SCTA VMT Reduction Calculator Tool—Design Document

Prepared for:
Sonoma County Transportation Authority

August 2022

WC19-3559

FEHR & PEERS

Table of Contents

Introduction

This report documents the design of the VMT Reduction Calculator Tool developed for the Sonoma County Transportation Authority (SCTA). The Microsoft Excel-based Tool produces estimates of the percent reduction in vehicle miles traveled (VMT) resulting from the application of mobility management strategies. The Tool is intended to act as a resource for evaluating and quantifying the impacts of mobility management strategies as part of the development review and transportation analysis process for development projects located in Sonoma County. The Tool supports the goals of Senate Bill (SB) 743 (Steinberg, 2013) by providing jurisdictions and developers with a resource to quantify VMT reductions resulting from implementation of a variety of mitigation strategies at various scales. Use of this Tool is voluntary at the discretion of the lead agency. The Tool is only applicable for projects within Sonoma County. Any action you take upon the information is strictly at your own risk, and neither SCTA nor its consultants will be liable for any losses or damages in connection with use of these data and this Tool.

This report describes the user inputs, constants and assumptions, formulas, and outputs for each strategy included in the Tool. Most of this information is available in the Tool itself, although this document provides some additional explanation of data sources and calculation methods.

The report is organized similarly to the Tool itself. The first section constitutes a User Guide, situating the Tool within a typical analytical workflow. The next four sections following the User Guide describe the *Introduction* page, *Main* page, *Results* page, and *Conflict Info* page of the Tool. The remaining sections describe the 32 strategies included in the Tool, grouped in the following five categories:

- Land Use Strategies
- Trip Reduction Programs
- Parking or Road Pricing/Management
- Neighborhood Design Enhancement Strategies
- Transit Strategies

User Guide

The SCTA VMT Reduction Calculator Tool is designed to help analysts quantify the effectiveness of a given suite of VMT reduction strategies, based on substantial research evidence. As such, it forms an important part, but only one part, of an analytical pipeline related to SB 743's VMT impact analysis mandate. This User Guide situates the Tool within that pipeline and provides tips on using the Tool as effectively as possible.

Before You Use the Tool

- A "VMT Tool Calculator – Supporting Worksheet" is being provided to guide the analyst through the VMT analysis and mitigation process. The analyst would need to fill in the project information by following the steps below:
  - Confirm whether the project is subject to VMT analysis. Some projects will be screened out of VMT analysis per local policy recommendations.[1]
  - Understand the project—its description, its components, and its location/context. While the Tool is intended to be easy to use, there is no substitute for a solid understanding of the project's elements and context.
  - Calculate the project's total VMT and VMT per capita/per service population prior to any reductions. The Tool reports VMT effects in terms of percentage reductions, so you will generally need to calculate the base number(s) onto which those reductions are applied.
    - Project VMT could be calculated using travel demand model runs, sketch model tools, and/or multiplying trip generation estimates and average trip lengths.

Using the Tool

- Begin by identifying the project location in terms of SCTA travel model Transportation Analysis Zones (TAZs). The Tool includes a link to Sonoma County's online TAZ Mapping Tool[2], a useful resource for identifying the project's TAZ.
  - Once you enter the TAZ number, the Tool will display the name of the jurisdiction containing that TAZ. This allows the analyst to quickly confirm they have selected the correct TAZ.
  - Because the research literature on VMT reduction strategies is based on studies in urban or suburban land use contexts (as opposed to rural areas), the Tool is not applicable in some very low-density parts of Sonoma County. If your project is in one of these areas, the Tool will

[1] https://arcg.is/0fuKrD

[2] SCTA Model TAZ Mapping Tool: https://www.arcgis.com/home/webmap/viewer.html?webmap=2aa1f84fb5cd4fb286deb5e1edab0e39&extent=-122.7951,38.4196,-122.569,38.5239

clearly indicate this fact. In that case, any quantification of VMT reductions would need to be done outside of this Tool and based on project- and context-specific evidence and calculations. Some mitigations may still be applicable to rural areas in some cases, such as within urban service areas of the unincorporated County, but care should be taken when applying any mitigations to rural areas.

- The Tool is designed to be self-documenting and to include extensive guidance; it is therefore vital to read and consider the documentation and guidance in the Tool. In particular, analysts should carefully review each VMT reduction strategy's description to confirm whether the strategy is plausibly applicable to the project being analyzed.
- Some strategies apply at the level of an individual project site and affect the VMT just from that site. Other strategies apply to a broader geographic area outside of the immediate project site and affect the VMT from an entire neighborhood or city. This distinction is discussed in detail in the 2021 CAPCOA *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity,* which is the source of the VMT reduction estimates presented in the Tool.
  - Although most strategies affecting VMT at a neighborhood or city scale are too ambitious to be undertaken singlehandedly by an individual project, many of these strategies (e.g., bikeway network expansion or transit frequency improvements) can be accomplished by a larger program into which a given project makes a partial financial contribution. This use case is not explicitly handled in the Tool but can be calculated by entering the total effect of the program and then prorating the resulting VMT reduction according to the project's share of total program costs.
    - Example:
      A proposed office building could apply a few project-specific measures, some of which would affect all project-generated trips and some of which are specific to employee commute trips; all of those project-specific trip reductions could be "credited" to the proposed project.

      In addition, the project may also be required to contribute to some neighborhood-wide improvements, such as completing the bike network that would connect the office park to a nearby trail. These measures would affect all neighborhood trips, not just those from the project site itself; the lead agency would need to consider what proportion of those areawide trip reductions would reasonably be attributed to the project's contribution.
- Refer to the hidden help texts located throughout the Tool (mouse over cells with a colored top right corner) for guidance on user inputs and other information about each strategy.
- Certain VMT reduction strategies conflict with one another. For example, a project cannot have both a mandatory AND a voluntary commute trip reduction program; such a program must be either mandatory or voluntary, not both.

    - If an analyst configures multiple conflicting strategies, the Tool will temporarily disable both conflicting strategies, excluding their effects from the aggregate effectiveness shown on the *Results* page until the conflict is resolved. Conflicting strategies are clearly labeled on the *Results* page as well as on the *Conflict Info* page, which is intended to help the analyst understand which strategies are in conflict.
    - To resolve a conflict, choose one conflicting strategy (typically the less effective one), navigate to that strategy's page, and zero out all user inputs so change in VMT will not be calculated.
- The *Results* page is designed to be ready to print as a durable report of the Tool's outputs.

After You Use the Tool

- Typically, the key question in a VMT impact analysis is "does the project's VMT, including the effect of VMT reduction strategies, constitute a significant environmental impact?" In order to answer this question, the analyst will need to apply the reductions calculated in the Tool to the baseline (pre-reduction) project VMT, then compare the result to the local jurisdiction's VMT impact significance thresholds. The "VMT Reduction Calculator - Supporting Worksheet" is intended to help guide the analyst through those steps.
- It is important to understand how the different types of VMT reduction calculated in the Tool interact. See the "Results Page" section below for more information.

Introduction Page

Users of this Tool should begin on the *Introduction* page. The *Introduction* page is organized around the following three boxes:

I. Overview

Describes the Tool and its purpose.

II. Disclaimers

Provides disclaimers and explanations about user discretion.

III. Frequently Asked Questions (FAQs)

Lists frequently asked questions and associated answers.

1. **What does this tool do?**
   The tool operates at two geographic scales: project/site-level and community/city-level. The tool user must provide simple input information about a strategy in order to produce a VMT reduction estimate. The tool is intended to act as a resource for evaluating and quantifying the impacts of mobility management strategies as part of the development review and transportation analysis process for development projects in Sonoma County. The tool supports the goals of SB 743 (Steinberg, 2013) by providing jurisdictions and developers with a resource to quantify VMT reductions resulting from implementation of a variety of mitigation strategies.
2. **Why do the strategy inputs read "#N/A"? / Why is the strategy not calculating a reduction?**
   The most common reason for this is that the user has not selected a TAZ for analysis, per the main screen (step #2 of the instructions, and cell H35 in the "Main" tab). This error may also occur if the TAZ selected does not have a high enough intensity of land use for the tool to be appropriate.
3. **How do I enter strategy information?**
   Tool users enter information about a strategy of interest in the green-colored cells found on each strategy page. Orange-colored cells are populated with default values from the Travel Demand Model, but can be replaced with user input. Users cannot enter information in the grey cells. Guidance on common sources for the information required for those cells is included as part of each measure's description.
4. **How do I see if the strategy reduces VMT?**
   Each strategy page has a row labeled "Change in VMT." A negative value in this row indicates a reduction in VMT; a positive value indicates an increase in VMT (denoted with a red outline of the cell). Most measures will never result in an increase in VMT. If a measure does not apply, or does not create a reduction, there will be a value of either "0%" or no value in the cell.

5. **What is the source for the VMT reduction strategies included in the tool?**
The strategies are listed on the *Main* page of this tool. These strategies are modeled after those included in the 2021 CAPCOA *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*. The tool does not include all strategies listed in CAPCOA; a few have been omitted because they are relevant for greenhouse gas emission reduction but not for VMT reduction.

6. **How do I select VMT reduction strategies?**
From the *Main* page or the *Results* page, the user can click on a strategy hyperlink of interest. On the strategy page, entering input values in all green-colored cells will activate that strategy. If the user does not want the VMT reduction results of a given strategy to be included in the summary results, delete the inputs from the green-colored cells.

7. **Where can I learn more about how the reductions are calculated?**
Each strategy page lists the references that were used to develop the VMT reduction estimates. The last section of this document also provides more information on each strategy to accompany the Tool.

8. **How is the total percent change in VMT adjusted when I select multiple strategies?**
The user will see on the *Results* page (a) the percent change in VMT associated with each strategy, and (b) the total percent change in VMT (total) from all strategies. If only one strategy is selected, the values will be the same. If more than one strategy is selected, the tool applies each reduction only to the remaining VMT after all previous reductions to adjust the sum of VMT reduction. This accounts for the diminished percent change in VMT that a strategy will have if other strategies are also selected. The total is calculated with the following formula:

   Total = {[100% - (Strategy A % change in VMT)] * [100% - (Strategy B % change in VMT)] * ... * [100% - (Strategy Z % change in VMT)]} - 100%

   In general, this process can be summarized through the following observation: two 50% reductions will not, when combined, result in a 100% reduction. Instead, they will result in a 75% reduction: the first reduces trips/VMT by 50%, and the second reduces by another 50%, for a total of 25% of the original total VMT. This reflects that strategies will only target individuals who have not yet "changed" their behavior.

9. **How are the mode share, trip length, and VMT per capita data derived?**
The mode share, trip length, and VMT per capita data found in this tool reflect travel by residents, employees, and visitors of Sonoma County only. The data are parsed by jurisdiction and by transportation analysis zone (TAZ) and are derived from year 2020 model estimates produced by the SCTA Travel Demand Forecasting Model. Visitor travel is estimated in the Sonoma County Travel Model using information from the Sonoma County Travel Behavior Study. The data do not include travel made by heavy-duty trucks or travel for commercial purposes.

10. **Can I calculate the total percent change in VMT from multiple strategies if the scales of analysis from my chosen strategies are not the same?**
Yes. The user may select any combination of strategies shown on the *Main* page. The *Results* page

shows the type of VMT affected by each strategy and presents the total change for each type of VMT.

11. **Why are there five totals displayed on the *Results* page?**
As discussed above in Question 8, the total percent change in VMT will be calculated when multiple strategies are selected. However, if the selected strategies reduce VMT from different types of trips (e.g., some strategies affect employee commute trips while others affect all project-generated trips), it may not be valid to combine the total percent change in VMT. For example, limiting the parking supply at a commercial facility affects VMT from all project-generated trips, while an employee vanpool program only affects VMT from the facility's employee commute trips. The total reduction for each type of VMT will be shown in the tool, and may be separately applied to off-model VMT estimates if the analyst is able to isolate VMT production by each of the individual sources.

12. **Can the tool be used to analyze strategies in rural / low-density areas?**
There is little empirical research to support the estimation of VMT reduction in rural areas. Because of the lack of relevant research, the tool cannot be applied to areas with densities below a certain level. Attempting to use the tool for a project located in a very low-density area will result in a message that the site cannot be analyzed using this Tool. Additional analysis outside of the Tool will likely be required to assess the true VMT characteristics of sites in those areas, due to the low intensity of existing development making it more difficult to extrapolate travel patterns. Similar caution may be warranted for projects that substantially depart from the existing land use types in the project TAZ.

13. **How is the maximum VMT reduction calculated for each strategy?**
On each strategy page below the "Type of VMT affected," the "Max VMT reduction" is listed. Sometimes a strategy's maximum VMT reduction is dependent only on user inputs, other times it is capped at a certain percentage, and other times it is based on regional parameters (e.g., mode share) specific to each TAZ or city. Furthermore, the max VMT reduction can also be changed by optional user inputs that override default data. The max VMT reduction listed on each strategy page is meant to provide the user with a general estimate of the reduction potential for each strategy. The values listed were derived from the tool using dense, urban TAZs as the analysis location with all default data. The user may achieve a max VMT reduction that is different than the max VMT reduction listed based on differences in regional parameters of the selected project site and any additional user overrides.

14. **There is text in a locked cell that is cut off, and I cannot adjust the cell margins to read the remainder of the text. How can I read the cell text?**
The margins of all cells have been adjusted so that at Excel's 100% zoom level all the text can be seen. Adjust your zoom level to 100% if you see that a cell's text is cut off. This also applies to any text in comment bubbles. If you still cannot read the text, try adjusting your zoom level to other percentages.

15. **What does "percent of employees eligible" mean, as used in strategies T-5 through T-9-B, T-11, and T-13?**

This refers to the percent of employees that would be able to participate in the strategy's program, if they desired to. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, employees who are required to drive to work as part of their job duties, or contract employees who do not receive certain employer-sponsored benefits. This input does not refer to the percent of employees who actually participate in the program.

Main Page

SCTA VMT Reduction Calculator Tool

The *Main* page is organized around the following four boxes:

I. Instructions

Describes how to use the Tool in a series of six steps.

II. Legend

Describes the formatting for cells used in the VMT reduction calculations for each strategy.

III. Project Information

The user can enter the following optional information:

- Project Name
- Project Address
- Project Type

The user must select the analysis location by indicating in which SCTA travel model Transportation Analysis Zone (TAZ) the project is located. The Tool includes a link to Sonoma County's online VMT Mapping Tool, a useful resource for identifying the project's TAZ.

IV. TDM Strategies

The user sees a list of the 32 strategies included in the Tool, shown below. Each strategy name is a hyperlink and clicking on a name will take the user to the specific page for that strategy. Note that the order in the list below may not be identical to the order in the Tool.

Most of the strategies in the first three groups reduce VMT at a project or site level, i.e., they reduce VMT associated with the specific project being analyzed. Most strategies in the last two groups reduce VMT at a neighborhood/city level, i.e., their reductions apply to all VMT within the geographic area affected by the strategy. In practice, only large projects or citywide programs will generally be able to employ these larger-scale strategies.

Land Use Strategies	
Strategies that modify the location or characteristics of development projects to encourage non-auto travel modes	
T-1	Increase Residential Density

T-2	Increase Job Density
T-3	Provide Transit-Oriented Development
T-4	Integrate Affordable and Below Market Rate Housing
T-17	Improve Street Connectivity
Trip Reduction Programs	
Strategies implemented by employers that encourage workers to commute by modes other than auto	
T-5	Implement Commute Trip Reduction Program (Voluntary)
T-6	Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring)
T-7	Implement Commute Trip Reduction Marketing
T-8	Provide Ridesharing Program
T-9-A	Implement Subsidized or Discounted Transit Program - All Trips
T-9-B	Implement Subsidized or Discounted Transit Program - Work Trips Only
T-10	Provide End-of-Trip Bicycle Facilities
T-11	Provide Employer-Sponsored Vanpool
T-12	Price Workplace Parking
T-13	Implement Employee Parking Cash-Out
T-23	Community-Based Travel Planning
Parking or Road Pricing/Management	
Strategies that discourage auto travel by modifying the price or supply of vehicle parking	
T-15	Limit Residential Parking Supply
T-16	Unbundle Residential Parking Costs from Property Cost
T-24	Implement Market Price Public Parking (On-Street)
Neighborhood Design Enhancement Strategies	
Strategies that improve or encourage neighborhood-level bicycle, pedestrian, and other multimodal travel options	
T-18	Provide Pedestrian Network Improvements
T-19-A	Construct or Improve Bike Facility
T-19-B	Construct or Improve Bike Boulevard
T-20	Expand Bikeway Network
T-21	Implement Carshare Program
T-22-A	Implement Pedal (Non-Electric) Bikeshare Program
T-22-B	Implement Electric Bikeshare Programs
T-22-C	Implement Scootershare Program
Transit Strategies	
Strategies that improve transit service and cause a mode shift from auto to transit	
T-25	Extend Transit Network Coverage or Hours
T-26	Increase Transit Service Frequency
T-27	Implement Transit-Supportive Roadway Treatments
T-28	Provide Bus Rapid Transit
T-29	Reduce Transit Fares

Results Page

The *Results* page lists all the strategies and displays the percentage reduction in VMT calculated for each strategy analyzed by the user. In the default state of the Tool, all strategies are “inactive,” so no VMT reduction results are initially shown on this page. As the user “activates” a strategy by providing inputs, the Tool calculates the percentage reduction in VMT for that strategy, displaying the results both on the individual strategy page and on the *Results* summary page.

The top of this page includes the project information from the *Main* page. Below that is a VMT Reduction Summary that includes eleven rows for total VMT reduction—one for each unique combination of strategy type (Land Use; Trip Reduction Program; Parking or Road Pricing/Management; Neighborhood Design; Transit) and VMT type (project-generated trips; all neighborhood/city trips; employee commute trips; household trips).

The bottom of this page displays the total percentage reduction in VMT for multiple strategies selected. The total VMT reduction formula applies multiplicative damping so as not to double-count VMT effects. For example, if one strategy reduces VMT by 10%, then only 90% of VMT remains to be affected by subsequent strategies. If a second strategy is applied that also reduces VMT by 10%, the combined resulting VMT would be 81% (10% reduction of 90% of VMT). Thus, the VMT reduction effect of both strategies is 19%, rather than 20% if the effects were considered purely additive. The following is the formula used to calculate the total VMT reduction if multiple strategies are selected:

> **Total** = { [100% - (Strategy A % change in VMT)] * [100% - (Strategy B % change in VMT)] * … * [100% - (Strategy Z % change in VMT)] } - 100%

The page shows multiple rows for total VMT reduction—two for project-specific strategies that affect either all project-generated trips or only employee commute trips, and three for community-scale strategies that may affect all neighborhood/city trips, all household trips, or only employee commute trips. The results are reported in these different rows because it may not be valid to combine VMT reductions for the different types. For example, parking pricing at a commercial facility affects VMT from all project-generated trips, while an employee vanpool program only affects VMT from the facility’s employee commute trips.

The categories overlap, but generally in only one direction. Employee commute VMT will be affected by strategies that reduce employee commute trips and strategies that reduce all project-generated trips; but strategies that reduce employee commute trips have no effect on project-generated trips that are not employee commute trips. Likewise, all project-generated trips (including employee commute trips) are affected by strategies that reduce all neighborhood/city trips; but strategies that reduce project-generated trips are not considered to affect non-project neighborhood/city VMT.

Conflict Info Page

Certain VMT reduction strategies conflict with one another. For example, a project may not have both a mandatory AND a voluntary commute trip reduction program: such a program must be either mandatory or voluntary, not both.

If a conflict occurs, the VMT reductions associated with both conflicting strategies will be omitted from the results until the conflict is resolved. The *Conflict Info* page displays all active conflicts among strategies currently in use. To resolve the conflict(s), the user will need to zero out the user input(s) of the strategy chosen to be excluded. Once the conflict(s) are resolved, the strategies' effects will be included in the *Results* page.

Strategy Descriptions

Land Use Strategies

Strategies that modify the location or characteristics of development projects to encourage non-auto travel modes.

T-1. Increase Residential Density

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.

Projects with a residential density greater than 9.1 dwelling units per acre (or user's optional override value) will see VMT reductions due to this strategy.

Formula:

% Change in VMT = ((Residential density of project development - Residential density of typical development) / Residential density of typical development) * Elasticity of VMT with respect to residential density

User Inputs:

- Residential density of project development (dwelling units per acre)
- Residential density of typical development (optional)
  The user may override the default residential density of typical development.

Constants and Assumptions:

- Residential density of typical development is 9.1 dwelling units per acre
- Elasticity of VMT with respect to residential density is -0.22

SCTA Model Data:

- None

Sources:

- Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., Chen, D. 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

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 United States. 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.

Formula:

% Change in VMT = ((Job density of project development (jobs per acre) - Job density of typical development)/ Job density of typical development)* Elasticity of VMT with respect to Job density

User Inputs:

- Job density of project development (jobs per acre)
- Job density of a typical development (optional)
  The user may override the default job density of a typical development.

Constants and Assumptions:

- Job density of a typical development is 145.0 jobs per acre
- Elasticity of VMT with respect to job density is -0.07

SCTA Model Data:

- None

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. Transit-Oriented Development

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. Projects in a rural context may be considered here only if it is adjacent to commuter rail station with convenient rail service to a major employment center. To qualify as a TOD, the development must be within a 10-minute walk (0.5 mile) of a high frequency transit station (either rail, or bus with headways less than 15 minutes). Additionally, the project must be designed to encourage the use of transit. For example, a project that provides ample parking and is located in a TOD location should not be considered a TOD because the project design encourages driving; a project located in a TOD location with meaningful pedestrian and bicycle connections to high quality transit could be considered a TOD.

Formula:

% Change in VMT = (Transit mode share in surrounding city * Ratio of transit mode share for TOD area with measure compared to existing transit mode share in surrounding city) / -Auto mode share in surrounding city

User Inputs:

- Is the project within 0.5 mile of a rail transit station (e.g., SPRINTER, COASTER, Trolley)? [Yes/No].
    - Transit service must provide frequent and reliable service, connecting to regional destinations.
    - If No, strategy cannot be used
- Transit mode share in surrounding city (optional)
  The user may override the above default community transit mode share in this cell.
- Auto mode share in surrounding city (optional)
  The user may override the above default community auto mode share in this cell.

Constants and Assumptions:

- Ratio of transit mode share for TOD area with strategy compared to existing transit mode share in surrounding city is 4.9.

SCTA Model Data:

- Default transit mode share in surrounding city

- Default auto mode share in surrounding city

Sources:

- Tal, G., et al. 2013. "Technical Background Document on the Impacts of Transit Access (Distance to Transit) Based on a Review of the Empirical Literature." www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf
- 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., Cervero, R., and Wilson, R. 2004. Travel Characteristics of Transit-Oriented Development in California. January. Available: https://community-wealth.org/sites/clone.communitywealth.org/files/downloads/report-lund-cerv-wil.pdf. Accessed: January 2021.

T-4. Integrate Affordable and Below Market Rate Housing

Description: Income has a statistically significant effect on the probability that a commuter will take transit or walk to work. Below market rate (BMR) housing provides greater opportunity for lower-income families to live closer to jobs centers and achieve jobs/housing match near transit. It also addresses to some degree the risk that new transit-oriented development would displace lower-income families. This strategy potentially encourages building a greater percentage of smaller units that allow a greater number of families to be accommodated on infill and transit-oriented development sites within a given building footprint and height limit. Lower-income families tend to have lower levels of auto ownership, allowing buildings to be designed with less parking which, in some cases, represents the difference between a project being economically viable or not.

Formula:

% Change in VMT = Percent of multi-family units permanently dedicated as affordable * Percent reduction in VMT for qualified units compared to market rate units

User Inputs:

- Percent of units in project that are dedicated as affordable housing

Constants and Assumptions:

- Percent reduction in VMT for qualified units compared to market rate units is -28.6%.

SCTA Model Data:

- None

Sources:

- Institute of Transportation Engineers (ITE). 2021. Trip Generation Manual. 11th Edition. ITE 2021. Available: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/
- National Center for Sustainable Transportation. Affordable Housing in Transit-Oriented Developments: Impacts on Driving and Policy Approaches. April 2017. Available: https://escholarship.org/uc/item/487994z4

T-17. Improve Street Connectivity

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 existing average intersection density. 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.

Example 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 to grid streets).

Formula:

% Change in VMT = ((Intersection density in project site with measure - Existing intersection density) / Existing intersection density) * Elasticity of VMT with respect to intersection density

User Inputs:

- Intersection density in project site with strategy (intersections per square mile)
- Average intersection density (intersections per square mile) (optional)
  The user may override the default average intersection density in this cell. Leave blank otherwise.

Constants and Assumptions:

- Elasticity of VMT with respect to intersection density is -0.14

Locally Specific Data:

- Default average intersection density (intersections per square mile)
  - Calculated based on EPA EnviroAtlas data

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.

Trip Reduction Programs

Strategies implemented by employers that encourage workers to commute by modes other than autos.

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

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. 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-A and T-9-B), 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).

Formula:

% Change in VMT = Percent of employees eligible for program * Percent reduction in commute VMT from eligible employees

User Inputs:

- Percent of employees eligible
  - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.

Constants and Assumptions:

- Percent reduction in commute VMT from eligible employees is 4%

- Strategy encompasses strategies T-8, T-9-A, T-9-B, T-10, and T-11 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- None

Sources:

- Boarnet, M., Hsu, H., Handy, S. 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)

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. The mandatory CTR program must include all other elements (i.e., Measures T-8 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.

Formula:

% Change in VMT = Percent of employees eligible for program * Percent reduction in vehicle mode share of employee commute trips * Adjustment from vehicle mode share to commute VMT

User Inputs:

- Percent of employees eligible
    - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.

Constants and Assumptions:

- Maximum percent reduction in vehicle mode share of employee commute trips is 26%
- Adjustment from vehicle mode share to commute VMT is 1

- Strategy cannot be used in combination with T-5.
- Strategy encompasses strategies T-8, T-9-A, T-9-B, T-10, and T-11 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- None

Sources:

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

T-7. Implement Commute Trip Reduction Marketing

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.

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.

Formula:

% Change in VMT = Percent of employees eligible for program * Percent reduction in employee commute vehicle trips

User Inputs:

- Percent of employees eligible
    - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.

Constants and Assumptions:

- Percent reduction in employee commute trips is 4%.
- Adjustment from vehicle mode share to commute VMT is 1.

SCTA Model Data:

- None

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

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.

Ridesharing must be promoted through a multi-faceted 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.

Formula:

% Change in VMT = Percent of employees eligible for program * Percent reduction in employee commute VMT

User Inputs:

- Percent of employees eligible
    - Refers to the percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, employees who are required to drive to work as part of their job duties, or contract employees who do not receive certain employer-sponsored benefits. This input does not refer to the percent of employees who actually participate in the program.

Constants and Assumptions:

- Maximum percent change in commute VMT:
  - Land use intensity too low for application of VMT tool: 0%
  - Low-Density Suburb or Suburban: -4%
  - Urban: -8%
- Strategy encompassed by strategies T-5 and T-6 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- Place type of project/site, automatically generated based on the density and mode share of the selected TAZ.
  - Urban
  - Suburban
  - Low density suburb

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-A. Implement Subsidized or Discounted Transit Program (All Trips)

Description: This measure will provide subsidized or discounted, or free, transit passes for employees and 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. 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.

Formula:

% Change in VMT = ((Subsidy amount / Average transit fare without subsidy)* Elasticity of transit boardings with respect to transit fare price) * Percent of residents eligible for subsidy * Percent of project-generated VMT from residents * Transit mode share in neighborhood/city * Percent of transit trips that would otherwise be made in a vehicle * Conversion factor of vehicle trips to VMT

User Inputs:

- Average transit fare without subsidy
- Subsidy amount
- Percent of residents/employees eligible for subsidy
    - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.
- Percent of project-generated VMT from residents/employees
  Please carefully specify this input, especially for projects with a high proportion of non-resident and non-work trips (e.g., schools, hotels, shopping centers).
- Transit mode share of work trips (optional)
  The user may override the above default existing transit mode share in this cell.

Constants and Assumptions:

- Elasticity of transit boardings with respect to transit fare price is -0.43
- Percent of transit trips that would otherwise be made in a vehicle is 50%
- Conversion factor of vehicle trips to VMT is 1
- Strategy encompassed by strategies T-5 and T-6 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- Default transit mode share of all trips

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., Boarnet, S. 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. 2020a. Transit Price Elasticities and Cross-elasticities. Victoria Transport Policy Institute. April. Available: https://www.vtpi.org/tranelas.pdf. Accessed: January 2021.
- Taylor, B., Miller, D., Iseki, H., & Fink, C. 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-9-B. Implement Subsidized or Discounted Transit Program (Work Trips Only)

Description: This measure will provide subsidized or discounted, or free transit passes for employees. 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. 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.

Note: please carefully specify the "Percent of project-generated VMT from employees" input, especially for projects with a high proportion of non-resident trips (e.g., schools, hotels, shopping centers). One way to estimate this value is to look at the trip generation calculations for the project and determine what proportion of the total trips comes from the employment portion of the project.

Formula:

% Change in VMT = (Subsidy amount / Average transit fare without subsidy * Elasticity of transit boardings with respect to transit fare price) * Percent of employees/residents eligible for subsidy * Percent of project-generated VMT from employees/residents * Transit mode share of all work trips * Percent of transit trips that would otherwise be made in a vehicle * Conversion factor of vehicle trips to VMT

User Inputs:

- Average transit fare without subsidy
- Subsidy amount
- Percent of employees eligible for subsidy
    - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.
- Percent of project-generated VMT from employees
- Transit mode share of work trips (optional)
  The user may override the above default existing transit mode share in this cell.

Constants and Assumptions:

- Elasticity of transit boardings with respect to transit fare price is -0.43
- Percent of transit trips that would otherwise be made in a vehicle is 50%
- Conversion factor of vehicle trips to VMT is 1
- Strategy encompassed by strategies T-5 and T-6 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- Default transit mode share of work trips

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., Boarnet, S. 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. 2020a. Transit Price Elasticities and Cross-elasticities. Victoria Transport Policy Institute. April. Available: https://www.vtpi.org/tranelas.pdf. Accessed: January 2021.
- Taylor, B., Miller, D., Iseki, H., & Fink, C. 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

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.

Formula:

% Change in VMT = (Existing bicycle trip length for all trips in region * (Existing bicycle mode share for work trips in region - (Bike mode adjustment factor * Existing bicycle mode share for work trips in region))) / (Existing vehicle trip length for all trips in region * Existing vehicle mode share for work trips in region)

User Inputs:

- Type of bike parking facility (drop-down)

  - Parking only
  - Parking with showers, bike lockers, and personal lockers

- Optional user inputs that may override the corresponding default values generated by SCTA Model.

  - One-way bicycle trip length in neighborhood/city (miles)
  - One-way vehicle trip length in neighborhood/city (miles)
  - Bicycle mode share for work trips in region
  - Vehicle mode share for work trips in region

Constants and Assumptions:

- Bike mode adjustment factor is

  - 1.78 for bike parking facility only
  - 4.86 for bike parking with showers, bike lockers, and personal lockers

SCTA Model Data:

- Default average one-way bicycle trip length in neighborhood/city (miles)
- Default average one-way vehicle trip length in neighborhood/city (miles)
- Default bicycle mode share for work trips in region
- Default vehicle mode share for work trips in region

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

Description: This strategy 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. 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.

Formula:

% Change in VMT = ((((1 - Percent of employees that participate in vanpool program) * Average length of one-way vehicle commute trip in region) + (Percent of employees that participate in vanpool program * Average length of one-way vanpool commute trip / Average vanpool occupancy (including driver))) / Average length of one-way vehicle commute trip in region) - 1

User Inputs:

- Percent of employees who participate in vanpool
- Average length of one-way vehicle commute trip in region (optional)
  The user may override the above average auto commute trip length in this cell.
- Average length of one-way vanpool commute trip (optional)
  The user may override the above default long (vanpool) commute trip length in this cell. Leave blank otherwise.
- Average vanpool occupancy (including driver) (optional)

Constants and Assumptions:

- Default average length of one-way vanpool commute trip is 42 miles
- Average vanpool occupancy (including driver) is 6.25
- If the user override of vanpool participation rate exceeds maximum of 15%, the default value will be used. This maximum is based on TCRP Report 95, Chapter 5 and ICF's experience implementing the 511NYRideshare program, the nation's largest regional TDM program.
- Strategy encompassed by strategies T-5 and T-6 and cannot be analyzed in combination with these strategies.

SCTA Model Data:

- Default average length of one-way vehicle commute trip in region (miles)

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. (4) 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/tooldesign-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

T-12. Price Workplace Parking

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.

When implementing workplace parking, 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 no alternative free parking available nearby (such as on-street). This strategy is ineffective in environments that do not have other modes available. Though like T-13, Employee Parking Cash-Out, this strategy focuses on implementing market rate and above market rate pricing to provide a price signal for employees to consider other modes for their work commute. Strategy T-13 requires employers to offer employee parking "cash-out."

Formula:

% Change in VMT = ((Proposed parking price - Baseline parking price) / Baseline parking price) * Elasticity of parking demand with respecting to parking price * Share of employees paying for parking * Ratio of vehicle trip reduction to VMT

User Inputs:

- Baseline parking price
- Proposed parking price

- Share of employees paying for parking

Constants and Assumptions:

- Elasticity of parking demand with respect to parking price is -0.4.
- Ratio of vehicle trip reduction to VMT is assumed to be 1

SCTA Model Data:

- None

Sources:

- Lehner, S., Stefanie, P. 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. Parking Cash Out

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.

Formula:

% Change in VMT = Percentage of employees eligible * Percent reduction in commute VMT from implementation of measure

User Inputs:

- Percent of employees eligible for this program
    - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. 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.

Constants and Assumptions:

- 12% reduction in commute VMT from implementation of strategy

SCTA Model Data:

- None

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-23. Community-Based Travel Planning

Description: This strategy will target residences in the neighborhood/city 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 VMT and associated GHG emissions. 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.

Formula:

% Change in VMT = - (Residences in plan/community targeted with CBTP / Residences in plan/community) * Percent of targeted residences that participate * Percent vehicle trip reduction by participating residences * Adjustment factor from vehicle trips to VMT

User Inputs:

- Residences in plan/community
- Residences in neighborhood/city targeted with CBTP

Constants and Assumptions:

- Percent of targeted households that participate is 19%.
- Percent of vehicle trip reduction among participating residences is 12%.
- Adjustment factor from vehicle trips to VMT is 1

Sources:

- Metropolitan Transportation Commission (MTC). 2021. Plan Bay Area 2050, Supplemental Report. (forthcoming)

Parking or Roadway Pricing/Management Strategies

Strategies that discourage auto travel by modifying the price or supply of vehicle parking.

T-15. Limit Residential Parking Supply

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. 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.

Formula:

% Change in VMT = - ((Residential parking demand - Project residential parking supply) / Residential parking demand) * Percentage of project VMT generated by residents * Percent of household VMT that is commute based * Percent reduction in commute mode share by driving among households in areas with scarce parking

User Inputs:

- Residential parking demand (# of spaces)
- Project residential parking supply
- Percent of project VMT generated by residents

Constants and Assumptions:

- 37% of household VMT is commute-based
- Percentage of reduction in commute mode share by driving among households in areas with scarce parking is 37%

SCTA Model Data:

- None

Sources:

- California Department of Transportation (Caltrans). 2012. California Household Travel Survey (CHTS). Available: https://www.nrel.gov/transportation/secure-transportation-data/tsdc-california-travelsurvey.html. Accessed: January 2021.
- Chatman, D. 2013. Does TOD need the T? On the importance of factors other than rail access. Journal of the American Planning Association 79(1). Available: https://trid.trb.org/view/1243004 . Accessed: January 2021.
- 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 Parking Costs from Property Cost

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

Formula:

% Change in VMT = (Annual parking cost per space / Average annual vehicle cost) * Elasticity of vehicle ownership with respect to total vehicle cost * Adjustment factor from vehicle ownership to VMT

User Inputs:

- Annual parking cost per space
  - Capped at $3,600 per year, or $300 per month

Constants and Assumptions:

- Average annual vehicle cost is $9,666
- Elasticity of vehicle ownership with respect to total vehicle cost is -0.4
- Adjustment factor from vehicle ownership to VMT is 1

SCTA Model Data:

- None

Sources:

- AAA. 2019. Your Driving Costs. September. Available: https://exchange.aaa.com/wpcontent/uploads/2019/09/AAA-Your-Driving-Costs-2019.pdf. Accessed: January 2021.
- California Department of Transportation (Caltrans). 2002. 2000–2001 California Statewide Household Travel Survey Final Report. Available: https://trid.trb.org/view.aspx?id=681358. Accessed: January 2021.
- Litman, T. 2020. Parking Requirement Impacts on Housing Affordability. June. Available: https://www.vtpi.org/park-hou.pdf. Accessed: January 2021.

T-24. Implement Market Price Public Parking (On-Street)

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. 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 without priced parking.

Formula:

% Change in VMT = (VMT in priced area without measure / VMT in plan/community without measure) * ((Proposed parking price - Initial parking price) / Initial parking price) * Percentage of trips parking on street * Elasticity of parking demand with respect to price * Ratio of VMT to vehicle trips

User Inputs:

- VMT in priced area without measure
- VMT in plan/community without measure
- Proposed parking price
- Initial parking price
- Percentage of trips parking on street

Constants and Assumptions:

- Elasticity of parking demand with respect to price is -0.4.
- Ratio of VMT to vehicle trips is 1.

SCTA Model Data:

- None

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.

Neighborhood Design Enhancement Strategies

Strategies that improve or encourage neighborhood-level bicycle, pedestrian, and other multimodal travel options.

T-18. Provide Pedestrian Network Improvements

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. The 'study area' should be based on a 1 KM buffer around the area where the pedestrian network is being improved. The VMT reduction is limited to household VMT.

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, and slopes, should be minimized.

Formula:

% Change in VMT = ((Sidewalk length in study area with measure / Existing sidewalk length in study area) - 1) * Elasticity of VMT with respect to the ratio of sidewalks-to-streets

User Inputs:

- Existing sidewalk length in study area (miles)
  Measure the sidewalk 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.
- Sidewalk length in study area with measure (miles)

Constants and Assumptions:

- Street length is assumed to remain constant, since the strategy involves adding sidewalks to the existing street network, not modifying street networks. Assuming a constant street length simplifies the user inputs and prevents users from erroneously entering unreasonable values.
- Elasticity of VMT with respect to the ratio of sidewalks-to-streets is -0.05.

SCTA Model Data:

- None

Sources:

- 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_P olicy_Brief.pdf. Accessed: January 2021.

T-19-A. Bike Facility Improvement

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.

Formula:

Formula: % Change in VMT = -Percent of plan/community VMT on parallel roadway * (((Annual days of use of new facility / Days per year) * (Active transportation adjustment factor + Credits for key destinations near project) * Growth factor adjustment for facility type * Existing regional average one-way bicycle trip length) / Existing regional average one-way vehicle trip length)

User Inputs:

- Existing annual average daily traffic of the facility (select from drop-down menu)
- Length of the proposed bike facility (select from drop-down menu)
- City population (select from drop-down menu)
  This can be estimated using ACS or jurisdictional data.
- Number of key destinations between 1/4 and 1/2 mile from bicycle facility (select from drop-down menu)
  Key destinations include banks, churches, hospitals, light rail stations (park & ride), office parks, post offices, public libraries, shopping areas or grocery stores, and universities or junior colleges.
- Number of key destinations within 1/4 mile of bicycle facility (select from drop-down menu)
- Proposed bicycle facility type (select from drop-down menu)
  - New Class I bike path or Class IV bikeway

- New Class II bike lane
- Conversion from Class II to IV
  See Table 1 on page 5 of this Caltrans memorandum for information on bicycle facility types.

- Percentage of plan/community VMT on parallel roadway
- Annual days of use of new facility
  The user may override the above default annual days of use in this cell.
- Regional average one-way bicycle trip length (miles)
  The user may override the above average bicycle trip length in this cell.
- Regional average one-way vehicle trip length (miles)
  The user may override the above average auto trip length in this cell.

Constants and Assumptions:

- Adjustment factor of AADT for auto trips replaced by bike trips due to strategy:

Average Daily Traffic	Bike Project Length (miles)	Adjustment Factor
0–12,000	<= 1	0.0019
	> 1 and <= 2	0.0029
	> 2	0.0038
12,001–24,000	<= 1	0.0014
	> 1 and <= 2	0.002
	> 2	0.0027
24,001–30,000	<= 1	0.001
	> 1 and <= 2	0.0014
	> 2	0.0019

  - Estimated based on CARB (2005). Based on assumption that at all municipalities would be either cities with a population greater than or equal to 250,000 or a non-university town with a population less than 250,000.

- Credit for activity centers based on number and distance:

Number of Key Destinations	Credit within ½ Mile of Facility	Credit within ¼ mile of Facility
0–2	0.0000	0.000
3	0.0005	0.001
4 - 6	0.0010	0.002
≥ 7	0.0015	0.003

- Growth Factor Adjustment
  - 1.54 for new Class I bike path or class IV bikeway

  - 1.0 for new Class II bike lane
  - 0.54 for conversion from Class II to IV

- Annual days of use of new facility are 320; days per year are 365.

SCTA Model Data:

- Existing regional average one-way bicycle trip length (miles)
- Existing regional average one-way vehicle trip length (miles)

Sources:

- California Air Resources Board (CARB). 2021. Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program. February. Available: https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/sgc_ahsc_qm_022521.pdf. Accessed: July 2022.
- 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/dailysummaries?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

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.

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.

Formula:

% Change in VMT = Percent of plan/community VMT on roadway to have bicycle boulevard * ((Existing bicycle trip length for all trips in region * (Existing bicycle mode share for work trips in region - (Bike mode adjustment factor * Existing bicycle mode share for work trips in region))) / (Existing vehicle trip length for all trips in region * Existing vehicle mode share for work trips in region))

User Inputs:

- Percent of plan/community VMT on roadway to have bicycle boulevard
- Existing bicycle trip length for all trips in region (optional)
  The user may override the above average bicycle trip length in this cell.
- Existing vehicle trip length for all trips in region (optional)
  The user may override the above average auto trip length in this cell.
- Existing bicycle mode share for work trips in region (optional)
- Existing vehicle mode share for work trips in region (optional)

Constants and Assumptions:

- Bike mode adjustment factor is assumed to be 1.14.

SCTA Model Data:

- Existing bicycle trip length for all trips in region (miles)
- Existing vehicle trip length for all trips in region (miles)
- Existing bicycle mode share for work trips in region (miles)
- Existing vehicle mode share for work trips in region (miles)

Sources:

- 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

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

Formula:

% Change in VMT = -1 * ((((Bikeway miles in plan/community with measure - Existing bikeway miles in plan/community) / Existing bikeway miles in plan/community) * Bicycle mode share in plan/community * Average one-way bicycle trip length in plan/community * Elasticity of bike commuters with respect to bikeway miles per 10,000 population) / (Vehicle mode share in plan/community * Average one-way vehicle trip length in plan/community))

User Inputs:

- Existing bikeway miles (only Class I, II, and IV) in neighborhood/city
  - Calculated as centerline miles of roadways containing bikeways.
  - For smaller analysis contexts, it may be easiest to show "bicycling" on Google Maps and measure the lengths of roadways containing bikeways. For larger contexts, contact the local jurisdiction's transportation planning staff, or contact Sonoma County Public Works for projects in unincorporated areas.
- Bikeway miles in plan/community with measure
  - Calculated as centerline miles of roadways containing bikeways.
- Bicycle mode share in neighborhood/city (optional)
  The user may override the above default community bicycle mode share in this cell.
- Vehicle mode share in neighborhood/city (optional)
  The user may override the above default community SOV mode share in this cell.
- One-way bicycle trip length in plan/community (miles) (optional)
  The user may override the above average bicycle trip length in this cell.
- One-way vehicle trip length in plan/community (miles) (optional)
  The user may override the above average auto trip length in this cell.

Constants and Assumptions:

- Elasticity of bike trips with respect to bikeway miles per 10,000 population is 0.25.

SCTA Model Data:

- Default bicycle mode share in plan/community
- Default vehicle mode share in plan/community
- Default average one-way bicycle trip length in plan/community (miles)
- Default average one-way vehicle trip length in plan/community (miles)

Sources:

- 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., 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. Implement Carshare Program

Description: This measure will increase carshare access in the user's community by deploying 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. 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.

Formula:

% Change in VMT = (Number of carshare vehicles deployed in plan/community * (Daily VMT added with measure - Daily VMT avoided with measure)) / Daily VMT in plan/community without measure

User Inputs:

- Number of carshare vehicles deployed in plan/community
- Daily VMT in plan/community without measure

Constants and Assumptions:

- Daily VMT avoided with measure is assumed to be 68.2.
- Daily VMT added with measure is assumed to be 24.4.

SCTA Model Data:

- None

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-shiftvehicle-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/defaultsource/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

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

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. 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. When implementing a bikeshare program, a best practice is to discount bikeshare membership and dedicate bikeshare parking to encourage use of the service.

Formula:

% Change in VMT = -1 * (((Percent of residences in plan/community with access to bikeshare system with measure - Percent of residences in plan/community with access to bikeshare system without measure) * Daily bikeshare trips per person * Vehicle to bikeshare substitution rate * Bikeshare average one-way trip length) / (Daily vehicle trips per person * Regional average one-way vehicle trip length))

User Inputs:

- Percent of residences in plan/community with access to bikeshare system without measure
- Percent of residences in plan/community with access to bikeshare system with measure
- Bikeshare average one-way trip length (miles) (optional)
  The user may override the above average one-way bikeshare trip length in this cell.
- Regional average one-way vehicle trip length (miles) (optional)
  The user may override the above average one-way vehicle trip length in this cell.

Constants and Assumptions:

- Daily bikeshare trips per person is 0.021

- Vehicle to bikeshare substitution rate is 19.6%
- Daily vehicle trips per person is 2.7

SCTA Model Data:

- Default bikeshare average one-way trip length (miles)
- Default average one-way vehicle trip length (miles)

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.
- Lazarus, J., J. Pourquier, F. Feng, H. Hammel, and S. Shaheen. 2019. Bikesharing Evolution and Expansion: Understanding How Docked and Dockless Models Complement and Compete – A Case Study of San Francisco. Paper No. 19-02761. Annual Meeting of the Transportation Research Board: Washington, D.C. Available: https://trid.trb.org/view/1572878. Accessed: January 2021.
- McQueen, M., G. Abou-Zeid, J. MacArthur, and K. Clifton. 2020. Transportation Transformation: Is Micromobility Making a Macro Impact on Sustainability? Journal of Planning Literature. November. Available: https://doi.org/10.1177/0885412220972696. Accessed: March 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.

T-22-B. Implement Electric Bikeshare Program

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. 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.

Formula:

% Change in VMT = -1 * (((Percent of residences in plan/community with access to electric bikeshare system with measure - Percent of residences in plan/community with access to electric bikeshare system without measure) * Daily electric bikeshare trips per person * Vehicle to electric bikeshare substitution rate * Electric bikeshare average one-way trip length) / (Daily vehicle trips per person * Regional average one-way vehicle trip length))

User Inputs:

- Percent of residences in plan/community with access to electric bikeshare system without measure
- Percent of residences in plan/community with access to electric bikeshare system with measure
- Electric bikeshare average one-way trip length (miles) (optional)
  The user may override the above average one-way bikeshare trip length in this cell.
- Regional average one-way vehicle trip length (miles) (optional)
  The user may override the above average one-way vehicle trip length in this cell.

Constants and Assumptions:

- Daily electric bikeshare trips per person is 0.021
- Vehicle to bikeshare substitution rate is 35%
- Daily vehicle trips per person is 2.7

SCTA Model Data:

- Default bikeshare average one-way trip length (miles)
- Default average one-way vehicle trip length (miles)

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.
- Fitch, D., H. Mohiuddin, and S. Handy. 2021. Examining the Effects of the Sacramento Dockless E-Bike Share on Bicycling and Driving. MDPI: Sustainability. January. Available: https://www.mdpi.com/2071-1050/13/1/368. Accessed: March 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.

T-22-C. Implement Scootershare Program

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. 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.

Formula:

% Change in VMT = -1 * (((Percent of residences in plan/community with access to scootershare system with measure - Percent of residences in plan/community with access to scootershare system without measure) * Daily scootershare trips per person * Vehicle to scootershare substitution rate * Scootershare average one-way trip length) / (Daily vehicle trips per person * Regional average one-way vehicle trip length))

User Inputs:

- Percent of residences in plan/community with access to scooterhare system without measure
- Percent of residences in plan/community with access to scootershare system with measure
- Scootershare average one-way trip length (miles) (optional)
  The user may override the above average one-way bikeshare trip length in this cell.
- Regional average one-way vehicle trip length (miles) (optional)
  The user may override the above average one-way vehicle trip length in this cell.

Constants and Assumptions:

- Daily bikeshare trips per person is 0.021
- Vehicle to scootershare substitution rate is 38.5%
- Daily vehicle trips per person is 2.7

SCTA Model Data:

- Default scootershare average one-way trip length (miles)
- Default average one-way vehicle trip length (miles)

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.
- McQueen, M., G. Abou-Zeid, J. MacArthur, and K. Clifton. 2020. Transportation Transformation: Is Micromobility Making a Macro Impact on Sustainability? Journal of Planning Literature. November. Available: https://doi.org/10.1177/0885412220972696. Accessed: March 2021. (5) Portland Bureau of Transportation (PBOT). 2021. Portland Bureau of Transportation E-Scooter Dashboard. Available: https://public.tableau.com/profile/portland.bureau.of.transportation#!/vizhome/PBOTEScooterTripsDashboard/ScooterDashboard. Accessed: March 2021.

Transit Strategies

Strategies that improve transit service and cause a mode shift from auto to transit.

T-25. Extend Transit Network Coverage or Hours

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.

This measure is ineffective in many areas of Sonoma County given the current development patterns. At some point in the future the patterns may evolve enough that the strategies would have some effect.

Formula:

% Change in VMT = -1 * ((Total transit service miles or service hours in plan/community after expansion / Total transit service miles or service hours in plan/community before expansion) / Total transit service miles or service hours in plan/community before expansion) * Transit mode share in plan/community * Elasticity of transit demand with respect to service miles or service hours * Statewide mode shift factor * Ratio of vehicle trip reduction to VMT

User Inputs:

- Total transit service miles or service hours in plan/community before expansion
- Total transit service miles or service miles in plan/neighborhood after expansion
- Transit mode share in plan/community (optional)

    ◦ The user may override the above default existing transit mode share in this cell.

Constants and Assumptions:

- Elasticity of transit demand with respect to service miles or service hours is 0.7.
- Statewide mode shift factor is 57.8%
- Ratio of vehicle trip reduction to VMT is 1

SCTA Model Data:

- Default transit mode share in plan/community

Sources:

- Handy, S., Lovejoy, K., Boarnet, M., Spears, S. 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.
- 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.

T-26. Increase Transit Service Frequency

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.

Formula:

% Change in VMT = -Percent of routes receiving improvement * ((Percent increase in transit frequency * Transit mode share in plan/community * Elasticity of transit ridership with respect to frequency of service * Statewide mode shift factor) / Vehicle mode share in plan/community).

User Inputs:

- Percent increase in transit frequency
  Refers to the transit frequency before the measure as a fraction of the transit frequency after the measure.
- Percent of routes receiving improvement
  Refers to the number of transit routes receiving the frequency improvement as a fraction of the total transit routes in the plan/community.

- Transit mode share in plan/community (optional)
  The user may override the above default existing transit mode share in this cell.
- Vehicle mode share in plan/community (optional)
  The user may override the above default mode share in this cell.

Constants and Assumptions:

- Elasticity of transit ridership with respect to frequency of service is 0.5.
- Statewide mode shift factor is 57.8%

SCTA Model Data:

- Default transit mode share in plan/community
- Default vehicle mode share in plan/community

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., Lovejoy, K., Boarnet, M., Spears, S. 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-27. Implement Transit-Supportive Roadway Treatments

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.

This measure is ineffective in many areas of Sonoma County given the current development patterns. At some point in the future the patterns may evolve enough that the strategies would have some effect.

Formula:

% Change in VMT = -1 * ((Percent of plan/community transit routes that receive treatments * Percent change in transit travel time due to treatments * Elasticity of transit ridership with respect to transit travel time * Transit mode share in plan/community * Statewide mode shift factor) / Vehicle mode share in plan/community)

User Inputs:

- Percent of plan/community transit routes that receive treatments
  Refers to the number of transit routes receiving treatment as a fraction of the total transit routes in the plan/community.
- Percent change in transit travel time due to treatments (optional)
  - The user may override the above percent change in transit travel time due to treatments in this cell.
- Transit mode share in plan/community (optional)
  - The user may override the above default existing transit mode share in this cell.
- Vehicle mode share in plan/community (optional)
  - The user may override the above default vehicle mode share in this cell.

Constants and Assumptions:

- Default percent change in transit travel time due to treatments is -8%.
- Elasticity of transit ridership with respect to transit travel time is -0.4.
- Statewide mode shift factor is 57.8%

SCTA Model Data:

- Default transit mode share in plan/community
- Default vehicle mode share in plan/community

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

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.

Formula:

% Change in VMT = -Percent of routes receiving improvement * ((Transit mode share in plan/community * Statewide mode shift factor * ((Percent increase in transit frequency due to BRT * Elasticity of transit ridership with respect to frequency of service) + (Percent change in transit travel time due to BRT * J) + Percent change in transit ridership due to BRT)) / Vehicle mode share in plan/community)

User Inputs:

- Percent increase in transit frequency due to BRT
- Percent of routes receiving improvement
  Refers to the number of transit routes receiving the frequency improvement as a fraction of the total transit routes in the plan/community.
- Transit mode share in plan/community (optional)
  The user may override the above default existing transit mode share in this cell.
- Vehicle mode share in plan/community (optional)
  The user may override the above default mode share in this cell.
- Percent change in transit travel time due to BRT (optional)

Constants and Assumptions:

- Statewide mode shift factor is 57.8%
- Percent change in transit ridership due to BRT is 25%.
- Percent change in transit travel time due to BRT is -10%.
- Elasticity of transit ridership with respect to frequency of service is 0.5.
- Elasticity of transit ridership with respect to transit travel time is -0.4.

SCTA Model Data:

- Default transit mode share in plan/community
- Default vehicle mode share in plan/community

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.
- 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-29. Reduce Transit Fares

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.

This measure is ineffective in many areas of Sonoma County given the current development patterns. At some point in the future the patterns may evolve enough that the strategies would have some effect.

Formula:

% Change in VMT = ((Percent reduction in transit fare with measure * Percent of plan/community transit routes that receive reduced fares * Elasticity of transit ridership with respect to transit fare * Transit mode share in plan/community * Statewide mode shift factor) / Vehicle mode share in plan/community)

User Inputs:

- Percent reduction in transit fare with measure
- Percent of plan/community transit routes that receive reduced fares
  Refers to the number of transit routes that received reduced fares as a fraction of the number of transit routes in the plan/community
- Transit mode share in plan/community (optional)
  - The user may override the above default existing transit mode share in this cell.
- Vehicle mode share in plan/community (optional)
  - The user may override the above default vehicle mode share in this cell.

Constants and Assumptions:

- Elasticity of transit ridership with respect to transit fare is -0.3.
- Statewide mode shift factor is 57.8%
- Percent change in transit fare is capped at 50%.

SCTA Model Data:

- Default transit mode share in plan/community
- Default vehicle mode share in plan/community

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., Lovejoy, K., Boarnet, M., Spears, S. 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.