's transportation system and make it more sustainable, equitable, and healthy for all Californians.

2.1 GOALS

A key goal for Chapter 2 is to conduct an analysis of the impact of CAPTI policy changes on the overall economic impact of transportation investments and on how such investments affect job quality.

As such, this chapter analyzes the economic and job quality impacts of California's transportation investments across three time periods: before the Executive Order N-19-19, a middle period after N-19-19, and a post-period where CAPTI policy goals were in place. Hereafter, we refer to these as the Pre, Mid, and Post periods.

To conduct our analysis, this report uses the IMPLAN economic impact modeling software and data package and takes the entire state of California as the unit of analysis. IMPLAN is an industry-standard Input-Output economic model that assembles data on the economy from a variety of public sources (more on IMPLAN and its methods and limitations follows). In addition to the results generated by IMPLAN, we analyzed the types of jobs created by transportation investments by occupation and used data from the U.S. Census American Community Survey (ACS) and the U.S. Bureau of Labor Statistics (BLS) to describe the degree to which supported jobs have benefits, and how accessible they are to workers without a post-secondary degree.

2.2 STRUCTURE OF THE CHAPTER

The remainder of this chapter is organized as follows. Section 2.3 presents the methodology for this analysis, focusing first on the nature of IMPLAN and Input-Output modeling and how to understand the various terms used in measuring economic impacts. Next, this section describes the steps used by the research team to interpret and code all projects listed in databases provided by the California Department of Transportation across the seven CAPTI-affected programs. Finally, this section describes the data sources used to generate the job quality analysis derived from the IMPLAN economic impact results. Section 2.5 presents the main findings that document the overall economic impact of California's transportation investments across the three phases studied. This section also describes the fiscal impacts and makes broad comparisons across the periods as to changes in job quality by occupation. Section 2.6 concludes and summarizes.

Figure 1. Summary of award cycles analyzed by the CAPTI Metrics Study*

Program	Pre-N-19-19 *(before September 2019)*	Post-N-19-19 *(October 2019-June 2021)*	Post-CAPTI Adoption *(after July 2021)*
ITIP	2018 ITIP (2017)	2020 ITIP (2019)	2022 ITIP (2021)
TIRCP	Cycle 3 (2018)	Cycle 4 (2020)	Cycle 5 (2022)
SCCP (SB1)	Cycle 1 (2018)	Cycle 2 (2020)	Cycle 3 (2022)
TECP (SB1)	Cycle 1 (2018)	Cycle 2 (2020)	Cycle 3 (2022)
LPP (SB1)	Cycle 1 (2018)	Cycle 2 (2020)	Cycle 3 (2022)
ATP	Cycle 4 (2019)	Cycle 5 (2021)	Cycle 6 (2023)
SHOPP	2018 SHOPP	2020 SHOPP	2022 SHOPP

Source: California State Transportation Agency. CAPTI Annual Report, 2022.Page 12. https://calsta.ca.gov/-/media/calsta-media/documents/capti-2022-annual-report-a11y.pdf

2.3 METHODOLOGY

This report conducts an economic impact analysis of California's transportation investments and seeks to understand if the policy changes enacted with CAPTI resulted in substantial differences in economic impact and job quality. The overall structure of the methodology is as follows. The research team used IMPLAN—an Input-Output model—to estimate the economic impacts of all transportation investments across seven State programs (listed in Figure 1). IMPLAN estimates the total number of jobs, labor income, value-added, and economic output associated with these investments. Then, IMPLAN results are combined with data from the Bureau of Labor Statistics (BLS) and American Community Survey (ACS) to measure job quality. Before turning to the development of the inputs for the IMPLAN modeling scenarios, this section begins by providing background on Input-Output modeling itself and how it is used in economics and regional planning. Next, we provide details on IMPLAN itself.

2.3.1 Input-Output Models

Input-Output (I-O) modeling is a technique used to estimate the economic impacts of a change in activity in one or more sectors of an economy. I-O models are based on the idea that all economic activity is interconnected, and that a change in one sector will have ripple effects throughout the rest of the economy.

I-O models are typically constructed using data from a social accounting matrix (SAM), which is a table that shows the flow of goods and services between different sectors of the economy. The SAM also includes information on household income and expenditure, government spending, and exports and imports.

Once an I-O model has been constructed, it can be used to estimate the impacts of a change in activity in one or more sectors of the economy. For example, an I-O model could be used to estimate the impact of a new factory on employment, income, and output in a region.

I-O models are a powerful tool for economic impact analysis, but they have some limitations. One limitation is that they are based on historical data, and therefore may not accurately reflect future economic conditions. Most I-O models, including IMPLAN, rely on detailed government statistics developed through the U.S. Census Bureau's Economic Census. This data source documents the production function of each industry by surveying firms and asking detailed questions about what input commodities are needed (in U.S. dollars) to produce their own output. It also calculates the labor share of value added. Since the economic census is conducted only every 5 years, some new emerging industries may not be well captured, and recent changes in production functions may not be accounted for.

Another limitation is that I-O models do not account for all of the potential impacts of a change in economic activity, such as the impact on the environment or social welfare. Despite these limitations, I-O models are widely used by economists, government agencies, and businesses to estimate the economic impacts of a variety of events and policies.

2.3.2 IMPLAN

IMPLAN, short for Impact Analysis for PLANning, is a widely used economic impact modeling software and database system. It primarily assesses the economic effects of various activities, events, or projects on a regional or local economy. Here's a summary of how economic impact modeling using IMPLAN works:

IMPLAN requires detailed data as input, including information about the project or activity to beanalyzed and the region where it will occur. This includes data on expenditures, employment, and other relevant factors. A description of IMPLAN input development for the CAPTI-affected program is provided in the next section.

IMPLAN categorizes economic activities into various industry sectors, such as agriculture, manufacturing, healthcare, and more. IMPLAN uses its own industry sectorization scheme, but it is based on the NAICS. In some cases, there is a direct correspondence between a 4-digit NAICS industry and an IMPLAN industry and in other cases, importantly in construction, IMPLAN aggregates several NAICS into a unique sector. The software uses a comprehensive database of industry-specific data to estimate how changes in one sector affect others (i.e., an I-O model described above).

IMPLAN uses the data developed in its I-O model to employ multiplier effects to estimate the indirect and induced impacts of a given (direct) economic activity. These effects account for the ripple effects that occur as dollars spent in one sector circulate through the economy, creating additional economic activity.

2.3.2.1 Types of Economic Impacts

IMPLAN can estimate several types of economic impacts, including:

- **Direct Impact:** The initial economic activity generated by the project or event. This accounts for the jobs created directly by the State's transportation projects as listed in the spreadsheets provided by CalSTA. Specifically, this covers all the road expansions, pedestrian trails, electric vehicle purchases, and transit investments.

- **Indirect Impacts:** Indirect impacts are the subsequent economic effects that occur as a result of the direct impacts. These impacts capture the additional economic activity that takes place in industries that supply goods and services to the industries directly affected by the project. Indirect impacts are often referred to as "backward linkages." In this case, indirectly stimulated industries are those that supply the direct sectors with inputs, such as concrete, truck leasing, employment services, and electronic components.

- **Induced Impacts:** Induced impacts represent the third round of economic effects and are the result of increased household spending by employees and others in the state's economy who benefit from the direct and indirect impacts. When workers in the direct and indirectly stimulated sectors receive their wages, they spend a portion of their income on goods and services in the state's economy, such as housing, groceries, entertainment, and more. This additional spending generates economic activity in various sectors, including retail, real estate, and services.

2.3.2.2 IMPLAN Outputs

IMPLAN provides detailed reports and data on the estimated economic impacts. These tables include information on employment changes, labor income, value added and changes in output (e.g., increased production in certain sectors). One metric that can be calculated from these outputs is the overall multiplier for each measure. This is simply done by taking the ratio of the total amount (e.g., employment) to the direct amount. So total employment divvied by direct employment yields a simple multiplier. This metric is a useful way of comparing the changes in impact across periods in the CAPTI program.

2.3.2.3 Limitations

It is important to recognize the limitations of IMPLAN. The accuracy of results depends on the quality of input data and assumptions made. Additionally, IMPLAN provides a snapshot of economic impacts at a specific point in time and does not account for dynamic changes in the economy.

In summary, IMPLAN is a powerful economic impact modeling tool that helps assess the economic effects of various activities on a regional or local scale. It's widely used in urban and regional planning, economic development, and policy analysis to understand the potential consequences of different projects or events on the economy.

2.4 DEVELOPMENT OF IMPLAN INPUTS

The authors were provided with detailed project-level data for each of the seven programs analyzed. These programs included the Active Transportation Program (ATP), the State Highway Operation and Protection Program SHOPP, the Local Partnership Program (LPP), the Trade Corridor Enhancement Program (TCE), the TIRCP, ITIP and the Solutions to Congested Corridors (SCCP). Each spreadsheet contained detailed information on individual transportation projects. Project counts ranged from a few dozen (ATP) to several hundred (TIRCP) in each phase. While these files contained information on the location, implementing agency, and transportation impact figures, the key variables for the purposes of economic impact analysis were the narrative project description and the total costs ($).

As noted above, IMPLAN needs inputs in order to conduct an analysis. This is essentially what the "exogenous" change in the economy is that one is seeking to study. This input needs to be specified in two dimensions. First, we need to determine which sector of the economy has changed (either by industry or by commodity). Next, we need to determine the magnitude of the change. The magnitude can be inputted by employment or output (sales in current year dollars).

The goal behind the coding process was to specify which IMPLAN industry sector (or commodity number) best matches each project listed in the seven spreadsheets provided by CalSTA. In many cases, the process was straightforward based on the project description field. For example, if a project called for the expansion of a State road or highway, this amounted to a simple one-to-one connection with the IMPLAN Sector 54 "Construction of New Highways and Streets." Similarly for transit projects, there was a direct correspondence with Sector 418 "Transit and Ground Passenger Transportation."

In addition, while some projects were not exactly related to highway or street construction or maintenance, these were the closest available options given the type of workers involved and the nature of construction production functions (i.e., similar materials and equipment used). For example, there is no IMPLAN sector for bike lanes or hiking trails. However, for the purposes of understanding the overall job creation and job quality of CAPTI-funded projects, these projects are still best approximated by either Sector 54 (new) or Sector 62 (maintenance and repair construction of highways, streets, bridges, and tunnels).In some instances, the project descriptions included aspects of projects that fell over multiple IMPLAN sectors. For example, some projects included expanding transit service (418) but also called for the purchase of new rail cars or other equipment purchases. Many projects called for the purchasing of new electric buses or cars. In the case where multiple IMPLAN sectors were stimulated in a given project, the authors split up the dollar amount listed in the total project cost column across the affected sectors through a linear approximation (e.g., 50/50, 33/33/33).

As indicated above, some projects involved the State (or local agency) purchasing new equipment. In these cases, the dollar amount was inputted as a Commodity purchase, rather than an industry. IMPLAN treats Commodity and Industries differently. When a Commodity purchase is made in a study region (California in this case) IMPLAN will allocate those dollars to the industries that produce that commodity; it first fills the demand for that commodity within the region. If California does not have firms in the affected industry or doesn't have enough capacity in that sector, then IMPLAN fills demand from outside the region (i.e., treats it as an import.). Thus, some amount of the commodities purchased may not have as large a multiplier effect due to the fact that some of the purchases were made to non-California entities. An example would be if some of the EVs purchases were made in China or Europe. When an input is entered as an industry, 100 percent of the direct dollar amount is assumed to be within the study region.

One exception to the intuitive, descriptive matching process conducted by the author was in the case of projects that involved ecological mitigation. IMPLAN does not have a separate code for mitigation work. In these cases, mitigation activities were coded to IMPLAN sectors based on a methodology developed by Bendor and Lester, et. al.[1] This project resulted in a percentage breakdown of how to distribute mitigation dollars across four distinct sectors.[2]

Once all projects across all seven spreadsheets were coded and associated with a specific IMPLAN industry or commodity code, total project cost figures were summed for each of the seven programs and entered into IMPLAN as dollar amounts. Since figures listed in the spreadsheet were assumed to be in nominal dollars, we entered Pre-projects in 2019 dollars, Mid-projects in 2020 dollars, and Post-projects in 2022 dollars. All figures presented in the results sections have been adjusted to 2023 dollars. Table 1 below summarizes the results of the coding process.

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1 Todd, BenDor, et al., "Estimating the Size and Impact of the Ecological Restoration Economy," *PloS one* 10, no. 6 (2015): e0128339; Todd K. BenDor, et al., "Defining and Evaluating the Ecological Restoration Economy." *Restoration Ecology* 23, no. 3 (2015): 209-219.

2 These sectors were: 19-Support activities for agriculture and forestry (27.1%), 369-Architectural, engineering, and related services (41.9%), 36-Construction of other new nonresidential structures (16.0%), and 375-Environmental and other technical consulting services (15.0%).

Table 1. Summary of IMPLAN Inputs by Sector/Commodity, Program and Period

IMPLAN Sector	IMPLAN Sector Name	Period		
ATP		**PRE ($)**	**MID ($)**	**POST ($)**
54	Construction of new highways and streets	543,453,500	723,801,500	2,359,949,000
463	Environmental and other technical consulting services	53,720,500	72,241,500	306,780,000
LPP		**PRE**	**MID**	**POST**
52	Construction of new power and communication structures			42,605,000
54	Construction of new highways and streets	356,884,000.00	727,230,000.00	526,761,000
62	Maintenance and repair construction of highways, streets, bridges, and tunnels	120,338,000.00	181,253,000.00	6,500,000
415	Rail transportation	107,155,000.00		27,761,000
3310	Other electronic components		35,000,000	6,630,000
3341	Light trucks and utility vehicles	15,253,000.00		
SCCP		**PRE**	**MID**	**POST**
52	Construction of new power and communication structures	2,557,500	29,107,500	105,450,000
54	Construction of new highways and streets			443,420,000
56	Construction of other new nonresidential structures		531,240,000	43,001,000
62	Maintenance and repair construction of highways, streets, bridges, and tunnels	833,775,000	2,269,943,000	166,421,500
385	Sign manufacturing		344,000	
415	Rail transportation			505,289,000
418	Transit and ground passenger transportation	291,920,000	479,151,000	1,600,172,000
457	Architectural, engineering, and related services			13,566,500
514	Electronic and precision equipment repair and maintenance	2,557,500	4,942,500	
3310	Other electronic components			23,849,000
3341	Light trucks and utility vehicles		5,414,000	78,414,000
SHOPP		**PRE**	**MID**	**POST**
19	Support activities for agriculture and forestry	27,615,076	14,753,820	22,624,113
49	Water, sewage and other systems	20,637,000	32,442,000	-
56	Construction of other new nonresidential structures	67,292,841	40,876,616	135,114,484
62	Maintenance and repair construction of highways, streets, bridges, and tunnels	4,173,240,000	6,104,573,000	6,462,521,000
457	Architectural, engineering, and related services	42,712,805	22,820,036	34,993,179
463	Environmental and other technical consulting services	15,332,278	8,191,528	12,561,225
ITIP		**PRE**	**MID**	**POST**

IMPLAN Sector	IMPLAN Sector Name	Period		
ATP		**PRE ($)**	**MID ($)**	**POST ($)**
19	Support activities for agriculture and forestry	33,086,296.23	1,110,246.34	-
54	Construction of new highways and streets	1,816,226,000.00	1,997,532,000	2,848,696,000
56	Construction of other new nonresidential structures	18,600,589	656,088	
415	Rail transportation	33,760,000	291,970,000	1,745,769,000
457	Architectural, engineering, and related services	48,685,033	1,717,240	
463	Environmental and other technical consulting services	17,476,081	616,424	
TCEP		**PRE**	**MID**	**POST**
52	Construction of new power and communication structures		19,588,000	266,026,000
54	Construction of new highways and streets	2,045,613,000	3,498,073,000	2,465,776,500
56	Construction of other new nonresidential structures		333,356,000	651,508,000
62	Maintenance and repair construction of highways, streets, bridges, and tunnels			68,400,000
274	Heating equipment (except warm air furnaces) manufacturing		2,333,333	
415	Rail transportation	91,137,000.00	1,143,010,000	93,686,500
453	Commercial and industrial machinery and equipment rental and leasing		2,333,333	
457	Architectural, engineering, and related services		2,333,333	
461	Other computer related services, including facilities management		19,588,000	
3310	Other electronic components			40,136,000
TIRCP		**PRE**	**MID**	**POST**
52	Construction of new power and communication structures	13,896,500	4,240,500	6,862,025
54	Construction of new highways and streets	6,419,545,000	624,768,066	97,289,059
56	Construction of other new nonresidential structures	54,209,000		
62	Maintenance and repair construction of highways, streets, bridges, and tunnels	7,204,000		
415	Rail transportation	449,530,000	87,196,969	
418	Transit and ground passenger transportation	7,326,252,000	1,135,130,823	781,998,808
514	Electronic and precision equipment repair and maintenance	1,768,200,000		
3341	Light trucks and utility vehicles	354,030,500	26,213,389	380,784,267
3359	Railroad rolling stock	2,259,147,000	3,536,400,000	-
3360	Ships		27,335,000	78,613,665
3428	Software publishers	75,041,000		

IMPLAN Sector	IMPLAN Sector Name	Period		
ATP		PRE ($)	MID ($)	POST ($)
TOTAL		29,706,083,000	24,038,826,746	22,449,928,824

2.5 FINDINGS

2.5.1 Pre-Period

The total economic impact of the pre-programs is $56.4 billion. The output multiplier means that for every one dollar spent in this period, an additional 0.92 cents is generated in the CA economy. These programs support 235,461 jobs directly. This means that the transportation projects themselves result in the employment of these workers. There are an additional 44,674 jobs supported in indirect sectors. These are the companies that supply the direct industries. Lastly, there are an additional 68,583 jobs supported in the induced sector. These represent jobs created through workers' household spending.

Table 2. Summary of Economic Impacts – Pre-Period

Impact	Employment	Labor Income	Value Added	Output
1 - Direct	235,461	$ 12,991,651,734	$ 16,756,238,060	$ 29,446,471,562
2 - Indirect	44,674	$ 4,070,861,419	$ 6,934,366,766	$ 12,739,767,368
3 - Induced	68,583	$ 5,040,432,875	$ 8,903,822,886	$ 14,298,193,163
	348,718	$ 22,102,946,028	$ 32,594,427,712	$ 56,484,432,093
Multiplier	1.48	1.70	1.95	1.92
Per $100,000	1.18	$ 75,061	$ 110,690	$ 191,821

The industry with the most direct jobs is 418 with 130,454 jobs. The industry with the second most direct jobs is 54 with 68,602 jobs. The industry with the ninth most direct jobs is 504 with 495 jobs. The industry with the 10th most direct jobs is 463 with 494 jobs.

Table 3. Top 10 Direct Industries-Pre-Period

Industry	Direct
418 - Transit and ground passenger transportation	130,454
54 - Construction of new highways and streets	68,602
62 - Maintenance and repair construction of highways, streets, bridges, and tunnels	15,826
514 - Electronic and precision equipment repair and maintenance	9,725
359 - Railroad rolling stock manufacturing	5,131
415 - Rail transportation	1,479
19 - Support activities for agriculture and forestry	1,134
56 - Construction of other new nonresidential structures	760
404 - Retail - Electronics and appliance stores	495
463 - Environmental and other technical consulting services	494

The industry with the most indirect jobs is 405 with 4,120 jobs. The industry with the second most indirect jobs is 472 with 2,881 jobs. The industry with the ninth most indirect jobs is 469 with 1,160 jobs. The industry with the 10th most indirect jobs is 441 with 1,005 jobs.

Table 4. Top 10 Indirect Industries – Pre-Period

Industry	Indirect
405 - Retail - Building material and garden equipment and supplies stores	4,120
472 - Employment services	2,881
417 - Truck transportation	1,951
447 - Other real estate	1,872
396 - Wholesale - Other durable goods merchant wholesalers	1,726
457 - Architectural, engineering, and related services	1,643
476 - Services to buildings	1,219
445 - Insurance agencies, brokerages, and related activities	1,181
469 - Management of companies and enterprises	1,160
441 - Monetary authorities and depository credit intermediation	1,005

The industry with the most induced jobs is 410 with 3,656 jobs. The industry with the second most induced jobs is 509 with 3,073 jobs. The industry with the ninth most induced jobs is 442 with 1,512 jobs. The industry with the 10th most induced jobs is 472 with 1,507 jobs.

Table 5. Top 10 Induced Industries – Pre-Period

Industry	Induced
510 - Limited-service restaurants	3,656
509 - Full-service restaurants	3,073
493 - Individual and family services	2,972
490 – Hospitals	2,481
483 - Offices of physicians	1,992
447 - Other real estate	1,806
406 - Retail - Food and beverage stores	1,702
411 - Retail - General merchandise stores	1,649
442 - Other financial investment activities	1,512
472 - Employment services	1,507

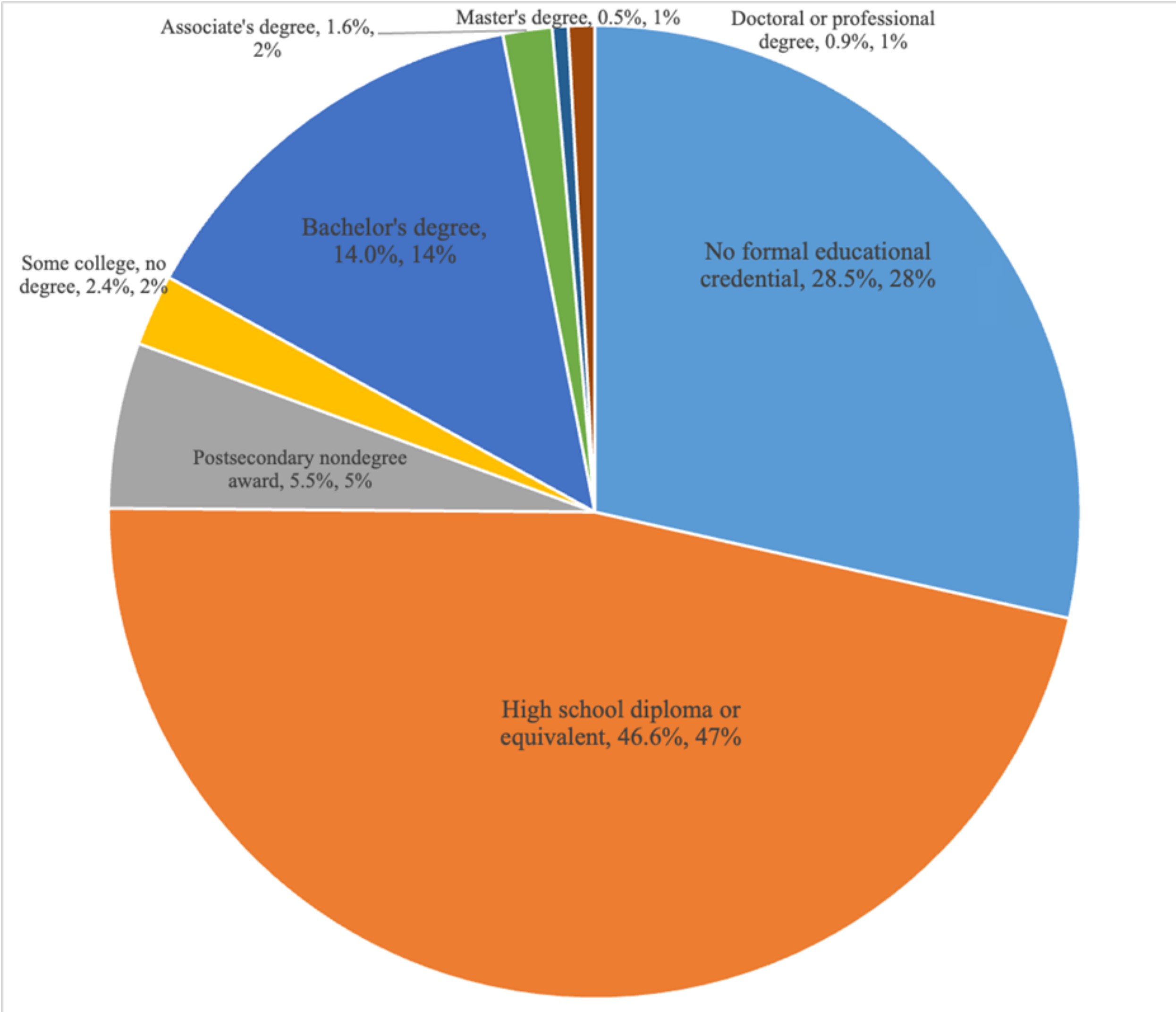
The occupation that has created the most jobs is passenger vehicle drivers, with 9,461 jobs created. The occupation that has created the second most jobs is construction labor with 7,741 jobs created. The occupation that has created the 10th most jobs is plumbing with 3,264 jobs created. The occupation that has created the 19th most jobs is the installation of heating and AC with 2,284 jobs created. The occupation that has created the 20th most jobs is bookkeeping and clerks with 2,265 jobs created.

Table 6. Top 20 Occupations by Number of Jobs Created – Pre-Period

Occupation	Total Employment	Typical Education Needed for Entry	Percent with W Health Insurance
Passenger Vehicle Drivers, Except Bus Drivers, Transit and Intercity	9,461.28	Bachelor's degree	0.277352916

Occupation	Total Employment	Typical Education Needed for Entry	Percent with W Health Insurance
Construction Laborers	7,741.36	High school diploma or equivalent	0.354084269
Carpenters	5,557.25	Doctoral or professional degree	0.420072476
Electricians	4,803.24	Associate’s degree	0.644266838
Office Clerks, General	4,633.86	Doctoral or professional degree	0.631663015
First-Line Supervisors of Construction Trades and Extraction Workers	4,300.34	Master’s degree	0.636379028
Retail Salespersons	4,170.02	High school diploma or equivalent	0.516426047
General and Operations Managers	3,665.90	No formal educational credential	0.767222122
Laborers and Freight, Stock, and Material Movers, Hand	3,513.92	High school diploma or equivalent	0.502114367
Plumbers, Pipefitters, and Steamfitters	3,264.66	High school diploma or equivalent	0.556913862
Heavy and Tractor-Trailer Truck Drivers	2,956.91	High school diploma or equivalent	0.530137659
Customer Service Representatives	2,817.72	High school diploma or equivalent	0.619535377
Fast Food and Counter Workers	2,660.13	Bachelor’s degree	0.506138614
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	2,641.26	Bachelor’s degree	0.651985532
Cashiers	2,557.53	Bachelor’s degree	0.432151993
Bus Drivers, Transit and Intercity	2,538.70	High school diploma or equivalent	0.683538719
Home Health and Personal Care Aides	2,414.52	Associate’s degree	0.471746679
Operating Engineers and Other Construction Equipment Operators	2,383.17	Doctoral or professional degree	0.675713045
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	2,284.59	High school diploma or equivalent	0.64568122
Bookkeeping, Accounting, and Auditing Clerks	2,265.79	No formal educational credential	0.628392112

Figure 2. Education Attainment Needed for All Jobs Supported – Pre-Period



2.5.2 Mid-Programs

The total economic impact of Mid programs is 46.7 billion. The output multiplier means that for every one dollar spent in this period, an additional 1.95 cents is generated in the CA economy. These programs support 132,997 jobs directly. This means that the transportation projects themselves result in the employment of these workers. There are an additional 38,105 jobs supported in indirect sectors. These are the companies that supply the direct industries. Lastly, there are an additional 55,198 jobs supported in the induced sector. These represent jobs created through workers' household spending.

Table 7. Summary of Economic Impacts Mid-Period

Impact	Employment	Labor Income	Value Added	Output
1 - Direct	132,997	$ 10,221,628,338	$ 12,405,511,911	$ 23,945,285,984
2 - Indirect	38,105	$ 3,528,752,978	$ 6,025,188,584	$ 11,251,978,184
3 - Induced	55,198	$ 4,057,230,429	$ 7,167,825,239	$ 11,510,331,869
	226,301	$ 17,807,611,745	$ 25,598,525,733	$ 46,707,596,036
Multiplier	1.70	1.74	2.06	1.95
Per $100,000	0.95	$ 74,368	$ 106,904	$ 195,060

The industry with the most direct jobs is 54 with 78,302 jobs. The industry with the second most direct jobs is 418 with 27,811 jobs. The industry with the ninth most direct jobs is 52 with 275 jobs. The industry with the 10th most direct jobs is 457 with 142 jobs.

Table 8. Top 10 Direct Industries – Mid-Period

Industry	Direct
54 - Construction of new highways and streets	78,302
418 - Transit and ground passenger transportation	27,811
62 - Maintenance and repair construction of highways, streets, bridges, and tunnels	8,867
359 - Railroad rolling stock manufacturing	8,144
56 - Construction of other new nonresidential structures	4,869
415 - Rail transportation	3,304
463 - Environmental and other technical consulting services	474
19 - Support activities for agriculture and forestry	298
52 - Construction of new power and communication structures	275
457 - Architectural, engineering, and related services	142

The industry with the most indirect jobs is 405 with 2,764 jobs. The industry with the second most indirect jobs is 417 with 2,166 jobs. The industry with the ninth most indirect jobs is 476 with 850 jobs. The industry with the 10th most indirect jobs is 204 with 740 jobs.

Table 9. Top 10 Indirect Industries – Mid-Period

Industry	Indirect
405 - Retail - Building material and garden equipment and supplies stores	2,764

417 - Truck transportation	2,166
396 - Wholesale - Other durable goods merchant wholesalers	2,107
472 - Employment services	1,873
457 - Architectural, engineering, and related services	1,577
447 - Other real estate	1,394
453 - Commercial and industrial machinery and equipment rental and leasing	1,056
469 - Management of companies and enterprises	930
476 - Services to buildings	850
204 - Ready-mix concrete manufacturing	740

The industry with the most induced jobs is 510 with 2,946 jobs. The industry with the second most induced jobs is 509 with 2,473 jobs. The industry with the ninth most induced jobs is 472 with 1,213 jobs. The industry with the 10th most induced jobs is 442 with 1,212 jobs.

Table 10. Top 10 Induced Industries – Mid-Period

Industry	**Induced**
510 - Limited-service restaurants	2,946
509 - Full-service restaurants	2,473
493 - Individual and family services	2,389
490 - Hospitals	2,000
483 - Offices of physicians	1,604
447 - Other real estate	1,454
406 - Retail - Food and beverage stores	1,371
411 - Retail - General merchandise stores	1,328
472 - Employment services	1,213
442 - Other financial investment activities	1,212

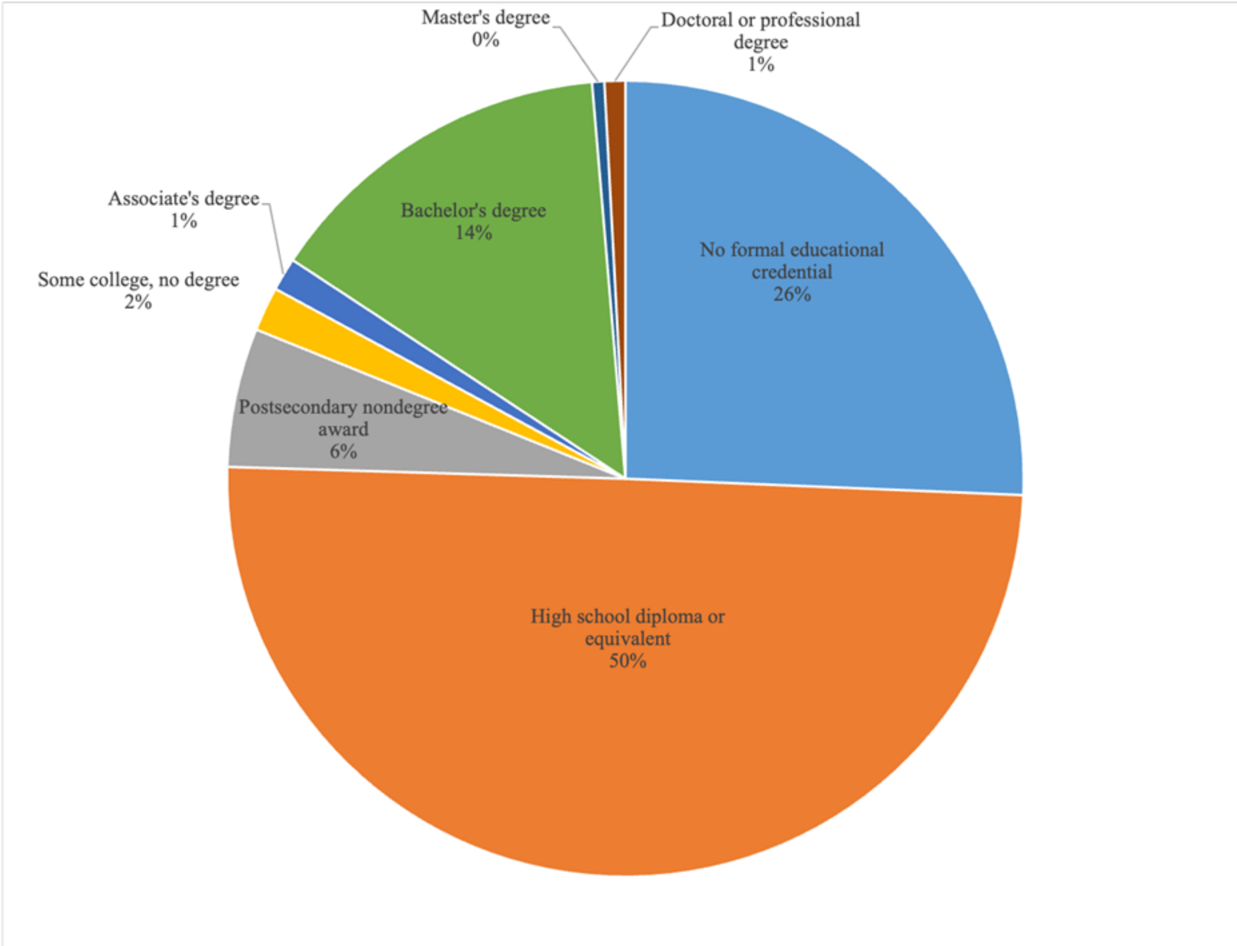
The occupation that has created the most jobs is construction labor with 8,341 jobs created. The occupation that has created the second most jobs is carpentry with 5,998 jobs created.

Table 11. Top 20 Occupations by Number of Jobs Created – Mid-Period

Occupation	**Total Employment**	**Typical Education Needed for Entry**	**Percent with Health Insurance**
Construction Laborers	8,341.11	No formal educational credential	0.354084
Carpenters	5,998.79	High school diploma or equivalent	0.420072
Electricians	5,213.29	High school diploma or equivalent	0.644267
First-Line Supervisors of Construction Trades and Extraction Workers	4,673.21	High school diploma or equivalent	0.636379
Office Clerks, General	4,122.41	High school diploma or equivalent	0.631663

Occupation	Total Employment	Typical Education Needed for Entry	Percent with Health Insurance
Plumbers, Pipefitters, and Steamfitters	3,537.25	High school diploma or equivalent	0.556914
General and Operations Managers	3,211.95	Bachelor’s degree	0.767222
Laborers and Freight, Stock, and Material Movers, Hand	3,186.34	No formal educational credential	0.502114
Retail Salespersons	3,033.59	No formal educational credential	0.516426
Heavy and Tractor-Trailer Truck Drivers	2,952.79	Postsecondary nondegree award	0.530138
Operating Engineers and Other Construction Equipment Operators	2,578.41	High school diploma or equivalent	0.675713
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	2,461.51	Postsecondary nondegree award	0.645681
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	2,393.57	High school diploma or equivalent	0.651986
Construction Managers	2,325.03	Bachelor’s degree	0.614503
Welders, Cutters, Solderers, and Brazers	2,251.12	High school diploma or equivalent	0.587433
Passenger Vehicle Drivers, Except Bus Drivers, Transit and Intercity	2,206.90	No formal educational credential	0.277353
Fast Food and Counter Workers	2,133.08	No formal educational credential	0.506139
Customer Service Representatives	2,076.59	High school diploma or equivalent	0.619535
Bookkeeping, Accounting, and Auditing Clerks	2,017.50	Some college, no degree	0.628392
Home Health and Personal Care Aides	1,933.16	High school diploma or equivalent	0.471747

Figure 3. Education Attainment Needed for All Jobs Supported – Mid-Period



The total Economic impact of Post programs is 43 billion. The output multiplier means that for every one dollar spent in this period, an additional 1.97 cents is generated in the CA economy. These programs support 128,432 jobs directly. This means that the transportation projects themselves result in the employment of these workers. There are an additional 38,339 jobs supported in indirect sectors. These are the companies that supply the direct industries. Lastly, there are an additional 49,664 jobs supported in the induced sector. These represent jobs created through workers' household spending.

Table 12. Summary of Economic Impacts – Post-Period

Impact	Employment	Labor Income	Value Added	Output
1 - Direct	128,432	$ 8,970,396,732	$ 11,604,631,930	$ 21,870,182,198
2 - Indirect	38,339	$ 3,399,187,679	$ 5,889,865,334	$ 10,762,539,350
3 - Induced	49,664	$ 3,650,273,201	$ 6,448,616,982	$ 10,355,437,726
	216,434	$ 16,019,857,613	$ 23,943,114,246	$ 42,988,159,274
Multiplier	1.69	1.79	2.06	1.97
Per $100,000	0.99	$ 73,250	$ 109,478	$ 196,561

The industry with the most direct jobs is 54 with 49,626 jobs. The industry with the second most direct jobs is 418 with 40,886 jobs. The industry with the ninth most direct jobs is 402 with 350 jobs. The industry with the 10th most direct jobs is 360 with 275 jobs.

Table 13. Top 10 Direct Industries – Post-Period

Industry	Direct
54 - Construction of new highways and streets	49,626
418 - Transit and ground passenger transportation	40,886
62 - Maintenance and repair construction of highways, streets, bridges, and tunnels	24,044
415 - Rail transportation	5,138
56 - Construction of other new nonresidential structures	4,420
463 - Environmental and other technical consulting services	1,857
52 - Construction of new power and communication structures	834
19 - Support activities for agriculture and forestry	422
402 - Retail - Motor vehicle and parts dealers	350
360 - Ship building and repairing	275

The industry with the most indirect jobs is 405 with 5,984 jobs. The industry with the second most indirect jobs is 472 with 1,983 jobs. The industry with the ninth most indirect jobs is 476 with 861 jobs. The industry with the 10th most indirect jobs is 422 with 736 jobs.

Table 14. Top 10 Induced Industries – Post-Period

Industry	Induced
510 - Limited-service restaurants	2,649
509 - Full-service restaurants	2,225
493 - Individual and family services	2,150
490 - Hospitals	1,799
483 - Offices of physicians	1,443
447 - Other real estate	1,308
406 - Retail - Food and beverage stores	1,233
411 - Retail - General merchandise stores	1,194
442 - Other financial investment activities	1,092
472 - Employment services	1,091

The occupation that has created the most jobs is construction labor with 7,148 jobs created. The occupation that has created the second most jobs is carpentry with 5,153 jobs created. The occupation that has created the 10th most jobs is hand movers with 2,665 jobs created. The occupation that has created the 19th most jobs is bookkeeping and clerks with 1,791 jobs created. The occupation that has created the 20th most jobs is care aides with 1,744 jobs created.

Table 15. Top 20 Occupations by Number of Jobs Created – Post-Period

Occupation	Total Employment	Typical Education Needed for Entry	Percent with Health Insurance
Construction Laborers	7,148.41	No formal educational credential	0.354084269
Carpenters	5,153.90	High school diploma or equivalent	0.420072476
Electricians	4,483.59	High school diploma or equivalent	0.644266838
Retail Salespersons	4,148.67	No formal educational credential	0.516426047
First-Line Supervisors of Construction Trades and Extraction Workers	4,053.43	High school diploma or equivalent	0.636379028
Office Clerks, General	3,694.54	High school diploma or equivalent	0.631663015
Passenger Vehicle Drivers, Except Bus Drivers, Transit and Intercity	3,138.24	No formal educational credential	0.277352916
Plumbers, Pipefitters, and Steamfitters	3,016.06	High school diploma or equivalent	0.556913862
General and Operations Managers	2,890.25	Bachelor’s degree	0.767222122
Laborers and Freight, Stock, and Material Movers, Hand	2,665.50	No formal educational credential	0.502114367
Heavy and Tractor-Trailer Truck Drivers	2,484.88	Postsecondary nondegree award	0.530137659
Operating Engineers and Other Construction Equipment Operators	2,227.56	High school diploma or equivalent	0.675713045
Customer Service Representatives	2,122.23	High school diploma or equivalent	0.619535377
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	2,107.98	Postsecondary nondegree award	0.64568122
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	2,094.59	High school diploma or equivalent	0.651985532
Cashiers	2,082.73	No formal educational credential	0.432151993
Construction Managers	2,001.26	Bachelor’s degree	0.61450308
Fast Food and Counter Workers	1,929.97	No formal educational credential	0.506138614
Bookkeeping, Accounting, and Auditing Clerks	1,791.68	Some college, no degree	0.628392112
Home Health and Personal Care Aides	1,744.24	High school diploma or equivalent	0.471746679

Figure 4. Education Attainment Needed for All Jobs Supported – Post-Period

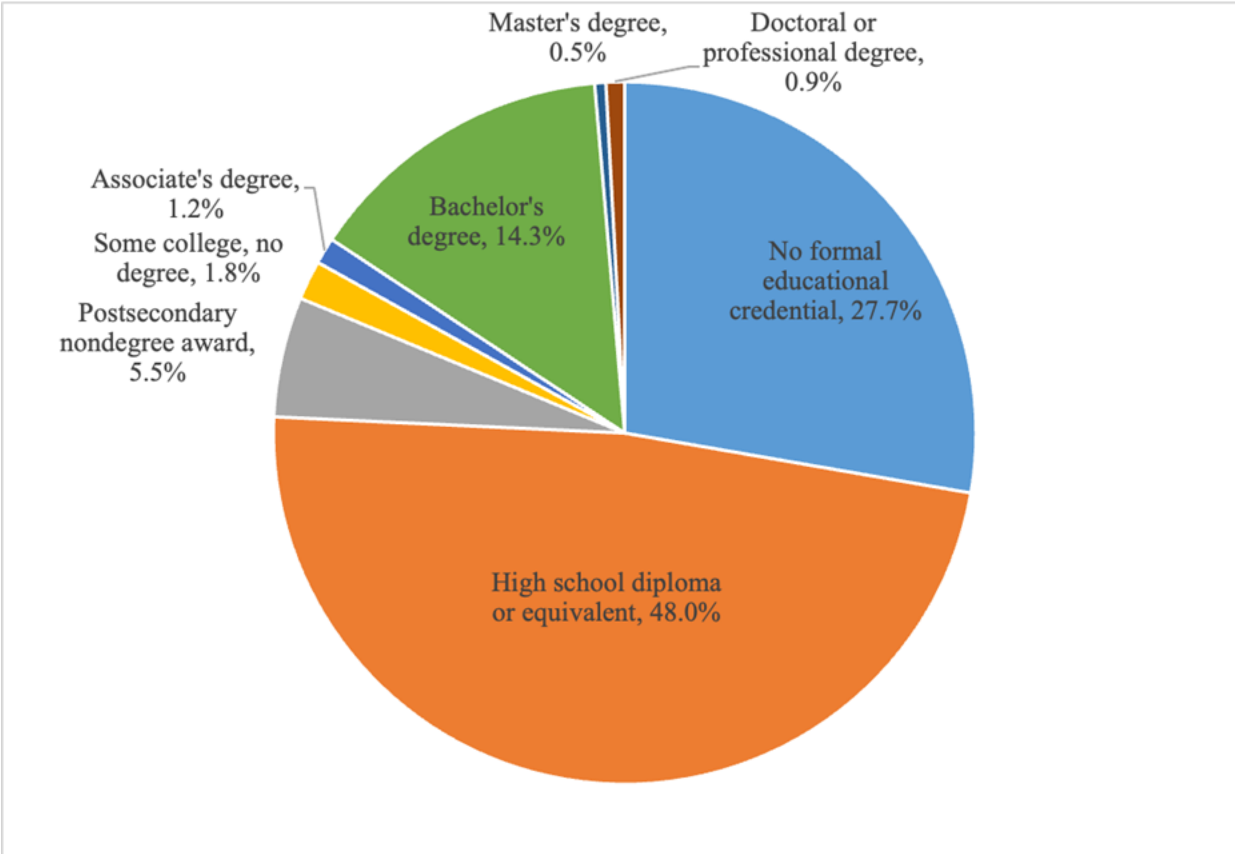
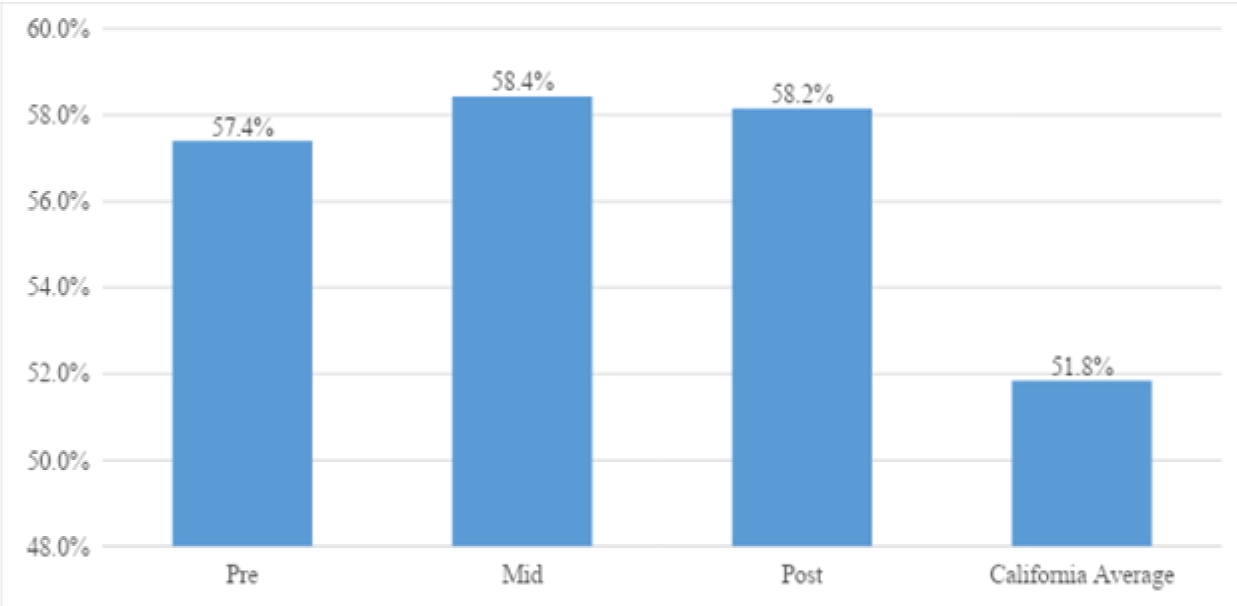


Figure 5 compares the quality of jobs created by CAPTI phase as indicated by the share of jobs with employer-sponsored health insurance. There is very little difference across the three phases, with the mid and post periods slightly higher with 58.4% and 58.2%, respectively. Interestingly, CAPTI supported jobs and the jobs they generate through the multiplier process are higher quality than the average job in California, where only 51.8% of positions carry health insurance.

Also, given the large shares of jobs created that only require a high-school degree (see Figures 4-6 above), the fact that these are relatively good paying and high-quality jobs, we can conclude that CAPTI funded transportation investments support access to critical economic opportunity for relatively disadvantaged workers.

Figure 5. Percent of Jobs with Employer-Paid Health Care



2.6 CONCLUSION

Overall, investments approved after the adoption of CAPTI generated consistent economic impact across California as compared to previous rounds of investments. There is very little variation in the overall economic impact of the three CAPTI scenarios, with the total economic output and jobs figures varying mostly due to the different levels of dollars invested across the programs.

Additionally, policy changes enacted in the CAPTI process did not result in the diminution of job quality and did not alter the accessibility of jobs to California workers. This contradicts the popular belief that only certain types of infrastructure projects, such as highway expansion, generate good jobs for Californians.

3. VMT AND EMISSIONS IMPACT ANALYSIS

In this chapter, the research team has estimated and compared the emissions impact of CAPTI on State Transportation Investment programs. First, the research team described the data collected to analyze this project. Next, we described the metric developed for this project, VMT Rating, to compare the effects of different investments on the Vehicle Miles Traveled (VMT) increase or decrease. The choice of VMT as a proxy of emissions from the transportation sector is established in the literature. Specifically, it is important that the CAPTI investments help California achieve its VMT reduction goal through investments in infrastructure. Finally, the research team described the VMT analysis results and discussed recommendations.

3.1 DATA

The data received from Caltrans included seven different CAPTI Programs:

- Active Transportation Program (ATP)
- Interregional Transportation Improvement Program (ITIP)
- Transit and Intercity Rail Capital Program (TIRCP)
- Local Partnership Program (LPP)
- Solutions for Congested Corridors Program (SCCP)
- Trade Corridor Enhancement Program (TCEP)
- State Highway Operation and Protection Program (SHOPP)

Each program's data was consolidated into seven unique spreadsheets; the data were inconsistent from program to program. The data from TCEP, SCCP, LPP, ITIP, ATP programs were similar in that they provided the total list of projects and similar if not identical output categories. For each of these five programs, the projects were sorted into rows and had output category values lined in columns as seen below. Output categories were further organized into our "bin categories" as reflected by the colors.

Among these five programs, many output categories are not included in their respective spreadsheet. The table below shows all the output categories that were listed in the LPP dataset and how they compare to respective programs. An "x" marks that the program does include the category.

Figure 6. Image of LPP Project Outputs Organized in a Spreadsheet

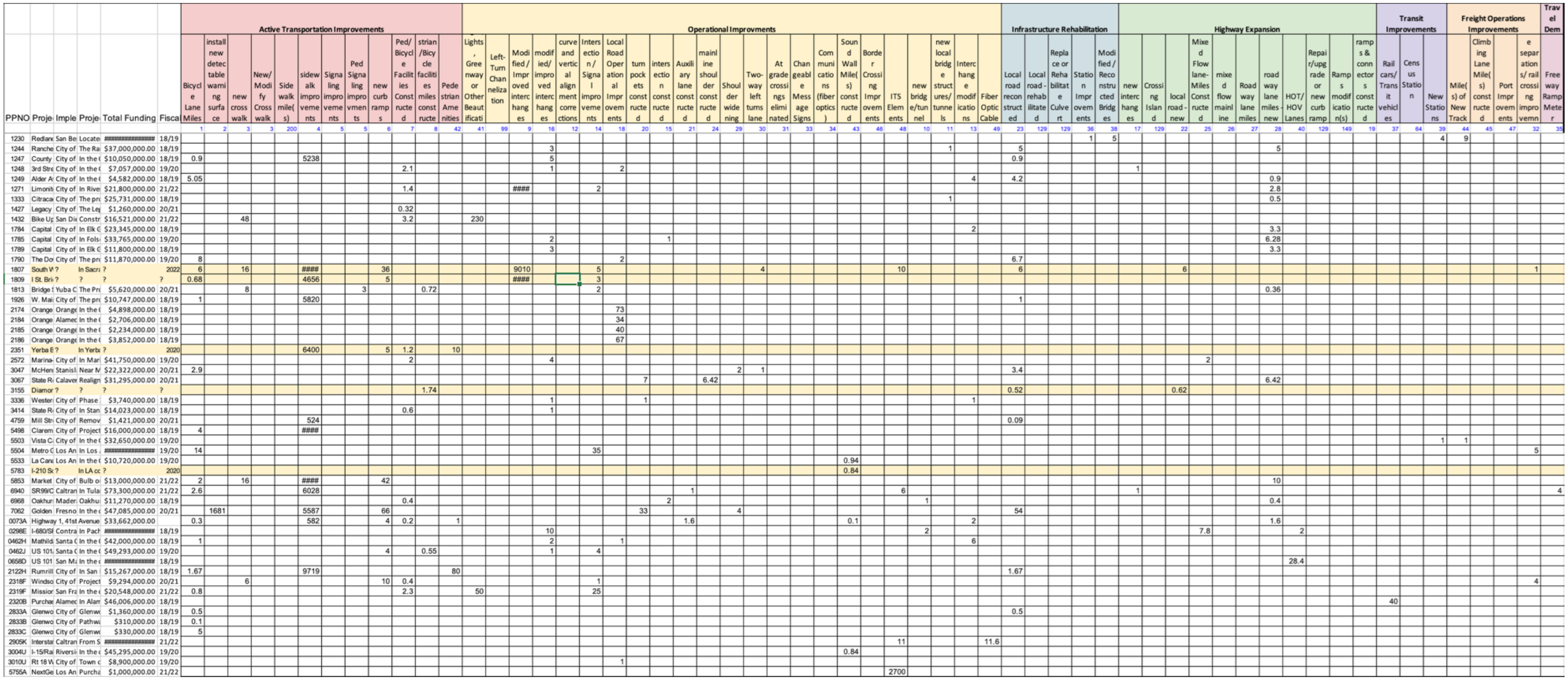


Table 16. Summary of 5/7/2022 CAPTI Programs' Output Categories Given Per the Data Request

	Does Program Include Category?				
Output Category	**LPP**	**TCEP**	**SCCP**	**ITIP**	**ATP**
Bicycle lane miles	x	x	x		x
Install new detectable warning surface	x	x	x		
Sign(s), light(s), greenway or other safety/beautification	x				
New crosswalk	x	x	x		x
Sidewalk improvements	x	x	x		x
Signaling improvements	x	x	x		
New curb ramps	x	x	x		
Ped/ bicycle facilities constructed	x	x	x	x	x
Pedestrian amenities	x				
Pedestrian/bicycle facilities miles constructed	x	x	x		x
Modified/improved interchanges	x	x	x		
New bridge/tunnel	x	x	x		
New local bridge structures/tunnels	x	x	x		
Curve and vertical alignment corrections	x	x	x		
Interchange modifications	x	x	x		
Intersection/signal improvements	x	x	x		
Intersection constructed	x	x	x		
Modified/improved interchanges	x	x	x		
New interchanges	x	x	x		
Local road operational improvements	x	x	x		
Ramps & connectors constructed	x	x	x		
Turn pockets constructed	x	x	x		
Auxiliary lane constructed	x	x	x	x	
Local road-new	x	x	x		
Local road reconstructed	x	x	x		
Mainline shoulder constructed	x	x	x		
Mixed flow lane miles constructed	x	x	x	x	
Mixed flow mainline	x	x	x		
Roadway lane miles	x	x	x		
Roadway lane miles-new	x	x	x		
Shoulder widening	x	x	x		
Two-way left turns lane	x	x	x		
At-grade crossings eliminated	x	x	x		
Grade separations/rail crossing improvements	x	x	x		
Changeable message signs	x	x	x		
Communications (fiber optics)	x	x	x		
Freeway ramp meter	x	x	x		
Station improvements	x	x	x		
Rail cars/transit vehicles	x	x	x		
Modified/reconstructed bridges	x	x	x		
New stations	x	x	x		

	Does Program Include Category?				
Output Category	**LPP**	**TCEP**	**SCCP**	**ITIP**	**ATP**
HOT/HOV lanes	x	x	x	x	
Sound wall mile(s) constructed	x	x		x	
Mile(s) of new track	x	x			
Truck climbing lane mile(s) constructed	x	x			
Border crossing improvements	x	x			
Port improvements	x	x			
ITS elements	x	x			
Fiber optic cable	x	x			

In addition, there are discrepancies in how much data is reported in proportion to each project for each program. For example, every LPP project of 61 has at least one output category value reported while ITIP has 10 of 363 reported projects.

Programs TIRCP and SHOPP did not report any output categories that align with the respective categories from the programs presented in the table above. The SHOPP program data is merely a project list with "advertised year," "project description," "programmed cost" and if the "project contains one or more of these features: accessibility, safety, air quality, climate change." The TIRCP program only reports "outcomes" and not "outputs." This program marks statistics like "estimated GHG reductions" and "cost per GHG Ton reduced" rather than outputs like "ZEV buses purchased," "bicycle lane miles added," etc.

Presented below is the metadata that was consolidated for each program. The variables differ from program to program because some information is unknown or presented differently.

Figure 7. Summary of LPP Program Metadata

		Total Number of Projects per year they were documented					
Total Projects	Total Program Cost	2017	2018	2019	2020	2021	2022
61	UNK	0	20	0	11	0	30

Figure 8. Summary of TCEP Program Metadata

		Total Number of Projects per FY they were Planned					
Total Projects	Total Program Cost	'17/18	'18/19	'19/20	'20/21	'21/22	'22/23
66	$ 7,157,365,000	2	13	22	9	11	9

Figure 9. Summary of TIRCP Program Metadata

		Total Number of Projects per Year they were Awarded					
Total Projects	Total Program Cost	17	18	19	20	21	22
68	$ 25,724,619,570	0	28	0	17	0	23

Figure 10. Summary of ATP Program Metadata

		Total Number of Projects per FY they were Planned					
Total Projects	Total Program Cost	'17/18	'18/19	'19/20	'20/21	'21/22	'22/23
241	UNK	UNK	UNK	UNK	UNK	UNK	UNK

Figure 11. Summary of SCCP Program Metadata

		Total Number of Projects per FY they were Planned					
Total Projects	Total Program Cost	'17/18	'18/19	'19/20	'20/21	'21/22	'22/23
42	$ 4,450,952,000	1	6	7	10	14	4

Figure 12. Summary of SHOPP Program Metadata

		Total Number of Projects per FY they were Advertised					
Total Projects	Total Program Cost	'17/18	'18/19	'19/20	'20/21	'21/22	'22/23
1249	$ 17,238,301,000	398	0	407	0	444	0

Figure 13. Summary of ITIP Program Metadata

		Total Number of Projects per FY they were Planned					
Total Projects	Total Program Cost	'17/18	'18/19	'19/20	'20/21	'21/22	'22/23
363	$ 20,196,017,000	UNK	UNK	UNK	UNK	UNK	UNK

3.2 METHODOLOGY

The research group was tasked to assess the vehicle miles travelled (VMT) impact among 7 unique programs under California's Climate Action Plan for Transportation Infrastructure (CAPTI). The 7 Programs included: Transit and Intercity Rail Capital Program (TIRCP); Interregional Transportation Improvement Program (ITIP); Solutions for Congested Corridors Program (SCCP); Active Transportation Program (ATP); Trade Corridor Enhancement Program (TCEP); State Highway Operation and Protection Program (SHOPP); Local Partnership Program (LPP).

3.2.1 Project Categorization Method

In the initial stages of the evaluation and decision-making metric, bins have been defined to appropriately categorize the aspects of different priority infrastructure projects. These bins are based off the projects and project descriptions discovered in CAPTI Programs. The infrastructure improvements and strategies that define each category are presented below. Many projects within the CAPTI Programs may possess multiple categories; for simplicity, the example projects below are projects exclusive to the respective category.

Table 17. Categories of Different Projects

Categories	Strategies Considered within the Category	Example Projects, Program
Transportation Demand Management (TDM)	Ramp metering strategies; New car-park fees/ charges; Incentives to reduce travel	Auburn Blvd Ramp Meter, SCCP
Zero-emissions Vehicle Strategies (ZEV)	All EV related infrastructure; Investment in transit EVs	Central Orange County Corridor - Bravo! Main Street Rapid Bus, SCCP
Active Transportation Improvements	New or improved bike networks, pedestrian commuter routes, crosswalks, sidewalks, micro-mobility	Santa Claus Lane Streetscape, Coastal Access Parking and Railroad Crossing, SCCP

Categories	Strategies Considered within the Category	Example Projects, Program
Transit Improvements	Adding capacity to: light rail, subway, trains, buses;	Redlands Passenger Rail Project, SCCP
Operational Improvements	Highway interchange improvements; ITS implementation (e.g., TSP, Timed signal networks); Junction improvements; Implementing toll lanes; New or improved traffic signal intersections/ networks	Central Orange County Corridor - Traffic Light Synchronization - MacArthur Boulevard, SCCP
Infrastructure Rehabilitation	Roadway and highway rehabilitation; Transit station renovation/modernization *unrelated to capacity expansions	Goleta Train Depot, TIRCP
Highway Expansion	Adding capacity to highways, roadways; Includes HOV lanes	I-5 Corridor Enhancement Project/I-5 HOV Lanes-Phase 1, SCCP
Freight Operations Improvements	Adding capacity or improving freight/ intermodal systems such as trucks, trains, ships, aircraft	Port of Stockton Rail Bridge, Phase I, TCEP

3.2.2 Vehicle Miles Traveled (VMT) Rating Approach

Each program was assessed for its individual projects' infrastructure "outputs" as reported by Caltrans. All programs' outputs were analyzed, and 152 unique outputs were consolidated. The consolidated list of outputs is given in **Appendix A**. The VMT impact for each project stems from the infrastructure outputs that the respective project adds. Each of the 152 outputs have been assigned a "VMT Rating/unit," which corresponds to the unit value that is assigned to each output. For example, the amount of new crosswalks added from an infrastructure project is measured in "each" while the amount of new roadway miles added is measured in "miles." After the outputs were organized into one table, The research team first depicted the outputs with "neutral" impact on VMT. The remaining outputs were analyzed to either have a "positive" impact on VMT (outputs that induce more VMT for a project) or a "negative" impact on VMT (outputs that induce less VMT for a project).

The VMT ratings were derived by studying literature to understand the impact that each output has by adding or removing metric tons of CO_2 per year. For clarification, not all assigned VMT ratings were calculated from the same source; assumptions were made by comparing the impact of outputs on VMT. Many VMT ratings were inconclusive due to inadequate information from the literature reviewed. Inconclusive VMT ratings were given a value of 0.

Neutral Impact

Regarding the process of analysis for the outputs among the seven CAPTI programs, the researchers first assigned a "neutral" rating to the outputs that have no VMT impact on a project. These outputs were grouped to have a VMT rating/unit of 0. Examples of outputs grouped into the neutral category include "fish passage remediation" (each), "LED install lighting" (each), and "guard rail added" (linear feet).

There is a common trend among neutral impacting outputs as seen above. Outputs that have a positive environmental effect or enhance driver safety were measured in programs like SHOPP and ITIP. Although these outputs are essential to a project's impact on safety and environmental outcomes, they were deemed not to have an impact on adding vehicle miles traveled from a transportation corridor. Thus, they were assigned a "neutral" impact. Outputs with a neutral impact can be seen in **Appendix B.**

Positive Impact

The outputs with a positive VMT rating are the ones that would add vehicle miles due to their construction in a new infrastructure project. Only 11 outputs of the 152 have a positive VMT rating. Among these outputs, there are two common groups: capacity expansion and facility improvements.

Adding lanes to highways and heavily trafficked roadways is considered capacity expansion. The outputs included in the data from Caltrans involve the addition of lanes in "miles" to an existing infrastructure project or new project. Examples include "mixed flow lane-miles," "HOV/HOT lane-miles" and "Roadway lane-miles." These outputs induce the highest VMT rating/mile because constructing additional lanes to a roadway facility allows for more vehicles to use the facility—thus, adding vehicle miles traveled to the project.

The facility improvement outputs reported by Caltrans that were deemed to increase vehicle miles traveled include lane widening, shoulder widening, and interchange modifications. Lane widening and shoulder widening were reported in "miles" while interchange modifications were reported in "each." Outputs with a positive impact can be found in **Appendix C.**

Negative Impact

The outputs with a negative VMT rating are the ones that would subtract vehicle miles due to their construction in a new infrastructure project. There are 38 out of 152 outputs reported by Caltrans that were deemed to have a negative VMT rating. New active transportation facilities, signaling improvements for pedestrians and bicyclists, and new transit infrastructure were predominant groups for outputs of which have a negative VMT rating. Outputs with a negative impact can be found in **Appendix D.**

Active transportation facilities involve multi-use pathways, all classes of bike-lanes, and new sidewalk improvements. The output for multi-use facilities is "Pedestrian/Bicycle Facility Miles Constructed" while "Bicycle Lane Miles" were also measured, and the unit "Sidewalk Improvements" is "length feet."

Signaling improvements for pedestrians and bicyclists include amenities at traffic signals and intersections that enhance the safety and accessibility for walking and biking. Examples of outputs in this group include installing "detectable warning surfaces," "new crosswalks," and "bike boxes," most of which used "each" as the unit of measurement.Adding new transit infrastructure creates an alternative and more sustainable mode of travel for individuals making trips. Examples of outputs that lie within this group include projects that build "new stations," "transit-only lanes," "rail cars/transit vehicles," and "miles of new track" for light rail.

3.2.3 Development of VMT Rating

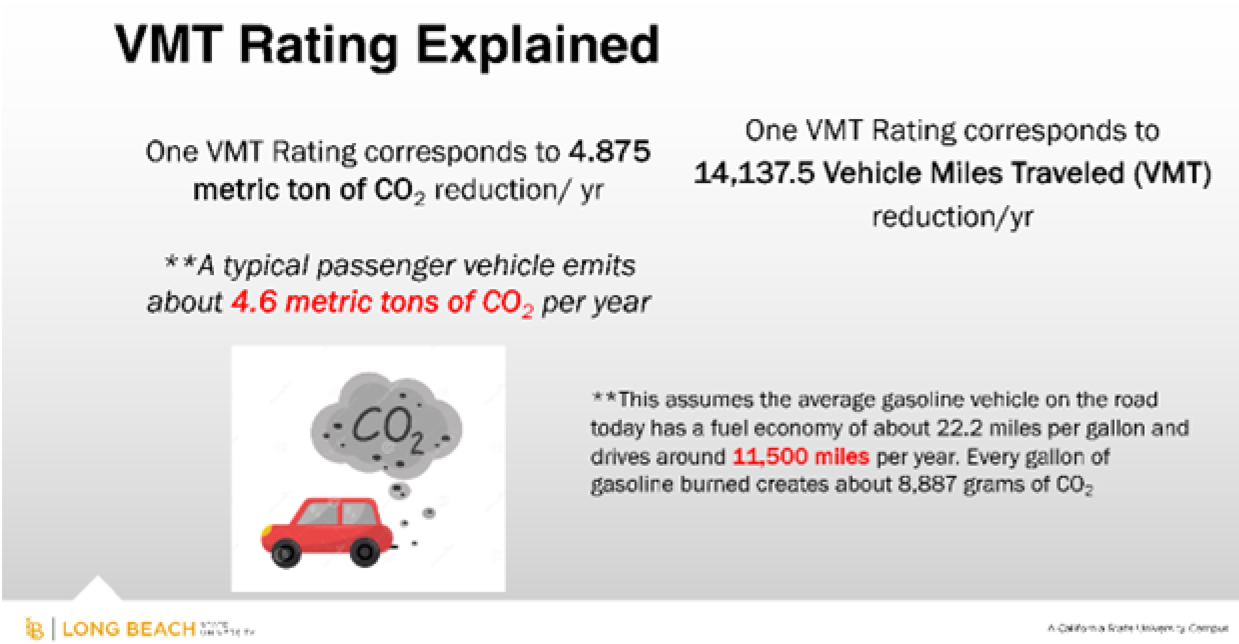
The VMT rating factors are based on a standardized amount of VMT reduction per year. Our strategy to assess a project's VMT impact stems from the infrastructure outputs that the respective project adds. Each of the 152 outputs has been assigned a "VMT Rating/ unit," which corresponds to the unit value that is assigned to each output. For example, the amount of new crosswalks added from an infrastructure project is measured in "each" while the amount of new roadway miles added is measured in "miles." The VMT ratings were derived by studying literature to understand the impact each output has by adding or removing metric tons of CO_2 per year. For clarification, not all assigned VMT ratings were calculated from the same source; assumptions were made by comparing the impact of outputs on VMT.

An output with a negative VMT Rating is identified as an infrastructure improvement that removes vehicle miles traveled from a traveled way; on the other hand, an output with a positive VMT Rating is a variable that adds vehicle miles traveled. For example, the "pedestrian/ bicycle facility miles constructed" output has a negative rating because adding multi-use pathways presents a non-car option to travel, while the "HOV/HOT Lanes" has a positive rating because these lanes add vehicle capacity to highways. Many outputs are assumed to have no impact on VMT—the rating for these outputs is 0.

One VMT Rating corresponds to 14,137.5 Vehicle Miles Traveled (VMT) reduction per year. This number came from Colorado Department of Transportation (CDOT, 2022)[3] report on "Greenhouse Gas Mitigation Measures Policy Directive" for the output of pedestrian/bike facility miles. According to the CDOT policy directive, one mile of added ped./bike facilities resulted in 39 metric tons of CO_2 reduced per year, and each metric ton of CO_2 reduction was caused by 2,900 VMT reduced from the roadway. Our methodology sets the VMT Rating / Mile for Pedestrian/Bicycle Facility Miles at -8. This arbitrary assumption allowed us to standardize the VMT rating value for a wide range of outputs with different units. A negative value in the VMT rating indicates the output has a VMT reducing (and thus GHG reducing) impact. Whereas a positive value in VMT rating indicates VMT increasing (and thus GHG increasing) impact. The following infographic shows how a VMT rating can be translated to VMT reduction and corresponding GHG reduction.

3 Colorado Department of Transportation, Division of Transportation Development. Greenhouse Gas Mitigation Measures Policy Directive. (Denver, CO: CODOT Publication No. 1610, 2022).

Figure 14. Conversion of VMT rating to corresponding VMT and GHG reduction



3.2.4 Estimation of VMT Ratings for Other Outputs

We estimated VMT Rating for other outputs by searching the literature for VMT reduction per unit value of the consolidated outputs. In absence of literature reported value for VMT, we estimated change in VMT/unit from reported VMT elasticity with respect to other variables, from corresponding GHG reduction, or from change in number of vehicle trips reported.

The CDOT guideline (CDOT, 2022) provided us the VMT and/or GHG reduction estimates for the following project types:

1. Pedestrian and Bicycle Strategies
2. Transit Strategies
3. Parking Management Strategies
4. Travel Demand Management Strategies
5. Traffic Operations Strategies
6. Land Use Strategies
7. MD/HD Strategies

The research team focused on extracting VMT ratings first from the "Handbook for Analyzing Greenhouse Gas Emission Reductions" (CAPCOA, 2021).[4] The CAPCOA guide provided corresponding quantitative estimate of GHG reduction for outputs in the following categories:

1. Land Use
2. Trip Reduction Programs
3. Parking, or Road Pricing Management
4. Neighborhood Design
5. Transit
6. Clean Vehicles and Fuels

In addition, the Transportation Investment Strategy Tool (GCC, 2023)[5] developed by Georgetown Climate Center provided VMT estimates for some of the VMT-reducing outputs.

It was challenging to find reliable and robust estimates for the VMT-increasing outputs. For example, there was no conclusive agreement in the literature on VMT estimates for High Occupancy Vehicle (HOV) lane construction. In these cases, the research team applied engineering judgment based on qualitative analysis of the reporting sources. In this particular example for finding VMT rating/lane-mile construction of HOV/HOT lane, we based our VMT rating calculation on the National Center for Sustainable Transportation's California Induced Travel Demand Calculator.[6]

Here are the steps used to calculate the VMT Rating/Unit of HOV/HOT lane-miles added:

1. According to the National Center for Sustainable Transportation's California Induced Travel Demand Calculator (UCD, 2022)[2], the addition of one lane mile of class 1 roadways is proportional to 5 million VMT in induced demand per year. This value was multiplied by the ratio of 8 VMT Rating per 39 metric tons of CO_2 per year.

$$\left(5{,}000{,}000\ \frac{VMT}{yr*lane\ mile}\right)*\frac{\left(8\ \frac{VMT\ Rating}{Unit}\right)}{\left(39\ \frac{metric\ tons\ of\ CO2}{yr}\right)} = 1{,}025{,}641\ \frac{VMT*\frac{VMT\ Rating}{Unit}}{metric\ tons\ of\ CO2*lane\ mile}$$

4 "Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity," California Air Pollution Control Officers Association, 2021. https://www.caleemod.com/handbook/index.html

5 "Transportation Investment Strategy Tool," Cambridge Systematics Inc., , 2023. https://www.georgetownclimate.org/files/report/GCC_Investment_Tool.pdf

6 "California Induced Travel Calculator," National Center for Sustainable Transportation, UC Davis, 2022. https://travelcalculator.ncst.ucdavis.edu/.

2. Respectively, the product above can be reduced to VMT Rating/unit by using the assumption that 2,900 VMT is proportional to 1 metric ton of CO_2 emitted (CDOT, 2022)

$$\left(1{,}025{,}641\ \frac{VMT*\frac{VMT\ Rating}{Unit}}{metric\ tons\ of\ CO2*lane\ mile}\right)*\left(\frac{1\ metric\ ton\ of\ CO2}{2{,}900\ VMT}\right)=354\ \frac{VMT\ Rating}{Lane\ Mile}$$

3.3 RESULTS

This section summarizes the meta data for the vehicle miles traveled (VMT) impact of unique Climate Action Plan for Transportation Infrastructure (CAPTI) program cycles using the Vehicle Miles Traveled (VMT) Rating Methodology. The research group was tasked to assess the vehicle miles traveled (VMT) impact among seven unique programs under California's Climate Action Plan for Transportation Infrastructure (CAPTI). The seven programs included: Transit and Intercity Rail Capital Program (TIRCP); Interregional Transportation Improvement Program (ITIP); Solutions for Congested Corridors Program (SCCP); Active Transportation Program (ATP); Trade Corridor Enhancement Program (TCEP); State Highway Operation and Protection Program (SHOPP); Local Partnership Program (LPP). Data was reported by Caltrans to the research group from each respective program. The infrastructure projects that make up the unique CAPTI program are sponsored by the program they were reported in. Each program has individual projects with total funding necessary for full completion of the project and specific outputs that describe the investment. Of the seven CAPTI programs, 152 outputs were consolidated and analyzed to assess their impact on vehicle miles traveled.

Using the VMT Rating methodology, the VMT impact of one project cycle can be compared to another project cycle specifically and only within the same program. A VMT rating for each project within a CAPTI program was calculated and the total project funding was given. Projects were then organized by cycle, and a score was calculated for respective cycles. This score is the sum of all VMT ratings from all projects within one cycle and is divided by the total cycle investment in millions of U.S. Dollars ($). A negative score for one cycle means that the total investment in the cycle procures VMT-reducing infrastructure while a positive score means the cycle's investment procures VMT-increasing infrastructure.

VMT scores should only be compared within the unique CAPTI program as the scores do not translate between programs. In addition, the meta data presented in this memorandum is not an accurate representation of the complete data among CAPTI program cycles.

Table 18. LPP (SB1)

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
Cycle 1 (2018)	Pre-N-19-19	20	$1,080,121,000	2,440	2.26

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
Cycle 2 (2020)	Post-N-19-19	32	$971,801,000	495	0.51
Cycle 3 (2022)	Post-CAPTI Adoption	16	$588,190,000	-1,130	-1.92

Table 19. ATP (SB1)

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
Cycle 4 (2019)	Pre-N-19-19	124	$685,122,000	-40,834	-59.60
Cycle 5 (2021)	Post-N-19-19	117	$851,606,000	-33,062	-38.82
Cycle 6 (2023)	Post-CAPTI Adoption	242	$2,647,467,000	-62,762	-23.71

Table 20. SCCP (SB1)

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
Cycle 1 (2018)	Pre-N-19-19	24	$3,002,565,000	17856	5.95
Cycle 2 (2020)	Post-N-19-19	18	$1,448,387,000	7219	4.98
Cycle 3 (2022)	Post-CAPTI Adoption	29	$3,026,318,000	2064	0.68

Table 21. TCEP (SB1)

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
Cycle 1 (2018)	Pre-N-19-19	36	$4,283,579,000	37,756	8.81
Cycle 2 (2020)	Post-N-19-19	29	$2,872,786,000	21,579	7.51
Cycle 3 (2022)	Post-CAPTI Adoption	34	$3,625,533,000	21,296	5.87

Table 22. ITIP

	Timeline	Total Projects	Total Program Cost	Total VMT Rating	Total VMT Rating / Total Program Cost (in $ Millions)
2018 ITIP (2017)	Pre-N-19-19	48	$5,929,998,000	36,394	6.14
2020 ITIP (2019)	Post-N-19-19	16	$2,333,751,000	31,211	13.37
2022 ITIP (2021)	Post-CAPTI Adoption	11	$187,675,000	(0)	0.00

Table 23. SHOPP

	Timeline	Total Projects	Total Cycle Cost	Total VMT Rating	Total VMT Rating / Total Cycle Cost (in $ Millions)
2018 SHOPP	Pre-N-19-19	399	$4,369,770,000	-12,600	-2.88
2020 SHOPP	Post-N-19-19	407	$6,223,657,000	-11,790	-1.89
2022 SHOPP	Post-CAPTI Adoption	444	$6,667,814,000	-29,310	-4.40

Table 24. TIRCP

	Timeline	Total Projects	Total Cycle Cost	Total GHG Reduction (tons/yr)	Total GHG Reduced / Total Cycle Cost (in $ Millions)	Total VMT Rating	Total VMT Rating / Total Cycle Cost (in $ Millions)
Cycle 3 (2018)	Pre-N-19-19	28	$18,927,055,000	-31,944,000	-1,688	-6,553	-0.35
Cycle 4 (2020)	Post-N-19-19	17	$5,441,284,746	-5,016,000	-922	-1,029	-0.19
Cycle 5 (2022)	Post-CAPTI Adoption	23	$1,356,279,824	-4,332,000	-3,194	-889	-0.66

The disproportionate scoring of the Active Transportation Program under CAPTI can be explained by the amount of investment in active transportation and the VMT ratings for the outputs of ATP projects. All eight outputs recorded among projects within ATP have a negative VMT rating— there are no VMT-increasing investment types in this program. Additionally, the cost of investment in active transportation projects is generally cheaper than projects like highway expansion. These two factors can explain the magnitude of the negative scores.

The data granted from Caltrans for TIRCP included a singular output value for the projects reported in "Estimated GHG Reductions." The research group studied literature to synthesize a factor that reduces GHG emissions in tons/year to vehicle miles traveled/year. This factor was applied across all cycles; thus, a Total GHG/$ score and a Total VMT Rating/$ score were reported for the TIRCP program.

3.4 DISCUSSION AND CONCLUSIONS

3.4.1 Discussions from the Emissions Analysis Section

A VMT Rating metric used qualitative and quantitative research to assign VMT attributes to different project components. The higher the VMT rating, the more VMT that is projected to be generated by the projects being funded in that program. Negative VMT ratings represent VMT decreases. Those VMT ratings were then normalized per dollar spent, to be able to illustrate and compare the magnitude of equivalent VMT generated or decreased between programs and cycles.

Overall, there has been a reduction of greenhouse gas (GHG) emissions generated across the portfolio of programs in the post-CAPTI adoption timeframe, as compared to earlier (pre- and post-N-19-19) timeframes. All SB1-related programs had a decrease of total VMT ratings.

Inversely, the number of investments that do not result in higher greenhouse gas emissions and other pollutants increased post-CAPTI adoption, and the number of investments that do not induce vehicle miles traveled (VMT), also increased post-CAPTI adoption.

All four programs that previously funded VMT-increasing components saw a decrease in the amount of VMT generated after CAPTI adoption compared to the previous two cycles. Notably, two of the four programs are now VMT neutral (ITIP) or VMT decreasing (LPP).

Collectively, the four programs' average VMT rating went from 6.19 in the two cycles pre-CAPTI adoption, to 1.16 in the first cycle of funding following CAPTI adoption.

The method used in this research can show powerful insights into these different statewide programs. For example, the Cycle 6 (2023) ATP program alone has a VMT rating of -62,762 which translates to approximately 887 million VMT displaced from the state roads. Considering an average mileage of 11,500 per year from a typical on-road vehicle, this amount corresponds to approximately 77 thousand cars displaced from the roads of California.

The VMT-increasing programs such as SCCP or TCEP also had a positive impact from CAPTI investments. For example, the difference in VMT rating between Cycle 2 (2020) and Cycle 3 (2022) of SCCP translates to approximately 73 million VMT reduction/year. This amount of VMT reduction has the similar effect of removing approximately 6 thousand cars.

3.4.2 Data Gap

The VMT rating metric can capture the VMT and emissions influencing effect of different investments if all the possible outputs are reported in the provided data. It is to be noted that the outputs vary from one program to another and the purposes of generating those outputs also vary. Some programs use those outputs at the project prioritization stage, some of these outputs are used for estimation and billing purposes, and some of the outputs are collected for other programmatic purposes. Therefore, it is possible that there is underreporting and omission of certain outputs. Also, while combining similar outputs in a single output category, the research team used engineering judgment. All these are reasons for potential bias in the estimation of VMT rating metric.

Ideally, Caltrans should maintain a database with a specific purpose of estimating emissions and VMT from the projects. This database framework needs to be well defined and distributed across all the programs and divisions of Caltrans. The research team suggests that the database input and display processes be linked to an online dashboard. This will enable the program administrators to access the VMT rating metrics in real time.

3.4.3 Research Gap

A significant amount of research is needed to quantitatively ascertain the effect of various types of transportation investments on the VMT. In absence of literature-reported values, the research team generalized and made assumptions regarding the VMT rating/unit of the reported outputs. Some of the outputs, especially the positive VMT impact outputs, had no consensus in the literature. The research team used engineering judgment to assign VMT ratings for projects such as new interchanges, interchange modifications, lane widening, etc. The qualitative analysis of these project types revealed that these improvements will likely lead to roadway capacity enhancement. Therefore, it is appropriate that the VMT rating for these projects needs to be positive. However, there is a big research gap in understanding the quantitative magnitude of VMT increase from these projects.

Similarly, several VMT reduction approaches did not have a definitive magnitude for VMT reduction in the literature. The research team relied on qualitative comparison among multiple of these output types. More research is required to understand the impact of a singular infrastructure element over a project containing several of these elements.

The research team assumed the impacts of multiple outputs from the same project with an additive approach. However, the effect of the joint presence of multiple outputs can have an enhancing or diminishing effect on one or both collocated outputs. The literature is lacking in the directions on how the researchers should combine the effects of multiple outputs.

One of the major literature drawbacks is the lack of knowledge related to the effect of investment in the rail infrastructure on on-road VMT. To enable conservative estimates of VMT reduction, the research team assumed a -3 VMT Rating/Mile of new track. More research is needed to ascertain the effect of intermodal facilities and transit on VMT reduction.

4. EQUITY ANALYSIS

Building upon the economic impact and VMT and emissions impacts analyses discussed in previous chapters, Chapter 4 analyzes the distributional and equity impacts of various investment programs. The research team used spatial analysis and maps to examine how projects with various VMT ratings are distributed across the state and in relationship with disadvantaged communities.

The three analyses discussed in this report utilized the same data provided by the California Department of Transportation; however, the ways in which projects were grouped for analysis varies between chapters, suiting the methodology of each independent analysis. Therefore, data attributes differ slightly in how they are referenced across the three chapters of this study, but this does not invalidate an earlier chapter's findings. For example, the number of projects, total investment or total cost by program and cycle may differ depending on how phased projects were grouped.

4.1 EQUITY ANALYSIS OF THE ACTIVE TRANSPORTATION PROGRAM (ATP)

The goal of the Active Transportation Program (ATP) is to "...encourage increased use of active modes of transportation through investments in walking, biking, Safe Routes to Schools, and trail infrastructure projects and non-infrastructure programs." As such, ATP investments have the potential to improve mobility, public health, and wellbeing across California, and at the same time, reduce air pollution and GHG emissions. Because disadvantaged communities are disproportionately impacted by pollution and often do not have equitable access to mobility—and, by extension, jobs, services, and amenities—ATP investments can have a more prominent positive impact on these communities.

Figure 15 shows the total investment in California through the ATP program and the distribution of active transportation projects across the state. Through Cycles 4, 5, and 6 of the ATP program, a total of $4.2 billion were invested in 48 counties. As depicted in Figure 15, investments in active transportation projects grew significantly in Cycle 6. In Cycles 4 and 5, a total of $664 and $774 million were invested in active transportation, respectively, whereas Cycle 6 investments alone totaled $2.7 billion. The significant increase in active transportation projects in California can be attributed to CAPTI and is the result of an increase of about $50 million per year in federal funding and a one-time $1.05 billion increase in state funds.

Figure 16 also illustrates that ATP projects are scattered around the entire state, but most notably concentrated in the largest metro areas in both Northern and Southern California. Focusing investments in large metro areas across the state is consistent with the state's climate and equity goals because of the greater need and sizeable chance of emissions reduction potential for ATP projects in more densely populated areas. Also, active transportation projects can significantly improve mobility and community health in disadvantaged communities in metropolitan areas since these communities are often severely burdened by multiple sources of pollution. Nonetheless, ATP investments are also benefiting many communities in Central California and rural areas, and Cycle 6 shows investments in many more such communities that did not benefit from investments during the previous two cycles (see Figures 15, 16). These investments can help make urban, suburban, and rural communities alike activity-friendly and more accessible by walking, biking, and rolling.

In sum, investing more in active transportation infrastructure and non-infrastructure projects and programs emphasizes both equity and climate goals in California. Significant increases in ATP funding after CAPTI is a clear sign that the state prioritizes active modes of transportation over driving. Active modes of transportation can help reduce VMT and GHG emissions and improve air quality and community health. Because disadvantaged communities are excessively burdened by pollution and thus adversely impacted by health disparities, the ATP program can be directly and significantly beneficial to these communities. Also, investing in active transportation can benefit local economies through a variety of mechanisms, such as decreased transportation and healthcare costs for California communities, and enhanced activity-friendly environments that boost local businesses.

Figure 15. All ATP Program Projects Across All Cycles

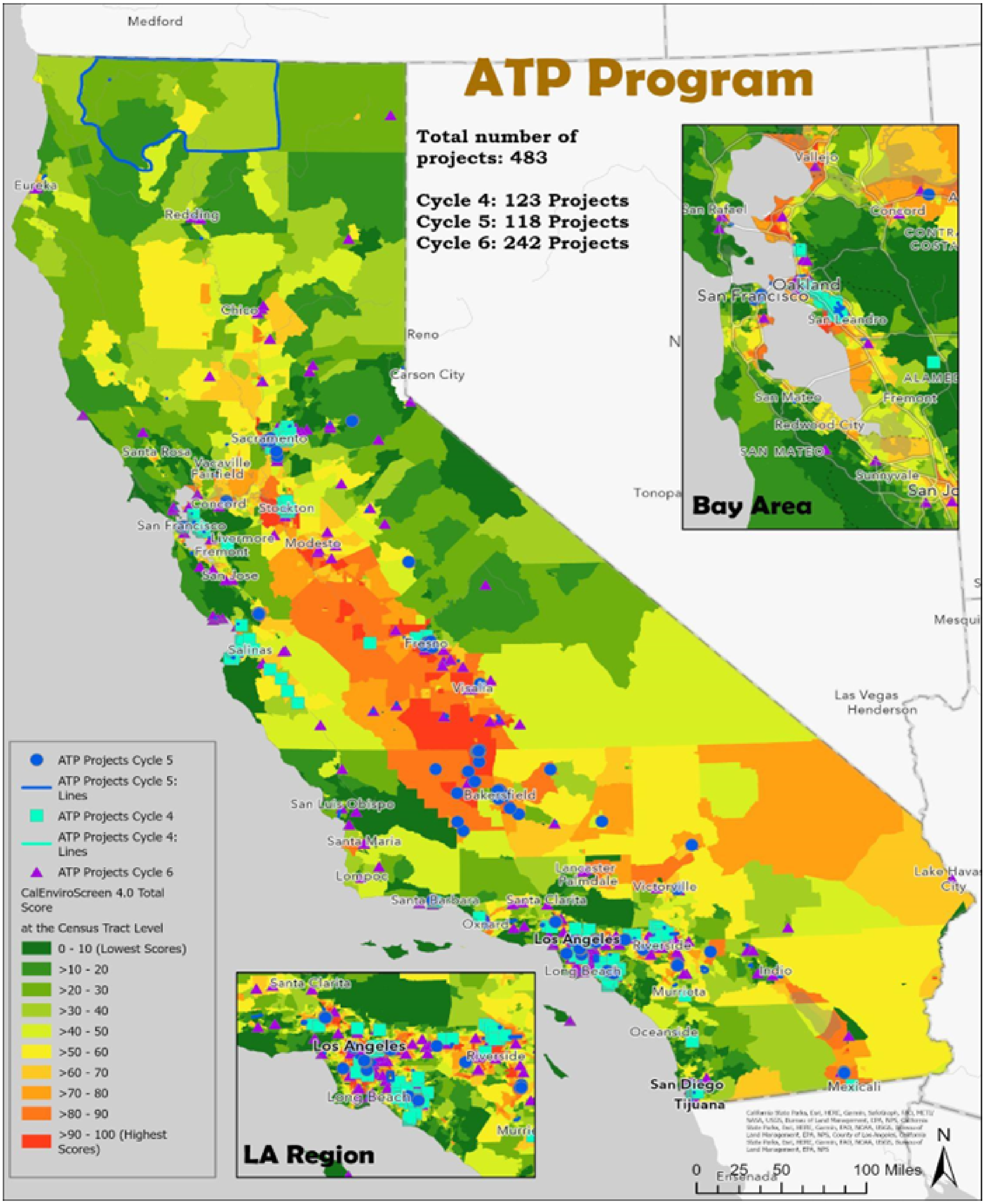
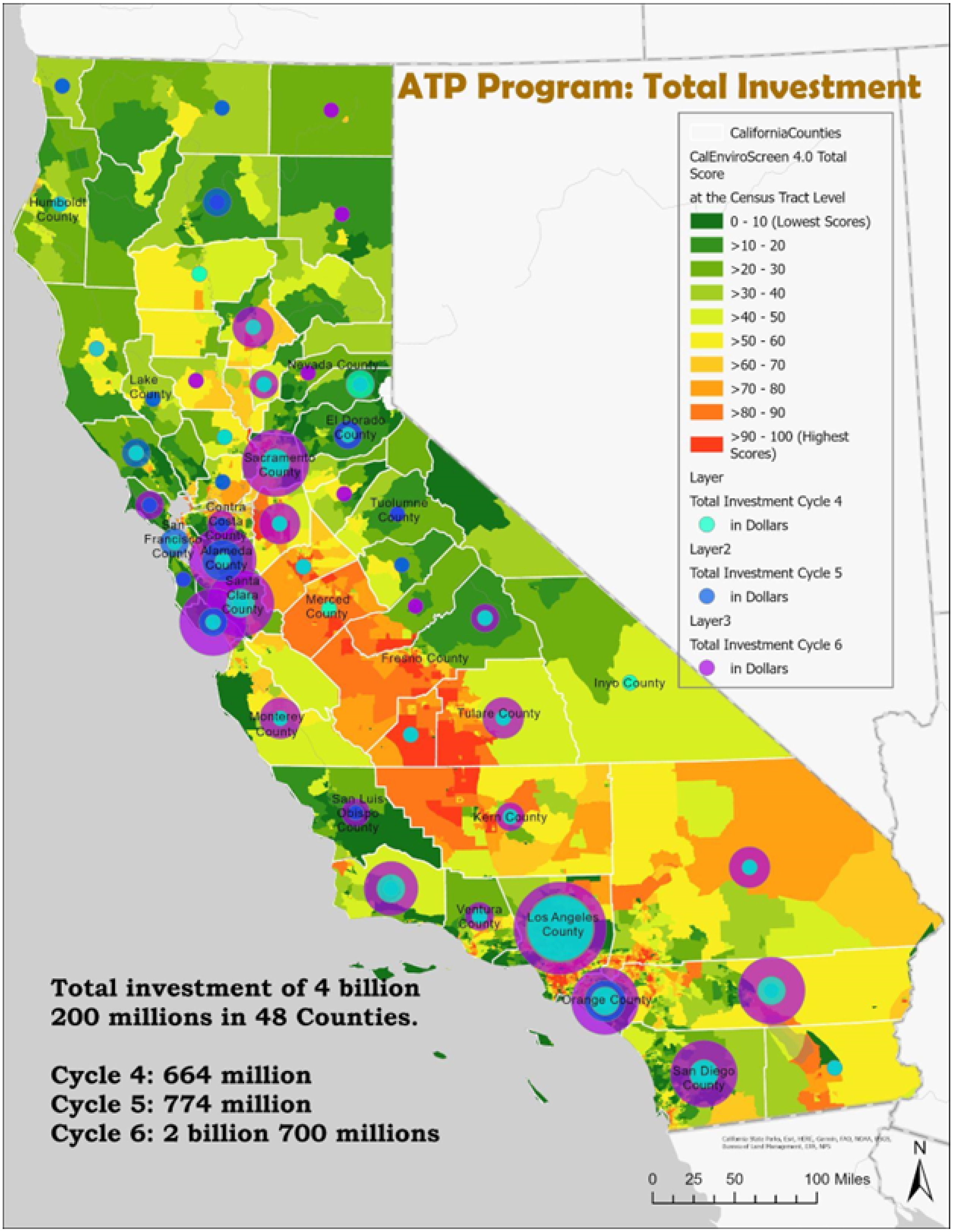


Figure 16. Total ATP Program Investment



4.2 EQUITY ANALYSIS OF THE TRADE CORRIDOR ENHANCEMENT PROGRAM (TCEP)

The goal of the Trade Corridor Enhancement Program (TCEP) is “to improve infrastructure on federally designated Trade Corridors of National and Regional Significance, on the Primary Freight Network, and along other corridors that have a high volume of freight movement.” Evidence shows that freight movement, although crucial for economic growth, often has a disproportionately negative impact on disadvantaged communities. A recent study on 53 U.S. cities concluded that low-income and minority communities are typically exposed to 28% more nitrogen dioxide pollution, mainly driven by these communities’ proximity to trucking routes on major roadways.[7] In addition to increasing air pollution and GHG emissions, freight trucks can significantly increase congestion and noise and reduce safety. Negative externalities associated with freight have recently increased as the demand for online shopping puts pressure on freight infrastructure. As such, it is critical to minimize the impact of freight traffic on disadvantaged communities.

Figure 18 shows total investment in California through the TCEP program, and the distribution of freight corridor improvement projects. Through Cycles 1, 2, and 3 of the TCEP program, a total of approximately $10.74 billion were invested in a total of 92 projects in 26 different counties. Cycle 1 represents the largest investment in freight corridors ($4.722 billion), followed by Cycle 3 ($3.625 billion), and Cycle 2 ($2.434 billion). Although the number of counties that received funding under each Cycle is fairly consistent across the Cycles (16 or 17 counties), both Cycles 2 and 3 included new recipients, which increased the total number of counties that received funding through the TCEP program. It is also clear that investments are concentrated in areas with the greatest freight needs or activities, such as large metro areas in Northern and Southern California.

The TCEP program involves a wide range of infrastructure enhancements along heavily used freight corridors, but several actions were taken in Cycle 3 to ensure equity and emissions reduction. For example, the program guidelines were updated to offer incentives for zero-emission vehicle infrastructure projects, enhancing community engagement processes, and delivering technical assistance to applicants. Additionally, an Interagency Transportation Equity Advisory Committee was established to elevate diverse and historically underrepresented voices in transportation infrastructure decision-making. As a result of these changes, we can anticipate mitigating GHG emissions, better accounting for community benefits and the distribution of these benefits in the project selection process, increasing the number of first-time recipients, and ensuring a more equitable distribution of resources to address freight-negative externalities. Because large metropolitan areas in California are the top origin and destination for the nation’s freight flows, and communities that are adjacent to freight hubs and major corridors (e.g., port communities, communities adjacent to major trucking routes, etc.) are disproportionately impacted by freight externalities, the concentration of freight infrastructure investments in these areas (see Figures 17, 18, 19) is appropriate and equitable. As seen in Figure 19, multiple projects funded by TECP that led to reduced VMTs were located in areas with relatively

7 2023 State Highway System Management Plan,” California Department of Transportation, June, 1, 2023, https://catc.ca.gov/-/media/ctc-media/documents/programs/shopp/2023-shsmp-draft.pdf

high CalEnviroScreen 4.0[8] scores, such as Oakland, Stockton, Modesto, and Bakersfield. This indicates that these freight infrastructure investments can lead to measurable VMT reductions in communities with some of the heaviest pollution burdens.

In sum, the TCEP program builds upon three important points related to the state's equity and climate goals: 1) freight emissions and other negative externalities are significant (e.g., freight represents approximately one-third of total transportation emissions); 2) freight externalities disproportionately impact disadvantaged communities that are often located in proximity to freight intensive areas (e.g., ports, major trucking routes); and 3) freight demand is strong and likely to further increase in the future. The TCEP program shows consistent investments in areas with notable freight needs throughout its three Cycles, but CAPTI introduced new guidelines and processes to ensure freight needs are met, and the investments are aligned with the state's climate and equity goals.

8 "California Communities Environmental Health Screening Tool: CalEnviroScreen 4.0," California Office of Environmental Health Hazard Assessment, May 01, 2023, https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40

Figure 17. All TCEP Program Projects Across All Cycles

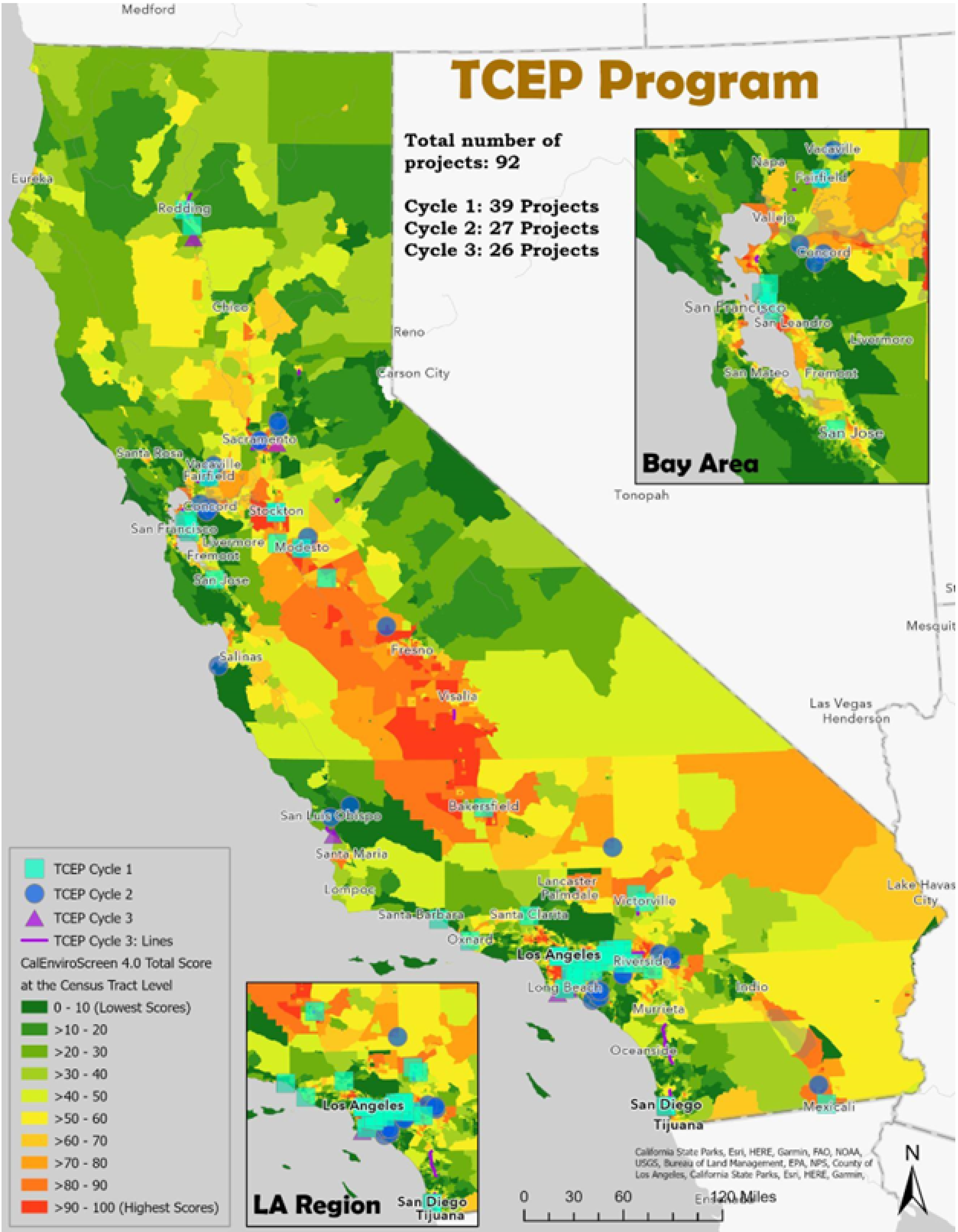


Figure 18. Total TCEP Program Investment

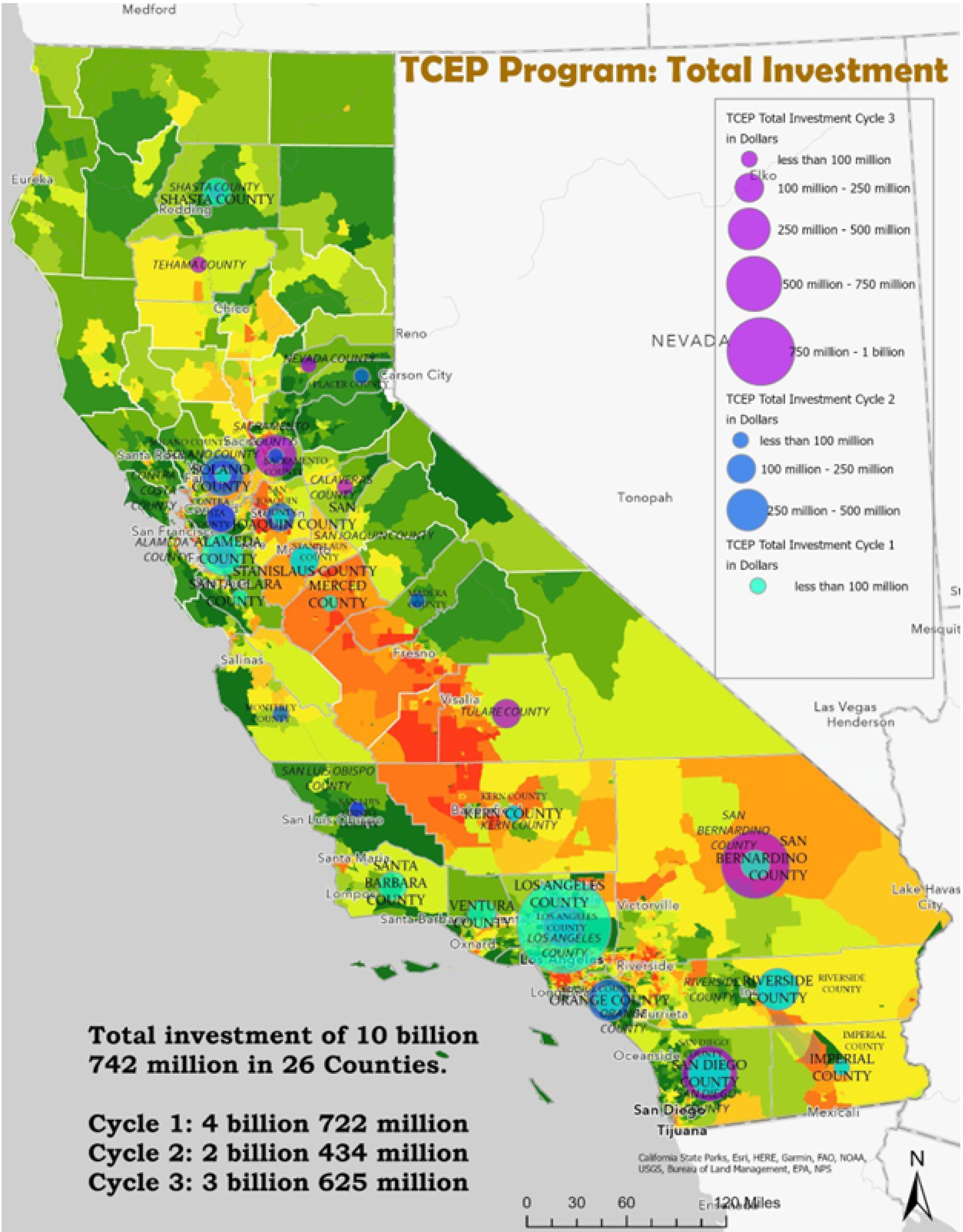
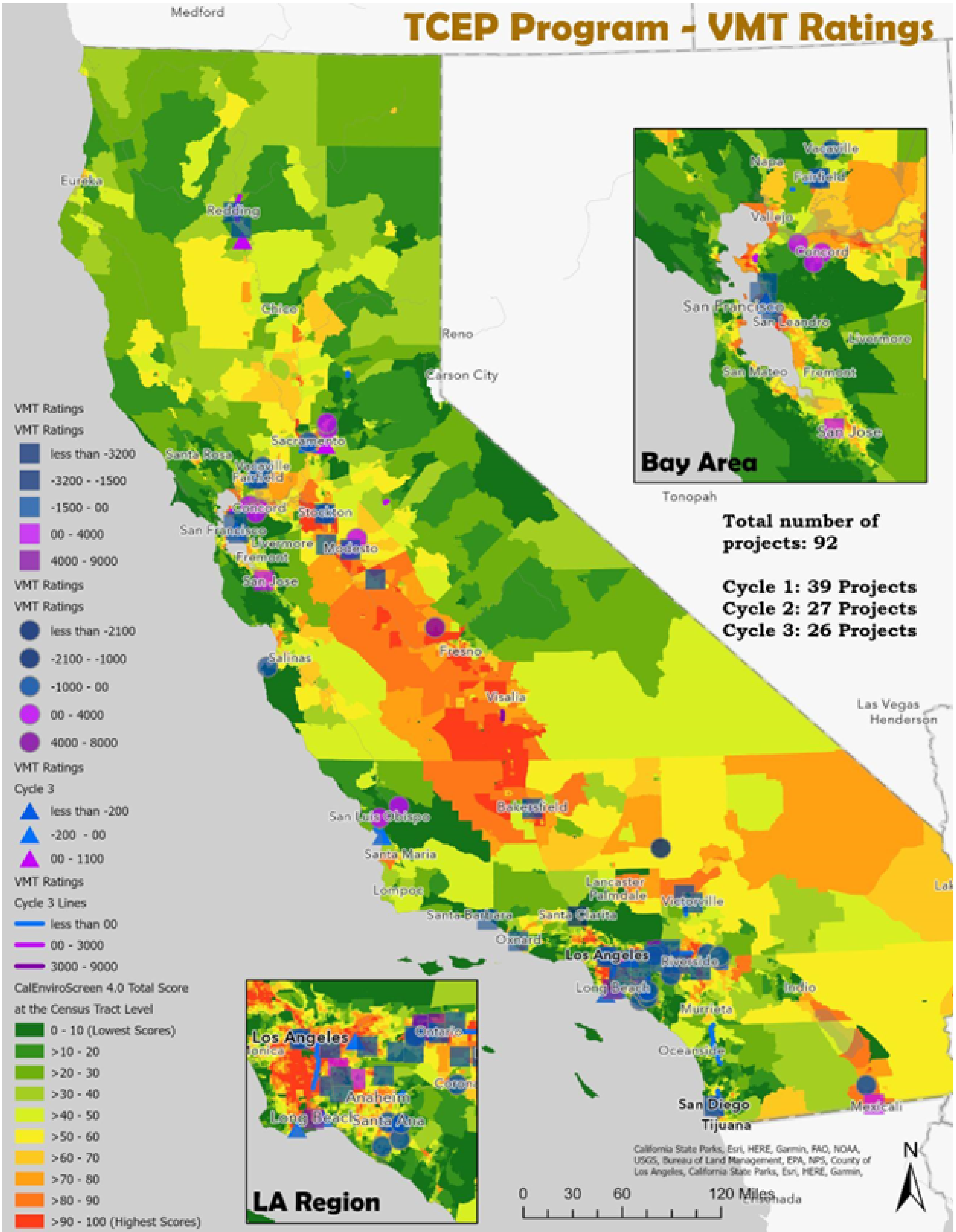


Figure 19. TCEP Program VMT Ratings



4.3 EQUITY ANALYSIS OF THE SOLUTIONS FOR CONGESTED CORRIDORS (SCCP)

The Solutions for Congested Corridors (SCCP) aims "to achieve a balanced set of transportation, environmental, and community access improvements within highly congested travel corridors throughout the state." A variety of projects are eligible for inclusion in a comprehensive corridor plan, including state highway and local street and road improvements, public transit and rail facilities, bicycle and pedestrian infrastructure, and even preservation or restoration of open space and local habitat. One key element of the SCCP program is that it does not fund the construction of general-purpose lanes on state highways, and capacity-increasing projects are restricted to either operational enhancement for all modes of travel (e.g., bicycle lanes, truck climbing lanes, etc.) or construction of high-occupancy vehicle lanes, or managed lanes. The SCCP can contribute to equity by improving access to transportation options, jobs, and amenities and by reducing the negative environmental and health consequences of traffic congestion.

Figure 21 shows total investment in California through the SCCP program, and the distribution of the congested corridor solution project across the state. Through Cycles 1, 2, and 3 of the SCCP program, a total of $7.47 billion were invested in 17 counties in California. Cycles 1 and 3 included approximately $3 billion dollars in investments in nine and seven counties, respectively (Figures 21), and Cycle 2 offered approximately $1.41 billion in nine counties. The total number of 52 SCCP projects are primarily scattered around Northern and Southern California major cities or metro areas, including significant investments in the Bay Area, as well as the Sacramento, Los Angeles, Santa Barbara, San Diego, and San Bernardino counties. Investments also benefited several rural communities, as shown in Figure 20. As shown in Figure 21, these projects have led to VMT reductions in densely populated areas that are burdened with traffic congestion and the health and environmental impacts associated with congestion. One significant finding is that the total VMT Rating per total dollar spent through SCCP significantly declined after the adoption of CAPTI. This is likely due to the structure of the program, which has strict requirements as to what kinds of projects can be funded by the program. The exclusion of general-purpose lanes and capacity-increasing projects reduces the potential of funding a project that may lead to an increase in VMTs. The counties of Los Angeles and Sacramento benefitted the most from this program as their CalEnvrioScreen 4.0 scores show that these counties experience high pollution burdens and stand to benefit from improved traffic flow.

CAPTI, and by extension SCCP, include key components to help align the SCCP objectives with the state's climate and equity goals. For example, CAPTI recommends prioritization of SCCP projects that enable or encourage travelers to use alternative modes of transportation and promotes the development of holistic "Multimodal Corridor Plans" that highlight a variety of transportation options to alleviate congestion. Consequently, Cycle 3 guidelines were updated to incentivize the prioritization of multi-modal or mode-shift projects, enhanced community engagement processes, and delivery of technical assistance to applicants. Additionally, SCCP incorporated pro-housing principles into Cycle 3 to help reduce VMT, such as infill development, and housing development near activity centers. Lastly, the newly established "Equity Advisory Committee" weighed in on SCCP Cycle 3 funding recommendations for the first time.

Overall, the SCCP program offers several key tools and strategies that contribute to equity, and VMT and GHG emissions mitigation. Disadvantaged communities often need to spend more money and time to get where they need to go and are commonly subject to traffic volumes that can be significantly higher than other areas. Low-income individuals are also more likely to lack access to a vehicle, while simultaneously being at a higher risk of traffic incidents. As such, by focusing on empowering communities to utilize other modes of transportation, the SCCP program can help alleviate both equity gaps and environmental impacts that previous decades of car-centric transportation planning have created in California.

Figure 20. All SCCP Program Projects Across All Cycles

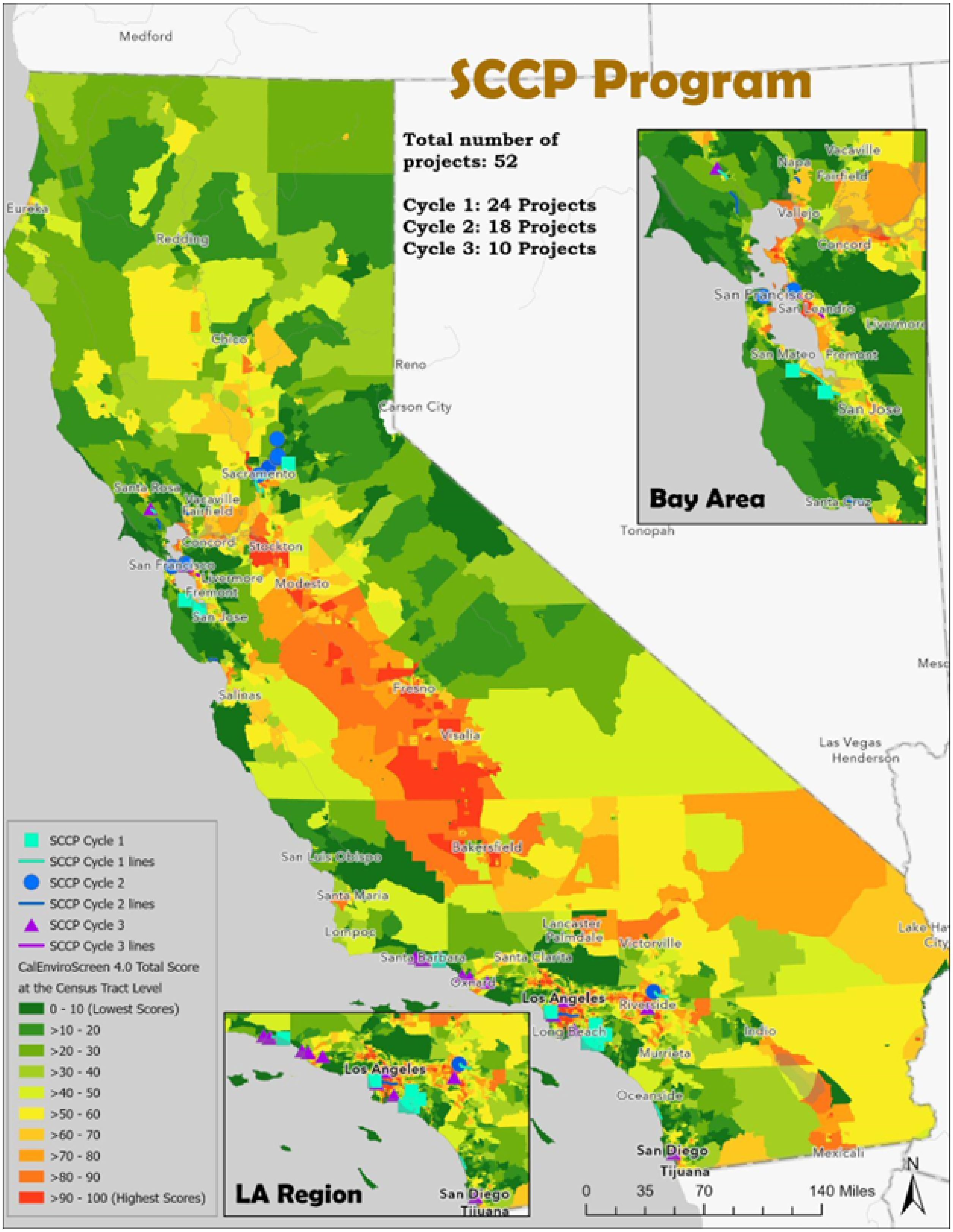


Figure 21. Total SCCP Program Investment

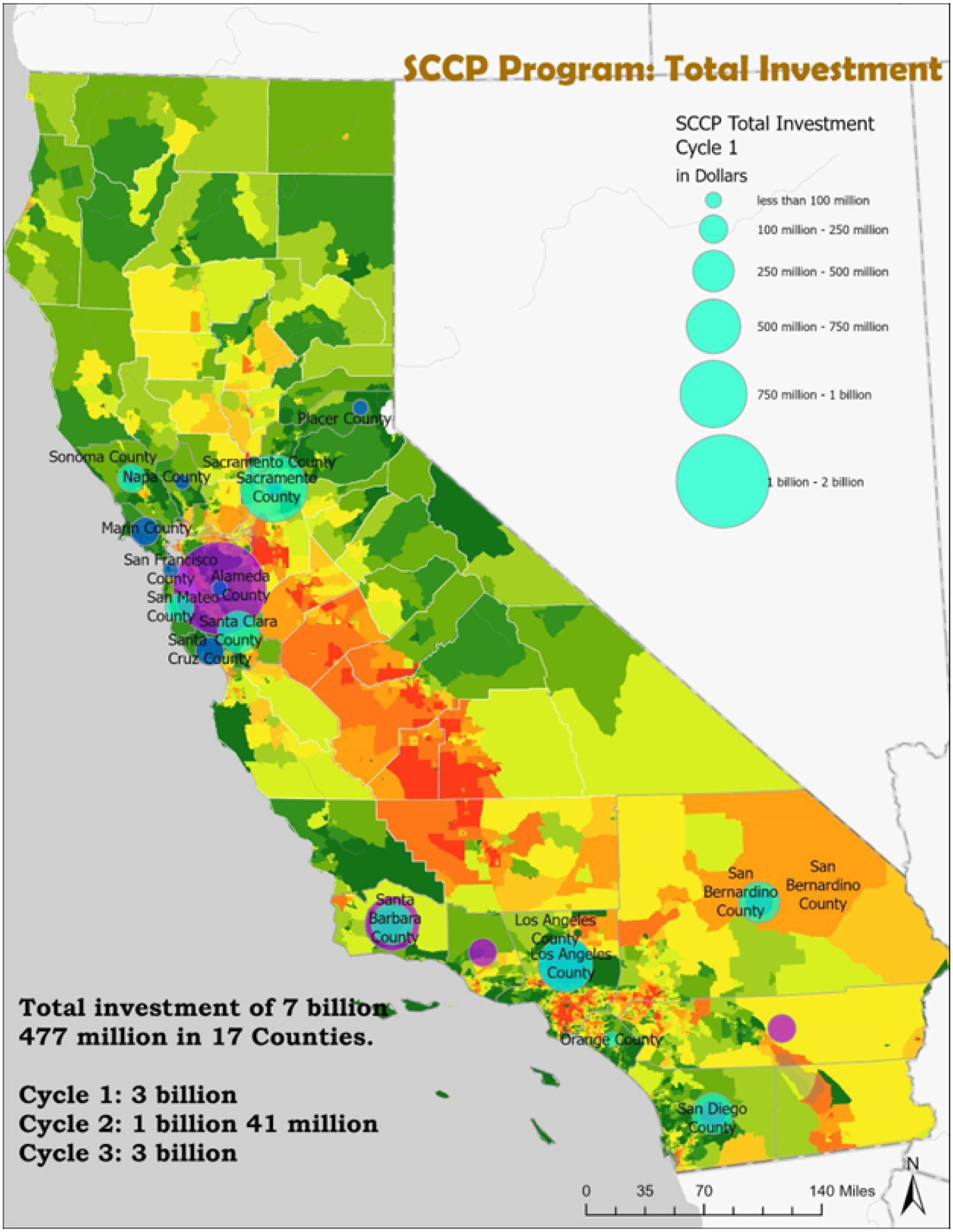
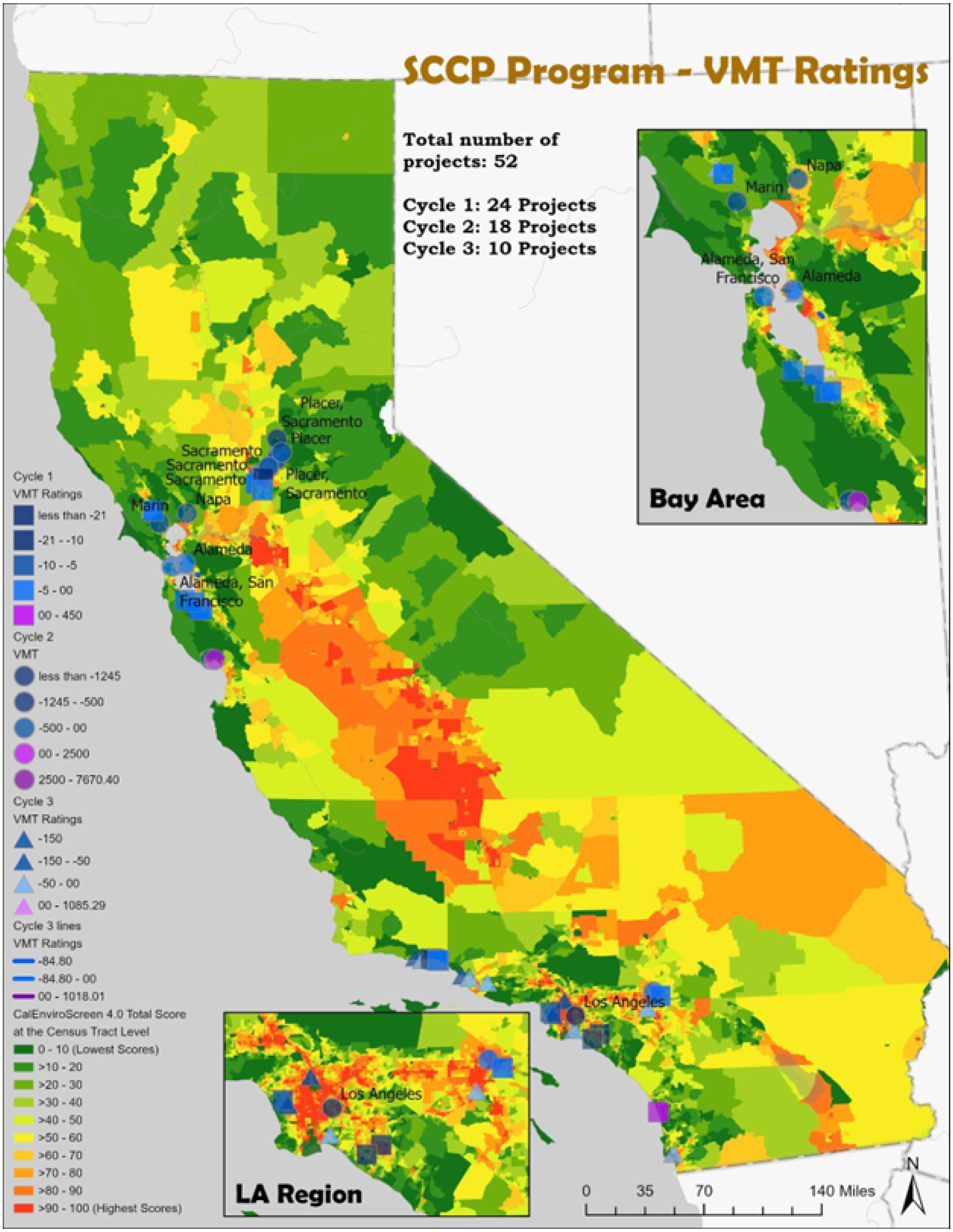


Figure 22. SCCP Program VMT Ratings



4.4. EQUITY ANALYSIS OF THE STATE HIGHWAY OPERATIONS AND PROTECTION PROGRAM (SHOPP)

The goal of the State Highway Operations and Protection Program (SHOPP) is “to preserve and protect the state highway system through improvements relative to the maintenance, safety, operation, and rehabilitation of state highways and bridges that do not add a new traffic lane to the system.” The SHOPP program is key to maintaining roads and bridges in good repair, but the program can also help balance persistent inequities in California’s transportation network. A recent study by the Government Accountability Office examined road surface conditions in the nation and found that low-income communities, urban areas, and minority communities are more likely to have poor pavement conditions.[9] Poor pavement conditions such as potholed, cracked, and rutted road surfaces can impact traffic flow, increase fuel consumption and emissions, and pose safety issues. As such, both CAPTI and the 2023 State Highway System Management Plan (SHSMP)[10] emphasize the importance of incorporating social equity, climate, and health goals into the highway planning and decision-making process.

Figure 24 shows total investment in California through the SHOPP program and the distribution of selected highway operation improvement and maintenance projects. Since 2018, through all three Cycles of the SHOPP program, a total of $17.4 billion were invested in 58 counties. Each Cycle of the SHOPP program included approximately four hundred projects scattered across the state, bringing the total number of SHOPP projects to more than one thousand two hundred projects. As shown in Figure 24, investment in the SHOPP program grew during the 2020 Cycle to $6.223 billion dollars from $4.346 billion dollars invested during the 2018 Cycle. Yet, compared to these two Cycles, the 2022 Cycle brought the largest investment into the SHOPP program, with a total of $6.667 billion to support various highway projects and beyond. Both the 2020 and 2022 Cycles include projects in new locations all over the state with larger concentration of projects in areas with the greatest need, such as locations surrounding large metro areas in both Northern and Southern California.

Several changes have been made to the SHOPP program’s planning process that can have equity and climate benefits. For example, the draft 2023 SHSMP plan calls for adding dedicated funding for active transportation and climate resilience projects, and the adoption of Safe System Approach (SSA) on the state highway network. Also, the draft 2023 SHSMP incorporates wildfire adaptation strategies into SHOPP. Although it is too early to examine CAPTI equity and climate outcomes using SHOPP data, aligning CAPTI goals with state highway planning and SHOP decision-making processes is an important step.

9 “National Highways: Analysis of Available Data Could Better Ensure Equitable Pavement Condition,” the United States Government Accountability Office, July 22, 2022, https://www.gao.gov/assets/gao-22-104578.pdf.

10 Mary, Demetillo, et al., “Space-based Observational Constraints on NO_2 Air Pollution Inequality from Diesel Traffic in Major US Cities,” *Geophysical Research Letters 48,* no. 17 (2021): e2021GL094333.

Figure 23. All Projects Across All Cycles

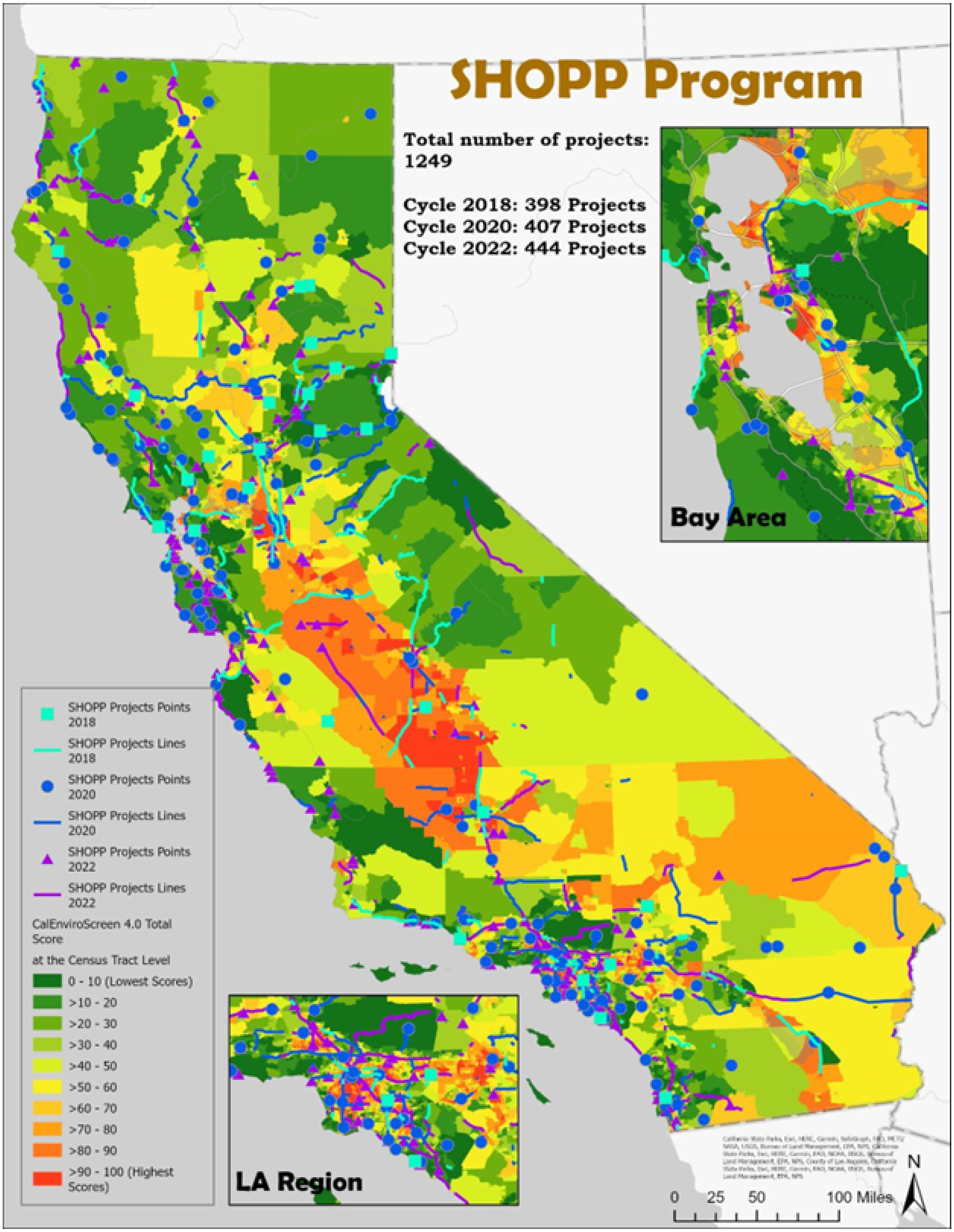
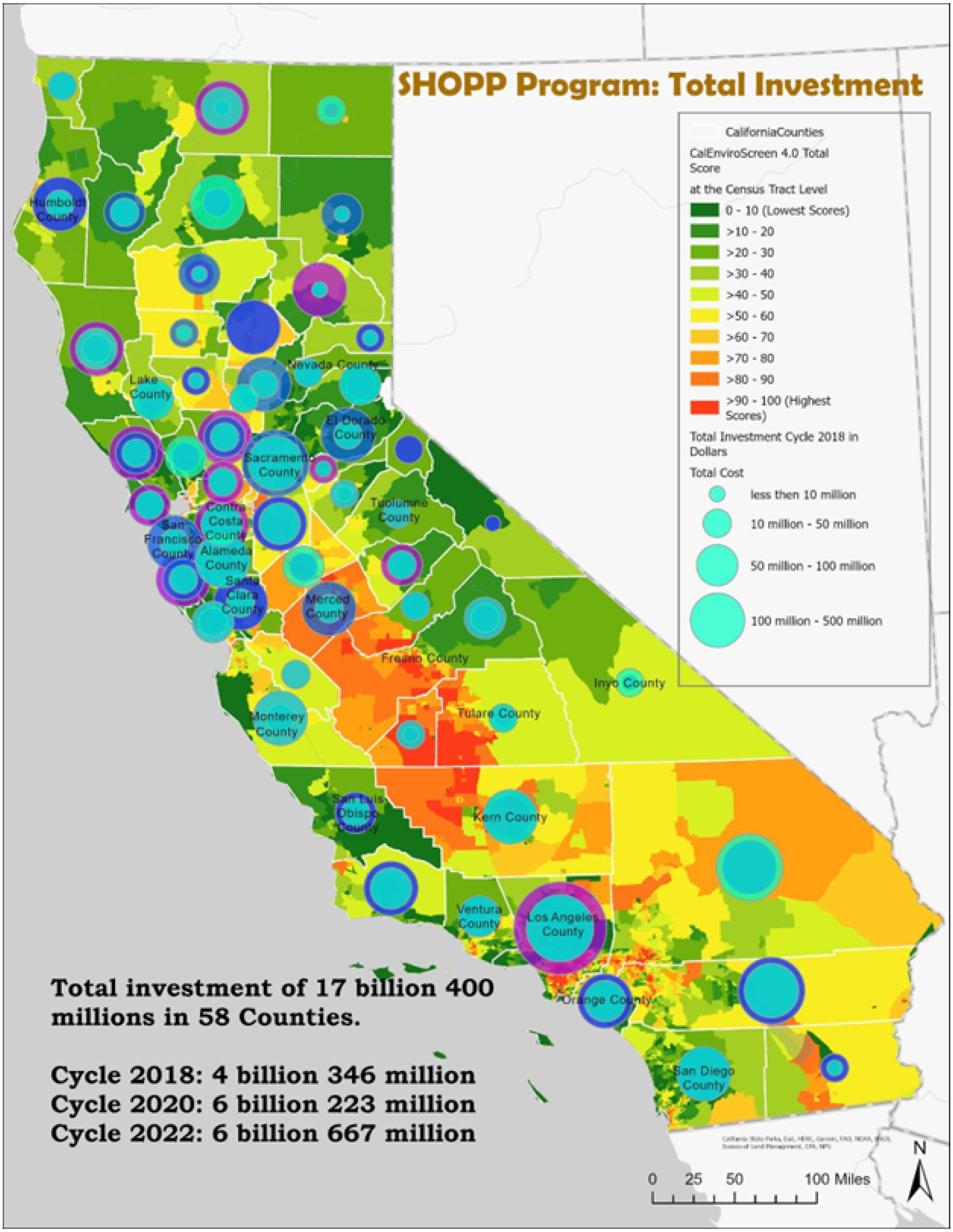


Figure 24. Figure 24: SHOPP Program Total Investment



4.5 EQUITY ANALYSIS OF THE TRANSIT AND INTERCITY RAIL CAPITAL PROGRAM (TIRCP)

The Transit and Intercity Rail Capital Program (TIRCP) aims "...to fund transformative capital improvements that will modernize California's intercity, commuter, and urban rail systems, and bus and ferry transit systems to significantly reduce GHG emissions, vehicle miles traveled, and congestion." As such, TIRCP investments have the potential to expand and improve some of the numerous transit and rail services across California. Additionally, these projects funded by TIRCP complement one of California's most ambitious transportation projects, the High-Speed Rail project. The proposed California High-Speed Rail project aims to connect San Francisco to Los Angeles, covering 171 miles in as little as two hours and forty minutes. Some examples of projects that are funded by this program include other high-speed rail lines, safety improvements, and general operational improvements. These projects, in turn, improve the mobility, public health, and well-being of residents across California while reducing air pollution and GHG emissions.

Figure 26 shows the total investment made through the TIRCP program as well as the distribution of transit expansion and rail integration projects across the state. Through Cycles 3, 4, and 5 of the TIRCP program, a total of $25.7 billion was invested in 68 projects across 22 counties. As depicted in Figure 26, Cycle 3 involved the most significant round of investment in transit improvement and rail integration projects totaling $18.9 billion. In Cycles 4 and 5, $5.4 and $1.4 billion were invested in TIRCP programs, respectively. The significant investment made in Cycle 3 into rail and transit improvement projects throughout California, which are the focal point of the TIRCP program, has enabled 22 counties to improve their residents' safety, health, and mobility.

Figures 25 and 26 also illustrate that TIRCP projects are notably concentrated in some of California's largest metropolitan areas, including the Bay and Los Angeles Metro areas. Still, there is also a fair distribution of projects throughout the state. Focusing investments in large metro areas across the state is consistent with the state's climate and equity goals because of the greater need and the opportunity for more significant emissions reduction because these projects are located in more densely populated areas. Disadvantaged communities, especially in dense urban areas, often suffer from higher pollution burdens with multiple sources of pollution. The projects funded by TIRCP can help relieve these burdens through the GHG and VMT reduction benefits associated with expanding public transit systems and improving the integration of rail systems. The VMT analysis shows that across all three programming cycles, the projects funded by the program reduced GHG emissions significantly.

In addition to metropolitan areas, TIRCP investments are also benefiting many communities in Central California and other rural areas, as indicated in Figures 25 and Figure 26. Cycles 4 and 5 show investments in many communities, such as Fresno, Kings, and Tulare County, which suffer from some of the worst pollution burdens in the state according to their respective CalEnviroScreen 4.0 scores. The success of these investments and projects spurred by TIRCP and the CAPTI program can further encourage transit-oriented development and lower automobile dependency, especially in rural communities.

In sum, investing more in transit improvements, rail integration, and affiliated projects emphasizes both the equity and climate goals in California. Significant upfront investments in TIRCP funding, specifically in Cycle 3, clearly indicate the State's commitment to promoting more equitable and environmentally friendly modes of transportation. Utilizing alternative forms of transportation such as trains, ferries, and buses can help improve air quality and community health by reducing VMTs and GHG emissions. Because disadvantaged communities, especially those in dense urban areas, are excessively burdened by pollution and adversely impacted by the health disparities caused by exposure to pollution, the TIRCP program can be directly and significantly beneficial to improving safety and mobility as well as providing feasible transportation alternatives in these communities.

Figure 25. All TIRCP Program Projects Across All Cycles

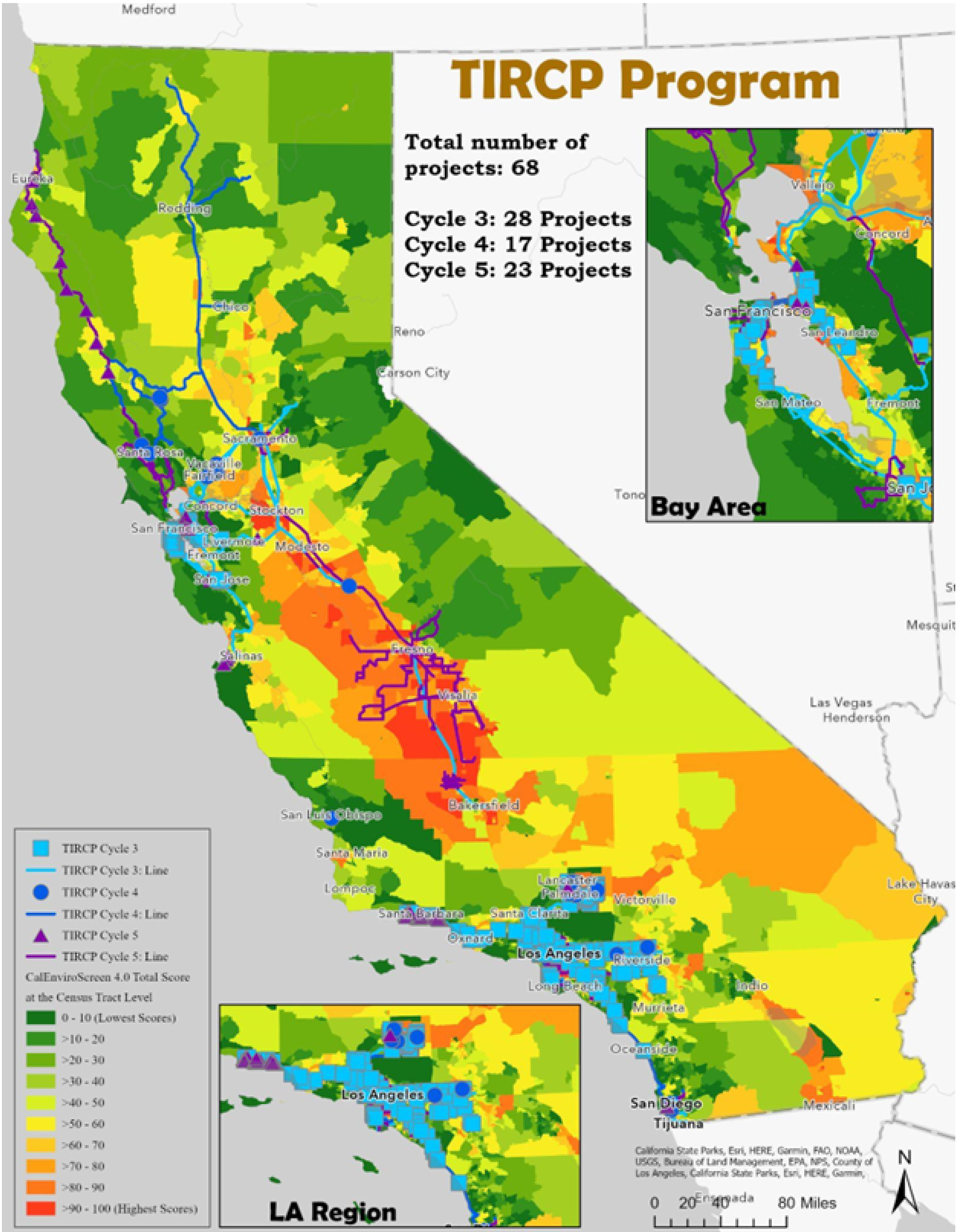
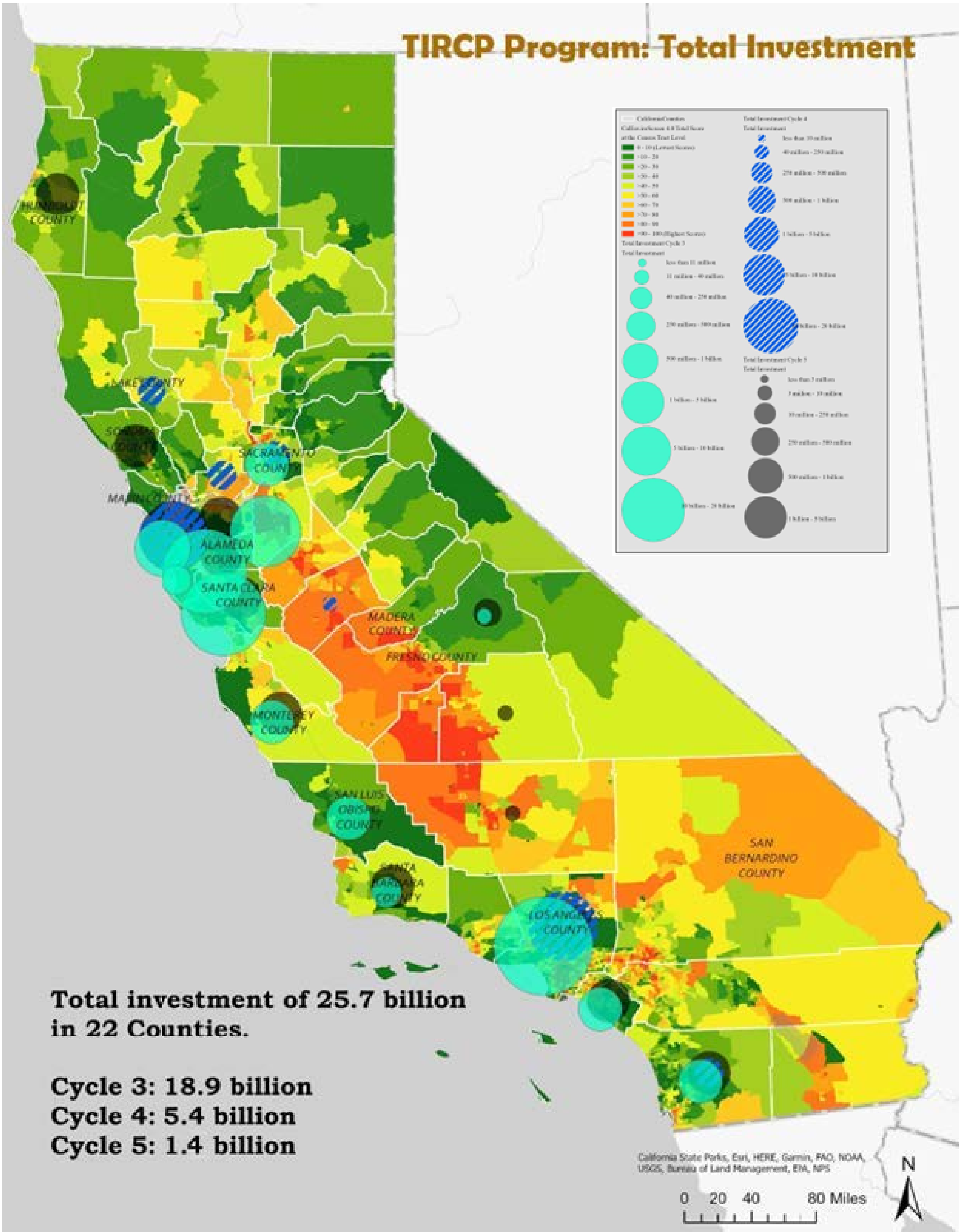


Figure 26. TIRCP Program Total Investment



4.6 EQUITY ANALYSIS OF THE LOCAL PARTNERSHIP PROGRAM (LPP)

The goal of the Local Partnership Program (LPP) is to "...provide funding to counties, cities, districts, and regional transportation agencies in which voters have approved fees or taxes dedicated solely to transportation improvements or that have imposed fees, including uniform developer fees, dedicated solely to transportation improvements." The LPP program funds are distributed through two different processes. The LPP utilizes a competitive application component as well as a formulaic component to obtain the goal of providing additional funding while equally distributing the economic impacts of these funding increases. As a result, LPP investments have the potential to address some of the most critical transportation infrastructure needs across the state by improving aging infrastructure, addressing worsening road conditions, and promoting active transportation.

Figure 28 shows the total investment in California through the LPP and the distribution of LPP-funded projects across the state. Through Cycles 1, 2, and 3 of the LPP program, a total of $2.1 billion was invested across 26 counties. As depicted in Figure 29, Cycle 2 involved the most significant round of investment, which included 26 projects in 18 counties, totaling approximately $943 million. In Cycles 1 and 3, approximately $599 and $610 million were invested in LPP projects, respectively. These three cycles have provided a critical funding source for over half of California's counties as well as providing critical support in supporting the goals of cities, counties, and towns that have prioritized improving their local transportation infrastructure.

Figures 28 and Figure 29 also illustrate the effectiveness of the LPP's funding distribution through the two separate allocation methods. While LPP projects are predominantly concentrated in the San Francisco Bay and Los Angeles Metro areas, many projects were funded in rural counties or counties with high CalEnviroScreen 4.0 scores. Figure 29 shows that most of the projects located in rural communities led to decreased VMTs in areas that are considered to be burdened by pollution based on the CalEnviroScreen 4.0 scores. However, large metropolitan areas also experienced significant VMT reductions due to LPP-funded projects. Both the San Francisco Bay area as well as the greater Los Angeles Metro area had a significant number of projects that led to VMT reductions across all three cycles.

Focusing investments in large metro areas across the state is consistent with the state's climate and equity goals because of the greater potential for LPP projects to result in lower GHG emissions and minimize the cost burden in areas where greater amounts of funding are required to undertake the projects encouraged by the LPP. Furthermore, disadvantaged communities in dense urban areas often rely more on different forms of transportation, and improving these systems can improve their mobility, economic opportunities, and the health of the surrounding environment. Notably, the structure of the LPP has enabled areas other than large metropolitan areas to benefit from state funding. Counties such as Fresno and Stanislaus, which have some of the highest CalEnviroScreen 4.0 scores in the State, have received funding from LPP and have the opportunity to improve their local transportation systems significantly.

The LPP program captures the essence of California's transportation, climate, and equity goals and aims to achieve these goals through collaboration. The program's structure not only allocates local transportation project funds but rewards local governments who have made the effort to generate their own funding sources through its application requirements. Furthermore, the inclusion of a formulaic component ensures that most of the funding will be equally distributed rather than only allocating funds to those who have gone through a competitive grant process. In addition, this also ensures that any experienced economic impacts are also equitably distributed. The results of Figure 28 and Figure 29 demonstrate that the LPP program has effectively invested in various transportation projects across California through equitable and collaborative means. Sustained investments made in LPP cycles 1-3 indicate the State's commitment to promoting more equitable and environmentally friendly modes of transportation across the state.

Figure 27. All LPP Program Projects Across All Cycles

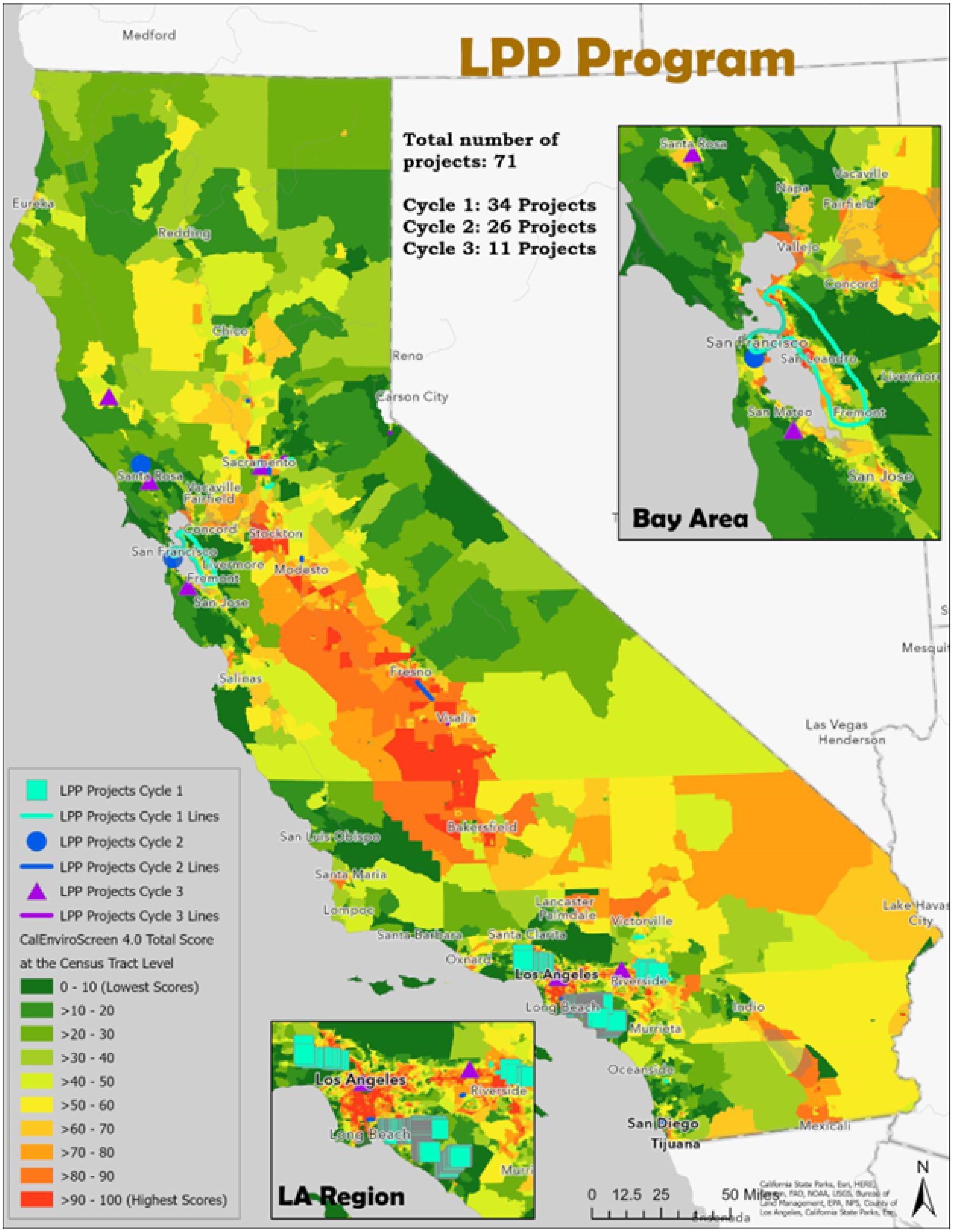


Figure 28. LPP Program Total Investment

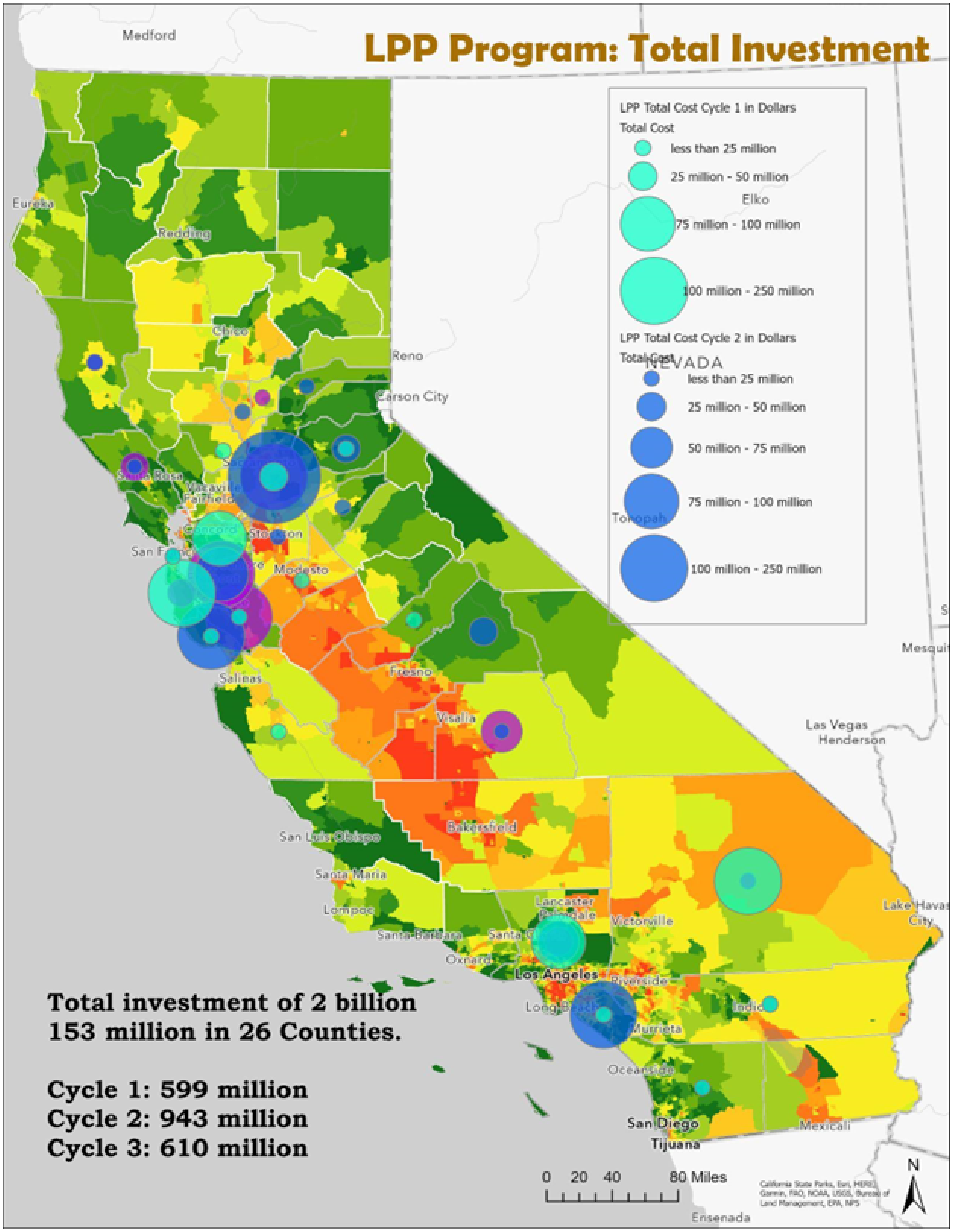
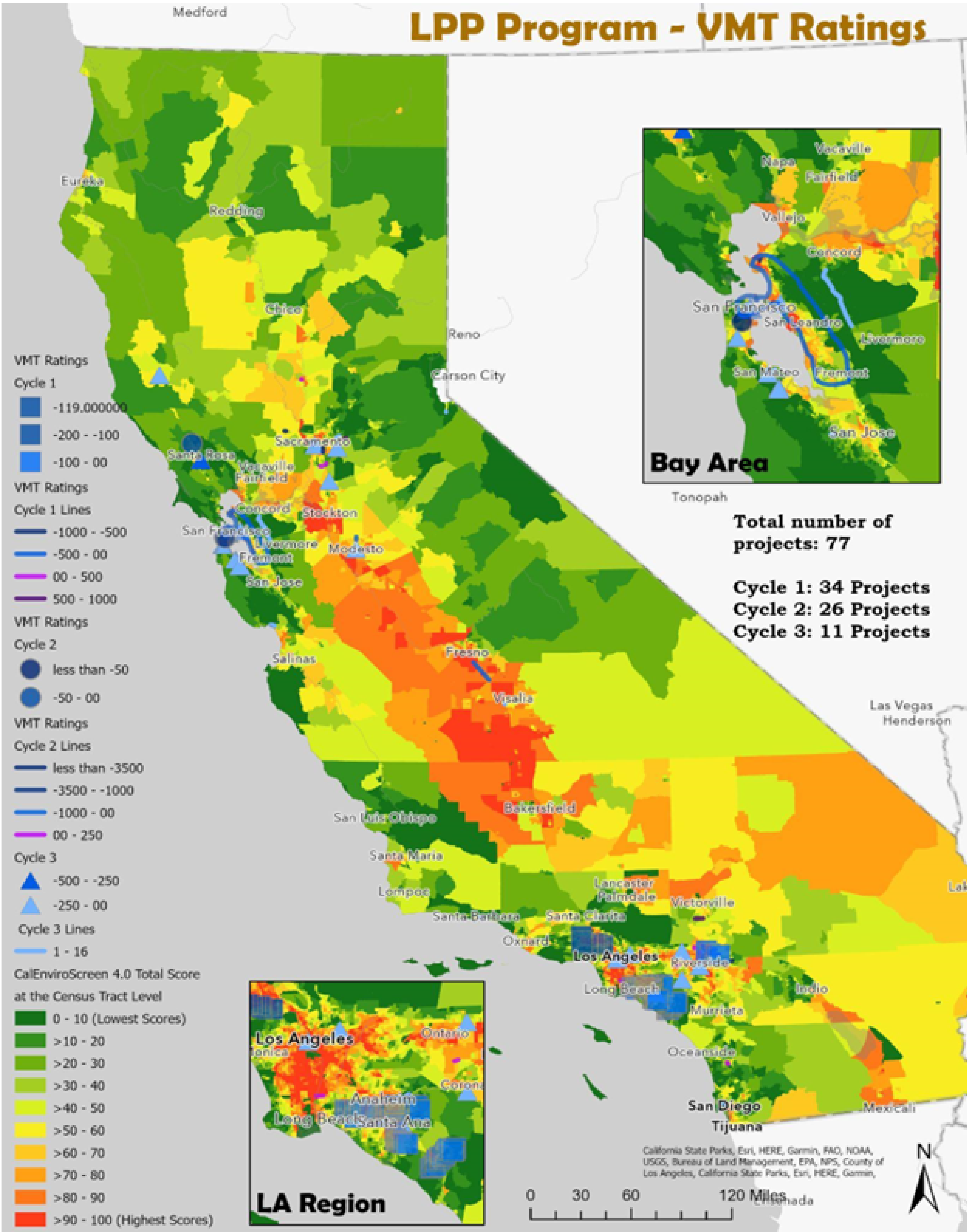


Figure 29. LPP Program VMT Ratings



4.7 EQUITY ANALYSIS CONCLUSIONS AND RECOMMENDATIONS

Overall, equity considerations are at the center of CAPTI implementation. Newly updated guidelines incentivize enhanced community engagement, and the newly established Equity Advisory Committee weighs on funding recommendations. Transportation infrastructure investments are reaching disadvantaged communities and areas with the greatest need for mobility improvements. The research team offers the following recommendations to safeguard equity in the implementation of CAPTI:

1) All key aspects of equity—process, input, output, and outcome—should be considered for a comprehensive evaluation of CAPTI.

It is evident that equity considerations are at the center of CAPTI implementation, which necessitates a detailed analysis of all key equity aspects for its ongoing monitoring and evaluation. First, only an equitable process can ensure an equitable outcome, and meaningful community engagement is a key element of equitable processes. As such, it is important to establish procedural equity by emphasizing community engagement and technical assistance in both the project selection and implementation phases. Second, a set of basic metrics can be defined to safeguard equity in inputs of CAPTI implementation, such as total dollars spent and number of communities engaged. Third, a set of metrics can be defined to ensure equity in outputs of CAPTI implementation, such as miles of infrastructure built or maintained, and transit service hours established. Fourth, the social, economic, and environmental impacts of transportation infrastructure investments should be analyzed to monitor outcome equity. CAPTI implementation can contribute to equitable mobility, which can be measured through a set of metrics focusing on accessibility, reliability, affordability, efficiency, and safety. Also, CAPTI implementation can help improve sustainability and community health by monitoring and reducing VMT, and by extension, emissions associated with it. While VMT is the key indicator for measuring progress toward climate goals, other indicators can be used to examine community health and air quality outcomes of CAPTI. Lastly, CAPTI can contribute to an equitable outcome by enhancing economic opportunity—especially in disadvantaged communities—by creating jobs, incentivizing fair labor practices, empowering local businesses, and improving connectivity to jobs, services, and amenities.

2) Both horizontal and vertical equity are goals worth attaining in the CAPTI implementation process, but if tradeoffs are necessary between different equity objectives, the needs of disadvantaged communities should be prioritized.

Horizontal equity—defined as the equal distribution of costs and benefits among various communities that are considered equal—focuses on fair treatment of communities with similar resources or needs. For example, many dense urban areas in California have similar or comparable needs in terms of mobility and access, necessitating a commensurate investment in transit and active transportation infrastructure. Vertical equity—defined as fair distribution of costs and benefits among communities with significantly different needs or resources—emphasizes that disadvantaged communities should shoulder less of the cost and collect more of the benefits of transportation projects. For example, low-income communities can be offered free transit passes to ensure vertical mobility equity. Although both vertical and horizontal equity are important, sometimes there is a need to make tradeoffs between different equity objectives, such as determining whether transit projects near disadvantaged communities or well-maintained roads across the state should be prioritized. CAPTI strategies appear to prioritize the needs of disadvantaged communities while promoting an accessible and safe transportation system for the entire state, especially areas with the greatest needs. In the next round of investments, CAPTI can further stress the importance of investing in areas and transportation modes with higher benefits and lower costs to disadvantaged communities.

3) Transportation infrastructure planning can focus on equity of opportunity as a step toward equity of outcome (or vertical equity).

Given the historic disinvestment in transportation infrastructure benefiting disadvantaged communities, outcome equity is an ambitious goal; yet focusing on equity of opportunity can help make steady progress toward this goal. Equity of opportunity—often defined as the distribution of costs and benefits proportionately among communities—can help set a basic standard for mobility access for all Californians. CAPTI investments across all cycles demonstrate a commitment to establishing higher standards for access to various modes of transportation, as well as to jobs, services, and amenities for all Californians. However, outcome equity would require acknowledging the unique needs of disadvantaged communities and assuring that they meet higher access standards set by CAPTI. Establishing an Equity Advisory Committee to weigh in on CAPTI funding recommendations was an important step toward understanding the unique needs of disadvantaged communities, but future evaluation can measure whether these needs were met. It is important to note that the evaluation of outcome equity is complex, and requires analysis of both macro-level aspects of the built environment (e.g., land use, density, housing, and employment access) and micro-level features (e.g., sidewalks, trees, and benches) that contribute to walkable, bikeable, and transit-friendly environments.[i]

5. APPENDIX A

Table 25. Table for Consolidated Improvement Outputs across CAPTI Programs

Program Reported	Improvement Output	Units	Program Reported	Improvement Output	Units
SCCP, LPP, ATP	Bicycle lane miles	Miles	SHOPP	Acceleration/ deceleration lane	Linear feet
SCCP, LPP, ITIP TCEP	Install new detectable warning surface	Square feet	SHOPP	Add safety edge (tapered edge)	Linear feet
SCCP, LPP, ATP, TCEP, SHOPP, ITIP	New crosswalk	Each	SHOPP	Bike and Pedestrian Signage	Each
SCCP, LPP, ATP, TCEP, SHOPP, ITIP	Sidewalk improvements	Linear feet	SHOPP	Bike boxes	Each
SCCP, LPP, TCEP, SHOPP	Signaling improvements	Each	SHOPP	Bike detection loops	Each
SCCP, LPP, TCEP, SHOPP, ITIP	New curb ramps	Each	SHOPP	Bike lane gap closure	Each
SCCP, LPP, ATP, SHOPP, ITIP TCEP	Ped/bicycle facilities constructed	Miles	SHOPP	Bike parking	Each
SCCP, LPP, ATP, SHOPP, ITIP, TCEP	Pedestrian/bicycle facilities miles constructed	Miles	SHOPP	Bike signals	Each
SCCP, LPP, ITIP TCEP	Modified/improved interchanges	Square feet	SHOPP	Bike tolerable drainage grates	Each
SCCP, LPP, TCEP	New bridge/tunnel	Square feet	SHOPP	Bike tolerable rumble strips	Linear feet
SCCP, LPP, ITIP TCEP	New local bridge structures/tunnels	Square feet	SHOPP	Bridge preservation	Square feet
SCCP, LPP, ITIP TCEP	Curve and vertical alignment corrections	Each	SHOPP	Bridge rail	Linear feet
SCCP, LPP, SHOPP, ITIP, TCEP	Interchange modifications	Each	SHOPP	Census station	Each
SCCP, LPP, SHOPP, ITIP, TCEP	Intersection/signal improvements	Each	SHOPP	Commercial vehicle enforcement station improvements	Square feet
SCCP, LPP, TCEP	Intersection constructed	Miles	SHOPP	Concrete pavement major rehab	Lane miles
SCCP, LPP, ITIP TCEP	Modified/improved interchanges	Each	SHOPP	Concrete pavement minor rehab	Lane miles
SCCP, LPP, TCEP	New interchanges	Square feet	SHOPP	Conflict zone green paint	Each
SCCP, LPP, SHOPP,TCEP	Local road operational improvements	Each	SHOPP	Cool pavement/ permeable pavement/ light colored pavement	Acres
SCCP, LPP, SHOPP,TCEP	Ramps & connectors constructed	Miles	SHOPP	Crash cushions	Each

Program Reported	Improvement Output	Units	Program Reported	Improvement Output	Units
SCCP, LPP, SHOPP,TCEP	Turn pockets constructed	Each	SHOPP	Curb extensions/bulb-outs	Each
SCCP, LPP, SHOPP, ITIP, TCEP	Auxiliary lane constructed	Miles	SHOPP	Curb ramp retired	Each
SCCP, LPP, TCEP	Local road - new	Miles	SHOPP	Daily Vehicle Hours of Delay (DVHD) reduced	Dvhd
SCCP, LPP, SHOPP, ITIP, TCEP	Local road reconstructed	Miles	SHOPP	Emergency opening	Locations
SCCP, LPP, SHOPP, ITIP, TCEP	Mainline shoulder constructed	Miles	SHOPP	Enhanced pavement surface friction	Linear feet
SCCP, LPP, ITIP TCEP	Mixed flow lanemiles Constructed	Miles	SHOPP	Equipment shop	Locations
SCCP, LPP, ITIP TCEP	Mixed flow mainline	Miles	SHOPP	Erosion control	Acres
SCCP, LPP, TCEP	Roadway lane miles	Miles	SHOPP	Extend merging/ acceleration lane	Linear feet
SCCP, LPP, ITIP TCEP	Roadway lane miles -new	Miles	SHOPP	Extinguishable message sign	Each
SCCP, LPP, TCEP	Shoulder widening	Each	SHOPP	Fish passage remediation	Yes=1/no=0
SCCP, LPP, TCEP	Two-way left turns lane	Each	SHOPP	Flashing beacons	Each
SCCP, LPP, ITIP TCEP	At grade crossings eliminated	Square feet	SHOPP	Gore area clean-up	Each
SCCP, LPP, ITIP TCEP	Grade separations/rail crossing improvements	Each	SHOPP	Guard rail	Linear feet
SCCP, LPP, SHOPP, ITIP, TCEP	Changeable message signs	Each	SHOPP	Habitat created	Acres
SCCP, LPP, SHOPP, TCEP	Communications (fiber optics)	Miles	SHOPP	Hazardous waste mitigation	Locations
SCCP, LPP, SHOPP, TCEP	Freeway ramp meter	Each	SHOPP	Highway advisory radio	Each
SCCP, LPP, SHOPP, ITIP, TCEP	Station improvements	Each	SHOPP	Improved highway geometry	Each
SCCP, LPP, ITIP TCEP	Rail cars/transit vehicles	Each	SHOPP	In lieu fee program established/credit purchase	Credits
SCCP, LPP, TCEP	Modified/reconstructed bridges	Each	SHOPP	Install cool/reflective or green roof	Each
SCCP, LPP, ITIP TCEP	New stations	Each	SHOPP	Install electric vehicle charging station	Locations
SCCP, LPP, ITIP TCEP	Hot/HOV lanes	Miles	SHOPP	Install led lighting	Each
LPP, SHOPP	Sign(s), light(s), greenway or other safety/ beautification	Each	SHOPP	Irrigation system	Acres
LPP, SHOPP	Pedestrian amenities	Each	SHOPP	Landscape elements	Square feet

Program Reported	Improvement Output	Units	Program Reported	Improvement Output	Units
LPP, ITIP TCEP	Sound wall mile(s) constructed	Miles	SHOPP	Landscaped areas	Square feet
LPP, ITIP TCEP	Mile(s) of new track	Miles	SHOPP	Lane narrowing	Linear miles
LPP, SHOPP, ITIP TCEP	Truck climbing lane mile(s) constructed	Miles	SHOPP	Lane reduction (road diet)	Linear miles
LPP, TCEP	Border crossing improvements	Each	SHOPP	Lane widening	Linear feet
LPP, TCEP	Port improvements	Each	SHOPP	LEED certified facility	Each
LPP, SHOPP, TCEP	Its elements	Each	SHOPP	Left-turn channelization	Each
LPP, TCEP	Fiber optic cable	Miles	SHOPP	Maintenance facilities	Locations
ATP, SHOPP	New roundabout constructed	Each	SHOPP	Maintenance facility	Square feet
SHOPP, ITIP	Turnouts constructed	Each	SHOPP	Material and testing laboratory	Square feet
SHOPP	Mitigation bank established/credit purchase	Credits	SHOPP	Median barrier	Linear feet
SHOPP	Mitigation planting	Yes=1/no=0	SHOPP	Roadway protective betterments	Locations
SHOPP	Modify driveway	Linear feet	SHOPP	Rock slope protection	Cubic yards
SHOPP	New culvert	Each	SHOPP	Rockfall mitigation	Each
SHOPP	Non-motorized overcrossing/ undercrossing for accessibility	Each	SHOPP	Rumble strips	Linear feet
SHOPP	Office buildings	Square feet	SHOPP	Slide removal or slope excavation	Cubic yards
SHOPP	Other	N/a	SHOPP	Standard slopes	Each
SHOPP	Overpass/underpass - pedestrian & bike	Each	SHOPP	Total maximum daily load mitigation	Acres
SHOPP	Park & ride lots	Each	SHOPP	Transit-only lanes	Linear miles
SHOPP	Permanent restoration	Locations	SHOPP	Trash reduction	Acres
SHOPP	Planting	Acres	SHOPP	Use of locally available building materials	Linear miles
SHOPP	Proactive safety improvements	Annual fatal & serious injury collisions	SHOPP	Use of recycled/ reclaimed materials	Linear miles
SHOPP	Reactive safety improvements	Collisions reduced	SHOPP	Vegetative buffer between cars/ bikes/ peds	Each
SHOPP	Relinquishments	Centerline miles	SHOPP	Vegetative street swales	Each
SHOPP	Remove obstructions	Each	SHOPP	Vehicle detection	Each
SHOPP	Replace or rehabilitate pump plants	Locations	SHOPP	Water & wastewater treatment at safety roadside rest area	Locations
SHOPP	Restripe bikeways	Linear miles	SHOPP	Weigh-in-motion system	Stations

Program Reported	Improvement Output	Units	Program Reported	Improvement Output	Units
SHOPP	Retaining wall	Square feet	SHOPP	Widen roadway	Linear feet
SHOPP	Roadside protection & restoration (Fish passage remediation, scenic enhancements, etc.)	Locations	SHOPP	Wildlife passage remediation	-
SHOPP	Roadside stopping opportunities (vista points, truck parking expansion)	Locations	SHOPP	Worker safety-barriers	Locations
SHOPP	Roadside weather information station	Each	SHOPP	Worker Safety-miscellaneous facilities and equipment	-
SHOPP	Roadway adapted to address climate change threats/vulnerability	Centerline miles	SHOPP	Worker safety-miscellaneous paving/ treatment	-
ITIP	Culvert(s)	Linear feet	SHOPP	Worker safety- safe access	Locations
ITIP	Passing lane mile(s) constructed	Miles	SHOPP	Worker safety-vegetation control	Locations
SHOPP	Bridge rehabilitation	Square feet	ITIP	Ramps modification(s)	Each

6. APPENDIX B

Table 26. List of Neutral VMT Impact Outputs with Corresponding VMT Rating

Improvement Output	Unit	VMT RATING
Border crossing improvements	Each	0
Intersection constructed	Miles	0
Ramps & connectors constructed	Miles	0
Auxiliary lane constructed	Miles	0
Mainline shoulder constructed	Miles	0
Shoulder widening	Each	0
Modified/reconstructed bridges	Each	0
Truck climbing lane mile(s) constructed	Miles	0
Acceleration/deceleration lane	Linear feet	0
Extend merging/acceleration lane	Linear feet	0
Roadside stopping opportunities (vista points, truck parking expansion)	Locations	0
Ramps modification(s)	Each	0
Passing lane mile(s) constructed	Miles	0
Install electric vehicle charging station	Locations	0
Daily Vehicle Hours of Delay (DVHD) reduced	DVHD	0
Curve and vertical alignment corrections	Each	0
Turn pockets constructed	Each	0
Local road reconstructed	Miles	0
Two-way left turns lane	Each	0
At grade crossings eliminated	Square feet	0
Grade separations/rail crossing improvements	Each	0
Changeable message signs	Each	0
Communications (fiber optics)	Miles	0
Sign(s), Light(s), Greenway or other safety/ beautification	Each	0
Sound wall mile(s) constructed	Miles	0
Port improvements	Each	0
Fiber optic cable	Miles	0
New roundabout constructed	Each	0
Turnouts constructed	Each	0
Add safety edge (i.e. tapered edge)	Linear feet	0
Bike tolerable drainage grates	Each	0
Bike tolerable rumble strips	Linear feet	0
Bridge preservation	Square feet	0
Bridge rail	Linear feet	0
Census station	Each	0
Commercial vehicle enforcement station improvements	Square feet	0
Concrete pavement major rehab	Lane miles	0
Concrete pavement minor rehab	Lane miles	0

Improvement Output	Unit	VMT RATING
Cool pavement/permeable pavement/light colored pavement	Acres	0
Crash cushions	Each	0
Curb ramp retired	Each	0
Emergency opening	Locations	0
Enhanced pavement surface friction	Linear feet	0
Equipment shop	Locations	0
Erosion control	Acres	0
Extinguishable message sign	Each	0
Fish passage remediation	Yes=1/No=0	0
Gore area clean-up	Each	0
Guard rail	Linear feet	0
Habitat created	Acres	0
Hazardous waste mitigation	Locations	0
Highway advisory radio	Each	0
Improved highway geometry	Each	0
In lieu fee program established/credit purchase	Credits	0
Install cool/reflective or green roof	Each	0
Install LED lighting	Each	0
Irrigation system	Acres	0
Landscape elements	Square feet	0
Landscaped areas	Square feet	0
LEED certified facility	Each	0
Left-turn channelization	Each	0
Maintenance facilities	Locations	0
Maintenance facility	Square feet	0
Material and testing laboratory	Square feet	0
Median barrier	Linear feet	0
Mitigation bank established/credit purchase	Credits	0
Mitigation planting	Yes=1/No=0	0
Modify driveway	Linear feet	0
New culvert	Each	0
Office buildings	Square feet	0
Other	N/A	0
Permanent restoration	Locations	0
Planting	Acres	0
Proactive safety improvements	Annual fatal & serious injury collisions	0
Reactive safety improvements	Collisions reduced	0
Relinquishments	Centerline miles	0
Remove obstructions	Each	0
Replace or rehabilitate pump plants	Locations	0
Retaining wall	Square feet	0

Improvement Output	Unit	VMT RATING
Roadside protection & restoration (fish passage remediation, scenic enhancements, etc)	Locations	0
Roadside weather information station	Each	0
Roadway adapted to address climate change threats/vulnerability	Centerline miles	0
Roadway protective betterments	Locations	0
Rock slope protection	Cubic yards	0
Rockfall mitigation	Each	0
Rumble strips	Linear feet	0
Slide removal or slope excavation	Cubic yards	0
Standard slopes	Each	0
Trash reduction	Acres	0
Use of locally available building materials	Linear miles	0
Use of recycled/reclaimed materials	Linear miles	0
Vehicle detection	Each	0
Water & wastewater treatment at safety roadside rest area	Locations	0
Weigh-in-motion system	Stations	0
Wildlife passage remediation	-	0
Worker safety-barriers	Locations	0
Worker safety-miscellaneous facilities and equipment	-	0
Worker safety-miscellaneous paving/treatment	-	0
Worker safety-safe access	Locations	0
Worker safety-vegetation control	Locations	0
Culvert(s)	Linear feet	0
Total maximum daily load mitigation	Acres	0

7. APPENDIX C

Table 27. List of Positive VMT Impact Outputs with Corresponding VMT Rating

Improvement Output	Unit	VMT Rating
New interchanges	Square feet	0.0001
Interchange modifications	Each	0.5
Modified/improved interchanges	Each	0.5
Lane widening	Linear feet	1
Widen roadway	Linear feet	1
Local road - new	Miles	5
Roadway lane miles - new	Miles	141
HOT/HOV lanes	Miles	141
Roadway lane miles	Miles	141
Mixed flow lane-miles constructed	Miles	354
Mixed flow mainline	Miles	354

8. APPENDIX D

Table 28. List of Negative VMT Impact Outputs with Corresponding VMT Rating

Improvement Output	Unit	VMT Rating
Ped/bicycle facilities constructed	Miles	-8
Pedestrian/bicycle facilities miles constructed	Miles	-8
Bicycle lane miles	Miles	-6
Signaling improvements	Each	-4
Mile(s) of new track	Miles	-3
Rail cars/transit vehicles	Each	-2
Lane narrowing	Linear miles	-2
Lane reduction (road diet)	Linear miles	-2
Park & ride lots	Each	-2
Transit-only lanes	Linear miles	-2
Intersection/signal improvements	Each	-1
Freeway ramp meter	Each	-1
Station improvements	Each	-1
New stations	Each	-1
Non-motorized overcrossing/undercrossing for accessibility	Each	-1
Overpass/underpass-pedestrian & bike	Each	-1
Restripe bikeways	Linear miles	-1
New crosswalk	Each	-0.5
Local road operational improvements	Each	-0.1
Install new detectable warning surface	Square feet	-0.1
Sidewalk improvements	Linear feet	-0.1
New curb ramps	Each	-0.1
Pedestrian amenities	Each	-0.1
Its elements	Each	-0.1
Bike and pedestrian Signage	Each	-0.1
Bike boxes	Each	-0.1
Bike detection loops	Each	-0.1
Bike lane gap closure	Each	-0.1
Bike parking	Each	-0.1
Bike signals	Each	-0.1
Conflict zone green paint	Each	-0.1
Curb extensions/bulb-outs	Each	-0.1
Flashing beacons	Each	-0.1
Vegetative buffer between cars/bikes/peds	Each	-0.1
Vegetative street swales	Each	-0.1

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