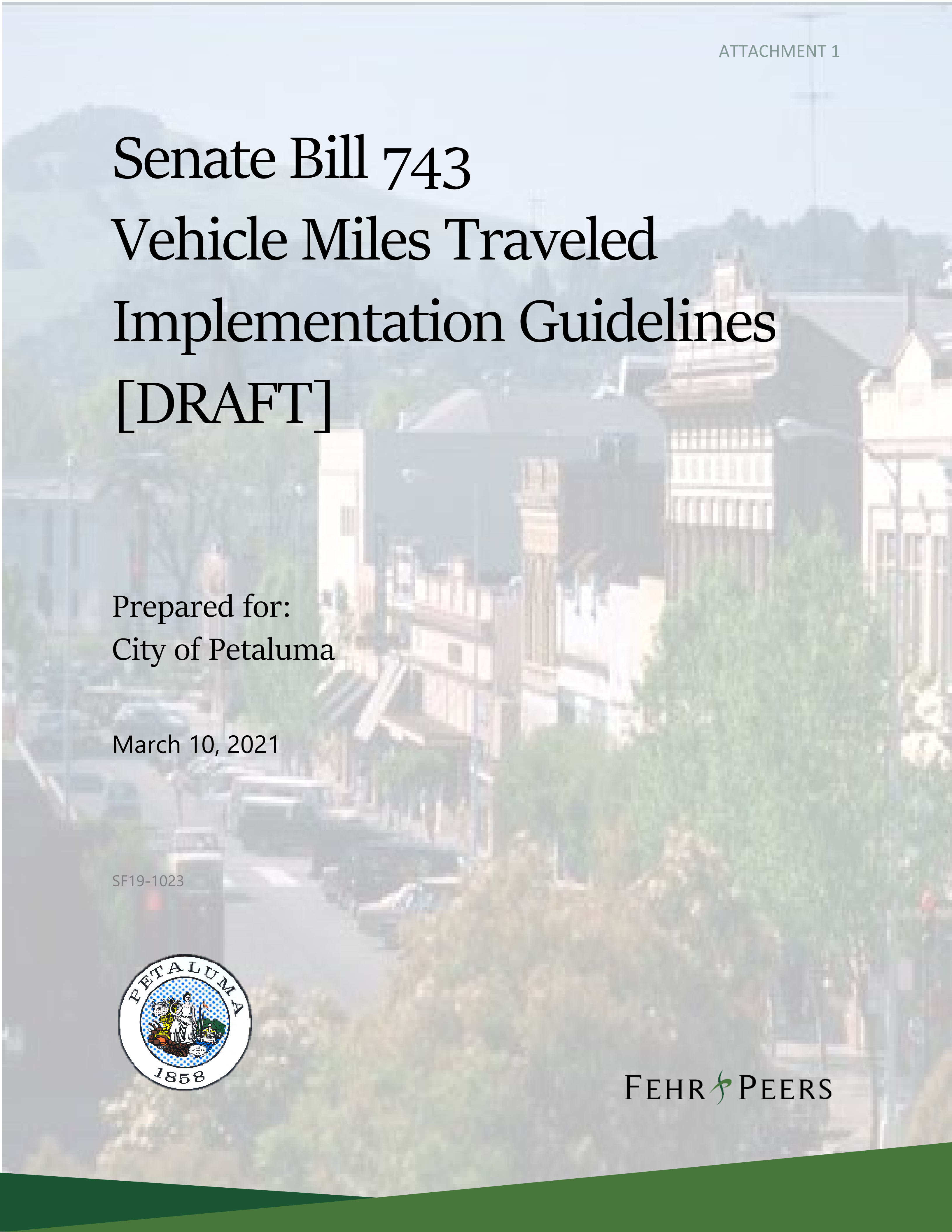
ATTACHMENT 1



Senate Bill 743 Vehicle Miles Traveled Implementation Guidelines [DRAFT]

Prepared for:
City of Petaluma

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FEHR PEERS

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Executive Summary

This report summarizes the recommendations and outcomes of the City of Petaluma's efforts to implement vehicle-miles traveled (VMT) as the California Environmental Quality Act (CEQA) Transportation analysis metric, pursuant to Senate Bill 743 (Steinberg, 2013) and corresponding updates to the CEQA Guidelines effective April 2019. Per Senate Bill 743, congestion-related metrics such as automobile Level of Service (LOS) shall no longer be used in CEQA Transportation analysis for land use projects; instead, VMT has been identified as the most appropriate metric for the evaluation of CEQA Transportation impacts.

The City of Petaluma's implementation efforts included the formation of a Technical Advisory Committee (TAC) comprised of liaisons from the City Council, Planning Commission, City committees/ commissions (Climate Action Commission, Bicycle and Pedestrian Committee, and the Transit Advisory Committee), City departments, and other regional transportation agencies (Caltrans, Permit Sonoma, and Sonoma County Transportation Authority). As part of three public meetings, the TAC reviewed materials related to key decision points in the implementation process and developed recommendations on how to proceed with implementing VMT for land use project, land use program, and local transportation infrastructure analysis in Petaluma. Additionally, the public was invited to provide feedback at the TAC meetings and via email. Based on their review of key implementation decisions, the TAC recommends implementing the following key decisions for SB 743 in Petaluma:

- **VMT metrics** - *"What VMT should be measured in traffic analyses?":*
  - *Residential projects:* Total home-based VMT per resident
  - *Office and other employment-focused projects:* Total home-based work VMT per employee
  - *Retail and other commercial service projects:* Total project effect on VMT within a geographic area
- **VMT methods –** *"How should VMT be calculated?":* Use the SCTA travel demand model.
- **VMT thresholds** – *"At what point does project VMT require mitigation?":*
  - *For residential projects:* Project total home-based VMT per resident exceeds 85% of the citywide average. The City-wide average baseline value applies until such time that the City of Petaluma exceeds the housing allocation for the City as identified in the Sustainable Communities Strategy (SCS) for the Bay Area region; if the City exceeds the SCS housing allocation, the nine-county Bay Area regional average applies.[1]

[1] The SCS housing allocation limit is suggested by the California State Office of Planning and Research (OPR) in the *Technical Advisory on Evaluating Transportation Impacts in CEQA* as when the use of a citywide average becomes inappropriate for the evaluation of CEQA VMT impacts (in favor of the Bay Area regional average).

- *For office and other employment-focused projects:* Project total home-based work VMT per employee exceeds 85% of the nine-county Bay Area regional average
- *For retail and other commercial service projects:* Project results in a net increase in VMT over the geographic area that the project influences.
- *For mixed-use and other projects:* Project components should be analyzed using the relevant thresholds for residential, office/employment-focus, or retail/commercial service projects. The benefit of a mix of uses on-site can and should be included in the analysis.
- *For transportation projects:* Project results in induced travel and an increase in citywide VMT
- *For redevelopment projects:* Project results in increased VMT versus current land uses. City staff retain discretion to identify the baseline VMT for use in the calculation (i.e. based on current uses or permitted uses).

- **VMT screening criteria** – *"What projects may qualify for bypassing the VMT analysis process?":*
  - *Small Projects:* Projects that generate or attract fewer than 110 trips per day, which is equivalent to a 15-unit residential project or a non-residential project of 10,000 square feet or less. Local-serving retail projects of less than 30,000 square feet may be screened on the basis that they may attract trips that would otherwise travel longer distances.
  - *Projects in Low-VMT Area:* Residential and office/employment-focused projects that are in low-VMT areas (based on adopted VMT thresholds of significance) that are similar in similar to nearby developments in terms of density, mix of uses, and transit accessibility.
  - *Projects in Proximity to a Major Transit Stop:* Projects within one-half mile of an existing or planned high-quality transit corridor or major transit station. Several additional criteria related to site design, parking supply and consistency with regional transportation plans must be met in order to qualify for this screening opportunity.
  - *Affordable Housing in Jobs-Rich Areas:* Projects with large affordable housing components that are located in infill locations and areas with a high jobs-housing imbalance.
  - *Transportation Projects:* Transit, bicycle, and pedestrian projects, and roadway maintenance projects that do not result in an increase in vehicle capacity or VMT.
  - Projects including a drive-through component would be precluded from qualifying for screening out of VMT analysis process.
  - City staff retains discretion to deny the use of screening if substantial evidence exists that screening is not appropriate for a given project.
- **VMT mitigation options** – *"How should a project mitigate a significant impact?":*
  - *Near-Term:* Perform mitigation on a project-by-project basis using available TDM effectiveness research. TDM strategies related to promoting transit usage, active transportation, and more sustainable parking strategies should be prioritized.

- *Medium-Term:* The City should investigate and implement citywide TDM programs and fund these programs through developer fees.
- *Far-Term:* The City should coordinate with SCTA and other agencies in Sonoma County to develop a VMT mitigation banking program, should pilot programs in Contra Costa County and Southern California prove successful.

Pursuant to Section 15064.7 of the CEQA Guidelines, the VMT thresholds of significance will be adopted by the City Council as part of an ordinance, resolution, rule or regulation.

1. Introduction

On September 27, 2013, Governor Jerry Brown signed Senate Bill (SB) 743 into law and started a process intended to fundamentally change transportation impact analysis as part of California Environmental Quality Act (CEQA) compliance. These changes include elimination of *auto delay, level of service (LOS), and other similar measures of vehicular capacity or traffic congestion* as a basis for determining significant impacts. Amendments and additions to the CEQA Guidelines eliminate auto delay for CEQA purposes and identify vehicle miles traveled (VMT) as the preferred CEQA transportation metric. Therefore, the City of Petaluma carried out a public process to select VMT analysis methodologies, set new VMT thresholds for transportation impacts, and determine what mitigation strategies are most feasible.

This report:

- Provides an overview of SB 743 and related policies and how VMT may be measured
- Discusses the public review and adoption process undertaken by the City of Petaluma
- Discusses alternatives for VMT measurement methods and thresholds
- Recommends VMT methods and thresholds for Petaluma, based on feedback from the City's Technical Advisory Committee formed for this SB 743 implementation effort
- Uses recent projects in Petaluma to demonstrate how these methods and thresholds would be used
- Recommends transportation demand management (TDM) strategies for reducing VMT on projects in Petaluma
- Provides information on considerations resulting in future updates to the recommendations in this document

2. Background

This chapter summarizes SB 743 and related policies and discusses how VMT may be measured.

2.1 Definitions

CEQA refers to the California Environmental Quality Act. This statute requires identification of any significant environmental impacts of state or local action including approval of new development or infrastructure projects. The process of identifying these impacts is typically referred to as the environmental review process.

LOS refers to "Level of Service," a metric that assigns a letter grade to network performance. The typical application of LOS in Petaluma is to measure the average amount of delay experienced by vehicle drivers at an intersection during the most congested time of day and to assign a report card range from LOS A (fewer than 10 seconds of delay for signalized intersections) to LOS F (more than 80 seconds of delay for signalized intersections). The City of Petaluma's LOS standard (as identified in the General Plan) is LOS D.

VMT refers to "vehicle miles traveled," a metric that accounts for the number of vehicle trips generated and the length or distance of those trips. For transportation impact analysis, VMT is commonly expressed as total VMT, total VMT per service population (residents plus employees), home-based VMT per resident (or capita), and home-based work VMT per employee for a typical weekday.

2.2 VMT Policy Overview

On September 27, 2013, Governor Jerry Brown signed SB 743 into law and started a process intended to fundamentally change transportation impact analysis as part of CEQA compliance. These changes include elimination of *auto delay, LOS, and other similar measures of vehicular capacity or traffic congestion* as a basis for determining significant impacts. The California Natural Resources Agency has issued amendments and additions to the CEQA Guidelines reflecting these changes (http://resources.ca.gov/ceqa/). The changes eliminate auto delay for CEQA purposes and identify VMT as the preferred CEQA transportation metric.

The Governor's Office of Planning and Research (OPR) has also issued supporting information entitled *Technical Advisory on Evaluating Transportation Impacts in CEQA* (December 2018) (http://opr.ca.gov/ceqa/updates/sb-743/), providing additional information on assessing VMT and setting significance thresholds.

The focus of SB 743's changes can be found in the following two legislative intent statements:

1. Ensure that the environmental impacts of traffic, such as noise, air pollution, and safety concerns, continue to be properly addressed and mitigated through the California Environmental Quality Act.
2. More appropriately balance the needs of congestion management with statewide goals related to infill development, promotion of public health through active transportation, and reduction of greenhouse gas emissions.

These statements are important because they provide direction to OPR and to lead agencies. For OPR, the direction is largely about what new metrics should achieve. For lead agencies like the City of Petaluma, the direction is about expected changes in transportation analysis plus what factors to consider for significance thresholds.

SB 743 does not prevent an agency from continuing to analyze delay or LOS as part of other plans (i.e. a general plan), fee programs, or ongoing network monitoring, but these metrics will no longer constitute the sole basis for CEQA impacts. Agencies determining that continued use of vehicle LOS is an important part of transportation analysis can still use vehicle LOS outside of the CEQA process. The most common applications will likely occur for jurisdictions wanting to use vehicle LOS to size roadways in their general plan or determine nexus relationships for their impact fee programs. Jurisdictions can also continue to condition projects to build transportation improvements through the entitlement process in a variety of ways, such as using general plan consistency findings.

The changes to the CEQA Guidelines identify automobile[2] VMT as the preferred CEQA transportation metric and, upon their certification on December 28, 2018, eliminated use of auto delay and LOS statewide for CEQA transportation analysis. The new guidelines and the OPR technical advisory include specifications for VMT methodology and recommendations for significance thresholds and mitigation. As noted above, SB 743 requires impacts to transportation network performance to be viewed through a filter that promotes *"the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses."* VMT can help identify how projects (land development and infrastructure) influence accessibility (i.e., lower VMT may indicate increased multimodal access to places and people) and emissions, so its selection is aligned with the objectives of SB 743.

Caltrans routinely reviews CEQA documents for local agency development projects. In this role, Caltrans is either a commenting agency or a responsible agency under CEQA (see CEQA §21069) and sets expectations for adequate analysis of the State highway system. Caltrans recently released an update to

[2] Automobile includes passenger cars and light trucks. However, OPR's Technical Advisory allows VMT analysis to include all vehicles (i.e., commercial trucks) for calculation convenience purposes.

their Transportation Impact Study Guide (TISG) (https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-05-20-approved-vmt-focused-tisg-a11y.pdf). Key points from this draft include the following:

- Caltrans recommends use of OPR's recommended thresholds for land use projects.
- Caltrans supports CEQA streamlining for land use projects in transit priority areas and areas with existing low VMT, as described in OPR's *Technical Advisory*.
- Caltrans recommends following the guidance on methods of VMT assessment found in OPR's *Technical Advisory*.
- Caltrans comments on a CEQA document may note methodological deviations from those methods and may recommend that significance determinations and mitigation be aligned with state GHG reduction goals as articulated in that guidance, California Air Resources Board's *(ARB's) 2017 Climate Change Scoping Plan Update: The Strategy for Achieving California's 2030 Greenhouse Gas Target* (2017), and related documentation.
- In rural areas, Caltrans may request VMT-reducing strategies for the rural area be included programmatically, including at the General Plan level, for example. Caltrans will also recommend establishment of programs or methods to reduce VMT and support appropriate bicycle, pedestrian, and transit infrastructure, services or incentives.

If a lead agency chooses a different threshold, but want to provide information to more directly satisfy potential Caltrans comments, they may have to complete more than one impact analysis.

In July 2020, Caltrans released interim guidance to its districts on how to review potential safety impacts for projects that affect the state highway system (https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-07-01-interim-ldigr-safety-guidance-a11y.pdf). Similar to VMT analysis, safety analysis for CEQA purposes is a rapidly evolving topic. While the focus of the SB 743 is on implementing VMT for CEQA, it is recommended that the City also review how Caltrans's safety analysis guidance may affect environmental documents in the future given the presence of US 101 and State Route 116 (Lakeville Highway) in the City. It is expected that Caltrans will apply this guidance when reviewing activities that affect Caltrans facilities. As such, it is recommended that the City require safety analysis for projects that add trips to the state highway system in the future; safety analysis methods and criteria will be developed as part of a future implementation effort (i.e. after VMT is implemented).

2.3 VMT Adoption Process Overview

CEQA Guidelines Section 15064.7 governs the establishment of thresholds of significance for CEQA analyses. For the purposes of the adoption of VMT-based CEQA Transportation analysis thresholds of significance, the following subsections are of particular note.

(b) Each public agency is encouraged to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. Thresholds of significance to be adopted for general use as part of the lead agency's environmental review process must be adopted by ordinance, resolution, rule, or regulation, and developed through a public review process and be supported by substantial evidence. Lead agencies may also use thresholds on a case-by-case basis as provided in Section 15064(b)(2).

(c) When adopting or using thresholds of significance, a lead agency may consider thresholds of significance previously adopted or recommended by other public agencies or recommended by experts, provided the decision of the lead agency to adopt such thresholds is supported by substantial evidence.

The City of Petaluma has undertaken a public review process to inform adoption of general use VMT thresholds at a City Council meeting through the passage of an ordinance, resolution, rule or regulation. A critical component of the public review process has been the formation of a Technical Advisory Committee (TAC), which was comprised of the following members:

- Appointed Council and Commission Liaisons
    - D'Lynda Fischer – Vice Mayor, Council Liaison
    - Sandi Potter – Planning Commission Liaison[3]
    - Sean Walling – Pedestrian and Bicycle Advisory Commission Liaison
    - Panama Bartholomy – Climate Action Commission Liaison
    - Dave Alden – Transit Advisory Committee Liaison
- Petaluma City Staff Liaisons
    - Gina Benedetti-Petnic – City Engineer
    - Jeff Stutsman – Traffic Engineer
    - Jared Hall – Transit Manager
- Other Agency Liaisons
    - Chris Barney – Sonoma County Transportation Authority
    - Gary Helfrich – Permit Sonoma
    - Andrew Chan – Caltrans

Three public meetings with the TAC occurred over the course of the adoption effort, including on June 18, 2020, July 30, 2020 and March 30, 2021. TAC members discussed the various options for implementation of SB 743 and adoption of VMT-based CEQA thresholds of significance. Members of the public were also invited to make public comments, consistent with typical procedures associated with public meetings governed by the Brown Act. The recommendations of the TAC are summarized in the next chapter of this report.

[3] Patrick Streeter served as Planning Commission Liaison for the June and July 2020 TAC meetings. Sandi Potter served as Planning Commission Liaison for the February 2021 TAC meeting.

2.4 VMT Assessment Overview

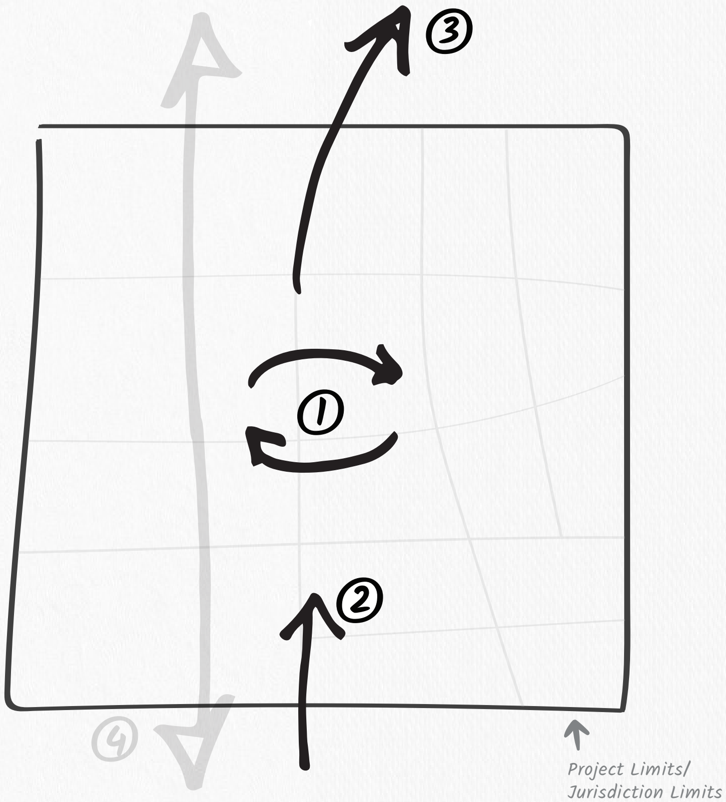
VMT can be measured in a variety of ways depending on whether the intent is to capture the amount of vehicle travel generated by a project (i.e., number of vehicle trips multiplied by their corresponding trip lengths) or a project's effect on VMT within a defined study area. Project effect information is more meaningful for VMT analysis because land use projects and land use plans often influence the vehicle travel associated with neighboring land uses. **Figure 1** illustrates the difference between these two types of VMT.

VMT is a preferred metric for environmental effects because it captures how a project influences the environment related to fuel consumption and emissions while also serving as an indicator of potential impacts to pedestrians, bicyclists, transit riders, and travel safety.

VMT growth associated with land use and transportation projects is part of adopted regional transportation plans (RTPs) and general plans. These plans typically consider the acceptability of VMT growth at a cumulative or programmatic level. Additional VMT reduction may be achieved at the project level especially through TDM strategies, which are not fully accounted for in regional level travel forecasting models.

Although VMT is focused on vehicle travel, the goal of reducing per capita VMT growth rates leads to an emphasis on the effects of development patterns (e.g., land use mix and density) together with pedestrian, bicycle, and transit infrastructure. These factors have an impact on the number and length of vehicle trips. Efforts to reduce VMT may also include TDM strategies that encourage more efficient forms of travel or vehicle use.

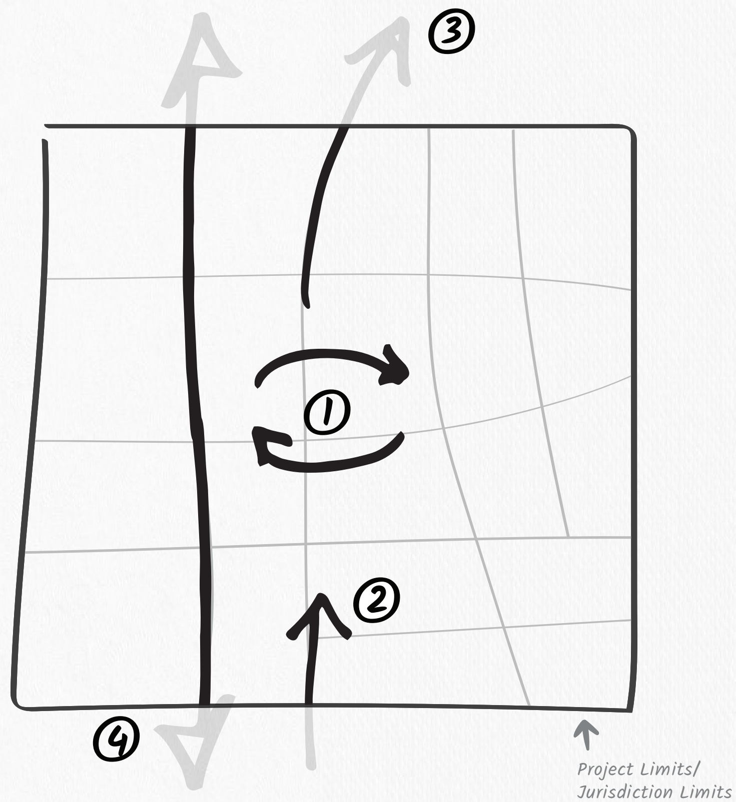
Project Generated VMT



① 2x Internal to Internal (2xII) VMT
② External to Internal (XI) VMT
③ Internal to External (IX) VMT
④ External to External (XX) VMT

Notes: External to External (XX) trips are excluded from this VMT metric. Adjustments to project generated VMT made to include the full length of trips that leave the jurisdiction to capture inter-jurisdiction travel.

Project Effect on VMT
(Boundary VMT)



① Internal to Internal VMT
② External to Internal (XI) VMT
③ Internal to External (IX) VMT
④ External to External (XX) VMT

Notes: Boundary VMT is all the VMT on the streets within the Project Limits / Jurisdiction Limits.

Figure 1

Measuring Vehicle Miles Traveled (VMT)

2.4.1 VMT Metrics

Metrics refer to the types of VMT that are captured in the calculations to be performed as part of the CEQA process. For example, trip types can be broken down by trip purpose, such as home-work, home-other and other-other (i.e. trips with neither a start nor end at a residence). Because the CEQA Guidelines focus analysis on (personal) automobile trips, OPR has given guidance (in the *Technical Advisory*) that metrics for most residential and office (i.e. employment-focused) projects should analyze the portion of the VMT attributable to a project that is focused on travel by personal automobiles. Further, the partial VMT calculated should be divided by the number of residents or employees to arrive at a per capita efficiency metric to provide a point of comparison between the project being analyzed and other similar developments in the city or region

New land use projects accommodate population and employment growth; this growth generates new VMT (e.g., a new office building resulting from a land use rezone will generate new vehicle trips and VMT). Whether a project contributes to a more efficient land use pattern (i.e., one that requires less vehicle travel compared to similar land uses) can be determined by using a VMT efficiency metric. Efficiency metrics express a total increase in VMT relative to the increase in residents and employees (VMT per resident, or VMT per worker). Total project-generated VMT as a stand-alone metric tends to be more relevant as an input to Air Quality, Greenhouse Gas, and Energy consumption impact analysis.

VMT efficiency metrics can be further disaggregated into specific types of VMT and populations, such as considering only the VMT generated by residents making trips to and from home. Each of the VMT efficiency metrics listed below addresses a slightly different question in terms of impact analysis. **Table 1** (presented below) also provides a primer on what types of VMT are captured under each category.

- **Home-based VMT per resident** measures VMT generated by trips that have an origin or destination at a home location and reflects how close households are to common destinations, as well as the available transportation options. Because the trip type is specific to local residents, it helps compare residential projects across different locations. However, it omits many different trip types (such as a trip made from a work location to a retail location or trip made by a delivery driver to a residence) and is considered a "partial" VMT metric.

  Answers the question: Do people living here drive more or less on average compared to other places?

- **Home-based work VMT per employee** reflects how close a workplace is to places where employees live. Because the trip type is specific to work trips, it helps compare office or other employment projects across different locations. However, it omits many different trip types (such as a trip made by an employee traveling from work to the grocery store) and is considered a "partial" VMT metric.

Answers the question: Do people working here drive more or less during their commutes compared to workers in other places?

- **Total project-generated VMT per service population** provides a more comprehensive understanding of VMT than the home-based per resident or home-based per employee, which are partial VMT metrics. By taking the total VMT to and from a project or geographic area and dividing it by the total number of residents *plus* the total number of employees, a comparison of how VMT intensive the project is as a whole can be made. For example, this metric would capture delivery trips to and from residences and businesses, which may be a substantially more considerable VMT source in the coming years.

  One caveat for total VMT per service population is that employment-based uses generate more total VMT than non-employment uses, so projects with more employment may have a higher VMT rate by this metric. Further, the VMT associated with employees also includes VMT generated by visitors and customers. Retail and commercial land uses, therefore, generate disproportionately higher levels of VMT per employee.

  Answers the question: Is this area or project as a whole more or less VMT intensive than other places?

- **Total project effect on VMT** assesses whether a project would cause a net increase or net decrease in VMT within the boundary of a geographic area, compared to a no project condition. Because the total project effect on VMT does not hinge on the ratio of residents to employees, it provides the most direct way of understanding how development would change local travel patterns. To reflect a project's effects, the boundary area should include full trip lengths and not be truncated at political or model boundaries.

  Answers the question: What effect would building this project have on the way people travel in Petaluma/Sonoma County/and the region? Would there be a net increase or net decrease in regional VMT compared to building a similar project elsewhere?

These potential VMT metrics were submitted to the TAC for review and discussion and to facilitate the development of a recommendation for adoption. TAC recommendations for adoption are presented in **Section 3.1** of this report.

Table 1: Illustration of Common Types of VMT

Vehicle Trip Type Examples	Included in Home-Based VMT?	Included in Home-Based Work VMT?	Included in Total VMT?	
			Petaluma Land Use Generated	Boundary Method[1]
A Petaluma resident drives directly from home to their workplace	X		X	X
A Petaluma employee drives directly from home to work		X	X	X
A Petaluma resident drives their child from home to soccer practice	X		X	X
A Petaluma resident drives their child from school to soccer practice				X
A Petaluma employee drives from work directly to the grocery store			X	X
A San Rafael resident drives from home to Santa Rosa through Petaluma, using US 101 or using city streets.				X
A Novato resident travels to Downtown Petaluma to eat out			X	X
A South San Francisco resident travels to the Petaluma to visit a family member who resides there			X	X
Amazon delivers to a resident of the Petaluma			X	X
Amazon delivers to an employer in the Petaluma			X	X
OPR recommendation for use?	**Residential Projects**	**Employment-Focused Projects**	***Not Recommended***	**Retail Projects**

1. Boundary method VMT assumes that SCTA model trip lengths at the boundaries of Sonoma County are appropriately calibrated for these trips.
Source: Fehr & Peers, 2020

2.4.2 VMT Methods

VMT methods refer to the manner in which VMT is calculated for project analysis purposes. For cases in which a project is not screened from a quantitative VMT analysis, a consistent methodology for calculating VMT should be developed. Travel forecasting models such as the Sonoma County Transportation Authority (SCTA) travel model are the most appropriate method for calculating VMT since they can produce forecasts for the project's effect on VMT and account for changes in travel behavior.

The matrix in **Table 2** (presented on the next page) contains a comparison of three travel forecasting models with geographies that overlap with Petaluma. These models include the City of Petaluma model, the SCTA model, and the Metropolitan Transportation Commission (MTC) model. The matrix includes relevant evaluation criteria for each model and compares the applicability of each model for forecasting VMT within Petaluma. As described in the matrix in Table 2, the SCTA travel model was recommended as the forecasting model for producing VMT forecasts in Petaluma. TAC recommendations for adoption are presented in **Section 3.2** of this report.

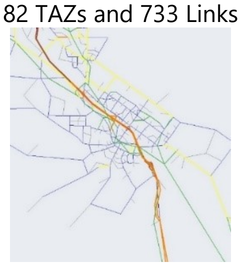
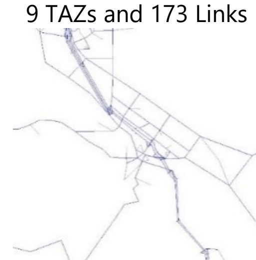
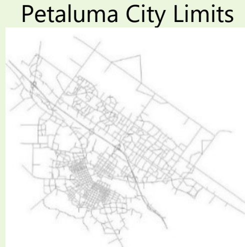
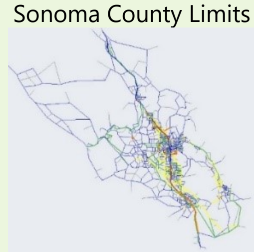
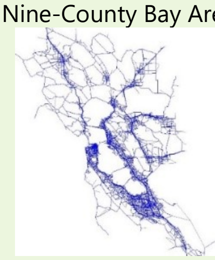
The SCTA model may be used to calculate the VMT metrics described above if the project is large enough for the model to be sensitive to changes in land use.[4] Ideally, this would consist of calculating total project-generated VMT, total citywide or County VMT, and VMT per employee/resident for model scenarios with and without the project. Impacts could be assessed based on both efficiency metrics (e.g., home-based VMT per resident) as well as the project's effect on VMT (the total change between no project and plus project scenarios). Because Petaluma is located near the edge of the SCTA model boundaries, VMT reported by the model should be adjusted to account for VMT that extends beyond the model limits (e.g., from Petaluma to San Rafael, which is outside the SCTA boundary). These adjustments should include adding an average trip length for vehicle trips leaving the model area based on data from the Sonoma County Travel Behavior Study, California State Travel Demand Model, the California Household Travel Survey, mobile devices, or the US Census Bureau; the version of the SCTA travel demand model (build date August 2020) has been adjusted for data in the Sonoma County Travel Behavior Study, and thus the VMT estimates from the model generally account for county boundary effects.

Appendix A describes the general methodologies and data sources for making these adjustments; it is noted that while the SCTA model has been updated to reduce the effects of trip length truncation, the City should encourage preparers of traffic studies to use judgement in determining if the VMT estimates from the model are appropriately accounting for trip lengths across the county boundary.

Mixed-use projects should be analyzed using the SCTA model to assess the project's effect on VMT and report home-based VMT per resident and home-based work VMT per employee for residential and office components, respectively. Home-based VMT per resident may also be useful for other uses with similar travel characteristics, such as hotels or group quarters. Home-based work VMT per employee may be useful for other uses similar to employment, such as schools, universities, etc.

[4] Model calibration and sensitivity testing should occur as part of any analysis involving travel demand model runs.

Table 2: Petaluma SB 743 Implementation – Travel Forecasting Model Comparison

Evaluation Criteria	City of Petaluma Model	SCTA Model	MTC Model
Model Structure	3-Step Trip-Based Model No Mode Split Step	4-Step Trip-Based Model With Mode Split Step	Activity-Based Model Auto-Ownership Model
Calibration Year[1]	2007	2015	2010
Model Detail within Petaluma	High: 383 TAZs and 2,146 Links 	Medium: 82 TAZs and 733 Links 	Low: 9 TAZs and 173 Links 
Model Boundaries	Petaluma City Limits 	Sonoma County Limits 	Nine-County Bay Area 
Level of Petaluma Trips Truncated at Model Boundaries	High: All trips leaving Petaluma City Limits are truncated.	Low: All trips leaving Sonoma County limits are truncated, however Big Data is used to account for the truncated portion of trips.	Low: Only trips leaving Nine-County Bay Area are truncated.
Model Run Time	<1 hour	~1 hour	~24 hours
Key Limitations Requiring Action	Updated model calibration and validation is necessary to accurately assess VMT impacts. The update would require substantial time and cost.	Modelers should review model trip lengths to confirm capture of full length of trips	Model sensitivity to local project land use changes is untested. Changing model inputs for land use projects requires substantial time and cost.
Recommendation	**Not Recommended:** - High level of truncated trips - Model requires substantial update and recalibration - No mode split step	**Recommended:** - Petaluma is member agency - Most recent calibration - Supplemented with empirical data (i.e., Big Data) - SCTA has consistently provided model maintenance and updates	**Not Recommended:** - Coarse model detail in off-the-shelf version - Unknown model accuracy and sensitivity for local projects - Time consuming to make land use changes - Long run time

Source: Fehr & Peers, 2020.
Notes: 1. Model should be calibrated within the past five years.

Some land use components (e.g. retail, restaurant, entertainment, recreation) may be assessed qualitatively if they serve primarily local trips. Particularly for retail uses, a qualitative discussion of how the uses would primarily serve local trips may be adequate to determine the project's effect on VMT. Otherwise, based on guidance in the OPR *Technical Advisory,* retail projects should be assessed based on the project's effect on VMT.

Some projects may not be large enough for the SCTA model to be sensitive to the changes they represent, but too large to qualify for small project screening. In these cases, spreadsheet-based methods based on a VMT generation rate for the project's TAZ may be useful. This method works well when the proposed project is similar to the types of land uses already present in the TAZ (for instance, adding a new multi-family development to a residential zone). If the project is small, and somewhat unique for the area in which it is proposed, additional data may need to be collected.

Other alternatives for assessing the VMT effects of smaller projects are to further validate a sub-area model (which requires additional time and effort for analysis and may be expensive), or to use a sketch planning tool such as CalEEMod or MXD+ that have been modified to reflect trip generation rates and trip lengths consistent with the SCTA model used to set thresholds.

The determination of whether a project requires a qualitative, sketch-level, or model-level assessment will be made during the environmental scoping process.

2.4.3 Baseline VMT

Baseline VMT information is dependent on the time that the project is deemed complete or a Notice of Preparation (NOP) for an environmental document is released, as well as the selected metric(s) and method to be applied for the VMT analysis of a given project. **Table 3** (located on the next page) presents baseline information derived from the SCTA travel demand model for Year 2015 conditions for a variety of VMT metrics. **Table 3** also includes examples of how the baseline VMT information could translate into thresholds of significance based on common threshold choices from agencies throughout California. It is noted that these baseline VMT values are subject to change as time progresses, and that future VMT analyses should carefully consider whether the baseline information in **Table 3** remains applicable and/or is relevant for a given project. For example, the Year 2015 base year model data may be reasonable for use in some parts of Sonoma County due to the effects of the 2017 and 2019 wildfires, as well as the economic and travel behavior effects of the COVID-19 pandemic in 2020.

It is noted, however, that the Year 2015 base year model does not include the effects of the SMART passenger rail system that opened in 2017. While the effects of the lack of SMART passenger rail in the model on VMT estimates are not precisely known, the lack of SMART passenger rail represents a conservative assumption because it assumes more overall driving in the model in the near-term analysis horizon scenario. By doing so, the model amplifies the VMT effects on projects, thus leading to a more conservative assumption. In the course of a traffic analysis, the City can qualitatively assess how SMART passenger rail affects the VMT calculation or the calculation of the effectiveness of VMT-related mitigation measures.

Table 3: City of Petaluma Baseline VMT by VMT Metric

VMT Metric	Baseline VMT	VMT Threshold Options		
		OPR 15% Below Baseline	ARB 16.8% Below Baseline	Any Net VMT Increase[1]
Home-Based VMT per Resident *Citywide Average*	19.3	16.4	16.1	n/a
Home-Based Work VMT per Employee *Nine-County Bay Area Average*	22.7	19.3	18.9	n/a
Total VMT per Service Population *Citywide Average*	36.7	31.2	30.5	n/a
Total VMT within city limits[1] *City generated VMT + pass-through*	1,185,199	n/a	n/a	1,185,199

Notes:

1. A threshold of any net increase in VMT is most appropriate when analyzing total VMT and the possibility for induced vehicle travel resulting from transportation improvement projects. It may also be useful for assessing retail and other local-serving land use projects.

Source: SCTA Travel Demand Model (August 2020); Fehr & Peers, 2020.

2.4.4 Factors Influencing VMT Estimates and Forecasts

Estimates of current VMT and forecasts of future VMT are inherently dependent on the methodology used. These estimates and forecasts may not account for recent changes in economic activity, or future trends such as greater transportation network company (TNC) use through autonomous vehicles (AVs). Prior to COVID-19, expectations about the influence of these factors is that vehicle travel is likely to increase over time as the human driving function is eliminated, operating and parking costs are reduced, and access to a variety of vehicle types becomes more ubiquitous. Immediate COVID-19 effects that have challenged these expectations include a shift to work-from-home for many office-located jobs, an increased use in online retail and entertainment, and a desire for recreational activities that allow for spacing between individuals. These VMT-suppressing factors may be counteracted in part or in whole by a slow recovery in public transit usage. Ultimately, VMT trends will need to be monitored over time as COVID-19 economic outcomes may dampen these expectations.

2.4.5 VMT Thresholds

The CEQA Guidelines encourage local jurisdictions to adopt significance thresholds intended for general use by resolution or ordinance as part of a public process. Lead agencies also have the option to establish thresholds on a project-by-project basis. Adopting these thresholds through a public process improves transparency and can be used to help educate the public and project applicants about the City's expectations. The City of Petaluma has two primary options for setting a VMT threshold for land use projects and plans: adopt a threshold recommended by another public agency or adopt a jurisdiction-specific VMT threshold.

The State's guidance on thresholds is presented in the OPR *Technical Advisory* and the ARB *California Air Resources Board 2017 Scoping Plan – Identified VMT Reductions and Relationship to State Climate Goals*. The OPR threshold generally requires land use projects to achieve a VMT reduction of 15 percent below the city or regional (i.e. nine-county Bay Area) baseline average depending on the type of land use. The ARB analysis indicates that the VMT threshold would need to be 16.8 percent for automobile only VMT to achieve state GHG reduction goals. These points of reference are subject to change over time, however, depending on statewide forecasts of population and travel, as well as economic conditions (e.g. short-term and long-term effects of the COVID-19 pandemic).

Specific OPR guidance for individual land uses is as follows:

- Residential projects – A proposed project exceeding a level of 15 percent below existing (baseline) home-based VMT per resident may indicate a significant transportation impact. Existing home-based VMT per resident may be measured as regional or citywide home-based VMT per resident.
- Office projects – A proposed project exceeding a level of 15 percent below existing (baseline) regional home-based work VMT per employee may indicate a significant transportation impact.
- Retail projects – A net increase in total VMT may indicate a significant transportation impact. This metric reflects the nature of most local-serving retail to distribute existing vehicle trips, rather than generate or induce new vehicle trips.
- Mixed-use projects – Lead agencies can evaluate each component of a mixed-use project independently and apply the significance threshold for each project type included (e.g., residential and office). In the analysis of each use, a project should take credit for internal capture.
- Other project types – Lead agencies, using more location-specific information, may develop their own more specific thresholds, which may include other land use types.
- Redevelopment projects – Where a project replaces existing VMT-generating land uses, if the replacement leads to a net overall decrease in VMT, the project would cause a less than

significant VMT impact. If the project leads to a net overall increase in VMT, then the thresholds described above should apply.

While OPR generally recommends a threshold at 15 percent below baseline levels for residential and office projects, OPR also recommends that any increase in VMT from a retail project be treated as significant. Further, ARB recommends a VMT reduction of 16.8 percent below 2018 levels (for automobile-only VMT) for new development to contribute its fair share to meeting state emissions reduction goals. The ARB threshold is supported by substantial evidence given its direct connection to emissions goals and forecasts.

A key consideration for Petaluma is that the city's current VMT rates for residents and employees are higher than the regional average (Table 1 below), and accomplishing a 15.0 or 16.8 percent reduction (when comparing cumulative VMT for projects to the existing Bay Area VMT average) would require mitigation strategies not previously attempted.

A potential challenge to any VMT threshold is the ARB SB 150 report (2017), which includes evidence that VMT per capita is increasing and, as a result, so are GHG per capita emissions. Furthermore, the thresholds published by ARB and OPR are based on a number of assumptions about future outcomes related to VMT generation of current residents, fuels, electric vehicles, that may not qualify as reasonably foreseeable under CEQA and do not consider the influence of transportation network companies (e.g., Uber and Lyft) and autonomous vehicles (AV) on travel behavior. These sorts of travel trends, if they continue, may contribute to 'other substantial evidence' that must be considered and discussed when making a significance finding. It is noted, however, that the ARB SB 150 report analyzed VMT per capita before the COVID-19 pandemic, and the quantified effects of the pandemic on VMT per capita is unknown at this time.

Caltrans released a draft *VMT-Focused Transportation Impact Study Guide* (February 28, 2020) that recommends use of the OPR thresholds for land use projects and plans. This guidance did not specify whether to use the 15.0 or 16.8 percent threshold value (both values are included in the OPR Technical Advisory). The Caltrans Guide also mentions that Caltrans may request additional analysis for transportation projects; standards for those projects are discussed below.

OPR and Caltrans recommend that a net increase in total VMT may indicate a significant impact for transportation projects. Why transportation projects should be treated differently than land use projects is not disclosed or supported by substantial evidence. A net decrease or no change in VMT would be evidence of a less than significant VMT impact.

Projects that reduce or have no impact on VMT include most active transportation projects, road diets, and minor operational changes to local roadways. However, capacity increases (i.e., lane additions) on arterial roadways or roadways that carry regional traffic have the potential to induce new vehicle traffic, and therefore new VMT. As an example, adding an additional lane on an arterial roadway that reduces delay, may make driving even more competitive than walking, and shift some trips to from walking to driving.

The no net new VMT threshold is the threshold preferred by Caltrans for assessment of impacts to Caltrans facilities and recommended in the OPR *Technical Advisory*. As a threshold, it is also reflective of whether a project simply improves operations for existing users (decreasing delay or improving safety with no change in VMT) or if it also induces demand for driving.

2.4.6 Screening Criteria

The OPR *Technical Advisory* includes suggested methods for screening projects to quickly identify when a project should be expected to cause a less than significant VMT impact for the CEQA Transportation section without conducting a detailed VMT analysis. The OPR *Technical Advisory* suggests that lead agencies may screen out VMT impacts for small projects, residential and office projects located in low-VMT areas (as per the SCTA travel demand model or other sources of VMT), projects located in proximity to a major transit stop (per specific definitions in the OPR *Technical Advisory*), affordable housing developments, and transportation projects that would not result in an increase to vehicle capacity. Since land use plans affect a larger area and serve as the basis for environmental analysis of future projects, all land use plans (including the General Plan, Precise Plans, and Specific Plans) should conduct a quantitative VMT analysis and not utilize screening, unless they can be screened out due to proximity to major transit.

2.4.7 Mitigating VMT Impacts

Mitigation strategies related to reducing VMT impacts to less-than-significant levels are related to reducing the number and distance of vehicle trips generated by a particular project. This is in contrast to mitigation under congestion-based metrics such as LOS, whereby congestion impacts are mitigated through adding capacity; in some cases, these capacity improvements induce driving, and thus lead to more VMT being generated.

VMT impact mitigation strategies generally take the form of Transportation Demand Management (TDM) measures. TDM measures include strategies related to parking, transit usage, encouraging a mix of land uses on site, and promoting the use of active transportation and higher-occupancy vehicle models (e.g. carpooling and transit). TDM can be applied on a project-by-project basis, or as part of a citywide TDM program. Until a citywide program is established, most projects requiring mitigation would apply TDM strategies on a project-by-project basis.

A key part in the CEQA process is the demonstration of the effectiveness of the selected mitigation strategies. For example, under congestion-based analyses, one could demonstrate the effectiveness of adding capacity by re-running the traffic operations model with the added capacity to determine the reduction in congestion after implementation of the improvement. Because the amount of research on the effectiveness of TDM strategies is limited (i.e. CAPCOA's *Quantifying Greenhouse Gas Mitigation Measures* publication), demonstrating the VMT reduction effectiveness of project-by-project TDM measures to the standard required by CEQA may be difficult. For example, the effectiveness research in the CAPCOA document is limited in its scope and breadth of research site locations and contexts; thus, in some cases, the research in the CAPCOA document may not be relevant to projects in Petaluma. Additionally, as noted in the CAPCOA document, the research suggests that there is a maximum potential effectiveness associated with implementing all feasible TDM strategies; for suburban contexts like Petaluma, this maximum potential effectiveness is 15 percent. As VMT effectiveness in Petaluma is monitored and evaluated, empirical data may support different, locally-specific conclusions relative to the CAPCOA research.

Citywide TDM strategies and fee programs may allow developers to mitigate land use project impacts through funding of strategies that will reduce VMT generated by the project as well as other existing land uses throughout the City. One such example of an in-lieu fee program includes San Diego's Complete Communities Initiative, which is described below.

Case Study – San Diego's Complete Communities: Housing Solutions and Mobility Choices Initiative

San Diego's proposed Complete Communities initiative aims to "connect every San Diegan with safe and convenient mobility choices to jobs, open spaces, shopping, services, neighborhood parks, and other amenities[5]." The program seeks to reduce VMT created by new development in more urban neighborhoods by requiring on-site or site-adjacent VMT reducing amenities and programs while development occurring in non-urban areas would be required to pay an in-lieu fee[6] that would be used to construct transit, bicycle, and pedestrian infrastructure in more urban areas of the City. Development in non-urban areas would result in the greatest VMT generation; however, VMT reducing amenities in non-urban areas are least effective as they are characterized by being farther away from jobs, services, and shopping (making bicycling and walking difficult) and limited access to transit. This program applies to ministerial and discretionary projects to comprehensively reduce citywide VMT and provides a mechanism

[5] For more information on San Diego's program, visit: https://www.sandiego.gov/planning/programs/mobility/mobilitychoices

[6] An in-lieu fee program requires a 'reasonable relationship between the ordinance and enhancement of public welfare' per decisions such as California Building Industry Assn. v. City of San Jose (2015) 61 Cal.4th 435 (CBIA) to establish the nexus for the in-lieu fee. A reasonable relationship could be established by demonstrating that new development increases citywide VMT and the VMT reduction ordinance amenities and construction transit, bicycle, and pedestrian infrastructure reduce citywide VMT.

for mitigation to address development project VMT impacts that is predictable; however, it does not replace or offset the City's traffic impact fee program.

Chapter 4 of this report includes a more detailed discussion of potential TDM strategies that could be implemented in Petaluma. **Section 3.5** presents TAC recommendations for mitigating VMT impacts in the City of Petaluma as well as recommendations for associated next steps to bolster mitigation options for future projects in the City.

3. Implementation Recommendations

This chapter includes recommendations for VMT metrics, methods, thresholds, screening criteria and mitigation options for the City of Petaluma. The recommendations are based on feedback from the TAC formed for the purposes of SB 743 implementation in the City of Petaluma.

3.1 Metrics

As noted in **Section 2.4.1**, a variety of VMT metrics were submitted to the TAC for their review and feedback. Topics for discussion amongst TAC members included consistency with the OPR *Technical Advisory*, a desire for the metrics to capture a wide range of VMT, and the ability of travel demand models to calculate the metrics.

Technical Advisory Committee Recommendation for VMT Metrics

The TAC discussed how various metrics would more fully capture VMT generated by, and interactions between, various land uses within the City (e.g. residential, office, retail, schools, commercial services, etc.), how the metrics could promote a more sustainable transportation future for the City that encourages walking, bicycling and transit uses between destinations, the ability of travel demand models to calculate the metrics, and the desirability of consistency with the OPR *Technical Advisory*. Based on the desire to find balance amongst these factors, the TAC has recommended the following VMT metrics for adoption by the City of Petaluma:

- **Residential projects:** total home-based VMT per resident
- **Office and other employment-focused projects:** total home-based work VMT per employee
- **Retail and other commercial service projects:** total project effect on VMT within a geographic area

3.2 Methods

As noted in **Section 2.4.2**, three candidate travel demand models were submitted to the TAC for review and feedback. Topics for discussion amongst the TAC members included the level of detail of each model, the schedule of previous/future updates to model data, and the ability of the model to precisely analyze developments that are typical for the City of Petaluma (with respect to project type and scale).

Technical Advisory Committee Recommendation for VMT Methods

The TAC received a presentation from Chris Barney, Senior Transportation Planner at SCTA and SCTA's lead travel demand modeler on the capabilities of the updated SCTA model. He noted that the model provides better detail on land uses in Sonoma County as well as a robust transportation system for which trips are routed upon; these details are key in the more precise estimate of VMT. The TAC discussed the need to use a travel demand model (as suggested by OPR in the *Technical Advisory*), the detail included in the three reviewed modeling options, the ease of use of each model, and the data update/model maintenance schedule for each model. Based on discussions amongst TAC members about these factors, the SCTA travel demand model is recommended for use in the calculation of VMT for projects in the City of Petaluma.

3.3 Thresholds of Significance

As noted in **Section 2.4.5**, a number of options for thresholds of significance exist. Thresholds should be based on substantial evidence per the CEQA Guidelines, and thresholds may be based on substantial evidence developed by other agencies. The TAC was presented with threshold options including the 15-percent and 16.8-percent thresholds recommended by OPR and ARB, respectively. TAC members discussed how the thresholds would consider the City's climate emergency declaration, commitment to sustainability and resiliency, need to address the housing crisis, and other factors contributing to VMT that are outside of the City's control (e.g. the City's location in the region relative to other areas of employment, retail and housing).

Technical Advisory Committee Recommendation for VMT Thresholds

Based on these discussions, the TAC recommended that the City of Petaluma adopt the following thresholds that identify a significant impact with respect to VMT:

A project would result in a significant impact and require mitigation if:

- **For residential projects:** Project total home-based VMT per resident exceeds __% of the citywide average. The citywide average baseline value applies until such time that the City of Petaluma exceeds the housing allocation for the City as identified in the Sustainable Communities Strategy (SCS) for the Bay Area region; if the City exceeds the SCS housing allocation, the nine-county Bay Area regional average applies[7].
- **For office and other employment-focused projects:** Project total home-based work VMT per employee exceeds __% of the nine-county Bay Area regional average
- **For retail and other commercial service projects:** Project results in a net increase in VMT over the geographic area that the project influences.

[7] The SCS housing allocation limit is suggested by the California State Office of Planning and Research (OPR) in the *Technical Advisory on Evaluating Transportation Impacts in CEQA* as when the use of a citywide average becomes inappropriate for the evaluation of CEQA VMT impacts (in favor of the Bay Area regional average).

- **For mixed-use and other projects:** Project components should be analyzed using the relevant thresholds for residential, office/employment-focus, or retail/commercial service projects. The benefit of a mix of uses on-site can and should be included in the analysis.
- **For transportation projects:** Project results in induced travel and an increase in citywide VMT.
- **For redevelopment projects:** Project results in increased VMT versus current land uses. City staff retain discretion to identify the baseline VMT for use in the calculation (i.e. based on current uses or permitted uses).

3.4 Screening Criteria

It is generally recommended that the City use the screening criteria presented in the OPR *Technical Advisory*, with minor modifications or exclusions. The TAC was presented with the *Technical Advisory* screening criteria, and generally recommended their adoption, with some minor modifications (e.g. limiting exemptions for projects with drive-throughs), as described below. A VMT analysis may still be required to provide inputs for the Air Quality, Greenhouse Gas and Energy CEQA analyses; this analysis could be completed using the SCTA travel demand model or other VMT evaluation tools (e.g. CalEEMOD).

Technical Advisory Committee Recommendation for VMT Screening Criteria:

Screening for Small Projects

The TAC has recommended that the City screen projects that generate or attract fewer than 110 trips per day. Based on research for small project triggers[8], this may equate to nonresidential (e.g., office) projects of 10,000 square feet or less and residential projects of 15 units or less. The City of Petaluma may also screen local-serving retail projects (projects with less than 30,000 square feet of retail) on the basis that they attract trips that would otherwise travel longer distances. Projects with drive-throughs would be excluded from screening under these criteria, and City staff retain discretion to deny the use of the small project exemption if substantial evidence exists that screening is not appropriate.

Screening for Projects Located in Low-VMT Areas

The TAC has recommended that the City screen residential and office projects located in low-VMT areas (per the CEQA thresholds to be established by the City) that incorporate similar features to the nearby developments (i.e., density, mix of uses, and transit accessibility) on the basis that the project will exhibit similarly low VMT. Typically, this screening is performed by utilizing data from a travel demand model (e.g. the SCTA travel demand model) and comparing the project's characteristics to land uses currently in the low-VMT area. Projects with drive-throughs would be excluded from screening under these criteria, and

[8] Refer to technical memorandum on small project triggers in **Attachment A**.

City staff retain discretion to deny the use of the low-VMT area exemption if substantial evidence exists that screening is not appropriate.

Screening for Projects in Proximity to a Major Transit Stop

The TAC has recommended that the City screen projects that are located within a half mile of an existing or planned high-quality transit corridor or major transit station. Proximity to transit is explicitly listed in the CEQA Guidelines as a reason to presume a project has no significant impacts based on VMT. In Petaluma, this includes the existing Downtown Petaluma SMART station, the planned Petaluma North SMART station (also known as the Corona Station), and at stops for bus routes with 15 minute or less headways.

The OPR *Technical Advisory* notes that a presumption of less than significant should not be applied, and a VMT analysis should be performed, if the project:

- Has a Floor Area Ratio (FAR) of less than 0.75
- Includes more parking than required by the City of Petaluma
- Is inconsistent with Plan Bay Area
- Replaces affordable residential units with a smaller number of moderate- or high-income residential units (although a small market-rate project could qualify for small project screening)

If any of the above conditions apply, a detailed VMT analysis should be conducted to determine whether the project exceeds the VMT thresholds. Projects with drive-throughs would be excluded from screening under these criteria, and City staff retain discretion to deny the use of the proximity to major transit stop exemption if substantial evidence exists that screening is not appropriate.

Screening for Affordable Housing

The TAC has recommended that the City screen residential projects containing a particular amount of affordable housing (based on local circumstances and substantial evidence as determined by the City) on the basis that affordable housing generates less VMT than market-rate housing. Furthermore, affordable housing located within infill locations generally improves jobs-housing balance and may thus result in shorter commutes for low-income workers.

Screening for Transportation Projects

The TAC has recommended that the City screen transit projects, bicycle and pedestrian projects, and roadway maintenance projects that do not result in an increase in vehicle capacity or VMT. Refer to pages 20 and 21 of the *Technical Advisory* for a complete list of transportation projects that may be screened out from a VMT analysis.

3.5 Mitigation Options

As noted in **Section 2.4.7**, project VMT in exceedance of thresholds of significance require that a project implement mitigation measures to reduce the number of project trips generated and/or reduce the length of project-generated trips. The TAC was provided with information regarding how mitigation measures may be applied on a project-by-project basis, how citywide TDM programs could be developed whereby projects could pay into an in-lieu fee program to fund the citywide TDM program, and how projects could take advantage of mitigation bank programs that may be developed in the future.

Technical Advisory Committee Recommendation for Mitigating VMT Impacts:

The TAC recommended the following near-term, medium-term and far-term strategies:

- **Near-Term:** The TAC has recommended that mitigation be performed on a project-by-project basis using available TDM effectiveness research as a guide to demonstrate the effectiveness of mitigation strategies. TDM strategies related to promoting transit usage, active transportation, and more sustainable parking strategies should be prioritized.
- **Medium-Term:** The TAC has recommended that the City investigate and implement citywide TDM programs and fund these programs through developer fees.
- **Far-Term**: The TAC has recommended that the City coordinate with SCTA and other agencies in Sonoma County to develop a VMT mitigation banking program, should pilot programs in Contra Costa County and Southern California prove successful.

Chapter 4 provides more information on near-term, project-by-project TDM strategies for use in mitigating land use projects until citywide or County-wide mitigation strategies can be established.

3.6 CEQA VMT Transportation Impact Analysis Guidelines

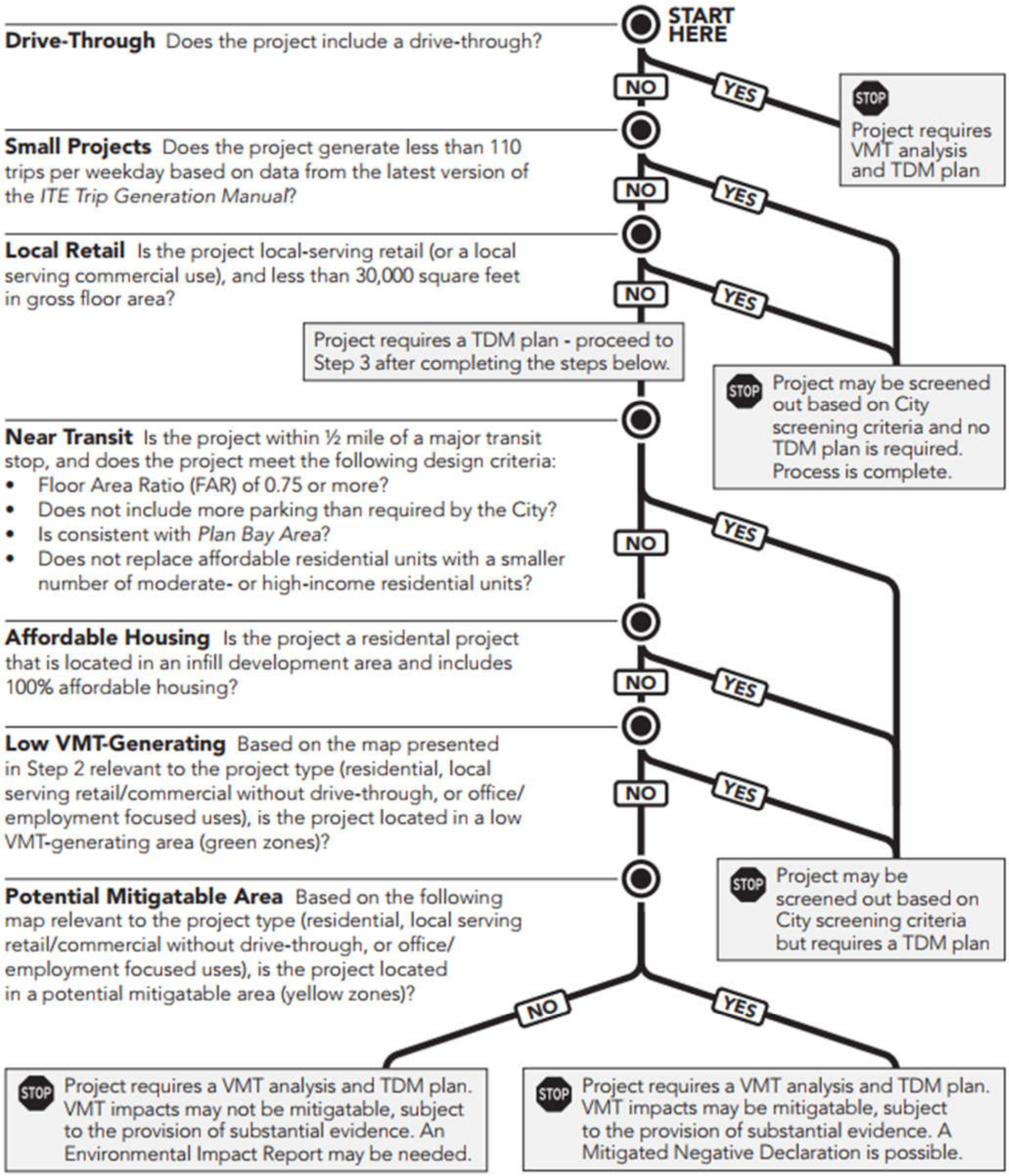
Fehr & Peers has developed guidelines for the study of a project's transportation impacts using VMT as the CEQA Transportation section metric. These guidelines are provided in **Appendix B**, and provide information on general VMT methodology, thresholds of significance and mitigation strategies; a flowchart of the process of determining if a traffic study is needed is presented on **Figure 2**. These guidelines are anticipated to evolve over time as (1) more data becomes available, (2) the City takes additional steps to implement VMT and mitigation measures in the City, and (3) as a body of CEQA case law develops around the topic of VMT analysis for CEQA Transportation purposes.

3.7 Disruptive Trend Impacts on VMT Estimation

The VMT methodologies and thresholds described above are based on a presumption that future travel behavior will be consistent with recent travel behavior. Disruptive trend changes including current COVID-

19 effects, TNCs such as Uber and Lyft, lower fuel prices, and public availability of AVs may change future travel behaviors, resulting in future VMT differing from current forecasts. As these trends evolve, models will need to be updated to reflect them. Generally, the SCTA travel demand model is updated on a five-year update schedule; the City of Petaluma, as one of SCTA's member agencies, could request a supplemental update once the effects of COVID-19, related economic effects, and other disruptive trends become more known and quantified.

Figure 2: Transportation CEQA Process



* See City of Petaluma's *CEQA VMT Transportation Impact Analysis Guidelines* for more information on these steps

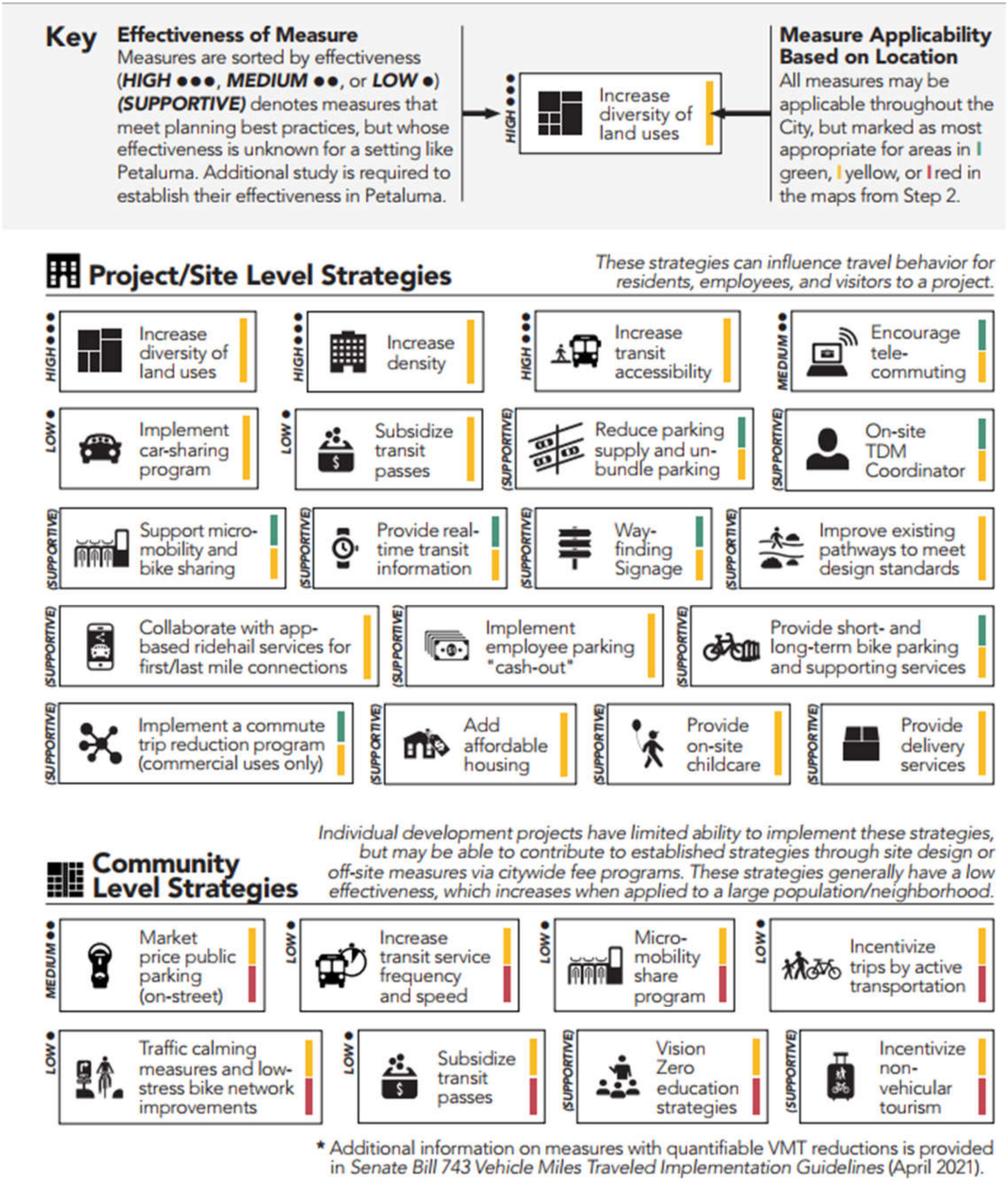
4. TDM Strategy Research

This chapter summarizes an assessment of new research related to transportation demand management (TDM) effectiveness for reducing VMT. The purpose of this work was to compile new TDM information that has been published in research papers since release of the *Quantifying Greenhouse Gas Mitigation Measures* (CAPCOA, August 2010) and to identify those strategies suited to Petaluma given its suburban land use context. This information has informed the development of a menu of mitigation options that are applicable for potential use in Petaluma, as outlined on **Figure 3**.

An important consideration for the effectiveness of these VMT reduction strategies is the appropriate scale of implementation. The strategies described in this section include programmatic strategies (e.g., VMT impact fee programs, VMT exchanges, and VMT banks), city-scale transportation infrastructure strategies (e.g., expanding the transit or bicycle network), and project-level strategies (e.g., building site transportation demand management [TDM] strategies such as parking pricing and transit pass subsidies). The largest reductions in VMT (and resulting emissions) derive from regional policies related to land use location efficiency and infrastructure investments that support transit, walking, and biking. While there are many measures related to site design and building operations that can influence VMT and emissions, these measures typically have smaller effects on VMT reduction and are often dependent on the travel behavior of residents/tenants.

To caveat the information presented in this section, the existing tools and methods for quantifying VMT reduction are prone to a high margin of error due to limited data and research on this topic as a result of recent regulatory changes (i.e., SB 743 and the policy change from LOS to VMT) as well as challenges in understanding the complex factors that influence travel behavior. To some degree, this is consistent with uncertainty that exists with previously acceptable CEQA transportation practices, such as calculations of Level of Service (LOS) based on forecasted intersection volumes. However, unlike LOS, monitoring of TDM effectiveness would be required at the project level as a condition of approval for discretionary projects. The ultimate strategies adopted for VMT reduction should be refined as additional research on the topic of VMT reduction becomes available and, as with all CEQA practice, based on substantial evidence.

Figure 3: Menu of VMT Options



4.1 Recommended VMT Reduction Strategies

Of the strategies included in the tools and research described above, only a few strategies are likely to be effective in a suburban setting such as Petaluma. With Petaluma's land use context in mind, each strategy's effectiveness was considered and nine were selected for detailed review. Strategies 1, 2, 3, and 4 present project-level mitigation, while strategies 5, 6, 7, 8 and 9 present community-level mitigation. Individual development projects have limited ability to implement community-level strategies, but may be able to contribute to established community-level strategies. It is noted that disruptive trends, including but not limited to, transportation network companies (TNCs such as Uber and Lyft), autonomous vehicles (AVs), internet shopping, and micro-transit (e.g., electric scooters) may affect the future effectiveness of these strategies.

4.1.1 Project/Site Level Strategies

1. Increase diversity of land uses – This strategy focuses on inclusion of mixed uses within projects or in consideration of the surrounding area to minimize vehicle travel in terms of both the number of trips and the length of those trips. Typical applications of a mix of uses include ground-floor retail at larger residential developments or the construction of live-work units. This strategy may not be feasible for smaller projects or projects subject to limited uses due to zoning such as single-family residential uses.
2. Increase density – This strategy focuses on increasing residential density within projects, which is associated with lower VMT per capita. Increased residential density in areas with high jobs access may have a greater VMT change than increases in regions with lower jobs access. The provision of Auxiliary Dwelling Units (ADUs) may reduce VMT per capita, depending on their use and person-occupancy. This measure also applies at the city and community level, with neighborhoods of higher density typically having lower VMT per capita.
3. Increase transit accessibility – This strategy focuses on ensuring site design favors access to existing or planned transit stations and is commonly referred to as Transit-Oriented Development (TOD). This strategy includes maximizing the amount of developable space within walking distance to transit stations (typically considered a radius of ¼ to ½ mile of a transit station), and/or deemphasizing automobile facilities such as vehicle parking, garages, and driveways.
4. Encourage telecommuting – This strategy relies on effective internet access/speeds, flex space, and/or accessory office units for individual project sites/buildings that provide the opportunity for telecommuting. The effectiveness of the strategy depends on the ultimate building tenants; this should be a factor in considering the potential VMT reduction, as tenants may change over time.

4.1.2 City/Community Level Strategies

5. Provide pedestrian network improvements – This strategy focuses on creating a pedestrian network and connecting projects to nearby destinations via pedestrian pathways. Projects in the City of Petaluma range in size, so the emphasis of this strategy for smaller projects would likely be the construction of network improvements that connect the project sites directly to nearby destinations. For larger projects, this strategy could focus on the development of a robust pedestrian network within the project itself. Alternatively, implementation could occur through an impact fee program or benefit/assessment district based on local or regional plans.

6. Provide traffic calming measures and low-stress bicycle network improvements – This strategy combines the CAPCOA research focused on traffic calming to provide a low-stress bicycle network. Traffic calming creates networks with low vehicle speeds and volumes that are more conducive to walking and bicycling. Implementation options are similar to those for providing pedestrian network improvements. One potential change in this strategy over time is that e-bikes (and e-scooters) could extend the effective range of travel on the bicycle network, which could enhance the effectiveness of this strategy.

7. Implement market price public parking (on-street) – This strategy focuses on implementing a market-based pricing strategy for on-street parking within central business districts, employment centers, and retail centers to encourage "park once" behavior. This measure deters parking spillover from project supplied parking to other public parking nearby, which undermine the vehicle miles traveled (VMT) benefits of project pricing. It may also generate sufficient area-wide mode shifts to justify increased transit service to the area.

8. Increase transit service frequency and speed – This strategy focuses on improving transit service convenience and travel time competitiveness with driving. While the City of Petaluma has fixed route rail and bus service that could be enhanced, it is possible that new forms of low-cost, demand-responsive transit service could be provided. Given land use density in Petaluma, this strategy may be limited to traditional commuter transit where trips can be pooled at the start and end locations or require new forms of demand-responsive transit service. The demand-responsive service could be provided as subsidized trips by contracting to private transportation network companies (TNCs) or Taxi companies. Alternatively, a public transit operator could provide the subsidized service but would need to improve on traditional cost effectiveness by relying on TNC ride-hailing technology, using smaller vehicles sized to demand, and flexible driver employment terms where drivers are paid by trip versus by hour. Note that implementation of this strategy would require regional or local agency implementation, substantial changes to current transit practices, and would not likely be applicable for individual development projects. Additionally, this strategy is only effective in VMT reduction if it includes a pooling element to increase average vehicle occupancy.

9. Implement a car and micro-mobility (bike or scooter) sharing program – This strategy reduces the need to own a vehicle or reduces the number of vehicles owned by a household by making it convenient to access a shared vehicle for those trips where vehicle use is essential. Bicycle and scooter sharing programs provide convenient connections for short-trips that do not require a car. Note that implementation of this strategy would require regional or local agency implementation and coordination and would not likely be applicable for individual development projects, although individual projects and provide parking and supportive services to these programs.

The VMT reduction strategies can be quantified using CAPCOA calculation methodologies, recent ARB research findings, or SANDAG's VMT calculator. **Appendix C** provides calculation methodologies for each of the mitigations provided above, along with their range of effectiveness.

Additional VMT reduction strategies that are not quantified in this section but may be considered for future implementation in Petaluma include:

- Engagement with bicycle advocacy groups such as the League of American Bicyclists to work towards certification as a bicycle friendly community
- Implement education strategies to inform the public about the Vision Zero strategies to improve road safety, increase health outcomes from active transportation, and decrease VMT
- Add additional wayfinding signage and safety procedures for bicycling through Downtown
- Incentivize non-vehicular tourism in Petaluma through partnerships with SMART and upcoming Bike Share providers as well as providing protected bicycle routes for tourists to major destinations, such as between SMART and Downtown
- Improve Petaluma's existing dirt trails to accommodate wider range of bicyclists
- Incentivize active transportation through market pricing strategies with employers, stores, and public transit[9]
- Collaborate with TNCs to provide first mile/last mile connections to high frequency transit corridors. Transit timing, carpooling, and ride discounts associated with TNC partnerships should be considered as simultaneous strategies, following the lead of other cities implementing such programs.

[9] The Dutch government pays workers 22 cents for every kilometer they pedal, reported by Huffington Post. https://www.huffpost.com/entry/netherlands-pays-bike-work-commute_n_5c6dc15ae4b0e2f4d8a23e3e

4.2 Combining VMT Reduction Strategies

Each of the TDM measures described previously can be combined with others to increase the effectiveness of VMT mitigation; however, the interaction between the various TDM measures is complex and sometimes counterintuitive. Generally, with each additional measure implemented, a VMT reduction is achieved, but the incremental benefit of VMT reduction may diminish. To quantify the VMT reduction that results from combining TDM measures, the formula below can be applied absent additional information:

$$Total\ VMT\ Reduction = (1 - P_a) * (1 - P_b) * (1 - P_c) * \dots$$

Where:

P_x = percent reduction of each VMT reduction strategy

This adjustment methodology is a mathematical approach to dampening the potential effectiveness and is not supported by research related to the actual effectiveness of combined TDM strategies. The intent of including this formula is to provide a mechanism for dampening to minimize the potential to overstate the VMT reduction effectiveness.

Another important consideration when combining TDM measures is whether a maximum VMT reduction should be applied based on the land use context. The CAPCOA methodology identifies VMT reduction maximums based on community types tied to land use context. The caps are applied at each step of the VMT reduction calculation (i.e., at the strategy scale, the combined strategy scale, and the global scale). However, these caps are not based on research related to the effectiveness of VMT reduction strategies in different land use contexts. The cap differences are largely based on VMT generation differences within different land use contexts and serves as a proxy for potential limits on VMT reduction strategy effectiveness. For suburban jurisdictions such as Petaluma, CAPCOA identifies a global VMT reduction maximum of 15 percent. For more information on VMT reduction maximums, see **Appendix D**, which contains an excerpt from the CAPCOA report describing the calculation of combined VMT reduction strategies.

As noted previously, additional data is needed to support and refine the above approach for quantifying the effects of combining VMT reduction strategies. Analysts should consider the available substantial evidence at the time a study is prepared and provide justification to support the effectiveness of TDM measures in order to inform CEQA review. We recommend conducting additional research into the effects of combining VMT reduction strategies, which may include the collection of measurable data from within Petaluma or cities of similar size and land use context, and summarizing the database for use in developing the justification for the effectiveness of mitigation measures (including supporting a finding of effectiveness beyond the 15 percent maximum reduction suggested in the CAPCOA guidance).

4.3 Implementing VMT Reduction Strategies

Project or site-level VMT reduction strategies often involve increasing land use density, changing the mix of uses, or altering the transportation network. However, a potential limitation of these physical design changes is that they may result in a project that no longer resembles the original applicant submittal. CEQA is intended to disclose the potential impacts of a project and mitigate those impacts but has limitations with regards to using mitigation to fundamentally change the project. Therefore, these strategies may result in an inconsistency with the project description when applied on an ad hoc basis.

Another common strategy is to add a TDM program to the project as a condition of approval. While evidence exists that TDM programs can reduce VMT, their success depends on the performance of future building tenants that can change over time. Hence, an effective TDM mitigation program will often require ongoing monitoring and adjustment to ensure long-term VMT reduction is achieved. The cost to provide this monitoring may not be feasible for all projects.

In response to the limitations of focusing exclusively on site-level TDM strategies, new mitigation concepts are emerging that cover larger areas and rely on citywide programs to achieve VMT reductions. These mitigation concepts (or programs) are outlined below. As with all VMT mitigation, these programs require substantial evidence to document that the projects included in the programs would achieve the expected VMT reductions. Additionally, the discretionary action to adopt the program may require CEQA review.

1. VMT Impact Fee Program – This concept resembles a traditional impact fee program in compliance with the mitigation fee act and uses VMT as a metric. The nexus for the fee program would be a VMT reduction goal consistent with the CEQA threshold established by a lead agency for SB 743 purposes. The main difference from a fee program based on a metric such as vehicle LOS is that the VMT reduction nexus results in a capital improvement program (CIP) consisting largely of transit, bicycle, and pedestrian projects. These types of fee programs are time consuming to develop, monitor, and maintain but are recognized as an acceptable form of CEQA mitigation if they can demonstrate that the CIP projects will be fully funded and implemented. The City of Los Angeles is the first city in California to complete a nexus study for this type of program.
2. VMT Exchanges – This concept (along with VMT banks) borrows mitigation approaches from other environmental analysis such as wetlands. The concept relies on a developer agreement to implement a predetermined VMT-reducing project in exchange for the ability to develop a VMT-generating project. The projects may or may not be located near each other. The concept

requires a facilitating entity (such as the lead agency) to match the VMT generator (the development project) with the VMT-reducing project and ensure through substantial evidence that the VMT reduction is valid (i.e., the VMT reduction is caused by the mitigation and would not occur otherwise; this concept is known as additionality). VMT Exchanges also require a determination of the necessary time period to demonstrate a VMT reduction.

3. VMT Banks – This concept attempts to create a monetary value for VMT reduction (e.g., credits) that can be exchanged amongst individual projects. This program is more complicated than a simple exchange and would require more time and effort to set up and implement. Another key challenge of this program is determining how much VMT reduction is associated with each credit. Similar to VMT exchanges, this mitigation program must also demonstrate additionality.

Table 4 compares the pros and cons of the above programs. As seen in **Table 4**, all of the program options have challenges.

Table 4: Comparison of Programmatic VMT Reduction Strategies

Program Structure	Pros	Cons
Impact Fee Program	• Common practice • Accepted for CEQA mitigation • Adds certainty to development costs • Allows for regional scale projects	• Time consuming and expensive to develop and maintain • Requires strong nexus
Mitigation Exchange	• Limited complexity • Reduced nexus obligation	• Requires additionality • Mismatch between mitigation need and mitigation projects • Unknown timeframe for mitigation life
Mitigation Bank	• Adds certainty to development costs • Allows for regional scale projects • Allows regional or state transfers	• Requires additionality • Time consuming and expensive to develop and maintain • Requires strong nexus • Political difficulty distributing mitigation dollars/projects

Although implementation of these programs would require an upfront cost, they have several advantages over site-level TDM strategies:

- CEQA streamlining – These programs provide a funding mechanism for project mitigation and require significantly less monitoring to demonstrate that significant impacts are reduced to a less-than-significant level. Additionally, projects could be screened from completing a quantitative VMT analysis; or, if a quantitative VMT analysis is required, the cost would be somewhat less than the cost for analyzing LOS impacts.

- Greater VMT reduction potential – Since these programs coordinate citywide land use and transportation projects, they have the potential to result in greater VMT reduction potential than site-level TDM strategies applied on an ad hoc basis. Additionally, these programs expand the amount of feasible mitigation for reducing VMT impacts.
- Legal defensibility – The VMT reduction programs can help build a case for a nexus between a VMT impact and funding for capital improvement programs.

A General Plan update is a desirable time to identify and implement any preferred VMT reduction programs as it allows for coordination between land development, capital improvement projects, and funding programs. It is recommended that a citywide VMT reduction program be developed as part of the forthcoming General Plan update. These citywide VMT reduction programs have the ability to reduce VMT associated with existing VMT sources and VMT from new developments, thus promoting achievement of citywide sustainability goals on the basis of new and existing development.

5. Considerations for Updating Recommendations

The information in this report is based on the latest research available at the time of publication as well as feedback and recommendations from TAC members. A number of factors may result in the revision of the recommendations in this report to reflect the following change factors:

- Updated technical research on VMT evaluation and VMT mitigation effectiveness research
- Updated technical guidance from the State Office of Planning and Research
- Updated City General Plan goals and policies related to the circulation system and environment
- New State-wide environmental legislation
- New court cases and other laws affecting CEQA (per typical CEQA practice)

Barring major court cases or new state laws affecting CEQA VMT analysis, the thresholds and other related recommendations are anticipated to be valid until the next General Plan update (scheduled to be concluded in the mid-2020s) and may remain valid after the update. At that time, the recommendations in this report may be revisited to reflect updates to the City's General Plan goals and policies; changes may be adopted by the City Council, if deemed necessary, to implement the City's update General Plan goals and policies as part of the General Plan adoption process (including environmental clearance).

Outside of the General Plan update process, the City retains discretion to set CEQA thresholds based on substantial evidence. If evidence exists that the adopted VMT thresholds, the City Council could choose to adopt an ordinance or resolution revising the VMT thresholds. The City also has discretion to use CEQA thresholds on a one-time (i.e. non-general use) basis as long as they are supported by substantial evidence per CEQA; this approach could be helpful if a new CEQA court ruling affects VMT thresholds or VMT analysis approaches.

Appendix A:
Trip Length Adjustments for SB 743 VMT Analysis

Technical Memorandum

Date: November 5, 2019

To: Erik Ruehr, VRPA
Bruce Griesenbeck and Maricela Salazar, SACOG

From: Jimmy Fong, Jinghua Xu, and Ronald T. Milam, Fehr & Peers

Subject: Trip Length Adjustments for SB 743 VMT Analysis

Introduction

SB 743 implementation has created the need to modify travel demand models to ensure they capture the full trip length for those trips that start or end outside the model boundary. This need stems from the CEQA guidance listed below and the general desire to avoid arbitrary truncation of trip lengths based on model or political boundaries.

- According to the Technical Advisory, the assessment should cover the full area in which driving patterns are expected to change, including induced growth impacts and cumulative impacts. OPR states that the VMT estimation should not be truncated at a modeling or jurisdictional boundary for convenience of analysis when travel behavior is substantially affected beyond that boundary. (p. 6 and 23 - Technical Advisory on Evaluating Transportation Impacts in CEQA, OPR, December 2018)

- CEQA Guidelines section 15277:
    - "…. Any emissions or discharges that would have a significant effect on the environment in the State of California are subject to CEQA where a California public agency has authority over the emissions or discharges." Since VMT is the key input for mobile emissions, tracking the full length of trips is essential for complying with this expectation.

Since all travel demand models in California have boundaries, they truncate trip lengths to varying degrees. Truncation tends to be most severe at the edge of the model boundary and when the modeled area exhibits a high proportion of external travel (i.e., from a suburban area in one region to a job center in another region). To compensate for the influence of model boundaries, the following steps can be used to modify trip lengths through model gateways.

Trip Length Adjustment Process

Adjusting the length of trips leaving a model boundary requires appending extra distance at the model gateway zone (or external centroid) connector as outlined below. This process results in new gateway distances that are weighted based on the amount and location of external travel origins and destinations. Other adjustment methods that are available include appending extra trip lengths to each individual origin-destination (OD) trip pair in the model or expanding the model's zone structure to cover a larger area. Both of the methods are much more resource and time intensive and are not covered further in this memo.

1. Model IX and XI Trips at Gateways

The first step of this process is to determine trip volume leaving or entering the model boundary. These are referred to in the remainder of this memo as internal-to-external (IX) and external-to-internal (XI) trips. This data can be generated either from OD trip matrices or by conducting a select zone analysis to track trips to the model gateways. The volume at the gateways for this purpose should not include external-to-external (XX) through trips. A table that identifies all gateways, IX volume, and XI volume should be prepared similar to the example below from the Mendocino Council of Governments (MCOG) model.

Table 1: Example Model Gateway and IX, XI Link Volumes Table

Gateway ID	Gateway	Link ID	IX Volume	XI Volume
7081	SR 1 - South	7081	1,190	1,190
7083	US 101 - South	7083	5,004	5,004
7082	US 101 - North	7082	567	567
7085	SR 20 - East	7085	3,529	3,529
7086	SR 175 - East	7086	551	551

2. Origin-Destination Data between Model and External Areas

Determining the full length of trips leaving or entering a model boundary requires an OD dataset that includes flows between the model area and the area external to the model. How much of the external area to include is an important question. Per the CEQA guidance cited, the full length of trip between their start and end is desired. Whether this extends outside of California has not been legally tested so it is possible that capturing trip lengths even beyond state limits could be necessary. An appropriate OD dataset should be chosen based on the details of your project, context of the study area, level of CEQA risk, and available time and budget for analysis. An assessment of each of the OD data sources is presented the Table 2.

Table 2: Origin-Destination Data Assessment

Origin-Destination Data Sources	Description	Advantages	Disadvantages
Available travel demand model larger than local model	All regional models in California nest within the California State Travel Demand Model (CSTDM). All local models (i.e., city models) nest within the CSTDM and their respective regional models.	• CSTDM Includes TAZs for the entire state of California • Regional models are often the source model for local model variants, so they have a high compatibility for making gateway adjustments. • CSTDM and regional models include changes in travel patterns over time between base and future years.	• Larger models may have greater aggregation and only coarse correspondence between TAZs in the smaller model. • Regional models may not fully capture full trip length. • CSTDM has not been recently calibrated and validated. • CSTDM truncates trip at state boundary.
California Household Travel Survey (CHTS)	Survey of California resident travel that documents full length of OD travel.	• Robust sample with data available for most cities and counties above 50,000 population. Data may be sufficient for smaller jurisdictions based on a review of the sample • Includes all trip purposes.	• Insufficient detail below city level. • 2012 data may not reflect recent changes in travel patterns. • Does not include data about future travel.
Longitudinal Employer-Household Dynamics Data (LEHD)	Employer/Employee data showing locations of where employees live and work, visualized in an online portal with export to OD tables, produced by the U.S. Census Bureau.	• Data available at the census tract level (or custom TAZ structure). • 2017 data is current. • Quick production of OD data.	• Employment data is only relevant for calculating trip lengths for home-based work trips, does not include other trip purposes. • Does not include data about future travel.
Mobile device OD Data	Data from smartphone/GPS devices that can be used to estimate OD trip tables associated with specific gateways.	• Data available at small scales (i.e., 250-meter grid cell, census block group, or custom traffic analysis zone). • Data scale allows isolation of specific land uses in many cases. • 2019 data available from multiple vendors. • Data includes all 365 days of the year and can be aggregated. • Limited trip length truncation. • Includes all trip purposes.	• Minimum purchase cost is about $5000, more expensive if greater detail/number of zones is desired. • Does not include data about future travel.

3. Gateway Identification

After identifying an appropriate OD data source, the next step requires determining the gateway(s) based on the model used in your project, which trips from the OD data source would travel through. An assessment of options for this process is presented in Table 3.

Table 3: Gateway Identification Methods and Assessment

Data Source	Gateway Identification Method
Available travel demand model larger than local model	• A highway skimming procedure to determine the gateway used for each OD pair for each assignment time period. This method is not able to track more than one gateway for an OD pair. • A select zone and select link assignment procedure to determine the gateway(s) for an OD pair. This method requires more processing/computing time – dependent on the specific travel model and software.
Mobile Device OD Data	• Data purchase includes identification of gateway locations and automatic filtering to create associated OD trip tables.
Streamlined selection with Google Maps (or online mapping program)	• Spreadsheet template that creates a link to Google Maps for each OD pair, manual identification of gateway(s) in the routing is required. • An off-model, quick assessment tool, suitable for limited number of OD pairs. • Not able to quantify the split across multiple routes/gateways (if applicable) for an OD pair. • Time consuming; not suitable for large number of OD pairs due to manual process.

4. Weighted Average Trip Length Beyond Model Gateways

The trip length adjustment process ultimately requires calculating the weighted average distance beyond each model gateway. A list of options for this process is identified in Table 4. Some of the processes calculate the distance beyond the model gateway directly; while other processes generate distance between each OD pair first, with a separate calculation for distance beyond the model gateway.

Table 4: Trip Length Beyond Model Boundary – Methods and Assessment

Data Source	Trip Length Method Description
Available travel demand model larger than local model	• Creates a new link variable equal to the link length for all the links external to the local model and 0 for all the links internal to the local model, and then uses a highway skimming procedure to skim this link variable to generate the total distance outside of the gateway for each OD pair for each assignment time period. • Uses a select zone and select link assignment procedure to generate the volume distribution for each selected gateway, and calculates the weighted average distance based on the select link volume associated with each gateway.
CHTS	• Estimates total OD distances between origin-destination for each trip record. • Calculates the distance from the trip-end within the model boundary to the gateway for each record, based on the distance skim from the model, and subtracts it from the total CHTS OD distance to generate external trip length for each trip record. • Aggregates the external trip distance across all the trip records to generate average external trip distance for each gateway.
Mobile Device OD Data	• Distance between origins-destinations through each gateway are provided in the dataset. • Calculates the distance from the trip-end within the model boundary to the gateway based on the distance skim from the model and subtracts it from the total mobile device OD distance to generate external trip length for each gateway.
Streamlined selection with Google Maps (or online mapping program)	• Links to Google Maps and generates a path for each OD pair. • Calculates the distance between the manually identified gateway(s) and the trip end location external to the model boundary, based on the shortest travel time path between the OD pair.

Process Summary

An analyst can mix and match the procedures based on the most appropriate method for each step. For example, if CHTS is the most appropriate OD dataset to generate external trip length estimates, the user can generate the OD trip matrices based on CHTS while following the TAZ structure of the CSTDM, then identify local model gateways in the CSTDM highway network, and calculate the average trip length beyond each gateway, using the distance skims of the CSTDM, weighted by trips from the CHTS OD trip matrices.

Trip Length Adjustment User Guide and Resources

This section provides a user-guide and links to resources for the data sources and processes previously described in this memorandum.

California Statewide Travel Demand Model (CSTDM)

Caltrans maintains and updates the California Statewide Travel Demand Model, and provides resources regarding the model on their website:

- https://dot.ca.gov/programs/transportation-planning/multi-modal-system-planning/statewide-modeling

Information regarding the previous version of the CSTDM is no longer available on Caltrans' website. Caltrans is currently in the process of updating the statewide travel demand model. Requests regarding statewide modeling should be directed to Caltrans.

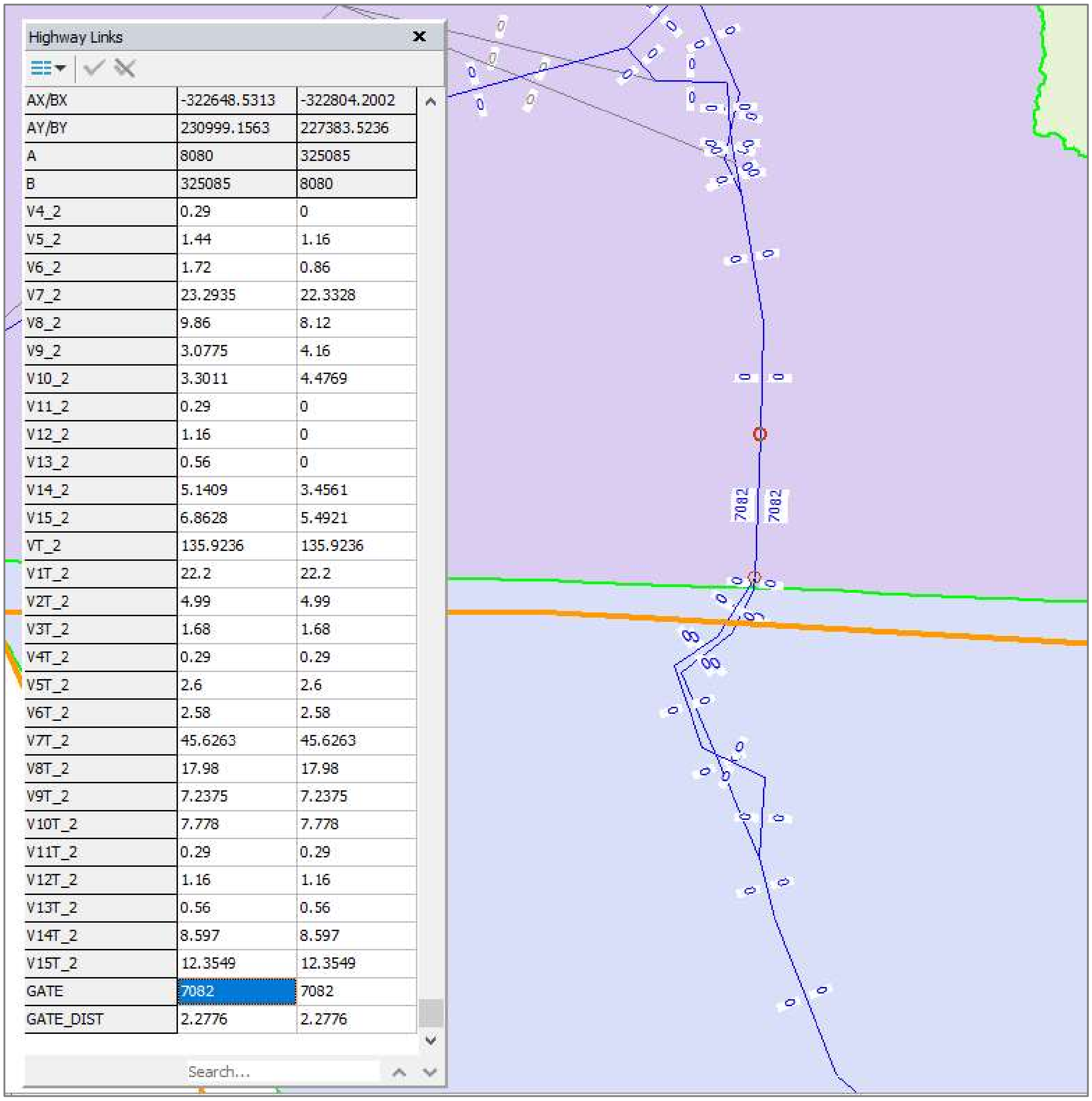
An example of the CSTDM used for OD data, gateway selection, and trip length beyond local model gateways is described below:

- Create correspondence between Study Area TAZs within local/regional model to the Statewide Model TAZs, similar to the example from the Mendocino Council of Governments (MCOG) Model, as shown in Table 5.

Table 5: Example TAZ Correspondence Table

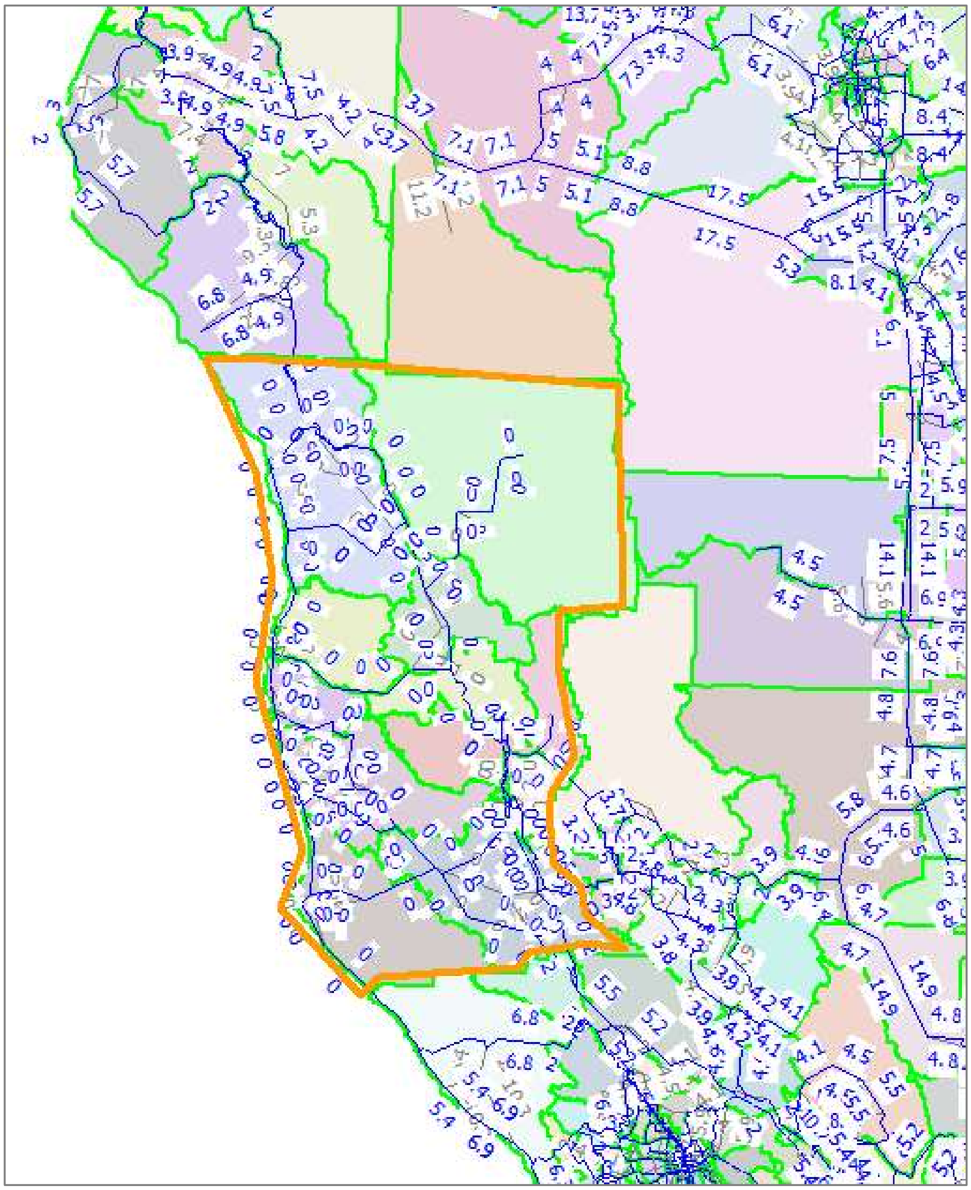
MCOG TAZ	CSTDM TAZ
1	256
3	259
5	259
6	259
7	259
8	260
9	260
10	260

- Add “Gate” attribute to CSTDM roadway network links and set “Gate” equal to gateway id only for those links identified as the locations corresponding to the local/regional model gateways.



AX/BX	-322648.5313	-322804.2002
AY/BY	230999.1563	227383.5236
A	8080	325085
B	325085	8080
V4_2	0.29	0
V5_2	1.44	1.16
V6_2	1.72	0.86
V7_2	23.2935	22.3328
V8_2	9.86	8.12
V9_2	3.0775	4.16
V10_2	3.3011	4.4769
V11_2	0.29	0
V12_2	1.16	0
V13_2	0.56	0
V14_2	5.1409	3.4561
V15_2	6.8628	5.4921
VT_2	135.9236	135.9236
V1T_2	22.2	22.2
V2T_2	4.99	4.99
V3T_2	1.68	1.68
V4T_2	0.29	0.29
V5T_2	2.6	2.6
V6T_2	2.58	2.58
V7T_2	45.6263	45.6263
V8T_2	17.98	17.98
V9T_2	7.2375	7.2375
V10T_2	7.778	7.778
V11T_2	0.29	0.29
V12T_2	1.16	1.16
V13T_2	0.56	0.56
V14T_2	8.597	8.597
V15T_2	12.3549	12.3549
GATE	7082	7082
GATE_DIST	2.2776	2.2776

- Add "Gate_Dist" attribute to CSTDM roadway network links and set "Gate_Dist" equal to the link distance for those links outside the local/regional model boundary. All the CSTDM roadway links inside the local/regional model boundary will have a "Gate_Dist" attribute of 0.



- Run a highway skim on the CSTDM roadway network to skim the shortest travel time between each OD pair, tracking the gateway and distance outside the local model boundary. A sample Cube Voyager script for this step is included in the Appendix. An example output of this process is presented in Table 6.

Table 6: Example OD with Gate Identification and Distance Beyond Local Model

CSTDM Origin TAZ	CSTDM Destination TAZ	Volume	Gateway ID	Distance Beyond Local Model Boundary (mi)
246	2	0.21	7082	189.31
246	108	0.1	7082	82.73
246	118	0.42	7082	13.65
246	119	0.29	7082	22.88
246	139	0.13	7085	167.35
246	141	0.07	7085	169.53
246	173	0.25	7082	106.45
246	201	0.07	7085	126.73

- For each gateway, summarize the average distance beyond the local model boundary weighted by volume at each gateway. An example is presented in Table 7.

Table 7: Example Weighted Average Distance Beyond Local Model Boundary

Gateway ID	Gateway	Weighted Average Distance Beyond Local Model Boundary (mi)
7081	SR 1 - South	28.4
7083	US 101 - South	63.2
7082	US 101 - North	44.7
7085	SR 20 - East	46.4
7086	SR 175 - East	15.9

- Tag the gateway distance from the above step using CSTDM to the gateways in the local/regional model and multiply to the gateway volume from the local/regional model to determine the gateway external VMT to the local/regional model. Make sure not to double-count any overlap distance that’s already accounted for in the VMT calculation from the local/regional model. An example for this calculation for IX trips from the MCOG model is shown in Table 8.

Table 8: Example Adjustment Gateway and IX, XI Link Volumes Table

Gateway	Weighted Average Distance Beyond Local Model Boundary (From CSTDM)	MCOG IX Volume	MCOG IX VMT Beyond Local Model Boundary
SR 1 - South	28.4	1,190	33,796
US 101 - South	63.2	5,004	316,253
US 101 - North	44.7	567	25,345
SR 20 - East	46.4	3,529	163,746
SR 175 - East	15.9	551	8,761

California Household Travel Survey (CHTS)

CHTS data was collected by Caltrans and is shared on the following website.

- https://www.nrel.gov/transportation/secure-transportation-data/tsdc-california-travel-survey.html

An example of CHTS data filtered for IX trips for Mendocino County is shown below. This example requires processing of the survey data and specific formatting such that it contains trip origin, destination, distance, and volume information.

oTract	oPlace	oCounty	dTract	dPlace	dCounty	distance_fine	time	avgSpeed	numVehTrips
6045010200	Unincorporatec	Mendocino	6023011500	Unincorpor	Humboldt	24	30	50	232.2
6045010200	Unincorporatec	Mendocino	6023011500	Unincorpor	Humboldt	24	30	50	0
6045010400	Fort Bragg	Mendocino	6033001000	Kelseyville	Lake	86	120	45	491.32
6045010500	Fort Bragg	Mendocino	6001450752	Dublin	Alameda	194	330	35	486.56
6045010700	Willits	Mendocino	6023001000	Arcata	Humboldt	133	170	45	0
6045010700	Willits	Mendocino	6023001000	Arcata	Humboldt	134	170	45	261.41
6045010700	Willits	Mendocino	6023011500	Unincorpor	Humboldt	60	70	50	62.31
6045010700	Willits	Mendocino	6023011500	Unincorpor	Humboldt	72	120	35	210.39
6045010700	Willits	Mendocino	6033000802	Clearlake	Lake	64	65	60	164
6045010700	Willits	Mendocino	6033001000	Kelseyville	Lake	51	70	45	221.9
6045010700	Willits	Mendocino	6075016500	San Francis	San Francisco	134	155	50	0
6045010700	Willits	Mendocino	6075016500	San Francis	San Francisco	135	155	50	49.48
6045010700	Willits	Mendocino	6081604800	Millbrae	San Mateo	149	200	45	89.91
6045010700	Willits	Mendocino	6097153403	Sebastopol	Sonoma	89	120	45	0
6045010700	Willits	Mendocino	6105000400	Mad River	Trinity	123	285	25	191.16
6045010801	Unincorporatec	Mendocino	6097152000	Santa Rosa	Sonoma	71	90	45	46.84
6045010802	Unincorporatec	Mendocino	6055201700	Angwin	Napa	83	120	40	103.69
6045010900	Unincorporatec	Mendocino	6023011100	Rio Dell	Humboldt	128	190	40	129.99
6045010900	Unincorporatec	Mendocino	6033000300	North Lake	Lake	28	60	30	274.5
6045010900	Unincorporatec	Mendocino	6033000400	Lakeport	Lake	34	40	50	916.13
6045011002	Unincorporatec	Mendocino	6001421700	Berkeley	Alameda	159	195	50	240.48

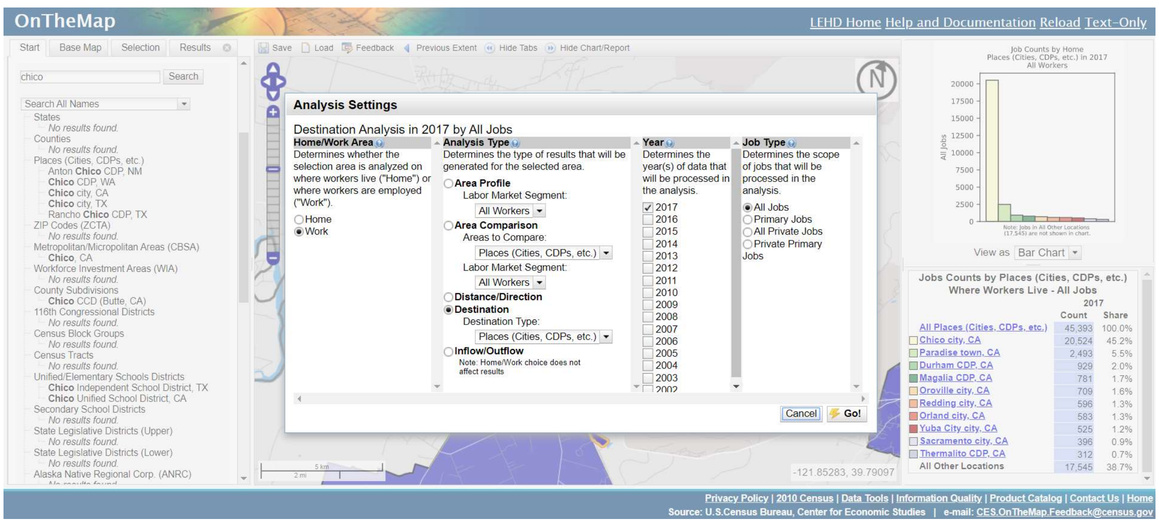
Longitudinal Employer-Household Dynamics Data (LEHD)

LEHD data can be accessed using the following online resource.

- https://onthemap.ces.census.gov/

OD data using this resource can be identified by searching a study area (City, County, or can upload a shapefile with specific geography) and looking at the "Destination" Analysis Type.

- For IX trips, use the "Home" setting for Home/Work Area
- For XI trips, use the "Work" setting for Home/Work Area



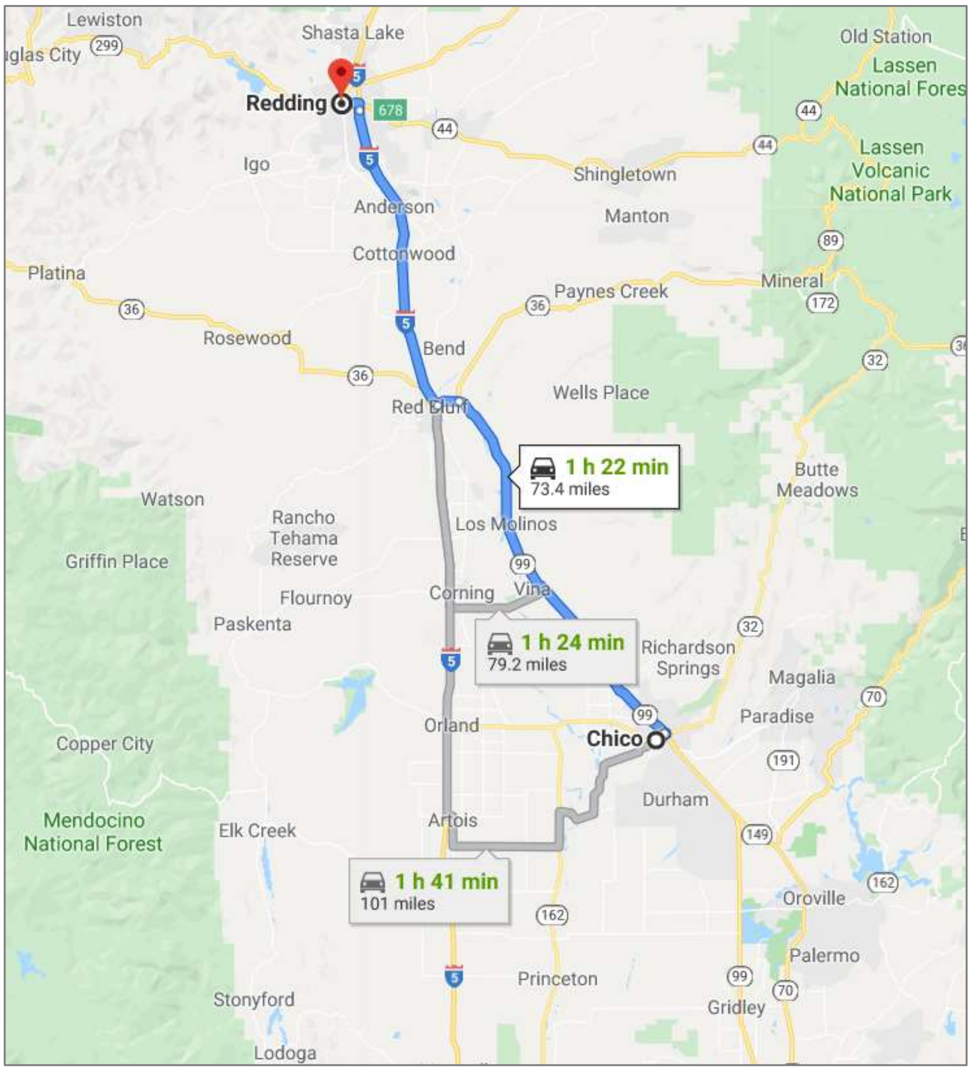
Mobile Device OD Data

Streetlight is one vendor that can provide data for OD, gateway identification, and trip lengths. A middle filter analysis is needed to determine which particular gateway a trip passes through. An example showing IX trips from Chico to areas beyond the Butte Council of Governments (BCAG) Model boundary is presented below.

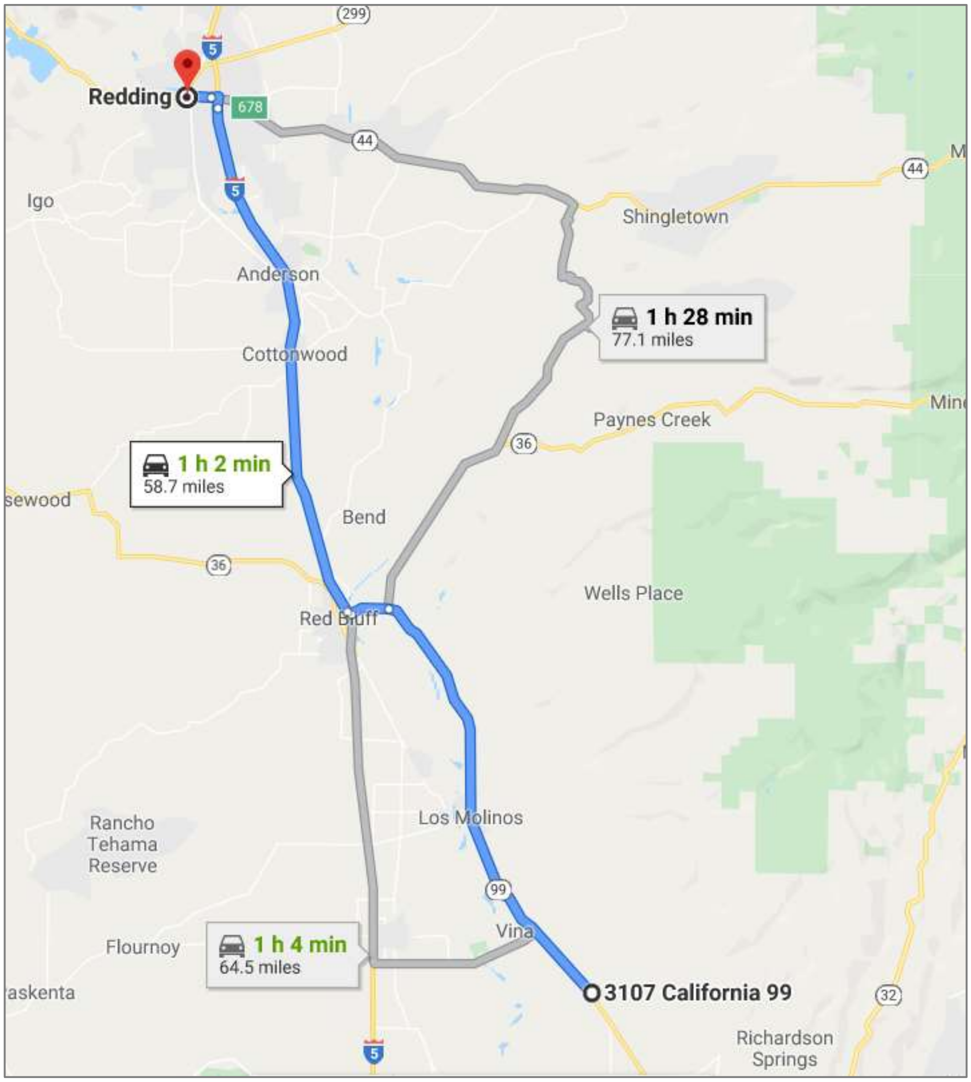
Type of Travel	Origin Zone ID	Origin Zone Name	Middle Filter Zone ID	Middle Filter Zone Name	Destination Zone ID	Destination Zone Name	Day Type	Day Part	Total O-M-D Traffic (Sample Trip Counts)
Personal	6	Biggs	1	CA 99 North of	16	Tehama County	1: Weekday (M-Th)	0: All Day (12am-12am)	3
Personal	6	Biggs	1	CA 99 North of	23	Shasta County	1: Weekday (M-Th)	0: All Day (12am-12am)	2
Personal	6	Biggs	9	Honcut Rd	30	Yuba County	1: Weekday (M-Th)	0: All Day (12am-12am)	3
Personal	6	Biggs	11	CA 70 South of	20	Nevada County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	6	Biggs	11	CA 70 South of	26	Placer County	1: Weekday (M-Th)	0: All Day (12am-12am)	2
Personal	6	Biggs	11	CA 70 South of	30	Yuba County	1: Weekday (M-Th)	0: All Day (12am-12am)	4
Personal	6	Biggs	12	Larkin Rd	28	Sutter County	1: Weekday (M-Th)	0: All Day (12am-12am)	2
Personal	6	Biggs	12	Larkin Rd	30	Yuba County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	6	Biggs	13	CA 99 South of	19	Glenn County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	6	Biggs	13	CA 99 South of	26	Placer County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	6	Biggs	13	CA 99 South of	27	Sacramento Coun	1: Weekday (M-Th)	0: All Day (12am-12am)	49
Personal	6	Biggs	13	CA 99 South of	28	Sutter County	1: Weekday (M-Th)	0: All Day (12am-12am)	174
Personal	6	Biggs	13	CA 99 South of	29	Yolo County	1: Weekday (M-Th)	0: All Day (12am-12am)	7
Personal	6	Biggs	13	CA 99 South of	30	Yuba County	1: Weekday (M-Th)	0: All Day (12am-12am)	17
Personal	6	Biggs	14	Almond Orcharc	28	Sutter County	1: Weekday (M-Th)	0: All Day (12am-12am)	3
Personal	6	Biggs	15	Gridley Road	18	Colusa County	1: Weekday (M-Th)	0: All Day (12am-12am)	3
Personal	6	Biggs	17	Biggs-Willows R	18	Colusa County	1: Weekday (M-Th)	0: All Day (12am-12am)	3
Personal	6	Biggs	17	Biggs-Willows R	19	Glenn County	1: Weekday (M-Th)	0: All Day (12am-12am)	8
Personal	6	Biggs	19	Ord Ferry Road	19	Glenn County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	6	Biggs	20	CA 32 Hamilton	19	Glenn County	1: Weekday (M-Th)	0: All Day (12am-12am)	2
Personal	7	Chico	1	CA 99 North of	16	Tehama County	1: Weekday (M-Th)	0: All Day (12am-12am)	2482
Personal	7	Chico	1	CA 99 North of	19	Glenn County	1: Weekday (M-Th)	0: All Day (12am-12am)	6
Personal	7	Chico	1	CA 99 North of	23	Shasta County	1: Weekday (M-Th)	0: All Day (12am-12am)	643
Personal	7	Chico	1	CA 99 North of	27	Sacramento Coun	1: Weekday (M-Th)	0: All Day (12am-12am)	2
Personal	7	Chico	1	CA 99 North of	30	Yuba County	1: Weekday (M-Th)	0: All Day (12am-12am)	1
Personal	7	Chico	3	CA 32 North of	14	Plumas County	1: Weekday (M-Th)	0: All Day (12am-12am)	19
Personal	7	Chico	3	CA 32 North of	16	Tehama County	1: Weekday (M-Th)	0: All Day (12am-12am)	4

Google Maps (for Gateway Identification and Trip Length Beyond Local Model Gateways)

Google Maps (or similar online mapping tool) can be used as a quick tool for gateway identification and for determining trip lengths beyond a local model boundary. An example of trips from Chico leaving the BCAG model boundary to Redding is shown below. Trips for this OD pair pass through the gateway on SR 99 (based on the shortest travel time).



After a gateway is identified, the distance from the gate location to the trip end outside of the local model boundary can also be searched, as shown below.



Appendix (Cube Voyager Sample Script)

```
;TAZs from local model within the CSTDM
Project1='246-261'
;====================================================
; PM peak period highway skim
RUN PGM=highway
NETI=..\LoadedNetworks\HwyNetwork_Loaded_PM_?.net                    ; input network
MATO=Skim_PM_?.mat, MO=1-4, NAME=TIME,GATE,GATE_DIST,FULL_DIST  ; output skim matrix
   PHASE=ILOOP
      PATH=LI.TIME_2,MW[1]=PATHTRACE(LI.TIME_2), MW[2]=PATHTRACE(LI.GATE), MW[3]=PATHTRACE(LI.GATE_DIST),
MW[4]=PATHTRACE(LI.DISTANCE)
endphase
ENDRUN
;====================================================
; Summarize OD Volumes and Skim Matrices
RUN PGM=MATRIX
   MATI[1]=..\TripTables\OD_?.mat
            MATI[2]=Skim_PM_?.mat
   MATO=OD_Gate_VMT_?.mat, MO=1-6, name=VOL_DAY,GATE,GATE_DIST,GATE_VMT_DAY,FULL_DIST,FULL_VMT
MW[1]=mi.1.1 + mi.1.2 + mi.1.3 + mi.1.4 + mi.1.5 + mi.1.6 + mi.1.7 + mi.1.8 + mi.1.9 + mi.1.10 + mi.1.11 + mi.1.12 +
mi.1.13 + mi.1.14 + mi.1.15      + mi.1.16 + mi.1.17 + mi.1.18 + mi.1.19 + mi.1.20 + mi.1.21 + mi.1.22 + mi.1.23 + mi.1.24 +
mi.1.25 + mi.1.26 + mi.1.27 + mi.1.28 + mi.1.29 + mi.1.30 + mi.1.31 + mi.1.32 + mi.1.33 + mi.1.34 + mi.1.35 + mi.1.36 +
mi.1.37 + mi.1.38 + mi.1.39 + mi.1.14 + mi.1.41 + mi.1.42 + mi.1.43 + mi.1.44 + mi.1.45 + mi.1.46 + mi.1.47 + mi.1.48 +
mi.1.49 + mi.1.50 + mi.1.51 + mi.1.52 + mi.1.53 + mi.1.54 + mi.1.55 + mi.1.56 + mi.1.57 + mi.1.58 + mi.1.59 + mi.1.60
            MW[2]=mi.2.2
            MW[3]=mi.2.3
            MW[4]=MW[1]*MW[3]
            MW[5]=mi.2.4
            MW[6]=MW[1]*MW[5]
ENDRUN
;=========================
; Export to CSV
run pgm=matrix
filei mati[1] = OD_Gate_VMT_?.mat
fileo mato[1]= OD_Gate_VMT_?_IX.csv, MO=1-6, FORMAT=csv, PATTERN=IJM:V, DEC=d, DELIMITER=','
fileo mato[2]= OD_Gate_VMT_?_XI.csv, MO=7-12, FORMAT=csv, PATTERN=IJM:V, DEC=d, DELIMITER=','
            IF (I=@Project1@)
                        MW[1]=MI.1.1  EXCLUDE=@Project1@
                        MW[2]=MI.1.2  EXCLUDE=@Project1@
                        MW[3]=MI.1.3  EXCLUDE=@Project1@
                        MW[4]=MI.1.4  EXCLUDE=@Project1@
                        MW[5]=MI.1.5  EXCLUDE=@Project1@
                        MW[6]=MI.1.6  EXCLUDE=@Project1@
            ELSE
                        MW[1]=0
                        MW[2]=0
                        MW[3]=0
                        MW[4]=0
                        MW[5]=0
                        MW[6]=0
            ENDIF

            JLOOP
            IF (I=@Project1@ & J=@Project1@)
                        MW[7]=0
                        MW[8]=0
```

```
                MW[9]=0
                MW[10]=0
                MW[11]=0
                MW[12]=0
        ELSEIF (J=@Project1@)
                MW[7]=MI.1.1
                MW[8]=MI.1.2
                MW[9]=MI.1.3
                MW[10]=MI.1.4
                MW[11]=MI.1.5
                MW[12]=MI.1.6
        ELSE
                MW[7]=0
                MW[8]=0
                MW[9]=0
                MW[10]=0
                MW[11]=0
                MW[12]=0
        ENDIF
        ENDJLOOP
ENDRUN
```

Appendix B:

CEQA VMT Transportation Impact Analysis Guidelines

Draft Memorandum

Date: March 10, 2021

To: Olivia Ervin, City of Petaluma

From: Ian Barnes and Matt Goyne, Fehr & Peers

Subject: CEQA VMT Transportation Impact Analysis Guidelines

SF19-1023

This memorandum summarizes the City of Petaluma's VMT Transportation Impact Analysis (TIA) guidance to project applicants and transportation consultants regarding the need, form, and methods of evaluating a project's impacts to VMT for the purposes of CEQA Transportation section impact analysis. The guidance in this memorandum was developed as part of the City of Petaluma's formal SB 743 VMT implementation process and reflects the recommendations of the Technical Advisory Committee and the decisions of the City Council as part of the formal implementation process.

It is noted that City staff retain discretion to deviate from the guidance in the memorandum, or when substantial evidence exists to deviate from the guidance. These VMT TIA Guidelines may be periodically updated at the staff level to reflect best practices based on industry standards. Also, the guidance in this memorandum is provided for VMT analysis only, the City may (at its discretion) require an informational analysis of congestion using Level of Service (LOS) or other metrics as part of a non-CEQA analysis. The change to VMT analysis as part of the CEQA Transportation analysis process does not replace the need to study previously-required topics such as construction phase impacts, impacts to the bicycle, pedestrian and transit modes, emergency vehicle access and circulation, and the implementation of hazardous design features and/or incompatible uses of the roadway system.

It is noted that these VMT TIA Guidelines are related to the evaluation of VMT for CEQA Transportation analysis purposes only. Other recent Senate Bill 743-related policies released by Caltrans in July 2020 will require that safety impacts are analyzed in the future. Safety analysis guidelines will be prepared by the City as a future effort after the adoption of the VMT TIA Guidelines.

1. When is a TIA Required?

An applicant seeking project approval will submit the proposed project to the City of Petaluma Planning Division with an application for project review and approval. The project planner will transmit the application to Public Works for preliminary review, as part of the project review process. After a preliminary review of the project by Public Works, the applicant will be notified by the project planner in writing within 30 days of the application submittal date as to whether a TIA is required. The decision-making process will be based, in part or in whole, on the flow chart presented in **Attachment A**.

A TIA and VMT assessment shall be required for a proposed project that does not satisfy any of the identified project screening criteria (specifics discussed further in **Section 2.1**):

- Small projects
- Local serving retail less than 30,000 square feet
- Projects in a Low-VMT area
- Projects in proximity to a major transit stop
- Affordable housing in a jobs-rich area
- Transportation projects that will not result in an increase in vehicle capacity or VMT

Projects with drive-throughs are not eligible for screening and must complete a VMT analysis.

In cases where insufficient information is available to make a preliminary assessment of a proposal's effect on VMT, additional information may be requested or Public Works staff shall determine, at their discretion, whether a TIA will be required. The Planning Division may recommend that a VMT analysis be performed in cases where there is heightened CEQA risk for a project. Similarly, in cases where City staff have determined that it is in the public interest to complete a VMT analysis, a TIA may be required at City staff discretion even if the project meets one of the screening criteria.

A TIA must be prepared under the direction of a registered California traffic engineer or a registered California civil engineer with documented experience in traffic engineering and transportation planning. The TIA shall be submitted to Public Works and the Planning Division in a draft form. Comments relative to the analysis shall be provided by City staff (in writing) to the project proponent and its engineer so that any necessary revisions can be made prior to final submittal. The TIA is not deemed complete or final until it incorporates all necessary revisions and is prepared to the City's satisfaction.

2. Analysis Methodology

For purposes of SB 743 compliance and satisfying CEQA Guidelines §15064.3, a VMT analysis should be conducted for land use projects as deemed necessary by the City Traffic Engineer and would apply to projects that have the potential to result in VMT in excess of a percentage of the baseline VMT per capita (i.e., per resident or per employee) for the land use.

2.1. Project Screening Categories

There are six types of screening that may be applied to projects to allow for the bypassing of project-level VMT assessment. These screening criteria are summarized below:

- *Small Projects:* Projects that generate or attract fewer than 110 trips per day, which is equivalent to a 15-unit residential project or a non-residential project of 10,000 square feet or less.
- *Local Serving Retail:* Local-serving retail projects of less than 30,000 square feet may be screened on the basis that they may attract trips that would otherwise travel longer distances.
- *Projects in Low-VMT Area:* Residential and office/employment-focused projects that are in low-VMT areas (based on adopted VMT thresholds of significance) that are similar in similar to nearby developments in terms of density, mix of uses, and transit accessibility. Maps of low-VMT areas in the City are presented in **Attachment A**. It is noted that the TIA preparer should verify that the data in the maps is still appropriate for use.
- *Projects in Proximity to a Major Transit Stop:* Projects within one-half mile (walking distance) of an existing or planned high-quality transit corridor or major transit station. These areas are generally delineated in the VMT maps in **Attachment A**; the TIA preparer must verify that the project site is within the one-half mile walks of the major transit stop. To qualify for this exemption, the following additional project design criteria must be met:
    - Floor Area Ratio (FAR) of 0.75 or more
    - Does not include more parking than required by the City of Petaluma
    - Is consistent with Plan Bay Area
    - Does not replace affordable residential units with a smaller number of moderate- or high-income residential units (although a small market-rate project could qualify for small project screening)
- *Affordable Housing in Jobs-Rich Areas:* Projects with large affordable housing components that are located in infill locations and areas with a high jobs-housing imbalance.
- *Transportation Projects:* Transit, bicycle, and pedestrian projects, and roadway maintenance projects that do not result in an increase in vehicle capacity or VMT.

As noted previously, projects with drive-throughs are not eligible for screening and must complete a VMT analysis unless otherwise exempted by City staff. City staff retain discretion to deny the use of a screening criteria if substantial evidence (as defined for CEQA purposes) exists that screening is not appropriate. Also, screening does not necessarily remove the requirement to analyze VMT for the purposes of the CEQA Air Quality, Greenhouse Gas and Energy analysis sections. City staff may require that a technical memorandum be prepared to support the rationale that a project meets screening criteria.

2.2. VMT Assessment for Non-Screened Development

Projects not screened through the steps above should complete VMT analysis and forecasting through the latest version of the Sonoma County Transportation Authority (SCTA) travel demand model to determine if the project results in a significant VMT impact. The version of the model being used should be approved by City staff and the release date of the model should be clearly documented in the TIA. This analysis should include "project generated VMT" and "project effect on VMT" estimates (where applicable) for the project TAZ (or TAZs) under the following scenarios:

- Baseline conditions – For residential and retail/commercial service information, baseline VMT information is available from the SCTA model. For office and employment-focused uses, baseline VMT information is available from the MTC model or published data sources from MTC; note that while baseline information of office and employment-focused projects is based on data from MTC, the SCTA model will be used in the evaluation of project impacts (see discussion is **Section 2.3**). Baseline conditions are defined as at the time of the release of the Notice of Preparation (NOP) when an Environmental Impact Report is being prepared or upon a determination that the project application is complete if an Initial study is being prepared. If baseline conditions at the time of NOP are not suitable based on substantial evidence, a historical baseline may be used. It is noted that the off-the-shelf SCTA base year (2015) travel demand model does not include the effects of SMART (which began revenue service in 2017); engineers completing traffic analyses are advised to justify and document selection of the baseline year and to secure acceptance by the City.

- Baseline plus project conditions - The project land use would be added to the project TAZ or a separate TAZ would be created to contain the project land uses. A full base year SCTA model run would be performed and VMT changes would be isolated for the project TAZ and across the full model network. The model output must include reasonableness checks of the production and attraction balancing to ensure the project effect is accurately captured. If this scenario results in a significant impact, then a Cumulative scenario analysis may be required at City staff discretion. Cumulative scenario analysis may reveal that the baseline plus project significant impact is temporary in nature if buildout of the General Plan land use pattern and multimodal transportation system results in a more efficient land use patterns and multimodal transportation connections (as measured by VMT per capita metrics).

- Cumulative conditions (if required) - This data is available from the SCTA model. Cumulative conditions are defined as Year 2040 conditions and include land use and transportation network buildout of the adopted City General Plan. Engineers completing traffic analyses are advised to check the model land use and transportation network inputs to verify that they represent appropriate Year 2040 assumptions.

- Cumulative plus project conditions (if required) – The project land use would be added to the project TAZ or a separate TAZ would be created to contain the project land uses. A full Year 2040 SCTA model run would be performed and VMT changes would be isolated for the project TAZ and across the full model network. The model output must include reasonableness checks of the production and attraction balancing to ensure the project effect is accurately captured.

The model output should include VMT per the relevant metric for the land use being studied. The VMT metrics by land use project type include:

- **Residential projects:** total home-based VMT per resident
- **Office and other employment-focused projects:** total home-based work VMT per employee
- **Retail and other commercial service projects:** total project effect on VMT within a geographic area
- **Redevelopment projects:** total project effect on VMT within a geographic area[1]

Project-generated VMT shall be extracted from the travel demand forecasting model using the origin-destination trip matrix and shall multiply that matrix by the final origin-destination assignment "skim" matrices in the model. The project-effect on VMT in a geographic area shall be estimated considering all VMT within the geographic boundary; the geographic boundary shall be defined based on the project's area of influence. In many cases, project-generated VMT and

[1] For redevelopment projects, City staff retain discretion to require a VMT analysis use the residential, office/employment, and/or retail thresholds if substantial evidence indicates that the redevelopment metric is not appropriate for a given project.

project-effect on VMT will be equal; engineers are advised to justify and document this assumption, if made.

2.3. Split-Model Approach for Office and Employment-Focused Uses

As noted in **Section 2.2** and as included in the thresholds for office and employment-focused uses provide in **Section 3**, analysis for these uses rely on a metric of total home-based work VMT per employee measured at the nine-county Bay Area level. This is due to the desire to maintain consistency with the OPR *Technical Advisory*. Data from the MTC model (or other published data from MTC) is suggested for the setting of baseline VMT values for this metric as it provides better information about home-based work VMT per employee for the entire Bay Area.

While the baseline information is based on the MTC model, the SCTA model should be used in the evaluation of VMT impacts. The SCTA model has been updated to include trip lengths on model gateway boundaries (at the border of Sonoma County with neighboring counties) based on location-based service "Big Data", thus the SCTA model is able to account for the length of project trips beyond the county boundary. Based on discussions with SCTA staff, this split-model approach is valid because the SCTA model does effectively model the length of trips between Sonoma County and other destinations in the Bay Area through the use of Big Data. As such, the SCTA model also provides data on the length of trips between Petaluma and Mendocino County, something that the MTC does not provide well.

Ultimately this split model approach provides for a more conservative calculation because the roadway network detail in the SCTA model is more robust than the MTC model. Thus, the calculation using the SCTA model generally leads to slightly higher estimates of home-based work VMT per worker than the MTC model. Using a higher estimate of the project's effect on VMT from the SCTA model versus the comparatively lower baseline value form the MTC model (or published information) yields a more conservative assessment of the projects CEQA impacts related to VMT.

2.4. Relationship between VMT and LOS Analyses

As noted previously, an analysis of congestion using Level of Service (LOS) or similar metrics may continue to be required by the City Traffic Engineer as part of an informational assessment of the project's effects on the operations of the City's circulation system. Guidelines for the conduction of informational, LOS-based congestion analysis are provided in a separate document. If the City requires improvement measures that add roadway capacity, the induced VMT effects of these improvements must be captured in the CEQA VMT analysis. The State Office of Planning and Research's *Technical Advisory on Evaluating Transportation Impacts in CEQA* contains a list of transportation system improvements that are presumed to not result in induced VMT; many typical LOS-related improvement strategies (installing traffic signals, installing turn pockets, etc.) are listed as presumed to not result in induced VMT.

2.5. CEQA Safety Analysis

In July 2020, Caltrans released interim guidance to its districts on how to review potential safety impacts for projects that affect the state highway system (https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-07-01-interim-ldigr-safety-guidance-a11y.pdf). Guidelines for safety analysis will be released in the future after the VMT TIA Guidelines have been adopted, although it is noted that Caltrans may begin to provide safety analysis-related comments on Notices of Preparation or draft environmental documents at their discretion.

3. CEQA VMT Impact Thresholds

The following CEQA VMT impact thresholds have been adopted by the City Council through Resolution XXXXX. Projects resulting in a significant VMT impact are required to implement mitigation measures to alleviate the significant impact.

A project would result in a significant impact and require mitigation if:

- **For residential projects:** Project total home-based VMT per resident exceeds __% of the City-wide average. The City-wide average baseline value applies until such time that the City of Petaluma exceeds the housing allocation for the City as identified in the Sustainable Communities Strategy (SCS) for the Bay Area region; if the City exceeds the SCS housing allocation, the nine-county Bay Area regional average applies.
- **For office and other employment-focused projects:** Project total home-based work VMT per employee exceeds __% of the nine-county Bay Area regional average
- **For retail and other commercial service projects:** Project results in a net increase in VMT over the geographic area that the project influences.
- **For mixed-use and other projects:** Project components should be analyzed using the relevant thresholds for residential, office/employment-focus, or retail/commercial service projects. The benefit of a mix of uses on-site can and should be included in the analysis.

- **For transportation projects:** Project results in induced travel and an increase in City-wide VMT[2]
- **For redevelopment projects:** Project results in increased VMT versus current land uses. City staff retain discretion to identify the baseline VMT for use in the calculation (i.e. based on current uses or permitted uses).

4. VMT Mitigation Measures

To mitigate VMT impacts, the following choices are available to the applicant:

1. Modify the project's built environment characteristics (density, design diversity of uses, distance to transit, etc.) to reduce VMT generated by the project.
2. Implement Transportation Demand Management (TDM) measures to reduce VMT generated by the project.
3. Participate in a VMT fee program and/or VMT mitigation exchange/banking program (if available) to reduce VMT from the project or other land uses to achieve acceptable levels.

Measures appropriate for most of the City of Petaluma are summarized in Chapter 4 of the City's *Senate Bill 743 Vehicle-Miles Traveled Implementation* Report. Other TDM measures may be included as part of mitigation if substantial evidence exists that they are relevant to the project being analyzed.

VMT reductions should be evaluated using state-of-the-practice methodologies recognizing that many of the TDM strategies are dependent on building tenant performance over time. As such, actual VMT reduction cannot be reliably predicted, and monitoring may be necessary to gauge performance related to mitigation expectations.

When a project is found to have a significant impact under CEQA, the City of Petaluma requires developers and the business community to assist in reducing total vehicular trips and VMT by implementing TDM plans. The potential of a proposed project to reduce traffic through the use of a TDM plan should be addressed in the TIA.

If a TDM plan is proposed as a mitigation measure for a project, and the TIA attributes a reduction in VMT to the TDM plan, the following information must be provided:

1. A detailed description of the major components of the TDM plan and how it would be implemented and maintained on a continuing basis.

[2] Analysis for non-screened transportation projects require the use of SCTA travel demand model runs for the No Project and Plus Project scenario and may include an assessment of induced VMT using the UC Davis Induced Travel Calculator or published literature on the topic (e.g. elasticities from *The Fundamental Law of Road Congestion: Evidence from US Cities.* (Duranton and Turner, 2012).

2. Case studies or empirical data that supports the anticipated reduction of traffic attributed to the TDM plan.
3. Enforcement Measures – how it will be monitored and enforced.

5. TIA Procedures

This section outlines the typical procedure for conducting a Transportation Impact Analysis (TIA) in Petaluma. The purpose of this procedure is to outline the process for securing necessary City staff concurrence and feedback on key study parameters, assumptions, results and conclusions throughout the TIA development process. This typical procedure can be modified at City staff discretion, but is a useful framework for communication between preparers of TIAs and City staff.

Step 1. Identify Scope of VMT Analysis: Using the flowchart presented in **Attachment A**, review the project description and characteristics such as types of uses, size, location, etc. to determine the level of VMT analysis required. Other required analysis beyond VMT analysis may include, but are not limited to, safety analysis, construction impact analysis, analysis of hazardous design features and incompatible uses, emergency vehicle access and circulation, analysis of the multimodal system (transit, bicycle and pedestrian modes), and informational LOS analysis.

Step 2. Develop Scope of Work and Submit for Approval: Develop scope of work for the TIA, including whether documentation will include a formal report or technical memorandum. Submit scope of work and supporting information and assumptions behind development of the scope to the City Traffic Engineer for review and approval. Additional review by other functional groups in the Public Works Department and Planning Division may be required for approval. Revise scope as necessary based on City staff comments.

Step 3. Prepare Draft TIA and Submit for Review: Conduct TIA and document in a formal report or memorandum (documentation assumption to be confirmed as part of scope review in Step 2). Documentation should include, at a minimum, relevant information about the project description, discussion of analysis assumptions, methods and procedures, summary of calculations and results, and CEQA findings and mitigation measures (if necessary). It is recommended that the CEQA analysis and informational LOS analyses be provided in separate sections in the documentation. Submit documentation to City staff for review and comment. City staff will review the calculations, results and findings of the TIA and provide questions and comments for the TIA preparer to respond to.

Step 4. Respond to Comments and Submit for Approval: Revise TIA documentation based on City comments and respond to questions as appropriate. Submit a redline version of the documentation with edits and responses to comments (as appropriate). City staff will review the updated documentation and approve the documentation or provide additional questions or comments. *It is noted that the City strives to approve TIA reports or memoranda after one round of comments, but the City retains discretion to request additional information or provide additional comments/questions based on the responses/modifications provided in the updated TIA documentation.*

Attachment A
Citywide TDM Requirements

City of Petaluma

Draft Citywide TDM Requirements

February 2021

prepared by

FEHR & PEERS

Step 1: Transportation CEQA Process

START HERE

Drive-Through Does the project include a drive-through?

- YES → STOP: Project requires VMT analysis and TDM plan
- NO ↓

Small Projects Does the project generate less than 110 trips per weekday based on data from the latest version of the *ITE Trip Generation Manual*?

- YES → STOP: Project may be screened out based on City screening criteria and no TDM plan is required. Process is complete.
- NO ↓

Local Retail Is the project local-serving retail (or a local serving commercial use), and less than 30,000 square feet in gross floor area?

- YES → STOP: Project may be screened out based on City screening criteria and no TDM plan is required. Process is complete.
- NO ↓

Project requires a TDM plan - proceed to Step 3 after completing the steps below.

Near Transit Is the project within ½ mile of a major transit stop, and does the project meet the following design criteria:

- Floor Area Ratio (FAR) of 0.75 or more?
- Does not include more parking than required by the City?
- Is consistent with *Plan Bay Area*?
- Does not replace affordable residential units with a smaller number of moderate- or high-income residential units?

- YES → STOP: Project may be screened out based on City screening criteria but requires a TDM plan
- NO ↓

Affordable Housing Is the project a residental project that is located in an infill development area and includes 100% affordable housing?

- YES → STOP: Project may be screened out based on City screening criteria but requires a TDM plan
- NO ↓

Low VMT-Generating Based on the map presented in Step 2 relevant to the project type (residential, local serving retail/commercial without drive-through, or office/ employment focused uses), is the project located in a low VMT-generating area (green zones)?

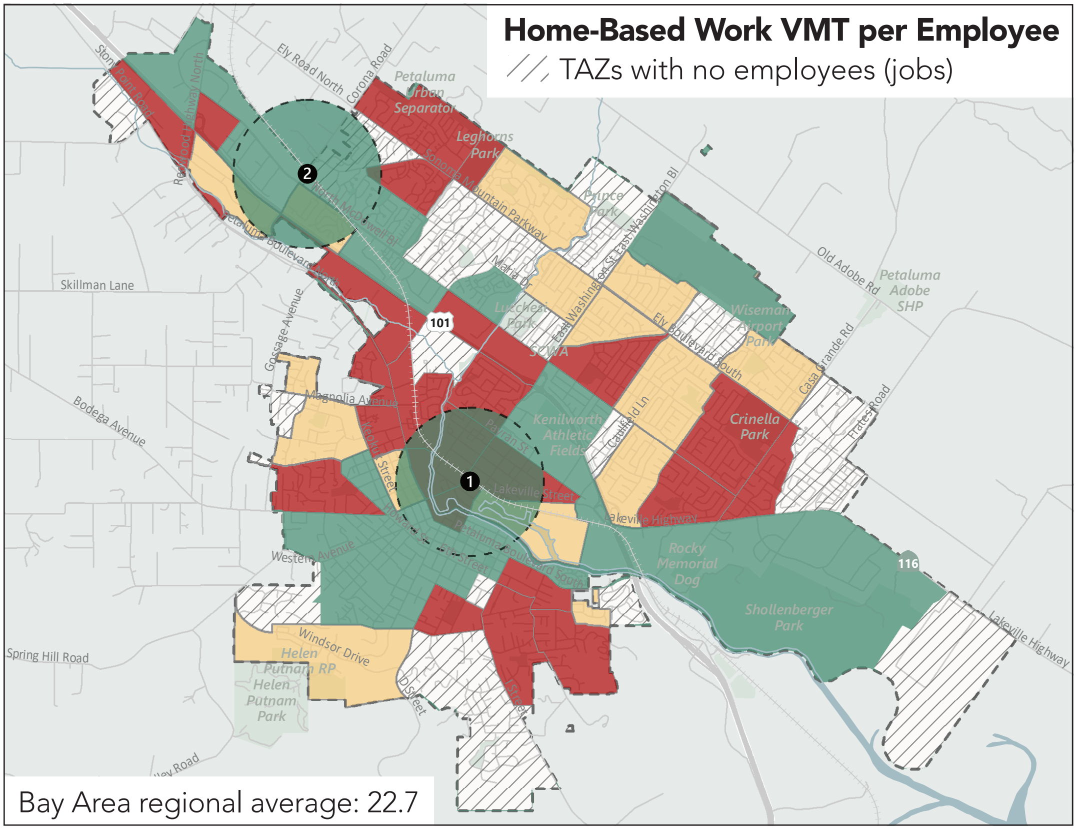
- YES → STOP: Project may be screened out based on City screening criteria but requires a TDM plan
- NO ↓

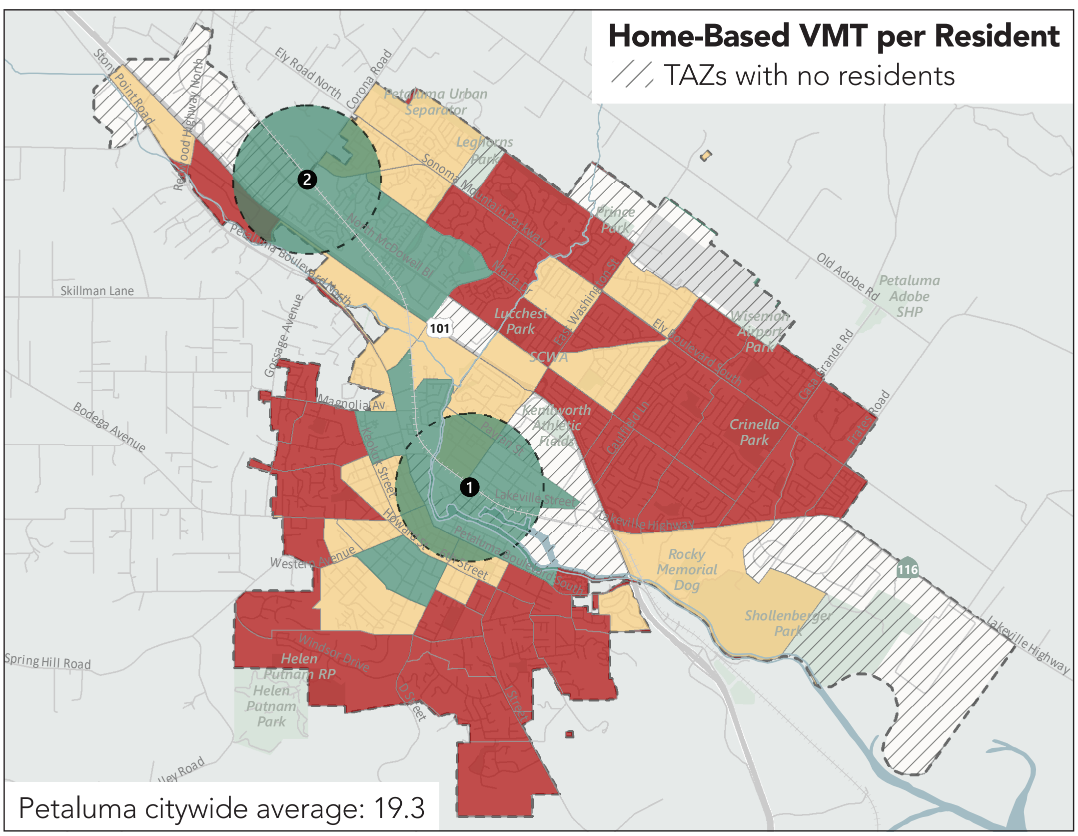
Potential Mitigatable Area Based on the following map relevant to the project type (residential, local serving retail/commercial without drive-through, or office/ employment focused uses), is the project located in a potential mitigatable area (yellow zones)?

- NO → STOP: Project requires a VMT analysis and TDM plan. VMT impacts may not be mitigatable, subject to the provision of substantial evidence. An Environmental Impact Report may be needed.
- YES → STOP: Project requires a VMT analysis and TDM plan. VMT impacts may be mitigatable, subject to the provision of substantial evidence. A Mitigated Negative Declaration is possible.

* See City of Petaluma's *CEQA VMT Transportation Impact Analysis Guidelines* for more information on these steps

Step 2: VMT Maps





Legend

Data from Sonoma County Travel Demand Model

- 15% or more below citywide average
- Between 15% and 0% below average
- Above average
- ❶ Petaluma Downtown SMART station
- ❷ Petaluma North SMART station (future)
- ½-mile station buffer
- City limits

* These values were calculated using the 2015 base year of the August 2020 version of the Sonoma County Transportation Authority (SCTA) travel demand model. This model incorporates 'Big Data' to refine trip length estimates for inter-county trips. The 2015 horizon year was chosen as a baseline due to the effects of 2017 and 2019 Sonoma County wildfires and the 2020 COVID-19 pandemic. **These values should be updated with new baseline SCTA model information as it becomes available.**

Step 3: Draft Menu of TDM Measures

Key

Effectiveness of Measure
Measures are sorted by effectiveness (***HIGH ●●●***, ***MEDIUM ●●***, or ***LOW ●***) ***(SUPPORTIVE)*** denotes measures that meet planning best practices, but whose effectiveness is unknown for a setting like Petaluma. Additional study is required to establish their effectiveness in Petaluma.

HIGH ●●● — Increase diversity of land uses

Measure Applicability Based on Location
All measures may be applicable throughout the City, but marked as most appropriate for areas in green, yellow, or red in the maps from Step 2.

Project/Site Level Strategies

These strategies can influence travel behavior for residents, employees, and visitors to a project.

- HIGH ●●● — Increase diversity of land uses
- HIGH ●●● — Increase density
- HIGH ●●● — Increase transit accessibility
- MEDIUM ●● — Encourage tele-commuting
- LOW ● — Implement car-sharing program
- LOW ● — Subsidize transit passes
- (SUPPORTIVE) — Reduce parking supply and un-bundle parking
- (SUPPORTIVE) — On-site TDM Coordinator
- (SUPPORTIVE) — Support micro-mobility and bike sharing
- (SUPPORTIVE) — Provide real-time transit information
- (SUPPORTIVE) — Way-finding Signage
- (SUPPORTIVE) — Improve existing pathways to meet design standards
- (SUPPORTIVE) — Collaborate with app-based ridehail services for first/last mile connections
- (SUPPORTIVE) — Implement employee parking "cash-out"
- (SUPPORTIVE) — Provide short- and long-term bike parking and supporting services
- (SUPPORTIVE) — Implement a commute trip reduction program (commercial uses only)
- (SUPPORTIVE) — Add affordable housing
- (SUPPORTIVE) — Provide on-site childcare
- (SUPPORTIVE) — Provide delivery services

Community Level Strategies

Individual development projects have limited ability to implement these strategies, but may be able to contribute to established strategies through site design or off-site measures via citywide fee programs. These strategies generally have a low effectiveness, which increases when applied to a large population/neighborhood.

- MEDIUM ●● — Market price public parking (on-street)
- LOW ● — Increase transit service frequency and speed
- LOW ● — Micro-mobility share program
- LOW ● — Incentivize trips by active transportation
- LOW ● — Traffic calming measures and low-stress bike network improvements
- LOW ● — Subsidize transit passes
- (SUPPORTIVE) — Vision Zero education strategies
- (SUPPORTIVE) — Incentivize non-vehicular tourism

* Additional information on measures with quantifiable VMT reductions is provided in *Senate Bill 743 Vehicle Miles Traveled Implementation Guidelines* (April 2021).

Appendix C:

Methodologies to Quantify VMT Reductions

FEHR PEERS

Increase Diversity of Urban and Suburban Developments (Mixed Use)

Range of Effectiveness:

0 – 12% vehicle miles traveled (VMT) reduction due to a mix of land uses within a single development (Ewing and Cervero, 2010).

0.3 – 4% VMT reduction due to change in land use entropy index (i.e., land use mix) within a project's sphere of influence (Zhang).

Measure Description:

Having different types of land uses near one another can decrease VMT since trips between land use types are shorter and may be accommodated by non-auto modes of transport. For example, when residential areas are in the same neighborhood as retail and office buildings, a resident does not need to travel outside of the neighborhood to meet his/her trip needs. A description of diverse uses for urban and suburban areas is provided below (CAPCOA 2010, p. 162)

Urban:

An urban project is predominantly characterized by properties on which various uses, such as office, commercial, institutional, and residential, are combined in a single building or on a single site in an integrated development project with functional interrelationships and a coherent physical design. These mixed-use developments should encourage walking and other non-auto modes of transport from residential to office/commercial/institutional locations (and vice versa). The residential units should be within a quarter mile of parks, schools, or other civic uses. These projects minimize the need for external trips by including services/facilities for day care, banking/ATM, restaurants, vehicle refueling, and shopping (CAPCOA 2010, p. 162).

Suburban:

A suburban project has at least three of the following on site and/or offsite within a quarter mile: residential development, retail development, park, open space, or office. These mixed-use developments should encourage walking and other non-auto modes of transport from residential to office/commercial locations (and vice versa). These projects minimize the need for external trips by including services/facilities for day care, banking/ATM, restaurants, vehicle refueling, and shopping (CAPCOA 2010, p. 162).

Measure Applicability:

- Urban and suburban context
- Negligible impact in a rural context (unless the project is a master-planned community)
- Appropriate for mixed-use projects

Inputs:

The following information needs to be provided by the project applicant:

- Percentage of each land use type in the project

Mitigation Method:

$$\% \, VMT \, Reduction = Land \, Use \times E_{Diversity}$$

$$(not \, to \, exceed \, 15\% \, for \, non-work \, trips \, and \, 25\% \, for \, commute \, trips)$$

Where:

$$Land \, Use = (Land \, Use \, Index - 0.15)/0.15 \, (not \, to \, exceed \, 500\% \, increase)$$

$$Land \, Use \, Index = -a/\ln(6)$$

$a = \sum_{i=1}^{6} a_i \times \ln(a_i)$ (Song and Knaap, 2004)

$$a_i = Building \, floor \, area \, of \, land \, use \, i/total \, square \, feet \, of \, project \, land \, area$$

- $a_1 = Single \, family \, residential$
- $a_2 = Multifamily \, residential$
- $a_3 = Commercial$
- $a_4 = Industrial$
- $a_5 = Institutional$
- $a_6 = Park$

$E_{Diversity} = Elasticity \, of \, VMT \, with \, restpect \, to \, land \, use \, index = 0.02 \, to \, 0.08$ [4]

If land use a_i is not present, set a_i equal to 0.01

Discussion:

In the above calculation, a land use index of 0.15 is used as a baseline representing a development with a single land use. There are two separate maxima that should be noted: an effective cap of 500% on the allowable percentage increase of land use index and a cap of 15% and 25% on percent VMT reduction for non-work and commute trips, respectively. The 500 percent cap reflects the expected change in a land use index from 0.15 to 0.90, or from single use to a nearly equal balance of all six uses included in this method. The purpose for the 15% and 25% caps is to limit the influence of any single environmental factor (such as diversity). This emphasizes that community designs that implement multiple land use strategies (such as density, design, diversity, etc.) will show more of a reduction than relying on improvements from a single land use factor (CAPCOA 2010, p. 164).

The land use (or entropy) index measurement looks at the mix of land uses of a development. An index of 0 indicates a single land use while 1 indicates a full mix of uses. The preferred elasticity of VMT with respect to the land use mix index for Riverside County is 0.02, per work examining policy effects on VMT conducted by Salon et al for the Air Resource Board.

Example:

Sample calculations are provided below:

<u>90% single family homes, 10% commercial</u>

- $Land\ use\ index = -[0.9 \times \ln(0.9) + 0.1 \times \ln(0.1) + 4 \times 0.01 \times \ln(0.01)]/\ln(6) = 0.3$
- $Low\ Range\ \%\ VMT\ Reduction = (0.3 - 0.15)/0.15 \times 0.02 = 2\%$

<u>1/6 single family, 1/6 multi-family, 1/6 commercial, 1/6 industrial, 1/6 institutional, 1/6 parks</u>

- $Land\ use\ index = -[6 \times 0.17 \times \ln(0.17)]/\ln(6) = 1$
- $High\ Range\ \%\ VMT\ Reduction\ (land\ use\ index = 1)$
- $Land\ use = (1 - 0.15)/0.15 = 5.6\ or\ 566\%.\ Since\ this\ is\ greater\ than\ 500\%, set\ to\ 500\%$
- $\%\ VMT\ Reduction = (5 \times 0.02) = 10\%$

References:

Ewing, R. and Cervero, R. (2010). Travel and the Built Environment - A Meta-Analysis. Journal of the American Planning Association,76(3),265-294. Cited in California Air Pollution Control Officers Association. (2010). Quantifying Greenhouse Gas Mitigation Measures. Retrieved from: http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

Frank, L., Greenwald, M., Kavage, S. and Devlin, A. (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. Retrieved from: http://www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf

Nasri, A. and Zhang, L. (2012). Impact of Metropolitan-Level Built Environment on Travel Behavior. Transportation Research Record: Journal of the Transportation Research Board, 2323(1), 75-79.

Sadek, A. et al. (2011). Reducing VMT through Smart Land-Use Design. New York State Energy Research and Development Authority. Retrieved from: https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-08-29%20Final%20Report_December%202011%20%282%29.pdf

Salon, D., Boarnet, M. G., Handy, S., Spears, S., & Tal, G. (2012). How do local actions affect VMT? A critical review of the empirical evidence. *Transportation research part D: transport and environment, 17(7),* 495-508

Song, Y., and Knaap, G., “Measuring the effects of mixed land uses on housing values.” Regional Science and Urban Economics 34 (2004) 663-680.(p. 669) http://urban.csuohio.edu/~sugie/papers/RSUE/RSUE2005_Measuring%20the%20effects%20of%20mixed%20land%20use.pdf

Spears, S.et al. (2014). Impacts of Land-Use Mix on Passenger Vehicle Use and Greenhouse Gas Emissions-Policy Brief and Technical Background Document. California Air Resources Board. Retrieved from: https://arb.ca.gov/cc/sb375/policies/policies.htm

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.1.3 Increase Diversity of Urban and Suburban Developments (Mixed Use).

Zhang, Wengia et al. "Short- and Long-Term Effects of Land Use on Reducing Personal Vehicle Miles of Travel."

Increase Residential Density

Range of Effectiveness:

0.4% – 10.75% VMT reduction due to increasing residential density

Measure Description:

Designing the Project with increased densities, where allowed by the General Plan and/or Zoning Ordinance reduces GHG emissions associated with traffic in several ways. Density is usually measured in terms of persons, jobs, or dwellings per unit area. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. This strategy also provides a foundation for implementation of many other strategies which would benefit from increased densities. For example, transit ridership increases with density, which justifies enhanced transit service.

The reductions in GHG emissions are quantified based on reductions to VMT. The relationship between density and VMT is described by its elasticity (CAPCOA 2010, p. 155). The range of reductions is based on a range of elasticities from -0.04 to -0.22. The low end of the reductions represents a -0.04 elasticity of demand in response to a 10% increase in residential units or employment density and a -0.22 elasticity in response to 50% increase to residential/employment density.

Measure Applicability:

- Urban and suburban context
    - Negligible impact in a rural context
- Appropriate for residential, retail, office, industrial, and mixed-use projects

Inputs:

The following information needs to be provided by the project applicant:

- Number of housing units per acre or jobs per job acre

Mitigation Method:

$$\%\, VMT\ Reduction = A * B\ [not\ to\ exceed\ 30\%]$$

Where:
A = Percentage increase in housing units per acre or jobs per job acre = (number of housing units per acre or jobs per job acre – number of housing units per acre or jobs per job acre for typical ITE development) / (number of housing units per acre or jobs per job acre for typical ITE development). For small and medium sites (less than ½ mile in radius) the calculation of housing and jobs per acre should be performed for the development site as a whole, so that the analysis does not erroneously attribute trip reduction benefits to measures that simply shift jobs and housing within the site with no overall increase in site density. For larger sites, the analysis should address the development as several ½-mile-radius sites, so that shifts from one area to another would increase the density of the receiving area but reduce

the density of the donating area, resulting in trip generation rate decreases and increases, respectively, which cancel one another.
B = Elasticity of VMT with respect to density (from literature)

Detail:

- A: [not to exceed 500% increase]
    - If housing: (Number of housing units per acre – 7.6) / 7.6
    - If jobs: Number of jobs per acre – 20) / 20
- B: -0.04 elasticity in response to a 10% increase in residential units or employment density and a -0.22 elasticity in response to 50% increase to residential/employment density

Discussion:

The VMT reductions for this strategy are based on changes in density versus the typical suburban residential and employment densities in North America (referred to as "ITE densities"). These densities are used as a baseline to mirror those densities reflected in the ITE Trip Generation Manual, which is the baseline method for determining VMT. There are two separate maxima noted in the fact sheet: a cap of 500% on the allowable percentage increase of housing units or jobs per acre (variable A) and a cap of 30% on % VMT reduction. The rationale for the 500% cap is that there are diminishing returns to any change in environment. For example, it is reasonably doubtful that increasing residential density by a factor of six instead of five would produce any additional change in travel behavior. The purpose for the 30% cap is to limit the influence of any single environmental factor (such as density). This emphasizes that community designs that implement multiple land use strategies (such as density, design, diversity, etc.) will show more of a reduction than relying on improvements from a single land use factor.

References:

Boarnet, M. and Handy, S. (2014). Impacts of Residential Density on Passenger Vehicle Use and Greenhouse Gas Emissions - Policy Brief and Technical Background Document. California Air Resources Board. Retrieved from: https://arb.ca.gov/cc/sb375/policies/policies.htm

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.1.1 Increase Density

Stevens, M. (2017). Does Compact Development Make People Drive Less? Journal of the American Planning Association, 83(1), 7-18.

Increase Transit Accessibility

Range of Effectiveness:

1) 0 – 5.8% VMT reduction

    VMT reduction when transit station is provided within 1/2 mile of development (compared to VMT for sites located outside 1/2 mile radius of transit). Locating high density development within 1/2 mile of transit will facilitate the use of transit by people traveling to or from the Project site. The use of transit results in a mode shift and therefore reduced VMT.

2) 0 – 7.3% VMT reduction

    Reduction in vehicle trips due to implementing TOD. A project with a residential/commercial center designed around a rail or bus station, is called a transit-oriented development (TOD). The project description should include, at a minimum, the following design features:

    - A transit station/stop with high-quality, high-frequency bus service located within a 5-10 minute walk (or roughly ¼ mile from stop to edge of development), and/or
    - A rail station located within a 20 minute walk (or roughly ½ mile from station to edge of development)
    - Fast, frequent, and reliable transit service connecting to a high percentage of regional destinations
    - Neighborhood designed for walking and cycling

Measure Description:

Locating a project with high density near transit will facilitate the use of transit by people traveling to or from the Project site. The use of transit results in a mode shift and therefore reduced VMT. A project with a residential/commercial center designed around a rail or bus station, is called a transit-oriented development (TOD). The project description should include, at a minimum, the following design features:

- A transit station/stop with high-quality, high-frequency bus service located within a 5-10 minute walk (or roughly ¼ mile from stop to edge of development), and/or
- A rail station located within a 20 minute walk (or roughly ½ mile from station to edge of development)
- Fast, frequent, and reliable transit service connecting to a high percentage of regional destinations
- Neighborhood designed for walking and cycling

Measure Applicability:

- Urban and suburban context

- Appropriate in a rural context if development site is adjacent to a commuter rail station with convenient rail service to a major employment center
- Appropriate for residential, retail, office, industrial, and mixed-use projects

Inputs:

The following information needs to be provided by the project applicant:

- Distance to transit station in project

Mitigation Method:

$$\% \; VMT \; Reduction = Transit * B [not \; to \; exceed \; 30\%]$$

Where:

Transit = Increase in transit mode share = % transit mode share for project - % transit mode share for typical ITE development

% transit mode share for project (see Table)

Distance to transit Transit mode share calculation equation	Distance to transit Transit mode share calculation equation
(where x = distance of project to transit)	(where x = distance of project to transit)
0 – 0.5 miles -50*x + 38	0 – 0.5 miles -50*x + 38
0.5 to 3 miles -4.4*x + 15.2	0.5 to 3 miles -4.4*x + 15.2
> 3 miles no impact	

B = adjustments from transit ridership increase to VMT (0.67)

Discussion:

The purpose for the 30% cap on percent VMT reduction is to limit the influence of any single environmental factor (such as transit accessibility). This emphasizes that community designs that implement multiple land use strategies (such as density, design, diversity, transit accessibility, etc.) will show more of a reduction than relying on improvements from a single land use factor.

References:

1) Lund, H. et al. (2004). Travel Characteristics of Transit-Oriented Development in California. Oakland, CA: Bay Area Rapid Transit District, Metropolitan Transportation Commission, and Caltrans.

   Tal, G. et al. (2013). Policy Brief on the Impacts of Transit Access (Distance to Transit) Based on a Review of the Empirical Literature. California Air Resources Board. Retrieved from: https://www.arb.ca.gov/cc/sb375/policies/transitaccess/transit_access_brief120313.pdf

2) Zamir, K. R. et al. (2014). Effects of Transit-Oriented Development on Trip Generation, Distribution, and Mode Share in Washington, D.C., and Baltimore, Maryland. Transportation Research Record: Journal of the Transportation Research Board. 2413, 45–53. DOI: 10.3141/2413-05

Encourage Telecommuting and Alternative Work Schedules

Range of Effectiveness:

0.2 – 4.5% commute VMT reduction.

Measure Description:

Encouraging telecommuting and alternative work schedules reduces the number of commute trips and therefore VMT traveled by employees. Alternative work schedules could take the form of staggered starting times, flexible schedules, or compressed work weeks (CAPCOA 2010, p. 236).

Measure Applicability:

- Urban, suburban, and rural context
- Appropriate for retail, office, industrial, and mixed-use projects
- VMT reduction is dependent on the performance of individual building tenants and may change over time. On-going monitoring and adjustment is necessary to achieve sustained reductions in VMT.

Inputs:

The following information needs to be provided by the project applicant:

- Percentage of employees participating (1 – 25%)
- Telecommute elasticity (see discussion below)

Mitigation Method:

$$\%\ Commute\ VMT\ Reduction = E_{Telecommute} * Telecommute\ Delta$$

Where:

$$Telecommute\ Delta = \%\ change\ in\ workers\ telecommuting\ with\ TDM\ Program$$

$$E_{Telecommute} = \%\ change\ in\ VMT\ per\ \%\ change\ in\ workers\ telecommuting$$

$$E_{Telecommute} = 0.18\ to\ 0.90$$

Discussion:

Telecommute Delta and $E_{Telecommute}$ should consider the potential for building tenants to change over time. Higher values require the employer at the site to be known and unlikely to change over time. $E_{Telecommute}$ will be lower in places with higher non-drive alone mode share, and higher in places with more drive alone vehicle mode share.

References:

Handy, Tal, Boarnet. 2013. "Policy Brief on the Impacts of Telecommuting Based on a Review of the Empirical Literature." https://www.arb.ca.gov/cc/sb375/policies/telecommuting/telecommuting_brief120313.pdf

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.4.6 Encourage Telecommuting and Alternative Work Schedules

Provide Pedestrian Network Improvements

Range of Effectiveness:

0.5 – 5.7% VMT reduction

Measure Description:

Providing pedestrian access at and near a project site encourages people to walk instead of drive, presuming that desirable destinations exist within walking distance of the project. This mode shift results in people driving less and thus a reduction in VMT. The pedestrian access network should internally link all uses and connect to all existing or planned external streets and pedestrian facilities contiguous with the project site. It should also minimize barriers to pedestrian access and interconnectivity. Physical barriers such as walls, landscaping, and slopes that impede pedestrian circulation should be eliminated (CAPCOA 2010, p. 186).

Measure Applicability:

- Urban, suburban, and rural context
- Appropriate for residential, retail, office, industrial, and mixed-use projects
- Reduction benefit only occurs if the project has both pedestrian network improvements on site and connections to the larger off-site network. All calculations should incorporate the status of the network in the project's walkshed (i.e., within a ¼ mile radius).
- Desirable destinations external to the project site must be within walking distance (i.e., preferably within a ¼ mile and no greater than ½ mile).

Inputs:

The project applicant must provide information regarding pedestrian access and connectivity within the project and to/from off-site destinations. The change in sidewalk coverage should represent the share of quality sidewalk and pedestrian facilities available in the surrounding area; for instance, if one block-face of ten is missing sidewalks, the existing coverage is 90%. This measure is not effective in reducing VMT in locations with already fully-developed, high quality sidewalk networks.

Mitigation Method:

$$\%\ VMT\ Reduction = E_{PedAccess} \times Sidewalk\ Delta$$

Where:

$$E_{PedAccess} = \%\ Change\ in\ VMT\ per\ \%\ Increase\ in\ Sidewalk\ Coverage$$

$$Sidewalk\ Delta = Assumed\ change\ in\ sidewalk\ coverage\ compared\ to\ background\ condition$$

Detail:

$E_{PedAccess} = 0.0\ to\ 0.14$ (0.07 preferred in absence of other data)

$$Sidwalk\ Delta = \ 5\%\ to\ 100\%$$

Discussion:

Pedestrian Access Elasticity varies at the local level and is dependent on many factors such as the urban form of the immediate area and population characteristics. When reliable studies are available and applicable to the project area, this elasticity should be calculated. Otherwise, 0.07 is recommended based on the range provided by Handy, S. et al.

References:

Handy, S. et al. (2014). Impacts of Pedestrian Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions – Policy Brief and Technical Background Document. California Air Resources Board. Retrieved from: https://arb.ca.gov/cc/sb375/policies/policies.htm

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.2.1 Provide Pedestrian Network Improvements.

Provide Traffic Calming Measures

Range of Effectiveness:

0 – 1.7% VMT reduction

Measure Description:

Providing traffic calming measures encourages people to walk or bike instead of using a vehicle. This mode shift results in a decrease in VMT. Project design should include pedestrian/bicycle safety and traffic calming measures in excess of jurisdiction requirements. Roadways should be designed to reduce motor vehicle speeds and encourage pedestrian and bicycle trips with traffic calming features. Traffic calming features may include: marked crosswalks, count-down signal timers, curb extensions, speed tables, raised crosswalks, raised intersections, median islands, tight corner radii, roundabouts or mini-circles, on-street parking, planter strips with street trees, chicanes/chokers, etc. (CAPCOA 2010, p. 190).

Measure Applicability:

- Urban, suburban, and rural context
- Appropriate for residential, retail, office, industrial and mixed-use projects

Inputs:

The following information needs to be provided by the project applicant:

- Percentage of streets within project with traffic calming improvements
- Percentage of intersections within project with traffic calming improvements

Mitigation Calculation:

The VMT reduction is a function of the percentage of streets and intersections within the project with traffic calming improvements based on the following look up table.

% VMT Reduction		% of Streets with Improvements			
		25%	50%	75%	100%
% of Intersections with Improvements	25%	0.425%	0.425%	0.85%	0.85%
	50%	0.425%	0.85%	0.85%	1.275%
	75%	0.85%	0.85%	1.275%	1.275%
	100%	0.85%	1.275%	1.275%	1.7%

Discussion:

The table above allows the project applicant to calculate a VMT reduction estimate based on the project's street and intersection design with respect to traffic calming. The applicant should look at the rows on the left and choose the percent of intersections within the project which will have traffic calming improvements. Then, the applicant should look at the columns along the top and choose the percent of streets within the project which will have traffic calming improvements. The intersection cell of the row and column selected in the matrix is the VMT reduction estimate.

Though the literature provides some difference between a suburban and urban context, the difference is small and thus the lower VMT reduction estimate was used to be applied to all contexts. Rural context is not specifically discussed in the literature but is presumed to have little to no effect on VMT reduction due to the long-distances between trip origins and destinations.

Research by Zahabi, S. et al. attributes up to a 1.7% VMT reduction to traffic calming measures. The table above illustrates the range of VMT reductions based on the percent of streets and intersections with traffic calming measures implemented. CAPCOA 2010 used a range of 0.25% to 1% for VMT reduction. The VMT reductions were updated using the same methodology to allow for reductions up to 1.7%.

Because of the high potential for double-counting, caution should be used when combining this measure with "Provide Pedestrian Network Improvements."

References:

California Air Resources Board. (2016). Greenhouse Gas Quantification Methodology for the California Transportation Commission Active Transportation Program Greenhouse Gas Reduction Fund Fiscal Year 2016-17. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ctc_atp_finalqm_16-17.pdf.

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.2.2 Provide Traffic Calming Measures.

Zahabi, S. et al. (2016). Exploring the link between the neighborhood typologies, bicycle infrastructure and commuting cycling over time and the potential impact on commuter GHG emissions. Transportation Research Part D: Transport and Environment. 47, 89-103.

Implement Market Price Public Parking (On-Street)

Range of Effectiveness:

2.8% - 14.5% VMT reduction.

Measure Description:

Implement a pricing strategy for parking by pricing all central business district/employment center/retail center on-street parking. It will be priced to encourage park once" behavior. The benefit of this measure above that of paid parking at the project only is that it deters parking spillover from project supplied parking to other public parking nearby, which undermine the vehicle miles traveled (VMT) benefits of project pricing. It may also generate sufficient area-wide mode shifts to justify increased transit service to the area.

The VMT reduction applies to VMT from visitor/customer trips only. Reductions higher than top end of range from CAPCOA report apply only in conditions with highly constrained on-street parking supply and lack of comparably priced off-street parking.

Inputs:

The following information needs to be provided by the project applicant:

- Location of project site: low density suburb, suburban center, or urban location
- Percent increase in on-street parking prices (minimum 25% needed)

Mitigation Method:

$$\% \, VMT \; Reduction = Park\$ * B$$

Where:

$$Park\$ = Percent \; increase \; in \; on \; street \; parking \; prices \; (minimum \; 25\% \; increase)$$

$$B = Elasticity \; of \; VMT \; with \; respect \; to \; parking \; price$$

Discussion:

The range of parking price increases should be a minimum of 25% and a maximum of 50%. The minimum is based on Moving Cooler discussions, which state that a less than 25% increase would not be a sufficient amount to reduce VMT. The case study looked at a 50% price increase, and thus no conclusions can be made on the elasticities above a 50% increase. This strategy may certainly be implemented at a higher price increase, but VMT reductions should be capped at results from a 50% increase to be conservative.

References:

Clinch, J.P. and Kelly, J.A. (2003). Temporal Variance Of Revealed Preference On-Street Parking Price Elasticity. Dublin: Department of Environmental Studies, University College Dublin. Retrieved from: http://www.ucd.ie/gpep/research/workingpapers/2004/04-02.pdf. Cited in Victoria Transport Policy

Institute (2017). Transportation Elasticities: How Prices and Other Factors Affect Travel Behavior. Retrieved from: http://www.vtpi.org/tdm/tdm11.htm

Hensher, D. and King, J. (2001). Parking Demand and Responsiveness to Supply, Price and Location in Sydney Central Business District. Transportation Research A. 35(3), 177-196.

Millard-Ball, A. et al. (2013). Is the curb 80% full or 20% empty? Assessing the impacts of San Francisco's parking pricing experiment. Transportation Research Part A. 63(2014), 76-92.

Shoup, D. (2011). The High Cost of Free Parking. APA Planners Press. p. 290. Cited in Pierce, G. and Shoup, D. (2013). Getting the Prices Right. Journal of the American Planning Association. 79(1), 67-81.

Increase Transit Service Frequency/Speed

Range of Effectiveness:

0.03 – 6.3% VMT reduction.

Measure Description:

This measure reduces transit-passenger travel time through reduced headways and increased speed and reliability. This makes transit service more attractive and may result in a mode shift from auto to transit which reduces VMT (CAPCOA 2010, p. 280).

Inputs:

The following information needs to be provided by the project applicant:

- Percentage reduction in headways (increase in frequency) for applicable transit routes
- Level of implementation
- Project setting: urban center, urban, suburban
- Existing transit mode share

Mitigation Method:

$$\%\,VMT\ Reduction = Headway \times B \times C \times Mode$$

Where:

$$Headway = \%\ reduction\ in\ headways$$

$$B = Elasticity\ of\ transit\ ridership\ with\ respect\ to\ increased\ frequency\ of\ service$$

$$C = Ratio\ of\ vehicle\ trips\ reduced\ to\ number\ of\ new\ transit\ riders$$

$$Mode = Existing\ transit\ mode\ share$$

Detail:

$$B = 0.50$$

$$C = 25\%\ to\ 75\%$$

Discussion:

A 1% reduction in headways leads to 0.5% increase in transit ridership. This change is translated into a VMT reduction by applying a mode shift adjustment to account for new transit trips that do not represent displaced vehicle trips in addition to considering the existing transit mode share.

Variable C should be calculated based on local data. It is calculated by taking the length of an average transit trip within the sphere of influence of the project divided by the average vehicle trip length within the sphere of influence of the project.

References:

Handy, Lovejoy, Boarnet, Spears. 2013. "Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions." http://www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf

Litman, T. (2004). Transit price elasticities and cross-elasticities. Journal of Public Transportation, 7(2), 3.

Taylor, B. D., Miller, D., Iseki, H., & Fink, C. (2009). 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.

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.5.4 Implement Transit Service Frequency/Speed

Implement Car-Sharing Program

Range of Effectiveness:

0.3 – 1.6% VMT reduction

Measure Description:

Implementation of a car-sharing program allows people to have on-demand access to a shared fleet of vehicles on an as-needed basis. VMT reduction occurs due to reductions in private vehicle ownership, lower convenience associated with indirect vehicle access, and the transparent cost of vehicle use. User costs are typically determined through mileage or hourly rates, with deposits and/or annual membership fees. The car-sharing program could be created through a local partnership or through one of many existing car-share companies. Car-sharing programs may be grouped into three general categories: residential- or citywide-based, employer-based, and transit station-based. Transit station-based programs focus on providing the "last-mile" solution and link transit with commuters' final destinations. Residential-based programs work to substitute entire household-based trips. Employer-based programs provide a means for business/day trips for alternative mode commuters and provide a guaranteed ride home option (CAPCOA 2010, p. 245).

Measure Applicability:

- Urban and suburban context
- Negligible in a rural context
- Appropriate for residential, retail, office, industrial, and mixed-use projects

Inputs:

The following information needs to be provided by the project applicant:

- % reduction in car share member annual VMT
- Number of car share members per household

Mitigation Method:

$$\%\ VMT\ Reduction = P_{CarShare} \times Adoption\ Rate$$

Where:

$$P_{CarShare} = \%\ reduction\ in\ car\ share\ member\ annual\ VMT$$

$$Adoption\ Rate = number\ of\ car\ share\ members\ per\ household$$

Detail:

$$P_{CarShare} = 26.9\ to\ 37\%$$

$$Adoption\ Rate = 1\%\ to\ 2\%$$

Discussion:

The applicant must consider the demand for car-shares in a community before calculating a VMT reduction. If a community cannot support the proposed number of cars deployed, VMT reduction may be overestimated.

The percent reduction in car share member annual VMT is dependent on characteristics of the community, its residents, and for what purposes the car-sharing program is to be used for. Analysts should consult the literature to understand how these variables affect the range of reductions prior to completing the calculation of VMT reduction.

References:

Clewlow, Regina R. and Mishra, Gouri Shankar, (2017). Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States. UC Davis, Institute of Transportation Studies. Research Report - UCD-ITS-RR-17-07.

Lovejoy, K. et al. (2013). Impacts of Carsharing on Passenger Vehicle Use and Greenhouse Gas Emissions - Policy Brief and Technical Background Document. California Air Resources Board. Retrieved from: https://arb.ca.gov/cc/sb375/policies/policies.htm

Quantifying Greenhouse Gas Mitigation Measures, California Air Pollution Control Officers Association (CAPCOA), 2010. Chapter 3.4.9 Implement Car-Sharing Program

Appendix D:

CAPCOA Guidance on Combining TDM Strategies

Chart 6-2: Transportation Strategies Organization

Transportation Measures (Five Subcategories) Global Maximum Reduction (all VMT): urban = 75%; compact infill = 40%; suburban center or suburban with NEV = 20%; suburban = 15%

Global Cap for Road Pricing needs further study

Transportation Measures (Four Categories) Cross-Category Max Reduction (all VMT): urban = 70%; compact infill = 35%; suburban center or suburban with NEV = 15%; suburban = 10%

Land Use / Location	Neighborhood / Site Enhancement	Parking Policy / Pricing	Transit System Improvements	Commute Trip Reduction	Road Pricing Management	Vehicles
				Max Reduction = 15% overall; work VMT = 25%; school VMT = 65%;	Max Reduction = 25% (all VMT)	
Max Reduction: urban = 65%; compact infill = 30%; suburban center = 10%; suburban = 5%	Max Reduction: without NEV = 5%; with NEV = 15%	Max Reduction = 20%	Max Reduction = 10%	(assumes mixed use) Max Reduction = 25% (work VMT)	Max Reduction = 25%	
Density (30%)	Pedestrian Network (2%)	Parking Supply Limits (12.5%)	Network Expansion (8.2%)	CTR Program Required = 21% work VMT Voluntary = 6.2% work VMT	Cordon Pricing (22%)	Electrify Loading Docks
Design (21.3%)	Traffic Calming (1%)	Unbundled Parking Costs (13%)	Service Frequency / Speed (2.5%)	Transit Fare Subsidy (20% work VMT)	Traffic Flow Improvements (45% CO_2)	Utilize Alternative Fueled Vehicles
Location Efficiency (65%)	NEV Network (14.4) <NEV Parking>	On-Street Market Pricing (5.5%)	Bus Rapid Transit (3.2%)	Employee Parking Cash-out (7.7% work VMT)	Required Contributions by Project	Utilize Electric or Hybrid Vehicles
Diversity (30%)	Car Share Program (0.7%)	Residential Area Parking Permits	Access Improvements	Workplace Parking Pricing (19.7% work VMT)		
Destination Accessibility (20%)	Bicycle Network <Lanes> <Parking> <Land Dedication for Trails>		Station Bike Parking	Alternative Work Schedules & Telecommute (5.5% work VMT)		
Transit Accessibility (25%)	Urban Non-Motorized Zones		Local Shuttles	CTR Marketing (5.5% work VMT)		
BMR Housing (1.2%)			Park & Ride Lots*	Employer-Sponsored Vanpool/Shuttle (13.4% work VMT)		
Orientation Toward Non-Auto Corridor				Ride Share Program (15% work VMT)		
Proximity to Bike Path				Bike Share Program		
				End of Trip Facilities		
				Preferential Parking Permit		
				School Pool (15.8% school VMT)		
				School Bus (6.3% school VMT)		

Note: Strategies in bold text are primary strategies with reported VMT reductions; non-bolded strategies are support or grouped strategies.

Grouping of Strategies

Strategies noted as "grouped" are separately documented in individual Fact Sheets but must be paired with other strategies within the category. When these "grouped" strategies are implemented together, the combination will result in either an enhancement to the primary strategy by improving its effectiveness or a non-negligible reduction in effectiveness that would not occur without the combination.

Rules for Combining Strategies or Measures

Mitigation measures or strategies are frequently implemented together with other measures. Often, combining measures can lead to better emission reductions than implementing a single measure by itself. Unfortunately, the effects of combining the measures are not always as straightforward as they might at first appear. When more and more measures are implemented to mitigate a particular source of emissions, the benefit of each additional measure diminishes. If it didn't, some odd results would occur. For example, if there were a series of measures that each, independently, was predicted to reduce emissions from a source by 10%, and if the effect of each measure was independent of the others, then implementing ten measures would reduce all of the emissions; and what would happen with the eleventh measure? Would the combination reduce 110% of the emissions? No. In fact, each successive measure is slightly less effective than predicted when implemented on its own.

On the other hand, some measures enhance the performance of a primary measure when they are combined. This Report includes a set of rules that govern different ways of combining measures. The rules depend on whether the measures are in the *same* category, or different categories. Remember, the categories include: Energy, Transportation, Water, Landscape Equipment, Solid Waste, Vegetation, Construction, Miscellaneous Categories, and General Plans.

Combinations Between Categories: The following procedures must be followed when combining mitigation measures that fall in separate categories. In order to determine the overall reduction in GHG emissions compared to the baseline emissions, the relative magnitude of emissions between the source categories needs to be considered. To do this, the user should determine the percent contribution made by each individual category to the overall baseline GHG emissions. This percent contribution by a category should be multiplied by the reduction percentages from mitigation measures in that category to determine the scaled GHG emission reductions from the measures in that category. This is done for each category to be combined. The scaled GHG emissions for each category can then be added together to give a total GHG reduction for the combined measures in all of the categories.

For example, consider a project whose total GHG emissions come from the following categories: transportation (50%), building energy use (40%), water (6%), and other (4%). This project implements a transportation mitigation measure that results in a 10% reduction in VMT. The project also implements mitigation measures that result in a 30% reduction in water usage. The overall reduction in GHG emissions is as follows:

Reduction from Transportation: 0.50 x 0.10 = 0.5 or 5%
Reduction from Water: 0.06 x 0.30 = 0.018 or 1.8%

Total Reduction: 5% + 1.8% = 6.8%

This example illustrates the importance of the magnitude of a source category and its influence on the overall GHG emission reductions.

The percent contributions from source categories will vary from project to project. In a commercial-only project it may not be unusual for transportation emissions to represent greater than 75% of all GHG emissions whereas for a residential or mixed use project, transportation emissions would be below 50%.

Combinations Within Categories: The following procedures must be followed when combining mitigation measures that fall within the same category.

Non-Transportation Combinations: When combining non-transportation subcategories, the total amount of reductions for that category should not exceed 100% except for categories that would result in additional excess capacity that can be used by others, but which the project wants to take credit for (subject to approval of the reviewing agency). This may include alternative energy generation systems tied into the grid, vegetation measures, and excess graywater or recycled water generated by the project and used by others. These excess emission reductions may be used to offset other categories of emissions, with approval of the agency reviewing the project. In these cases of excess capacity, the quantified amounts of excess emissions must be carefully verified to ensure that any credit allowed for these additional reductions is truly surplus.

Category Maximum- Each category has a maximum allowable reduction for the combination of measures in that category. It is intended to ensure that emissions are not double counted when measures within the category are combined. Effectiveness levels for multiple strategies within a subcategory (as denoted by a column in the appropriate chart, above) may be multiplied to determine a combined effectiveness level up to a maximum level. This should be done first to mitigation measures that are a source reduction followed by those that are a reduction to emission factors. Since the combination of mitigation measures and independence of mitigation measures are both complicated, this Report recommends that mitigation measure reductions within a category be multiplied unless a project applicant can provide substantial evidence indicating that emission reductions are independent of one another. This will take the following form:

GHG emission reduction for category = 1-[(1-A) x (1-B) x (1-C)]

Where:

A, B and C = Individual mitigation measure reduction percentages for the strategies to be combined in a given category.

Global Maximum- A separate maximum, referred to as a global maximum level, is also provided for a combination across subcategories. Effectiveness levels for multiple strategies across categories may also be multiplied to determine a combined effectiveness level up to global maximum level.

For example, consider a project that is combining 3 mitigation strategies from the water category. This project will install low-flow fixtures (measure WUW-1), use water-efficient irrigation (measure WUW-4, and reduce turf (measure WUW-5). Reductions from these measures will be:

- low-flow fixtures 20% or 0.20 (A)
- water efficient irrigation 10% or 0.10 (B)
- turf reductions 20% or 0.20 (C)

To combine measures within a category, the reductions would be
= 1-[(1-A) x (1-B) x (1-C)]
= 1-[(1-.20) x (1-.10) x (1-.20)]
= 1-[(0.8) x (0.9) x (.8)]
= 1-0.576 = 0.424
= 42.4%

Transportation Combinations: The interactions between the various categories of transportation-related mitigation measures is complex and sometimes counter-intuitive. Combining these measures can have a substantive impact on the quantification of the associated emission reductions. In order to safeguard the accuracy and reliability of the methods, while maintaining their ease of use, the following rules have been developed and should be followed when combining transportation-related mitigation measures. The rules are presented by sub-category, and reference Chart 6-2 Transportation Strategies Organization. The maximum reduction values also reflect the highest reduction levels justified by the literature. The chart indicates maximum reductions for individual mitigation measures just below the measure name.

Cross-Category Maximum- A cross-category maximum is provided for any combination of land use, neighborhood enhancements, parking, and transit strategies (columns A-D in Chart 6-1, with the maximum shown in the top row). The total project VMT reduction across these categories should be capped at these levels based on empirical evidence.[3] Caps are provided for the location/development type of the project. VMT reductions may be multiplied across the four categories up to this maximum. These include:

- Urban: 70% VMT
- Compact Infill: 35%
- Suburban Center (or Suburban with NEV): 15%
- Suburban: 10% (note that projects with this level of reduction must include a diverse land use mix, workforce housing, and project-specific transit; limited empirical evidence is available)

(See blue box, pp. 58-59.)

[3] As reported by Holtzclaw, et al for the State of California.

As used in this Report, location settings are defined as follows:

Urban: A project located within the central city and may be characterized by multi-family housing, located near office and retail. Downtown Oakland and the Nob Hill neighborhood in San Francisco are examples of the typical urban area represented in this category. The urban maximum reduction is derived from the average of the percentage difference in per capita VMT versus the California statewide average (assumed analogous to an ITE baseline) for the following locations:

Location	Percent Reduction from Statewide VMT/Capita
Central Berkeley	-48%
San Francisco	-49%
Pacific Heights (SF)	-79%
North Beach (SF)	-82%
Mission District (SF)	-75%
Nob Hill (SF)	-63%
Downtown Oakland	-61%

The average reflects a range of 48% less VMT/capita (Central Berkeley) to 82% less VMT/capita (North Beach, San Francisco) compared to the statewide average. The urban locations listed above have the following characteristics:

- Location relative to the regional core: these locations are within the CBD or less than five miles from the CBD (downtown Oakland and downtown San Francisco).
- Ratio or relationship between jobs and housing: jobs-rich (jobs/housing ratio greater than 1.5)
- Density character
  - typical building heights in stories: six stories or (much) higher
  - typical street pattern: grid
  - typical setbacks: minimal
  - parking supply: constrained on and off street
  - parking prices: high to the highest in the region
- Transit availability: high quality rail service and/or comprehensive bus service at 10 minute headways or less in peak hours

Compact infill: A project located on an existing site within the central city or inner-ring suburb with high-frequency transit service. Examples may be community redevelopment areas, reusing abandoned sites, intensification of land use at established transit stations, or converting underutilized or older industrial buildings. Albany and the Fairfax area of Los Angeles are examples of typical compact infill area as used here. The compact infill maximum reduction is derived from the average of the percentage difference in per capita VMT versus the California statewide average for the following locations:

Location	Percent Reduction from Statewide VMT/Capita
Franklin Park, Hollywood	-22%
Albany	-25%
Fairfax Area, Los Angeles	-29%
Hayward	-42%

The average reflects a range of 22% less VMT/capita (Franklin Park, Hollywood) to 42% less VMT/capita (Hayward) compared to the statewide average. The compact infill locations listed above have the following characteristics:

- Location relative to the regional core: these locations are typically 5 to 15 miles outside a regional CBD
- Ratio or relationship between jobs and housing: balanced (jobs/housing ratio ranging from 0.9 to 1.2)
- Density character
  - typical building heights in stories: two to four stories
  - typical street pattern: grid
  - typical setbacks: 0 to 20 feet
  - parking supply: constrained
  - parking prices: low to moderate
- Transit availability: rail service within two miles, or bus service at 15 minute peak headways or less

As used in this Report, additional location settings are defined as follows:

Suburban Center: A project typically involving a cluster of multi-use development within dispersed, low-density, automobile dependent land use patterns (a suburb). The center may be an historic downtown of a smaller community that has become surrounded by its region's suburban growth pattern in the latter half of the 20th Century. The suburban center serves the population of the suburb with office, retail and housing which is denser than the surrounding suburb. The suburban center maximum reduction is derived from the average of the percentage difference in per capita VMT versus the California statewide average for the following locations:

Location	Percent Reduction from Statewide VMT/Capita
Sebastopol	0%
San Rafael (Downtown)	-10%
San Mateo	-17%

The average reflects a range of 0% less VMT/capita (Sebastopol) to 17% less VMT/capita (San Mateo) compared to the statewide average. The suburban center locations listed above have the following characteristics:

- Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD
- Ratio or relationship between jobs and housing: balanced
- Density character
    - typical building heights in stories: two stories
    - typical street pattern: grid
    - typical setbacks: 0 to 20 feet
    - parking supply: somewhat constrained on street; typically ample off-street
    - parking prices: low (if priced at all)
- Transit availability: bus service at 20-30 minute headways and/or a commuter rail station

While all three locations in this category reflect a suburban "downtown," San Mateo is served by regional rail (Caltrain) and the other locations are served by bus transit only. Sebastopol is located more than 50 miles from downtown San Francisco, the nearest urban center. San Rafael and San Mateo are located 20 miles from downtown San Francisco.

Suburban: A project characterized by dispersed, low-density, single-use, automobile dependent land use patterns, usually outside of the central city (a suburb). Suburbs typically have the following characteristics:

- Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD
- Ratio or relationship between jobs and housing: jobs poor
- Density character
    - typical building heights in stories: one to two stories
    - typical street pattern: curvilinear (cul-de-sac based)
    - typical setbacks: parking is generally placed between the street and office or retail buildings; large-lot residential is common
    - parking supply: ample, largely surface lot-based
    - parking prices: none
- Transit availability: limited bus service, with peak headways 30 minutes or more

The maximum reduction provided for this category assumes that regardless of the measures implemented, the project's distance from transit, density, design, and lack of mixed use destinations will keep the effect of any strategies to a minimum.

Global Maximum- A global maximum is provided for any combination of land use, neighborhood enhancements, parking, transit, and commute trip reduction strategies (the first five columns in the organization chart). This excludes reductions from road-pricing measurements which are discussed separately below. The total project VMT reduction across these categories, which can be combined through multiplication, should be capped at these levels based on empirical evidence.[4] Maximums are provided for the location/development type of the project. The Global Maximum values can be found in the top row of Chart 6-2.

These include:

- Urban: 75% VMT
- Compact Infill: 40% VMT
- Suburban Center (or Suburban with NEV): 20%
- Suburban: 15% (limited empirical evidence available)

Specific Rules for Subcategories within Transportation- Because of the unique interactions of measures within the Transportation Category, each subcategory has additional rules or criteria for combining measures.

❖ Land Use/Location Strategies – Maximum Reduction Factors: Land use measures apply to a project area with a radius of ½ mile. If the project area under review is greater than this, the study area should be divided into subareas of radii of ½ mile, with subarea boundaries determined by natural “clusters” of integrated land uses within a common walkshed. If the project study area is smaller than ½ mile in radius, other land uses within a ½ mile radius of the key destination point in the study area (i.e. train station or employment center) should be included in design, density, and diversity calculations. Land use measures are capped based on empirical evidence for location setting types as follows:[5]

- Urban: 65% VMT
- Compact Infill: 30% VMT
- Suburban Center: 10% VMT
- Suburban: 5% VMT

❖ Neighborhood/Site Enhancements Strategies – Maximum Reduction Factors: The neighborhood/site enhancements category is capped at 12.7% VMT reduction (with Neighborhood Electric Vehicles (NEVs)) and 5% without NEVs based on empirical evidence (for NEVs) and the multiplied combination of the non-NEV measures.

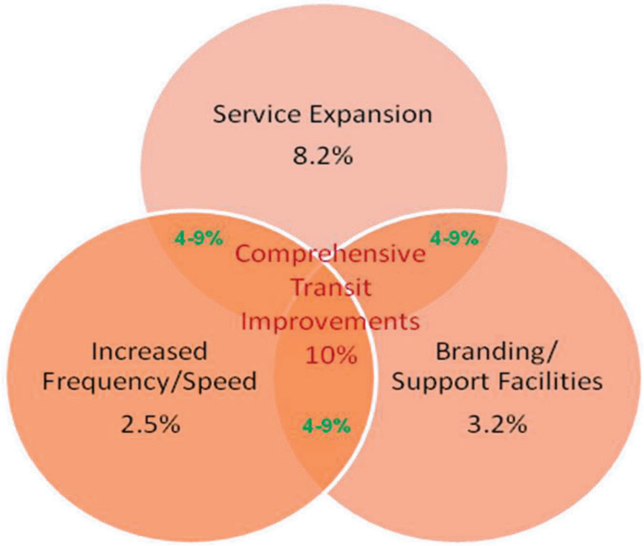
❖ Parking Strategies – Maximum Reduction Factors: Parking strategies should be implemented in one of two combinations:

- Limited (reduced) off-street supply ratios plus residential permit parking and priced on-street parking (to limit spillover), or
- Unbundled parking plus residential permit parking and priced on-street parking (to limit spillover).

[4] As reported by Holtzclaw, et al for the State of California. Note that CTR strategies must be converted to overall VMT reductions (from work-trip VMT reductions) before being combined with strategies in other categories.
[5] As reported for California locations in Holtzclaw, et al. “Location Efficiency: Neighborhood and Socioeconomic Characteristics Determine Auto Ownership and Use – Studies in Chicago, Los Angeles, and San Francisco.” *Transportation Planning and Technol*ogy, 2002, Vol. 25, pp. 1–27.

Note: The reduction maximum of 20% VMT reflects the combined (multiplied) effect of unbundled parking and priced on-street parking.

- Transit System Strategies – Maximum Reduction Factors: The 10% VMT reduction maximum for transit system improvements reflects the combined (multiplied) effect of network expansion and service frequency/speed enhancements. A comprehensive transit improvement would receive this type of reduction, as shown in the center overlap in the Venn diagram, below.



- Commuter Trip Reductions (CTR) Strategies – Maximum Reduction Factors: The most effective commute trip reduction measures combine incentives, disincentives, and mandatory monitoring, often through a transportation demand management (TDM) ordinance. Incentives encourage a particular action, for example parking cash-out, where the employee receives a monetary incentive for not driving to work, but is not punished for maintaining status quo. Disincentives establish a penalty for a status quo action. An example is workplace parking pricing, where the employee is now monetarily penalized for driving to work. The 25% maximum for work-related VMT applies to comprehensive CTR programs. TDM strategies that include only incentives, only disincentives, and/or no mandatory monitoring, should have a lower total VMT reduction than those with a comprehensive approach. Support strategies to strengthen CTR programs include guaranteed-ride-home, taxi vouchers, and message boards/marketing materials. A 25% reduction in work-related VMT is assumed equivalent to a 15% reduction in overall project VMT for the purpose of the global maximum; this can be adjusted for project-specific land use mixes.

  Two school-related VMT reduction measures are also provided in this category. The maximum reduction for these measures should be 65% of school-related VMT based on the literature.

- Road Pricing/Management Strategies – Maximum Reduction Factors: Cordon pricing is the only strategy in this category with an expected VMT reduction potential. Other forms of road pricing would be applied at a corridor or region-wide level rather than as mitigation applied to an individual development project. No domestic case studies are available for cordon pricing, but international studies suggest a VMT reduction maximum of 25%. A separate, detailed, and project-specific study should be conducted for any project where road pricing is proposed as a VMT reduction measure.

Additional Rules for Transportation Measures- There are also restrictions on the application of measures in rural applications, and application to baseline, as follows:

- Rural Application: Few empirical studies are available to suggest appropriate VMT reduction caps for strategies implemented in rural areas. Strategies likely to have the largest VMT reduction in rural areas include vanpools, telecommute or alternative work schedules, and master planned communities (with design and land use diversity to encourage intra-community travel). NEV networks may also be appropriate for larger scale developments. Because of the limited empirical data in the rural context, project-specific VMT reduction estimates should be calculated.

- Baseline Application: As discussed in previous sections of this report, VMT reductions should be applied to a baseline VMT expected for the project, based on the Institute of Transportation Engineers' 8th Edition *Trip Generation Manual* and associated typical trip distance for each land use type. Where trip generation rates and project VMT provided by the project Applicant are derived from another source, the VMT reductions must be adjusted to reflect any "discounts" already applied.

Range of Effectiveness of Mitigation Measures

The following charts provide the range of effectiveness for the quantified mitigation measures. Each chart shows one category of measures, with subcategories identified. The charts also show the basis for the quantification, and indicate applicable groupings. IMPORTANT: these ranges are approximate and should NOT be used in lieu of the specific quantification method provided in the fact sheet for each measure. Restrictions on combining measures must be observed.