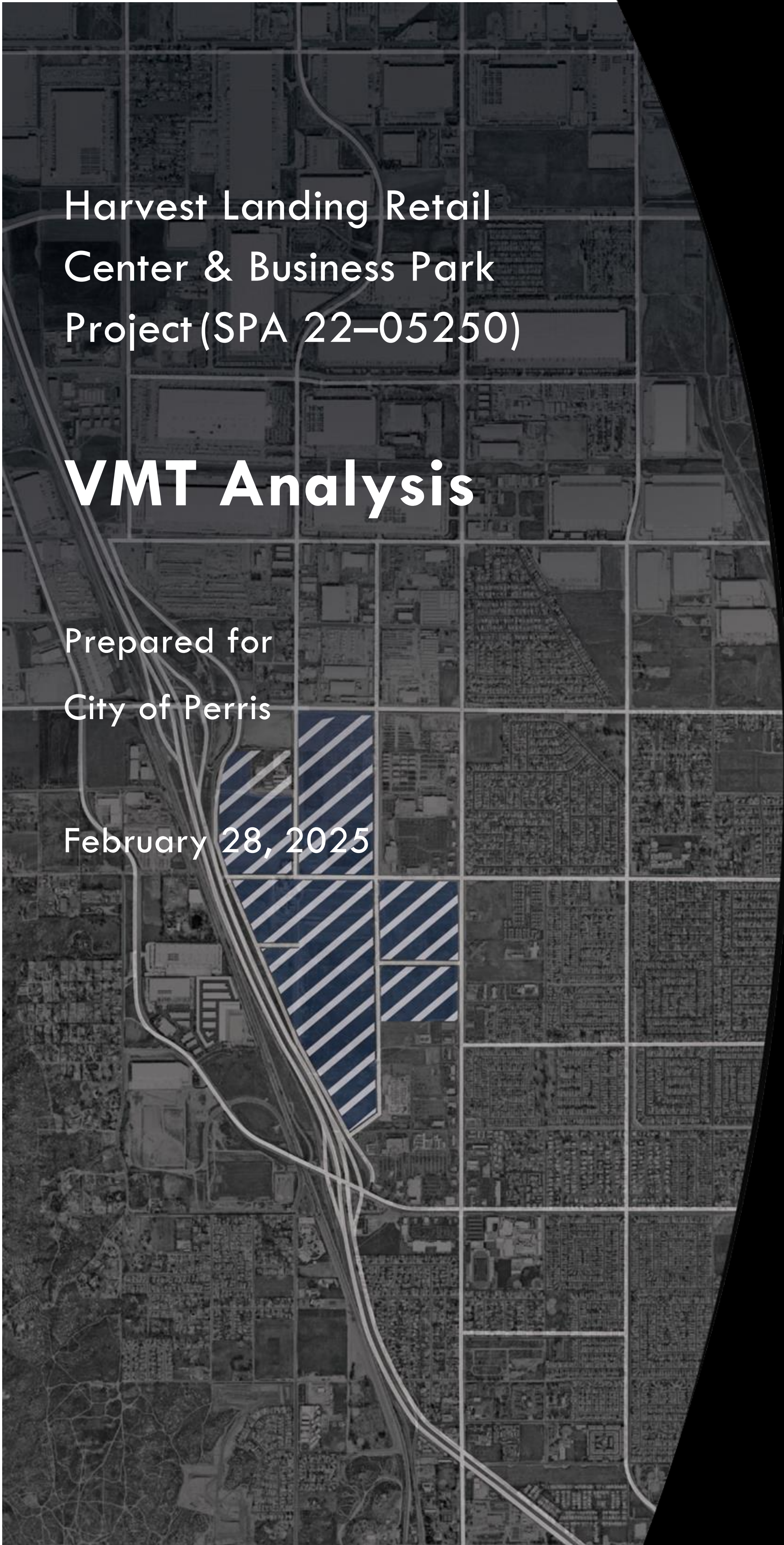

Harvest Landing Retail Center & Business Park Project (SPA 22–05250)

VMT Analysis

Prepared for

City of Perris

February 28, 2025

Prepared by

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Harvest Landing Retail Center & Business Park Project (SPA 22–05250)

Vehicle Miles Traveled (VMT) Analysis

City of Perris

Prepared For

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1 EXECUTIVE SUMMARY

This vehicle miles traveled (VMT) analysis has been prepared by EPD Solutions, Inc. (EPD) to analyze the potential traffic related impacts of the proposed Harvest Landing Retail Center and Business Park Project (Project). The Project would construct a commercial retail center and business park development within the City of Perris's Harvest Landing Specific Plan area. The Project requires a General Plan Amendment and a Specific Plan Amendment.

Project Description

The Project includes a total of 358.28 acres and consists of three components: Commercial, Business Park Phase 1 (development), and Business Park Phase 2 (programmatic). The following acreages and square footage (SF) are proposed across the three components:

- The Commercial component consists of lots totaling 46.72 acres south of Orange Avenue, east of Barrett Avenue, and west of Perris Boulevard. The Commercial component includes 423,007 SF of shopping center uses, including: retail anchor, shopping center, supermarket, fast casual restaurant, high turnover (sit-down) restaurant, fast Food restaurant with drive through and coffee/donut shop with drive-through window, a 5,500 SF medical office building, and a gasoline/service station with 12 vehicle fueling positions.
- Business Park Phase 1 consists of lots totaling 140.70 acres south of Orange Avenue, east of I-215 Frontage Road, and west of Barrett Avenue. Business Park Phase 1 proposes industrial uses; including 1,207,000 SF of high-cube warehouse, 322,079 SF of parcel hub, and 198,500 SF of general light industrial use.
    - The remaining areas of 48.17 acres within the proposed Project are dedicated to a water quality retention basin and roadways with the buildout of Business Park Phase 1.
- Business Park Phase 2 consists of lots totaling 112.01 acres and an overlay zone of 10.66 acres north of Orange Avenue, east of I-215 Frontage Road and west of Barrett Avenue. Business Park Phase 2 is analyzed programmatically for future industrial uses with no detailed site plan available. Business Park Phase 2 includes 3,659,693 SF of allowed industrial park building square footage on the 112.01 acres and 348,262 SF of industrial park on the 10.66-acre overlay.

The Project also proposes to remove 2,700 feet of Indian Avenue between Orange Avenue and I-215 Frontage Road. The Project would also construct the planned segment of Barrett Ave south of Orange Avenue from Orange Avenue to the existing southern portion of Barrett Avenue that connects to I-215 Frontage Road with a length of 3,000 ft (or 0.57 miles). This portion of Barrett Avenue is proposed to be constructed as a two-lane collector with one 16 ft travel lane and a 5 ft Class II bike lane on each side of the road.

This VMT analysis is based on the requirements of the City of Perris Transportation Impact Analysis Guidelines for CEQA (City's Guidelines), adopted by the City in May 2020, and the City of Perris General Plan 2030.

Project Trip Generation

The proposed Project is estimated to generate approximately 40,321 daily trips, 2,778 AM peak hour trips, and 3,106 PM peak hour trips.

Project VMT Screening Analysis

The City's Guidelines provide the following screening criteria to identify if the Project would be considered to have a less-than-significant impact on VMT and therefore could be screened out from further VMT analysis:

A. Is the Project 100% affordable housing?

Projects that consists of 100% affordable housing would be presumed to have a less-than-significant impact on VMT. This Project does not include 100% affordable housing; therefore, the Project would not meet Screening Criteria A.

B. Is the Project within one-half (1/2) mile of qualifying transit?

Projects located within a Transportation Priority Area (TPA; an area within one-half mile of qualifying transit) may be presumed to have a less-than-significant impact on VMT. According to the Western Riverside Council of Governments (WRCOG) VMT screening tool, although a portion of the Project site falls within a TPA, it includes more parking for use than required by the jurisdiction, and therefore the Project does not satisfy the conditions of Screening Criteria B.

C. Is the Project a local serving land use?

Projects that propose local-serving land uses may be presumed to have a less-than-significant impact on VMT. The Harvest Landing Project is not considered a local-serving land use. Therefore, it does not meet the requirements of Screening Criteria C.

D. Is the Project in a low VMT area?

Projects located within a low VMT-generating area that are consistent with the existing land use within that traffic analysis zone (TAZ) may be presumed to have a less-than-significant impact on VMT. The Project requires a General Plan Amendment and Specific Plan Amendment; therefore, the WRCOG VMT screening tool would not be appropriate to use and the Project would not meet the requirements of Screening Criteria D.

E. Are the Project's Net Daily Trips Fewer Than 500 ADT?

Projects generating less than 500 average daily trips (ADT) are presumed to have a less-than-significant impact on VMT, as they would not cause a substantial increase in citywide or regional VMT. The Project as a whole is expected to generate 40,321 daily trips, which exceeds the 500 daily trip thresholds. Therefore, the Project would not meet the requirements of Screening Criteria E.

VMT Screening for Transportation Projects

Based on Appendix D, The City of Perris VMT Scoping Form for Transportation Projects, of the City's Guidelines, the addition of new through lanes less than one (1) mile in length with multi-modal facilities would be presumed to have a less-than-significant impact. The proposed segment of Barrett Avenue is 3,000 ft (or 0.57 miles) in length with bike lanes and sidewalks. Therefore, the Project's proposed roadway addition can be presumed to have a less-than-significant impact on VMT.

Project VMT Evaluation

The Project encompasses three TAZs, numbered 1797, 1798, and 1870. The applicable threshold of 32.2 VMT per Service Population (VMT/SP) was determined using the Riverside County Model (RIVCOM). Linear interpolation between the 2018 and 2045 No-Project Model outputs was used to identify the Project Baseline (2024) VMT per SP and confirmed via the WRCOG VMT screening tool.

The Commercial (TAZ 1870) portion of the Project would have a VMT/SP 111.53% above the threshold under the Project Baseline (2024) condition and 108.55% above the threshold under the Cumulative (2045) condition. Therefore, the Commercial component of the Project would result in a significant VMT impact, and mitigation would be required.

The Business Park Phase 1 (TAZ 1798) portion of the Project would have a VMT/SP 6.85% below the threshold under the Project Baseline (2024) condition and 4.22% below the threshold under the Cumulative (2045) condition. Therefore, the Business Park Phase 1 portion of the Project would not result in a significant VMT impact, and mitigation would not be required.

The Business Park Phase 2 (TAZ 1797) portion of the Project would have a VMT/SP 9.92% below the threshold under the Project Baseline (2024) condition and 10.32% below the threshold under the Cumulative (2045) condition. Therefore, the Business Park Phase 2 portion of the Project would not result in a significant VMT impact, and mitigation would not be required.

The Project's total VMT/SP would be 14.12% above the threshold under the Project Baseline (2024) condition and 18.27% above the threshold under the Cumulative (2045) condition. Therefore, the total Project would result in a significant VMT impact, and mitigation would be required.

Project's Cumulative Effect on VMT

In addition to the stated thresholds, a boundary method analysis was conducted in coordination with the City to evaluate cumulative impacts. The Perris Citywide Boundary VMT/SP is 3.9% lower with the Project added under Project Baseline (2024) conditions and 1.0% lower with the Project added under Cumulative (2045) conditions. Therefore, the Project's cumulative effect on VMT is considered less than significant.

VMT Mitigation Measures

The California Air Pollution Control Officers Association (CAPCOA) Handbook identifies a total of 34 VMT reduction measures; however, not all 34 measures would be effective for Project mitigation. The following 12 measures were determined to be appropriate/feasible and VMT reducing for the Project:

- **Measure T-2: Increase Job Density.** This measure is relevant due to the Project's design, particularly in the Business Park components, where job density will be increased. By concentrating on jobs within the city, the distance employees must travel to reach their workplaces is reduced, resulting in shorter commutes. This spatial arrangement enhances accessibility to employment and promotes active transportation modes, such as walking and biking, thereby decreasing reliance on motor vehicles. Consequently, the project is anticipated to reduce vehicle miles traveled (VMT) and enhance overall transportation efficiency.

- **Measure T-5: Implement Commute Trip Reduction Program (Voluntary).** This measure will implement the Voluntary Commute Trip Reduction Program (T-5) for facilities with fewer than 250 employees, where SCAQMD Rule 2202 is not applicable. It encourages employers to track and report employee commute data and provide resources to support participation in commute reduction efforts, without mandatory compliance or penalties.
- **Measure T-6: Implement Commute Trip Reduction (CTR) Program (Mandatory Implementation and Monitoring).** The Project will implement a mandatory CTR program (CAPCOA Measure T-6) to enforce VMT reduction. The program will require participation from employees in carpooling, transit use, or biking, with established trip reduction targets, compliance measures, and monitoring procedures to ensure effectiveness. This program includes the following measures as a part of the measure:

    - **Measure T-7: Implement Commute Trip Reduction Marketing.** This measure will ensure that employees are informed about available transportation options, thereby maximizing participation in the CTR programs and contributing to the reduction of traffic congestion.
    - **Measure T-8: Provide Ridership Program.** This measure will provide transit passes or other incentives to employees, encouraging the use of public transportation. Given the scale of employment in the Business Park phases, this program is expected to reduce vehicle use and lower VMT.
    - **Measure T-9: Implement Subsidized or Discounted Transit Program.** This measure involves offering subsidized or discounted transit passes to employees. By reducing the cost of public transportation, it aims to increase its use among employees, thereby decreasing single-occupancy vehicle trips and contributing to a reduction in vehicle miles traveled (VMT).
    - **Measure T-10: Provide End-of-Trip Bicycle Facilities.** End-of-trip facilities, including bike racks, lockers, and showers, will be provided to support employees who choose to bike to work. These facilities are necessary to facilitate and increase bicycle commuting.
    - **Measure T-11: Provide Employer-Sponsored Vanpool.** This measure will support a vanpool program, reducing single-occupancy vehicle use. The vanpool program is particularly applicable to the large workforce anticipated in the Business Park phases.

- **Measure T-18 – Provide Pedestrian Network Improvement.** This measure will enhance safety and accessibility for pedestrians, encouraging walking as a primary mode of transportation. Improved pedestrian infrastructure will benefit the community by increasing mobility, reducing reliance on vehicles, and promoting healthier lifestyles. Additionally, a well-connected pedestrian network can boost local businesses and improve overall community connectivity.
- **Measure T-19-A – Construct or Improve Bike Facility.** This measure will construct or improve bike facilities as part of the project. Enhancements will include the development of dedicated bike lanes and multi-use paths, which will optimize safety and accessibility for cyclists. These improvements will encourage cycling as a viable transportation option, reduce vehicle congestion, and promote overall public health, thereby contributing to a more sustainable and connected transportation network.

- **Measure T-20 – Expand Bikeway Network** This measure will expand the bikeway network, thereby promoting active transportation options and encouraging greater participation in cycling, which contributes to the reduction of vehicle miles traveled (VMT) and enhances overall community mobility.
- **Measure T-27 – Implement Transit-Supportive Roadway Treatments** This measure is applicable as the project provides two bus stops with bus turnout lanes, which enhances accessibility for public transit users. By implementing transit-supportive roadway treatments, such as dedicated bus lanes and improved crosswalks, the project will facilitate efficient transit operations and promote higher ridership. These enhancements will create a more integrated transportation network, ensuring that transit services are safe, reliable, and convenient for the community.

To comply with CAPCOA Measures T-6 (inclusive of measures T-7 through T-11), T-17 through T-20, and T-27, the following strategies have been identified:

- **Implementation of Infrastructure Mitigation Measures:** The project will implement the infrastructure portions of the mitigation, including the construction of a bus stop with a turnaround to facilitate transit access, improving street connectivity through the extension and realignment of local roads, installing dedicated bike lanes to support cyclist safety, and constructing sidewalks to enhance pedestrian access and mobility throughout the area.
- **Tenant Participation in Inland Empire (IE) Commuter Program:** Tenants of the Harvest Landing Project, including those in both the commercial and business park phases, shall enroll in the IE Commuter program. This program would offer rideshare matching, guaranteed ride home reimbursements, commuter incentives, and vanpool subsidies, directly supporting the Project's goals for reducing traffic congestion and VMT. For operations that exceed 250 employees, the reporting provided by IE Commuter shall be submitted to SCAQMD to comply with measure 2202.
- **Designated Parking and Bicycle Facilities:** The Project shall include reserved parking spaces for car-share, carpool, and low-emission vehicles within the commercial and business park areas. Additionally, secure bike parking, storage lockers, and other end-of-trip bicycle facilities shall be provided, particularly in the Business Park phases, to encourage cycling as a viable commute option.
- **On-Site Transportation Coordinator:** The Project shall appoint a Transportation Coordinator to oversee the implementation and promotion of the IE Commuter or similar program. This role would involve coordinating with tenants to maximize employee participation in ridesharing, transit, and cycling initiatives across both commercial and business park components.
- **Financial Incentives for Alternative Transportation:** The Project shall offer financial incentives or subsidies to employees who regularly use vanpools, public transit, or bicycles for their commute. This would be particularly effective in the Business Park phases, where a large number of employees are expected, and would contribute to the reduction of single-occupancy vehicle use.
- **Commuter Information Center:** The Harvest Landing Project shall establish an on-site commuter information center within the commercial area to provide employees and visitors with resources on ridesharing options, public transit routes, and cycling infrastructure. Real-time information on transit schedules shall also be displayed to encourage the use of alternative transportation.

- **Transportation Fairs and Workshops:** The Project shall host regular transportation fairs or workshops in collaboration with IE Commuter or similar program to educate employees on the benefits of participating in the program. These events shall be held within the Business Park phases to increase awareness and enrollment in commute reduction initiatives.
- **Employee Recognition Program:** The Project shall implement an employee recognition program that rewards those who consistently use alternative transportation methods. This shall include incentives such as gift cards, additional time off, or public recognition within the workplace, encouraging ongoing engagement with the CTR measures.

The combined effect of all measures are anticipated to result in a total VMT reduction of 12.94%.

With mitigation incorporated, the Commercial component of the Project's VMT/SP would be 98.59% above the threshold under Project Baseline (2024) conditions and 95.61% above than the threshold under Cumulative (2045) conditions, while the Project as a whole's VMT/SP would be 1.18% above the threshold under Project Baseline (2024) conditions and 5.33% above the threshold under Cumulative (2045) conditions.

VMT Conclusion

In conclusion, the VMT impact that the Project generates is listed as follows:

- VMT impact of the commercial component of the Project would remain significant and unavoidable even with mitigation measures incorporated.
- VMT impact of the Business Park Phase 1 of the Project would not result in a significant VMT impact.
- VMT impact of the Business Park Phase 2 of the Project would not result in a significant VMT impact.
- VMT impact of the Project as a whole would remain significant and unavoidable even with mitigation measures incorporated.

Additionally, the following VMT impact are also evaluated:

- The Project's cumulative effect on VMT would be considered less than significant.
- The Project's proposed roadway addition can be presumed to have a less-than-significant impact on VMT.

2 INTRODUCTION

This vehicle miles traveled (VMT) analysis has been prepared by EPD Solutions, Inc. (EPD) to analyze the potential traffic related impacts of the proposed Harvest Landing Retail Center and Business Park Project (Project). The scope of work for this VMT analysis was reviewed and approved by the City of Perris and is provided in Appendix A. The background of this analysis and Project description for the Harvest Landing Project (Project) is discussed in detail below.

This VMT analysis is based on the requirements of the *City of Perris Transportation Impact Analysis Guidelines for CEQA* (City's Guidelines), adopted by the City Council in May 2020, and the City of Perris General Plan 2030.

2.1 Existing Roadway Circulation

The existing, general plan and project proposed characteristics of each roadway providing regional access and local access to the site Project are discussed in Table 1. The removal of Indian Ave will be discuss in detail in Section 2.2 and Section 4.3.

Table 1: Characteristic of Existing Roadway System

Road Name	From	To	Direction	Current Condition		General Plan (City of Perris)		Project Proposed	
				Speed Limit (mph)	Number of Lanes	Number of Lanes	Classification	Number of Lanes	Classification
Indian Ave	Walnut Ave	Orange Ave	North-South	40	2	4	Secondary Arterial	4	Secondary Arterial
Indian Ave	Orange Ave	Interstate 215 Frontage Rd	North-South	40	2	4	Secondary Arterial	Removed	
Perris Blvd	Placentia Ave	4th St	North-South	45	4	6	Major Arterial	6	Major Arterial
Barrett Ave	Rider St	Placentia Ave	North-South	25	2	No Info	No Info	2	Collector
Placentia Ave	Indian Ave	Redlands Ave	East-West	40	4 to 5	6	Major Arterial	6	Major Arterial
Orange Ave	Indian Ave	Evans Rd	East-West	25	2 to 4	4	Secondary Arterial	4	Secondary Arterial
Nuevo Rd	Perris Blvd	Murrieta Rd	East-West	25	4	6	Major Arterial	6	Major Arterial
Interstate 215 Frontage Rd	Placentia Ave	Nuevo Rd	North-South	45	2-Lane undivided	2	Collector	4	Secondary Arterial
I-215	Placentia Ave	Nuevo Rd	North-South	65	6-Lane Divided	6	Freeway	6	Freeway

2.2 Project Description

The Harvest Landing Retail Center and Business Park Project is a proposed commercial retail center and business park development in the City of Perris. The Project includes a General Plan Amendment that incorporates Land Use modifications and adjustments to roadway designations, in addition to a Specific Plan Amendment.

The Project includes a total of 358.28 acres and consists of three components: Commercial, Business Park Phase 1, and Business Park Phase 2. The following acreages and square footage (SF) are proposed across the three components:

- The Commercial component consists of lots totaling 46.72 acres south of Orange Avenue, east of Barrett Avenue, and west of Perris Boulevard. The Commercial component includes 423,007 SF of shopping center uses, including retail anchor, shopping center, supermarket, fast casual restaurant, high turnover (sit-down) restaurant, fast Food restaurant with drive through and coffee/donut shop with drive-through window, a 5,500 SF medical office building, and a gasoline/service station with 12 vehicle fueling positions.
- Business Park Phase 1 consists of lots totaling 140.70 acres south of Orange Avenue, east of I-215 Frontage Road, and west of Barrett Avenue. Business Park Phase 1 includes general light industrial uses including: 1,207,000 SF of high-cube warehouse use, 322,079 SF of parcel hub use, and 198,500 SF of other general light industrial use.
    - The remaining areas of 48.17 acres within the proposed Project are dedicated to a water quality retention basin and roadways with the buildout of Business Park Phase 1.
- Business Park Phase 2 consists of lots totaling 112.01 acres and an overlay zone of 10.66 acres north of Orange Avenue, east of I-215 Frontage Road and west of Barrett Avenue. Business Park Phase 2 is analyzed programmatically for future multiple business uses with no detailed site plan available. Business Park Phase 2 includes 3,659,693 SF of industrial park and 348,262 SF of industrial park overlays.

The Project also proposes to remove 2,700 feet of Indian Avenue between Orange Avenue and I-215 Frontage Road. This portion of Indian Avenue is currently a two-lane collector with one 11 ft travel lane and no bike lane on each side of the road. Indian Avenue is designated as a future secondary arterial in the City of Perris General Plan 2030.

The Project would also construct the planned segment of Barrett Ave south of Orange Avenue from Orange Avenue to the existing southern portion of Barrett Avenue that connects to I-215 Frontage Road with a length of 3,000 ft (or 0.57 miles). This portion of Barrett Avenue is proposed to be constructed as a two-lane collector with one 16 ft travel lane and a 5 ft Class II bike lane on each side of the road.

The proposed Project site is identified by 111 Assessor's Parcel Numbers (APN), listed in Table 2 *Parcel Exhibit*. The location of the Project is shown in Figure 1, *Project Location*, the Project site plan is shown in Figure 2, *Project Site Plan*, and the proposed realignment is shown below in Figure 3, *Proposed Realignment of Indian Avenue and Barrett Avenue*, and the proposed cross section for Barrett Avenue is shown in Figure 4, *Cross-Section of Proposed Barrett Avenue Segment*.

Table 2: Parcel Exhibit

APN Site List			
305-110-001	305-120-006	305-160-028	305-220-021
305-110-002	305-120-007	305-160-027	305-190-033
305-110-003	305-120-008	305-160-025	305-220-059
305-110-021	305-120-026	305-160-026	305-220-060
305-110-007	305-130-001	305-160-022	305-220-061
305-110-006	305-130-002	305-160-023	305-220-062
305-110-005	305-130-003	305-160-024	305-240-027
305-110-004	305-130-004	305-190-028	305-100-028
305-120-020	305-130-005	305-190-029	305-100-008
305-120-021	305-130-006	305-190-030	305-100-009
305-120-022	305-160-001	305-190-031	305-170-018
305-120-023	305-160-002	305-190-014	305-110-015
305-120-024	305-160-003	305-190-020	305-110-016
305-120-025	305-130-009	305-190-019	305-110-022
305-120-004	305-160-030	305-220-011	305-110-023
305-120-005	305-160-029	305-220-020	305-110-024
305-110-025	305-110-026	305-110-027	305-110-032
305-110-033	305-110-034	305-110-035	305-140-012
305-140-024	305-140-025	305-140-026	305-140-027
305-140-031	305-140-032	305-140-034	305-140-040
305-140-041	305-140-049	305-140-050	305-140-052
305-140-053	305-140-054	305-140-055	305-140-056
305-140-057	305-140-058	305-140-059	305-140-060
305-140-061	305-060-042	305-060-036	305-060-037
305-090-055	305-090-026	305-090-028	305-090-030
305-090-032	305-090-056	305-090-057	305-090-058
305-090-059	305-090-015	305-090-016	305-090-017
305-090-019	305-090-018	305-070-004	

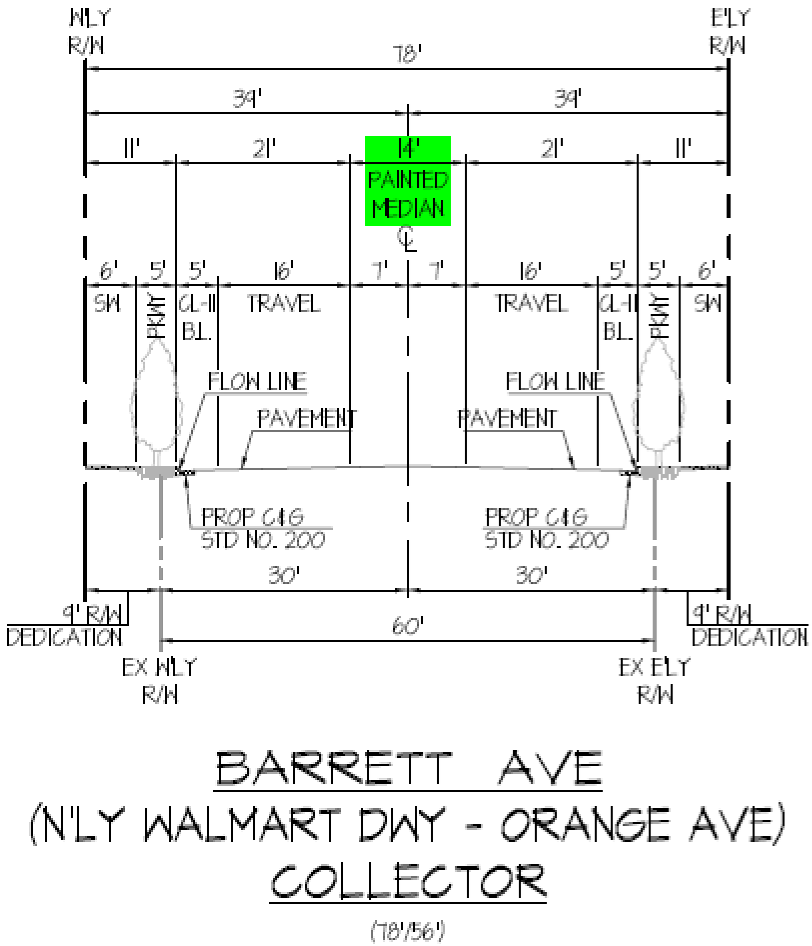
Figure 1: Project Location

Figure 2: Project Site Plan

Source: FM Civil

Figure 3: Proposed Realignment of Indian Avenue and Barrett Avenue

Figure 4: Cross-Section of Proposed Barrett Avenue Segment



Source: FMCIVIL Engineers, Inc.

3 VMT BACKGROUND AND SIGNIFICANCE THRESHOLD

Senate Bill (SB) 743 was signed by Governor Brown in 2013 and required the Governor's Office of Planning and Research (OPR) to amend the California Environmental Quality Act (CEQA) Guidelines to replace level of service (LOS) as the appropriate method for evaluating transportation impacts under CEQA. SB 743 specified that the new criteria should promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses. The bill also specified that delay-based LOS could no longer be considered an indicator of a significant impact on the environment under CEQA. In response, the Natural Resources Agency amended the CEQA Guidelines to include Section 15064.3, *Determining the Significance of Transportation Impacts*. This section states that VMT is the most appropriate measure of a project's transportation impacts and provides lead agencies with the discretion to choose the most appropriate methodology and thresholds for evaluating VMT. Section 15064.3(c) states that the provisions of the section shall apply statewide beginning on July 1, 2020.

3.1 City of Perris VMT Screening Criteria

The City's Guidelines provide the following screening criteria to identify if a project would be considered to have a less-than-significant impact on VMT and therefore could be screened out from further VMT analysis:

A. **Project 100% Affordable Housing.** If a project consists of 100% affordable housing, it may be presumed to have a less-than-significant impact on VMT. Additionally, projects with any affordable units can consider the reduced VMT impact of those units in their overall VMT analysis.
B. **Transit Priority Area (TPA) Screening.**[1] Projects located within a TPA may be presumed to have a less-than-significant impact on VMT.
C. **Project Type Screening.** Projects that propose local-serving land use may be presumed to have a less-than-significant impact on VMT.
D. **Low VMT Area Screening.** Projects located within a low VMT-generating area and consistent with the existing land uses within that traffic analysis zone (TAZ) may be presumed to have a less-than-significant impact on VMT.

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[1] A TPA is defined as a half-mile area around an existing major transit stop or an existing stop along a high-quality transit corridor per the definitions below.

Pub. Resources Code, § 21064.3 - 'Major transit stop' means a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods.

Pub. Resources Code, § 21155 - For purposes of this section, a 'high-quality transit corridor' means a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours.

E. **Project's Net Daily Trips Fewer Than 500 ADT.** Projects generating fewer than 500 average daily trips (ADT) are presumed to have a less-than-significant impact on VMT, as they would not cause a substantial increase in citywide or regional VMT.

If a project meets one of the criteria above, then the VMT impact of the Project would be considered less-than-significant and no further analysis of VMT would be required.

Additionally, based on Appendix D, *The City of Perris VMT Scoping Form for Transportation Projects*, of the City's Guidelines, the addition of new through lanes less than one (1) mile in length with multi-modal facilities would be presumed to have a less-than-significant impact.

3.2 VMT Significance Threshold

Projects not screened through the steps above may complete VMT analysis and forecasting through the Riverside County Transportation Analysis Model (RIVTAM/RIVCOM) to determine if they have a significant VMT impact, if any of the following conditions are satisfied:

- Project requires a zone change and/or General Plan amendment and generates 2,500 or more net daily trips, or
- Project is located in a TAZ without VMT data for screening, or
- Project is not able to effectively mitigate impacts using the VMT Scoping Form

As the project generates more than 2,500 daily trips and proposes a General Plan amendment, the Project would be required to conduct RIVTAM/RIVCOM modeling.

For projects that require RIVTAM/RIVCOM VMT modeling, a project would result in a significant project-generated VMT impact if either of the following conditions are satisfied:

- The base model year project-generated VMT per service population exceeds the City of Perris baseline VMT per service population, or
- The future model year project-generated VMT per service population exceeds the City of Perris base year VMT per service population.

For residential projects: If a development project exceeds the housing unit numbers specified in the Southern California Association of Government's (SCAG) Regional Housing Needs Assessment (RHNA) Final Allocation Plan for the City of Perris, the net VMT per capita for the project should be analyzed to determine if it exceeds the average VMT per capita for the city in the Regional Transportation Plan (RTP)/Sustainable Communities Strategy (SCS) horizon year. If it does, this would be considered a significant impact.

This threshold would not apply to the project, as the project does not propose residential land use.

For projects requiring a General Plan Amendment or Zone Change: If the project generates more than 2,500 net daily trips, net VMT modeling should be performed. If the VMT modeling shows that the project's net VMT exceeds the thresholds specified for significance, it would indicate a significant impact.

For all projects: If a project is inconsistent with the RTP/SCS, such as being located outside the footprint of development or in an area designated as open space, or if it causes the Citywide housing supply to exceed the RHNA Allocation, additional modeling should be conducted. If the modeling indicates a significant increase in future year Citywide or project TAZ VMT rates, this would be considered a significant impact.

According to the City's Guidelines, if a project results in a significant impact under either of the impact criteria, feasible mitigation measures would be required to reduce the project impact to a less-than-significant level.

4 VMT ANALYSIS

4.1 Project Trip Generation

The Project trip generation was calculated using trip rates from the Institute of Transportation Engineers (ITE) *Trip Generation Manual, 11th Edition* (2021) and the *TUMF High-Cube Warehouse Trip Generation Study* by Fehr & Peers (2023). The trip generation for the Project is shown in Table 3. Table 3 includes passenger vehicle and truck vehicle trips. For the purposes of consistency, Table 3 includes a passenger vehicle equivalent (PCE) factor applied to trucks as included in the *Harvest Landing Retail Center & Business Park Project (SPA 22–05250) Traffic Impact Analysis* by EPD Solutions, Inc. (February 2025). VMT is a focus on actual trips, specifically passenger vehicle trips, therefore, the PCE trips for trucks are for informational purposes only.

As shown in Table 3, the proposed Project is estimated to generate approximately 40,321 daily trips, 2,778 AM peak hour trips, and 3,106 PM peak hour trips.

Table 3a: Project Trip Generation

					AM Peak Hour			PM Peak Hour		
Land Use			**Units**	**Daily**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Trip Rates										
High-Cube Fulfilment Center[1]			TSF	1.744	0.070	0.017	0.087	0.047	0.073	0.120
High-Cube Parcel Hub[2]			TSF	4.63	0.35	0.35	0.70	0.44	0.20	0.64
General Light Industrial[3]			TSF	4.87	0.65	0.09	0.74	0.09	0.56	0.65
Free-Standing Discount Superstore[4]			TSF	50.52	1.04	0.82	1.86	2.12	2.21	4.33
Gasoline/Service Station[5]			VFP	172.01	5.14	5.14	10.28	6.96	6.96	13.91
Shopping Center[6]			TSF	37.01	0.52	0.32	0.84	1.63	1.77	3.40
Fast Food Restaurant with Drive Through[7]			TSF	467.48	22.75	21.86	44.61	7.23	6.68	13.91
High Turnover (Sit-Down) Restaurant[8]			TSF	107.20	5.26	4.31	9.57	5.52	3.53	9.05
Industrial Park[9]			TSF	3.37	0.28	0.06	0.34	0.07	0.27	0.34
Medical Office Building[10]			TSF	36.00	2.45	0.65	3.10	1.18	2.75	3.93
Supermarket[11]			TSF	93.84	1.69	1.17	2.86	4.48	4.48	8.95
Coffee/Donut Shop with Drive-Through Window[12]			TSF	533.57	43.80	42.08	85.88	19.50	19.50	38.99
Fast Casual Restaurant[13]			TSF	97.14	0.72	0.72	1.43	6.90	5.65	12.55
PHASE 1 Total Vehicle Trip Generation										
PHASE 1 Industrial										
TUMF High Cube (Building 2, 6, and 7)	1,207.000		TSF	2,105	85	20	105	56	88	145
Vehicle Mix [14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	86.70%	93.70%	87.30%	1,838	74	17	91	53	83	136
2-Axle Trucks	2.91%	1.38%	2.78%	59	2	1	3	1	1	2
3-Axle Trucks	2.35%	1.12%	2.25%	47	2	0	2	1	1	2
4+-Axle Trucks	8.02%	3.80%	7.66%	161	7	2	8	2	3	6
	100%	100%	100%	2,105	85	20	105	56	88	145
PCE Trip Generation [15]			***PCE Factor***							
Passenger Vehicles			1.0	1,838	74	17	91	53	83	136
2-Axle Trucks			1.5	88	4	1	5	1	2	3
3-Axle Trucks			2.0	95	4	1	5	1	2	3
4+-Axle Trucks			3.0	484	20	5	25	6	10	17
Total High Cube PCE Trip Generation				2,504	102	24	126	62	97	158
Parcel Hub (Building 1)	322.079		TSF	1,491	113	113	225	140	66	206
Vehicle Mix [14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	87.10%	90.60%	87.50%	1,305	98	98	196	127	60	187
2-Axle Trucks	2.83%	2.06%	2.74%	41	3	3	6	3	1	4
3-Axle Trucks	2.28%	1.66%	2.21%	33	3	3	5	2	1	3
4+-Axle Trucks	7.78%	5.67%	7.54%	112	9	9	18	8	4	12
	100%	100%	100%	1,491	113	113	225	140	66	206
PCE Trip Generation [15]			***PCE Factor***							
Passenger Vehicles			1.0	1,305	98	98	196	127	60	187
2-Axle Trucks			1.5	61	5	5	10	4	2	6
3-Axle Trucks			2.0	66	5	5	10	5	2	7
4+-Axle Trucks			3.0	337	26	26	53	24	11	35
Total Parcel Hub PCE Trip Generation				1,769	134	134	269	160	75	235

Table 3b: Project Trip Generation (Continued)

General Light Industrial (Building 3, 4, and 5)	198.500		TSF	967	129	18	147	18	111	129
Vehicle Mix [14]		***Percent*** [18]								
	AM	**PM**	**Daily**							
Passenger Vehicles	95.60%	95.90%	90.50%	875	124	17	140	17	106	124
2-Axle Trucks	0.96%	0.90%	2.08%	20	1	0	1	0	1	1
3-Axle Trucks	0.78%	0.73%	1.68%	16	1	0	1	0	1	1
4+-Axle Trucks	2.65%	2.47%	5.73%	55	3	0	4	0	3	3
	100%	100%	100%	967	129	18	147	18	111	129
PCE Trip Generation [15]			***PCE Factor***							
Passenger Vehicles			1.0	875	124	17	140	17	106	124
2-Axle Trucks			1.5	30	2	0	2	0	1	2
3-Axle Trucks			2.0	33	2	0	2	0	2	2
4+-Axle Trucks			3.0	166	10	1	12	1	8	10
Total Light Industrial PCE Trip Generation				1,104	138	19	157	19	118	137
PHASE 1 Commercial										
Medical Office Building										
Total Medical Office Trip Generation	5.500		TSF	198	13	4	17	6	15	21
Large Format Retail Anchor	167.050		TSF	8,439	174	137	311	354	369	723
Internal Capture[16] (OP 1 Retail)				-1,182	-38	-26	-64	-92	-66	-159
Retail Trip Generation with internal capture				7,258	136	111	246	262	302	565
Pass By [17] *(0% Daily, 0% AM, 29% PM)*				*0*	*0*	*0*	*0*	*-76*	*-88*	*-164*
Total Retail Trip Generation				7,258	136	111	246	186	215	401
Shopping Center >150k	189.845		TSF	7,026	99	61	159	310	336	645
Pass By [17] *(0% Daily, 0% AM, 29% PM)*				*0*	*0*	*0*	*0*	*-90*	*-97*	*-187*
Total Retail Trip Generation				7,026	99	61	159	220	238	458
Supermarket	23.256		TSF	2,182	39	27	67	104	104	208
Internal Capture[16] (OP 1 Retail)				-306	-9	-5	-14	-27	-19	-46
Retail Trip Generation with internal capture				1,877	31	22	53	77	85	162
Pass By [17] *(0% Daily, 0% AM, 24% PM)*				*0*	*0*	*0*	*0*	*-18*	*-20*	*-39*
Total Retail Trip Generation				1,877	31	22	53	59	65	123
Fast Casual Restaurant	8.934		TSF	868	6	6	13	62	50	112
Internal Capture[16] (OP 1 Restaurant)				-148	-2	-1	-3	-19	-22	-41
Restaurant Trip Generation with internal capture				720	5	5	10	43	28	71
Total Restaurant Trip Generation				720	5	5	10	43	28	71
High Turnover (Sit-Down) Restaurant	21.122		TSF	2,264	111	91	202	117	75	191
Internal Capture[16] (OP 1 Restaurant)				-385	-29	-14	-43	-36	-33	-69
Restaurant Trip Generation with internal capture				1,879	82	77	160	80	42	122
Pass By [17] *(0% Daily, 0% AM, 43% PM)*				*0*	*0*	*0*	*0*	*-35*	*-18*	*-53*
Total Restaurant Trip Generation				1,879	82	77	160	46	24	70

Table 3c: Project Trip Generation (Continued)

Fast Food Restaurant with Drive Through	11.000		TSF	5,142	250	240	491	80	73	153
Internal Capture[16] (OP 1 Restaurant)				-874	-65	-36	-101	-25	-32	-57
Restaurant Trip Generation with internal capture				4,268	185	204	390	55	41	96
Pass By[17] (50% Daily, 50% AM, 55% PM)				*-2,134*	*-93*	*-102*	*-195*	*-30*	*-23*	*-53*
Total Restaurant Trip Generation				2,134	93	102	195	25	19	43
Coffee/Donut Shop with Drive-Through Window	1.800		TSF	960	79	76	155	35	35	70
Internal Capture[16] (OP 1 Restaurant)				-163	-20	-11	-32	-11	-15	-26
Restaurant Trip Generation with internal capture				797	58	64	123	24	20	44
Pass By (50% Daily, 50% AM, 55% PM)				*-399*	*-29*	*-32*	*-61*	*-13*	*-11*	*-24*
Total Restaurant Trip Generation				399	29	32	61	11	9	20
Gasoline/Service Station	12		VFP	2,064	62	62	123	83	83	167
Internal Capture[16] (OP 1 Retail)				-289	-14	-12	-25	-22	-15	-37
Retail Trip Generation with internal capture				1,775	48	50	98	62	68	130
Pass By (57% Daily, 63% AM, 57% PM)				*-1,012*	*-30*	*-31*	*-62*	*-35*	*-39*	*-74*
Total Retail Trip Generation				763	18	18	36	27	29	56
COMMERCIAL TOTAL	**428.507**		**KSF**	**22,254**	**505**	**433**	**938**	**622**	**642**	**1,264**
Phase 1 Total Project Passenger Car Trip Generation				26,272	801	565	1,366	819	891	1,709
Phase 1 Total Project Truck Trip Generation (Non PCE)				545	32	18	49	17	16	34
Phase 1 Total Project Trip Generation (Non PCE)				26,817	832	583	1,415	836	907	1,743
Phase 1 Total Project Trip Generation (PCE)				27,631	879	610	1,489	863	932	1,793
PHASE 2 Total Vehicle Trip Generation										
Industrial Park	3,659.693		TSF	12,333	1,008	236	1,244	274	971	1,244
Vehicle Mix[14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	88.24%	88.24%	83.10%	10,249	889	209	1,098	242	856	1,098
2-Axle Trucks	2.58%	2.58%	3.70%	456	26	6	32	7	25	32
3-Axle Trucks	2.08%	2.08%	2.99%	369	21	5	26	6	20	26
4+-Axle Trucks	7.09%	7.09%	10.19%	1,257	72	17	88	19	69	88
	100%	100%	100%	12,331	1,008	236	1,244	274	970	1,244
PCE Trip Generation[15]			***PCE Factor***							
Passenger Vehicles			1.0	10,249	889	209	1,098	242	856	1,098
2-Axle Trucks			1.5	685	39	9	48	11	38	48
3-Axle Trucks			2.0	738	42	10	52	11	40	52
4+-Axle Trucks			3.0	3,771	215	50	265	58	207	265
Total Industrial PCE Trip Generation				15,442	1,185	278	1,463	322	1,141	1,463
Industrial Park (Overlay)	348.262		TSF	1,174	96	22	118	26	92	118
Vehicle Mix[14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	88.24%	88.24%	83.10%	975	85	20	104	23	81	104
2-Axle Trucks	2.58%	2.58%	3.70%	43	2	1	3	1	2	3
3-Axle Trucks	2.08%	2.08%	2.99%	35	2	0	2	1	2	2
4+-Axle Trucks	7.09%	7.09%	10.19%	120	7	2	8	2	7	8
	100%	100%	100%	1,173	96	22	118	26	92	118
PCE Trip Generation[15]			***PCE Factor***							
Passenger Vehicles			1.0	975	85	20	104	23	81	104
2-Axle Trucks			1.5	65	4	1	5	1	4	5
3-Axle Trucks			2.0	70	4	1	5	1	4	5
4+-Axle Trucks			3.0	359	20	5	25	6	20	25
Total Industrial PCE Trip Generation				1,469	113	26	139	31	109	139

Table 3d: Project Trip Generation (Continued)

Phase 2 Total Project Passenger Car Trip Generation	11,224	974	228	1,202	265	938	1,202
Phase 2 Total Project Truck Trip Generation (Non PCE)	2,280	130	30	160	35	125	160
Phase 2 Total Project Trip Generation (Non PCE)	13,505	1,104	259	1,363	300	1,063	1,363
Phase 2 Total Project Trip Generation (PCE)	16,911	1,297	304	1,602	352	1,249	1,602

Total Project Passenger Car Trip Generation	37,496	1,775	793	2,568	1,084	1,829	2,912
Total Project Truck Trip Generation (Non PCE)	2,825	161	48	210	53	141	194
Total Project Trip Generation (Non PCE)	40,321	1,936	842	2,778	1,136	1,970	3,106
Total Project Trip Generation (PCE)	44,542	2,177	914	3,091	1,215	2,181	3,395

Notes:
TSF = Thousand Square Feet PCE = Passenger Car Equivalent VFP = Vehicle Fueling Positions
1 Trip rates from TUMF High-Cube Warehouse Trip Generation Study Update, Fehr & Peers, November 13, 2023. In/Out splits from the Institute of Transportation Engineers, Trip Generation,11th Edition, 2021. Land Use Code 155 - High-Cube Fulfillment Center Warehouse.
2 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 156 - High-Cube Parcel hub Warehouse.
3 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 110 - General Light Industrial.
4 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 813 - Free-Standing Discount Superstore.
5 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 944 - Gasoline/Service Station.
6 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 820 - Shopping Center >150K.
7 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 934 - Fast Food Restaurant with Drive Through.
8 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 932 - High Turnover (Sit-Down) Restaurant.
9 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 130 - Industrial Park.
10 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 720 - Medical-Dental Office Building
11 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 850 - Supermarket.
12 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 937 - Coffee/Donut Shop with Drive-Through Window.
13 Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 930 - Fast Casual Restaurant
14 Truck% from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Truck axle split from the SCAQMD Warehouse Truck Trip Study Data Results and Usage, July 17, 2014.
15 Passenger Car Equivalent (PCE) factors from County of Riverside TA guidelines, 2020.
16 Internal capture rates from NCHRP Report 684.
17 Pass-by rates from the Institute of Transportation Engineers, Trip Generation Handbook,3rd Edition, 2017.
18 Manufacturing truck% used from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021.

4.2 VMT Screening Analysis

The applicability of each screening criteria to the Project is discussed below.

Screening Criteria A - Project 100% Affordable Housing

Projects consisting of 100% affordable housing are generally presumed to have a less-than-significant impact on VMT due to their lower VMT generation compared to market-rate housing. According to Office of Planning and Research (OPR) sources, this presumption allows lead agencies to determine a less-than-significant impact when a high percentage of affordable housing is included. Additionally, projects with any affordable units can consider the reduced VMT impact of those units in their overall VMT analysis.

The Project does not propose any affordable housing units; therefore, the Project does not meet Screening Criteria A.

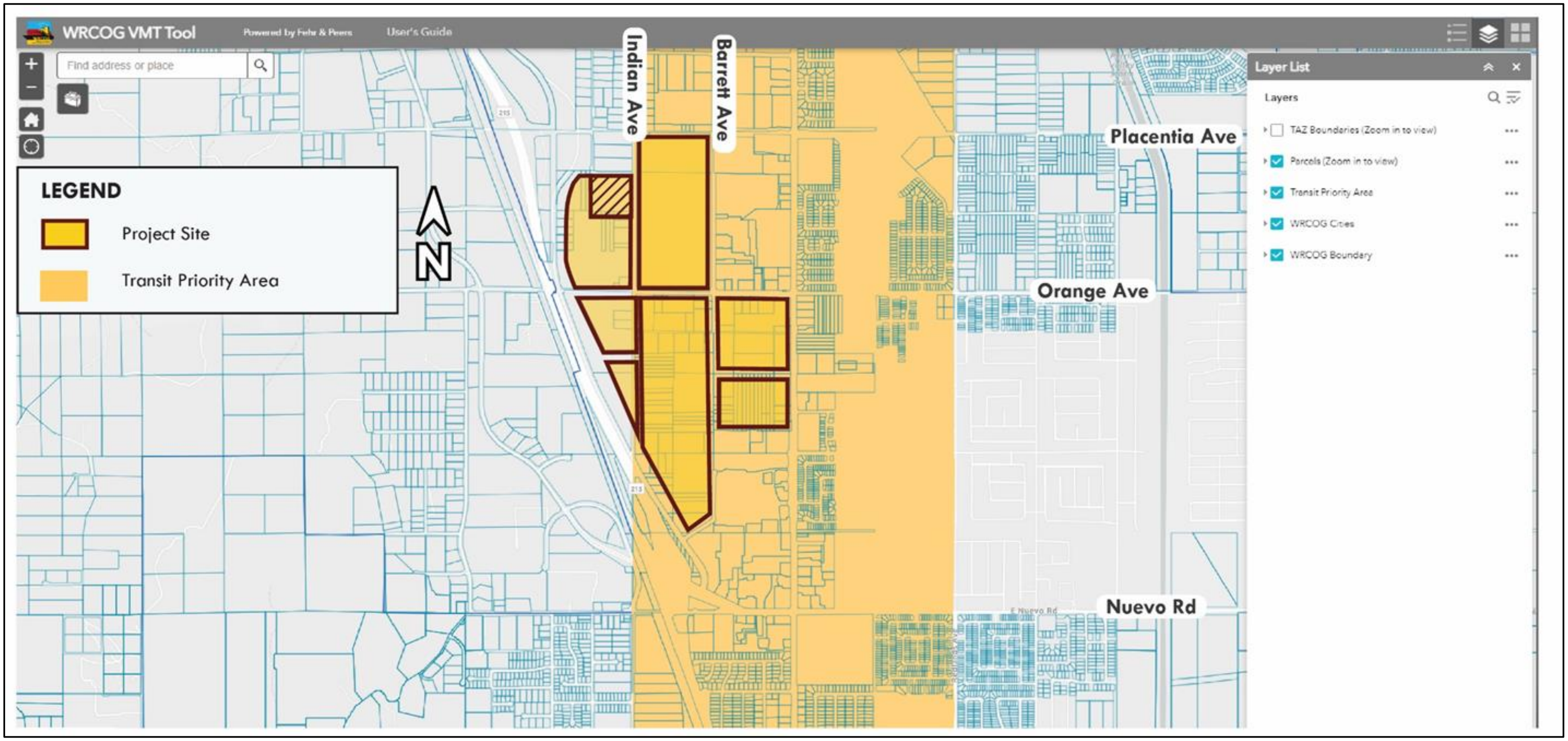
Screening Criteria B – Transit Priority Area (TPA) Screening

Per the City's Guidelines, projects located in a TPA may be presumed to have a less-than-significant VMT impact. A TPA is defined as within one-half mile of major transit stops or along a high-quality transit corridor. This presumption may NOT be appropriate if the project:

- Includes more parking for use by residents, customers, or employees of the project than required by the jurisdiction (if the jurisdiction requires the project to supply parking);
- Is inconsistent with the applicable Sustainable Communities Strategy (as determined by the lead agency, with input from the Metropolitan Planning Organization); or
- Replaces affordable residential units with a smaller number of moderate or high-income residential units.

Figure 5, *TPA Map Based on WRCOG VMT Screening Tool*, shows the output from the Western Riverside Council of Governments (WRCOG) VMT screening tool. This map identifies areas designated as Transit Priority Areas (TPAs) according to the City's criteria. Although a portion of the Project site falls within a TPA, it includes more parking for use than required by the jurisdiction, and therefore the Project does not satisfy the conditions of Screening Criteria B.

Figure 5: TPA Map Based on WRCOG VMT Screening Tool



Note: The Project area is only partially within a TPA.

Screening Criteria C - Project Type Screening

Based on the guidelines referenced, the following projects would satisfy Screening Criteria 3 and can be presumed to have a less-than-significant impact on VMT:

- Local Serving Retail < 50,000 sf
    - General retail less than 50,000 sf
    - Supermarket
    - Restaurant/cafe/bar
    - Coffee/donut shop
    - Dry cleaners
    - Barber shop
    - Hair/nails salon
    - Banks
    - Walk-in medical clinic
    - Urgent Care
    - Gas service station
    - Auto repair/tire shop
    - Gyms/health club
    - Dance/yoga/fitness/martial arts studio
- Education/Institutional
    - Public elementary school
    - Public middle school
    - Public high school
    - Community college
    - Day care center
    - Pre-school
    - Local religious institution
- Municipal/Public Services
    - Library
    - Civic center
    - Police/fire station
    - Community center
    - Public works support facility
    - Local/community park
    - Other local serving civic uses

The Project does not propose any Municipal/Public Service type uses, nor does it propose Education/Institutional uses. Additionally, the Commercial component of the project proposes more than 50,000 sf of retail uses, with multiple buildings over 50,000 sf individually.

Screening Criteria D – Low VMT Area Screening

Projects located within a low VMT-generating area that are consistent with the existing land use within that traffic analysis zone (TAZ) may be presumed to have a less-than-significant impact on VMT. The Project requires a General Plan Amendment and Specific Plan Amendment; therefore, the WRCOG VMT screening tool would not be appropriate to use, and the Project would not meet the requirements of Screening Criteria 4.

Screening Criteria E: Project's Net Daily Trips Fewer Than 500 ADT

Projects generating fewer than 500 average daily trips (ADT) are presumed to have a less-than-significant impact on VMT, as they would not cause a substantial increase in citywide or regional VMT. However, as shown in Table 3, *Project Trip Generation,* the Project as a whole is expected to generate 40,321 daily trips, which exceeds the 500 daily trip thresholds. Therefore, the Project would not meet the requirements of Screening Criteria E.

Therefore, the Project would not meet the requirements of Screening Criteria E.

Screening Criteria for Transportation Projects

Based on Appendix D, The City of Perris VMT Scoping Form for Transportation Projects, of the City's Guidelines, the addition of new through lanes less than one (1) mile in length with multi-modal facilities would be presumed to have a less-than-significant impact.

As previously mentioned in Section 2.2, Indian Avenue is removed between Orange Avenue and I-215 Frontage Road; while Barrett Avenue is added between Orange Avenue and I-215 Frontage Road, to reflect the roadway circulation under Cumulative Year (2045) With-Project conditions.

- The proposed segment of Barrett Avenue is 3,000 ft (or 0.57 miles) in length with bike lanes and sidewalks. Therefore, the Project's proposed roadway addition can be presumed to have a less-than-significant impact on VMT.

4.3 RIVCOM Model Configuration

As described in Section 3.2, *VMT Significance Threshold*, the City's Guidelines require the use of RIVCOM for preparation of VMT analysis. RIVCOM output results are provided in Appendix B.

RIVCOM Version 3.5.1, which incorporated the roadway circulation and land use data from the City's most current 2030 General Plan was utilized for the analysis. RIVCOM includes validated scenarios for the Model's Base Year (2018) and Cumulative Year (2045).

The Project is located within RIVCOM TAZ 1797, 1798, and 1870. RIVCOM was run for the Base Year (2018) and Cumulative Year (2045) under No-Project and With-Project conditions (i.e., four full Model runs). The RIVCOM roadway network near the Project site was reviewed for each model run, and no changes were necessary for the roadway network except for the Cumulative Year (2045) With-Project conditions:

- As previously mentioned in Section 2.2, Indian Avenue is removed between Orange Avenue and I-215 Frontage Road from RIVCOM; while Barrett Avenue is added between Orange Avenue and I-215 Frontage Road to RIVCOM, to reflect the roadway circulation under Cumulative Year (2045) With-Project conditions.
    - Despite being presumed to have a less-than-significant impact on VMT, the additional segment of Barrett Avenue and the removal of Indian Avenue segment are both added to the Cumulative Year (2045) Riverside County Model (RIVCOM) With-Project conditions, as it is part of the Project and therefore the VMT evaluation of the land use portion of the Project would include the effects of the proposed roadway modifications.

The Base and Cumulative Year "Plus Project" conditions were derived by incorporating the Project land use across the three TAZs in which the Project is located. The potential employment generated by each project component was calculated using a rate of employment per square foot, based on land use type, from the County of Riverside General Plan Environmental Impact Report (EIR) (2020).

- The Commercial component of the Project is located within TAZ 1870. The land use category "Commercial Retail" which would yield 1 employee per 500 SF, was used for the Commercial component of the Project. Based on these rates, the proposed Project would add 426 retail employees, 334 wholesale employees, 50 service employees, and 7 educational and medical employees. This Project employment was added to TAZ 1870.

- The Business Park Phase 1 portion of the Project is located within TAZ 1798. The land use category "Transportation and Warehousing" which would yield 1 employee per 1,030 SF, and land use category "Manufacturing" which would yield 1 employee per 1,030 SF, were used for the Business Park Phase 1 portion of the Project. Based on these rates, the proposed Project would add 1,485 transportation employees and 193 manufacturing employees. This Project employment was added to TAZ 1798.

- The Business Park Phase 2 portion of the Project is located within TAZ 1797. The land use category "Transportation and Warehousing" which would yield 1 employee per 1,030 SF, and land use category "Manufacturing" which would yield 1 employee per 1,030 SF, were used for the Business Park Phase 2 portion of the Project. Based on these rates, the proposed Project would add 1,946 transportation employees and 1,946 manufacturing employees. This Project employment was added to TAZ 1797.

The total Origin-Destination (OD) VMT of the Project TAZs was evaluated using the RIVCOM VMT post-processor from the RIVCOM Base Year (2018) and Cumulative Year (2045) With-Project Model runs. To determine OD VMT/Service Population (hereafter referred to as VMT/SP), the total OD VMT of the Project TAZ is divided by the total service population (service population = population + employment) of the Project TAZ. The 2024 VMT/SP of the Project TAZ was interpolated using linear interpolation between the 2018 and 2045 Model outputs.

The VMT/SP within the City of Perris under the No-Project conditions for Base Year (2018) and Cumulative Year (2045) were obtained using the No-Project Model run. The City of Perris VMT/SP for Project Baseline (2024) was calculated from the RIVCOM results using linear interpolation between the 2018 and 2045 Model outputs. It has also been confirmed via the WRCOG VMT tool.

4.4 Project VMT Evaluation

The applicable threshold of 32.2 OD VMT/SP for the City of Perris 2024 baseline was determined using the RIVCOM results using linear interpolation between the 2018 and 2045 No-Project Model outputs and confirmed via the WRCOG VMT tool.

The Project's VMT analysis results for the Commercial component of the Project (TAZ 1870) using RIVCOM are shown in Table 4, *RIVCOM VMT Analysis of Project – TAZ 1870 (Commercial)*. As shown in Table 4, the Commercial component of the Project's VMT/SP would be 111.53% above the threshold under Project Baseline (2024) conditions and 108.55% above than the threshold under Cumulative (2045) conditions. Therefore, the Commercial component of the Project would result in a significant VMT impact, and mitigation would be required.

Table 4: RIVCOM VMT Analysis of Project – TAZ 1870 (Commercial)

	Base Year 2018	Baseline 2024	Cumulative 2045
Project TAZ 1870 Zone VMT	91,238	98,824	125,373
TAZ 1870 Service Population	1,332	1,451	1,867
Project TAZ 1870 VMT/SP	**68.5**	**68.1**	**67.2**
City of Perris Baseline 2024 VMT/SP	**32.2**		
% Above/Below Threshold	-	111.53%	108.55%
Impact?	**-**	**Yes**	**Yes**

Source: RIVCOM

The Project's VMT analysis results for the Business Park Phase 1 (TAZ 1798) using RIVCOM are shown in Table 5, *RIVCOM VMT Analysis of Project – TAZ 1798 (Business Park Phase 1)*. As shown in Table 5, the Business Park Phase 1 portion of the Project's VMT/SP would be 6.85% below the threshold under Project Baseline (2024) conditions and 4.22% below the threshold under Cumulative (2045) conditions. Therefore, the Business Park Phase 1 portion of the Project would not result in a significant VMT impact, and mitigation would not be required.

Table 5: RIVCOM VMT Analysis of Project – TAZ 1798 (Business Park Phase 1)

	Base Year 2018	Baseline 2024	Cumulative 2045
Project TAZ 1798 Zone VMT	135,474	138,196	147,723
TAZ 1798 Service Population	4,555	4,607	4,790
Project TAZ 1798 VMT/SP	**29.7**	**30.0**	**30.8**
City of Perris Baseline 2024 VMT/SP	**32.2**		
% Above/Below Threshold	-	-6.85%	-4.22%
Impact?	**-**	**No**	**No**

Source: RIVCOM

The Project's VMT analysis results for the Business Park Phase 2 (TAZ 1797) using RIVCOM are shown in Table 6, *RIVCOM VMT Analysis of Project – TAZ 1797 (Business Park Phase 2)*. As shown in Table 6, the Business Park Phase 2 portion of the Project's VMT/SP would be 9.92% below the threshold under Project Baseline (2024) conditions and 10.32% below the threshold under Cumulative (2045) conditions. Therefore, the Business Park Phase 2 portion of the Project would not result in a significant VMT impact, and mitigation would not be required.

Table 6: RIVCOM VMT Analysis of Project – TAZ 1797 (Business Park Phase 2)

	Base Year 2018	Baseline 2024	Cumulative 2045
Project TAZ 1797 Zone VMT	51,887	53,992	61,362
TAZ 1797 Service Population	1,786	1,861	2,125
Project TAZ 1797 VMT/SP	**29.1**	**29.0**	**28.9**
City of Perris Baseline 2024 VMT/SP	**32.2**		
% Above/Below Threshold	-	-9.92%	-10.32%
Impact?	**-**	**No**	**No**

Source: RIVCOM

The VMT analysis results for all Project TAZs using RIVCOM are shown in Table 7, *RIVCOM VMT Analysis- All Project TAZs*. As shown in Table 7, the Project as a whole's VMT/SP would be 14.12% above the threshold under Project Baseline (2024) conditions and 18.27% above the threshold under Cumulative (2045) conditions. Therefore, the Project as a whole would result in a significant VMT impact, and mitigation would be required.

Table 7: RIVCOM VMT Analysis of Project- All Project TAZs

	Base Year 2018	Baseline 2024	Cumulative 2045
Harvest Landing Total VMT for all Project TAZs	278,599	291,012	334,457
Harvest Landing Total SP for all Project TAZs	7,673	7,919	8,782
Harvest Landing VMT/SP	**36.3**	**36.7**	**38.1**
City of Perris Baseline 2024 VMT/SP	**32.2**		
% Above/Below Threshold	-	14.12%	18.27%
Impact?	**-**	**Yes**	**Yes**

Source: RIVCOM

4.5 Project's Cumulative Effect on VMT

A boundary method analysis is conducted in coordination with the City staff to evaluate cumulative impacts.

As shown in Table 8, the Perris Citywide Boundary VMT/SP is 3.9% lower with the Project added under Project Baseline (2024) conditions and 1.0% lower with the Project added under Cumulative (2045) conditions; therefore, the Project's cumulative effect on VMT would be considered less than significant.

Table 8: Project's Effect on VMT Results per City's Guidelines

	Base Year 2018	Baseline 2024	Cumulative 2045
Citywide Boundary VMT With Project	1,972,046	2,222,941	3,101,072
Citywide Population With Project	72,873	84,734	126,247
Citywide Employment With Project	23,852	27,588	40,662
Citywide Service Population With Project	96,725	112,321	166,909
With Project Citywide Boundary VMT/SP	**20.39**	**19.79**	**18.58**
Citywide Boundary VMT No Project	1,946,272	2,202,787	3,100,586
Citywide Population No Project	72,886	85,791	130,959
Citywide Employment No Project	17,465	21,201	34,275
Citywide Service Population No Project	90,351	106,992	165,234
No Project Citywide Boundary VMT/SP	**21.54**	**20.59**	**18.76**
% Above/Below Threshold	-	-3.9%	-1.0%
Impact?	**-**	**No**	**No**

5 VMT MITIGATION

5.1 VMT Mitigation Overview

As shown previously in Section 4.3, *Project VMT Evaluation*, the Commercial component of the Project's VMT/SP would be 111.53% above the threshold under Project Baseline (2024) conditions and 108.55% above the threshold under Cumulative (2045) conditions, while the Project as a whole's VMT/SP would be 14.12% above the threshold under Project Baseline (2024) conditions and 18.27% above the threshold under Cumulative (2045) conditions. Therefore, the Project would require VMT mitigation measures. The City's Guidelines state that individual project mitigation measures are recommended to reduce project specific VMT impacts by implementing Transportation Demand Management (TDM) strategies. The effectiveness of identified TDM strategies is based primarily on research documented in the California Air Pollution Control Officers Association (CAPCOA) *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity* (CAPCOA Handbook).

5.2 VMT Mitigation Measures

The CAPCOA Handbook identifies a total of 34 VMT reduction measures. Per the CAPCOA Handbook, measures are applicable to different scales and geographies (Project/Site scale and Program/Community scale). Project/Site refers to measures that reduce emissions at the scale of a parcel, employer, or development project. Program/Community refers to measures that reduce emissions at the scale of a neighborhood (e.g., specific plan), corridor, or entire municipality (e.g., city- or county-level).

For the proposed Project, measures from both scales of application are being considered. The project is a Specific Plan, which would typically be restricted to Program/Community measures; however, the project also includes multiple development level projects that would meet the Project/Site scale. Therefore, given the limited availability of options for VMT reduction measures, allowing the Project to combine measures from both scales can maximize their contributions. Projects that adopt a broader range of strategies are able to lead to greater overall benefits to project and community reduction in VMT. Therefore, both measures are considered for this project.

While measures from both scales of application were considered for implementation, some measures, based on their description are inappropriate to apply to the proposed Project.

Table 9, *CAPCOA VMT Reduction Measures*, identifies each of the 34 mitigation measures and identifies whether the mitigation measure would or would not apply to the Project. The pages from the CAPCOA Handbook describing each measure are provided in Attachment C. As shown in Table 9, out of 34 VMT reduction measures, 13 are applicable, and 12 of them would apply to the Project and contribute to VMT reduction. The remaining 22 measures would not apply or not reduce VMT for the following reasons:

- **Not VMT Reducing:** The retail area of the project will include electric vehicle charging stations, which could reduce greenhouse gas (GHG) emissions but would not result in a measurable reduction in vehicle miles traveled (VMT) and were therefore not included as VMT mitigation measures.

  - T-14 – Provide Electric Vehicle Charging Infrastructure (Electric Vehicle Charging Infrastructure would be implemented, which would contribute to a reduction in greenhouse gases: however, this would not translate to a reduction in VMT).
  - T-30 – Use Cleaner-Fuel Vehicles

- **Limitations of Transit Infrastructure for TOD:** The current level of transit infrastructure in the area is insufficient to support a Transit-Oriented Development (TOD) effectively; therefore, the following measure is not applicable:
  - T-3 – Provide Transit Oriented Development
- **Not Applicable to Non-Residential Projects:** The following five (5) measures are not applicable to a non-residential project:

  - T-1 – Increase Residential Density
  - T-4 – Integrate Affordable and Below Market Rate Housing
  - T-15 – Limit Residential Parking Supply
  - T-16 – Unbundle Residential Parking Costs from Property Cost
  - T-23 – Provide Community-Based Travel Planning

- **Limitations on Implementing Mobility Programs:** The following six (6) measures for implementing mobility programs are not applicable due to insufficient infrastructure and support systems. The lack of necessary facilities and a community engagement framework limits the feasibility and effectiveness of these options. Without these foundational elements, such initiatives cannot be successfully implemented.

  - T-19-B – Construct or Improve Bike Boulevard
  - T-21-A – Implement Conventional Carshare Program
  - T-21-B – Implement Electric Carshare Program
  - T-22-A – Implement Pedal (Non-Electric) Bikeshare Program
  - T-22-B – Implement Electric Bikeshare Program
  - T-22-C – Implement Scooter-share Program

- **Economic Infeasibility:** The following three (3) measures are not feasible for the project due to economic reasons. Given the low prevalence of paid parking in Perris, its implementation may adversely impact recruitment and business operations.

  - T-12 – Price Workplace Parking
  - T-13 – Implement Employee Parking Cash-Out
  - T-24 – Implement Market Price Public Parking (On-Street)
- **Limitations on Transit Network Expansion and Service Frequency:** The following four (4) measures are not applicable due to the City's lack of a funding mechanism and low ridership, combined with the transit connectivity challenges of suburban and rural development patterns, which limit service frequency.

  - T-25– Extend Transit Network Coverage or Hours
  - T-26– Increase Transit Service Frequency

- T-28 –Provide Bus Rapid Transit
- T-29– Reduce Transit Fares

- **Scope Limitation for Street Connectivity Improvements:** The following measure is designed for projects that increase intersection density through the construction of new street networks or retrofitting existing ones. Since this project involves only a number of driveways, not a full street network, the measure does not apply.

  - T-17 – Improve Street Connectivity

Table 9: CAPCOA VMT Reduction Measures

Mitigation		VMT Reducing?	Scale of Application	Applicable to Project?	Justification
Land Use Measures					
T-1	Increase Residential Density	Yes	Project/Site	No	Not Applicable to Non-Residential Projects
T-2	Increase Job Density	Yes	Project/Site	Yes	Applicable
T-3	Provide Transit Oriented Development	Yes	Project/Site	No	Limitations of Transit Infrastructure for TOD
T-4	Integrate Affordable and Below Market Rate Housing	Yes	Project/Site	No	Not Applicable to Non-Residential Projects
T-17	Improve Street Connectivity	Yes	Project/Site	No	•Scope Limitation for Street Connectivity Improvements
Trip Reduction Programs					
T-5	Implement Commute Trip Reduction Program (Voluntary)	Yes	Project/Site	Yes	Applicable to facilitates that have less than 250 employees.
T-6	Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring)	Yes	Project/Site	Yes	Applicable to facilitates that have more than 250 employees.
T-7	Implement Commute Trip Reduction Marketing	Yes	Project/Site	Yes	Applicable, if T-6 is applicable, this measure would be a part of T-6
T-8	Provide Ridership Program	Yes	Project/Site	Yes	Applicable, if T-6 is applicable, this measure would be a part of T-6
T-9	Implement Subsidized or Discounted Transit Program	Yes	Project/Site	Yes	Applicable, if T-6 is applicable, this measure would be a part of T-6
T-10	Provide End-of-Trip Bicycle Facilities	Yes	Project/Site	Yes	Applicable, if T-6 is applicable, this measure would be a part of T-6
T-11	Provide Employer-Sponsored Vanpool	Yes	Project/Site	Yes	Applicable, if T-6 is applicable, this measure would be a part of T-6
T-12	Price Workplace Parking	Yes	Project/Site	No	Paid parking, uncommon in Perris, undermines business competitiveness.

Mitigation		VMT Reducing?	Scale of Application	Applicable to Project?	Justification
T-13	Implement Employee Parking Cash-Out	Yes	Project/Site	No	Parking Cash-Out, uncommon in Perris, undermines business competitiveness.
T-23	Provide Community-Based Travel Planning	Yes	Program/Community	No	Not applicable since it is only relevant to residential projects based on CAPCOA-Transportation Section (Page 171).
Parking or Road Pricing/Management					
T-14	Provide Electric Vehicle Charging Infrastructure	No	Project/Site	Yes*	Retail area includes EV charging stations; however, VMT reduction not achieved.
T-15	Limit Residential Parking Supply	Yes	Project/Site	No	Not Applicable to Non-Residential Projects
T-16	Unbundle Residential Parking Costs from Property Cost	Yes	Project/Site	No	Not Applicable to Non-Residential Projects
T-24	Implement Market Price Public Parking (On-Street)	Yes	Program/Community	No	Paid parking, uncommon in Perris, undermines business competitiveness.
Neighborhood Design					
T-18	Provide Pedestrian Network Improvement	Yes	Program/Community	Yes	Applicable
T-19-A	Construct or Improve Bike Facility	Yes	Program/Community	Yes	Applicable
T-19-B	Construct or Improve Bike Boulevard	Yes	Program/Community	No	The City's lack of infrastructure limits Bike Boulevard construction.
T-20	Expand Bikeway Network	Yes	Program/Community	Yes	Applicable
T-21-A	Implement Conventional Carshare Program	Yes	Program/Community	No	Limited infrastructure (carshare agency) in Perris restricts carshare implementation.
T-21-B	Implement Electric Carshare Program	Yes	Program/Community	No	Limited infrastructure (carshare agency) in Perris restricts carshare implementation.
T-22-A	Implement Pedal (Non-Electric) Bikeshare Program	Yes	Program/Community	No	Perris lacks the necessary infrastructure for Pedal (Non-Electric) Bikeshare implementation.

Mitigation		VMT Reducing?	Scale of Application	Applicable to Project?	Justification
T-22-B	Implement Electric Bikeshare Program	Yes	Program/Community	No	Perris lacks the necessary infrastructure for Electric Bikeshare implementation.
T-22-C	Implement Scootershare Program	Yes	Program/Community	No	Perris lacks the necessary infrastructure for Scooter share Program implementation.
Transit					
T-25	Extend Transit Network Coverage or Hours	Yes	Program/Community	No	The City's lack of funding mechanism and the lack of ridership combined with the transit connectivity challenges of suburban and rural development patterns limits service frequency.
T-26	Increase Transit Service Frequency	Yes	Program/Community	No	The City's lack of funding mechanism and the lack of ridership combined with the transit connectivity challenges of suburban and rural development patterns limits service frequency.
T-27	Implement Transit-Supportive Roadway Treatments	Yes	Program/Community	Yes	Applicable
T-28	Provide Bus Rapid Transit	Yes	Program/Community	No	The City's lack of funding mechanism and the lack of ridership combined with the transit connectivity challenges of suburban and rural development patterns limits bus rapid transit.
T-29	Reduce Transit Fares	Yes	Program/Community	No	The City's lack of funding mechanism and the lack of ridership combined with the transit connectivity challenges of suburban and rural development patterns limits fare reductions.
Clean Vehicles and Fuels					
T-30	Use Cleaner-Fuel Vehicles	No	Project/Site	No	Not VMT Reducing

* Measure would be implemented by the Project as a supportive measure without quantified VMT reduction.

The following 12 VMT reduction measures can be applied to the Project and quantified:

- **Measure T-2: Increase Job Density.** This measure is relevant due to the Project's design, particularly in the Business Park components, where job density will be increased. By concentrating on jobs within the city, the distance employees must travel to reach their workplaces is reduced, resulting in shorter commutes. This spatial arrangement enhances accessibility to employment and promotes active transportation modes, such as walking and biking, thereby decreasing reliance on motor vehicles. Consequently, the project is anticipated to reduce vehicle miles traveled (VMT) and enhance overall transportation efficiency.
- **Measure T-5: Implement Commute Trip Reduction Program (Voluntary).** This measure will implement the Voluntary Commute Trip Reduction Program (T-5) for facilities with fewer than 250 employees, where SCAQMD Rule 2202 is not applicable. It encourages employers to track and report employee commute data and provide resources to support participation in commute reduction efforts, without mandatory compliance or penalties.
- **Measure T-6: Implement Commute Trip Reduction (CTR) Program (Mandatory Implementation and Monitoring).** This measure will implement a mandatory CTR program (CAPCOA Measure T-6) to enforce VMT reduction. The program will require participation from employees in carpooling, transit use, or biking, with established trip reduction targets, compliance measures, and monitoring procedures to ensure effectiveness. This program includes the following measures as a part of the measure:
    - **Measure T-7: Implement Commute Trip Reduction Marketing.** This measure will ensure that employees are informed about available transportation options, thereby maximizing participation in the CTR programs and contributing to the reduction of traffic congestion.
    - **Measure T-8: Provide Ridership Program.** This measure will provide transit passes or other incentives to employees, encouraging the use of public transportation. Given the scale of employment in the Business Park phases, this program is expected to reduce vehicle use and lower VMT.
    - **Measure T-9: Implement Subsidized or Discounted Transit Program.** This measure involves offering subsidized or discounted transit passes to employees. By reducing the cost of public transportation, it aims to increase its use among employees, thereby decreasing single-occupancy vehicle trips and contributing to a reduction in vehicle miles traveled (VMT).
    - **Measure T-10: Provide End-of-Trip Bicycle Facilities.** End-of-trip facilities, including bike racks, lockers, and showers, will be provided to support employees who choose to bike to work. These facilities are necessary to facilitate and increase bicycle commuting.
    - **Measure T-11: Provide Employer-Sponsored Vanpool.** This measure will support a vanpool program, reducing single-occupancy vehicle use. The vanpool program is particularly applicable to the large workforce anticipated in the Business Park phases.

- **Measure T-18 – Provide Pedestrian Network Improvement.** This measure will enhance safety and accessibility for pedestrians, encouraging walking as a primary mode of transportation. Improved pedestrian infrastructure will benefit the community by increasing mobility, reducing reliance on vehicles, and promoting healthier lifestyles. Additionally, a well-connected pedestrian network can boost local businesses and improve overall community connectivity.

- **Measure T-19-A – Construct or Improve Bike Facility.** This measure will construct or improve bike facilities as part of the project. Enhancements will include the development of dedicated bike lanes and multi-use paths, which will optimize safety and accessibility for cyclists. These improvements will encourage cycling as a viable transportation option, reduce vehicle congestion, and promote overall public health, thereby contributing to a more sustainable and connected transportation network.
- **Measure T-20 – Expand Bikeway Network** This measure will expand the bikeway network, thereby promoting active transportation options and encouraging greater participation in cycling, which contributes to the reduction of vehicle miles traveled (VMT) and enhances overall community mobility.
- **Measure T-27 – Implement Transit-Supportive Roadway Treatments** This measure is applicable as the project provides two bus stops with bus turnout lanes, which enhances accessibility for public transit users. By implementing transit-supportive roadway treatments, such as dedicated bus lanes and improved crosswalks, the project will facilitate efficient transit operations and promote higher ridership. These enhancements will create a more integrated transportation network, ensuring that transit services are safe, reliable, and convenient for the community.

To comply with CAPCOA Measures T-5 through T-11, T-17 through T-20, and T-27, the following strategies have been identified:

- **Implementation of Infrastructure Mitigation Measures:** The project will implement the infrastructure portions of the mitigation, including the construction of a bus stop with a turnaround to facilitate transit access, improving street connectivity through the extension and realignment of local roads, installing dedicated bike lanes to support cyclist safety, and constructing sidewalks to enhance pedestrian access and mobility throughout the area.
- **Tenant Participation in Inland Empire (IE) Commuter or Similar Program:** Tenants of the Harvest Landing Project, including those in both the commercial and business park phases, shall enroll in the IE Commuter program. This program would offer rideshare matching, guaranteed ride home reimbursements, commuter incentives, and vanpool subsidies, directly supporting the Project's goals for reducing traffic congestion and VMT. For operations that exceed 250 employees, the reporting provided by IE Commuter shall be submitted to SCAQMD to comply with measure 2202.
- **Designated Parking and Bicycle Facilities:** The Project shall include reserved parking spaces for car-share, carpool, and low-emission vehicles within the commercial and business park areas. Additionally, secure bike parking, storage lockers, and other end-of-trip bicycle facilities shall be provided, particularly in the Business Park phases, to encourage cycling as a viable commute option.
- **On-Site Transportation Coordinator:** The Project shall appoint a Transportation Coordinator to oversee the implementation and promotion of the IE Commuter program. This role would involve coordinating with tenants to maximize employee participation in ridesharing, transit, and cycling initiatives across both commercial and business park components.
- **Financial Incentives for Alternative Transportation:** The Project shall offer financial incentives or subsidies to employees who regularly use vanpools, public transit, or bicycles for their commute. This would be particularly effective in the Business Park phases, where a large number of employees are expected, and would contribute to the reduction of single-occupancy vehicle use.
- **Commuter Information Center:** The Harvest Landing Project shall establish an on-site commuter information center within the commercial area to provide employees and visitors with resources on ridesharing options, public transit routes, and cycling infrastructure. Real-time information on transit schedules shall also be displayed to encourage the use of alternative transportation.

- **Transportation Fairs and Workshops:** The Project shall host regular transportation fairs or workshops in collaboration with IE Commuter to educate employees on the benefits of participating in the program. These events shall be held within the Business Park phases to increase awareness and enrollment in commute reduction initiatives.
- **Employee Recognition Program:** The Project shall implement an employee recognition program that rewards those who consistently use alternative transportation methods. This would include incentives such as gift cards, additional time off, or public recognition within the workplace, encouraging ongoing engagement with the CTR measures.

The project will be required to enforce the implementation of these VMT mitigation measures under CEQA. The Project's anticipated VMT mitigation results that could be achieved based on the applicable and full compliance of both voluntary and mandatory measures identified above are shown in Table 10 and Table 11 below.

Supporting documents for the VMT mitigation measures are included in Appendix C.

Table 10: VMT Mitigation Results for Commercial component of the Project

	Baseline 2024	Cumulative 2045
% Above/Below Threshold	111.53%	108.55%
Impact?	**Yes**	**Yes**
Mitigation Measures	**VMT Reduction**	**VMT Reduction**
T-2: Increase Job Density	-6.14%	-6.14%
T-5: Implement Commute Trip Reduction Program (Voluntary)	-4.00%	-4.00%
T-6: Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring)	No VMT Reduction Credit Taken	
T-7: Implement Commute Trip Reduction Marketing	No VMT Reduction Credit Taken	
T-8: Provide Ridership Program	No VMT Reduction Credit Taken	
T-9: Implement Subsidized or Discounted Transit Program	No VMT Reduction Credit Taken	
T-10: Provide End-of-Trip Bicycle Facilities	No VMT Reduction Credit Taken	
T-11: Provide Employer-Sponsored Vanpool	No VMT Reduction Credit Taken	
T-18: Provide Pedestrian Network Improvement.	-2.32%	-2.32%
T-19-A: Construct or Improve Bike Facility.	-0.20%	-0.20%
T-20 :Expand Bikeway Network	-0.02%	-0.02%
T-27: Implement Transit-Supportive Roadway Treatments	-0.01%	-0.01%
Total VMT Reduction with Mitigation Measures	-12.94%	-12.94%
% Above/Below Threshold with Mitigation	98.59%	95.61%
Impact with Mitigation?	**Yes**	**Yes**

Source: RIVCOM & CAPCOA

Table 2: VMT Mitigation Results for Project as a Whole

	Baseline 2024	Cumulative 2045
% Above/Below Threshold	14.12%	18.27%
Impact?	**Yes**	**Yes**
Mitigation Measures	**VMT Reduction**	**VMT Reduction**
T-2: Increase Job Density	-6.14%	-6.14%
T-5: Implement Commute Trip Reduction Program (Voluntary)	-4.00%	-4.00%
T-6: Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring)	No VMT Reduction Credit Taken	
T-7: Implement Commute Trip Reduction Marketing	No VMT Reduction Credit Taken	
T-8: Provide Ridership Program	No VMT Reduction Credit Taken	
T-9: Implement Subsidized or Discounted Transit Program	No VMT Reduction Credit Taken	
T-10: Provide End-of-Trip Bicycle Facilities	No VMT Reduction Credit Taken	
T-11: Provide Employer-Sponsored Vanpool	No VMT Reduction Credit Taken	
T-18: Provide Pedestrian Network Improvement.	-2.32%	-2.32%
T-19-A: Construct or Improve Bike Facility.	-0.20%	-0.20%
T-20 :Expand Bikeway Network	-0.02%	-0.02%
T-27: Implement Transit-Supportive Roadway Treatments	-0.01%	-0.01%
Total VMT Reduction with Mitigation Measures	-12.94%	-12.94%
% Above/Below Threshold with Mitigation	1.18%	5.33%
Impact with Mitigation?	**Yes**	**Yes**

Source: RIVCOM & CAPCOA

5.3 VMT Reduction Result

As shown in Table 10 and Table 11, the following amounts of VMT reduction is anticipated to be achieved with the full application of the VMT mitigation measures identified in Section 5.2:

- By applying measure T-2 (Increase Job Density), Project VMT is anticipated to be reduced by 6.1%.
- By applying measure T-5 (Implement Commute Trip Reduction Program (Voluntary)), Project VMT is anticipated to be reduced by 4.00%.
- By applying measure T-18 (Provide Pedestrian Network Improvement), Project VMT is anticipated to be reduced by 2.32%.
- By applying measure T-19-A (Construct or Improve Bike Facility), Project VMT is anticipated to be reduced by 0.20%.
- By applying measure T-19-B (Construct or Improve Bike Boulevard), Project VMT is anticipated to be reduced by 0.01%.
- By applying measure T-20 (Expand Bikeway Network), Project VMT is anticipated to be reduced by 0.02%.
- By applying measure T-27 (Implement Transit-Supportive Roadway Treatments), Project VMT is anticipated to be reduced by 0.01%.

The combined effect of all measures is calculated based on the formula below:

$$\text{Reduction}_{\text{subsector}} = 1 - [(1 - A) \times (1 - B) \times (1 - C)]$$

Where A, B, and C are the individual measure reduction percentages for the measures to be combined in each subsector.

The measures are anticipated to result in a total VMT reduction of 12.94%. VMT mitigation percentage calculations are included in Appendix C.

With mitigations incorporated, the Commercial component of the Project's VMT/SP would be 98.59% above the threshold under Project Baseline (2024) conditions and 95.61% above than the threshold under Cumulative (2045) conditions, while the Project as a whole's VMT/SP would be 1.18% above the threshold under Project Baseline (2024) conditions and 5.33% above the threshold under Cumulative (2045) conditions.

6 VMT CONCLUSION

In conclusion, the VMT impact that the Project generates is listed as follows:

- VMT impact of the commercial component of the Project would remain significant and unavoidable even with mitigation measures incorporated.
- VMT impact of the Business Park Phase 1 of the Project would not result in a significant VMT impact.
- VMT impact of the Business Park Phase 2 of the Project would not result in a significant VMT impact.
- VMT impact of the Project as a whole would remain significant and unavoidable even with mitigation measures incorporated.

Additionally, the following VMT impact are also evaluated:

- The Project's cumulative effect on VMT would be considered less than significant.
- The Project's proposed roadway addition can be presumed to have a less-than-significant impact on VMT.

APPENDIX A – SCOPE OF WORK

City of Perris
www.cityofperris.org

CITY OF PERRIS
VMT SCOPING FORM FOR LAND USE PROJECTS

This Scoping Form acknowledges the City of Perris requirements for the evaluation of transportation impacts under CEQA. The analysis provided in this form should follow the City of Perris TIA Guidelines, dated May 12, 2020.

I. Project Description

Tract/Case No. SPA22-05250

Project Name: Harvest Landing

Project Location: East of I-215 Between Placentia Ave and Nuevo Rd

Project Description: Please see Attachment A for project description
(Please attach a copy of the project Site Plan)

Current GP Land Use: Harvest Landing SP | **Proposed GP Land Use:** Harvest Landing SP

Current Zoning: Harvest Landing SP | **Proposed Zoning:** Harvest Landing SP

If a project requires a General Plan Amendment or Zone change, then additional information and analysis should be provided to ensure the project is consistent with RHNA and RTP/SCS Strategies.

II. VMT Screening Criteria

	YES		NO		Attachments
A. Is the Project 100% affordable housing?	YES		NO	X	A
B. Is the Project within 1/2 mile of qualifying transit?	YES		NO	X	B
C. Is the Project a local serving land use?	YES		NO	X	A
D. Is the Project in a low VMT area?	YES		NO	X	B
E. Are the Project's Net Daily Trips less than 500 ADT?	YES		NO	X	C

Low VMT Area Evaluation:

Citywide VMT Averages[1]		
Citywide Home-Based VMT =		VMT/Capita
Citywide Employment-Based VMT =	16.9	VMT/Employee

WRCOG VMT MAP

Project TAZ	VMT Rate for Project TAZ[1]	Type of Project	
1797&1798&1870	VMT/Capita	Residential:	
	VMT/Employee	Non-Residential:	17

[1] Base year (2012) projections from RivTAM

Trip Generation Evaluation:

Source of Trip Generation: ITE Trip Generation Manual 11th Edition, 2021

Project Trip Generation: 37,369 **Daily Passenger Car Trips**

	YES		NO			
Internal Trip Credit:	YES	X	NO		% Trip Credit:	
Pass-By Trip Credit:	YES	X	NO		% Trip Credit:	
Affordable Housing Credit:	YES		NO	X	% Trip Credit:	
Existing Land Use Trip Credit:	YES		NO	X	Trip Credit:	

Please see Attachment C for % Trip Credits taken

Net Project Daily Trips: 37,369 **Daily Passenger Car Trips** Attachments: C

Does project trip generation warrant an LOS evaluation outside of CEQA? YES: X | NO:

III. VMT Screening Summary

A. Is the Project presumed to have a less than significant impact on VMT?

A Project is presumed to have a less than significant impact on VMT if the Project satisfies at least one (1) of the VMT screening criteria.

NO

B. Is mitigation required?

If the Project does not satisfy at least one (1) of the VMT screening criteria, then mitigation is required to reduce the Project s impact on VMT.

TBD

C. Is additional VMT modeling required to evaluate Project impacts?

YES	X	NO	

Please see Attachment D for VMT modeling inputs.

If the Project requires a one change and/or General Plan Amendment AND generates 2,500 or more net daily trips, then additional VMT modeling using RIVTAM/RIVCOM is required. If the project generates less than 2,500 net daily trips, the Project TAZ VMT Rate can be used for mitigation purposes.

IV. MITIGATION

A. Citywide Average VMT Rate (Threshold of Significance) for Mitigation Purposes:

B. Unmitigated Project TAZ VMT Rate:

C. Percentage Reduction Required to Achieve the Citywide Average VMT:

D. VMT Reduction Mitigation Measures:

Source of VMT Reduction Estimates:	
Project Location Setting	

VMT Reduction Mitigation Measure:		Estimated VMT Reduction (%)
1.		0.00%
2.		0.00%
3.		0.00%
4.		0.00%
5.		0.00%
6.		0.00%
7.		0.00%
8.		0.00%
9.		0.00%
10.		0.00%
Total VMT Reduction (%)		**0.00%**

(Attach additional pages, if necessary, and a copy of all mitigation calculations.)

E. Mitigated Project TAZ VMT Rate:

F. Is the project pressumed to have a less than significant impact with mitigation?

TBD

If the mitigated Project VMT rate is below the Citywide Average Rate, then the Project is presumed to have a less than significant impact with mitigation. If the answer is no, then additional VMT modeling may be required and a potentially significant and unavoidable impact may occur. All mitigation measures identified in Section IV.D. are subject to become Conditions of Approval of the project. Development review and processing fees should be submitted with, or prior to the submittal of this Form. The Planning Department staff will not process the Form prior to fees being paid to the City.

Prepared By		Developer/Applicant	
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Email:	techservices@epdsolutions.com	**Email:**	thoward@hipre.net
Date:	6/14/2024	**Date:**	6/14/2024

Approved by:

Perris Development Services Dept.	**Date**	**Perris Public Works Dept.**	**Date**

Attachment A
Project Description

Project Description:

The Harvest Landing Retail Center and Business Park Project is a proposed retail and business park development for the City of Perris's Harvest Landing Specific Plan. The project includes a General Plan Amendment, Specific Plan Amendment, and development reviews of the proposed project's Phase 1. The Project consists of two Phases, Phase 1 and Phase 2.

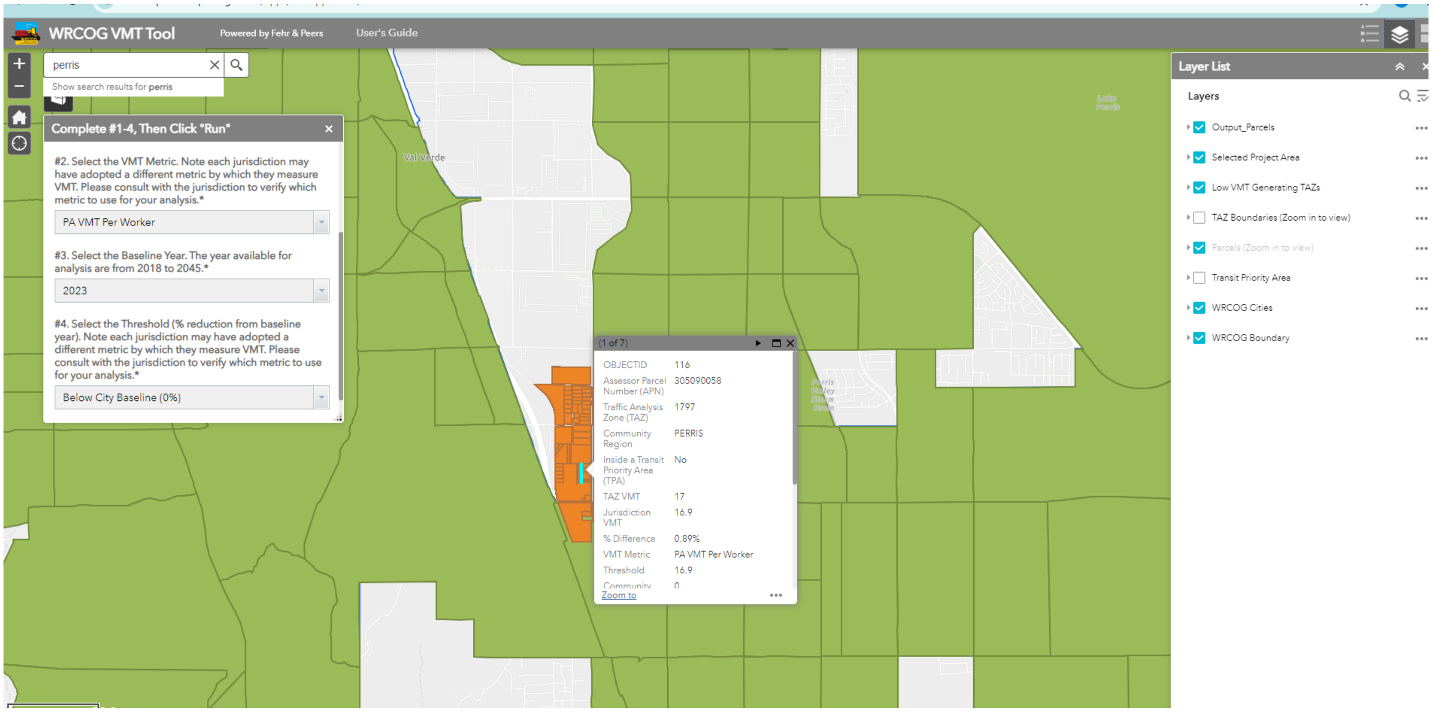
Phase 1 consists of lots south of Orange Avenue. Phase 1 is consistent with a development application for a mix of multiple business uses, a retail center and a water quality retention basin. Phase 1 includes: 1,207,000 SF TUMF High Cube, 322,079 SF Parcel Hub, 198,500 SF General Light Industrial, 423,000 SF Commercial uses, 5,500 SF medical office building, and a gasoline/service station with 10 vehicle fueling positions.

Phase 2 consists of lots north of Orange Avenue. Phase 2 is analyzed for future multiple business uses. No detailed site plan is available for Phase 2. Phase 2 includes: 3,659,693 SF industrial park and 348,262 industrial park overlay.

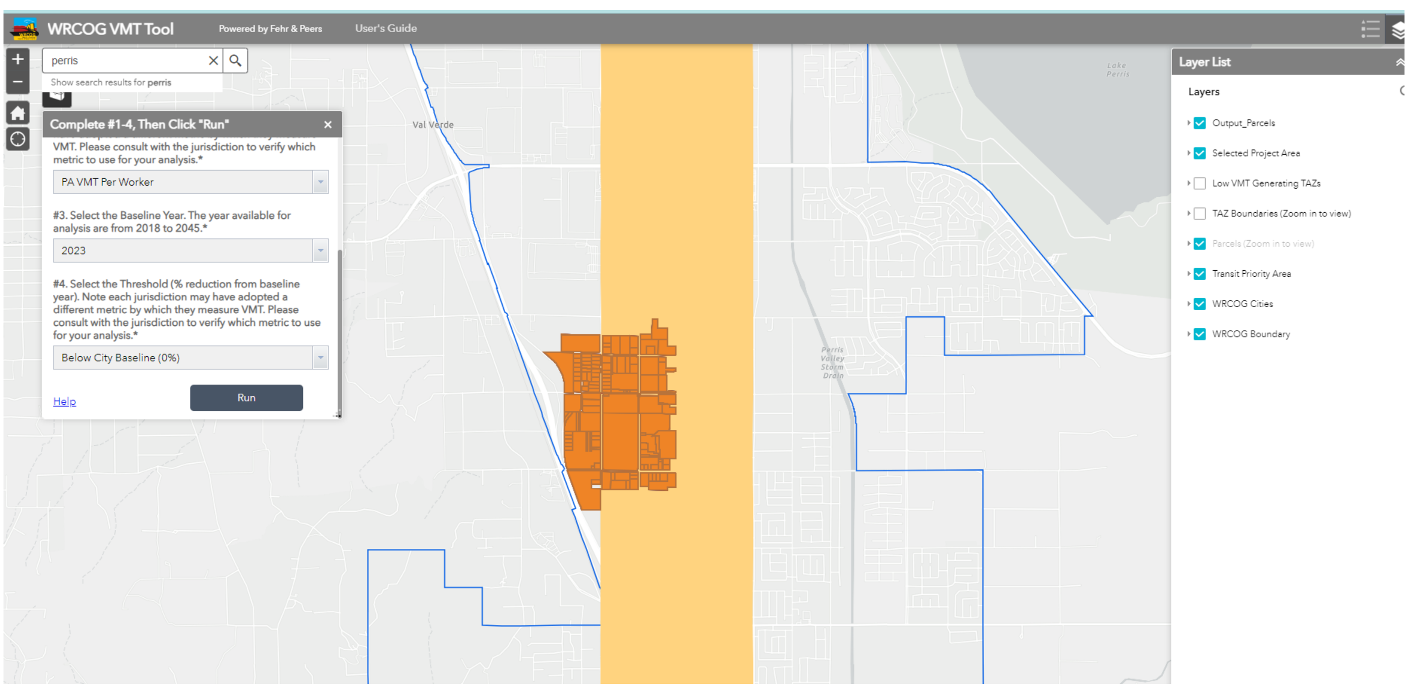
The proposed Project acreage totals 358.28 acres and consists of the following acreages and SF across the three proposed zones. 252.73 acres of the project will be zoned Multiple Business Use (MBU) and will consist of an anticipated SF of 5,735,534 across the Project's two Phases. A MBU overlay is included within the project that analyzes 10.66 acres to the projects north and would potentially include 348,262 SF of MBU uses. 46.72 acres of the project will be zoned Commercial (COMM) and will be developed during Phase 1 with an anticipated maximum SF of 428,507 of commercial and retail use including 5,500 SF medical office building and a gasoline/service station with 10 vehicle fueling positions. The remaining areas of 48.17 acres within the proposed project are dedicated to a water quality retention basin and roadways.

Attachment B
WRCOG Screening
Tool Results

PA VMT Per Worker & Low VMT Area



TPA



Attachment C
Project Trip
Generation

Table 1. Trip Generation

Land Use			Units	Daily	AM Peak Hour In	AM Peak Hour Out	AM Peak Hour Total	PM Peak Hour In	PM Peak Hour Out	PM Peak Hour Total
Trip Rates										
High-Cube Fulfilment Center[1]			TSF	1.744	0.070	0.017	0.087	0.047	0.073	0.120
High-Cube Parcel Hub[2]			TSF	4.63	0.35	0.35	0.70	0.44	0.20	0.64
General Light Industrial[3]			TSF	4.87	0.65	0.09	0.74	0.09	0.56	0.65
Free-Standing Discount Superstore[4]			TSF	50.52	1.04	0.82	1.86	2.12	2.21	4.33
Gasoline/Service Station[5]			VFP	172.01	5.14	5.14	10.28	6.96	6.96	13.91
Shopping Center[6]			TSF	37.01	0.52	0.32	0.84	1.63	1.77	3.40
Fast Food Restaurant with Drive Through[7]			TSF	467.48	22.75	21.86	44.61	7.23	6.68	13.91
High Turnover (Sit-Down) Restaurant[8]			TSF	107.20	5.26	4.31	9.57	5.52	3.53	9.05
Industrial Park[9]			TSF	3.37	0.28	0.06	0.34	0.07	0.27	0.34
Medical Office Building[10]			TSF	36.00	2.45	0.65	3.10	1.18	2.75	3.93
Supermarket[11]			TSF	93.84	1.69	1.17	2.86	4.48	4.48	8.95
Coffee/Donut Shop with Drive-Through Window[12]			TSF	533.57	43.80	42.08	85.88	19.50	19.50	38.99
Fast Casual Restaurant[13]			TSF	97.14	0.72	0.72	1.43	6.90	5.65	12.55
PHASE 1 Total Vehicle Trip Generation										
PHASE 1 Industrial										
TUMF High Cube (Building 2, 6, and 7)	1,207.000		TSF	2,105	85	20	105	56	88	145
Vehicle Mix [14]		*Percent*								
	AM	*PM*	*Daily*							
Passenger Vehicles	86.70%	93.70%	87.30%	1,838	74	17	91	53	83	136
2-Axle Trucks	2.91%	1.38%	2.78%	59	2	1	3	1	1	2
3-Axle Trucks	2.35%	1.12%	2.25%	47	2	0	2	1	1	2
4+-Axle Trucks	8.02%	3.80%	7.66%	161	7	2	8	2	3	6
	100%	100%	100%	2,105	85	20	105	56	88	145
PCE Trip Generation [15]			*PCE Factor*							
Passenger Vehicles			1.0	1,838	74	17	91	53	83	136
2-Axle Trucks			1.5	88	4	1	5	1	2	3
3-Axle Trucks			2.0	95	4	1	5	1	2	3
4+-Axle Trucks			3.0	484	20	5	25	6	10	17
Total High Cube PCE Trip Generation				2,504	102	24	126	62	97	158
Parcel Hub (Building 1)	322.079		TSF	1,491	113	113	225	140	66	206
Vehicle Mix [14]		*Percent*								
	AM	*PM*	*Daily*							
Passenger Vehicles	87.10%	90.60%	87.50%	1,305	98	98	196	127	60	187
2-Axle Trucks	2.83%	2.06%	2.74%	41	3	3	6	3	1	4
3-Axle Trucks	2.28%	1.66%	2.21%	33	3	3	5	2	1	3
4+-Axle Trucks	7.78%	5.67%	7.54%	112	9	9	18	8	4	12
	100%	100%	100%	1,491	113	113	225	140	66	206
PCE Trip Generation [15]			*PCE Factor*							
Passenger Vehicles			1.0	1,305	98	98	196	127	60	187
2-Axle Trucks			1.5	61	5	5	10	4	2	6
3-Axle Trucks			2.0	66	5	5	10	5	2	7
4+-Axle Trucks			3.0	337	26	26	53	24	11	35
Total Parcel Hub PCE Trip Generation				1,769	134	134	269	160	75	235
General Light Industrial (Building 3, 4, and 5)	198.500		TSF	967	129	18	147	18	111	129
Vehicle Mix [14]		*Percent* [18]								
	AM	*PM*	*Daily*							
Passenger Vehicles	95.60%	95.90%	90.50%	875	124	17	140	17	106	124
2-Axle Trucks	0.96%	0.90%	2.08%	20	1	0	1	0	1	1
3-Axle Trucks	0.78%	0.73%	1.68%	16	1	0	1	0	1	1
4+-Axle Trucks	2.65%	2.47%	5.73%	55	3	0	4	0	3	3
	100%	100%	100%	967	129	18	147	18	111	129
PCE Trip Generation [15]			*PCE Factor*							
Passenger Vehicles			1.0	875	124	17	140	17	106	124
2-Axle Trucks			1.5	30	2	0	2	0	1	2
3-Axle Trucks			2.0	33	2	0	2	0	2	2
4+-Axle Trucks			3.0	166	10	1	12	1	8	10
Total Light Industrial PCE Trip Generation				1,104	138	19	157	19	118	137

Table 1. Trip Generation

PHASE 1 Commercial

Medical Office Building									
Total Medical Office Trip Generation	5.500	TSF	198	13	4	17	6	15	21
Large Format Retail Anchor	167.050	TSF	8,439	174	137	311	354	369	723
Internal Capture[16] (OP 1 Retail)			-1,182	-38	-26	-64	-92	-66	-159
Retail Trip Generation with internal capture			7,258	136	111	246	262	302	565
Pass By[17] (0% Daily, 0% AM, 29% PM)			*0*	*0*	*0*	*0*	*-76*	*-88*	*-164*
Total Retail Trip Generation			7,258	136	111	246	186	215	401
Shopping Center >150k	189.845	TSF	7,026	99	61	159	310	336	645
Pass By[17] (0% Daily, 0% AM, 29% PM)			*0*	*0*	*0*	*0*	*-90*	*-97*	*-187*
Total Retail Trip Generation			7,026	99	61	159	220	238	458
Supermarket	23.256	TSF	2,182	39	27	67	104	104	208
Internal Capture[16] (OP 1 Retail)			-306	-9	-5	-14	-27	-19	-46
Retail Trip Generation with internal capture			1,877	31	22	53	77	85	162
Pass By[17] (0% Daily, 0% AM, 24% PM)			*0*	*0*	*0*	*0*	*-18*	*-20*	*-39*
Total Retail Trip Generation			1,877	31	22	53	59	65	123
Fast Casual Restaurant	8.934	TSF	868	6	6	13	62	50	112
Internal Capture[16] (OP 1 Restaurant)			-148	-2	-1	-3	-19	-22	-41
Restaurant Trip Generation with internal capture			720	5	5	10	43	28	71
Total Restaurant Trip Generation			720	5	5	10	43	28	71
High Turnover (Sit-Down) Restaurant	21.122	TSF	2,264	111	91	202	117	75	191
Internal Capture[16] (OP 1 Restaurant)			-385	-29	-14	-43	-36	-33	-69
Restaurant Trip Generation with internal capture			1,879	82	77	160	80	42	122
Pass By[17] (0% Daily, 0% AM, 43% PM)			*0*	*0*	*0*	*0*	*-35*	*-18*	*-53*
Total Restaurant Trip Generation			1,879	82	77	160	46	24	70
Fast Food Restaurant with Drive Through	11.000	TSF	5,142	250	240	491	80	73	153
Internal Capture[16] (OP 1 Restaurant)			-874	-65	-36	-101	-25	-32	-57
Restaurant Trip Generation with internal capture			4,268	185	204	390	55	41	96
Pass By[17] (50% Daily, 50% AM, 55% PM)			*-2,134*	*-93*	*-102*	*-195*	*-30*	*-23*	*-53*
Total Restaurant Trip Generation			2,134	93	102	195	25	19	43
Coffee/Donut Shop with Drive-Through Window	1.800	TSF	960	79	76	155	35	35	70
Internal Capture[16] (OP 1 Restaurant)			-163	-20	-11	-32	-11	-15	-26
Restaurant Trip Generation with internal capture			797	58	64	123	24	20	44
Pass By (50% Daily, 50% AM, 55% PM)			*-399*	*-29*	*-32*	*-61*	*-13*	*-11*	*-24*
Total Restaurant Trip Generation			399	29	32	61	11	9	20
Gasoline/Service Station	10	VFP	1,720	51	51	103	70	70	139
Internal Capture[16] (OP 1 Retail)			-241	-11	-10	-21	-18	-13	-31
Retail Trip Generation with internal capture			1,479	40	42	82	51	57	108
Pass By (57% Daily, 63% AM, 57% PM)			*-843*	*-25*	*-26*	*-51*	*-29*	*-33*	*-62*
Total Retail Trip Generation			636	15	15	30	22	25	47
Phase 1 Total Project Passenger Car Trip Generation			26,145	798	562	1,360	815	886	1,700
Phase 1 Total Project Truck Trip Generation (Non PCE)			545	32	18	49	17	16	34
Phase 1 Total Project Trip Generation (Non PCE)			26,690	829	580	1,409	832	902	1,734
Phase 1 Total Project Trip Generation (PCE)			27,504	876	607	1,483	858	927	1,784

Table 1. Trip Generation

PHASE 2 Total Vehicle Trip Generation										
Industrial Park	3,659.693		TSF	12,333	1,008	236	1,244	274	971	1,244
Vehicle Mix [14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	88.24%	88.24%	83.10%	10,249	889	209	1,098	242	856	1,098
2-Axle Trucks	2.58%	2.58%	3.70%	456	26	6	32	7	25	32
3-Axle Trucks	2.08%	2.08%	2.99%	369	21	5	26	6	20	26
4+-Axle Trucks	7.09%	7.09%	10.19%	1,257	72	17	88	19	69	88
	100%	100%	100%	12,331	1,008	236	1,244	274	970	1,244
PCE Trip Generation [15]			***PCE Factor***							
Passenger Vehicles			1.0	10,249	889	209	1,098	242	856	1,098
2-Axle Trucks			1.5	685	39	9	48	11	38	48
3-Axle Trucks			2.0	738	42	10	52	11	40	52
4+-Axle Trucks			3.0	3,771	215	50	265	58	207	265
Total Industrial PCE Trip Generation				15,442	1,185	278	1,463	322	1,141	1,463
Industrial Park (Overlay)	348.262		TSF	1,174	96	22	118	26	92	118
Vehicle Mix [14]		***Percent***								
	AM	***PM***	***Daily***							
Passenger Vehicles	88.24%	88.24%	83.10%	975	85	20	104	23	81	104
2-Axle Trucks	2.58%	2.58%	3.70%	43	2	1	3	1	2	3
3-Axle Trucks	2.08%	2.08%	2.99%	35	2	0	2	1	2	2
4+-Axle Trucks	7.09%	7.09%	10.19%	120	7	2	8	2	7	8
	100%	100%	100%	1,173	96	22	118	26	92	118
PCE Trip Generation [15]			***PCE Factor***							
Passenger Vehicles			1.0	975	85	20	104	23	81	104
2-Axle Trucks			1.5	65	4	1	5	1	4	5
3-Axle Trucks			2.0	70	4	1	5	1	4	5
4+-Axle Trucks			3.0	359	20	5	25	6	20	25
Total Industrial PCE Trip Generation				1,469	113	26	139	31	109	139
Phase 2 Total Project Passenger Car Trip Generation				11,224	974	228	1,202	265	938	1,202
Phase 2 Total Project Truck Trip Generation (Non PCE)				2,280	130	30	160	35	125	160
Phase 2 Total Project Trip Generation (Non PCE)				13,505	1,104	259	1,363	300	1,063	1,363
Phase 2 Total Project Trip Generation (PCE)				16,911	1,297	304	1,602	352	1,249	1,602
Total Project Passenger Car Trip Generation				37,369	1,772	790	2,562	1,079	1,824	2,902
Total Project Truck Trip Generation (Non PCE)				2,825	161	48	210	53	141	194
Total Project Trip Generation (Non PCE)				40,194	1,933	839	2,772	1,132	1,965	3,096
Total Project Trip Generation (PCE)				44,415	2,174	911	3,085	1,211	2,176	3,386

Table 1 Footnotes. Trip Generation

TSF = Thousand Square Feet

PCE = Passenger Car Equivalent

VFP = Vehicle Fueling Positions

[1] Trip rates from TUMF High-Cube Warehouse Trip Generation Study Update, Fehr & Peers, November 13, 2023. In/Out splits from the Institute of Transportation Engineers, Trip Generation,11th Edition, 2021. Land Use Code 155 - High-Cube Fulfillment Center Warehouse.

[2] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 156 - High-Cube Parcel hub Warehouse.

[3] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 110 - General Light Industrial.

[4] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 813 - Free-Standing Discount Superstore.

[5] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 944 - Gasoline/Service Station.

[6] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 820 - Shopping Center >150K.

[7] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 934 - Fast Food Restaurant with Drive Through.

[8] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 932 - High Turnover (Sit-Down) Restaurant.

[9] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 130 - Industrial Park.

[10] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 720 - Medical-Dental Office Building

[11] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 850 - Supermarket.

[12] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 937 - Coffee/Donut Shop with Drive-Through Window.

[13] Trip rates from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Land Use Code 930 - Fast Casual Restaurant

[14] Truck% from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021. Truck axle split from the SCAQMD Warehouse Truck Trip Study Data Results and Usage, July 17, 2014.

[15] Passenger Car Equivalent (PCE) factors from County of Riverside TA guidelines , 2020.

[16] Internal capture rates from NCHRP Report 684.

[17] Pass-by rates from the Institute of Transportation Engineers, Trip Generation Handbook,3rd Edition, 2017.

[18] Manufactuing truck% used from the Institute of Transportation Engineers, Trip Generation, 11th Edition, 2021.

Attachment D
VMT Modeling
Inputs

TAZ	Land Use	Acreage	FAR	SQ FT		Emp1 Type	Emp1	Emp2 Type	Emp2	Emp3 Type	Emp3	Emp4 Type	Emp4
1798	Business Park phase I	140.71											
	TUMF High Cube			1,207,000		Transportation and Warehousing	1,172						
	General Light Industrial			198,500		Manufacturing	193						
	Parcel Hub			322,079		Transportation and Warehousing	313						
	Total Industrial SF (TAZ 1798)			1,727,579									
1797	Business Park phase II												
	Industrial Park	112.02	0.75	3,659,693		Transportation and Warehousing	1,777	Manufacturing	1,777				
	Industrial Park (Overlay)	10.66	0.75	348,262		Transportation and Warehousing	169	Manufacturing	169				
	Total Industrial SF (TAZ 1797)			4,007,956		Transportation and Warehousing	1,946	Manufacturing	1,946				
	Total Industrial SF (2 TAZs)			5,735,535									
1870	Commercial	46.72											
	Retail												
	Supermarket			23,256		Commercial Retail (CR)	47						
	Shopping Center			189,845		Commercial Retail (CR)	380						
	Free-Standing Discount Store			167,050		Wholesale	334						
	Restaurants			42,856		Services	50						
	Medical Office Buildings			5,500		Educational & Medical	7						
	Total Commercial SF			428,507		Commercial Retail (CR)	426	Services	50	Educational & Medical	7	Wholesale	334
	Total Employment Added for Project Site					6,387							
	Total Household Removed from Project Site					(1,619)							

Conversion Rates (SQ FT/EMP)	SCAG (Suburban)	Riverside County
Transportation and Warehousing		1030
Manufacturing		1030
Construction		1030
Medical and Health Services	800	
Business Park		600
Commercial Retail (CR)		500
Other Services	850	

Incremental SED data for RIVCOM

TAZ	SFDU	MFDU	GQPopulation	TotEmp	Agriculture	Construction	Manufacture	Wholesale	Retail	Transportation	Information	FIRE	Professional	Educational	ArtEnt	OthService	PubAdmin	K8Enrollment	G912Enrollment	CollegeEnroll
1797	-3	-23	0	1678	0	0	193	0	0	1485	0	0	0	0	0	0	0	0	0	0
1798	0	-88	0	3892	0	0	1946	0	0	1946	0	0	0	0	0	0	0	0	0	0
1870	-881	-624	0	817	0	0	0	334	426	0	0	0	0	7	0	50	0	0	0	0

APPENDIX B – RIVCOM OUTPUTS

Scenario: D:\RIVCOM\rivcom_model\scenarios\21-052_NoProject_No_Indian

TAZ	Daily_Hom	Daily_HBW	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Population	Employmer	Enrollment
1793	51.31273	21476.66	14824.06	16285.62	5.906996	762.3913	764.064	0.131104	15586.45	17049.69	6.0381	14.06138	3	972	0
1794	9262.33	10739.62	12963.42	12879.9	4.224088	1723.899	1722.956	0.963285	14687.31	14602.85	5.187373	12.89838	513	460	0
1795	20393.15	786.5492	15519.03	14299.68	13.74905	459.2565	459.6476	0.095445	15978.29	14759.33	13.84449	10.46951	1111	27	0
1796	9446.653	1076.693	7430.101	6962.436	2.347006	253.0196	253.4574	0.023559	7683.12	7215.894	2.370565	10.94818	499	38	0
1797	1171.865	10188.84	10877.98	11755.11	4.575592	537.7072	538.8263	0.088532	11415.69	12293.93	4.664124	10.45718	76	447	984
1798	3603.748	20127.78	26651.71	29842.21	72.64249	2157.2	2166.896	1.489904	28808.91	32009.11	74.13239	10.29217	227	898	0
1799	52158.48	27909.41	70145.87	73180.29	283.752	1789.773	1793.715	1.220274	71935.64	74974.01	284.9722	8.733684	3418	1250	601
1800	54594.73	8328.73	48463.21	47992.68	90.26624	1316.125	1318.783	0.459745	49779.34	49311.46	90.72598	8.481215	3526	337	0
1801	19654.87	13420.56	32795.4	34737.79	84.91618	1254.491	1256.47	0.596044	34049.89	35994.26	85.51222	9.041769	1327	589	0
1802	53830.06	10225.08	55458.71	54934.97	105.8576	1462.741	1467.169	0.563759	56921.45	56402.14	106.4213	7.85592	3685	422	3433
1803	48772.19	5690.139	45450.76	45158.98	94.79981	1725.788	1728.041	1.055984	47176.55	46887.02	95.8558	8.494921	3130	229	994
1804	110773.8	5839.947	85442.59	80658.62	279.026	2555.396	2560.826	2.099362	87997.98	83219.45	281.1253	9.369749	6344	227	0
1805	22104.08	27032.44	42927.31	46297.97	72.01978	1130.434	1132.021	0.424682	44057.75	47429.99	72.44446	9.008201	1451	1265	90
1806	58239.85	22980.28	61702.29	62043.18	177.0602	2108.582	2115.231	1.720719	63810.87	64158.4	178.7809	9.618341	3437	1029	55
1807	82805.27	12117.12	73060.77	71376.09	262.6336	2281.479	2288.017	1.959133	75342.25	73664.1	264.5928	9.56917	4826	509	22
1808	35968.24	1902.885	27906.8	26682.91	41.40623	953.6654	955.0963	0.367166	28860.46	27638.01	41.77339	9.567324	2054	75	0
1809	37197.32	3956.653	30827.36	29587.7	57.17658	890.4021	893.7593	0.361619	31717.76	30481.46	57.5382	10.03853	1993	161	258
1810	0	11982.65	7507.949	8159.71	0.822456	574.4644	574.7759	0.085872	8082.414	8734.486	0.908328	15.74269	0	524	0
1811	282.8578	503.5151	495.7954	511.887	0.002694	25.68098	25.69485	0.000173	521.4763	537.5819	0.002867	14.46514	15	20	0
1812	520.6282	7862.138	4907.604	5242.855	0.165291	346.8264	347.3603	0.025119	5254.431	5590.216	0.19041	16.60754	34	331	0
1813	6426.849	8182.688	9214.15	9167.813	1.606899	417.703	418.0892	0.043755	9631.854	9585.902	1.650654	13.42338	407	324	0
1814	13521.03	4743.335	13056.5	12257.24	10.35963	457.6448	455.2385	0.066299	13514.15	12712.48	10.42592	11.99787	752	164	0
1815	2045.12	8242.447	6316.214	6591.141	0.523185	108.2046	108.0847	0.003303	6424.418	6699.226	0.526489	14.10814	142	360	0
1816	0	8009.275	4558.398	4980.026	0.142959	49.90238	50.0341	0.000714	4608.301	5030.06	0.143673	16.1487	0	356	0
1817	0	25791.52	14753.11	16067.75	1.486816	750.7512	752.1169	0.125987	15503.86	16819.86	1.612803	15.99509	0	1169	0
1818	2464.68	3644.9	4261.901	4375.577	0.524475	294.4827	294.902	0.025955	4556.384	4670.479	0.55043	11.95019	150	158	0
1819	16097.54	4695.618	15302.22	14832.24	8.319824	750.4233	754.4614	0.171295	16052.64	15586.7	8.491119	10.74926	891	177	0
1820	183.373	749.1411	624.0145	671.1058	0.009353	31.90377	31.95702	0.000376	655.9182	703.0629	0.00973	13.80465	10	34	0
1821	1795.665	4080.449	4480.504	4733.69	0.949301	414.1991	414.9474	0.063665	4894.703	5148.637	1.012966	12.31546	94	176	0
1822	22443.57	1427.443	17167.82	16078.17	16.2319	430.4308	431.3719	0.082539	17598.25	16509.54	16.31444	9.567545	1222	53	0
1823	29619.72	7136.748	25345.94	24048.61	24.01459	825.1561	826.4984	0.198749	26171.09	24875.11	24.21334	9.620401	1841	286	0
1824	1021.046	14949.11	9181.695	9807.181	1.038771	583.7644	583.3184	0.118969	9765.459	10390.5	1.157741	15.79568	67	707	0
1825	168445.1	9327.287	125243.2	115715.7	961.6659	3141.882	3145.763	5.050111	128385.1	118861.4	966.7159	10.63149	8437	337	0
1826	40453.44	198.4409	28010.3	25199.63	51.38283	663.3971	663.9924	0.271426	28673.69	25863.62	51.65425	10.85588	1908	7	0
1827	57108.77	3610.251	44675.92	40728.2	187.3516	942.751	944.2882	0.595753	45618.67	41672.49	187.9473	10.8333	2650	129	1849
1828	165.5857	63545.39	82051.06	93569.42	580.887	7464.672	7479.178	15.10409	89515.73	101048.6	595.991	9.99057	11	2797	0
1829	833.5153	6929.83	4978.673	5405.252	0.522316	1320.547	1325.589	0.453165	6299.221	6730.842	0.975481	14.14907	49	301	0
1830	409.7202	13568.94	9129.049	9948.968	1.758459	2673.36	2675.959	1.769744	11802.41	12624.93	3.528203	14.27083	36	619	0
1831	217.3843	24960.61	37419.33	42360.2	136.1197	3467.333	3474.025	3.008794	40886.66	45834.22	139.1284	9.288312	11	1064	454
1832	19722.29	10637.38	21394.16	20814.33	15.15765	876.876	879.5424	0.174977	22271.04	21693.88	15.33263	10.58216	1438	410	0
1833	1287.471	23317.44	16536.39	17771.18	8.708151	1287.509	1280.83	0.428386	17823.9	19052.01	9.136537	16.34393	55	914	0
1834	62572.46	104.9252	44796.95	41614.44	139.8369	1449.175	1450.624	1.132432	46246.13	43065.06	140.9694	10.56702	3173	4	0
1835	26890.15	2888.931	21539.76	20334.23	22.13184	574.6536	575.7772	0.129392	22114.42	20910	22.26123	9.88422	1410	105	0
1836	55089.49	3584.516	43087.1	40793.9	113.3544	1093.73	1096.81	0.469848	44180.83	41890.71	113.8242	9.152796	3254	132	0
1837	45464.99	5969.761	39346.88	37632.19	97.47334	969.4173	968.8188	0.408203	40316.3	38601.01	97.88155	9.575953	2411	229	1089
1838	56608.54	1209.68	41985.41	39522.82	82.72953	1151.164	1151.849	0.486483	43136.58	40674.66	83.21601	9.099395	3401	45	0
1839	60345.21	5332.964	48745.9	46670.24	115.6791	1316.97	1321.526	0.596772	50062.87	47991.77	116.2759	9.172899	3550	210	138
1840	7491.142	0	5365.527	4916.471	1.680174	130.2863	130.543	0.007572	5495.813	5047.014	1.687746	9.564806	426	0	0
1841	37039.33	23251.86	54110.11	55324.76	133.9755	1445.781	1447.818	0.685739	55555.89	56772.57	134.6612	8.841463	2193	1011	3443
1842	43620.32	2104.155	32255.64	29799.22	57.63341	852.3796	855.119	0.346021	33108.02	30654.34	57.97943	10.81119	2075	77	0
1843	85260.97	2035.595	60983.26	54510.14	178.6401	1676.037	1676.875	2.146596	62659.3	56187.02	180.7867	12.62724	3745	74	0
1844	22829.66	1019.425	17093.41	15991.12	17.76933	478.414	478.7816	0.120139	17571.83	16469.9	17.88947	10.16657	1180	39	0
1845	12071.13	21570.83	57243.82	63777.06	979.2532	4304.545	4315.775	8.809634	61548.38	68092.84	988.0629	9.335796	703	1002	0
1846	0	1663.73	1467.422	1728.281	0.079261	20.09903	20.07465	0.000219	1487.521	1748.356	0.079479	12.43936	0	81	0
1847	0	17663.95	11135.39	12404.46	2.264857	32.91012	32.85566	0.000518	11168.3	12437.32	2.265375	15.10379	0	853	0
1848	10169.91	0	6892.816	6122.215	2.036176	199.2378	198.9399	0.041587	7092.055	6321.155	2.077762	14.07846	397	0	0
1849	89544.35	1521.874	63309.49	57601.75	171.3448	1761.292	1754.168	1.383597	65070.78	59355.91	172.7284	11.33388	4099	63	0
1850	95610.85	2493.734	66573.44	59691.02	172.0511	1506.887	1504.701	1.585603	68080.32	61195.73	173.6367	12.82546	3879	104	0
1851	19545.51	99.20906	13350.85	11900.42	7.273535	344.3506	343.5486	0.126433	13695.2	12243.96	7.399967	13.43119	751	4	0
1852	51223.13	8617.584	45998.69	43728.2	203.1553	1310.185	1311.257	1.076521	47308.88	45039.45	204.2319	10.62549	2573	352	648
1853	0	1482.639	1766.626	2071.212	0.529331	26.68004	26.77047	0.00062	1793.306	2097.983	0.529952	10.29321	0	77	0
1854	29907.26	1635.059	21815.54	20263.35	30.7821	1035.089	1035.87	0.567846	22850.62	21299.22	31.34995	11.56421	1425	70	0
1855	92077.44	424.9135	65412.23	60721.62	261.3057	2051.729	2045.4	2.248417	67463.96	62767.02	263.5541	11.29504	4344	17	0
1856	22388.4	3157.022	20787.92	19933.61	26.64578	524.6418	524.3805	0.156809	21312.56	20457.98	26.80259	10.30872	1119	133	1016
1857	41598.39	3519.137	35284.62	33268.49	83.90192	967.0488	968.0787	0.496811	36251.67	34236.57	84.39873	10.20571	2194	143	1354
1858	103793.2	2823.356	77272.3	71871.99	381.6885	2605.586	2591.532	3.208382	79877.89	74463.52	384.8968	10.51202	5612	107	0
1859	64575.16	3366.998	47439.15	44184.52	128.4091	1485.297	1504.803	1.064199	48924.45	45689.32	129.4733	11.732	2953	135	0
1860	61085.32	18443.85	72509.98	74317.43	432.6354	3079.249	3093.145	3.756	75589.23	77410.57	436.3914	10.25046	2956	853	0
1861	5198.13	21165.35	26445.34	29855.46	60.04115	1052.448	1058.384	0.518269	27497.79	30913.85	60.55942	10.61554	222	1072	0
1862	0	10785.12	13302.03	15583.8	19.89782	415.4525	417.9648	0.09083	13717.48	16001.76	19.98865	9.536899	0	551	0
1863	0	2782.487	3465.907	4061.484	1.573919	114.4385	114.8141	0.007321	3580.346	4176.298	1.58124	9.683145	0	142	0

1864	89760.07	1865.22	67199.13	62265.35	207.5703	2040.731	2040.761	1.805233	69239.86	64306.11	209.3755	9.868499	4724	71	1225
1865	21232.12	2529.949	17615.91	17065.38	14.18775	505.2477	506.1573	0.104995	18121.16	17571.53	14.29275	9.690641	1176	103	0
1866	18228.02	26168.87	47142.43	51027.92	321.4362	1922.477	1919.368	1.83057	49064.91	52947.29	323.2667	9.969654	1060	1226	0
1867	188.8735	9899.061	10507	12350.4	7.298755	219.2364	219.1421	0.018465	10726.23	12569.55	7.31722	10.08606	12	496	0
1868	727.2463	6410.392	4065.738	4330.922	0.268843	36.54198	36.32012	0.00074	4102.28	4367.242	0.269583	15.61552	42	319	0
1869	14207.24	22747.69	26942.02	28077.92	25.43027	2564.944	2573.657	2.839731	29506.96	30651.58	28.27001	10.79301	934	1127	0
1870	77578.73	25957.48	89464.2	91517.95	546.2537	3333.39	3378.121	3.798571	92797.59	94896.08	550.0522	9.887272	4410	1050	0
1871	160.249	2116.841	2410.53	2809.813	0.6841	15.56718	15.80172	0.000217	2426.097	2825.615	0.684317	10.93469	7	105	0
1872	1578.99	28781.93	17097.29	18289.61	2.147829	1187.977	1190.468	0.328312	18285.27	19480.08	2.476141	17.76019	93	1202	0
1873	0	721.463	533.2836	594.6688	0.006202	43.36121	43.37674	0.000607	576.6448	638.0455	0.00681	14.00624	0	31	0
1874	193.7693	10853.54	6389.001	6936.398	0.318976	412.3939	413.1653	0.050091	6801.395	7349.564	0.369067	16.34727	9	480	0
1875	10336.32	0	7100.522	6353.689	3.808306	195.4338	195.1629	0.031185	7295.956	6548.853	3.839491	12.65321	433	0	0
1876	2920.612	0	2072.99	1899.542	0.307168	73.26997	73.16348	0.004392	2146.26	1972.706	0.311559	13.21605	124	0	0
1877	757.6177	50.05481	619.6825	582.9922	0.032613	16.28577	16.28172	0.000176	635.9683	599.2739	0.03279	10.24627	50	2	0
1878	0	0	68.06148	103.4774	0	0	0	0	68.06148	103.4774	0	9.343848	0	0	0
1879	0	530.7407	706.8611	824.3388	0.123344	18.30329	18.30027	0.000498	725.1643	842.639	0.123842	11.69776	0	26	0
													130959	34275	

Scenario: D:\rivcom_model\scenarios\RIVCOM_2018

TAZ	Daily_Hom	Daily_HBW	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Population	Employmen	Enrollment
1793	58.89037	2341.681	4227.355	4739.911	3.528779	39.33208	39.69304	0.000446	4266.688	4779.604	3.529225	10.16788	4	140	0
1794	123.8384	7133.268	5793.145	6255.504	0.701516	1652.95	1656.395	0.916497	7446.095	7911.899	1.618013	17.79684	9	422	0
1795	9472.828	459.2723	8479.898	7952.961	7.11541	246.2451	248.8538	0.031123	8726.144	8201.815	7.146532	10.09397	657	27	0
1796	0	0	53.33421	78.88684	0	0	0	0	53.33421	78.88684	0	7.987201	0	0	0
1797	57.32594	1855.213	4303.334	4683.517	1.615566	331.0802	330.5804	0.038764	4634.415	5014.097	1.65433	8.175565	7	108	846
1798	0	11264.01	18338.91	20852.2	61.39685	1953.895	1953.72	1.504181	20292.81	22805.92	62.90103	10.37669	0	663	0
1799	35416.32	12380.87	47336.33	49416.55	200.4238	1067.649	1068.753	0.470033	48403.98	50485.3	200.8938	8.91586	2360	791	516
1800	52150.56	4622.321	48966.4	48233.6	146.5945	1470.55	1478.329	0.648101	50436.95	49711.93	147.2426	8.862334	3536	300	0
1801	11507.61	6043.217	21547.55	23001.84	62.72556	980.4252	981.4905	0.369019	22527.98	23983.33	63.09458	9.215867	831	368	0
1802	46947.95	5749.594	49170.39	48032.65	136.812	1260.815	1250.148	0.488762	50431.2	49282.8	137.3007	8.525308	3060	370	2951
1803	24735.2	2578.473	27108.81	27032.63	59.54492	1071.808	1075.279	0.363761	28180.62	28107.91	59.90869	8.646627	1777	160	854
1804	83184.19	2907.146	68016.08	63899.71	274.0844	1940.874	1938.439	1.260228	69956.95	65838.15	275.3446	10.13706	5068	181	0
1805	6445.694	14745.49	22679.48	24917.45	27.82445	519.0892	518.1233	0.087929	23198.57	25435.57	27.91238	10.50708	476	898	77
1806	18139.98	7808.558	23585.89	23914.9	48.19963	776.5029	777.6308	0.243088	24362.4	24692.53	48.44272	10.18934	1159	472	47
1807	55765.95	3370.949	46859.9	44230.98	196.5881	1438.332	1441.595	0.877481	48298.23	45672.58	197.4655	10.50759	3333	196	19
1808	44.0426	0	62.15168	70.45947	0.000429	1.698992	1.699863	0.000001	63.85068	72.15933	0.00043	8.718566	4	0	0
1809	14982.93	906.8746	12802.99	12007.07	18.40099	358.9291	360.458	0.071747	13161.92	12367.53	18.47274	10.53315	827	52	222
1810	0	2407.836	2783.908	3082.404	0.525528	256.2066	256.6649	0.01958	3040.115	3339.069	0.545108	13.1907	0	144	0
1811	242.1053	0	219.5324	213.229	0.002032	7.209257	7.217776	0.000017	226.7416	220.4468	0.002049	11.46159	15	0	0
1812	400.4023	510.2073	969.358	1015.558	0.04489	66.37836	66.55178	0.001082	1035.736	1082.11	0.045972	11.79411	34	30	0
1813	5516.256	585.1334	4909.385	4589.054	1.404373	157.4908	157.7443	0.007232	5066.876	4746.798	1.411604	11.3867	333	33	0
1814	11757.56	1976.661	11649.77	10972.3	12.51292	491.5377	492.3344	0.089246	12141.3	11464.64	12.60216	12.27643	750	107	0
1815	1773.62	5523.256	5889.347	6153.508	0.605216	91.81322	92.70293	0.002599	5981.16	6246.211	0.607815	14.97051	145	328	0
1816	0	5071.741	3955.822	4280.718	0.147012	10.6549	10.68124	0.000036	3966.477	4291.4	0.147048	19.0109	0	302	0
1817	0	7316.341	6127.187	6707.275	0.624255	124.5056	124.7083	0.004528	6251.692	6831.984	0.628784	15.00283	0	431	0
1818	324.7563	1128.663	1508.154	1629.22	0.138155	188.338	188.7357	0.012444	1696.492	1817.956	0.150599	12.46496	24	69	0
1819	14644.79	1787.053	14322.55	13665.7	9.668959	789.2606	790.4545	0.204011	15111.81	14456.16	9.87297	11.00214	894	108	0
1820	0	67.22112	96.44057	127.5039	0.000028	9.431127	9.448654	0.000043	105.8717	136.9525	0.000071	10.94995	0	4	0
1821	1163.679	2598.991	3763.706	3981.571	1.109509	441.0831	442.4333	0.084857	4204.789	4424.004	1.194365	13.1932	74	153	0
1822	16549.87	112.2045	12843.33	11889.49	13.23076	358.3047	359.1158	0.068087	13201.63	12248.6	13.29885	9.542162	986	7	0
1823	28552.94	32.8963	22565.28	20909.68	33.73108	637.372	638.3293	0.146546	23202.65	21548.01	33.87763	9.395839	1845	2	0
1824	743.0324	147.7977	722.5518	695.4207	0.04497	18.82347	18.84655	0.000192	741.3752	714.2672	0.045161	9.247171	55	9	0
1825	157793.7	1867.059	120056.4	110791.2	1136.918	3251.111	3260.654	6.224445	123307.5	114051.8	1143.143	10.91628	8323	115	0
1826	36636.91	122.633	26878.96	24007.99	68.95053	675.0392	675.6564	0.345963	27554	24683.65	69.29649	11.39874	1825	7	0
1827	52645.68	1947.688	42334.08	38484.09	239.7265	971.6649	975.0426	0.765318	43305.75	39459.13	240.4918	11.59415	2528	108	1589
1828	55.09078	33546.28	70345.55	80989.84	660.8381	7617.22	7630.959	15.7855	77962.78	88620.8	676.6237	9.429059	7	1938	0
1829	710.7229	4962.263	4729.041	5081.335	0.592323	1408.524	1412.348	0.625031	6137.564	6493.683	1.217353	15.13099	55	284	0
1830	193.8792	10045.27	8719.298	9559.103	2.36137	2828.739	2860.876	2.409788	11548.04	12419.98	4.771157	15.48722	18	600	0
1831	65.79569	15687.21	33888.15	38811.03	174.9139	3788.302	3799.24	3.974269	37676.45	42610.27	178.8882	8.931442	7	904	390
1832	17059.57	2937.636	17351.08	16803.13	17.39252	711.4714	713.7324	0.12774	18062.55	17516.86	17.52026	10.05734	1391	171	0
1833	1025.101	8248.365	10322.47	11188.95	9.050542	957.2711	958.9458	0.298238	11279.74	12147.9	9.34878	15.27305	56	454	0
1834	5922.104	70.42318	4315.609	3921.639	1.389564	106.4275	106.274	0.006679	4422.037	4027.913	1.396243	12.13158	251	4	0
1835	19699.67	926.2679	16462.37	15508.71	18.43501	461.6599	462.9513	0.104099	16924.03	15971.66	18.53911	9.888673	1130	58	0
1836	50848.5	1596.332	41935.34	39613.7	163.9536	1157.254	1157.963	0.657614	43092.59	40771.66	164.6112	9.473762	3283	98	0
1837	21662.25	3224.038	21962.56	21311.66	52.09048	457.9486	458.2411	0.118339	22420.51	21769.9	52.20882	9.332725	1290	195	936
1838	53048.08	709.5955	42181.51	40105.6	115.4091	1304.876	1297.36	0.672909	43486.38	41402.96	116.082	9.323951	3409	45	0
1839	55663.58	814.5781	45004.85	42542.48	131.2143	1398.453	1390.138	0.683635	46403.3	43932.62	131.8979	9.326189	3532	52	138
1840	6671.231	0	5051.123	4629.86	2.036706	131.6726	131.9569	0.009158	5182.795	4761.817	2.045865	9.970647	387	0	0
1841	11567.33	13492.32	29332.03	30790.72	59.09744	634.7609	636.5665	0.138209	29966.79	31427.29	59.23565	9.501525	776	790	2960
1842	24793.54	17.31223	18341.91	16589.36	30.66526	488.7718	489.6848	0.143296	18830.68	17079.04	30.80856	10.91463	1280	1	0
1843	41577.9	398.8038	29873.06	26486.18	78.31334	758.7899	760.3701	0.57387	30631.85	27246.55	78.88722	13.42661	1777	20	0
1844	8963.94	0	6624.402	6046.503	4.22749	168.5885	167.7145	0.018061	6792.991	6214.217	4.245552	10.50733	480	0	0
1845	513.6763	1129.568	3850.146	4267.613	8.935397	336.5945	336.5135	0.05452	4186.74	4604.126	8.989918	10.98619	27	62	0
1846	0	95.25648	113.4346	148.0172	0.000063	0	0	0	113.4346	148.0172	0.000063	12.62918	0	5	0
1847	0	13227.89	8741.325	9504.319	1.437236	0	0	0	8741.325	9504.319	1.437236	20.86	0	678	0
1848	427.3495	0	349.3731	319.8481	0.008403	15.90306	16.12923	0.000279	365.2762	335.9773	0.008681	16.17744	18	0	0
1849	48812.16	463.7786	34926.73	31205.28	82.25577	909.7318	911.6321	0.525738	35836.46	32116.91	82.78151	12.87073	2055	26	0
1850	47483.12	247.176	32972.65	28881.97	56.71912	748.7529	749.1879	0.452515	33721.4	29631.16	57.17164	14.3867	1735	13	0
1851	75.4352	38.50956	174.5752	186.9586	0.004055	3.280415	3.281667	0.000011	177.8557	190.2402	0.004066	11.5439	8	2	0
1852	27562.42	1730.905	23654.95	22013.78	78.73133	674.791	676.2321	0.294676	24329.74	22690.01	79.026	10.95484	1461	95	557
1853	0	0	60.15115	90.27586	0	0	0	0	60.15115	90.27586	0	8.540933	0	0	0
1854	1020.084	218.3696	984.6582	925.9374	0.113696	110.25	110.4918	0.007347	1094.908	1036.429	0.121043	12.55966	62	12	0
1855	0	0	60.10041	89.51598	0	0	0	0	60.10041	89.51598	0	8.4437	0	0	0
1856	1521.067	2500.503	5812.614	6199.122	4.228267	57.79232	57.96259	0.002027	5870.407	6257.084	4.230294	9.724748	128	133	873
1857	12550.09	2325.076	14016.53	13520.5	23.77109	280.6221	280.6888	0.042249	14297.16	13801.19	23.81334	10.29486	672	128	1164
1858	34926.82	520.3091	27995.05	25877.03	96.42203	979.2946	979.6007	0.50235	28974.35	26856.63	96.92437	11.00657	2036	29	0
1859	0	214.5428	528.9197	610.2842	0.140201	34.27103	34.30168	0.000711	563.1907	644.5859	0.140911	11.1874	0	12	0
1860	0	10917.04	25010.7	28484.92	222.9044	1859.047	1849.041	1.463387	26869.75	30333.96	224.3678	10.18735	0	619	0
1861	59.68958	6391.582	7383.953	8400.226	6.465208	482.6478	482.6469	0.102644	7866.601	8882.873	6.567852	12.45729	7	363	0
1862	0	0	61.70907	92.86618	0	0	0	0	61.70907	92.86618	0	8.29833	0	0	0
1863	0	196.7638	318.3517	367.6431	0.023014	20.95767	20.85088	0.000197	339.3094	388.494	0.023211	10.84754	0	11	0

1864	38869.97	859.625	31699.46	29169.32	79.31886	1005.674	1000.428	0.518881	32705.13	30169.75	79.83775	9.928082	2241	50	1053
1865	13643.72	805.9055	11547.82	11120.41	8.763933	338.6693	336.9214	0.050358	11886.49	11457.33	8.814291	10.23007	760	50	0
1866	9380.785	11225.63	27803.84	29876.97	244.513	1424.976	1425.631	1.190484	29228.82	31302.6	245.7035	11.17077	559	644	0
1867	119.8209	4929.102	7462.654	8716.886	10.53896	138.358	138.5681	0.011065	7601.013	8855.453	10.55003	11.04215	9	281	0
1868	402.565	3275.651	2645.149	2831.472	0.165165	33.88528	33.91037	0.000672	2679.034	2865.382	0.165837	18.19176	25	184	0
1869	11878.54	13572.55	22298.81	23002.64	28.19227	2797.774	2799.292	3.054518	25096.59	25801.94	31.24679	12.25104	719	798	0
1870	92.73241	8672.636	17088.78	19793.39	80.12401	831.1839	834.6901	0.297178	17919.96	20628.08	80.42119	9.145267	6	515	0
1871	0	0	61.15369	92.27842	0	0	0	0	61.15369	92.27842	0	8.659221	0	0	0
1872	986.7175	157.5327	1134.682	1104.247	0.113788	51.66961	51.74184	0.000739	1186.352	1155.989	0.114527	10.46191	93	9	0
1873	0	371.2809	416.1503	463.8853	0.007978	40.74285	40.81035	0.000527	456.8931	504.6956	0.008504	14.25882	0	22	0
1874	114.4956	50.62592	200.6133	213.7566	0.004134	3.358453	3.362471	0.000004	203.9717	217.1191	0.004138	8.587119	11	3	0
1875	3773.683	0	2545.396	2196.856	0.828625	42.53912	43.15306	0.001592	2587.936	2240.01	0.830217	14.58636	145	0	0
1876	0	0	52.23843	74.05491	0	0	0	0	52.23843	74.05491	0	10.60289	0	0	0
1877	876.7589	38.95927	673.7135	604.5254	0.049202	14.92299	14.99871	0.000155	688.6365	619.524	0.049357	12.42863	41	2	0
1878	0	0	54.77759	82.3179	0	0	0	0	54.77759	82.3179	0	9.234906	0	0	0
1879	0	0	55.48338	83.09162	0	0	0	0	55.48338	83.09162	0	9.37006	0	0	0
													72886	17465	

Scenario: D:\rivcom_model\scenarios\21-052_BY18

TAZ	Daily_Hom	Daily_HBW	Daily_Total Auto OD From VMT	Daily_Total Auto OD To VMT	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Population	Employmer	Enrollment		
1793	57.71055	2363.517	4209.706543	4726.189941	3.441184	38.58379	38.99316	0.000419	4248.29	4765.183	3.441603	10.16003	4	140	0		
1794	121.7574	7187.573	5806.486816	6262.166504	0.687513	1628.978	1633.545	0.871145	7435.465	7895.712	1.558657	17.77916	9	422	0		
1795	9335.905	463.5795	8385.813477	7859.418457	7.047014	242.1046	244.9191	0.029633	8627.918	8104.338	7.076647	9.993622	657	27	0		
1796	0	0	53.181305	78.67157	0	0	0	0	53.18131	78.67157	0	8.000416	0	0	0		
1797	0	31053.26	24921.73438	26964.78125	6.7514	1519.344	1518.835	0.6606	26441.08	28483.62	7.412	15.29531	0	1786	846	51886.52	
1798	0	78256.01	64564.9375	70908.84375	109.2395	13682.11	13699.22	59.8233	78247.05	84608.06	169.0628	15.10509	0	4555	0	135473.8	
1799	33797.35	12569.71	46351.32422	48513.61719	194.5183	1032.296	1034.246	0.419196	47383.62	49547.86	194.9375	8.799983	2360	791	516		
1800	49000.84	4700.917	46964.46094	46462.78516	135.8868	1428.457	1437.315	0.587975	48392.91	47900.1	136.4748	8.563038	3536	300	0		
1801	11071.09	6113.595	21229.25977	22682.60156	60.70739	956.3388	958.0246	0.338735	22185.6	23640.63	61.04613	9.144971	831	368	0		
1802	45361.85	5825.894	48208.375	47165.16406	134.2915	1232.254	1222.77	0.453544	49440.63	48387.93	134.745	8.412538	3060	370	2951		
1803	24006.24	2614.297	26633.0293	26602.54883	58.47913	1050.112	1055.207	0.340936	27683.14	27657.76	58.82007	8.541711	1777	160	854		
1804	80834.17	2947.694	66588.04688	62629.58594	268.2032	1903.36	1902.718	1.185525	68491.41	64532.3	269.3887	9.965996	5068	181	0		
1805	6245.908	14932.22	22551.53516	24806.19141	27.11961	509.392	509.0074	0.082391	23060.93	25315.2	27.202	10.51603	476	898	77		
1806	17705.42	7898.575	23312.82813	23676.45117	47.20304	764.8289	766.7039	0.231634	24077.66	24443.16	47.43467	10.1174	1159	472	47		
1807	54467.84	3405.225	46076.14063	43520.96875	192.5963	1416.818	1421.114	0.840887	47492.96	44942.09	193.4371	10.3539	3333	196	19		
1808	43.57317	0	61.700531	70.01754	0.000423	1.669165	1.671492	0.000001	63.36969	71.68903	0.000425	8.682333	4	0	0		
1809	14668.31	915.8029	12610.05859	11826.17188	18.16671	353.415	354.8336	0.068633	12963.47	12181	18.23534	10.39752	827	52	222		
1810	0	2434.111	2781.413574	3084.123535	0.514765	252.3813	253.2175	0.018536	3033.795	3337.341	0.533301	13.21717	0	144	0		
1811	238.1633	0	216.922699	210.365021	0.002015	7.111116	7.129476	0.000016	224.0338	217.4945	0.002031	11.34627	15	0	0		
1812	396.8466	514.3893	965.959595	1012.207642	0.044165	65.41367	65.65603	0.001028	1031.373	1077.864	0.045193	11.7726	34	30	0		
1813	5454.44	589.2138	4868.884766	4549.404297	1.392539	155.5276	155.9452	0.006939	5024.412	4705.35	1.399478	11.30658	333	33	0		
1814	11687.16	1989.608	11596.18945	10916.78516	12.44139	486.4937	487.8495	0.086304	12082.68	11404.63	12.52769	12.23489	750	107	0		
1815	1741.952	5573.345	5860.430664	6160.90625	0.593362	90.05409	91.07561	0.002431	5950.485	6251.981	0.595793	14.95672	145	328	0		
1816	0	5120.436	3955.901611	4284.550293	0.142848	10.38474	10.42263	0.000033	3966.286	4294.973	0.142881	19.07543	0	302	0		
1817	0	7386.511	6131.093262	6711.848145	0.610941	120.6999	121.0406	0.004066	6251.793	6832.889	0.615006	15.05508	0	431	0		
1818	314.4149	1142.417	1499.544434	1621.316162	0.134161	183.1462	183.7805	0.011289	1682.691	1805.097	0.14545	12.40576	24	69	0		
1819	14255.52	1805.407	14067.30176	13421.65625	9.515173	771.6118	773.8693	0.190607	14838.91	14195.52	9.70578	10.8342	894	108	0		
1820	0	68.03825	96.408783	127.304108	0.000027	9.179317	9.207808	0.000039	105.5881	136.5119	0.000066	10.98365	0	4	0		
1821	1135.912	2624.122	3742.851074	3959.09668	1.083897	432.0294	433.857	0.079526	4174.881	4392.954	1.163423	13.12837	74	153	0		
1822	16170.76	113.6861	12606.5332	11667.0957	13.10013	349.5862	351.0094	0.06337	12956.12	12018.11	13.1635	9.38898	986	7	0		
1823	27528.09	33.33476	21936.67578	20353.43555	33.02863	615.6978	617.3168	0.131204	22552.37	20970.75	33.15984	9.181787	1845	2	0		
1824	724.9267	149.7752	711.466858	685.215454	0.044123	18.2697	18.31771	0.000175	729.7366	703.5331	0.044298	9.136582	55	9	0		
1825	154660.1	1889.935	118141.625	108835.0859	1127.882	3188.911	3203.015	5.901943	121330.5	112038.1	1133.784	10.75168	8323	115	0		
1826	35951.13	123.984	26439.5625	23600	68.2604	660.9517	662.4946	0.325764	27100.51	24262.5	68.58616	11.22783	1825	7	0		
1827	51846	1966.31	41815.62891	37995.95703	238.3287	955.0685	959.9275	0.73041	42770.7	38955.88	239.0591	11.46673	2528	108	1589		
1828	53.51598	33848.21	70153.78125	80693.89063	649.6472	7398.409	7419.696	14.34592	77552.19	88113.6	663.9932	9.399759	7	1938	0		
1829	685.7723	5012.761	4713.764648	5066.995117	0.570271	1365.785	1370.765	0.563034	6079.549	6437.76	1.133304	14.96877	55	284	0		
1830	190.9286	10166.84	8675.523438	9524.344727	2.124871	2721.604	2755.7	2.096936	11397.13	12280.04	4.221808	15.19268	18	600	0		
1831	63.91182	15825.69	33789.02734	38680.79297	172.3344	3708.241	3723.115	3.726249	37497.27	42403.91	176.0606	8.919427	7	904	390		
1832	16806.95	2961.644	17171.70313	16630.06055	17.22816	697.6749	700.7946	0.120752	17869.38	17330.86	17.34891	9.970998	1391	171	0		
1833	1015.523	8303.307	10308.09961	11176.61328	8.927718	947.4562	950.3207	0.288097	11255.56	12126.93	9.215816	15.28464	56	454	0		
1834	5764.388	71.39143	4216.499023	3855.613281	1.357613	104.6054	104.6531	0.00633	4321.104	3960.267	1.363943	11.92847	251	4	0		
1835	19341.14	937.1355	16236.35547	15277.0752	18.28634	453.3	455.4304	0.098839	16689.66	15732.51	18.38518	9.768267	1130	58	0		
1836	48746.81	1617.996	40670.07031	38476.26172	159.9281	1115.564	1117.444	0.585989	41785.64	39593.71	160.5141	9.245532	3283	98	0		
1837	20934.82	3266.529	21517.01563	20900.42188	51.03437	444.4121	445.28	0.107921	21961.43	21345.7	51.14229	9.179958	1290	195	936		
1838	50968.09	721.319	40951.32422	38982.57813	112.7784	1268.349	1262.323	0.613926	42219.67	40244.9	113.3924	9.106422	3409	45	0		
1839	53752.48	827.8054	43864.96094	41507.52734	128.3531	1364.249	1358.277	0.632737	45229.21	42865.8	128.9858	9.140006	3532	52	138		
1840	6529.995	0	4962.074219	4546.689453	2.015928	128.6979	129.2083	0.008575	5090.772	4675.897	2.024503	9.818147	387	0	0		
1841	11220.42	13646.94	29100.04297	30581.69922	57.85745	621.9818	624.502	0.129354	29722.02	31206.2	57.98681	9.461753	776	790	2960		
1842	24261.5	17.50897	18009.91016	16279.78223	30.29952	477.8514	479.5694	0.13482	18487.76	16759.35	30.43434	10.73759	1280	1	0		
1843	41019.13	402.1011	29520.2207	26170.95313	77.23066	747.6694	749.7887	0.553182	30267.89	26920.74	77.78384	13.28117	1777	20	0		
1844	8711.258	0	6472.487305	5908.491699	4.14244	165.0177	164.31	0.016891	6637.505	6072.802	4.159331	10.29654	480	0	0		
1845	504.1974	1141.574	3819.091309	4235.203125	8.653186	331.0483	331.3933	0.051816	4150.14	4566.597	8.705002	10.9438	27	62	0		
1846	0	95.91577	113.408447	147.976593	0.000062	0	0	0	113.4084	147.9766	0.000062	12.66648	0	5	0		
1847	0	13315.38	8754.820313	9530.813477	1.410439	0	0	0	8754.82	9530.813	1.410439	20.96155	0	678	0		
1848	424.3837	0	347.167114	317.812012	0.008346	15.75707	15.98761	0.000272	362.9242	333.7997	0.008618	16.08788	18	0	0		
1849	48320.61	467.4199	34620.23047	30925.68359	81.6549	900.8615	903.3877	0.511165	35521.09	31829.07	82.16607	12.77258	2055	26	0		
1850	47085.23	248.8554	32722.45703	28660.15234	56.32484	741.9036	742.7983	0.440946	33464.36	29402.95	56.76579	14.29089	1735	13	0		
1851	75.34724	38.76129	174.084427	186.480927	0.004014	3.251724	3.2549	0.000011	177.3362	189.7358	0.004025	11.53276	8	2	0		
1852	27070.37	1747.867	23347.13867	21670.64453	77.80857	664.9343	666.5333	0.28283	24012.07	22337.18	78.0914	10.82087	1461	95	557		
1853	0	0	59.961754	90.002464	0	0	0	0	59.96175	90.00246	0	8.550514	0	0	0		
1854	1011.29	220.049	978.137939	923.280518	0.112048	109.04	109.4825	0.007136	1087.178	1032.763	0.119184	12.50985	62	12	0		
1855	0	0	59.879265	89.062988	0	0	0	0	59.87927	89.06299	0	8.470716	0	0	0		
1856	1514.126	2520.394	5799.603516	6185.130371	4.186262	57.13246	57.34636	0.001963	5856.735	6242.477	4.188224	9.729012	128	133	873		
1857	12349.39	2346.404	13886.6582	13398.99414	23.53523	276.7071	277.0027	0.040661	14163.37	13676	23.57589	10.22227	672	128	1164		
1858	34159.63	525.4904	27515.79102	25436.61914	95.02898	960.7256	961.8188	0.475846	28476.52	26398.44	95.50482	10.8413	2036	29	0		
1859	0	216.2336	526.355347	608.204712	0.136978	33.93852	33.99801	0.000688	560.2939	642.2027	0.137665	11.17746	0	12	0		
1860	0	10989.58	24982.12891	28433.41797	220.3476	1844.136	1836.04	1.423704	26826.26	30269.46	221.7713	10.20123	0	619	0		
1861	59.68994	6432.402	7381.436523	8398.427734	6.379888	478.4884	479.0425	0.099713	7859.925	8877.47	6.479601	12.48744	7	363	0		
1862	0	0	61.49794	92.619385	0	0	0	0	61.49794	92.61939	0	8.297556	0	0	0		
1863	0	198.0448	318.117798	367.353699	0.022744	20.78232	20.69748	0.000191	338.9001	388.0511	0.022935	10.8699	0	11	0		
1864	37866.98	870.0006	31088.16211	28607.74219	77.92107	984.8773	980.648	0.484629	32073.04	29588.39	78.4057	9.758518	2241	50	1053		
1865	13132.86	817.7935	11242.98438	10842.07617	8.564602	330.5341	329.1411	0.046691	11573.52	11171.22	8.611294	10.0083	760	50	0		
1866	9180.686	11268.57	27717.76563	29680.44727	232.0797	1403.094	1404.047	1.115623	29120.86	31084.5	233.1954	11.08433	559	644	0		
1867	117.0421	4976.045	7404.197266	8663.770508	9.909837	136.5418	136.9049	0.010605	7540.739	8800.675	9.920442	11.02571	9	281	0		
1868	394.5453	3305.596	2644.687988	2835.539063	0.161244	33.46096	33.51379	0.000648	2678.149	2869.053	0.161893	18.24296	25	184	0		
1869	11649.17	13713.41	22163.85938	22887.83594	27.67024	2758.73	2762.772	2.927912	24922.59	25650.61	30.59815	12.21344	719	798	0		
1870	0	22727.6	42348.54688	48889.89844	422.4166	2842.098	2856.431	3.159812	45190.64	51746.33	425.5764	8.928973	0	1332	0	91238.45	
1871	0	0	60.962467	92.016403	0	0	0	0	60.96247	92.0164	0	8.672287	0	0	0		
1872	980.4277	158.7015	1127.555176	1096.154175	0.112769	50.80727	50.93686	0.000707	1178.362	1147.091	0.113476	10.40867	93	9	0		
1873	0	375.0798	415.924377	463.998932	0.007819	40.18816	40.31736	0.0005	456.1125	504.3163	0.008319	14.28669	0	22	0		
1874	113.2822	51.04166	199.666046	212.816162	0.004096	3.307695	3.31512	0.000004	202.9738	216.1313	0.0041	8.563862	11	3	0		
1875	3749.659	0	2530.632813	2183.095703	0.822784	42.15242	42.78004	0.001551	2572.785	2225.875	0.824334	14.511	145	0	0		
1876	0	0	52.102692	73.863678	0	0	0	0	52.10269	73.86368	0	10.61073	0	0	0		
1877	869.0505	39.25835	668.451355	600.553711	0.0487	14.74936	14.83761	0.00015	683.2007	615.3913	0.04885	12.3547	41	2	0		
1878	0	0	54.579796	82.028648	0	0	0	0	54.5798	82.02865	0	9.247537	0	0	0		
1879	0	0	55.324345	82.849365	0	0	0	0	55.32435	82.84937	0	9.380115	0	0	0		
													72873	23852			96725

Scenario: D:\RIVCOM\rivcom_model\scenarios\21-052_PlusProject_No_Indian

TAZ	Daily_Hom	Daily_HBW (incl. EIHBW) Att	Daily_Total Auto OD From VMT	Daily_Total Auto OD To VMT	Daily_Total Auto OD Intr	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Daily_Total	Population	Employmen	Enrollment		
1793	50.6994	21637.66992	14871.12598	16358.29492	5.831443	753.9763	754.6436	0.125837	15625.1	17112.94	5.95728	14.16019	3	972	0		
1794	9169.877	10796.33106	12927.63379	12851.19434	4.20392	1707.177	1705.232	0.930438	14634.81	14556.43	5.134358	12.88412	513	460	0		
1795	20187.46	787.68335	15395.86231	14170.4375	13.738245	454.9145	454.6823	0.092316	15850.78	14625.12	13.83056	10.402	1111	27	0		
1796	9332.017	1079.494629	7362.480957	6897.206055	2.344153	250.2937	250.373	0.022676	7612.775	7147.58	2.366829	10.87595	499	38	0		
1797	0	46312.71484	29444.39063	31917.39453	10.605522	1586.588	1585.781	0.754765	31030.98	33503.18	11.36029	13.74111	0	2125	984	61361.79	
1798	0	106155.9063	70311.98438	77410.5625	137.073868	13403.78	13412.6	50.76951	83715.76	90823.16	187.8434	14.41283	0	4790	0	147722.5	
1799	50446.93	28431.5625	68924.83594	71977.57813	244.59581	1745.926	1747.664	1.063432	70670.77	73725.25	245.6592	8.768486	3418	1250	601		
1800	52834.82	8467.936523	47347.94922	46941.21484	76.22316	1287.381	1288.647	0.417433	48635.33	48229.86	76.64059	8.477306	3526	337	0		
1801	19251.13	13565.19824	32521.83008	34486.11719	83.093773	1233.377	1234.169	0.581657	33755.2	35720.29	83.67543	9.07094	1327	589	0		
1802	52756.22	10313.97168	54780.09375	54280.08594	105.084335	1440.734	1443.699	0.535487	56220.83	55723.79	105.6198	7.857969	3685	422	3433		
1803	47842.32	5726.822266	44878.90234	44599.61719	94.309639	1707.116	1707.645	1.016812	46586.02	46307.26	95.32645	8.456665	3130	229	994		
1804	108803.4	5876.371094	84268.6875	79505.84375	277.821259	2522.237	2525.468	2.011266	86790.92	82031.31	279.8325	9.310546	6344	227	0		
1805	21677.79	27300.57813	42716.40625	46112.01563	71.326355	1116.636	1117.195	0.406362	43833.04	47229.21	71.73273	9.05551	1451	1265	90		
1806	57220.23	23130.57813	61109.875	61546.35938	175.057205	2088.788	2093.101	1.669006	63198.66	63639.46	176.7262	9.566923	3437	1029	55		
1807	81599.05	12187.98047	72344.95313	70689.27344	260.876648	2261.993	2265.92	1.905419	74606.95	72955.19	262.782	9.517846	4826	509	22		
1808	35302.88	1914.20166	27511.42383	26305.93945	41.247616	942.8356	943.4382	0.354006	28454.26	27249.38	41.60162	9.495431	2054	75	0		
1809	36570.59	3978.79248	30463.36328	29232.01172	56.55246	885.8709	884.8108	0.35139	31349.23	30116.82	56.90384	9.956496	1993	161	258		
1810	0	12052.65039	7538.84082	8191.337891	0.81221	569.0334	568.248	0.082685	8107.875	8759.586	0.894896	15.83827	0	524	0		
1811	279.8725	505.530212	494.853088	511.100891	0.002678	25.48961	25.46742	0.000168	520.3427	536.5684	0.002845	14.47594	15	20	0		
1812	516.6725	7901.832031	4922.928711	5261.955078	0.163504	343.6816	343.735	0.02431	5266.61	5605.689	0.187814	16.69657	34	331	0		
1813	6384.997	8217.818359	9203.070313	9157.71875	1.603274	414.5475	414.2731	0.042461	9617.617	9571.991	1.645736	13.44066	407	324	0		
1814	13466.11	4753.518555	13023.44141	12214.17578	10.366575	454.2437	451.1974	0.06426	13477.69	12665.37	10.43084	11.98949	752	164	0		
1815	2026.921	8299.254883	6330.803223	6606.822754	0.518769	106.9675	106.6933	0.003162	6437.771	6713.516	0.521932	14.18369	142	360	0		
1816	0	8074.972656	4587.16748	5012.839355	0.140805	49.1633	49.2053	0.00067	4636.331	5062.045	0.141475	16.31104	0	356	0		
1817	0	26059.16016	14870.06641	16193.11914	1.467994	736.3298	736.7816	0.116907	15606.4	16929.9	1.584901	16.15222	0	1169	0		
1818	2423.515	3673.601807	4244.329102	4361.37793	0.519138	289.5221	289.5801	0.024341	4533.852	4650.958	0.543479	11.95936	150	158	0		
1819	15835.86	4709.166992	15181.25781	14689.18164	8.2248	740.2174	738.5748	0.162939	15921.47	15427.76	8.387739	10.6679	891	177	0		
1820	180.6281	755.642456	624.42749	672.149414	0.00923	31.40003	31.41814	0.000355	655.8275	703.5676	0.009585	13.86844	10	34	0		
1821	1768.12	4106.71582	4469.225586	4726.099609	0.938146	409.0727	409.299	0.060649	4878.298	5135.399	0.998795	12.32531	94	176	0		
1822	22135.53	1433.499756	16987.12109	15907.81445	16.214367	424.3439	424.7943	0.078652	17411.47	16332.61	16.29302	9.49707	1222	53	0		
1823	29104.21	7187.561523	25072.06445	23733.38281	24.011822	808.1012	808.2418	0.184465	25880.17	24541.63	24.19629	9.568812	1841	286	0		
1824	1004.256	15101.17773	9231.515625	9870.044922	1.019316	573.7285	572.6398	0.112153	9805.244	10442.68	1.131469	15.91061	67	707	0		
1825	166482.6	9353.516602	124058.3125	114749.2266	959.255371	3107.086	3107.628	4.866186	127165.4	117856.9	964.1216	10.55927	8437	337	0		
1826	39989.54	199.057724	27734.59375	24940.75	51.324959	655.8573	655.7898	0.261064	28390.45	25596.54	51.58602	10.77135	1908	7	0		
1827	56556.11	3619.052246	44329.83594	40414.09766	186.649689	934.0311	934.5496	0.577242	45263.87	41348.65	187.2269	10.77326	2650	129	1849		
1828	163.4518	64156.22656	81990.92188	93461.46094	575.664307	7333.222	7340.332	14.09533	89324.15	100801.8	589.7596	10.07768	11	2797	0		
1829	829.3916	7007.15918	5011.303711	5442.043945	0.539538	1292.434	1295.916	0.414225	6303.738	6737.959	0.953763	14.22962	49	301	0		
1830	404.4295	13716.50195	9180.490234	9995.484375	1.707	2609.719	2608.795	1.609044	11790.21	12604.28	3.316044	14.26205	36	619	0		
1831	214.1575	25148.03125	37384.58594	42302.74219	135.000885	3420.514	3422.544	2.857125	40805.1	45725.29	137.858	9.354981	11	1064	454		
1832	19616.48	10682.90234	21340.7832	20746.72852	15.144854	867.6807	869.1034	0.168535	22208.46	21615.83	15.31339	10.58243	1438	410	0		
1833	1276.93	23404.60742	16565.41797	17797.21875	8.637903	1278	1269.492	0.414577	17843.42	19066.71	9.052481	16.41501	55	914	0		
1834	61447.28	105.43924	44139.51563	41004.03906	137.9664	1434.12	1434.324	1.095572	45573.63	42438.37	139.062	10.44933	3173	4	0		
1835	26579.76	2897.474609	21355.15039	20178.92578	22.078041	568.7531	569.1558	0.124818	21923.9	20748.08	22.20286	9.825308	1410	105	0		
1836	53329.57	3611.572266	42043.48438	39844.17188	112.745422	1066.143	1068.141	0.429464	43109.63	40912.31	113.1749	9.035665	3254	132	0		
1837	44441.52	6007.712891	38725.85156	37058.76563	97.027527	949.8972	948.2897	0.380049	39675.75	38007.06	97.40757	9.513048	2411	229	1089		
1838	55257.94	1218.100098	41212.23438	38790.11719	82.475784	1127.608	1127.013	0.453833	42339.84	39917.13	82.92962	9.01737	3401	45	0		
1839	59096.21	5374.862793	48001.92578	45980.10156	115.055603	1295.913	1299.312	0.565005	49297.84	47279.41	115.6206	9.117336	3550	210	138		
1840	7405.047	0	5312.977051	4866.454102	1.680845	128.5835	128.6978	0.007235	5441.561	4995.152	1.68808	9.496999	426	0	0		
1841	36360.36	23447.90625	53693.28516	54915.32422	132.809998	1428.928	1429.84	0.660016	55122.21	56345.16	133.47	8.861895	2193	1011	3443		
1842	42929.9	2113.015625	31858.54883	29426.82422	57.497311	841.5779	843.4222	0.331886	32700.13	30270.25	57.8292	10.71065	2075	77	0		
1843	84362.63	2045.540527	60421.11719	53956.64844	178.51976	1666.83	1660.093	2.087442	62087.95	55616.74	180.6072	12.5365	3745	74	0		
1844	22411.31	1025.052734	16851.35547	15749.65625	17.648243	471.4913	471.3715	0.114389	17322.85	16221.03	17.76263	10.07801	1180	39	0		
1845	11885.3	21748.57227	57000.83984	63533.09375	966.388672	4263.218	4270.203	8.538805	61264.05	67803.3	974.9274	9.345792	703	1002	0		
1846	0	1672.728271	1470.365479	1730.499268	0.078384	19.97811	19.93971	0.000214	1490.344	1750.439	0.078598	12.50862	0	81	0		
1847	0	17779.0625	11181.68945	12455.60059	2.226884	32.62739	32.59227	0.000505	11214.32	12488.19	2.22739	15.2267	0	853	0		
1848	10115.87	0	6860.59375	6084.452637	2.037647	198.4173	197.9175	0.040963	7059.011	6282.37	2.07861	14.01448	397	0	0		
1849	88793.56	1524.815674	62894.12109	57120.00781	170.93399	1752.306	1743.171	1.359196	64646.43	58863.18	172.2932	11.26562	4099	63	0		
1850	94997.78	2500.118652	66230.54688	59293.48438	172.082977	1499.197	1495.386	1.558753	67729.75	60788.87	173.6417	12.76508	3879	104	0		
1851	19419.18	99.484581	13278.45996	11821.66406	7.274498	342.7824	341.6389	0.124492	13621.24	12163.3	7.398991	13.36467	751	4	0		
1852	50615.59	8667.785156	45641.19141	43333.29688	202.646393	1303.91	1298.754	1.047413	46945.1	44632.05	203.6938	10.57613	2573	352	648		
1853	0	1490.43335	1766.156982	2071.188721	0.522612	26.51029	26.57328	0.000608	1792.667	2097.762	0.523219	10.32339	0	77	0		
1854	29673.31	1639.5354	21679.97656	20126.02344	30.738201	1029.638	1029.336	0.557344	22709.61	21155.36	31.29555	11.50461	1425	70	0		
1855	90917.72	426.291809	64735.94531	60011.41406	261.029419	2037.958	2029.069	2.199276	66773.91	62040.48	263.2287	11.1997	4344	17	0		
1856	22156.97	3173.290771	20628.07422	19795.71289	26.53006	521.0048	520.3635	0.153298	21149.08	20316.08	26.68336	10.27551	1119	133	1016		
1857	41124.19	3537.47168	34981.60938	32977.28516	83.685692	959.6854	959.7007	0.484717	35941.3	33936.98	84.17041	10.16025	2194	143	1354		
1858	102236.5	2836.463867	76344.04688	70932.5625	380.683563	2576.515	2559.699	3.105201	78920.56	73492.27	383.7888	10.43509	5612	107	0		
1859	63968.29	3374.133057	47075.48828	43754.41016	128.137436	1476.447	1495.069	1.044484	48551.93	45249.48	129.1819	11.65061	2953	135	0		
1860	60560.8	18504.44922	72154.8125	74058.78906	430.065796	3064.446	3076.808	3.69876	75219.25	77135.59	433.7646	10.22671	2956	853	0		
1861	5159.53	21265.19336	26440.40234	29870.33789	59.70472	1047.708	1052.84	0.509981	27488.11	30923.18	60.2147	10.64634	222	1072	0		
1862	0	10841.28906	13307.43164	15602.84277	19.778971	413.4289	415.6548	0.08932	13720.86	16018.5	19.86829	9.578908	0	551	0		
1863	0	2795.538086	3467.616699	4064.590332	1.565597	113.9799	114.1878	0.007202	3581.597	4178.778	1.572799	9.71842	0	142	0		
1864	88031.39	1874.853271	66199.58594	61329.21484	205.139893	2012.481	2010.396	1.722362	68212.07	63339.61	206.8622	9.760663	4724	71	1225		
1865	20767.24	2549.373047	17345.52539	16807.44922	14.115314	496.7671	497.0828	0.099337	17842.29	17304.53	14.21465	9.616214	1176	103	0		
1866	17991.03	26348.73438	46998.59766	50897.16016	317.544495	1904.992	1900.408	1.775399	48903.59	52797.57	319.3199	9.97663	1060	1226	0		
1867	186.9117	9964.091797	10533.74023	12359.79297	7.210372	217.6309	217.2164	0.018013	10751.37	12577.01	7.228385	10.14745	12	496	0		
1868	717.3955	6458.09082	4080.38916	4349.532227	0.266383	36.30911	36.01489	0.000722	4116.698	4385.547	0.267105	15.71622	42	319	0		
1869	13996.73	22951.83008	26871.57813	28050.01953	25.13393	2544.215	2550.235	2.759766	29415.79	30600.26	27.8937	10.80987	934	1127	0		
1870	0	39565.82813	58137.07031	67235.8125	367.996674	3033.999	3034.332	2.771234	61171.07	70270.15	370.7679	8.637736	1	1867	0	125372.9	
1871	158.6833	2127.344482	2415.061035	2808.459229	0.675955	15.47063	15.67732	0.000212	2430.531	2824.136	0.676168	10.97584	7	105	0		
1872	1569.172	28956.64844	17167.17969	18372.75	2.125517	1175.953	1176.798	0.316294	18343.13	19549.55	2.44181	17.87252	93	1202	0		
1873	0	725.279907	534.606323	595.92395	0.00614	42.99781	42.92409	0.000586	577.6041	638.848	0.006725	14.0796	0	31	0		
1874	192.4996	10917.63379	6415.992188	6967.56543	0.315805	408.508	408.6389	0.048292	6824.5	7376.205	0.364097	16.45394	9	480	0		
1875	10285.7	0	7070.823242	6316.384277	3.808774	194.64	194.1668	0.03072	7265.463	6510.551	3.839494	12.60253	433	0	0		
1876	2903.127	0	2062.673096	1887.238525	0.30701	72.96724	72.7845	0.004326	2135.64	1960.023	0.311336	13.15451	124	0	0		
1877	753.4973	50.291527	616.680786	580.382141	0.03252	16.17669	16.1607	0.000172	632.8575	596.5428	0.032692	10.22327	50	2	0		
1878	0	0	67.903831	103.172714	0	0	0	0	67.90383	103.1727	0	9.363936	0	0	0		
1879	0	533.569458	706.906494	824.197998	0.122033	18.25726	18.18522	0.000489	725.1638	842.3832	0.122522	11.73221	0	26	0		
													126247	40662			166909

APPENDIX C – SUPPORTING DOCUMENTATION FOR VMT MITIGATION

T-2. Increase Job Density

GHG Reduction formula	GHG Reduction formula
$A = \frac{B - C}{C} * D$	$6.1\% = \frac{17.82 - 145}{145} * -0.07$

User Inputs		Value	Unit	Source
B	Job density of project development	17.82	jobs per acre	User input
Constants, Assumptions, and Available Defaults				
C	Job density of typical development	145	jobs per acre	ITE 2020
D	Elasticity of VMT with respect to residential density	-0.07	Unitless	Stevens 2016
Output				
A	Percent reduction in GHG emissions from project VMT in study area	6.14%	%	Calculated

T-5. Implement Commute Trip Reduction Program (Voluntary)

GHG Reduction formula	GHG Reduction formula
A = B * C	-4.0% = 100% * -0.04

User Inputs	Value	Unit	Source
B Percent of employees eligible for program	100%	%	User input
Constants, Assumptions, and Available Defaults			
C Percent reduction in commute VMT from eligible employees	-4%	%	Boarnet et al. 2014
Output			
A Percent reduction in GHG emissions from project VMT in study area	4.00%	%	Calculated

T-18. Provide Pedestrian Network Improvement

GHG Reduction formula	GHG Reduction formula
$A = \left(\frac{C}{B} - 1\right) * D$	$-2.3\% = \left(\frac{3.56}{5.21} - 1\right) * -0.05$

User Inputs		Value	Unit	Source
B	Existing sidewalk length in study area	3.56	miles	User input
C	Sidewalk length in study area with measure	5.21	miles	User input
Constants, Assumptions, and Available Defaults				
D	Elasticity of household VMT with respect to the ratio of sidewalks-to-streets	-0.05	Unitless	Frank et al. 2011
Output				
A	Percent reduction in GHG emissions from project VMT in study area	-2.32%	%	Calculated

T-19-A: Construct or Improve Bike Facility

***The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).**

GHG Reduction Formula

$$A = -B \times \frac{\frac{F}{I} \times (C + D) \times E \times G}{H} = -1 \times \frac{\frac{337}{365} \times (0.0104 + 0.001) \times 1 \times 2.2}{11.7} = -0.198\%$$

Where,

			Value Source	Unit
B = Percent of plan/community VMT on parallel roadway	=	100%		%
C = Active transportation adjustment factor	=	0.0104	Per Table T-19.1	Unitless
D = Credits for key destinations near project	=	0.001	Per Table T-19.2	Unitless
E = Growth factor adjustagent for facility type	=	1	Per Table T-19.3	Unitless
F = Annual days of use of new facility	=	337	Per Table T-19.4	Days Per Year
G = Existing regional average one-way bicycle trip length	=	2.2	Per Table T-10.1	Miles Per Trip
H = Existing regional average one-way vehicle trip length	=	11.7	Per Table T-10.1	Miles Per Trip
I = Days per year	=	365		Days Per Year
A = Percent reduction in GHG emissions from displaced vehicles on roadway parallel to bicycle facility	=	**-0.198%**		%

Value C - Active transportation adjustagent factor = 0.0104

7000 1.04

Table T-19.1. Active Transportation Adjustment Factors

Average Daily Traffic (vehicle trips per day)	One-way Facility Length[1]	Adjustment Factor for a Population > 250,000 or a Non-university Town with Population < 250,000	Adjustment Factor for a University Town with Population <250,000
1 to 12,000	≤1	0.0019	0.0104
	1.02 to 2	0.0029	0.0155
	>2	0.0038	0.0207
12,001 to 24,000	≤1	0.0014	0.0073
	1.02 to 2	0.0020	0.0109
	>2	0.0027	0.0145
24,001 to 30,000	≤1	0.0010	0.0052
	1.02 to 2	0.0014	0.0078
	>2	0.0019	0.0104

Source: California Air Resources Board. 2020. Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program. September. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/draft_sgc_ahsc_qm_091620.pdf. Accessed: January 2021.

< = less than; > = greater than; ≤ = less than or equal to

[1]Measurements of bike facilities should not include the length of crosswalks.

Value D - Credits for key destinations near project = 0.001

Table T-19.2. Key Destination Credits[1,2]

Number of Key Destinations[3]	Credit within ½ Mile of Facility	Credit Within ¼ Mile of Facility
0 to 2	0.0000	0.000
3	0.0005	0.001
4 to 6	0.0010	0.002
≥ 7	0.0015	0.003

Source: California Air Resources Board. 2020. *Quantification Methodology for the California Natural Resource Agency's Urban Greening Grant Program*. March. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/cnra_ug_finalqm.pdf. Accessed: January 2021.

≥ = greater than or equal to

[1] The largest value from either credit column that matches the project activities should be used. For example, if there are 3 activity centers within ¼ mile of the facility and 7 activity centers within ½ mile of the facility, the correct value to use is 0.0015.

[2] These metrics should be evaluated for the project location site and surrounding area which can extend a distance not to exceed a ½ mile. If a shopping center has multiple activity centers, each of those activity centers would count individually. For example, if a bank, grocery store, and post office are all located in a shopping center, they would be input as three activity centers for the purposes of this quantification methodology.

[3] Key destination examples: banks, post offices, grocery stores, medical centers, pharmacies, office parks, places of worship, public libraries, schools, universities, colleges, and light rail stations (park & ride).

Value E - Growth factor adjustagent for facility type = 1

Table T-19.3. Growth Factor Adjustment

Facility Type	Growth Factor Adjustment
New Class I bike path[1] or Class IV bikeway[2]	1.54
New Class II bike lane[3]	1.0
Conversion from Class II to IV	0.54

Source: California Air Resources Board. 2020. *Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program*. September. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/sgc_ahsc_qm_022521.pdf. Accessed: March 2021.

[1] Class I bike paths are physically separated from motor vehicle traffic.

[2] Class IV bikeways are protected on-street bikeways, also called cycle tracks.

[3] Class II bike lanes are striped bicycle lanes that provide exclusive use to bicycles on a roadway.

Value F - Annual days of use of new facility = 337

Table T-19.4. Bike Facility Default Days of Use per Year by County

County	Days	County	Days	County	Days	County	Days
Alameda	302	Kern	333	Placer	291	San Joaquin	314
Alpine	291	Kings	328	Plumas	292	San Luis Obispo	321
Amador	302	Lake	298	Riverside	337	San Mateo	295
Butte	294	Los Angeles	332	Sacramento	307	Solano	309
Calaveras	304	Lassen	309	San Benito	315	Stanislaus	319
Contra Costa	307	Madera	314	San Bernardino	333	Sutter	304
Colusa	309	Marin	296	Santa Barbara	328	Tehama	297
Del Norte	252	Mariposa	307	Santa Clara	307	Trinity	277
El Dorado	295	Mendocino	279	Santa Cruz	304	Tulare	314
Fresno	320	Merced	316	San Diego	323	Tuolumne	299
Glenn	304	Modoc	287	San Francisco	301	Ventura	334
Humboldt	262	Mono	311	Shasta	283	Yolo	311
Imperial	353	Monterey	310	Sierra	301	Yuba	293
Inyo	331	Orange	335	Siskiyou	280	Statewide	311

Value G - Existing regional average one-way bicycle trip length = 2.2

Value H - Existing regional average one-way vehicle trip length = 11.7

Table T-10.1. Average One-Way Bicycle and Vehicle Trip Length of All Trips by California Core-Based Statistical Area

	Trip Length (miles)	
Core-Based Statistical Area	Bicycle	Vehicle
Los Angeles-Long Beach-Anaheim	1.7	9.7
Riverside-San Bernardino-Ontario	2.2	11.7
Sacramento-Roseville-Arden-Arcade	2.9	10.9
San Diego-Carlsbad	2.0	19.1
San Francisco-Oakland-Hayward	2.1	12.4
San Jose-Sunnyvale-Santa Clara	2.8	11.5

T-20. Expand Bikeway Network

GHG Reduction formula	GHG Reduction formula
$A = -1 * \frac{\frac{C - B}{B} * D * F * H}{E * G}$	$-0.02\% = -1 * \frac{\frac{0.5 - 3.21}{3.21} * 0.0006 * 0.9688 * 2.2}{0.9688 * 11.7}$

User Inputs		Value	Unit	Source
B	Existing bikeway miles in plan/community	0.50	miles	User input
C	Bikeway miles in plan/community with measure	3.21	miles	User input
Constants, Assumptions, and Available Defaults				
D	Bicycle mode share in plan/community	0.06%	%	FHWA 2017
E	Vehicle mode share in plan/community	97%	%	FHWA 2017
F	Average one-way bicycle trip length in plan/community	2.20	miles per trip	FHWA 2017
G	Average one-way vehicle trip length in plan/community	11.70	miles per trip	FHWA 2017
H	Elasticity of bike commuters with respect to bikeway miles per 10,000 population	0.25	Unitless	Pucher & Buehler 2011
Output				
A	Percent reduction in GHG emissions from project VMT in study area	-0.02%	%	Calculated

Table T-3.1. Average Transit and Vehicle Mode Share of All Trips by California Core-Based Statistical Area

	Mode Share	
Core-Based Statistical Area	**Transit**	**Vehicle**
Los Angeles-Long Beach-Anaheim	4.23%	94.19%
Riverside-San Bernardino-Ontario	1.37%	96.88%
Sacramento-Roseville-Arden-Arcade	2.90%	95.04%
San Diego-Carlsbad	2.40%	94.85%
San Francisco-Oakland-Hayward	11.38%	86.96%
San Jose-Sunnyvale-Santa Clara	6.69%	91.32%

Source: Federal Highway Administration. 2017. National Household Travel Survey – 2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

Source: Federal Highway Administration. 2017. National Household Travel Survey – 2017 Table Designer. WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

Table T-10.1. Average One-Way Bicycle and Vehicle Trip Length of All Trips by California Core-Based Statistical Area

	Trip Length (miles)	
Core-Based Statistical Area	**Bicycle**	**Vehicle**
Los Angeles-Long Beach-Anaheim	1.7	9.7
Riverside-San Bernardino-Ontario	2.2	11.7
Sacramento-Roseville-Arden-Arcade	2.9	10.9
San Diego-Carlsbad	2.0	19.1
San Francisco-Oakland-Hayward	2.1	12.4
San Jose-Sunnyvale-Santa Clara	2.8	11.5

Source: Federal Highway Administration. 2017. National Household Travel Survey – 2017 Table Designer. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

01125:59:59. Accessed: May 2021.

Table T-20.1. Bicycle Mode Share of All Trips by California Core-Based Statistical Area

Core-Based Statistical Area	Bicycle Mode Share
Los Angeles-Long Beach-Anaheim	0.18%
Riverside-San Bernardino-Ontario	0.06%
Sacramento-Roseville-Arden-Arcade	0.56%
San Diego-Carlsbad	0.23%
San Francisco-Oakland-Hayward	0.47%
San Jose-Sunnyvale-Santa Clara	0.79%

Source: Federal Highway Administration. 2017. National Household Travel Survey – 2017 Table Designer. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

Table T-26.1. Transit Bus Fuel Economy by Fuel Type

Fuel Type	Fuel Economy	Unit

T-27. Implement Transit-Supportive Roadway Treatments

GHG Reduction formula	GHG Reduction formula
A = -1 * (B*C*D*E*G) / F	-0.01% = (0.4*-0.1*-0.4*0.0137*0.578) / 96.88% * -1

User Inputs		Value	Unit	Source
B	Percent of plan/community transit routes that receive treatments	40%	%	User input
Constants, Assumptions, and Available Defaults				
C	Percent change in transit travel time due to treatments	-10%	%	TRB 2007
D	Elasticity of transit ridership with respect to transit travel time	-0.40	Unitless	TRB 2007
E	Transit mode share in plan/community	1.37%	%	FHWA 2017a
F	Vehicle mode share in plan/community	96.88%	%	FHWA 2017a
G	Statewide mode shift factor	57.80%	%	FHWA 2017a
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	-0.01%	%	Calculated

Table T-3.1. Average Transit and Vehicle Mode Share of All Trips by California Core-Based Statistical Area

	Mode Share	
Core-Based Statistical Area	Transit	Vehicle
Los Angeles-Long Beach-Anaheim	4.23%	94.19%
Riverside-San Bernardino-Ontario	1.37%	96.88%
Sacramento-Roseville-Arden-Arcade	2.90%	95.04%
San Diego-Carlsbad	2.40%	94.85%
San Francisco-Oakland-Hayward	11.38%	86.96%
San Jose-Sunnyvale-Santa Clara	6.69%	91.32%

Source: Federal Highway Administration. 2017. National Household Travel Survey – 2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

T-1. Increase Residential Density

GHG Mitigation Potential

30%

Up to 30.0% of GHG emissions from project VMT in the study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increased density can put people closer to resources they may need to access during an extreme weather event. Increased density can also shorten commutes, decreasing the amount of time people are on the road and exposed to hazards such as extreme heat or flooding.

Health and Equity Considerations

Neighborhoods should include different types of housing to support a variety of household sizes, age ranges, and incomes.

Measure Description

This measure accounts for the VMT reduction achieved by a project that is designed with a higher density of dwelling units (du) compared to the average residential density in the U.S. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. Increasing residential density results in shorter and fewer trips by single-occupancy vehicles and thus a reduction in GHG emissions. This measure is best quantified when applied to larger developments and developments where the density is somewhat similar to the surrounding area due to the underlying research being founded in data from the neighborhood level.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

This measure is most accurately quantified when applied to larger developments and/or developments where the density is somewhat similar to the surrounding neighborhood.

Cost Considerations

Depending on the location, increasing residential density may increase housing and development costs. However, the costs of providing public services, such as health care, education, policing, and transit, are generally lower in more dense areas where things are closer together. Infrastructure that provides drinking water and electricity also operates more efficiently when the service and transmission area is reduced. Local governments may provide approval streamlining benefits or financial incentives for infill and high-density residential projects.

Expanded Mitigation Options

When paired with Measure T-2, *Increase Job Density*, the cumulative densification from these measures can result in a highly walkable and bikeable area, yielding increased co-benefits in VMT reductions, improved public health, and social equity.

GHG Reduction Formula

$$A = \frac{B - C}{C} \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	0–30.0	%	calculated
User Inputs				
B	Residential density of project development	[ ]	du/acre	user input
Constants, Assumptions, and Available Defaults				
C	Residential density of typical development	9.1	du/acre	Ewing et al. 2007
D	Elasticity of VMT with respect to residential density	-0.22	unitless	Stevens 2016

Further explanation of key variables:

- (C) – The residential density of typical development is based on the blended average density of residential development in the U.S. forecasted for 2025. This estimate includes apartments, condominiums, and townhouses, as well as detached single-family housing on both small and large lots. An acre in this context is defined as an acre of developed land, not including streets, school sites, parks, and other undevelopable land. If reductions are being calculated from a specific baseline derived from a travel demand forecasting model, the residential density of the relevant transportation analysis zone should be used instead of the value for a typical development.
- (D) – A meta-regression analysis of five studies that controlled for self-selection found that a 0.22 percent decrease in VMT occurs for every 1 percent increase in residential density (Stevens 2016).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 30 percent. The purpose for the 30 percent cap is to limit the influence of any single built environmental factor (such as density). Projects that implement multiple land use strategies (e.g., density, design, diversity) will show more of a reduction than relying on improvements from a single built environment factor.

Subsector Maximum

($\sum A_{max_{T\text{-}1 \text{ through } T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subcategory includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces VMT by increasing the residential density of the project study area. In this example, the project's residential density would be 15 du per acre (B), which would reduce GHG emissions from project VMT by 14.2 percent.

$$A = \frac{15\ \frac{du}{ac} - 9.1\ \frac{du}{ac}}{9.1\ \frac{du}{ac}} \times -0.22 = -14.2\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Ewing, R., K. Bartholomew, S. Winkelman, J. Walters, and D. Chen. 2007. *Growing Cooler: The Evidence on Urban Development and Climate Change*. October. Available: https://www.nrdc.org/sites/default/files/cit_07092401a.pdf. Accessed: January 2021.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? *Journal of the American Planning Association* 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available: https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

T-2. Increase Job Density

GHG Mitigation Potential

30%

Up to 30.0% of GHG emissions from project VMT in the study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increased density can put people closer to resources they may need to access during an extreme weather event. Increased density can also shorten commutes, decreasing the amount of time people are on the road and exposed to hazards such as extreme heat or flooding.

Health and Equity Considerations

Increased job density may increase nearby housing prices. Jurisdictions should consider the jobs-housing balance and consider measures to reduce displacement and increase affordable housing.

Measure Description

This measure accounts for the VMT reduction achieved by a project that is designed with a higher density of jobs compared to the average job density in the U.S. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. Increasing job density results in shorter and fewer trips by single-occupancy vehicles and thus a reduction in GHG emissions.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

This measure is most accurately quantified when applied to larger developments and/or developments where the density is somewhat similar to the surrounding neighborhood.

Cost Considerations

Areas with increased job density generally have higher economic gross metropolitan product (GMP) and job growth. Prosperity, measured as GMP per job, also grows faster in areas with increased job density. Decreased commute times and car use may also generate funds for public transit and reduce the need for infrastructure spending on road maintenance.

Expanded Mitigation Options

When paired with Measure T-1, *Increase Residential Density*, the cumulative densification from these measures can result in a highly walkable and bikeable area, yielding increased co-benefits in VMT reductions, improved public health, and social equity.

GHG Reduction Formula

$$A = \frac{B - C}{C} \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	0–30.0	%	calculated
User Inputs				
B	Job density of project development	[ ]	jobs per acre	user input
Constants, Assumptions, and Available Defaults				
C	Job density of typical development	145	jobs per acre	ITE 2020
D	Elasticity of VMT with respect to job density	-0.07	unitless	Stevens 2016

Further explanation of key variables:

- (C) – The jobs density is based on the calculated density of a development with a floor-area ratio of 1.0 and 300 square feet (sf) of building space per employee:

  $$\frac{43{,}560\ \frac{\text{sf}}{\text{acre}}}{300\ \frac{\text{sf}}{\text{employee}}} \times 1.0\frac{\text{sf}}{\text{acre}} = 145\frac{\text{employees}}{\text{acre}}$$

  If reductions are being calculated from a specific baseline derived from a travel demand forecasting model, the job density of the relevant transportation analysis zone should be used for this variable instead of the default value presented above.
- (D) – A meta-regression analysis of two studies that controlled for self-selection found that a 0.07 percent decrease in VMT occurs for every 1 percent increase in job density (Stevens 2016).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 30 percent. The purpose for the 30 percent cap is to limit the influence of any single built environmental factor (such as density). Projects that implement multiple land use strategies (e.g., density, design, diversity) will show more of a reduction than relying on improvements from a single built environment factor.

Subsector Maximum

($\sum A_{max_{T\text{-}1 \text{ through } T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subcategory includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces VMT by increasing the job density of the project study area. In this example, the project's job density would be 400 jobs per acre (B), which would reduce GHG emissions from project VMT by 12.3 percent.

$$A = \frac{400\ \frac{\text{job}}{\text{acre}} - 145\ \frac{\text{job}}{\text{acre}}}{145\ \frac{\text{job}}{\text{acre}}} \times -0.07 = -12.3\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Institute of Transportation Engineers (ITE). *Trip Generation Manual.* 10th Edition. Available: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/trip-generation-10th-edition-formats/. Accessed: January 2021.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? *Journal of the American Planning Association* 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available: https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

T-3. Provide Transit-Oriented Development

GHG Mitigation Potential

31%

Up to 31.0% of GHG emissions from project VMT in study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Providing TOD puts a large number of people close to reliable public transportation, diversifying their transportation options during an extreme weather event.

Health and Equity Considerations

TOD may increase housing prices, leading to gentrification and displacement. Please refer to the *Accountability and Anti-Displacement and Housing* section in Chapter 5, *Measures for Advancing Health and Equity*, for potential strategies to minimize disruption to existing residents. TOD coupled with affordable housing options can help to support equity by helping to lower transportation costs for residents and increase active mobility.

Measure Description

This measure would reduce project VMT in the study area relative to the same project sited in a non-transit-oriented development (TOD) location. TOD refers to projects built in compact, walkable areas that have easy access to public transit, ideally in a location with a mix of uses, including housing, retail offices, and community facilities. Project site residents, employees, and visitors would have easy access to high-quality public transit, thereby encouraging transit ridership and reducing the number of single-occupancy vehicle trips and associated GHG emissions.

Subsector

Land Use

Locational Context

Urban and suburban. Rural only if adjacent to commuter rail station with convenient rail service to a major employment center.

Scale of Application

Project/Site

Implementation Requirements

To qualify as a TOD, the development must be a residential or office project that is within a 10-minute walk (0.5 mile) of a high frequency transit station (either rail, or bus rapid transit with headways less than 15 minutes). Ideally, the distance should be no more than 0.25 to 0.3 of a mile but could be up to 0.5 mile if the walking route to station can be accessed by pedestrian-friendly routes. Users should confirm "unmitigated" or "baseline" VMT does not already account for reductions from transit proximity.

Cost Considerations

TOD reduces car use and car ownership rates, providing cost savings to residents. It can also increase property values and public transit use rates, providing additional revenue to municipalities, as well as open new markets for business development. Increased transit use will likely necessitate increased spending on maintaining and improving public transit systems, the costs of which may be high.

Expanded Mitigation Options

When building TOD, a best practice is to incorporate bike and pedestrian access into the larger network to increase the likelihood of transit use.

GHG Reduction Formula

$$A = \frac{(B \times C)}{-D}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	6.9–31.0	%	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
B	Transit mode share in surrounding city	Table T-3.1	%	FHWA 2017a
C	Ratio of transit mode share for TOD area with measure compared to existing transit mode share in surrounding city	4.9	unitless	Lund et al. 2004
D	Auto mode share in surrounding city	Table T-3.1	%	FHWA 2017b

Further explanation of key variables:

- (B and D) – Ideally, the user will calculate transit and auto mode share for a Project/Site at a scale no larger than a census tract. Ideally, variables B and D will reflect travel behavior in locations that are *not* already within 0.5 mile of a high-quality transit stop and may instead substitute data from nearby tracts further from transit if such locations exist. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode share for one of the six most populated core-based statistical areas (CBSAs) in California, as presented in Table T-3.1 in Appendix C, *Emission Factors and Data Tables*. Transit mode share is likely to be smaller for areas not covered by the listed CBSAs, which represent the most transit-accessible areas of the state. Conversely, auto mode share is likely to be larger.
- (C) – A study of people living in TODs in California found that, on average, transit shares for TOD residents exceed the surrounding city by a factor of 4.9 (Lund et al. 2004).

GHG Calculation Caps or Maximums

Measure Maximum

$((B \times C)_{max})$ The transit mode share in the project study area with the measure is capped at 27 percent. This is based on the weighted average transit commute mode share of five surveyed sites in California where residents lived within 3 miles of rail stations (Lund et al. 2004). As transit mode share is typically higher for commute trips compared to all trips, 27 percent represents a reasonable upper bound for expected transit mode share in a TOD area. Projects in the CBSAs of San Francisco-Oakland-Hayward and San Jose-Sunnyvale-Santa Clara would have their transit mode share capped at 27 percent in the formula.

(A_{max}) For projects that use default CBSA data from Table T-3.1 in Appendix C, the maximum percent reduction in GHG emissions (A) is 31.0 percent. This is based on a project in the CBSA of San Francisco-Oakland-Hayward with a transit mode share that reaches the cap ($(B \times C)_{max}$). This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}1 \text{ through } T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subcategory includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces VMT by locating their project in a TOD location. Project site residents, employees, and visitors would have easy access to high-quality public transit, thereby encouraging transit use and reducing single occupancy vehicle travel. In this example, the project is within the San Jose-Sunnyvale-Santa Clara CBSA with an existing transit mode share (B) of 6.69 percent. Applying a 4.9 ratio of transit mode share for TOD area with the measure compared to existing transit mode share in the surrounding city yields 33 percent, which exceeds the 27 percent cap ($(B \times C)_{max}$). Therefore, 27 percent is used to define ($B \times C$). The existing vehicle mode share is 86.96 percent (D). The user would reduce GHG emissions from project study area VMT (as compared to the same project in a non-TOD location) by 31 percent.

$$A = \frac{27\%}{-86.96\%} = -31\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration. 2017a. *National Household Travel Survey–2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA*. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration. 2017b. *National Household Travel Survey – 2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS*. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Lund, H., R. Cervero, and R. Wilson. 2004. *Travel Characteristics of Transit-Oriented Development in California*. January. Available: https://community-wealth.org/sites/clone.community-wealth.org/files/downloads/report-lund-cerv-wil.pdf. Accessed: January 2021.

T-4. Integrate Affordable and Below Market Rate Housing

GHG Mitigation Potential

28.6%

Up to 28.6% of GHG emissions from project/site multifamily residential VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increasing affordable housing creates the opportunity for a greater diversity of people to be closer to their desired destinations and the resources they may need to access during an extreme weather event. Close proximity to destinations allows for more opportunities to use active transportation and transit and to be less reliant on private vehicles. Alleviating the housing-cost burden also enables more people to remain housed, and increases people's capacity to respond to disruptions, including climate impacts.

Health and Equity Considerations

Neighborhoods should include different types of housing to support a variety of household sizes, age ranges, abilities, and incomes.

Measure Description

This measure requires below market rate (BMR) housing. BMR housing provides greater opportunity for lower income families to live closer to job centers and achieve a jobs/housing match near transit. It is also an important strategy to address the limited availability of affordable housing that might force residents to live far away from jobs or school, requiring longer commutes. The quantification method for this measure accounts for VMT reductions achieved for multifamily residential projects that are deed restricted or otherwise permanently dedicated as affordable housing.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Multifamily residential units must be permanently dedicated as affordable for lower income families. The California Department of Housing and Community Development (2021) defines lower-income as 80 percent of area median income or below, and affordable housing as costing 30 percent of gross household income or less.

Cost Considerations

Depending on the source of the affordable subsidy, BMR housing may have implications for development costs but would also have the benefit of reducing costs for public services, similar to Measure T-1, *Increase Residential Density*.

Expanded Mitigation Options

Pair with Measure T-1, *Increase Residential Density*, and Measure T-2, *Increase Job Density*, to achieve greater population and employment diversity.

GHG Reduction Formula

A = **B** × C

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from Project/Site VMT for multifamily residential developments	0–28.6	%	calculated
User Inputs				
B	Percent of multifamily units permanently dedicated as affordable	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in VMT for qualified units compared to market rate units	-28.6	%	ITE 2021

Further explanation of key variables:

- (B) – This refers to percent of multifamily units in the project that are deed restricted or otherwise permanently dedicated as affordable.
- (C) – The 11th Edition of the *ITE Trip Generation Manual* (ITE 2021) contains daily vehicle trip rates for market rate multifamily housing that is low-rise and not close to transit (ITE code 221) as well as affordable multifamily housing (ITE code 223). While these rates do not account for trip length, they serve as a proxy for the expected difference in vehicle trip generation and VMT generation presuming similar trip lengths for both types of land use. If the user has information about trip length differences between market rate and affordable housing, then adjusting the percent reduction accordingly is recommended.

  Users should note that the ITE trip rate estimates are based on a small sample of studies for the affordable housing rate and that no stratification of affordable housing by number of stories was available. This is an important distinction since the multifamily low-rise vehicle trip rate applies to four or fewer stories. Therefore, this measure may not apply to affordable housing projects with more than four stories.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 28.6 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}1\ through\ T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subsector includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces project VMT by requiring a portion of the multifamily residential units to be permanently dedicated as affordable. In this example, the percent of units (B) is 100 percent, which would reduce GHG emissions from VMT by 28.6 percent.

$$A = \mathbf{100\%} \times -28.6\% = -28.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

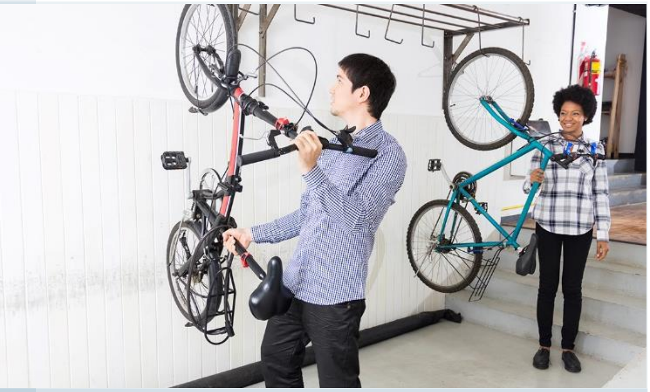
VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

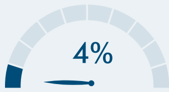
Sources

- California Department of Housing and Community Development. 2021. *Income Limits*. Available: https://www.hcd.ca.gov/grants-funding/income-limits/index.shtml#:~:text=%E2%80%9CAffordable%20housing%20cost%E2%80%9D%20for%20lower,of%20gross%20income%2C%20with%20variations. Accessed; November 2021.
- Institute of Transportation Engineers (ITE). 2021. *Trip Generation Manual*. 11th Edition. Available: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/. Accessed; November 2021.

T-5. Implement Commute Trip Reduction Program (Voluntary)



GHG Mitigation Potential



Up to 4.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

CTR programs could result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Lower transportation costs would also increase community resilience by freeing up resources for other purposes.

Health and Equity Considerations

Design of CTR programs need to ensure equitable access and benefits to all employees are provided considering disparate existing mobility options in diverse communities.

Measure Description

This measure will implement a voluntary commute trip reduction (CTR) program with employers. CTR programs discourage single-occupancy vehicle trips and encourage alternative modes of transportation such as carpooling, taking transit, walking, and biking, thereby reducing VMT and GHG emissions. Voluntary implementation elements are described in this measure.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Voluntary CTR programs must include the following elements to apply the VMT reductions reported in literature.

- Employer-provided services, infrastructure, and incentives for alternative modes such as ridesharing (Measure T-8), discounted transit (Measure T-9), bicycling (Measure T-10), vanpool (Measure T-11), and guaranteed ride home.
- Information, coordination, and marketing for said services, infrastructure, and incentives (Measure T-7).

Cost Considerations

Employer costs may include recurring costs for transit subsidies, capital and maintenance costs for the alternative transportation infrastructure, and labor costs for staff to manage the program. Where the local municipality has a VMT reduction ordinance, costs may include the labor costs for government staff to track the efficacy of the program.

Expanded Mitigation Options

Other strategies may also be included as part of a voluntary CTR program, though they are not included in the VMT reductions reported by literature and thus are not incorporated in the VMT reductions for this measure.

This program typically serves as a complement to the more effective workplace CTR measures such as pricing workplace parking (Measure T-12) or implementing employee parking "cash-out" (Measure T-13).

GHG Reduction Formula

$A = B \times C$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site employee commute VMT	0–4.0	%	calculated
User Inputs				
B	Percent of employees eligible for program	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in commute VMT from eligible employees	-4	%	Boarnet et al. 2014

Further explanation of key variables:

- (B) – This refers to the percent of employees that would be able to participate in the program. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who participate in the program.
- (C) – A policy brief summarizing the results of employer-based trip reduction studies concluded that these programs reduce total commute VMT for employees at participating work sites by 4 to 6 percent (Boarnet et al. 2014). To be conservative, the low end of the range is cited.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 4 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}5 \text{ through } T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for Measure T-6, which represents the same implementation activities as Measure T-5, except that the CTR program would be mandatory. Users should select either Measure T-5 or T-6.

If this measure is selected, the user may not also take credit for Measures T-7 through T-11. Measure T-5 accounts for the combined GHG reductions achieved by each of these individual measures. To combine the GHG reductions from T-5 with any of these measures would be considered double counting. However, the user may take credit for Measures T-12 through T-13 within the larger CTR subcategory, so long as the combined VMT reduction does not exceed 45 percent, as noted above.

Example GHG Reduction Quantification

The user reduces employee commute VMT by requiring that employers of a project offer a voluntary commute trip reduction program to their employees. In this example, the percent of employees eligible (B) is 100 percent, which would reduce GHG emissions from employee commute VMT by 4 percent.

A = **100%** × -4% = -4%

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Boarnet, M., H. Hsu, and S. Handy. 2014. *Impacts of Employer-Based Trip Reduction Programs and Vanpools on Passenger Vehicle Use and Greenhouse Gas Emissions*. September. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Employer-Based_Trip_Reduction_Programs_and_Vanpools_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.

T-6. Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring)

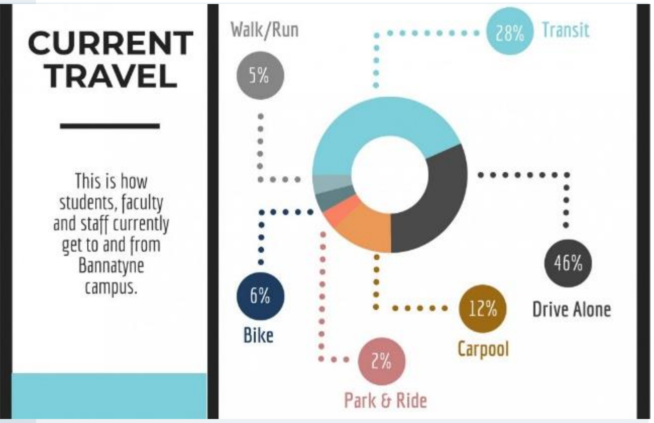


Photo Credit: University of Manitoba, 2018

GHG Mitigation Potential

26%

Up to 26.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Commute trip reduction programs could result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Lower transportation costs would also increase community resilience by freeing up resources for other purposes.

Health and Equity Considerations

Design of CTR programs needs to consider existing mobility options in diverse communities and ensure equitable access and benefit to all employees.

Measure Description

This measure will implement a mandatory CTR program with employers. CTR programs discourage single-occupancy vehicle trips and encourage alternative modes of transportation such as carpooling, taking transit, walking, and biking, thereby reducing VMT and GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

The mandatory CTR program must include all other elements (i.e., Measures T-7 through T-11) described for the voluntary program (Measure T-5) plus include mandatory trip reduction requirements (including penalties for non-compliance) and regular monitoring and reporting to ensure the calculated VMT reduction matches the observed VMT reduction.

Cost Considerations

Employer costs may include recurring, direct costs for transit subsidies, capital and maintenance costs for alternative transportation infrastructure, and labor costs for staff to manage the program. If the local municipality has a mandatory VMT reduction ordinance, additional employer costs could include non-compliance penalties if the municipality fines CTR programs that do not meet a VMT goal. Municipal costs may include the labor costs for government staff to track the efficacy of the program, which may be outweighed by revenue generated from fines collected from non-compliant businesses.

Expanded Mitigation Options

This program typically serves as a complement to the more effective workplace CTR measures, such as pricing workplace parking (Measure T-12) or implementing employee parking "cash-out" (Measure T-13).

GHG Reduction Formula

$A = B \times C \times D$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site employee commute VMT	0–26.0	%	calculated
User Inputs				
B	Percent of employees eligible for program	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in vehicle mode share of employee commute trips	-26	%	Nelson\Nygaard Consulting Associates 2015
D	Adjustment from vehicle mode share to commute VMT	1	unitless	assumed

Further explanation of key variables:

- (B) – This refers to the percent of employees that would be able to participate in the program. This will usually be 100 percent. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who participate in the program.
- (C) – A multiyear study of mode share on Genentech's South San Francisco campuses tracked the long-run change in employee commute mode share with implementation of mandatory CTR. Between 2006 and 2014, employee vehicle mode share (includes single-occupied vehicles and carpools) decreased from approximately 90 percent to 64 percent, which is a 26 percent reduction (Nelson\Nygaard Consulting Associates 2015).
- (D) – The adjustment factor from vehicle mode share to commute VMT is 1. This assumes that all vehicle trips will average out to typical trip length. Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 26 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}5 \text{ through } T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for Measure T-5, which represents the same implementation activities as Measure T-5, except that the CTR program would be mandatory. Users should select either Measure T-5 or T-6.

If this measure is selected, the user may not also take credit for Measures T-7 through T-11. Measure T-6 accounts for the combined GHG reductions achieved by each of these individual measures. To combine the GHG reductions from T-6 with any of these measures would be considered double counting. However, the user may take credit for Measure T-12 and T-13 within the larger CTR subcategory, so long as the combined VMT reduction does not exceed 45 percent, as noted above.

Example GHG Reduction Quantification

The user reduces employee commute VMT by requiring that the employer of the proposed project offer a mandatory CTR program to their employees. In this example, the percent of employees eligible (B) is 100 percent, which would reduce GHG emissions from employee commute VMT by 26 percent.

$A = \mathbf{100\%} \times -26\% \times 1 = -26\%$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Nelson/Nygaard Consulting Associates. 2015. *Genentech–South San Francisco Campus TDM and Parking Report*. June. Available: http://ci-ssf-ca.granicus.com/MetaViewer.php?view_id=2&clip_id=859&meta_id=62028. Accessed: January 2021.

T-7. Implement Commute Trip Reduction Marketing

Photo Credit: Sacramento Area Council of Governments, 2012

GHG Mitigation Potential

4%

Up to 4.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Commute trip reduction programs could result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Lower transportation costs would also increase community resilience by freeing up resources for other purposes.

Health and Equity Considerations

Design of CTR programs needs to consider existing mobility options in diverse communities and ensure equitable access and benefit to all employees. CTR programs may need to include multi-language materials.

Measure Description

This measure will implement a marketing strategy to promote the project site employer's CTR program. Information sharing and marketing promote and educate employees about their travel choices to the employment location beyond driving such as carpooling, taking transit, walking, and biking, thereby reducing VMT and GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

The following features (or similar alternatives) of the marketing strategy are essential for effectiveness.

- Onsite or online commuter information services.
- Employee transportation coordinators.
- Onsite or online transit pass sales.
- Guaranteed ride home service.

Cost Considerations

Employer costs include labor and materials for development and distribution of survey and marketing materials to promote the program and educate potential participants.

Expanded Mitigation Options

This measure could be packaged with other commute trip reduction measures (Measures T-8 through T-13) as a comprehensive CTR program (Measure T-5 or T-6).

GHG Reduction Formula

$A = B \times C \times D$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site employee commute VMT	0–4.0	%	calculated
User Inputs				
B	Percent of employees eligible for program	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in employee commute vehicle trips	-4	%	TRB 2010
D	Adjustment from vehicle trips to VMT	1	unitless	assumed

Further explanation of key variables:

- (B) – This refers to the percent of employees that would be able to participate in the program. This will usually be 100 percent. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.
- (C) – A review of studies measuring the effect of transportation demand management measures on traveler behavior notes that the average empirically-based estimate of reductions in vehicle trips for full-scale, site-specific employer support programs is 4 to 5 percent. To be conservative, the low end of the range is cited (TRB 2010).
- (D) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 4 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}5\ \text{through}\ T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for either Measure T-5 or T-6. However, this measure may be implemented alongside other individual CTR measures (Measures T-8 through T-13). The efficacy of individual programs may vary highly based on individual employers and local contexts.

Example GHG Reduction Quantification

The user reduces employee commute VMT by requiring that employers of a project market to employees travel options for modes alternative to single-occupied vehicles. In this example, the percent of employees eligible (B) is 100 percent, which would reduce GHG emissions from employee commute VMT by 4 percent.

$$A = \mathbf{100\%} \times -4\% \times 1 = -4\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Transportation Research Board (TRB). 2010. *Traveler Response to Transportation System Changes Handbook, Third Edition: Chapter 19, Employer and Institutional TDM Strategies*. June. Available: http://www.trb.org/Publications/Blurbs/163781.aspx. Accessed: January 2021.

T-8. Provide Ridesharing Program

GHG Mitigation Potential

8%

Up to 8.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Ridesharing programs could result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Lower transportation costs would also increase community resilience by freeing up resources for other purposes.

Health and Equity Considerations

Program should include all onsite workers, such as contractors, interns, and service workers. Because ridesharing is vehicle-based, and some employees may not be in areas with feasible rideshare networks, design of programs need to ensure equitable benefits to those with and without access to rideshare opportunities.

Measure Description

This measure will implement a ridesharing program and establish a permanent transportation management association with funding requirements for employers. Ridesharing encourages carpooled vehicle trips in place of single-occupied vehicle trips, thereby reducing the number of trips, VMT, and GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Ridesharing must be promoted through a multifaceted approach. Examples include the following.

- Designating a certain percentage of desirable parking spaces for ridesharing vehicles.
- Designating adequate passenger loading and unloading and waiting areas for ridesharing vehicles.
- Providing an app or website for coordinating rides.

Cost Considerations

Costs of developing, implementing, and maintaining a rideshare program in a way that encourages participation are generally borne by municipalities or employers. The beneficiaries include the program participants saving on commuting costs, the employer reducing onsite parking expenses, and the municipality reducing cars on the road, which leads to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

When providing a ridesharing program, a best practice is to establish funding by a non-revocable funding mechanism for employer-provided subsidies. In addition, encourage use of low-emission ridesharing vehicles (e.g., shared Uber Green).

This measure could be paired with any combination of the other commute trip reduction strategies (Measures T-7 through T-13) for increased reductions.

GHG Reduction Formula

$A = B \times C$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site employee commute VMT	0–8.0	%	calculated
User Inputs				
B	Percent of employees eligible for program	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in employee commute VMT	Table T-8.1	%	SANDAG 2019

Further explanation of key variables:

- (B) – This refers to the percent of employees that would be able to participate in the program. This will usually be 100 percent. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.
- (C) – The percent reduction in employee commute VMT by place type is provided in Table T-8.1 in Appendix C. The reduction differs by place type because the willingness and ability to participate in carpooling is higher in urban areas than in suburban areas. Note that this measure is not applicable for implementation in rural areas (SANDAG 2019).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 8 percent.

Subsector Maximum

($\sum A_{max_{T\text{-}5\ through\ T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for either Measure T-5 or T-6. However, this measure may be implemented alongside other individual CTR measures (Measures T-7 and T-9 through T-13). The efficacy of individual programs may vary highly based on individual employers and local contexts.

Example GHG Reduction Quantification

The user reduces employee commute VMT by requiring that employers of a project provide a ridesharing program to their employees. In this example, the percent of employees eligible (B) at a packaging and distribution center is 50 percent and the place type of the project is urban (C). GHG emissions from employee commute VMT would be reduced by 4 percent.

$A = \mathbf{50\%} \times -8\% = -4\%$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool–Design Document.* June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

T-9. Implement Subsidized or Discounted Transit Program

GHG Mitigation Potential

5.5 %

Up to 5.5% of emissions from employee/resident vehicles accessing the site

Co-Benefits (icon key on pg. 34)

Climate Resilience

Subsidized and discounted transit programs increase the capacity of low-income populations to use transit to evacuate or access resources during an extreme weather event. They could also incentivize more people to use transit, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event. Lower overall out-of-pocket costs would also help increase community resilience by freeing up resources for other purposes.

Health and Equity Considerations

Program should include all onsite workers, such as contractors, interns, and service workers.

Measure Description

This measure will provide subsidized or discounted, or free transit passes for employees and/or residents. Reducing the out-of-pocket cost for choosing transit improves the competitiveness of transit against driving, increasing the total number of transit trips and decreasing vehicle trips. This decrease in vehicle trips results in reduced VMT and thus a reduction in GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

The project should be accessible either within 1 mile of high-quality transit service (rail or bus with headways of less than 15 minutes), 0.5 mile of local or less frequent transit service, or along a designated shuttle route providing last-mile connections to rail service. If a well-established bikeshare service (Measure T-22-A) is available, the site may be located up to 2 miles from a high-quality transit service.

If more than one transit agency serves the site, subsidies should be provided that can be applied to each of the services available. If subsidies are applied for only one service, all variable inputs below should also pertain only to the service that is subsidized.

Cost Considerations

The employer cost is the recurring, direct cost for transit subsidies. The subsidies will lower the per capita income of the transit service, decreasing the revenue of the local transit agency. This cost may be offset by increased revenue from increased ridership. The beneficiaries include the program participants saving on commuting cost, the employer reducing onsite parking expenses, and the municipality reducing cars on the road, which leads to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

This measure could be paired with any combination of the other commute trip reduction strategies (Measures T-7 through T-13) for increased reductions.

GHG Reduction Formula

$$A = \frac{C}{B} \times G \times D \times E \times F \times H \times I$$

GHG Calculation Variables

If subsidies or discounts target employees, the GHG reduction from this measure may be limited to work-related employee trips only (i.e., home-to- work) and work-to-other, where at least one trip end is work). If residents are targeted, the GHG reductions extend to all trips.

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from employee/resident vehicles accessing the site	0–5.5	%	calculated
User Inputs				
B	Average transit fare without subsidy	[ ]	$	user input
C	Subsidy amount	[ ]	$	user input
D	Percent of employees/residents eligible for subsidy	0–100	%	user input
E	Percent of project-generated VMT from employees/residents	0–100	%	user input
Constants, Assumptions, and Available Defaults				
F	Transit mode share of all trips or work trips	Table T-3.1 or Table T-9.1	%	FHWA 2017
G	Elasticity of transit boardings with respect to transit fare price	-0.43	unitless	Taylor et al. 2008
H	Percent of transit trips that would otherwise be made in a vehicle	50	%	Handy & Boarnet 2013
I	Conversion factor of vehicle trips to VMT	1.0	unitless	assumption

Further explanation of key variables:

- (B and C) – The average transit fare and subsidy amount can be presented as either a fare per ride, or the cost of a monthly pass for typical transit service near the site. Pricing should be based on the expected means of subsidy implementation; for instance, if a monthly pass is provided to all residents, prices should be input on a monthly basis.
- (D) – The percentage of employees/residents associated with the site who have access to the subsidy. If subsidy is provided as an employee benefit, care should be taken to account for any contract or temporary workers who do not receive such benefits.
- (E) – The percentage of project-generated VMT from employees/residents is used to adjust the percent reduction in GHG emissions from the scale of employee and/or resident-generated VMT to project-generated VMT. If subsidies or discounts target employees at an office development, this value would simply be 100 percent. If the project site is a multifamily development with no onsite workers, this value would also be

100 percent. If the project site is a retail development, this value would be less than 100 percent, as it does not account for retail shopper trips to the site. The share of total VMT generated by employees for visitor-intensive uses, such as retail or medical offices, can be roughly estimated by multiplying the total number of employees by two (to account for both arrival and departure), divided by the total number of daily trips.

- (F) – Ideally, the user will calculate transit mode share for work trips or all trips of a Project/Site at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. Care should be taken *not* to present the reported commute mode share as retrieved from the American Community Survey (ACS), unless the land use is office or employment based and the tables are based on work location (rather than home location). If the subsidies or discounts target employees and their commute trips, then the mode share should use the home-to-work trip purpose. If the user is not able to provide a project-specific value using one of the data sources described above, they have the option to input the transit mode share for one of the six most populated CBSAs in California. The transit mode share for work trips by CBSA is presented in Table T-9.1 in Appendix C (FHWA 2017). The transit mode share for all trips is provided in Table T-3.1 in Appendix C.
- (G) – A cross-sectional analysis of transit use in 265 urbanized areas in the U.S. found that a 0.43 percent decrease in transit boardings occurs for every 1 percent increase in transit fare price (Taylor et al. 2008). A policy brief summarizing the results of transit service strategies found this analysis to fall in the mid-point of observed, short-term values (Handy & Boarnet 2013). Price elasticities of transit demand vary based on both long-term and short-term demand, service type, and service location (Litman 2020 and Handy & Boarnet 2013).
- (H) – Not all new transit trips replace a vehicle trip. The share of transit trips that would otherwise be made by private vehicle ranges from less than 5 percent to 50 percent across studies. This assumption is based on observed values for high quality BRT service under the assumption that this measure is implemented alongside marketing measures and is targeted primarily at reducing vehicle commute trips. (Handy & Boarnet 2013). Note that this study looked at service improvements rather than fare changes and is used as a proxy variable. If project-specific or location-specific information is available, it should be substituted for this assumptive variable.
- (I) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT. Subsidies or discounts targeting commute trips may have a higher factor as they are generally longer than the trip lengths for other purposes.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The GHG reduction is capped at 5.5 percent, which is based on the following assumptions:

- (C=B) – The subsidy coverage is capped at 100 percent of the typical transit fare.
- (D) – All employees are eligible for the subsidy.

- (E) – All project-generated VMT is from employee-generated VMT.
- (F) – Employees at an office development in the San Francisco-Oakland-Hayward CBSA have a default transit mode share for work trips of 25.60 percent.

Subsector Maximum

$(\sum A_{max_{T\text{-}5\ through\ T\text{-}13}} \leq 45\%)$ This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for either Measure T-5 or T-6. However, this measure may be implemented alongside other individual CTR measures (Measures T-7, T-8, T-10 through T-13). The efficacy of individual programs may vary highly based on individual employers and local contexts.

Example GHG Reduction Quantification

In this example, the user reduces VMT by providing all employees (D) of a proposed office development in the San Francisco-Oakland-Hayward CBSA a 100 percent transit subsidy in the form of a \$100 monthly transit pass (C=B). The user would reduce GHG emissions from VMT by 5.5 percent.

$$A = \left(\frac{\$100}{\$100} \times -0.43\right) \times \mathbf{100\%} \times \mathbf{100\%} \times 25.60\% \times 50\% \times 1 = -5.5\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer.* Travel Day PMT by TRPTRANS by HH_CBSA, Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, L. and S. Boarnet. 2013. *Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions.* Available: http://www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf. Accessed: January 2021.
- Litman, T. 2020. *Transit Price Elasticities and Cross-elasticities.* Victoria Transport Policy Institute. April. Available: https://www.vtpi.org/tranelas.pdf. Accessed: January 2021.
- Taylor, B., D. Miller, H. Iseki, and C. Fink. 2008. *Nature and/or Nurture? Analyzing the Determinants of Transit Ridership Across US Urbanized Areas.* Transportation Research Part A: Policy and Practice, 43(1), 60-77. Available: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.367.5311&rep=rep1&type=pdf. Accessed: January 2021.

T-10. Provide End-of-Trip Bicycle Facilities

GHG Mitigation Potential

4.4%

Up to 4.4% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

End-of-trip bicycle facilities could take more cars off the road, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event. They could also make it easier for bicycle users to access resources in an extreme weather event.

Health and Equity Considerations

Facilities should be inclusive of all gender identities and expressions. Consider including gender-neutral, single-occupancy options to allow for additional privacy for those who want it.

Measure Description

This measure will install and maintain end-of-trip facilities for employee use. End-of-trip facilities include bike parking, bike lockers, showers, and personal lockers. The provision and maintenance of secure bike parking and related facilities encourages commuting by bicycle, thereby reducing VMT and GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

End-of-trip facilities should be installed at a size proportional to the number of commuting bicyclists and regularly maintained.

Cost Considerations

Employer costs include capital and maintenance costs for construction and maintenance of facilities and potentially labor and materials costs for staff to monitor facilities and provide marketing to encourage use of new facilities. The beneficiaries include the program participants saving on commuting cost, the employer reducing onsite parking expenses, and the municipality reducing cars on the road, which leads to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Best practice is to include an onsite bicycle repair station and post signage on or near secure parking and personal lockers with information about how to reserve or obtain access to these amenities.

This measure could be paired with any combination of the other commute trip reduction strategies (Measures T-7 through T-13) for increased reductions.

GHG Reduction Formula

$$A = \frac{C \times (E - (B \times E))}{D \times F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from employee project/site commute VMT	0.1–4.4	%	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
B	Bike mode adjustment factor	1.78 or 4.86	unitless	Buehler 2012
C	Existing bicycle trip length for all trips in region	Table T-10.1	miles	FHWA 2017a
D	Existing vehicle trip length for all trips in region	Table T-10.1	miles	FHWA 2017a
E	Existing bicycle mode share for work trips in region	Table T-10.2	%	FHWA 2017b
F	Existing vehicle mode share for work trips in region	Table T-10.2	%	FHWA 2017b

Further explanation of key variables:

- (B) – The bike mode adjustment factor should be provided by the user based on type of bike facility. A study found that commuters with showers, lockers, and bike parking at work are associated with 4.86 times greater likelihood to commute by bicycle when compared to individuals without any bicycle facilities at work. Individuals with bike parking, but no showers and lockers at the workplace, are associated with 1.78 times greater likelihood to cycle to work than those without trip-end facilities (Buehler 2012).
- (C and D) – Ideally, the user will calculate bicycle and auto trip length for a Project/Site at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the trip lengths for bicycles and vehicles for one of the six most populated CBSAs in California, as presented in Table T-10.1 in Appendix C (FHWA 2017a). Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state.
- (E and F) – Ideally, the user will calculate bicycle and auto mode share for work trips for a Project/Site at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the regional average mode shares for bicycle and vehicle

work trips for one of the six most populated CBSAs in California, as presented in Table T-10.2 in Appendix C (FHWA 2017b). If the project study area is not within the listed CBSAs or the user is able to provide a project-specific value, the user should replace these regional defaults in the GHG reduction formula. For areas not covered by the listed CBSAs, which represent the denser areas of the state, bicycle mode share is likely to be lower and vehicle share higher than presented in Table T-10.2.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 4.4 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}5\text{ through }T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for either Measure T-5 or T-6. However, this measure may be implemented alongside other individual CTR measures (Measures T-7, T-8, T-9, and T-11 through T-13). The efficacy of individual programs may vary highly based on individual employers and local contexts.

Example GHG Reduction Quantification

The user reduces VMT by providing end-of-trip facilities for the project's employees, which encourages bicycle trips in place of vehicle trips. In this example, the type of bike facility provided by the project is parking with showers, bike lockers, and personal lockers (B). The project is within San Jose-Sunnyvale-Santa Clara CBSA, and the user does not have project-specific values for trip lengths and mode shares and for bicycles and vehicles. Per Tables T-10.1 and T-10.2 in Appendix C, inputs for these variables are 2.8 miles, 11.5 miles, 4.1 percent, and 86.6 percent, respectively (C, D, E, and F). GHG emissions from employee commute VMT would be reduced by 4.4 percent.

$$A = \frac{2.8\text{ miles} \times \left(4.1\% - (4.86 \times 4.1\%)\right)}{11.5\text{ miles} \times 86.6\%} = \text{-}4.4\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Buehler, R. 2012. *Determinants of bicycle commuting in the Washington, DC region: The role bicycle parking, cyclist showers, and free car parking at work.* Transportation Research Part D, 17, 525–531. Available: http://www.pedbikeinfo.org/cms/downloads/DeterminantsofBicycleCommuting.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer.* Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

T-11. Provide Employer-Sponsored Vanpool

Photo Credit: UCLA Transportation/Flickr, 2021

GHG Mitigation Potential

20.4%

Up to 20.4% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Employer-sponsored vanpools could result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site.

Health and Equity Considerations

Consider using zero-emission or plug-in electric vehicles (PHEVs) for additional emission reduction benefits.

Measure Description

This measure will implement an employer-sponsored vanpool service. Vanpooling is a flexible form of public transportation that provides groups of 5 to 15 people with a cost-effective and convenient rideshare option for commuting. The mode shift from long-distance, single-occupied vehicles to shared vehicles reduces overall commute VMT, thereby reducing GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban, rural

Scale of Application

Project/Site

Implementation Requirements

Vanpool programs are more appropriate for the building occupant or tenant (i.e., employer) to implement and monitor than the building owner or developer.

Cost Considerations

Employer costs primarily include the capital costs of vehicle acquisition and the labor costs of drivers, either through incentives to current employees or the hiring of dedicated drivers. The beneficiaries include the program participants saving on commuting cost, the employer reducing onsite parking expenses, and the municipality reducing cars on the road, which leads to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

When implementing a vanpool service, best practice is to subsidize the cost for employees that have a similar origin and destination and provide priority parking for employees that vanpool.

This measure could be paired with any combination of the other commute trip reduction strategies (Measures T-7 through T-13) for increased reductions.

GHG Reduction Formula

$$A = \frac{((1 - B) \times C \times F) + \left(B \times \frac{D}{E} \times G\right)}{((1 - B) \times C \times F) + (B \times D \times F)} - 1$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site employee commute VMT	3.4–20.4	%	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
B	Percent of employees that participate in vanpool program	2.7	%	SANDAG 2019
C	Average length of one-way vehicle commute trip in region	Table T-11.1	miles per trip	FHWA 2017
D	Average length of one-way vanpool commute trip	42.0	miles per trip	SANDAG 2019
E	Average vanpool occupancy (including driver)	6.25	occupants	SANDAG 2019
F	Average emission factor of average employee vehicle	307.5	g CO_2e per mile	CARB 2020
G	Vanpool emission factor	763.4	g CO_2e per mile	CARB 2020

Further explanation of key variables:

- (B) – The percent of employees that would participate in a vanpool program is based on a survey of commuters in San Diego County (SANDAG 2019). If the project is not within San Diego County or the user is able to provide a project-specific value for within San Diego County, the user should replace the default employee participation rate in the GHG reduction formula.
- (C) – Ideally, the user will calculate auto commute trip lengths for a Project/Site at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the regional average one-way auto commute trip length for one of the six most populated CBSAs in California, as presented in Table T-11.1 in Appendix C (FHWA 2017). Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state.
- (D and E) – The average one-way vanpool commute trip length and occupancy are based on data from the San Diego Association of Government's regional vanpool program (SANDAG 2019). If the project is not within San Diego County or the user is

able to provide a project-specific value for within San Diego County, the user should replace these defaults in the GHG reduction formula.

- (F and G) – The average GHG emission factors for employee commute and vanpool vehicles were calculated in terms of CO_2e per mile using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average using diesel and gasoline fuel. The average of the light-duty automobile (LDA) and light duty truck (LDT1/LDT2) vehicle categories represents employee non-vanpool vehicles and the light-heavy duty truck (LHDT1) vehicle category conservatively represents a large cargo vanpool vehicle. The running emission factors for CO_2, CH_4, and N_2O (CARB 2020) were multiplied by the corresponding 100-year GWP values from the IPCC's Fourth Assessment Report (IPCC 2007). If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the defaults in the GHG reduction formula.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects in San Diego County that use default CBSA data from Table T-11.1 and (B_{max}), the maximum percent reduction in GHG emissions (A) is 20.4 percent. This maximum scenario is presented in the below example quantification.

(B_{max}) The percent of employees that participate in the vanpool program is capped at 15 percent, which is based on the high end of vanpool participation survey data for several successful programs in the U.S. (SANDAG 2019).

Subsector Maximum

($\sum A_{max_{T\text{-}5 \text{ through } T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for either Measure T-5 or T-6. However, this measure may be implemented alongside other individual CTR measures (Measures T-7 through T-10, T-12, and T-13). The efficacy of individual programs may vary highly based on individual employers and local contexts.

Example GHG Reduction Quantification

The user reduces employee commute VMT by requiring that the employer of the project to sponsor a vanpool program. In this example, the project is in the San Diego-Carlsbad CBSA and would have an average vehicle commute trip length of 14.52 miles (C). The percent of employees that participate in the vanpool program is 15 percent (B_{max}). GHG emissions from employee commute would be reduced by 20.4 percent.

$$A = \frac{\left((1-15\%) \times 14.52\ \frac{\text{miles}}{\text{trip}} \times 307.5\ \frac{\text{g } CO_2e}{\text{miles}}\right) + \left(15\% \times \frac{42\ \frac{\text{miles}}{\text{trip}}}{6.25 \text{ occupants}} \times 763.4\ \frac{\text{g } CO_2e}{\text{miles}}\right)}{\left((1-15\%) \times 14.52\ \frac{\text{miles}}{\text{trip}} \times 307.5\ \frac{\text{g } CO_2e}{\text{miles}}\right) + \left(15\% \times 42\ \frac{\text{miles}}{\text{trip}} \times 307.5\ \frac{\text{g } CO_2e}{\text{miles}}\right)} - 1 = \text{-}20.4\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption (H) can be calculated using the GHG reduction formula except that (F) and (G) should be replaced by (I) and (J), as follows.

Fuel Use Reduction Formula

$$H = \frac{\left((1-B) \times C \times I\right) + \left(B \times \frac{D}{E} \times J\right)}{\left((1-B) \times C \times I\right) + (B \times D \times I)} - 1$$

Fuel Use Reduction Calculation Variables

ID	Variable	Value	Unit	Source
Output				
H	Percent reduction in fuel use from project/site employee commute VMT	4.7–21.4	%	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
I	Fuel efficiency of average employee vehicle	0.03639	gallon (gal) per mile	CARB 2020
J	Fuel efficiency of vanpool vehicle	0.08328	gal per mile	CARB 2020

Further explanation of key variables:

- (I and J) – The average fuel efficiencies for employee commute and vanpool vehicles were calculated using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average using diesel and gasoline fuel. The average of the LDA, LDT1, and LDT2 vehicle categories represents employee non-vanpool vehicles, and the LHDT1 vehicle category conservatively represents a large cargo vanpool vehicle. If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the defaults in the fuel use reduction formula.

- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

VMT Reductions

The percent reduction in VMT can be calculated using a modified version of the GHG reduction formula, as shown below.

$$\%\ \text{VMT Reduction} = \frac{((1 - B) \times C) + \left(B \times \frac{D}{E}\right)}{C} - 1$$

Sources

- California Air Resources Board (CARB). 2020. *EMFAC2017 v1.0.3*. August. Available: https://arb.ca.gov/emfac/emissions-inventory. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Travel Day VT by HH_CBSA by TRPTRANS by TRIPPURP. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. Available: https://www.ipcc.ch/report/ar4/wg1/. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool–Design Document*. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

T-12. Price Workplace Parking

GHG Mitigation Potential

20%

Up to 20.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Priced workplace parking could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site.

Health and Equity Considerations

Parking pricing should include hourly and daily options so part-time staff do not need a monthly pass. If the project includes low-waged employees that have fewer transportation choices or time and resource constraints, it is instead recommended to consider implementing Measure T-13, *Implement Employee Parking Cash-Out*, or other transportation subsidy.

Measure Description

This measure will price onsite parking at workplaces. Because free employee parking is a common benefit, charging employees to park onsite increases the cost of choosing to drive to work. This is expected to reduce single-occupancy vehicle commute trips, resulting in decreased VMT, thereby reducing associated GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Implementation may include the following.

- Explicitly charging for employee parking.
- Implementing above-market rate pricing.
- Validating parking only for invited guests (or not providing parking validation at all).
- Not providing employee parking and transportation allowances.

In addition, this measure should include marketing and education regarding available alternatives to driving.

Cost Considerations

Parking fees would be a direct, recurring cost for employees. Employer costs include labor costs for program management and monitoring, but this may be offset by revenue generated by the program.

Expanded Mitigation Options

Best practice is to ensure that other transportation options are available, convenient, and have competitive travel times (i.e., transit service near the project site, shuttle service, or a complete active transportation network serving the site and surrounding community), and that there is not alternative free parking available nearby (such as on-street). This measure is substantially less effective in environments that do not have other modes available or where unrestricted street parking or other offsite parking is available nearby and has adequate capacity to accommodate project-related vehicle parking demand.

GHG Reduction Formula

For calculating effectiveness of pricing residential parking, see Measure T-16, *Unbundle Residential Parking Costs from Property Cost*. For calculating effectiveness of pricing parking at visitor-intensive land uses, see Measure T-24, *Implement Market Price Public Parking (On-Street)*.

$$A = \frac{B - C}{C} \times E \times D \times F$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from employee commute VMT	0–20.0	%	calculated
User Inputs				
B	Proposed parking price	[ ]	$	user input
C	Baseline parking price	[ ]	$	user input
D	Share of employees paying for parking	[ ]	%	user input
Constants, Assumptions, and Available Defaults				
E	Elasticity of parking demand with respecting to parking price	-0.4	unitless	Lehner & Peer 2019
F	Ratio of vehicle trip reduction to VMT	1	unitless	assumption

Further explanation of key variables:

- (B) – Parking price can be provided on an hourly, daily, or monthly basis. Monthly pricing is less effective than requiring daily or hourly payment since the price signal is diluted to only once a month.
- (C) – If baseline parking price is $0 (that is, if parking is typically free), set C = ¼ B, allowing for the maximum 50 percent increase in price. Alternatively, for locations that are located within 0.5 mile of transit service, set C = average transit fare to/from the location.
- (D) – Many organizations allow some employees free parking benefits. VMT reductions should be adjusted based on the share of employees that would be paying for parking.
- (E) – A meta-analysis of parking price studies found that a 0.40 percent decrease in parking demand occurs for every 1 percent increase in parking price (Lehner & Peer 2019). Price elasticity of parking demand varies by location, day of the week, and time of day.
- (F) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT. Subsidies or discounts targeting commute trips may have a higher factor as they are generally longer than the trip lengths for other purposes.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The GHG reduction from priced workplace parking is capped at 20 percent. This maximum scenario is presented in the below example quantification.

($\frac{B-C}{C}_{max}$) The percent increase in parking price is capped at 50 percent.

Subsector Maximum

($\sum A_{max_{T\text{-}5\text{ through }T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for Measure T-13, *Implement Employee Parking Cash-Out*. While both measures focus on providing a price signal for employees to consider other modes for their work commute, this measure actively charges all employees to park, while Measure T-13 reimburses employees who do not park. Users should select either Measure T-12 or T-13.

Example GHG Reduction Quantification

The user reduces VMT by increasing the price of a monthly parking permit. In this example, the permit fee is increased from $50 (C) to $75 (B). If 100 percent of employees are subject to parking pricing (D), the user would reduce GHG emissions from VMT by 20 percent.

$$A = \frac{\$75 - \$50}{\$50} \times -0.4 \times 100\% \times 1 = -20\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Lehner, S., Peer, S. 2019. *The Price Elasticity of Parking: A Meta-analysis*. Transportation Research Part A: Policy and Practice 121 2019. Available: http://sustainabletransportationsc.org/garage/pdf/parking_elasticity.pdf. Accessed: January 2021.

T-13. Implement Employee Parking Cash-Out

GHG Mitigation Potential

12%

Up to 12.0% of GHG emissions from project/site employee commute VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Employee parking cash-out could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site.

Health and Equity Considerations

Non-applicable

Measure Description

This measure will require project employers to offer employee parking cash-out. Cash-out is when employers provide employees with a choice of forgoing their current subsidized/free parking for a cash payment equivalent to or greater than the cost of the parking space. This encourages employees to use other modes of travel instead of single occupancy vehicles. This mode shift results in people driving less and thereby reduces VMT and GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

To prevent spill-over parking and continued use of single occupancy vehicles, residential parking in the surrounding area must be permitted, and public on-street parking must be market rate.

Cost Considerations

Employer costs include the recurring, direct cost for payment to program participants and labor costs for program management. Employees that participate in the program would achieve cost savings through the cash-out benefit and potentially through reduced vehicle ownership and usage.

Expanded Mitigation Options

This measure could be paired with many other commute trip reduction strategies (Measures T-7 through T-11) for increased reductions.

GHG Reduction Formula

$A = B \times C$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project/site commute VMT	0–12.0	%	calculated
User Inputs				
B	Percentage of employees eligible	[ ]	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in commute VMT from implementation of measure	-12	%	Shoup 2005

Further explanation of key variables:

- (B) – The percentage of employees eligible refers to the employees that would be able to participate in the program. This will usually be 100 percent. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available or employees who are required to drive to work as part of their job duties. This does not refer to the percentage of employees who end up participating in the program.
- (C) – A study of eight California firms that complied with California's 1992 parking cash-out law found employee commute VMT decreased by an average of 12 percent (Shoup 2005).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum percent reduction in GHG emissions (A) is 12.0 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}5 \text{ through } T\text{-}13}} \leq 45\%$) This measure is in the Trip Reduction Programs subsector. This subcategory includes Measures T-5 through T-13. The employee commute VMT reduction from the combined implementation of all measures within this subsector is capped at 45 percent.

Mutually Exclusive Measures

If this measure is selected, the user may not also take credit for Measure T-12, *Price Workplace Parking*. While both measures focus on providing a price signal for employees to consider other modes for their work commute, this measure reimburses employees who do not park, while Measure T-12 actively charges all employees to park. Users should select either Measure T-12 or T-13.

Example GHG Reduction Quantification

The user reduces project/site VMT by offering commuters the option to choose a cash payment equal to or greater than the current parking subsidy offered by their employer. In this example, all employees (i.e., 100 percent) are eligible to participate (B), which would reduce GHG emissions from employee commute VMT by 12 percent.

$$A = \mathbf{100\%} \times -12\% = -12\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Shoup, D. 2005. *Parking Cash Out.* Planners Advisory Service, American Planning Association. Available: http://shoup.bol.ucla.edu/ParkingCashOut.pdf. Accessed: January 2021.

T-14. Provide Electric Vehicle Charging Infrastructure

Measure Description

Install onsite electric vehicle chargers in an amount beyond what is required by the 2019 California Green Building Standards (CALGreen) at buildings with designated parking areas (e.g., commercial, educational, retail, multifamily). This will enable drivers of PHEVs to drive a larger share of miles in electric mode (eVMT), as opposed to gasoline-powered mode, thereby displacing GHG emissions from gasoline consumption with a lesser amount of indirect emissions from electricity. Most PHEVs owners charge their vehicles at home overnight. When making trips during the day, the vehicle will switch to gasoline mode if/when it reaches its maximum all-electric range.

Subsector

Parking or Road Pricing/Management

Locational Context

Urban, suburban, rural

Scale of Application

Project/Site

Implementation Requirements

Parking at the chargers must be limited to electric vehicles.

Cost Considerations

The primary costs associated with electric vehicle charging infrastructure include the capital costs of purchasing and installing charging stations, electricity costs from use of stations, and maintenance costs of keeping the charging stations in working order. Costs initially fall to the station owners, either municipalities or private owners, but can be passed along to station users with usage fees. Depending on station placement and charging times required for PHEVs, businesses near charging stations can derive benefits from patronage of station users.

Expanded Mitigation Options

In addition to increasing the percentage of electric miles for PHEVs, the increased availability of chargers from implementation of this measure could mitigate consumer "range anxiety" concerns and increase the adoption and use of battery electric vehicles (BEVs), but this potential effect is not included in the calculations as a conservative assumption. Expanded mitigation could include quantification of the effect of this measure on BEV use.

GHG Mitigation Potential

11.9%

Up to 11.9% of GHG emissions from vehicles accessing the commercial or multifamily housing building

Co-Benefits (icon key on pg. 34)

Climate Resilience

Providing electric vehicle charging infrastructure increases fuel redundancy for electric vehicles even if an extreme weather event disrupts other fuel sources. Electric vehicles could also provide benefits to buildings and the grid, such as emergency backup, energy reserves, and demand response.

Health and Equity Considerations

Differential costs of PHEVs compared to conventional vehicles are decreasing over time, but at present are more expensive, which means this measure could disproportionately benefit those of greater economic means. As costs come into parity over time, this will be less of an issue. Employer, electricity provider, and state incentives for PHEV purchase could help address near-term disparities.

GHG Reduction Formula

$$A = \frac{B \times D \times (F - E) \times (G - (H \times I \times K \times L))}{-C \times J}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicles accessing the office building or housing	0–11.9	%	calculated
User Inputs				
B	Number of chargers installed at site	[ ]	integer	user input
C	Total vehicles accessing the site per day	[ ]	integer	user input
Constants, Assumptions, and Available Defaults				
D	Average number of PHEVs served per day per charger installed	2	integer	CARB 2019
E	Percent of PHEV miles in electric mode without measure	46	%	CARB 2020a
F	Percent of PHEV miles in electric mode with measure	80	%	CARB 2017
G	Average emission factor of PHEV in gasoline mode	205.1	g CO_2e per mile	CARB 2020a; U.S. DOE 2021
H	Energy efficiency of PHEV in electric mode	0.327	kilowatt hours (kWh) per mile	CARB 2020b; U.S. DOE 2021
I	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per megawatt hour (MWh)	CA Utilities 2021
J	Average emission factor of non-electric vehicles accessing the site	307.5	g CO_2e per mile	CARB 2020a
K	conversion from lb to g	454	g per lb	conversion
L	Conversion from kWh to MWh	0.001	MWh per kWh	conversion

Further explanation of key variables:

- (D) – The average number of PHEVs served per day per charger installed is 2 vehicles (CARB 2019). If the user can provide a project-specific value, they should replace the default in the GHG reduction formula.
- (E) - Based on the EMFAC2017 model (v1.0.3), 46 percent of miles traveled by PHEVs in California are eVMT, and 54 percent are in gasoline mode (CARB 2020a).

- (F) – A review of EV user surveys and analytics included in the CARB's *Advanced Clean Cars Mid-Term Report* suggest that PHEV owners can reach 80 percent eVMT with access to adequate supportive charging infrastructure (CARB 2017).
- (G) – As described for (J), the average GHG emission factor for gasoline vehicles is 307.5 grams of CO_2e per mile.
- The fuel efficiency of a PHEV in gasoline mode is calculated as 66.7 percent of the fuel consumption rate of a gasoline vehicle, based on the assumption that a gasoline hybrid vehicle has 50 percent higher fuel economy (miles per gal [mpg]) than a comparable gasoline vehicle, based on a comparison of the gasoline and hybrid Toyota Camry and Corolla models (U.S. DOE 2021). This percentage is applied to the average GHG emission factor for gasoline vehicles to determine the average emission factor for PHEVs in gasoline mode as (66.7%×307.5 g CO_2e per mile). If the user can provide a project-specific value by running EMFAC based on the future year of a project, they should replace the default in the GHG reduction formula.
- (H) – Scaled from a light-duty automobile gasoline equivalent fuel economy 30.3 mpg (CARB 2020a), an energy efficiency ratio (EER) of 2.5 (CARB 2020b), and an assumption of 33.7 kWh electricity per gallon of gasoline (U.S. DOE 2021).
- (I) – GHG intensity factors for major California electricity providers are provided in Tables E-4.3 and E-4.4 in Appendix C. If the project study area is not serviced by a listed electricity provider, or the user is able to provide a project-specific value (i.e., for the future year not referenced in Appendix C), the user should replace the default in the GHG calculation formula. If the electricity provider is not known, the user may elect to use the statewide grid average carbon intensity.
- (J) – The average GHG emission factor for non-electric vehicles accessing the site was calculated in terms of CO_2e per mile using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average of LDA, LDT1, and LDT2 vehicles using diesel and gasoline fuel. The running emission factors for CO_2, CH_4, and N_2O (CARB 2020a) were multiplied by the corresponding 100-year GWP values from the IPCC's Fourth Assessment Report (IPCC 2007). If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the default in the GHG reduction formula.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 11.9 percent, which is based on the following assumptions used to generate a maximum scenario:

- (B) – number of chargers installed = 20. CALGreen provides a non-residential voluntary Tier 2 measure that requires projects with 201 or more parking spaces to allocate 10 percent of total parking spaces for "EV Capable" parking spaces (or 20 parking spaces) (CBSC 2019). Note that EV Capable parking spaces do not actually have EV chargers installed, though they do have electrical panel capacity, a dedicated branch circuit, and a raceway to the EV parking spot to support future installation of charging stations. Therefore, using the number of EV Capable parking spaces as a proxy for EV chargers as a high-end estimate is conservative.

- (C) – total vehicles accessing the site = 200. Per the CALGreen voluntary measure, the number of total parking spaces that correspond with 20 "EV Capable" parking spaces is 201.
- (D) – PHEVs served per day per charger installed = 7. This value is the max (D_{max}). This assumes that all PHEV drivers would coordinate sharing of the limited number of chargers at the site. Value is based on data from the National Renewable Energy Laboratory (CARB 2019).
- (I) – carbon intensity of local electricity provider = 0 lb CO_2e per MWh. This assumes that the local electricity provider is powered 100 percent by renewables and thus has a carbon intensity of zero.

Subsector Maximum

($\sum A_{max_{T\text{-}14 \text{ through } T\text{-}16}} \leq 35\%$) This measure is in the Parking or Road Pricing/Management subsector. This subcategory includes Measures T-14 through T-16. The VMT reduction from the combined implementation of all measures within this subsector is capped at 35 percent.

Example GHG Reduction Quantification

The user will install electric vehicle chargers at their proposed office or multifamily housing development, which will enable employees or residents with PHEVs to drive a larger share of miles in electric mode, as opposed to gasoline-powered mode, thereby displacing GHG emissions from gasoline consumption with a lesser amount of indirect emissions from indirect electricity. In this example, 20 chargers (B) will be installed at a workplace with 200 daily employee vehicles accessing the site (C). The electricity provider for the project area is the Sacramento Municipal Utility District (SMUD) and the analysis year is 2022. The carbon intensity of electricity is therefore 344 lb CO_2e per MWh (I). The GHG impact is calculated as a 3.4 percent reduction from the total emissions from vehicles accessing the site.

$$A = \frac{20 \times 2 \frac{\text{PHEVs}}{\text{charger}\cdot\text{day}} \times (80\% - 46\%) \times \left(205.1 \frac{\text{g } CO_2e}{\text{miles}} - \left(0.327 \frac{\text{kWh}}{\text{mile}} \times 344 \frac{\text{lb } CO_2e}{\text{MWh}} \times 454 \frac{\text{g}}{\text{lb}} \times 0.001 \frac{\text{MWh}}{\text{kWh}}\right)\right)}{-200 \text{ vehicles} \times 307.5 \frac{\text{g } CO_2e}{\text{miles}}} = 3.4\%$$

Quantified Co-Benefits

While the measure will achieve fuel savings, it will also increase electricity consumption. This section defines the methods for quantifying Improved Local Air Quality and fuel savings, as well as increased electricity consumption.

Improved Local Air Quality

Local criteria pollutants will be reduced by the reduction in fossil fuel combustion. The percent reduction in criteria pollutants can be calculated using the GHG reduction formula. Electricity supplied by statewide fossil-fueled or bioenergy power plants will generate criteria pollutants. However, because these power plants are located throughout the state, electricity consumption from vehicles charging will not generate localized criteria pollutant emissions. Consequently, for the quantification of criteria pollutant emission reductions, either the electricity portion of the equation can be removed, or the electricity intensity (I) can be set to zero.

Fuel Savings (Increased Electricity)

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in criteria pollutant emissions. The percent increase in electricity use (M) from this measure can be calculated as follows.

Electricity Use Increase Formula

$$M = \frac{B \times D \times (F - E) \times J \times N \times O}{-C \times P}$$

Electricity Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
M	Increase in electricity from PHEVs	[ ]	%	calculated
User Inputs				
N	Existing electricity consumption of project/site	[ ]	kWh per year	user input
O	Days per year with vehicles accessing the site	260–365	days per year	user input
P	Average annual VMT of vehicles accessing the site	[ ]	miles per day per vehicle	user input
Constants, Assumptions, and Available Defaults				
	None			

Further explanation of key variables:

- (N) – The user should take care to properly quantify building electricity using accepted methodologies (such as CalEEMod).
- (O) – If the proposed development is a workplace in which employees access the site an average of 5 days per week, the user should input 260 workdays. If the development is multifamily dwelling, the user should input 365 days.
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

Sources

- California Air Resources Board (CARB). 2017. *Advanced Clean Cars Mid-Term Report, Appendix G: Plug-in Electric Vehicle In-Use and Charging Data Analysis*. Available: https://ww2.arb.ca.gov/resources/documents/2017-midterm-review-report. Accessed: January 2021.
- California Air Resources Board (CARB). 2019. *Final Sustainable Communities Strategy Program and Evaluation Guidelines Appendices*. November. Available: https://ww2.arb.ca.gov/sites/default/files/2019-11/Final%20SCS%20Program%20and%20Evaluation%20Guidelines%20Appendices.pdf. Accessed: January 2021.

- California Air Resources Board (CARB). 2020a. *EMFAC2017 v1.0.3.* August. Available: https://arb.ca.gov/emfac/emissions-inventory. Accessed: January 2021.
- California Air Resources Board (CARB). 2020b. *Unofficial electronic version of the Low Carbon Fuel Standard Regulation.* Available: https://ww2.arb.ca.gov/sites/default/files/2020-07/2020_lcfs_fro_oal-approved_unofficial_06302020.pdf
- California Air Resources Board (CARB). 2021. OFFROAD2017–ORION. Available: https://arb.ca.gov/emfac/emissions-inventory. Database queried by Ramboll and provided electronically to ICF. March 2021.
- California Utilities. 2021. Excel database of GHG emission factors for delivered electricity, provided to the Sacramento Metropolitan Air Quality Management District and ICF. January through March 2021.
- California Building Standards Commission (CBSC). 2019. Green Building Standards Code, Title 24, Part 11. Appendix A5 – Nonresidential Voluntary Measures. Table A5.601 Nonresidential Buildings: Green Building Standards Code Proposed Performance Approach. July. Available: https://codes.iccsafe.org/content/CAGBSC2019/appendix-a5-nonresidential-voluntary-measures. Accessed: May 2021.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. Available: https://www.ipcc.ch/report/ar4/wg1/. Accessed: January 2021.
- U.S. Department of Energy (U.S. DOE). 2021. *Download Fuel Economy Data.* January. Available: https://www.fueleconomy.gov/feg/download.shtml. Accessed: January 2021.

T-15. Limit Residential Parking Supply

GHG Mitigation Potential

13.7%

Up to 13.7% of GHG emissions from resident vehicles accessing the site

Co-Benefits (icon key on pg. 34)

Climate Resilience

Limiting residential parking supply could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Evacuation plans and plans for transport to cooling/heating/clean air centers during power outages or unhealthy air quality events, however, would need to consider needs of households without access to private vehicles.

Health and Equity Considerations

Limiting parking supply can reduce the cost of housing development and, potentially, increase housing supply and decrease housing expenses. However, this may negatively impact residents that do not have a viable alternative to personal vehicle travel.

Measure Description

This measure will reduce the total parking supply available at a residential project or site. Limiting the amount of parking available creates scarcity and adds additional time and inconvenience to trips made by private auto, thus disincentivizing driving as a mode of travel. Reducing the convenience of driving results in a shift to other modes and decreased VMT and thus a reduction in GHG emissions. Evidence of the effects of reduced parking supply is strongest for residential developments.

Subsector

Parking or Road Pricing/Management

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

This measure is ineffective in locations where unrestricted street parking or other offsite parking is available nearby and has adequate capacity to accommodate project-related vehicle parking demand.

Cost Considerations

Reducing residential parking supply, especially in high density residential areas, can have high-cost savings if it reduces the need for additional investment in parking infrastructure. Some of these savings may be offset by investments in alternative transport solutions, which will need to be robust to ensure that residents can effectively travel to work and all other destinations without a car.

Expanded Mitigation Options

When limiting parking supply, a best practice is to do so at sites that are located near high quality alternative modes of travel (such as a rail station, frequent bus line, or in a higher density area with multiple walkable locations nearby). Limiting parking supply may also allow for more active uses on any given lot, which may support Measures T-1 and T-2 by allowing for higher density construction.

GHG Reduction Formula

$$A = -\frac{B - C}{B} \times D \times E \times F$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from resident vehicles accessing the site	0–13.7	%	calculated
User Inputs				
B	Residential parking demand	[ ]	parking spaces	user input
C	Project residential parking supply	[ ]	parking spaces	user input
D	Percentage of project VMT generated by residents	[ ]	%	user input
Constants, Assumptions, and Available Defaults				
E	Percent of household VMT that is commute based	37	%	Caltrans 2012
F	Percent reduction in commute mode share by driving among households in areas with scarce parking	37	%	Chatman 2013

Further explanation of key variables:

- (B) – The user can calculate the parking demand in the *ITE Parking Generation Manual* based on the project building square footage or number of du. For residential projects, this demand varies based on the size of each unit, and ranges from 1.0 spaces/unit for one-bedroom apartments to 2.6 spaces/unit for single-family homes with 3+ bedrooms.
- (D) – Available research on changes in parking supply focuses on residential land uses. Therefore, reductions are applied only to the share of VMT generated by residents of a project. For most residential projects, this will be 100 percent; however, for mixed-use projects, the user will need to provide project-specific data.
- (E) – The percent of household VMT that is commute-based varies from location to location; the statewide average is 37 percent (Caltrans 2012). If the user can provide a project-specific value based on their project type and area, they should replace the default in the GHG reduction formula.
- (F) – A study found that among households with limited off-street parking (<1 space per adult), there was a 37 percent decrease in auto mode share for commute trips. The method above pro-rates this reduction based on how much the project's parking supply is reduced from demand rates calculated in the *ITE Parking Generation Manual* (ITE 2019). In addition, this reduction is applied to commute trips only due to the limitations of the research.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions is capped at 13.7 percent. This occurs for projects that have no onsite parking (C), 100 percent of VMT arising from residential land use (D), and 37 percent of all VMT arising from commute trips (E). This maximum scenario is presented in the below example quantification.

(C>B) Parking supply is considered to be limited when demand (C) exceeds supply (B). If demand is equal to or less than supply, then implementation of this measure would not result in a GHG reduction.

Subsector Maximum

($\sum A_{max_{T\text{-}14\ through\ T\text{-}16}} \leq 35\%$) This measure is in the Parking or Road Pricing/Management subsector. This subcategory includes Measures T-14 through T-16. The VMT reduction from the combined implementation of all measures within this subsector is capped at 35 percent.

Example GHG Reduction Quantification

The user reduces VMT by reducing a project's parking supply. In this example, the parking demand per ITE is 100 parking spaces (B) and the project would not supply any parking spaces (C). The user would reduce GHG emissions from VMT by 13.7 percent.

$$A = -\frac{100\ \text{spaces} - 0\ \text{spaces}}{100\ \text{spaces}} \times 100\% \times 37\% \times 37\% = -13.7\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- California Department of Transportation (Caltrans). 2012. *California Household Travel Survey (CHTS)*. Available: https://www.nrel.gov/transportation/secure-transportation-data/tsdc-california-travel-survey.html. Accessed: January 2021.
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- Institute of Transportation Engineers (ITE). 2019. Parking Generation Manual. 5th Edition. February. Available: https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=PG5-ALL. Accessed: May 2021.

T-16. Unbundle Residential Parking Costs from Property Cost

GHG Mitigation Potential

15.7%

Up to 15.7% of GHG emissions from project VMT in the study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Unbundling residential parking costs from property costs could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site.

Health and Equity Considerations

The unbundling of parking costs would help decrease housing costs for individuals who do not own personal vehicles.

Measure Description

This measure will unbundle, or separate, a residential project's parking costs from property costs, requiring those who wish to purchase parking spaces to do so at an additional cost. On the assumption that parking costs are passed through to the vehicle owners/drivers utilizing the parking spaces, this measure results in decreased vehicle ownership and, therefore, a reduction in VMT and GHG emissions. Unbundling may not be available to all residential developments, depending on funding sources.

Subsector

Parking or Road Pricing/Management

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Parking costs must be passed through to the vehicle owners/drivers utilizing the parking spaces for this measure to result in decreased vehicle ownership.

Cost Considerations

Unbundling residential parking costs from property costs may decrease revenue for property owners. This loss may be partially offset by reduced costs needed to maintain parking facilities with less car occupancy and the potential for non-resident parking as a supplementary income stream. For residents, reduced fees and the ability to go without owning a car is a major cost benefit. Municipalities also benefit from a reduction of cars on the road, which can lead to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Pair with Measure T-19-A or T-19-B to ensure that residents who eliminate their vehicle and shift to a bicycle can safely access the area's bikeway network.

GHG Reduction Formula

$$A = \frac{B}{C} \times D \times E$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	0–15.7	%	calculated
User Inputs				
B	Annual parking cost per space	[ ]	$ per year	user input
Constants, Assumptions, and Available Defaults				
C	Average annual vehicle cost	$9,282	$ per year	AAA 2019
D	Elasticity of vehicle ownership with respect to total vehicle cost	-0.4	unitless	Litman 2020
E	Adjustment factor from vehicle ownership to VMT	1.01	unitless	FHWA 2017

Further explanation of key variables:

- (B) – For most projects, this represents a monthly parking fee multiplied by 12. For deeded parking spaces, an estimate of the additional cost to a mortgage may be used, or the total cost may be prorated over 30 years. Costs to park will vary widely based on location; however, this value should consider if other nearby offsite parking options are available at lower cost. See Table T-16.1 in Appendix C for examples of monthly parking prices for different facility types.
- (C) – The average vehicle cost per year in 2019 was $9,282, based on a car driven 15,000 miles per year. Costs include gasoline, maintenance, insurance, license and registration, loan finance charges, and depreciation but do not include parking (AAA 2019).
- (D) – A synthesis of literature reported that, on the low end, a 0.4 percent decrease in vehicle ownership occurs for every 1 percent increase in total vehicle costs (Litman 2020).
- (E) – The adjustment factor from vehicle ownership to VMT is based on the following (FHWA 2017):
  - The average Californian household with 1 vehicle drives 11,117 miles per vehicle while households with 2 vehicles drives 11,223 miles per vehicle.
  - The reduction of 1 vehicle from a 2-vehicle household leads to a 0.94 percent decrease in VMT per vehicle.
  - So, $E = 1 - \left(\frac{11{,}117 \frac{\text{miles}}{\text{vehicle}} - 11{,}223 \frac{\text{miles}}{\text{vehicle}}}{11{,}223 \frac{\text{miles}}{\text{vehicle}}} \right) = 1.01$

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The GHG reduction from unbundled parking is capped at 15.7 percent, which is based on the use of (B_{max}) in the GHG reduction formula.

(B_{max}) The annual cost of parking space is capped at $3,600, or $300 per month. At monthly costs above $300, the cost of parking represents more than a 30 percent increase in total vehicle cost. In addition, this reflects the upper maximum of observed parking prices outside of extremely dense downtown areas (such as San Francisco's SOMA neighborhood).

Subsector Maximum

($\sum A_{max_{T\text{-}14 \text{ through } T\text{-}16}} \leq 35\%$) This measure is in the Parking or Road Pricing/Management subsector. This subcategory includes Measures T-14 through T-16. The VMT reduction from the combined implementation of all measures within this subsector is capped at 35 percent.

Example GHG Reduction Quantification

The user reduces VMT by unbundling the parking costs from property costs of a project, discouraging vehicle ownership, and therefore reducing VMT. In this example, the annual parking cost per space is $1,800 (B), which would reduce GHG emissions from project study area VMT (as compared to the same project with bundled parking costs) by 7.8 percent.

$$A = \left(\frac{\$1{,}800}{\$9{,}282}\right) \times -0.4 \times 1.01 = -7.8\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- AAA. 2019. *Your Driving Costs*. September. Available: https://exchange.aaa.com/wp-content/uploads/2019/09/AAA-Your-Driving-Costs-2019.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey – 2017 Table Designer*. Annual VMT / Vehicle by Count of Household Vehicles in California. Available: https://nhts.ornl.gov/. Accessed: March 2021.
- Litman, T. 2020. *Parking Requirement Impacts on Housing Affordability*. June. Available: https://www.vtpi.org/park-hou.pdf. Accessed: January 2021.

T-17. Improve Street Connectivity

GHG Mitigation Potential

30%

Up to 30.0% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Improving street connectivity could increase route redundancy, allowing faster and more efficient travel during extreme weather events, evacuations, or for emergency vehicles requiring access to hazard sites.

Health and Equity Considerations

Multiple active modes routing options allows vulnerable road users to choose based on perceived safety, comfort, speed, and other factors.

Measure Description

This measure accounts for the VMT reduction achieved by a project that is designed with a higher density of vehicle intersections compared to the average intersection density in the U.S. Increased vehicle intersection density is a proxy for street connectivity improvements, which help to facilitate a greater number of shorter trips and thus a reduction in GHG emissions.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

Projects that increase intersection density would be building a new street network in a subdivision or retrofitting an existing street network to improve connectivity (e.g., converting cul-de-sacs or dead-end streets to grid streets).

Cost Considerations

Capital and infrastructure costs for improved street connectivity may be high. Depending on the location, losses may also be incurred through the reduction of sellable land due to the increased street footprint. Benefits come mainly from the reduction of traffic on arterial streets, which reduces congestion and allows for safer use of nonmotorized transportation, such as bikes. These outcomes, in turn, can reduce car usage, which provides costs savings to commuters and municipalities.

Expanded Mitigation Options

Pair with Measure T-18, *Provide Pedestrian Network Improvement*, to best support use of the local pedestrian network.

GHG Reduction Formula

$$A = \frac{B - C}{C} \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–30.0	%	calculated
User Inputs				
B	Intersection density in project site with measure	[ ]	intersections per sq mile	user input
Constants, Assumptions, and Available Defaults				
C	Average intersection density	36	intersections per sq mile	Fehr & Peers 2009
D	Elasticity of VMT with respect to intersection density	-0.14	unitless	Stevens 2016

Further explanation of key variables:

- (C) – The average intersection density is based on the standard suburban intersection density in the U.S. (Fehr & Peers 2009). This density is approximately equivalent to block faces of 750 to 800 feet, or cul-de-sac–style built environments, which are appropriate for suburban areas.
- (D) – A meta-regression analysis of 15 studies found that a 0.14 percent decrease in VMT occurs for every 1 percent increase in intersection density (Stevens 2016).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 30 percent. The purpose of the 30 percent cap is to limit the influence of any single built environmental factor (such as intersection density).

Subsector Maximum

Same as (A_{max}). Measure T-17 is the only measure at the Plan/Community scale within the Land Use subsector.

Example GHG Reduction Quantification

The user reduces VMT by constructing their project with a higher intersection density than the surrounding city. In this example, the project intersection density (B) would be 72 intersections per square mile (sq mile), which would reduce GHG emissions from project VMT by 14 percent.

$$A = \frac{72\ \frac{int}{sq\ mile} - 36\ \frac{int}{sq\ mile}}{36\ \frac{int}{sq\ mile}} \times -0.14 = -14\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Fehr & Peers. 2009. *Proposed Trip Generation, Distribution, and Transit Mode Split Forecasts for the Bayview Waterfront Project Transportation Study*.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? *Journal of the American Planning Association* 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available: https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

T-18. Provide Pedestrian Network Improvement

GHG Mitigation Potential

6.4%

Up to 6.4% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Improving pedestrian networks increases accessibility of outdoor spaces, which can provide health benefits and thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Ensure that the improvements also include accessibility features to allow for people of all abilities to use the network safely and conveniently. Ensure that sidewalks connect to nearby community assets, such as schools, retail, and healthcare.

Measure Description

This measure will increase the sidewalk coverage to improve pedestrian access. Providing sidewalks and an enhanced pedestrian network encourages people to walk instead of drive. This mode shift results in a reduction in VMT and GHG emissions.

Subsector

Neighborhood Design

Locational Context

Urban, suburban, rural

Scale of Application

Plan/Community

Implementation Requirements

The GHG reduction of this measure is based on the VMT reduction associated with expansion of sidewalk coverage expansion, which includes not only building of new sidewalks but also improving degraded or substandard sidewalk (e.g., damaged from street tree roots). However, pedestrian network enhancements with non-quantifiable GHG reductions are encouraged to be implemented, as discussed under *Expanded Mitigation Options*.

Cost Considerations

Depending on the improvement, capital and infrastructure costs may be high. However, improvements to the pedestrian network will increase pedestrian activity, which can increase businesses patronage and provide a local economic benefit. The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

When improving sidewalks, a best practice is to ensure they are contiguous and link externally with existing and planned pedestrian facilities. Barriers to pedestrian access and interconnectivity, such as walls, landscaping buffers, slopes, and unprotected crossings should be minimized. Other best practice features could include high-visibility crosswalks, pedestrian hybrid beacons, and other pedestrian signals, mid-block crossing walks, pedestrian refuge islands, speed tables, bulb-outs (curb extensions), curb ramps, signage, pavement markings, pedestrian-only connections and districts, landscaping, and other improvements to pedestrian safety (see Measure T-35, *Provide Traffic Calming Measures*).

GHG Reduction Formula

$$A = \left(\frac{C}{B} - 1\right) \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from household vehicle travel in plan/community	0–6.4	%	calculated
User Inputs				
B	Existing sidewalk length in study area	[ ]	miles	user input
C	Sidewalk length in study area with measure	[ ]	miles	user input
Constants, Assumptions, and Available Defaults				
D	Elasticity of household VMT with respect to the ratio of sidewalks-to-streets	-0.05	unitless	Frank et al. 2011

Further explanation of key variables:

- (B and C) – Sidewalk length should be measured on both sides of the street. For example, if one 0.5-mile-long street has full sidewalk coverage, the sidewalk length would be 1.0 mile. If there is only sidewalk on one side of the street, the sidewalk length would be 0.5 mile. The recommended study area is 0.6 mile around the pedestrian network improvement. This represents a 6- to 10-minute walking time.
- (D) – A study found that a 0.05 percent decrease in household vehicle travel occurs for every 1 percent increase in the sidewalk-to-street ratio (Frank et al. 2011; Handy et al. 2014).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 3.4 percent, which is based on the following assumptions:

- 35.2 percent of vehicle trips are short trips (2 mile or less, average of 1.29 miles) and thus could easily shift to walking (FHWA 2019).
- 64.8 percent of vehicle trips are longer trips that are unlikely to shift to walking (2 miles or more, average of 10.93 miles) (FHWA 2019).
- So $A_{max} = \frac{35.2\% \times 1.29 \text{ miles}}{64.8\% \times 10.93 \text{ miles}} = 6.4\%$

Subsector Maximum

$(\sum A_{max_{T\text{-}18\ through\ T\text{-}22\text{-}C}} \leq 10\%)$ This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces household VMT by improving the pedestrian network in the study area. In this example, the existing sidewalk length (B) is 9 miles, and the sidewalk length with the measure (C) would be 10 miles. With these conditions, the user would reduce GHG emissions from household VMT within the study area by 0.6 percent.

$$A = \left(\frac{10 \text{ miles}}{9 \text{ miles}} - 1\right) \times -0.05 = -0.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in household VMT would be the same as the percent reduction in GHG emissions (A).

Improved Public Health

Users are directed to the Integrated Transport and Health Impact Model (ITHIM) (CARB et al. 2020). The ITHIM can quantify the annual change in health outcomes associated with active transportation, including deaths, years of life lost, years of living with disability, and incidence of community and individual disease.

Sources

- California Air Resources Board (CARB), California Department of Public Health (CDPH), and Nicholas Linesch Legacy Fund. 2020. Integrated Transport and Health Impact Model. Available: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#Home. Accessed: September 17, 2021.
- Federal Highway Administration (FHWA). 2019. *2017 National Household Travel Survey Popular Vehicle Trip Statistics*. Available: https://nhts.ornl.gov/vehicle-trips. Accessed: January 2021.

- Frank, L., M. Greenwald, S. Kavage, and A. Devlin. 2011. *An Assessment of Urban Form and Pedestrian and Transit Improvements as an Integrated GHG Reduction Strategy*. WSDOT Research Report WA-RD 765.1, Washington State Department of Transportation. April. Available: www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf. Accessed: January 2021.
- Handy, S., S. Glan-Claudia, and M. Boarnet. 2014. *Impacts of Pedestrian Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief.* September. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Pedestrian_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.

T-19-A. Construct or Improve Bike Facility

GHG Mitigation Potential

0.8%

Up to 0.8% of GHG emissions from vehicles parallel roadways

Co-Benefits (icon key on pg. 34)

Climate Resilience

Constructing and improving bike facilities can incentivize more bicycle use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Prioritize low-income and underserved areas and communities with lower rates of vehicle ownership or fewer transit options. Make sure that the bicycle facility connects to a larger existing bikeway network that accesses destinations visited by low-income or underserved communities.

Measure Description

This measure will construct or improve a single bicycle lane facility (only Class I, II, or IV) that connects to a larger existing bikeway network. Providing bicycle infrastructure helps to improve biking conditions within an area. This encourages a mode shift on the roadway parallel to the bicycle facility from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. When constructing or improving a bicycle facility, a best practice is to consider local or state bike lane width standards. A variation of this measure is provided as T-19-B, *Construct or Improve Bike Boulevard*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community. This measure reduces VMT on the roadway segment parallel to the bicycle facility (i.e., the corridor). An adjustment factor is included in the formula to scale the VMT reduction from the corridor level to the plan/community level.

Implementation Requirements

The bicycle lane facility must be either Class I, II, or IV. Class I bike paths are physically separated from motor vehicle traffic. Class IV bikeways are protected on-street bikeways, also called cycle tracks. Class II bike lanes are striped bicycle lanes that provide exclusive use to bicycles on a roadway.

Cost Considerations

Capital and infrastructure costs for new bike facilities may be high. The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Implement alongside Measures T-22-A, T-22-B, and/or T-22-C to ensure that micromobility users can ride safely along bicycle lane facilities and not have to ride along pedestrian infrastructure, which is a risk to pedestrian safety.

GHG Reduction Formula

$$A = -B \times \frac{\frac{F}{I} \times (C + D) \times E \times G}{H}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from displaced vehicles on roadway parallel to bicycle facility	0–0.8	%	calculated
User Inputs				
B	Percent of plan/community VMT on parallel roadway	0–100	%	user input
C	Active transportation adjustment factor	Table T-19.1	unitless	CARB 2020
D	Credits for key destinations near project	Table T-19.2	unitless	CARB 2020
E	Growth factor adjustment for facility type	Table T-19.3	unitless	CARB 2020
Constants, Assumptions, and Available Defaults				
F	Annual days of use of new facility	Table T-19.4	days per year	NOAA 2017
G	Existing regional average one-way bicycle trip length	Table T-10.1	miles per trip	FHWA 2017
H	Existing regional average one-way vehicle trip length	Table T-10.1	miles per trip	FHWA 2017
I	Days per year	365	days per year	standard

Further explanation of key variables:

- (B) – The percent of total plan/community VMT within the roadway parallel to the bike facility should represent the expected total VMT generated by all land use in that area, including office, residences, retail, schools, and other uses. The most appropriate source for this data is from a local travel demand forecasting model. An alternate method uses VMT per worker or VMT per resident as calculated for SB 743 compliance and screening purposes multiplied by the population in the area.
- (C, D, and E) – The active transportation adjustment factor, key destination credit, and growth factor adjustment should be looked up by the user in Tables T-19.1 through T-19.3 in Appendix C. The active transport adjustment factor is based on the existing annual average daily traffic (AADT) of the facility, length of the proposed bike facility, and the city population. The key destination credit is based on the number of key destinations within 0.5-mile of the facility. The growth factor is based on the type of proposed bicycle facility.
- (F) – The annual days of use for the new facility should be looked up by users in Table T-19.4 based on the county in which the project is located. The days of use is based on the number of days per year where there is no rainfall (i.e., <=0.1 inches) (NOAA 2017).

- (G and H) – Ideally, the user will calculate bicycle and vehicle trip lengths for the corridor at a scale no larger than the surrounding census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input regional average one-way bicycle and vehicle trip lengths for one of the six most populated CBSAs in California provided in Table T-10.1 in Appendix C (FHWA 2017).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use CBSA data from Table T-10.1 in Appendix C, the maximum percent reduction in GHG emissions (A) is 0.8 percent. This is based on a neighborhood project the size of a large corridor (B = 100%) within the CBSA of Sacramento-Roseville-Arden-Arcade that uses the highest values for (C, D, and E) in Tables T-19.1 through T-19.3 and annual use days for Sacramento County (F) in Table T-19.4. This maximum scenario is presented in the below example quantification.

(C_{max}) The active transportation adjustment factor (C) was determined for roadways with AADT ranging from 1 to 30,000 (CARB 2020). Roadways with AADT greater than 30,000 are generally not appropriate for bicycle facilities. Care should be taken by the user in interpreting the results from this equation for a project roadway with AADT greater than 30,000.

Subsector Maximum

($\sum A_{max_{\text{T-18 through T-22-C}}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces VMT by constructing a bicycle facility that displaces vehicle trips with bicycle trips. In this example, the following assumptions are made to obtain inputs from Tables T-19.1 through T-19.3 in Appendix C:

- Percent of plan/community VMT on parallel roadway (B) = 100%. The project would establish a bike corridor the whole length of a central commercial thoroughfare. It is assumed this main street makes up the entire neighborhood.
- Active transportation adjustment factor (C) = 0.0207. Existing AADT on the roadway parallel to the proposed bicycle facility is 10,000, the facility length is 2.5 miles, and the project site is in a university town with a population of 200,000.
- Key destination credit (D) = 0.003. There are 10 key destinations within 0.25 mile of the project site.
- Growth factor adjustment (E) = 1.54. The bike facility would be a new Class IV bikeway.

The project is within the Sacramento-Roseville-Arden-Arcade CBSA and the user does not have project-specific values for average bicycle and vehicle trip lengths. Accordingly, the inputs of 2.9 miles and 10.9 miles, respectively (G and H), from Table T-10.1 in Appendix C are assumed. The user would displace GHG emissions from project study area VMT by 0.8 percent.

$$A = \mathbf{-100\%} \times \left(\frac{\frac{307 \text{ days}}{365 \text{ days}} \times (\mathbf{0.0207} + \mathbf{0.003}) \times \mathbf{1.54} \times 2.9 \text{ miles}}{10.9 \text{ miles}} \right) = -0.8\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Improved Public Health

Users are directed to the ITHIM (CARB et al. 2020). The ITHIM can quantify the annual change in health outcomes associated with active transportation, including deaths, years of life lost, years of living with disability, and incidence of community and individual disease.

Sources

- California Air Resources Board (CARB). 2020. *Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program*. September. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/draft_sgc_ahsc_qm_091620.pdf. Accessed: January 2021.
- California Air Resources Board (CARB), California Department of Public Health (CDPH), and Nicholas Linesch Legacy Fund. 2020. Integrated Transport and Health Impact Model. Available: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#Home. Accessed: September 17, 2021.
- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

- National Oceanic and Atmospheric Administration (NOAA). 2021. *Global Historical Climatology Network–Daily (GHCN-Daily), Version 3*. 2015-2019 Average of Days Per Year with Precipitation >0.1 Inches. Available: https://www.ncei.noaa.gov/access/search/data-search/daily-summaries?bbox=38.922,-120.071,38.338,-119.547&place=County:1276&dataTypes=PRCP&startDate=2015-01-01T00:00:00&endDate=2019-01-01T23:59:59. Accessed: May 2021.

T-19-B. Construct or Improve Bike Boulevard

GHG Mitigation Potential

0.2%

Up to 0.2% of GHG emissions from vehicles on roadway

Co-Benefits (icon key on pg. 34)

(icon key on pg. 34)

Climate Resilience

Constructing and improving bike boulevards can incentivize more bicycle use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Prioritize low-income and underserved areas and communities with lower rates of vehicle ownership or fewer transit options. Make sure that the bicycle boulevard connects to a larger existing bikeway network that accesses destinations visited by low-income or underserved communities.

Measure Description

Construct or improve a single bicycle boulevard that connects to a larger existing bikeway network. Bicycle boulevards are a designation within Class III Bikeway that create safe, low-stress connections for people biking and walking on streets. This encourages a mode shift from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. A variation of this measure is provided as T-19-A, *Construct or Improve Bike Facility*, which is for Class I, II, or IV bicycle infrastructure.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community. This measure reduces VMT on the roadway segment parallel to the bicycle facility (i.e., the corridor). An adjustment factor is included in the formula to scale the VMT reduction from the corridor level to the plan/community level.

Implementation Requirements

The following roadway conditions must be met.

- Functional classification: local and collector if there is no more than a single general-purpose travel lane in each direction.
- Design speed: <= 25 miles per hour.
- Design volume <= 5,000 average daily traffic.
- Treatments at major intersections: both directions have traffic signals (or an effective control device that prioritizes pedestrian and bicycle access such as rapid flashing beacons, pedestrian hybrid beacons, high-intensity activated crosswalks, TOUCANs), bike route signs, "sharrowed" roadway markings, and pedestrian crosswalks.

Cost Considerations

Capital and infrastructure costs for new bike boulevards may be high, though lower than implementing the same length of protected bicycle lanes (Class IV). After the bike boulevard is complete, the local municipality may achieve cost savings from reduced infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Construct boulevards with forced turns for vehicles every few blocks to minimize through traffic while ensuring that speed and volume metrics are met. Implement alongside Measures T-22-A, T-22-B, and/or T-22-C to ensure that micromobility users can ride safely along bicycle lane facilities and not pedestrian infrastructure, which is a risk to pedestrian safety.

GHG Reduction Formula

$$A = B \times \frac{D \times (F - (C \times F))}{E \times G}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from displaced vehicles on roadway with bicycle boulevard	0–0.2	%	calculated
User Inputs				
B	Percent of plan/community VMT on roadway to have bicycle boulevard	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Bike mode adjustment factor	1.14	unitless	Schwartz 2021
D	Existing bicycle trip length for all trips in region	Table T-10.1	miles	FHWA 2017a
E	Existing vehicle trip length for all trips in region	Table T-10.1	miles	FHWA 2017a
F	Existing bicycle mode share for work trips in region	Table T-10.2	%	FHWA 2017a
G	Existing vehicle mode share for work trips in region	Table T-10.2	%	FHWA 2017a

Further explanation of key variables:

- (C) – The bike mode adjustment factor is based on a database of before/after bicycle counts for 10 projects in four U.S. cities that invested in bicycle boulevards. Bicycle ridership increased on average by 114 percent (Schwartz 2021).
- (D and E) – Ideally, the user will calculate bicycle and vehicle trip lengths for the corridor at a scale no larger than the surrounding census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input regional average one-way bicycle and vehicle trip lengths for one of the six most populated CBSAs in California provided in Table T-10.1 in Appendix C (FHWA 2017a).
- (F and G) – Ideally, the user will calculate bicycle and auto mode share for work trips for a Project/Site at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the regional average mode shares for bicycle and vehicle work trips for one of the six most populated CBSAs in California, as presented in Table T-10.2 in Appendix C (FHWA 2017b). If the project study area is not within the listed

CBSAs or the user is able to provide a project-specific value, the user should replace these regional defaults in the GHG reduction formula. For areas not covered by the listed CBSAs, which represent the denser areas of the state, bicycle mode share is likely to be lower and vehicle share higher than presented in Table T-10.2.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use CBSA data from Tables T-10.1 and T-10.2 in Appendix C, the maximum percent reduction in GHG emissions (A) is 0.2 percent. This is based on a neighborhood project the size of a large corridor (B = 100%) within the CBSA of San Jose-Sunnyvale-Santa Clara that uses the highest values for (C, D, and E) in Tables T-19.1 through T-19.3 and annual use days for Sacramento County (F) in Table T-19.4. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18 \text{ through } T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces VMT by providing a bicycle boulevard on the targeted roadway, which encourages bicycle trips in place of vehicle trips. In this example, it is assumed this main street makes up the entire plan area, i.e., (B) is 100 percent. The project is within San Jose-Sunnyvale-Santa Clara CBSA and the user does not have project-specific values for trip lengths and mode shares for bicycles and vehicles. Per Tables T-10.1 and T-10.2, inputs for these variables are 2.8 miles, 11.5 miles, 4.1 percent, and 86.6 percent, respectively (D, E, F, and G). GHG emissions from plan/community VMT would be reduced by 0.2 percent.

$$A = \mathbf{100\%} \times \frac{2.8 \text{ miles} \times \left(4.1\% - (1.14 \times 4.1\%)\right)}{11.5 \text{ miles} \times 86.6\%} = \text{-}0.2\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Improved Public Health

Users are directed to the ITHIM (CARB et al. 2020). The ITHIM can quantify the annual change in health outcomes associated with active transportation, including deaths, years of life lost, years of living with disability, and incidence of community and individual disease.

Sources

- California Air Resources Board (CARB), California Department of Public Health (CDPH), and Nicholas Linesch Legacy Fund. 2020. Integrated Transport and Health Impact Model. Available: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#Home. Accessed: September 17, 2021.
- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer*. Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Schwartz, S. 2021. *Planning for Stress Free Connections: Estimating VMT Reductions.* February.

T-20. Expand Bikeway Network

GHG Mitigation Potential

0.5%

Up to 0.5% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Expanding bikeway networks can incentivize more bicycle use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Prioritize low-income and underserved areas and communities with lower rates of vehicle ownership or fewer transit options. Make sure that destinations visited by low-income or underserved communities are served by the network.

Measure Description

This measure will increase the length of a city or community bikeway network. A bicycle network is an interconnected system of bike lanes, bike paths, bike routes, and cycle tracks. Providing bicycle infrastructure with markings and signage on appropriately sized roads with vehicle traffic traveling at safe speeds helps to improve biking conditions (e.g., safety and convenience). In addition, expanded bikeway networks can increase access to and from transit hubs, thereby expanding the "catchment area" of the transit stop or station and increasing ridership. This encourages a mode shift from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. When expanding a bicycle network, a best practice is to consider bike lane width standards from local agencies, state agencies, or the National Association of City Transportation Officials' *Urban Bikeway Design Guide*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The bikeway network must consist of either Class I, II, or IV infrastructure.

Cost Considerations

Capital and infrastructure costs for expanding the bikeway network may be high. Construction of these facilities may also increase vehicle traffic, leading to more congestion and temporarily longer trip times for motorist. However, the local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

As networks expand, ensure safe, secure, and weather-protected bicycle parking facilities at origins and destinations. Also, implement alongside T-22-A, T-22-B, and/or T-22-C to ensure that micromobility options can ride safely along bicycle lane facilities and not have to ride along pedestrian infrastructure, which is a risk to pedestrian safety.

GHG Reduction Formula

$$A = -1 \times \frac{\left(\frac{C - B}{B}\right) \times D \times F \times H}{E \times G}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from employee commute vehicle travel in plan/community	0–0.5	%	calculated
User Inputs				
B	Existing bikeway miles in plan/community	[ ]	miles	user input
C	Bikeway miles in plan/community with measure	[ ]	miles	user input
Constants, Assumptions, and Available Defaults				
D	Bicycle mode share in plan/community	Table T-20.1	%	FHWA 2017
E	Vehicle mode share in plan/community	Table T-3.1	%	FHWA 2017
F	Average one-way bicycle trip length in plan/community	Table T-10.1	miles per trip	FHWA 2017
G	Average one-way vehicle trip length in plan/community	Table T-10.1	miles per trip	FHWA 2017
H	Elasticity of bike commuters with respect to bikeway miles per 10,000 population	0.25	unitless	Pucher & Buehler 2011

Further explanation of key variables:

- (B) – The existing bikeway miles in a plan/community should be calculated by measuring the distance of all Class I, II, III, and IV bikeways within the plan/community. This information can sometimes be found in a city's bicycle master plan, if a plan has been prepared and is up to date.
- (D, E, F, and G) – Ideally, the user will calculate bicycle and auto mode share and trip length for a plan/community at the city scale. Potential data sources include the California Household Travel Survey (preferred) or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode shares and trip lengths for bicycles and vehicles for one of the six most populated CBSAs in California, as presented in Table T-3.1, T-10.2, and T-20.1 in Appendix C. Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state. Similarly, it is likely for areas outside of the area covered by the listed CBSAs to have vehicle mode shares higher and bicycle mode shares lower than the values provided in the tables.
- (H) – A multivariate analysis of the impacts of bike lanes on cycling levels in the 100 largest U.S. cities found that a 0.25 percent increase in commute cycling occurs for every 1 percent increase in bike lane distance (Pucher & Buehler 2011).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use CBSA data from Tables T-3.1, T-10.2, and T-20.1 in Appendix C, the maximum percent reduction in GHG emissions (A) is 0.5 percent. This is based on a project within the CBSA of San Jose-Sunnyvale-Santa Clara that has no existing bike lane infrastructure. This maximum scenario is presented in the below example quantification.

($\frac{C-B}{B}_{max}$) The maximum percent increase in bike lane miles in the plan/community is conservatively capped at 1000 percent. If there is no existing bike lane infrastructure in the plan/community, (B) should be set to (1/11×C), resulting in a percentage change of 1000 percent.

Subsector Maximum

($\sum A_{max_{T\text{-}18 \text{ through } T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces employee commute VMT by increasing the length of a bicycle network within a plan/community, which displaces commute vehicle trips with bicycle trips. In this example, the existing bikeway length in the plan/community (B) is 0 miles and the length with the measure (C) is 11 miles. The project is within the San Jose-Sunnyvale-Santa Clara CBSA, yielding the following inputs from Tables T-3.1, T-10.2, and T-20.1 in Appendix C.

- Bicycle mode share (D) = 0.79 percent.
- Vehicle mode share (E) = 91.32 percent.
- Average one-way bicycle trip length (F) = 2.8 miles.
- Average one-way vehicle trip length (G) = 11.5 miles.

The user would displace GHG emissions from project study area employee commute VMT by 0.5 percent.

$$A = -1 \times \left(\frac{(1000\%) \times 0.79\% \times 2.8 \text{ miles} \times 0.25}{91.32\% \times 11.5 \text{ miles}} \right) = -0.5\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an

adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in employee commute VMT would be the same as the percent reduction in GHG emissions (A).

Improved Public Health

Users are directed to the ITHIM (CARB et al. 2020). The ITHIM can quantify the annual change in health outcomes associated with active transportation, including deaths, years of life lost, years of living with disability, and incidence of community and individual disease.

Sources

- California Air Resources Board (CARB), California Department of Public Health (CDPH), and Nicholas Linesch Legacy Fund. 2020. Integrated Transport and Health Impact Model. Available: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#Home. Accessed: September 17, 2021.
- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey – 2017 Table Designer*. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Pucher, J., and Buehler, R. 2011. *Analysis of Bicycling Trends and Policies in Large North American Cities: Lessons for New York*. March. Available: http://www.utrc2.org/sites/default/files/pubs/analysis-bike-final_0.pdf. Accessed: January 2021.

T-21-A. Implement Conventional Carshare Program

GHG Mitigation Potential

0.15%

Up to 0.15% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Carshare programs can increase accessibility and provide redundancy to vehicles that can be used to evacuate or obtain resources during an extreme weather event. Carshare programs can allow residents to give up or avoid car ownership, leading to cost savings that can help build economic resilience.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will increase carshare access in the user's community by deploying conventional carshare vehicles. Carsharing offers people convenient access to a vehicle for personal or commuting purposes. This helps encourage transportation alternatives and reduces vehicle ownership, thereby avoiding VMT and associated GHG emissions. A variation of this measure, electric carsharing, is described in Measure T-21-B, *Implement Electric Carshare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing one-way carsharing service with a free-floating operational model. This measure should be applied with caution if using a different form of carsharing (e.g., roundtrip, peer-to-peer, fractional).

Cost Considerations

The costs incurred by the carshare program service manager (typically a municipality or carshare company) may include the capital costs of purchasing vehicles; costs of storing, maintaining, and replacing the fleet; and costs for marketing and administration. Some of these costs may be offset by income generated through program use.

Expanded Mitigation Options

When implementing a carshare program, best practice is to discount carshare membership and provide priority parking for carshare vehicles to encourage use of the service.

GHG Reduction Formula

$$A = \frac{B \times (E - D)}{C}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.15	%	calculated
User Inputs				
B	Number of vehicles deployed in plan/community	[ ]	integer	user input
C	VMT in plan/community without measure	[ ]	VMT per day	user input
Constants, Assumptions, and Available Defaults				
D	Conventional VMT avoided with measure	68.2	VMT per day per vehicle	Martin and Shaheen 2016
E	Conventional VMT added with measure	24.4	VMT per day per vehicle	Martin and Shaheen 2016

Further explanation of key variables:

- (B) – The number of cars in the carshare program is selected by the carshare provider, but its magnitude is relative to the size of the service area. A study of several carsharing programs (Martin and Shaheen 2016) documented a range of carshare fleet sizes for different North American cities: Calgary (590), San Diego (406), Seattle (640), Vancouver (920), Washington, D.C. (626).
- (C) – The total plan/community VMT should represent the expected total VMT generated by all land use in that area. The most appropriate source for this data is from a local travel demand model.
- (D) – Conventional VMT avoided per deployed carshare vehicle was derived based on a study of conventional-engine based car share programs in Calgary, Seattle, Vancouver, and Washington, D.C. It accounts for VMT avoided from carshare users who sold their personal vehicles and carshare users who decided not to purchase a personal vehicle, both directly because of the availability of carshare (Martin and Shaheen 2016).
- (E) – Conventional VMT added per deployed carshare vehicle was derived based on a study of conventional-engine based car share programs in Calgary, Seattle, Vancouver, and Washington, D.C. It accounts for the VMT of the carshare vehicles (Martin and Shaheen 2016).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 0.15 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18 \text{ through } T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying carshare vehicles. In this example, the project would be in the city of San Diego, which in 2017 had a VMT per day of 24,101,089 miles (C) (SANDAG 2019). Assuming twice the number of vehicles used in the Car2go San Diego program (B), the GHG emissions from plan/community VMT would be reduced by 0.15 percent.

$$A = \frac{\textbf{812 vehicles} \times (24.4 \frac{\text{VMT}}{\text{day·vehicle}} - 68.2 \frac{\text{VMT}}{\text{day·vehicle}})}{\textbf{24,101,089} \frac{\textbf{VMT}}{\textbf{day}}} = \text{-}0.15\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Martin, E. and S. Shaheen. 2016. *The Impacts of Car2go on Vehicle Ownership, Modal Shift, Vehicle Miles Traveled, and Greenhouse Gas Emissions: An Analysis of Five North American Cities.* July. Available: https://tsrc.berkeley.edu/publications/impacts-car2go-vehicle-ownership-modal-shift-vehicle-miles-traveled-and-greenhouse-gas. Accessed: March 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool – Design Document.* June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

T-21-B. Implement Electric Carshare Program

GHG Mitigation Potential

0.18%

Up to 0.18% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Electric carshare programs can increase accessibility and provide redundancy to vehicles that can be used to evacuate or obtain resources during an extreme weather event. Electric vehicles also provide fuel redundancy by allowing an alternative fuel source if an extreme event disrupts other fuel sources; however, they may decrease resilience if they are the only option available during a power outage.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will increase carshare access in the user's community by deploying electric carshare vehicles. Carsharing offers people convenient access to a vehicle for personal or commuting purposes. This helps encourage transportation alternatives and reduces vehicle ownership, thereby avoiding VMT and associated GHG emissions. This also encourages a mode shift from internal combustion engine vehicles to electric vehicles, displacing the emissions-intensive fossil fuel energy with less emissions-intensive electricity. Electric carshare vehicles require more staffing support compared to conventional carshare programs for shuttling electric vehicles to and from charging points. A variation of this measure, conventional carsharing, is described in Measure T-21-A, *Implement Conventional Carshare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing one-way carsharing service with a free-floating operational model. This measure should be applied with caution if using a different form of carsharing (e.g., roundtrip, peer-to-peer, fractional).

Cost Considerations

Costs incurred by the service manager (e.g., municipality, carshare company) may include the capital costs of purchasing vehicles; costs of storing, maintaining, and replacing the fleet; and costs for marketing and administration. Some of these costs may be offset by income generated through program use. Participants' recurring costs of renting a carshare vehicle may be offset by the cost savings from access to cheaper transportation.

Expanded Mitigation Options

When implementing a carshare program, best practice is to discount carshare membership and provide priority parking for carshare vehicles to encourage use of the service.

GHG Reduction Formula

$$A = -1 \times \frac{B \times ((E \times G \times H \times I \times J) - (D \times F))}{C \times F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.18	%	calculated
User Inputs				
B	Number of electric vehicles deployed in plan/community	[ ]	integer	user input
C	VMT in plan/community without measure	[ ]	VMT per day	user input
Constants, Assumptions, and Available Defaults				
D	Conventional VMT avoided with measure	54.8	VMT per day per EV	Martin and Shaheen 2016
E	Electric VMT added with measure	13.7	VMT per day per EV	Martin and Shaheen 2016
F	Emission factor of non-electric light duty fleet mix	307.5	g CO_2e per mile	CARB 2020a
G	Energy efficiency of carshare electric vehicle	0.327	kWh per mile	CARB 2020b; U.S. DOE 2021
H	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per MWh	CA Utilities 2021
I	Conversion from lb to g	454	g per lb	conversion
J	Conversion from kWh to MWh	0.001	MWh per kWh	conversion

Further explanation of key variables:

- (B) – The number of cars in the carshare program is selected by the carshare provider, but its magnitude is relative to the size of the service area. A study of several carsharing programs (Martin and Shaheen 2016) documented a range of carshare fleet sizes for different North American cities: Calgary (590), San Diego (406), Seattle (640), Vancouver (920), Washington, D.C. (626).
- (C) – The total plan/community VMT should represent the expected total VMT generated by all land use in that area. The most appropriate source for this data is from a local travel demand forecasting model.
- (D) – Conventional VMT avoided per deployed carshare vehicle was derived based on a study of an electric vehicle carshare program in San Diego. It accounts for VMT avoided from carshare users who sold their personal vehicles and carshare users who decided not to purchase a personal vehicle, both directly because of the availability of carshare (Martin and Shaheen 2016).

- (E) – Electric VMT added per deployed carshare vehicle was derived based on a study of an electric vehicle carshare program in San Diego. It accounts for the VMT of the carshare vehicles and includes staff-driven VMT needed to bring the vehicles to charging points (Martin and Shaheen 2016).
- (F) – The average GHG emission factor for non-electric vehicles was calculated in terms of CO_2e per mile using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average of LDA, LDT1, and LDT2 vehicles using diesel and gasoline fuel. The running emission factors for CO_2, CH_4, and N_2O (CARB 2020a) were multiplied by the corresponding 100-year GWP values from the IPCC's Fourth Assessment Report (IPCC 2007). If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the default in the GHG reduction formula.
- (G) – Scaled from light-duty automobile gasoline equivalent fuel economy (G from Measure T-14) based on energy efficiency ratio (EER) of 2.5 (CARB 2020b) and an assumption of 33.7 kWh electricity per gallon of gasoline (U.S. DOE 2021).
- (H) – GHG intensity factors for major California electricity providers are provided in Tables E-4.3 and E-4.4 in Appendix C. If the project study area is not serviced by a listed electricity provider, or the user is able to provide a project-specific value (i.e., for the future year not referenced in Appendix C), the user should replace the default in the GHG calculation formula. If the electricity provider is not known, the user may elect to use the statewide grid average carbon intensity.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 0.18 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18\ through\ T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying carshare vehicles. In this example, the project would be in the city of San Diego, which in 2017 had a VMT per day of 24,101,089 miles (C) (SANDAG 2019). Assuming twice the number of vehicles used in the Car2go San Diego program (B), and a commitment by the carshare service provider to purchase zero-carbon electricity for all carshare charging stations (H), the GHG emissions from plan/community VMT would be reduced by 0.18 percent.

$$A = -1 \times \frac{812 \times \left(\left(13.7\,\frac{eVMT}{day \cdot vehicle} \times 0.327\,\frac{kWh}{mile} \times 0\,\frac{lb\ CO_2e}{MWh} \times 454\,\frac{g}{lb} \times 0.001\,\frac{MWh}{kWh}\right) - \left(54.8\,\frac{cVMT}{day \cdot vehicle} \times 307.5\,\frac{g\ CO_2e}{mile}\right)\right)}{24{,}101{,}089\,\frac{VMT}{day} \times 307.5\,\frac{g\ CO_2e}{mile}} = -0.18\%$$

Quantified Co-Benefits

Improved Local Air Quality

Local criteria pollutants will be reduced by the reduction in vehicle fuel consumption. Electricity supplied by statewide fossil-fueled or bioenergy power plants will generate criteria pollutants. However, because these power plants are located throughout the state, electricity consumption from electric vehicles will not generate localized criteria pollutant emissions. Accordingly, the percent reduction in NO_X, CO, NO_2, SO_2, and PM (K) is calculated using a simplified version of the GHG reduction formula, as follows:

$$K = -1 \times \frac{B \times -D}{C}$$

Reductions in ROG emissions can be calculated by multiplying the percent reduction in other criteria pollutant emissions (K) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Fuel Savings (Increased Electricity)

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in criteria pollutant emissions (K). The percent increase in electricity use (L) from this measure can be calculated using a variation of the GHG reduction formula, as follows.

Electricity Use Increase Formula

$$L = \frac{B \times E \times G \times N}{M}$$

Electricity Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
L	Increase in electricity from electric vehicles	[ ]	%	calculated
User Inputs				
M	Existing electricity consumption of plan/community	[ ]	kWh per year	user input
Constants, Assumptions, and Available Defaults				
N	Days per year carshare program operational	365	days per year	assumed

Further explanation of key variables:

- (M) – The user should take care to properly quantify building electricity using accepted methodologies (such as CalEEMod).
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

VMT Reductions

The percent reduction in VMT (O) is calculated using a simplified version of the GHG reduction formula that excludes the variables related to emission factors, as follows.

$$O = -1 \times \frac{B \times (E - D)}{C}$$

Sources

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T-22-A. Implement Pedal (Non-Electric) Bikeshare Program

GHG Mitigation Potential

0.02%

Up to 0.02% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Bikeshare programs can incentivize more bicycle use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will establish a bikeshare program. Bikeshare programs provide users with on-demand access to bikes for short-term rentals. This encourages a mode shift from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. Variations of this measure are described in Measure T-22-B, *Implement Electric Bikeshare Program*, and Measure T-22-C, *Implement Scootershare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing docked (i.e., station-based) bikeshare programs. This measure should be applied with caution if using dockless (free-floating) bikeshare.

Cost Considerations

The costs incurred by the service manager (e.g., municipality or bikeshare company) may include the capital costs for purchasing a bicycle fleet; installing accessible and secure docking stations; storing, maintaining, and replacing the fleet; and marketing and administration. Some of these costs may be offset by income generated through program use. Program participants will benefit from the cost savings from access to cheaper transportation alternatives (compared to private vehicles, private bicycles, or use of ride-hailing services). The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Best practice is to discount bikeshare membership and dedicate bikeshare parking to encourage use of the service. Also consider including space on the vehicle to store personal items while traveling, such as a basket.

GHG Reduction Formula

This measure methodology does not account for the direct GHG emissions from vehicle travel of program employees picking up and dropping off bikes.

$$A = -1 \times \frac{(C - B) \times D \times E \times F}{G \times H}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.02	%	calculated
User Inputs				
B	Percent of residences in plan/community with access to bikeshare system without measure	0–100	%	user input
C	Percent of residences in plan/community with access to bikeshare system with measure	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Daily bikeshare trips per person	0.021	trips per day per person	MTC 2017
E	Vehicle to bikeshare substitution rate	19.6	%	McQueen et al. 2020
F	Bikeshare average one-way trip length	1.4	miles per trip	Lazarus et al. 2019
G	Daily vehicle trips per person	2.7	trips per day per person	FHWA 2018
H	Regional average one-way vehicle trip length	Table T-10.1	miles per trip	FHWA 2017

Further explanation of key variables:

- (B and C) – Access to bikesharing is measured as the percent of residences in the plan/community within 0.25 mile of a bikeshare station. For dockless bikes, assume that all residences within 0.25 mile of the designated dockless service area would have access.
- (D) – An analysis of bike share service areas in the San Francisco Bay Area estimated that in locations with access to bikesharing, there were between 21 and 25 bikeshare trips per day per 1,000 residents (MTC 2017). To be conservative, the low end of this range is cited.
- (E) – A literature review of several academic and government reports found that the average car trip substitution rate by bikeshare trips was 19.6 percent. This included bikeshare programs in Washington D.C., Minneapolis, and Montreal (McQueen et al. 2020).

- (F) – A case study on average trip lengths for pedal and electric bikeshare programs in San Francisco reported a one-way pedal bikeshare trip of 1.4 miles (Lazarus et al. 2019).
- (G) – A summary report of the 2017 National Household Travel Survey data found that the average person in the U.S. takes 2.7 vehicle trips per day (FHWA 2018).
- (H) – Ideally, the user will calculate auto trip length for a plan/community at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a plan-specific value using one of these data sources, they have the option to input the existing regional average one-way auto trip length for one of the six most populated CBSAs in California, as presented in Table T-10.1 in Appendix C (FHWA 2017). Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-10.1, the maximum percent reduction in GHG emissions (A) is 0.02 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18 \text{ through } T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying bikesharing throughout the area. In this example, the project is in the Los Angeles-Long Beach-Anaheim CBSA, and the one-way vehicle trip length would be 9.72 miles (H). Assuming 100 percent of residents in the plan/community would have bikeshare access (C) where there was no existing access (B), the user would reduce GHG emissions from plan/community VMT by 0.02 percent.

$$A = -1 \times \frac{(100\% - 0\%) \times 0.021 \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 19.6\% \times 1.4 \frac{\text{miles}}{\text{trip}}}{2.7 \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 9.72 \frac{\text{miles}}{\text{trip}}} = -0.02\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an

adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2018. *Summary of Travel Trends 2017–National Household Travel Survey*. July. Available: https://www.fhwa.dot.gov/policyinformation/documents/2017_nhts_summary_travel_trends.pdf. Accessed: January 2021.
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T-22-B. Implement Electric Bikeshare Program

GHG Mitigation Potential

0.06%

Up to 0.06% of GHG emissions vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Bikeshare programs can incentivize more bicycle use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event. However, they may decrease resilience if they are the only option available during a power outage.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will establish an electric bikeshare program. Electric bikeshare programs provide users with on-demand access to electric pedal assist bikes for short-term rentals. This encourages a mode shift from vehicles to electric bicycles, displacing VMT and reducing GHG emissions. Variations of this measure are described in Measure T-22-A, *Implement Pedal (Non-Electric) Bikeshare Program*, and Measure T-22-C, *Implement Scootershare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing docked (i.e., station-based) bikeshare programs. This measure should be applied with caution if using dockless (free-floating) bikeshare.

Cost Considerations

The costs incurred by the service manager (e.g., municipality or bikeshare company) may include the capital costs for purchasing a bicycle fleet; installing accessible and secure charging stations; storing, maintaining, and replacing the fleet; and marketing and administration. Some of these costs may be offset by income generated through program use. Program participants will benefit from the cost savings from access to cheaper transportation alternatives (compared to private vehicles, private bicycles, or use of ride-hailing services). The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Best practice is to discount electric bikeshare membership and dedicate electric bikeshare parking to encourage use of the service. Consider also including space on the vehicle to store personal items while traveling, such as a basket.

GHG Reduction Formula

The quantification methodology does not account for indirect GHG emissions from electricity used to charge the bicycles or direct GHG emissions from vehicle travel of program employees picking up and dropping off bikes.

$$A = -1 \times \frac{(C - B) \times D \times E \times F}{G \times H}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.06	%	calculated
User Inputs				
B	Percent of residences in plan/community with access to electric bikeshare system without measure	0–100	%	user input
C	Percent of residences in plan/community with access to electric bikeshare system with measure	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Daily electric bikeshare trips per person	0.021	trips per day per person	MTC 2017
E	Vehicle to electric bikeshare substitution rate	35	percent	Fitch et al. 2021
F	Electric bikeshare average one-way trip length	2.1	miles per trip	Fitch et al. 2021
G	Daily vehicle trips per person	2.7	trips per day per person	FHWA 2018
H	Regional average one-way vehicle trip length	Table T-10.1	miles per trip	FHWA 2017

Further explanation of key variables:

- (B and C) – Access to electric bikesharing is measured as the percent of residences in the plan/community within 0.25-mile of an electric bikeshare station. For dockless bikes, assume that all residences within 0.25 mile of the designated dockless service area would have access.
- (D) – An analysis of bike share service areas in the San Francisco Bay Area estimated that in locations with access to bikesharing, there were between 21 and 25 bikeshare trips per day per 1,000 residents (MTC 2017). To be conservative, the low end of this range is cited. Conventional bikeshare trip rate data was used due to lack of specific data for electric bikeshare.
- (E) – A study of dockless electric bike share in Sacramento found that the substitution rate of vehicles trips by electric bikeshare trips was 35 percent (Fitch et al. 2021).

- (F) – A study of dockless electric bike share in Sacramento found that the average one-way bikeshare trip was 2.1 miles (Fitch et al. 2021).
- (G) – A summary report of the 2017 National Household Travel Survey data found that the average person in the U.S. takes 2.7 vehicle trips per day (FHWA 2018).
- (H) – Ideally, the user will calculate auto trip length for a plan/community at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a plan-specific value using one of these data sources, they have the option to input the existing regional average one-way auto trip length for one of the six most populated CBSAs in California, as presented in Table T-10.1 in Appendix C (FHWA 2017). Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-10.1, the maximum percent reduction in GHG emissions (A) is 0.06 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18\text{ through }T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying electric bikesharing throughout the area. In this example, the project is in the Los Angeles-Long Beach-Anaheim CBSA, and the one-way vehicle trip length would be 9.72 miles (H). Assuming 100 percent of residents in the plan/community would have bikeshare access (C) where there was no existing access (B), the user would reduce GHG emissions from plan/community VMT by 0.06 percent.

$$A = -1 \times \frac{(100\% - 0\%) \times 0.021 \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 35\% \times 2.1 \frac{\text{miles}}{\text{trip}}}{2.7 \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 9.72 \frac{\text{miles}}{\text{trip}}} = -0.06\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an

adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A). This quantification methodology does not account for the increase in electricity used to charge the vehicles or the fuel consumption from vehicle travel of program employees picking up and dropping off bikes.

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A). This quantification methodology does not account for the miles traveled from vehicle travel of program employees picking up and dropping off bikes.

Sources

- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
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- Metropolitan Transportation Commission (MTC). 2017. *Plan Bay Area 2040 Final Supplemental Report–Travel Modeling Report*. July. Available: http://2040.planbayarea.org/files/2020-02/Travel_Modeling_PBA2040_Supplemental%20Report_7-2017.pdf. Accessed: January 2021.

T-22-C. Implement Scootershare Program

GHG Mitigation Potential

0.07%

Up to 0.07% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Scootershare programs can incentivize more scooter use and decrease vehicle use, which have health benefits and can thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will establish a scootershare program. Scootershare programs provide users with on-demand access to electric scooters for short-term rentals. This encourages a mode shift from vehicles to scooters, displacing VMT and thus reducing GHG emissions. Variations of this measure are described in Measure T-22-A, *Implement Pedal (Non-Electric) Bikeshare Program*, and Measure T-22-B, *Implement Electric Bikeshare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing docked (i.e., station-based) bikeshare programs. This measure should be applied with caution given the likely higher popularity of scootershare compared to bikeshare.

Cost Considerations

The costs incurred by the service manager (e.g., municipality or scootershare company) may include the capital costs for purchasing a scooter fleet; installing accessible and secure docking stations; storing, maintaining, and replacing the fleet; and marketing and administration. Some of these costs may be offset by income generated through program use. Program participants will benefit from cost savings from access to cheaper transportation alternatives (compared to private vehicles, private scooters, or use of ride-hailing services). The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Best practice is to discount scootershare membership and dedicate scootershare parking to encourage use of the service. Consider also including space on the vehicle to store personal items while traveling, such as a basket.

GHG Reduction Formula

This measure methodology does not account for the indirect GHG emissions from electricity used to charge the scooters or direct GHG emissions from vehicle travel of program employees picking up and dropping off scooters.

$$A = -1 \times \frac{(C - B) \times D \times E \times F}{G \times H}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.07	%	calculated
User Inputs				
B	Percent of residences in plan/community with access to scootershare system without measure	0–100	%	user input
C	Percent of residences in plan/community with access to scootershare system with measure	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Daily scootershare trips per person	0.021	trips per day per person	MTC 2017
E	Vehicle to scootershare substitution rate	38.5	%	McQueen et al. 2020
F	Scootershare average one-way trip length	2.14	miles per trip	PBOT 2021
G	Daily vehicle trips per person	2.7	trips per day per person	FHWA 2018
H	Regional average one-way vehicle trip length	Table T-10.1	miles per trip	FHWA 2017

Further explanation of key variables:

- (B and C) – Access to scootersharing is measured as the percent of residences in the plan/community within 0.25-mile of a scootershare station. For dockless scooters, assume that all residences within 0.25-mile of the designated dockless service area would have access.
- (D) – An analysis of bike share service areas in the San Francisco Bay Area estimated that in locations with access to bikesharing, there were between 21 and 25 bikeshare trips per day per 1,000 residents (MTC 2017). To be conservative, the low end of this range is cited. Conventional bikeshare trip rate data was used due to lack of specific data for scootershare.
- (E) – A literature review of several academic and government reports found that the average car trip substitution rate by scootershare trips was 38.5 percent. This included scootershare programs in Santa Monica, Minneapolis, San Francisco, and Portland (McQueen et al. 2020).

- (F) – In Oregon, Portland's scootershare pilot data dashboard reports that the average trip length of scootershare trips is 2.14 miles (PBOT 2021).
- (G) – A summary report of the 2017 National Household Travel Survey data found that the average person in the U.S. takes 2.7 vehicle trips per day (FHWA 2018).
- (H) – Ideally, the user will calculate auto trip length for a plan/community at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a plan-specific value using one of these data sources, they have the option to input the existing regional average one-way auto trip length for one of the six most populated CBSAs in California, as presented in Table T-10.1 in Appendix C (FHWA 2017). Trip lengths are likely to be longer for areas not covered by the listed CBSAs, which represent the denser areas of the state.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-10.1, the maximum percent reduction in GHG emissions (A) is 0.07 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum {A_{max}}_{\text{T-18 through T-22-C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying scootershare throughout the area. In this example, the project is in the Los Angeles-Long Beach-Anaheim CBSA, and the one-way vehicle trip length would be 9.72 miles (H). Assuming 100 percent of residents in the plan/community would have scootershare access (C) where there was no existing access (B), the user would reduce GHG emissions from plan/community VMT by 0.07 percent.

$$A = -1 \times \frac{(\mathbf{100\% - 0\%}) \times 0.021\ \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 38.5\% \times 2.14\ \frac{\text{miles}}{\text{trip}}}{2.7\ \frac{\text{trips}}{\text{day}\cdot\text{person}} \times 9.72\ \frac{\text{miles}}{\text{trip}}} = -0.07\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an

adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A). This quantification methodology does not account for the increase in electricity used to charge the scooters or the fuel consumption from vehicle travel of program employees picking up and dropping off scooters.

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A). This quantification methodology does not account for the miles traveled from vehicle travel of program employees picking up and dropping off scooters.

Sources

- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2018. *Summary of Travel Trends 2017–National Household Travel Survey*. July. Available: https://www.fhwa.dot.gov/policyinformation/documents/2017_nhts_summary_travel_trends.pdf. Accessed: January 2021.
- Metropolitan Transportation Commission (MTC). 2017. *Plan Bay Area 2040 Final Supplemental Report–Travel Modeling Report*. July. Available: http://2040.planbayarea.org/files/2020-02/Travel_Modeling_PBA2040_Supplemental%20Report_7-2017.pdf. Accessed: January 2021.
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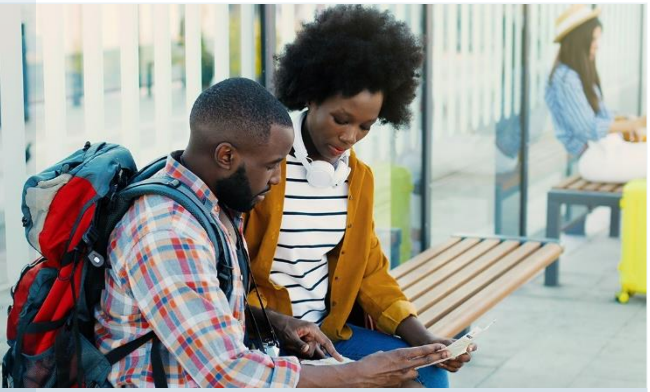
- Portland Bureau of Transportation (PBOT). 2021. *Portland Bureau of Transportation E-Scooter Dashboard*. Available: https://public.tableau.com/profile/portland.bureau.of.transportation#!/vizhome/PBOTE-ScooterTripsDashboard/ScooterDashboard. Accessed: March 2021.

T-23. Provide Community-Based Travel Planning



GHG Mitigation Potential

2.3%

Up to 2.3% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

CBTP can decrease vehicle use and thus improve air quality, resulting in health impacts that may increase the resilience of communities near freeways and roads. This can also increase the adaptive capacity of communities by informing them of travel alternatives if certain modes become disrupted due to extreme events.

Health and Equity Considerations

Outreach materials may need to be in multiple languages to address diverse linguistic communities.

Measure Description

This measure will target residences in the plan/community with community-based travel planning (CBTP). CBTP is a residential-based approach to outreach that provides households with customized information, incentives, and support to encourage the use of transportation alternatives in place of single occupancy vehicles, thereby reducing household VMT and associated GHG emissions.

Subsector

Trip Reduction Programs

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

CBTP involves teams of trained travel advisors visiting all households within a targeted geographic area, having tailored conversations about residents' travel needs, and educating residents about the various transportation options available to them. Due to the personalized outreach method, communities are typically targeted in phases.

Cost Considerations

The main cost consideration for CBTP is labor costs for program managers and resident outreach staff plus material costs for development of educational material. The beneficiaries are the commuters who may be able to reduce vehicle usage or ownership. The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

Pair with any of the Measures from T-17 through T-22-C to ensure that residents that are targeted by CBTP who want to use alternative transportation have the infrastructure and technology to do so.

GHG Reduction Formula

$$A = \frac{C}{B} \times D \times -E \times F$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from household vehicle travel in plan/community	0–2.3	%	calculated
User Inputs				
B	Residences in plan/community	[ ]	residences	user input
C	Residences in plan/community targeted with CBTP	[ ]	residences	user input
Constants, Assumptions, and Available Defaults				
D	Percent of targeted residences that participate	19	%	MTC 2021
E	Percent vehicle trip reduction by participating residences	12	%	MTC 2021
F	Adjustment factor from vehicle trips to VMT	1	unitless	assumed

Further explanation of key variables:

- (D) – Results from program evaluations of CBTP in several counties in Washington and Oregon across multiple years indicate that an average of 19 percent of residences targeted will participate (MTC 2021).
- (E) – Results from program evaluations of CBTP in several counties in Washington and Oregon across multiple years indicate that a 12 percent vehicle trip reduction will occur among participating residences (MTC 2021).
- (F) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum percent reduction in GHG emissions (A) is 2.3 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

Same as (A_{max}). Measure T-23 is the only measure at the Plan/Community scale within the Trip Reduction Programs subsector.

Example GHG Reduction Quantification

The user reduces household VMT by having residences in the plan/community participate in CBTP. In this example, all of the residences in a city of 5,000 are targeted (B and C), which would reduce GHG emissions from citywide household VMT by 2.3 percent.

$$A = \left(\frac{5{,}000 \text{ residences}}{5{,}000 \text{ residences}}\right) \times 19\% \times -12\% \times 1 = -2.3\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in household VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Metropolitan Transportation Commission (MTC). October 2021. *Plan Bay Area 2050, Forecasting and Modeling Report*. Available: https://www.planbayarea.org/sites/default/files/documents/Plan_Bay_Area_2050_Forecasting_Modeling_Report_October_2021.pdf. Accessed: November 2021.

T-24. Implement Market Price Public Parking (On-Street)

GHG Mitigation Potential

30%

Up to 30.0% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Implementing market price public parking could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. In addition, this reduces illegal loading/standing in bus stops and travel lanes. When these reductions occur during extreme weather events, they better allow emergency responders to access a hazard site.

Health and Equity Considerations

Pricing on-street parking at market rates reduces illegal loading/standing in bus stops and travel lanes, improving transit times.

Measure Description

This measure will price all on-street parking in a given community, with a focus on parking near central business districts, employment centers, and retail centers. Increasing the cost of parking increases the total cost of driving to a location, incentivizing shifts to other modes and thus decreasing total VMT to and from the priced areas. This VMT reduction results in a corresponding reduction in GHG emissions.

Subsector

Parking or Road Pricing/Management

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

When pricing on-street parking, best practice is to allow for dynamic adjustment of prices to ensure approximately 85 percent occupancy, which helps prevent induced VMT due to circling behaviors as individuals search for a vacant parking space. In addition, this method should primarily be implemented in areas with available alternatives to driving, such as transit availability within 0.5. mile or areas of high residential density nearby (allowing for increased walking/biking). If the measure is implemented in a small area, residential parking permit programs should be considered to prevent parking intrusion on nearby streets in residential areas without priced parking.

Cost Considerations

Municipalities may incur costs from installing the meter network, which may require meters at individual spaces or at more central terminals. There would also be staffing costs to monitor the metered spaces and collect payments. Residents also incur a cost by having to pay for on-street parking. A portion of costs to the municipality may be offset through revenue collected by the parking system.

Expanded Mitigation Options

Pricing on-street parking also helps support individual projects with priced onsite parking by removing potential alternative parking locations.

GHG Reduction Formula

$$A = \frac{B}{C} \times \frac{D - E}{E} \times F \times G \times H$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–30.0	%	calculated
User Inputs				
B	VMT in priced area without measure	[ ]	VMT per day	user input
C	VMT in plan/community without measure	[ ]	VMT per day	user input
D	Proposed parking price	1.00–5.00	$ per hour	user input
E	Initial parking price	0.00–5.00	$ per hour	user input
F	Default percentage of trips parking on street	5–75	%	user input
Constants, Assumptions, and Available Defaults				
G	Elasticity of parking demand with respect to price	-0.4	unitless	Pierce and Shoup 2013
H	Ratio of VMT to vehicle trips	1	unitless	assumption

Further explanation of key variables:

- (B and C) – Total daily VMT in both the priced area and the plan/community area should represent the expected total VMT generated by all land use in that area, including office, residences, retail, schools, and other uses. The most appropriate source for this data is from a local travel demand forecasting model. An alternate method uses VMT per worker or VMT per resident as calculated for SB 743 compliance and screening purposes multiplied by the population in the area.
  - These variables for VMT by area are used to ensure that the percent GHG reduction from the priced area is at the same geographic scale as the vehicle travel in the plan/community. If the area priced is a business district and the analysis is limited to the business district, then the VMT would be equal (B=C).
- (D) – The proposed parking price can be presented in cost per minute, hour, or day, provided that the same units are used for variable (E)
- (E) – Because this is used to calculate the percent change in parking price, if parking is free under existing conditions, (E) should be set to (1/2×D), resulting in a percentage change of 100 percent. In areas where metered parking is common, E may instead by set to equal the average metered parking price in nearby areas or districts.
- (F) – On-street parking represents only a portion of the total available parking supply. An estimate will typically range from 5 percent (in locations with offsite parking garages available) to 75 percent (in locations where most parcels have little to no onsite parking for visitors). The user should provide a project-specific value within this range, by surveying the total on-street vs. off-street parking spaces within ¼ mile of the study area.

- (G) – An evaluation of the SFPark program in San Francisco found that a 0.4 percent decrease in parking demand occurs for every 1 percent increase in parking price (Pierce and Shoup 2013). Price elasticity of parking demand varies by location, day of the week, and time of day.
- (H) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The total reduction in VMT due to on-street parking pricing is capped at 30 percent, which is based on the following assumptions:

- $\left(\frac{D-E}{E}=100\%\right)$ – Parking prices double (i.e., increase by 100 percent) or parking pricing is introduced in previously free areas.
- (F) – 75 percent of all vehicle trips utilize on-street parking. Note that only within a small-scale commercial district is 75 percent of parking likely to occur on street.

This maximum scenario is presented in the below example quantification.

Subsector Maximum

Same as (A_{max}). Measure T-24 is the only measure at the Plan/Community scale within the Parking or Road Pricing/Management subsector.

Example GHG Reduction Quantification

The user reduces VMT by increasing hourly on-street parking costs. In this example, the hourly parking cost increases from $1.00 (E) to $2.00 (D) in a business district. The business district daily VMT is 1,000,000 (B), and the scale of implementation is the business district (B=C). If around 75 percent of the district's parking supply is on street (F), the user would reduce GHG emissions from VMT by 30 percent.

$$A = \frac{1{,}000{,}000\,\frac{\text{VMT}}{\text{day}}}{1{,}000{,}000\,\frac{\text{VMT}}{\text{day}}} \times \frac{\$2.00 - \$1.00}{\$1.00} \times 75\% \times -0.4 \times 1 = -30\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an

adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Pierce, G., and D. Shoup. 2013. Getting the Prices Right: An Evaluation of Pricing Parking by Demand in San Francisco. *Journal of the American Planning Association* 79(1)67–81. May. Available: https://www.tandfonline.com/doi/pdf/10.1080/01944363.2013.787307?needAccess=true. Accessed: January 2021.

T-25. Extend Transit Network Coverage or Hours

GHG Mitigation Potential

4.6%

Up to 4.6% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increasing transit network coverage or hours improves the reliability of the transportation network and allows redundancy to exist even if an extreme event disrupts part of the system. They could also incentivize more people to use transit, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event.

Health and Equity Considerations

This measure increases access to social, educational, and employment opportunities. Expansion of transit networks need to ensure equitable access by all communities to the transit system.

Measure Description

This measure will expand the local transit network by either adding or modifying existing transit service or extending the operation hours to enhance the service near the project site. Starting services earlier in the morning and/or extending services to late-night hours can accommodate the commuting times of alternative-shift workers. This will encourage the use of transit and therefore reduce VMT and associated GHG emissions.

Subsector

Transit

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

There are two primary means of expanding the transit network: by increasing the frequency of service, thereby reducing average wait times and increasing convenience, or by extending service to cover new areas and times.

Cost Considerations

Infrastructure costs for extending the physical network coverage of a transit system can be significant. Costs to expand track-dependent transit, such as light rail and passenger rail, are high and can require resource- and time-intensive advanced planning. Costs to expand vehicle-dependent transit, such as busses, are likewise high but may be limited to procurement of additional vehicles. Any expansion of transit, including just service hours, would increase staffing and potentially maintenance costs. A portion of these costs may be offset by increased transit usage and associated income. Commuters who may more easily be able to travel without a car may also observe cost savings from reduce vehicle usage or ownership.

Expanded Mitigation Options

This measure is focused on providing additional transit network coverage, with no changes to transit frequency. This measure can be paired with Measure T-26, *Increase Transit Service Frequency*, which is focused on increasing transit service frequency, for increased reductions.

GHG Reduction Formula

$$A = -1 \times \frac{C - B}{B} \times D \times E \times F \times G$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from plan/community VMT	0–4.6	%	calculated
User Inputs				
B	Total transit service miles or service hours in plan/community before expansion	[ ]	miles	user input
C	Total transit service miles or service hours in plan/community after expansion	[ ]	miles	user input
D	Transit mode share in plan/community	Table T-3.1	%	user input
Constants, Assumptions, and Available Defaults				
E	Elasticity of transit demand with respect to service miles or service hours	0.7	unitless	Handy et al. 2013
F	Statewide mode shift factor	57.8	%	FHWA 2017
G	Ratio of vehicle trip reduction to VMT	1	unitless	assumption

Further explanation of key variables:

- (A) – This formula does not reflect any increase in transit vehicle travel and emissions, which can at least partially offset the reduction in GHG emissions from passenger vehicle travel. Inclusion of this component in the percent GHG reduction formula would require inputs that would not be available to most users.
- (B and C) – Transit service miles are defined as the total service mileage. Service hours represent the hours of operation. Either metric can be used in the GHG reduction formula so long as both B and C use the same metric.
- (D) – The transit mode share for the six most populated CBSAs in California are provided in Table T-3.1 in Appendix C (FHWA 2017). If the project study area is not within the listed CBSAs or the user is able to provide a project-specific value, the user should replace these regional defaults in the GHG reduction formula. It is likely for areas outside of the area covered by the listed CBSAs to have transit mode shares lower than the values provided in the table. Ideally, the user will calculate existing transit mode share for work trips or all trips at a scale no larger than a census tract. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. Care should be taken to not present the reported commute mode share as retrieved from the ACS, unless the land use is office or employment based and the ACS tables are based on work location (rather than home location).
- (E) – A policy brief summarizing the results of transit service strategies concluded that a 0.7 percent increase in transit ridership occurs for every 1 percent increase in service miles or hours (Handy et al. 2013).

- (F) – Mode shift factor is an adjustment to reflect the reduction in vehicle trips associated with a reduction in person trips, since some vehicles carry more than one person. It is calculated as (1/average vehicle occupancy).
- (G) – The adjustment factor from vehicle trips to VMT is 1. This assumes that all vehicle trips will average out to typical trip length ("assumes all trip lengths are equal"). Thus, it can be assumed that a percentage reduction in vehicle trips will equal the same percentage reduction in VMT.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The GHG reduction from expanding the transit network is capped at 4.6 percent, which is based on the following assumptions:

- $\left(\frac{C-B}{B} \leq 100\%\right)$ – The transit network increase is capped at a doubling in size, or 100 percent (twice as many revenue miles are provided, for a 100 percent increase).
- (D) – The CBSA is San Francisco-Oakland-Hayward, which has a default transit mode share for all trips of 11.38 percent.

This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}25\text{ through }T\text{-}29}} \leq 15\%$) This measure is in the Transit subsector. This subcategory includes Measures T-25 through T-29. The VMT reduction from the combined implementation of all measures within this subsector is capped at 15 percent.

Example GHG Reduction Quantification

The user reduces VMT by extending an existing transit route or lengthening the service hours. In this example, the project in a neighborhood of the San Francisco-Oakland-Hayward CBSA and would increase transit coverage in the area from 20 miles (B) to 40 miles (C). If the existing transit mode share in the study area is 11.38 percent (D), the user would reduce GHG emissions from VMT by 4.6 percent.

$$A = -1 \times \frac{(40\text{ miles} - 20\text{ miles})}{20\text{ miles}} \times 11.38\% \times 0.7 \times 57.8\% \times 1 = -4.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration (FHWA). 2017. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., K. Lovejoy, M. Boarnet, and S. Spears. 2013. *Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions*. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.

T-26. Increase Transit Service Frequency

GHG Mitigation Potential

11.3%

Up to 11.3% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increasing transit service frequency improves the reliability of the transportation network and allows redundancy to exist even if an extreme event disrupts part of the system. It could also incentivize more people to use transit, resulting in less traffic and better allow emergency responders to access a hazard site during an extreme weather event.

Health and Equity Considerations

This measure increases access to social, educational, and employment opportunities. Expansion of transit service needs to ensure equitable access by all communities to the transit system.

Measure Description

This measure will increase transit frequency on one or more transit lines serving the plan/community. Increased transit frequency reduces waiting and overall travel times, which improves the user experience and increases the attractiveness of transit service. This results in a mode shift from single occupancy vehicles to transit, which reduces VMT and associated GHG emissions.

Subsector

Transit

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

See measure description.

Cost Considerations

Increasing transit service frequency may require capital investment to purchase additional vehicles. Staff and maintenance costs may also increase. A portion of these costs may be offset by increased transit usage and associated income. Commuters who may more easily be able to travel without a car may also observe cost savings from reduce vehicle usage or ownership.

Expanded Mitigation Options

This measure is focused on providing increased transit frequency, with no changes to transit network coverage. This measure can be paired with Measure T-25, *Extend Transit Network Coverage or Hours*, which is focused on increasing transit network coverage, for increased reductions.

GHG Reduction Formula

$$A = -C \times \frac{B \times E \times D \times G}{F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–11.3	%	calculated
User Inputs				
B	Percent increase in transit frequency	0–300	%	user input
C	Level of implementation	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Elasticity of transit ridership with respect to frequency of service	0.5	unitless	Handy et al. 2013
E	Transit mode share in plan/community	Table T-3.1	%	FHWA 2017a
F	Vehicle mode share in plan/community	Table T-3.1	%	FHWA 2017a
G	Statewide mode shift factor	57.8	%	FHWA 2017b

Further explanation of key variables:

- (A) – This formula does not reflect any increase in transit vehicle travel and emissions, which can at least partially offset the reduction in GHG emissions from passenger vehicle travel. Inclusion of this component in the percent GHG reduction formula would require inputs that would not be available to most users. Users can calculate the absolute changes in passenger vehicle and bus VMT and emissions using the process described under *Co-Benefits*.
- (B) – Frequency is measured as the number of arrivals over a given time (e.g., buses per hour). Frequency is the inverse of transit headway, defined as the time between transit vehicle arrivals on a given route. This variable can be calculated as [transit frequency with measure minus existing transit frequency] divided by existing transit frequency.
- (C) – The level of implementation refers to the number of transit routes receiving the frequency improvement as a fraction of the total transit routes in the plan/community.
- (D) – A policy brief summarizing the results of transit service strategies concluded that a 0.5 percent increase in transit ridership occurs for every 1 percent increase in frequency (Handy et al. 2013).
- (E and F) – Ideally, the user will calculate transit and auto mode shares for a plan/community at the city scale (or larger). Potential data sources include the California Household Travel Survey (preferred) or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode shares for transit and vehicles for one of the six most populated CBSAs in California, as presented in Table T-3.1 in Appendix C. It is likely for areas outside of

the area covered by the listed CBSAs to have vehicle mode shares higher and transit mode shares lower than the values provided in the table.

- (G) – Mode shift factor is an adjustment to reflect the reduction in vehicle trips associated with a reduction in person trips, since some vehicles carry more than one person. It is calculated as (1/average vehicle occupancy).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-3.1 and (B_{max}), the maximum percent reduction in GHG emissions (A) is 11.3 percent. This maximum scenario is presented in the below example quantification.

(B_{max}) The percent change in transit frequency is capped at 300 percent (SANDAG 2019).

Subsector Maximum

($\sum A_{max_{T\text{-}25 \text{ through } T\text{-}29}} \leq 15\%$) This measure is in the Transit subsector. This subcategory includes Measures T-25 through T-29. The VMT reduction from the combined implementation of all measures within this subsector is capped at 15 percent.

Mutually Exclusive Measures

If the user selects Measure T-28, *Provide Bus Rapid Transit*, and converts all transit routes in the plan/community to BRT, then the user cannot also take credit for this measure or Measure T-27, *Implement Transit-Supportive Roadway Treatments*. This is because Measure T-28 accounts for the VMT reduction associated with increased transit frequency and decreased transit travel time as well as the additional BRT-specific bonus. To combine the GHG reductions from Measure T-28 with Measure T-27 and/or Measure T-26 would be considered double counting. However, where BRT is proposed on less than all of the existing bus routes in the plan/community area, this measure and/or Measure T-27 could be applied to the remaining bus routes, and the measure reductions could be combined with Measure T-28 to determine the emissions reduction at the larger plan/community scale.

Example GHG Reduction Quantification

The user reduces plan/community GHGs by increasing transit frequency, thereby encouraging a mode shift from vehicles to transit and reducing VMT. In this example, the project is in the San Francisco-Oakland-Hayward CBSA where the transit and vehicle mode shares would be 11.38 percent and 86.96 percent, respectively (E and F). Assuming the maximum increase in transit frequency of 300 percent (B) and implementation for all transit routes (100 percent) in the plan/community (C), the user would reduce plan/community GHG emissions from VMT by 11.3 percent.

$$A = -100\% \times \frac{300\% \times 11.38\% \times 0.5 \times 57.8\%}{86.96\%} = -11.3\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

VMT Reductions

The decrease in passenger vehicle miles (H) and increase in bus miles (L) by the measure can be calculated as follows.

Passenger Vehicle VMT Reduction Formula

The percent reduction in passenger VMT would be the same as the percent reduction in GHG emissions (A). The absolute reduction in passenger VMT can be calculated using the following formula.

$$H = \mathbf{I} \times E \times \mathbf{J} \times \mathbf{B} \times D \times G \times K$$

Passenger Vehicle VMT Reduction Calculation Variables

ID	Variable	Value	Unit	Source
Output				
H	Reduction in passenger vehicle miles in plan/community	[ ]	miles per year	calculated
User Inputs				
I	Total daily person trips in corridor(s)	[ ]	trips per day	user input
J	Vehicle trip length	[ ]	miles per trip	user input
Constants, Assumptions, and Available Defaults				
K	Days per year transit available	365	days per year	assumed

Further explanation of key variables:

- (I) – The total daily person trips in the corridor(s) represents the total daily trips by all modes between the bus route origin area and the bus route destination area. This may be obtained through travel demand modeling. If the strategy involves frequency improvements for more than one transit route, then the total person trips should reflect the sum of all the routes being improved.
- (J) – If the strategy involves frequency improvements for more than one transit route, then the trip length should reflect the average of all the routes being improved.
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

Bus VMT Increase Formula

The absolute increase in bus VMT can be calculated using the formula below. As noted above, the formula for the percent GHG reduction (A) does not reflect any increase in bus VMT and bus emissions. Users that wish to capture these impacts should calculate absolute changes.

$$L = P \times (M_2 - M_1) \times N \times O \times K$$

Bus VMT Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
L	Increase in annual bus miles in plan/community	[ ]	miles per year	calculated
User Inputs				
M_1	Bus frequency without measure	[ ]	transit vehicle roundtrips per hour	user input
M_2	Bus frequency with measure	[ ]	transit vehicle roundtrips per hour	user input
N	Bus hours of operation	0–24	hours per day	user input
O	Bus route one-way length	[ ]	miles per route	user input
Constants, Assumptions, and Available Defaults				
P	One-way trips in a roundtrip	2	one-way trips per roundtrip	conversion

Further explanation of key variables:

- (L) – If the strategy involves frequency improvements for more than one transit route, then the increase in bus miles should be calculated separately for each route.
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

Energy and Fuel Savings

The decrease in passenger vehicle fuel consumption and increase in bus fuel consumption by the measure can be calculated as follows.

Passenger Vehicle Fuel Use Reduction Formula

Multiply the reduction in passenger vehicle miles (H) above by the fuel efficiency of the vehicle type (see Table T-30.2 in Appendix C) to output the change in fuel consumption.

Bus Fuel Use Increase Formula

The absolute increase in bus fuel consumption (Q) can be calculated using the formula below.

$Q = L \times R$

Bus Fuel Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
Q	Increase in annual bus fuel consumption in plan/community	[ ]	gal per year	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
R	Fuel economy of a transit bus, by fuel type	Table T-26.1	gal or kilowatt hour per mile	CARB 2020; U.S. DOE 2021

Further explanation of key variables:

- (R) – The average fuel economy for gasoline, diesel, and natural gas transit buses was calculated using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average of UBUS vehicles, disaggregated by fuel type (CARB 2020). The efficiency of electric buses was calculated based on the gasoline equivalent value (U.S. DOE 2021). The user should reference Table T-26.1 for the fuel economy of the appropriate fuel type for their location's transit system. If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the default in the fuel use increase formula.
- Please refer to the Bus VMT Increase Calculation Variables table above for definitions of variables that have been previously defined.

Sources

- California Air Resources Board (CARB). 2020. *EMFAC2017 v1.0.3*. August. Available: https://arb.ca.gov/emfac/emissions-inventory. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., K. Lovejoy, M. Boarnet, S. Spears. 2013. *Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions*. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool–Design Document*. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.
- U.S. Department of Energy (U.S. DOE). 2021. *Fuel Economy Datasets for All Model Years (1984-2021)*. January. Available: https://www.fueleconomy.gov. Accessed: January 2021.

T-27. Implement Transit-Supportive Roadway Treatments

GHG Mitigation Potential

0.6%

Up to 0.6% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Implementing transit-supportive roadway treatments improves the reliability of the transportation network and allows redundancy to exist even if an extreme event disrupts part of the system. It could also incentivize more people to use transit, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event. Furthermore, emergency responders can use queue jumps and dedicated bus lanes when needed.

Health and Equity Considerations

Transit facilities can have conflicts with cyclists. Consider appropriate treatments to minimize conflicts. Improved transit investments should be equitably distributed prioritizing areas with transit deficiencies in underserved communities.

Measure Description

This measure will implement transit-supportive treatments on the transit routes serving the plan/community. Transit-supportive treatments incorporate a mix of roadway infrastructure improvements and/or traffic signal modifications to improve transit travel times and reliability. This results in a mode shift from single occupancy vehicles to transit, which reduces VMT and the associated GHG emissions.

Subsector

Transit

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

Treatments can include transit signal priority, bus-only signal phases, queue jumps, curb extensions to speed passenger loading, and dedicated bus lanes.

Cost Considerations

Costs and savings of transit-supportive roadway treatments vary depending on the strategy pursued, ranging from low-cost route optimization changes to high-cost infrastructure projects (e.g., bus-only lanes). Reducing route cycle time without significantly increasing the number of transit vehicles can result in net cost savings for the transit system. Dedicated transit infrastructure will improve transit reliability and increase ridership. This supplements existing transit income streams for municipalities. Increased ridership similarly reduces vehicle use, which has cost benefits for both commuters and municipalities.

Expanded Mitigation Options

This measure could be paired with other Transit subsector strategies (Measure T-25 and Measure T-29) for increased reductions.

GHG Reduction Formula

$$A = -1 \times \frac{B \times C \times D \times E \times G}{F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.6	%	calculated
User Inputs				
B	Percent of plan/community transit routes that receive treatments	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent change in transit travel time due to treatments	-10	%	TRB 2007
D	Elasticity of transit ridership with respect to transit travel time	-0.4	unitless	TRB 2007
E	Transit mode share in plan/community	Table T-3.1	%	FHWA 2017a
F	Vehicle mode share in plan/community	Table T-3.1	%	FHWA 2017a
G	Statewide mode shift factor	57.8	%	FHWA 2017b

Further explanation of key variables:

- (C) – A literature review of studies from the U.S. and United Kingdom indicates that the travel time savings associated with one type of transit-supportive roadway treatment—transit signal prioritization—typically ranged from 8 to 12 percent (TRB 2007). To account for the likelihood that a user would implement multiple transit-supportive treatments, the midpoint of this range is used for the measure formula. Use of the midpoint is still conservative given the additional travel time savings associated with other transit-supportive treatments. If the user can provide a project-specific value based on the suite of their treatments, then the user should replace this default in the GHG reduction formula.
- (E and F) – Ideally, the user will calculate transit and auto mode shares for a plan/community at the city scale (or larger). Potential data sources include the California Household Travel Survey (preferred) or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode shares for transit and vehicles for one of the six most populated CBSAs in California, as presented in Table T-3.1 in Appendix C. It is likely for areas outside of the area covered by the listed CBSAs to have vehicle mode shares higher and transit mode shares lower than the values provided in the table.

- (G) – Mode shift factor is an adjustment to reflect the reduction in vehicle trips associated with a reduction in person trips as some vehicles carry more than one person. It is calculated as (1/average vehicle occupancy) (FHWA 2017b).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-3.1 and (C_{max}), the maximum percent reduction in GHG emissions (A) is 0.6 percent. This maximum scenario is presented in the below example quantification.

(C_{max}) The percent reduction in transit travel time is capped at 20 percent, which is based on the values reported in a literature review of studies from the U.S. and United Kingdom (TRB 2007).

Subsector Maximum

($\sum A_{max_{T\text{-}25 \text{ through } T\text{-}29}} \leq 15\%$) This measure is in the Transit subsector. This subcategory includes Measures T-25 through T-29. The VMT reduction from the combined implementation of all measures within this subsector is capped at 15 percent.

Mutually Exclusive Measures

If the user selects Measure T-28, *Provide Bus Rapid Transit*, and converts all transit routes in the plan/community to BRT, then the user cannot also take credit for this measure or Measure T-26, *Increase Transit Service Frequency*. This is because Measure T-28 accounts for the VMT reduction associated with increased transit frequency and decreased transit travel time as well as the additional BRT-specific bonus. To combine the GHG reductions from Measure T-28 with Measure T-27 and/or Measure T-26 would be considered double counting. However, where BRT is proposed on less than all of the existing bus routes in the plan/community area, this measure and/or Measure T-26 could be applied to the remaining bus routes, and the measure reductions could be combined with Measure T-28 to determine the emissions reduction at the larger plan/community scale.

Example GHG Reduction Quantification

The user reduces plan/community GHGs by implementing transit-supportive roadway treatments that decrease transit travel time, thereby encouraging a mode shift from vehicles to transit and reducing VMT. In this example, the project is in San Francisco-Oakland-Hayward CBSA where the transit and vehicle mode shares would be 11.38 percent and 86.96 percent, respectively (E and G). Assuming the maximum decrease in transit travel time of 20 percent (C_{max}) and implementation for all transit routes (100 percent) in the plan/community (B), the user would reduce plan/community GHG emissions from VMT by 0.6 percent.

$$A = -1 \times \frac{100\% \times -20\% \times -0.4 \times 11.38\% \times 57.8\%}{86.96\%} = -0.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in passenger vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in passenger VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Transportation Research Board (TRB). 2007. *Transit Cooperative Research Program Report 118: Bus Rapid Transit Practitioner's Guide*. Available: https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf. Accessed: January 2021.

T-28. Provide Bus Rapid Transit

Photo Credit: LA Metro, 2021

GHG Mitigation Potential

13.8%

Up to 13.8% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Providing BRT can incentivize more people to use transit, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event. Furthermore, emergency responders can use queue jumps and dedicated BRT lanes when needed.

Health and Equity Considerations

Transit facilities can have conflicts with cyclists. Consider appropriate BRT components to minimize conflicts. Improved transit investments should be equitably distributed, prioritizing areas with transit deficiencies in underserved communities.

Measure Description

This measure will convert an existing bus route to a bus rapid transit (BRT) system. BRT includes the following additional components, compared to traditional bus service: exclusive right-of-way (e.g., busways, queue jumping lanes) at congested intersections, increased limited-stop service (e.g., express service), intelligent transportation technology (e.g., transit signal priority, automatic vehicle location systems), advanced technology vehicles (e.g., articulated buses, low-floor buses), enhanced station design, efficient fare-payment smart cards or smartphone apps, branding of the system, and use of vehicle guidance systems. BRT can increase the transit mode share in a community due to improved travel times, service frequencies, and the unique components of the BRT system. This mode shift reduces VMT and the associated GHG emissions.

Subsector

Transit

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The measure quantification methodology accounts for the increase in ridership from (1) improved travel times from transit signal prioritization, (2) increased service frequency, and (3) the unique ridership increase associated with a full-featured BRT service operating on a fully segregated running way with specialized (or stylized) vehicles, attractive stations, and efficient fare collection practices. To take credit for the estimated emissions reduction, the user should implement, at minimum, these components.

Cost Considerations

Providing BRT will require capital investment to purchase specialized vehicles, develop passenger information systems, and construct stations and busways. Total costs vary depending on the suite of BRT components pursued. Grade-separated busways are more expensive than at-grade busways and mixed flow lanes. Dedicated transit infrastructure will improve transit reliability and increase ridership. This supplements existing transit income streams for municipalities. Increased ridership similarly reduces vehicle use, which has cost benefits for both commuters and municipalities.

Expanded Mitigation Options

This measure could be paired with Measure T-25, *Extend Transit Network Coverage or Hours,* and Measure T-29, *Reduce Transit Fares,* for increased reductions.

GHG Reduction Formula

$$A = -C \times \frac{D \times F \times \left((B \times I) + (H \times J) + G\right)}{E}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–13.8	%	calculated
User Inputs				
B	Percent increase in transit frequency due to BRT	0–300	%	user input
C	Level of implementation	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Transit mode share in plan/community	Table T-3.1	%	FHWA 2017a
E	Vehicle mode share in plan/community	Table T-3.1	%	FHWA 2017a
F	Statewide mode shift factor	57.8	%	FHWA 2017b
G	Percent change in transit ridership due to BRT	25	%	TRB 2007
H	Percent change in transit travel time due to BRT	-10 to -20	%	TRB 2007
I	Elasticity of transit ridership with respect to frequency of service	0.5	unitless	Handy et al. 2013
J	Elasticity of transit ridership with respect to transit travel time	-0.4	unitless	TRB 2007

Further explanation of key variables:

- (A) – This formula does not reflect any increase in transit vehicle travel and emissions, which can at least partially offset the reduction in GHG emissions from passenger vehicle travel.[14] Inclusion of this component in the percent GHG reduction formula would require inputs that would not be available to most users. Users can calculate the absolute changes in passenger vehicle and bus VMT and emissions using the process described under *Co-Benefits*.
- (B) – Frequency is measured as the number of arrivals over a given time (e.g., buses per hour). Frequency is the inverse of transit headway, defined as the time between transit vehicle arrivals on a given route. This variable can be calculated as [transit frequency with measure minus existing transit frequency] divided by existing transit frequency.

[14] As discussed in Chapter 2, *Integrated and Resilient Planning*, the ICT regulation requires all public transit agencies to gradually transition to 100 percent zero-emission bus fleets by 2040. Accordingly, combustion emissions from transit operation will decline as vehicle fleets move to achieve the state's zero-emission bus goals.

- (C) – The level of implementation refers to the number of transit routes receiving the frequency improvement as a fraction of the total transit routes in the plan/community.
- (D and E) – Ideally, the user will calculate transit and auto mode shares for a plan/community at the city scale (or larger). Potential data sources include the California Household Travel Survey (preferred) or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, the user has the option to input the mode shares for transit and vehicles for one of the six most populated CBSAs in California, as presented in Table T-3.1 in Appendix C. It is likely for areas outside of the area covered by the listed CBSAs to have vehicle mode shares higher and transit mode shares lower than the values provided in the table.
- (F) – Mode shift factor is an adjustment to reflect the reduction in vehicle trips associated with a reduction in person trips, since some vehicles carry more than one person. It is calculated as (1/average vehicle occupancy).
- (G) – A BRT practitioner's guide summarizing the results of numerous BRT case studies concluded that, on top of the ridership gains from improved travel times and increased service frequency, an additional 25 percent increase in ridership would occur from a full-featured BRT service operating on a fully segregated running way with specialized (or stylized) vehicles, attractive stations, and efficient fare collection practices.
- (H) – A literature review of studies from the United States and United Kingdom indicates that the travel time savings associated with one type of BRT component—transit signal prioritization—typically average 10 percent (TRB 2007). If the user can provide a project-specific value based on the suite of BRT components, then the user should replace this default in the GHG reduction formula. Note that, as described below, (H) should not exceed 20 percent.
- (I) – A policy brief summarizing the results of transit service strategies concluded that a 0.5 percent increase in transit ridership occurs for every 1 percent increase in frequency (Handy et al. 2013).
- (J) – A BRT practitioner's guide summarizing the results of numerous BRT case studies concluded that a -0.4 percent decrease in transit ridership occurs for every 1 percent increase in transit travel time (TRB 2007).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-3.1 and (B_{max}), the maximum percent reduction in GHG emissions (A) is 13.8 percent. This maximum scenario is presented in the below example quantification.

(B_{max}) The percent change in transit frequency is capped at 300 percent (SANDAG 2019).

(H_{max}) The percent reduction in transit travel time is capped at 20 percent, which is based on the values reported in a literature review of studies from the United States and United Kingdom (TRB 2007).

Subsector Maximum

($\sum A_{max_{\text{T-25 through T-29}}} \leq 15\%$) This measure is in the Transit subsector. This subcategory includes Measures T-25 through T-29. The VMT reduction from the combined implementation of all the non–mutually-exclusive measures within this subsector is capped at 15 percent.

Mutually Exclusive Measures

If the user selects this measure and converts all transit routes in the plan/community to BRT (B), then the user cannot also take credit for Measure T-26, *Increase Transit Service Frequency*, or Measure T-27, *Implement Transit-Supportive Roadway Treatments*. This is because Measure T-28 accounts for the VMT reduction associated with increased transit frequency and decreased transit travel time as well as the additional BRT-specific bonus. To combine the GHG reductions from Measure T-28 with Measure T-27 and/or Measure T-26 would be considered double counting. However, where BRT is proposed on less than all of the existing bus routes in the plan/community area, Measure T-26 and/or Measure T-27 could be applied to the remaining bus routes, and the measure reductions could be combined to determine the emissions reduction at the larger plan/community scale.

Example GHG Reduction Quantification

The user reduces plan/community GHGs by implementing a full-featured BRT system, thereby encouraging a mode shift from vehicles to transit and reducing VMT. In this example, the project is in the San Francisco–Oakland–Hayward CBSA where transit and vehicle mode shares would be 11.38 percent and 86.96 percent, respectively (D and E). Assuming the maximum increase in transit frequency of 300 percent (B_{max}), the maximum decrease in transit travel time of 20 percent (H_{max}), and implementation for all transit routes (100 percent) in the plan/community (B), the user would reduce plan/community GHG emissions from VMT by 13.8 percent.

$$A = -100\% \times \frac{11.38\% \times 57.8\% \times ((300\% \times 0.5) + (-20\% \times -0.4) + 25\%)}{86.96\%} = -13.8\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

VMT Reductions

The decrease in passenger vehicle miles (K) and increase in BRT miles (O) by the measure can be calculated as follows.

Passenger Vehicle VMT Reduction Formula

The percent reduction in passenger VMT would be the same as the percent reduction in GHG emissions (A). The absolute reduction in passenger VMT can be calculated using the following formula.

$$K = -\left(D \times \mathbf{L} \times \mathbf{M} \times N \times \left((\mathbf{B} \times I) + (H \times J) + G\right)\right)$$

Passenger Vehicle VMT Reduction Calculation Variables

ID	Variable	Value	Unit	Source
Output				
K	Reduction in passenger vehicle miles in plan/community	[ ]	miles per year	calculated
User Inputs				
L	Total daily person trips in corridor(s)	[ ]	trips per day	user input
M	Vehicle trip length	[ ]	miles per trip	user input
Constants, Assumptions, and Available Defaults				
N	Days per year BRT available	365	days per year	assumed

Further explanation of key variables:

- (L) – The total daily person trips in the corridor(s) represents the total daily trips by all modes between the BRT origin area and the BRT destination area. This may be obtained through travel demand modeling. If the strategy involves BRT for more than one route, then the total person trips should reflect the sum of all the routes being improved.
- (M) – If the strategy involves BRT for more than one transit route, then the trip length should reflect the average of all the routes being converted.
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

BRT VMT Increase Formula

The absolute increase in BRT VMT can be calculated using the formula below. As noted above, the formula for the percent GHG reduction (A) does not reflect any increase in BRT VMT or BRT emissions. Users that wish to capture these impacts should calculate absolute changes.

$$O = S \times (P_2 - P_1) \times \mathbf{Q} \times \mathbf{R} \times N$$

BRT VMT Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
O	Increase in annual BRT miles in plan/community	[ ]	miles per year	calculated
User Inputs				
P_1	Bus frequency without measure	[ ]	transit vehicle roundtrips per hour	user input
P_2	BRT frequency with measure	[ ]	transit vehicle roundtrips per hour	user input
Q	BRT hours of operation	0–24	hours per day	user input
R	BRT route one-way length	[ ]	miles per route	user input
Constants, Assumptions, and Available Defaults				
S	One-way trips in a roundtrip	2	One-way trips per roundtrip	conversion

Further explanation of key variables:

- (O) – If the strategy involves frequency improvements for more than one transit route, then the increase in BRT miles should be calculated separately for each route.
- Please refer to the Passenger Vehicle VMT Reduction Calculation Variables table above for definitions of variables that have been previously defined.

Energy and Fuel Savings

The decrease in passenger vehicle fuel consumption and increase in BRT fuel consumption by the measure can be calculated as follows.

Passenger Vehicle Fuel Use Reduction Formula

Multiply the reduction in passenger vehicle miles (K) above by the fuel efficiency of the vehicle type (see Table T-30.2 in Appendix C) to output the change in fuel consumption.

BRT Fuel Use Increase Formula

The absolute increase in BRT fuel consumption (T) can be calculated using the formula below.

$$T = O \times U$$

BRT Fuel Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
T	Increase in annual BRT fuel consumption in plan/community	[ ]	gal per year	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
U	Fuel economy of BRT, by fuel type	Table T-26.1	gal or kilowatt hour per mile	CARB 2020; U.S. DOE 2021

Further explanation of key variables:

- (U) – The average fuel economy for gasoline, diesel, and natural gas transit buses was calculated using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average of UBUS vehicles, disaggregated by fuel type (CARB 2020). The efficiency of electric buses was calculated based on the gasoline equivalent value (U.S. DOE 2021). The user should reference Table T-26.1 for the fuel economy of the appropriate fuel type for their location's transit system. If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the default in the fuel use increase formula. Also, if the BRT vehicles are fueled by hydrogen, the user will need to calculate the increase in hydrogen fuel consumption using project-specific values, as hydrogen is currently not included as a fuel type in EMFAC.
- Please refer to the BRT VMT Increase Calculation Variables table above for definitions of variables that have been previously defined.

Sources

- California Air Resources Board (CARB). 2020. *EMFAC2017 v1.0.3*. August. Available: https://arb.ca.gov/emfac/emissions-inventory. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., K. Lovejoy, M. Boarnet, and S. Spears. 2013. *Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions*. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool–Design Document*. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.
- Transportation Research Board (TRB). 2007. *Transit Cooperative Research Program Report 118: Bus Rapid Transit Practitioner's Guide*. Available: https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf. Accessed: January 2021.
- U.S. Department of Energy (U.S. DOE). 2021. *Fuel Economy Datasets for All Model Years (1984-2021)*. January. Available: https://www.fueleconomy.gov. Accessed: January 2021.

T-29. Reduce Transit Fares

GHG Mitigation Potential

1.2%

Up to 1.2% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Reducing transit fares increases the capacity of low-income populations to use transit to evacuate or access resources during extreme weather events. Reduced fares could also incentivize more people to use transit, resulting in less traffic and better allowing emergency responders to access sites. This also reduces transit system disruptions due to extreme weather events. Lower transportation costs would also increase community resilience by freeing up resources for other purposes, such as increased cooling costs.

Health and Equity Considerations

Transit fare reduction programs should first prioritize routes with higher-volume potential in underserved communities and those most reliant on transit for travel (e.g., students, persons with disabilities, seniors).

Measure Description

This measure will reduce transit fares on the transit lines serving the plan/community. A reduction in transit fares creates incentives to shift travel to transit from single-occupancy vehicles and other traveling modes, which reduces VMT and associated GHG emissions.

This measure differs from Measure T-8, *Implement Subsidized or Discounted Transit Program*, which can be offered through employer-based benefits programs in which the employer fully or partially pays the employee's cost of transit.

Subsector

Transit

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

Transit fare reductions can be implemented systemwide or in specific fare-free or reduced-fare zones.

Cost Considerations

Reducing transit fares will lower the per capita income of the transit service. This may be outweighed by increased ridership, and savings on infrastructure costs due to reduced car usage. Reduced fares can be targeted to specific populations or groups, depending on need. Individuals receiving the reduced fare will obtain a cost savings.

Expanded Mitigation Options

This measure could be paired with other Transit subsector strategies (Measure T-25, *Extend Transit Network Coverage or Hours,* and Measure T-26, *Increase Transit Service Frequency*) for increased reductions.

GHG Reduction Formula

$$A = \frac{B \times C \times D \times E \times G}{F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–1.2	%	calculated
User Inputs				
B	Percent reduction in transit fare with measure	0–50	%	user input
C	Percent of plan/community transit routes that receive reduced fares	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Elasticity of transit ridership with respect to transit fare	-0.3	unitless	Handy et al. 2013
E	Transit mode share in plan/community	Table T-3.1	%	FHWA 2017a
F	Vehicle mode share in plan/community	Table T-3.1	%	FHWA 2017a
G	Statewide mode shift factor	57.8	%	FHWA 2017a

Further explanation of key variables:

- (B) – The user can calculate the percent reduction in transit fare based on the percent difference between the existing fare price and the proposed fare price.
- (C) – The level of implementation refers to the fraction of transit routes that on which fare reductions are implemented. Typically, fare reductions are made system-wide, so this variable would be 100.
- (D) – A policy brief summarizing the results of transit service studies reported that a 0.3 to 1.0 percent increase in transit ridership occurs for every 1.0 percent decrease in transit fares (Handy et al. 2013). To be conservative, the low end of this range is cited.
- (E and F) – Ideally, the user will calculate transit and auto mode shares for a plan/community at the city scale (or larger). Potential data sources include the California Household Travel Survey (preferred) or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode shares for transit and vehicles for one of the six most populated CBSAs in California, as presented in Table T-3.1 in Appendix C. It is likely for areas outside of the area covered by the listed CBSAs to have vehicle mode shares higher and transit mode shares lower than the values provided in the table.
- (G) – Mode shift factor is an adjustment to reflect the reduction in vehicle trips associated with a reduction in person trips as some vehicles carry more than one person. It is calculated as (1/average vehicle occupancy) (FHWA 2017b).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) For projects that use default CBSA data from Table T-3.1 and (B_{max}), the maximum percent reduction in GHG emissions (A) is 1.2 percent.

(B_{max}) The percent reduction in transit fare is capped at 50 percent (SANDAG 2019).

Subsector Maximum

($\sum A_{max_{T\text{-}25\ through\ T\text{-}29}} \leq 15\%$) This measure is in the Transit subsector. This subcategory includes Measures T-25 through T-29. The VMT reduction from the combined implementation of all measures within this subsector is capped at 15 percent.

Example GHG Reduction Quantification

The user reduces plan/community GHGs by reducing the costs associated with using transit, thereby encouraging a mode shift from single occupancy vehicles to transit and reducing VMT. In this example, the project is in the San Jose-Sunnyvale-Santa Clara CBSA, where the transit and vehicle mode shares would be 6.69 percent and 91.32 percent, respectively (E and F). Assuming the maximum decrease in transit fares of 50 percent (B) and implementation for all transit routes (100 percent) in the plan/community (C), the user would reduce plan/community GHG emissions from VMT by 0.6 percent.

$$A = \frac{\mathbf{50\%} \times \mathbf{100\%} \times -0.3 \times 6.69\% \times 57.8\%}{91.32\%} = -0.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in passenger VMT would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in passenger vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

Sources

- Federal Highway Administration (FHWA). 2017a. *National Household Travel Survey–2017 Table Designer*. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., K. Lovejoy, M. Boarnet, and S. Spears. 2013. *Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions*. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool–Design Document*. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

T-30. Use Cleaner-Fuel Vehicles

GHG Mitigation Potential

100%

Up to 100% of GHG emissions from on-road vehicles

Co-Benefits (icon key on pg. 34)

Climate Resilience

Using cleaner-fuel vehicles increases transportation resilience by providing a wider range of available vehicles if other fuels (like gasoline) become unavailable.

Health and Equity Considerations

While most cleaner fuels reduce both GHG and criteria air pollutants, a few may increase criteria pollutant emissions. The most prominent example of this is biodiesel, which generally results in higher NO_x emissions, but lower PM emissions compared to diesel.

Measure Description

This measure requires use of cleaner-fuel vehicles in lieu of similar vehicles powered by gasoline or diesel fuel. Cleaner-fuel vehicles addressed in this measure include electric vehicles, natural gas and propane vehicles, and vehicles powered by biofuels such as composite diesel (blend of renewable diesel, biodiesel, and conventional fossil diesel), ethanol, and renewable natural gas.

The full GHG emissions impact of cleaner fuels depends on the emissions from the vehicle's tailpipe as well as the emissions associated with production of the fuel (sometimes termed "upstream" emissions). For example, tailpipe GHG emissions from renewable natural gas are identical to tailpipe GHG emissions from conventional natural gas; the GHG benefits of renewable natural gas come from the fact that it is produced from biomass. Similarly, BEVs have zero tailpipe emissions, but properly accounting for their GHG impacts requires quantifying the emissions associated with the electricity generation needed to charge the vehicle's batteries.

Subsector

Clean Vehicles and Fuels

Locational Context

Non-applicable

Scale of Application

Project/Site or Plan/Community

Implementation Requirements

See measure description.

Cost Considerations

Capital costs to purchase cleaner fuel vehicles are high. Fueling infrastructure may be required, which will add to the upfront cost of transitioning to cleaner fuel vehicles. Fuel costs and savings compared to gasoline and diesel will vary depending on the type of fuel and market conditions. It is feasible to expect reduced fuel costs from cleaner fuels with an increased market and overall fuel cost savings over the life of the vehicle fleet.

Expanded Mitigation Options

If using electric vehicles, pair with Measure T-14 to ensure that electric vehicles have sufficient access to charging infrastructure.

GHG Reduction Formula

California has a well-defined process for quantifying the GHG emissions impacts of cleaner-fuel vehicles by virtue of the state's Low Carbon Fuel Standard (LCFS) program. An emissions calculation that considers both vehicle tailpipe and upstream fuel production emissions is sometimes referred to as a "well-to-wheels" analysis (A3 below). An emissions calculation that considers only vehicle tailpipe emissions is referred to as a "tank-to-wheels" analysis (A1 and A2 below).

The convention for project analysis under CEQA typically employs a hybrid approach. For natural gas, propane, and biofuels vehicles, the CEQA analysis quantifies only tailpipe emissions and does not seek to capture differences in emission associated with fuel production. However, for electric vehicles, CEQA analyses typically account for emissions associated with electricity generation (A1 and A2 below).

$$A1 = \mathbf{B} \times \frac{(D \times E \times F \times G) - \mathbf{C}}{\mathbf{C}}$$

$$A2 = \mathbf{B} \times \frac{(D \times E \times F \times G \times H) + \left(\mathbf{C} \times \frac{1}{I} \times (1 - H)\right) - \mathbf{C}}{\mathbf{C}}$$

$$A3 = \mathbf{B} \times \frac{J - K}{K}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A1	Percent reduction in GHG emissions from on-road vehicle emissions for BEVs	0–100	%	calculated
A2	Percent reduction in GHG emissions from on-road vehicle emissions for PHEVs	0–64	%	calculated
A3	Percent reduction in well-to-wheels GHG emissions from cleaner fuels or vehicle technologies	0–100	%	calculated
User Inputs				
B	Percent of vehicle fleet being converted to cleaner fuels	1–100	%	user input
C	Emission factor for existing (conventional fuel) vehicle	[ ]	g CO_2e per mile	CARB 2020a
Constants, Assumptions, and Available Defaults				
D	BEV efficiency	Table T-30.1	kWh per mile	see note

ID	Variable	Value	Unit	Source
E	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per MWh	CA Utilities 2021
F	Conversion from lb to gram	454	g per lb	conversion
G	Conversion from kWh to MWh	0.001	MWh per kWh	conversion
H	Percent of PHEV miles in electric mode	46	%	CARB 2020a
I	Ratio of average hybrid vehicle mpg to comparable gasoline vehicle mpg	1.5	unitless	see below
J	Well-to-wheels emission factor for cleaner vehicle/fuel	Table T-30.2	g CO_2e per mile	CARB 2020a, 2020b, 2020c; U.S. DOE 2021
K	Well-to-wheels emission factor for existing (conventional fuel) vehicle	Table T-30.2	g CO_2e per mile	CARB 2020a, 2020b, 2020c; U.S. DOE 2021

Further explanation of key variables:

- (A1 or A2) – Use of these equations is appropriate for a typical CEQA project analysis, which considers tailpipe GHG emissions and, for electric vehicles, electricity generation emissions.
- (A3) – Use of this equation is appropriate for a user interested in a well-to-wheels analysis for all fuel types. The user should determine the appropriate emission factors for the conventional fuel and cleaner fuel.
- (C) – The user should run EMFAC to output GHG emission factors (CO_2, CH_4, and N_2O) for the existing (conventional fuel) vehicles. The EMFAC run should be based on project-specific values for the region, project year, season, vehicle category, model year, speed, and fuel type (gasoline, diesel, or a weighted average).[15] To determine the CO_2e emission factor of the conventional fuel vehicle, the emission factors for CO_2, CH_4, and N_2O from EMFAC should be multiplied by the corresponding 100-year GWP values (1, 25, and 298, respectively) from the IPCC's Fourth Assessment Report (IPCC 2007) and then summed.
- (E) – GHG intensity factors for major California electricity providers are provided in Tables E-4.3 and E-4.4. If the project study area is not serviced by a listed electricity provider, or the user is able to provide a project-specific value (i.e., for a future year not referenced in Tables E-4.3 and E-4.4), the user should use that specific value in the GHG calculation formula. If the electricity provider is not known, users may elect to use the statewide grid average carbon intensity.
- (H) – Based on the EMFAC2017 model (v1.0.3), 46 percent of miles traveled by PHEVs in California are in electric mode (eVMT), with 54 percent in gasoline mode (CARB 2020a).

[15] There are many different combinations of input variables a user could specify in EMFAC to result in a unique emission factor output. This report does not attempt to consolidate a standardized group of emission factor output into a database table for the user to refer to. It is recommended the user run EMFAC to obtain project-specific results.

- (I) – Assumes that a PHEV operating in gasoline mode is similar to a gasoline hybrid (non-plug-in) vehicle. A typical gasoline hybrid vehicle has 50 percent higher fuel economy (mpg) than a comparable gasoline vehicle, based on a comparison of the gasoline and hybrid Toyota Camry and Corolla models (U.S. DOE 2021).
- (J and K) – The average California values for fuel efficiency, energy density, and carbon intensity of typical vehicle and fuel types are provided in Table T-30.2 (CARB 2020a, 2020b, 2020c; U.S. DOE 2021). Table T-30.2 also provides the well-to-wheels emission factor, which can be calculated based on the product of the fuel efficiency, energy density, and carbon intensity. If the user can provide a project-specific value, then the user should replace in the GHG calculation formula one or more of these values that produces the emission factor.
- (D) – BEV energy efficiency varies by vehicle type. The average California values are provided in Table T-30.1 in Appendix C. If the user can provide a project-specific value, they should replace the default in the GHG reduction formula. BEV energy efficiency can be calculated as:

$$\text{BEV efficiency (kWh per mile)} = \frac{L}{M \times N}$$

Where,

- (L) – Gasoline to electricity conversion. Users can assume 33.7 kWh per gallon of gasoline, which is a standard conversion factor used by U.S. EPA and U.S DOE (U.S. EPA 2021).
- (M) – Fuel economy (mpg) of a comparable gasoline vehicle. Users can obtain this from Table T-30.2.
- (N) –EER for an electric vehicle. Users can assume 3.4, which is the EER established by CARB for electric vehicles as stated in the LCFS regulation. (CARB 2020b).

GHG Calculation Caps or Maximums

Measure Maximum

($A1_{max}$) The GHG reduction from the use of BEVs is capped at 100 percent, which assumes that 100 percent of the fleet would be converted (B) and that the local electricity provider is powered 100 percent by renewables and thus has a carbon intensity of zero (E).

($A2_{max}$) The GHG reduction from the use of PHEVs is capped at 64 percent, which assumes that 100 percent of the fleet would be converted (B) and that the local electricity provider is powered 100 percent by renewables and thus has a carbon intensity of zero (E).

($A3_{max}$) For a well-to-wheels analysis, the GHG reduction from the use of electric vehicles is capped at 100 percent, which assumes that the local electricity provider is powered 100 percent by renewables and thus has a carbon intensity of zero (L). Note that the maximum percent reduction for all other cleaner vehicles and fuels presented in Table T-30.2 will not reach this maximum.

Subsector Maximum

Same as (A_{max}). Measure T-30 is the only measure at the Plan/Community scale within the Clean Vehicles and Fuels subsector.

Example GHG Reduction Quantification

The user reduces vehicle emissions by avoiding the use of conventional fuels in place of cleaner fuels or vehicle technologies. In this example, a municipality that sources their electricity from an electricity provider powered 100 percent by renewables (E) is converting half of their fleet of gasoline light duty automobiles to BEVs (B). The user has run EMFAC for their county, vehicle category, and project year, and determined the fleet emission factor to be 400 g CO_2e (C). The user would reduce GHG emissions from the existing fleet by 50 percent.

$$A1 = \mathbf{50\%} \times \frac{(0.33\,\frac{\text{kWh}}{\text{mi}} \times 0\,\frac{\text{lb CO}_2\text{e}}{\text{MWh}} \times 454\,\frac{\text{g}}{\text{lb}} \times 0.001\,\frac{\text{MWh}}{\text{kWh}}) - \mathbf{400\,\frac{g\ CO_2e}{mi}}}{\mathbf{400\,\frac{g\ CO_2e}{mi}}} = \text{-50\%}$$

Quantified Co-Benefits

Improved Local Air Quality

(O1) – The use of BEVS in lieu of conventional vehicles would decrease local criteria pollutants. The percent reduction is equal to (B). Electricity supplied by statewide fossil-fueled or bioenergy power plants will generate criteria pollutants. However, because these power plants are located throughout the state or outside the state, electricity consumption from vehicles charging typically will not generate localized criteria pollutant emissions on the project site or roadways traveled by the electric vehicles.

(O2) – The percent reduction in local criteria pollutants from use of PHEVs in lieu of conventional vehicles (A2) is equal to ($B \times A2_{max}$). See ($A2_{max}$) above, which assumes (E) is set to zero to nullify eVMT activity and vehicle fleet conversion (B_{max}) is set to 100 percent. ($A2_{max}$) is multiplied by the actual conversion of the vehicle fleet (B) to adjust the percent reduction calculated from ($A2_{max}$). Electricity supplied by statewide fossil-fueled or bioenergy power plants will generate criteria pollutants. However, because these power plants are located throughout the state or outside the state, electricity consumption from vehicles charging typically will not generate localized criteria pollutant emissions.

(O3) – For a well-to-wheels analysis, the fuels produced by facilities within and outside of California will generate criteria pollutants. Because these facilities are dispersed, offsite of the project/site or plan/community, fuel production typically will not generate localized criteria pollutant emissions. Therefore, only the tank-to-wheels (i.e., tailpipe) portion of the vehicle criteria pollutant emissions should be quantified. For BEVs and PHEVs, this can be done using the methodologies described above (O1 and O2, respectively). For vehicles fueled by diesel, biodiesel, renewable diesel, and natural gas, the criteria pollutant emission factor can be outputted by EMFAC (see C). The criteria pollutant reductions from use of gasoline hybrid or flex fuel vehicles cannot be readily quantified within EMFAC as these fuel types are not inputs the user can specify.

Fuel Savings (Increased Electricity)

(P1 and Q1) – The use of BEVs in lieu of conventional vehicles would decrease vehicle fuel consumption and increase electricity use. The percent reduction in fuel use (P1) is equal to (B). The absolute increase in electricity use can be calculated using the below formula (Q1).

(P2 and Q2) – The use of PHEVs in lieu of conventional vehicles would decrease vehicle fuel consumption and increase electricity use. The percent reduction in fuel use (P2) is equal to $(B \times A2_{max})$. The absolute increase in electricity use (Q2) is equal to $(H \times Q1)$.

(P3 and Q3) – For gasoline, gasoline hybrid, flex fuel, diesel, biodiesel, renewable diesel, and natural gas, the percent reduction in fuel use of the existing (conventional fuel) vehicle is equal to (B). The absolute increase in the cleaner fuel/vehicle energy can be calculated using the below formula (P3).

BEV Electricity Use Increase Formula

$$Q1 = \mathbf{B} \times \mathbf{D} \times \mathbf{R}$$

Electricity Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
Q1	Increase in electricity from electric vehicles	[ ]	kWh per year	calculated
User Inputs				
R	Average annual VMT of all vehicles in fleet	[ ]	miles per year	user input
Constants, Assumptions, and Available Defaults				
	None			

Further explanation of key variables:

- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

Cleaner Vehicle Energy Use Increase Formula

$$P3 = \mathbf{B} \times \mathbf{R} \times \frac{S}{T}$$

Cleaner Vehicle Energy Use Increase Variables

ID	Variable	Value	Unit	Source
Output				
P3	Increase in vehicle fuel use in fleet	[ ]	megajoules (MJ)	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
S	Energy density for cleaner fuel/vehicle	Table T-30.2	MJ per gal	CARB 2019, 2020a, 2020b, 2020c; U.S. DOE 2021
T	Fuel efficiency for cleaner fuel/vehicle	Table T-30.2	mpg	

Further explanation of key variables:

- (S and T) – The average California values for fuel efficiency and energy density of typical vehicle and fuel types are provided in Table T-30.2 (CARB 2019, 2020a, 2020b, 2020c; U.S. DOE 2021). If the user can provide a project-specific value, then the user should replace in the fuel use reduction formula one or more of these values that produces the energy consumption value (MJ).
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

Sources

- California Air Resources Board (CARB). 2019. *LCFS Pathway Certified Carbon Intensities*. Available: https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities. Accessed: January 2021.
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