FEHR & PEERS

Memorandum

Date: February 21, 2023

To: Julio Perucho, Metro

From: Anna Luo, Chelsea Richer, Ron Milam, and Jeremy Klop, Fehr & Peers

Subject: VMT Quantification Tools and Preferred Methodology (Task 4)

LA22-3343

Executive Summary

This memorandum establishes an evidence-based approach to refine the VMT quantification methods established by Caltrans for projects on the State Highway System (SHS) specific to the context in Los Angeles County. Current VMT quantification practice is based on statewide application of national research on induced travel. While these efforts and prior research are robust, travel in Los Angeles County and changes in local travel patterns over the last two decades are inconsistent with national trends and different than other regions in California. The observed changes in total Vehicle Miles Traveled (VMT) and VMT per capita in Los Angeles County outperform national and statewide trends: lower than national averages, lowest in the Southern California Association of Governments (SCAG) region, and on the lower end of VMT per capita growth statewide.[1, 2] These trends are elaborated in this memorandum.

This memorandum outlines notable and consequential differences in induced travel effects that are unique to Los Angeles County, and which justify refinements to VMT quantification methods applied to projects on the SHS in Los Angeles County. Consistent application of this locally refined method provides clarity for project teams working on environmental compliance for projects on the SHS and a consistent approach against which Caltrans' District 7 and Headquarters can conduct their review of Metro's environmental documents for SHS projects. A locally specific VMT quantification method also ensures that project impact mitigation actions and associated costs

[1] US DOT Transportation and Health Tool, 2015. Available at https://www7.transportation.gov/transportation-health-tool.

[2] California Air Resources Board. Draft 2022 Progress Report: California's Sustainable Communities and Climate Protection Act (SB 375). Available at https://ww2.arb.ca.gov/sites/default/files/2022-07/2022_SB_150_Main_Report_Draft_ADA.pdf.

are both fair and reasonably related to expected changes in local travel patterns and locally specific substantial evidence.

Key issues addressed in this memo, and their corresponding recommended approaches, include:

- The types of projects that are presumed to not result in a VMT impact (i.e., screened from VMT quantification)
  - This memo recommends the addition of five types of projects to the list of projects that are presumed not to result in a VMT impact.[3]
- Selection of the appropriate quantification method to estimate long-term induced VMT (i.e., a simpler approach using an elasticity factor, that only works for projects with lane-mile additions, or a more complex approach using a travel demand model that works for all types of projects but may not fully capture long-term induced VMT)
  - For projects that include lane-mile additions, this memo recommends the use of a hybrid approach, using both the elasticity method and the SCAG 2020 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) Activity Based Model (SCAG 2020 ABM).
  - For projects that do not include lane-mile additions, this memo recommends the use of the SCAG 2020 ABM.
- Approach to modifying selected quantification method (i.e., local refinement of the elasticity factors used in the Caltrans-preferred National Center for Sustainable Transportation (NCST) Induced Travel Calculator (NCST Calculator) to better align the elasticity factor with CEQA statute, published research, and Los Angeles County context)
  - For program-level VMT quantification, this memo recommends using a modified elasticity factor of 0.39 for Class 1 facilities and 0.29 for Class 2 and 3 facilities, which reflects local context, is supported by multiple sources of published literature, and is consistent with the category of induced VMT that aligns most closely to the CEQA statute.
  - For project-level VMT quantification, this memo recommends further adjusting the elasticity factor to reflect differences in project location and project type, which would be derived by deploying the SCAG 2020 ABM in conjunction with the above long-term elasticity factors.

Introduction

The Los Angeles County Metropolitan Transportation Authority (Metro), in partnership with the California Department of Transportation (Caltrans), is developing the VMT Mitigation Program to

[3] This list can be found in the Caltrans policy document *Transportation Analysis under CEQA for Projects on the State Highway System* (TAC), 2020, pages 13-15. Available at https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/2020-09-10-1st-edition-tac-fnl-a11y-new-nov2021.pdf.

support the region's Senate Bill (SB) 743 goals of reducing the impacts of VMT and correlated greenhouse gas (GHG) emissions while affording greater mobility and access for Los Angeles County's residents. Aligning Metro's highway investments with the legislative intent of SB 743 that emphasizes multi-modal and smart growth strategies to reduce VMT, this program will allow Metro to support the region's goal of reducing VMT impacts, provide Metro, Caltrans, and other project delivery partners within the County with refined tools to determine project VMT impacts more accurately, and provide feasible and enforceable VMT mitigation strategies.

The purpose of this memorandum is to summarize an evaluation of VMT quantification tools and present recommendations on model improvements and a suggested approach to forecast VMT, in the context of potential application to SHS improvement projects included in Metro's Sales Tax Measures Expenditure Plans/Ordinances and corresponding subregional programs. Although the CEQA Guidelines [Section 15064.3(a)] only require the evaluation of automobile VMT (light-duty cars and trucks), the quantification tool recommended by Caltrans includes all types of VMT, including medium and heavy-duty vehicles (reflecting commercial or freight activity), and applies a state-wide approach that imposes extra cost on projects in low-VMT areas. Therefore, to best respond to CEQA requirements and to calibrate the quantification to local context in the Los Angeles MSA, a modification to the Caltrans-recommended tool is warranted.[4]

This memorandum also provides recommended project types as additions to the induced VMT screening list outlined in the first version of the Caltrans policy document *Transportation Analysis under CEQA for Projects on the State Highway System* (TAC) as they are projects not likely to lead to measurable and substantial increases in VMT.[5] Per the scope of work for this effort, this memorandum is not intended to, and does not, quantify the VMT impacts of Metro's program of highways and complete streets projects.

Finally, this memorandum offers a brief discussion of alignment of this effort with other efforts underway at Metro that relate to VMT quantification, including how the proposed California Environmental Quality Act (CEQA) methodology included herein relate to other published estimates of induced travel and VMT increases over time.

Background

In response to recent revisions to the CEQA Guidelines, CEQA case law, and guidance issued by the California Governor's Office of Planning and Research (OPR), Caltrans has determined that VMT is the most appropriate metric for determining transportation impacts for capacity-

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[4] CEQA Guidelines Section 15064.3(b)(2) and (4) do provide lead agency discretion in setting a different form of the metric; however, Caltrans' policy documents do not establish the requirement to include commercial trips.

[5] Transportation Analysis under CEQA for Projects on the State Highway System. Caltrans, 2020. Retrieved from https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/2020-09-10-1st-edition-tac-fnl-a11y-new-nov2021.pdf.

increasing transportation projects on the SHS. VMT impact analysis may also be required for National Environmental Policy Act (NEPA) purposes.

For roadway capacity projects on local roadways not on the SHS, lead agencies have the discretion to select their preferred metric consistent with CEQA expectations. This has traditionally been the case for NEPA projects as well. Beyond transportation impacts, VMT is also a required input for air quality, GHG, and energy impact analysis.

Induced vehicle travel effects are the underlying forces behind VMT changes associated with roadway capacity expansion projects. The concept of induced demand for VMT is well-established by transportation planning research, dating back to a 1962 paper by Anthony Downs.[6] However, the best approach to estimating the effects of building new lane miles, and the potential magnitude of such effects, is still widely debated.[7] These effects can potentially diminish expected congestion relief benefits of building new non-priced capacity improvements. Note, congestion relief is only one possible benefit gained from capacity improvements, along with the accommodation of additional travelers, improved access, and safety enhancements. The main resources on induced vehicle travel for environmental impact analysis of transportation projects are listed below.

- OPR's Technical Advisory on Evaluating Transportation Impacts in CEQA, December 2018.
    - https://opr.ca.gov/docs/20190122-743_Technical_Advisory.pdf
- Caltrans' Transportation Analysis Framework (TAF) First Edition: Evaluating Transportation Impacts of State Highway System Projects, September 2020.[8]
    - https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/2020-09-10-1st-edition-taf-fnl-a11y-new-.pdf
- Caltrans' Transportation Analysis Under CEQA (TAC) First Edition: Evaluating Transportation Impacts of State Highway System Projects, September 2020.[9]
    - https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/2020-09-10-1st-edition-tac-fnl-a11y-new-nov2021.pdf
- CARB 2017 Scoping Plan – Identified VMT Reductions and Relationship to State Climate Goals, January 2019.
    - https://ww2.arb.ca.gov/sites/default/files/2019-01/2017_sp_vmt_reductions_jan19.pdf

[6] The Law of Peak-Hour Expressway Congestion. Anthony Downs, Traffic Quarterly, 1962. Volume 16, pp393-409.. Retrieved from https://babel.hathitrust.org/cgi/pt?id=uc1.$b3477&view=1up&seq=457.

[7] Induced Demand: An Urban and Metropolitan Perspective. Robert Cervero, 2001. Prepared for Policy Forum: Working Together to Address Induced Demand. Retrieved from https://escholarship.org/uc/item/5pj337gw.

[8] Updates to the TAF and the TAC are periodically posted as Bulletins and Hot Topics at https://dot.ca.gov/programs/sustainability/sb-743/sb743-resources.

[9] Updates to the TAC and the TAF are periodically posted as Bulletins and Hot Topics at https://dot.ca.gov/programs/sustainability/sb-743/sb743-resources.

- CARB Research on Effects of Transportation and Land-Use Related Policies
  - https://ww2.arb.ca.gov/sites/default/files/2020-06/Impact_of_Highway_Capacity_and_Induced_Travel_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf
  - https://ww2.arb.ca.gov/sites/default/files/2020-06/Impact_of_Highway_Capacity_and_Induced_Travel_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Technical_Background_Document.pdf
- NEPA Travel and Land Use Forecasting
  - https://www.environment.fhwa.dot.gov/env_topics/other.aspx
- Ronald T. Milam, et al., Closing the Induced Vehicle Travel Gap between Research and Practice, Transportation Research Record (TRR) #2653, 2017, p10-16.
  - https://pdfs.semanticscholar.org/48aa/57a40a71f7c6ba90106f0acdbfccb37de0b2.pdf
- Ronald T. Milam and Jerry Walters, et al. Induced Travel Technical Investigation. Caltrans TAG/TISG Induced Demand Subcommittee – Status Summary, April 24, 2016.
- Dowling Associates for the California Air Resources Board. Effects of Increased Highway Capacity on Travel Behavior, 1994.

Importantly, establishment of a VMT impact presumes the future plus project condition results in VMT levels that are higher than the existing conditions. A review of HPMS data from the past 20 years – aligning with the timeframe along which the effects of long-term induced VMT should be visible – demonstrates a different trend in the Los Angeles-Long Beach-Anaheim MSA (previously referred to as the Los Angeles, Long Beach, Pomona, Ontario MSA or simply, the Los Angeles MSA which captures both Los Angeles and Orange counties). As shown in Table 1, below, between 2001-2019, HPMS data experienced a decline in daily total VMT (-4%) despite a smaller decline in lane miles (-0.28%) and an increase in population (+5%). In contrast, California has seen an increase in lane miles, VMT, and population state-wide.

Table 1: Comparison of HPMS and Population Data, Los Angeles MSA & California

	Los Angeles MSA	California
Change in Total Lane Miles, 2001-2019	-0.28%	+7.7%
Change in Total VMT, 2001-2019	-4%	+15%
Change in Total Population, 2001-2019	+5%	+14%

Source: Fehr & Peers, 2023.

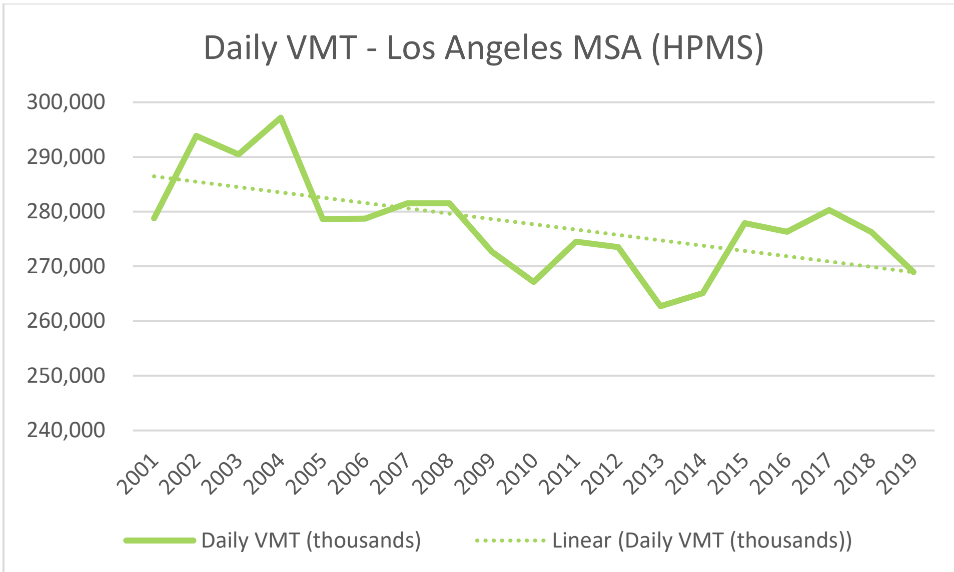

Figure 1: Daily VMT (Los Angeles MSA), 2001-2019

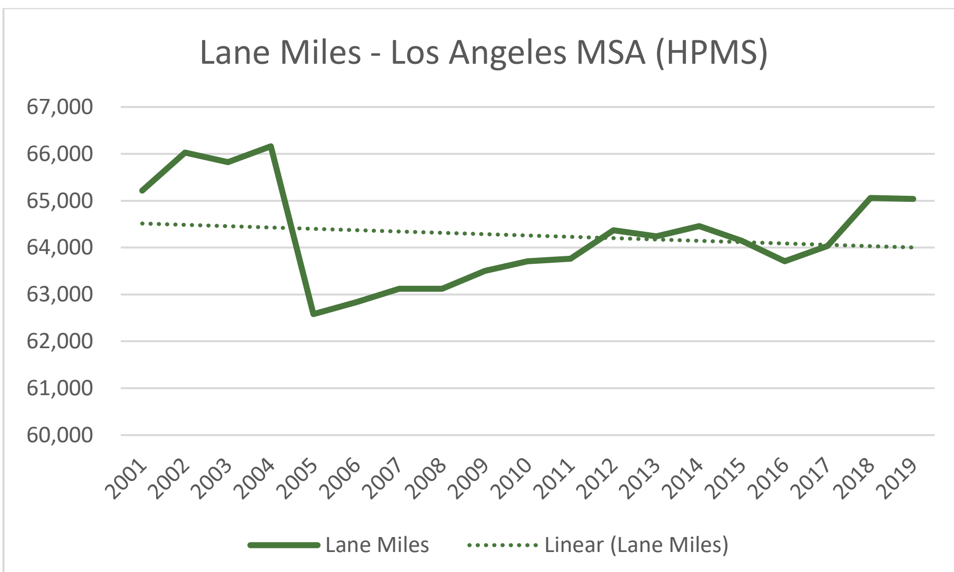

Figure 2: Total Lane Miles (Los Angeles MSA), 2001-2019

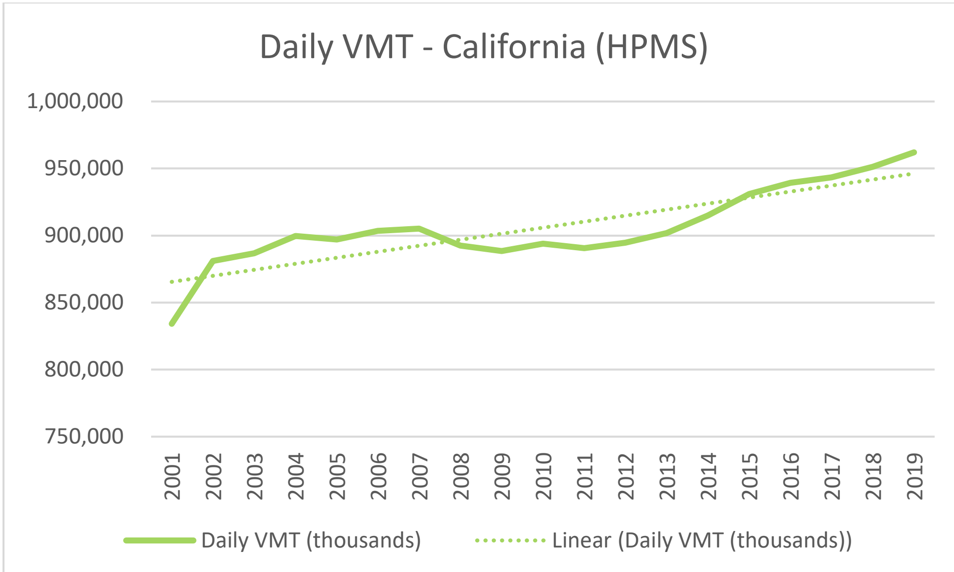

Figure 3: Daily VMT (California), 2001-2019

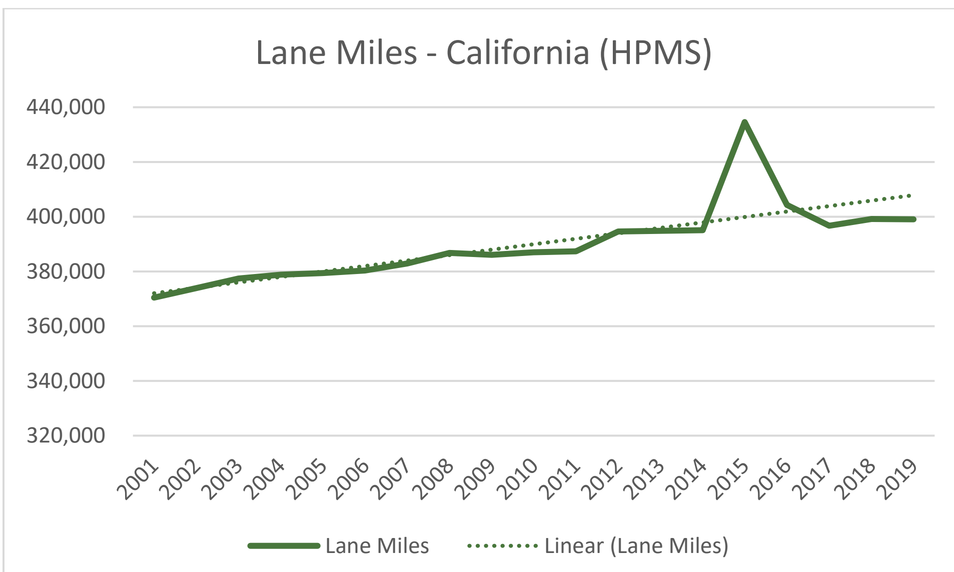

Figure 4: Total Lane Miles (California), 2001-2019

This data points to a more efficient travel pattern in Los Angeles compared to other parts of the California, as well as other parts of the US and past periods of Southern California's history (as documented in the induced VMT literature), where rapid expansion of developed land and expansion of the vehicle transportation system to connect to those areas led to less efficient travel patterns and induced demand as a result. These notable and consequential differences in induced travel effects that are unique to Los Angeles County justify refinements to VMT quantification methods applied to projects on the SHS in Los Angeles County. The following sections explain the locally specific quantification methodology to forecast induced VMT for Metro's highway projects based on the above documents and CEQA compliance.

VMT Quantification Tools

As indicated in the OPR's Technical Advisory and Caltrans' Transportation Analysis Framework (TAF) and TAC, two methods are highlighted to forecast induced VMT: 1) an empirical approach using elasticities, and 2) a travel demand model.

- **Elasticity-based methods**, which produce a percent increase in VMT associated with a given percent increase in roadway lane miles. The tool that is emerging as the most commonly used is the National Center for Sustainable Transportation (NCST) Induced Travel Calculator (NCST Calculator), based on national research and published literature on the relationship between lane miles and induced VMT. Although the concept and calculation is simple, the selection of the right elasticity number is debated.[10] Furthermore, an elasticity-based approach cannot be deployed on projects that do not have lane-mile additions.
- **Travel demand models**, which spatially locate socio-economic data into analysis zones and forecast trips to and from those zones based on the related data. Travel demand models aim to capture complex relationships between both land use and transportation changes and can vary in terms of their levels of calibration and validation as well as their associated reasonableness and sensitivity.

Each method has its merits and limitations, and this evaluation offers an approach to understanding and potentially reconciling these two methods to perform a complete analysis satisfying the CEQA (and NEPA) expectations, specific to the context in Los Angeles County.

NCST Calculator

The elasticity method is based on statistical studies that aim to quantify induced vehicle travel that is exclusively associated with expanding roadway capacity (i.e., adding lane miles). The elasticity of VMT to lane miles includes short-term and long-term estimates of induced travel effects. Short-term effects occur in the short period of time (1-2 years) after a roadway capacity project is open to traffic. Long-term effects tend to occur within a 10- to 20-year timeframe, although the most recent research tends to focus on 20 years. In general, the elasticities reflect the change in total VMT attributable to lane mile increases while controlling for other factors that contribute to VMT growth such as population and economic growth.

Some researchers have also included an accounting of the specific sources of induced VMT including the proportion from passenger (light-duty) versus commercial (medium and heavy-

[10] Cervero, 2001.

duty) vehicles. This accounting is relevant for CEQA purposes since different types of VMT may be required depending on the impact subject. For transportation impacts, only passenger VMT is required per CEQA Guidelines Section 15064.3(a).

Under the elasticity method, Caltrans recommends the use of the NCST Calculator (https://travelcalculator.ncst.ucdavis.edu/) to forecast long-term induced VMT. The process of calculating induced travel using elasticities is shown in Figure 5. The NCST Calculator includes 2016-2019 VMT and lane-mile data so the user only needs to input the baseline year (preferably the latest year), change in lane miles associated with a proposed project, and the type of functional classification (selected from a drop-down menu). For interstate highways (Class 1), the VMT forecast is based on inputs for the corresponding Metropolitan Statistical Area (MSA) and uses an elasticity of 1.0. For other freeways and expressways (Class 2) and other principal arterials (Class 3), the calculator uses county-level inputs and an elasticity of 0.75.

To estimate VMT impacts from roadway expansion projects:

1. Determine the total lane-miles over an area that fully captures travel behavior changes resulting from the project (generally the region, but for projects affecting interregional travel look at all affected regions).
2. Determine the percent change in total lane miles that will result from the project.
3. Determine the total existing VMT over that same area.
4. Multiply the percent increase in lane miles by the existing VMT, and then multiply that by the elasticity from the induced travel literature:

[% increase in lane miles] x [existing VMT] x [elasticity] = [VMT resulting from the project]

Figure 5: Method recommended for estimating VMT impacts on roadway expansion projects. Governor's Office of Planning and Research. 2018, April. Technical Advisory on Evaluating Transportation Impacts in CEQA.

According to the NCST, the NCST Calculator is applicable for General Purpose (GP), High Occupancy Vehicle (HOV), and high-occupancy toll (HOT) lane projects involving the addition of lanes to class 1, 2, and 3 facilities, which cover the SHS and most major arterials. For a specific map of class 1, 2, and 3 facilities, refer to the Caltrans statewide functional classification map available at the website - https://dot.ca.gov/programs/research-innovation-system-information/office-of-highway-system-information-performance/functional-classification. Users of the map need to zoom in closely to their study area for the map to reveal all functional classes.

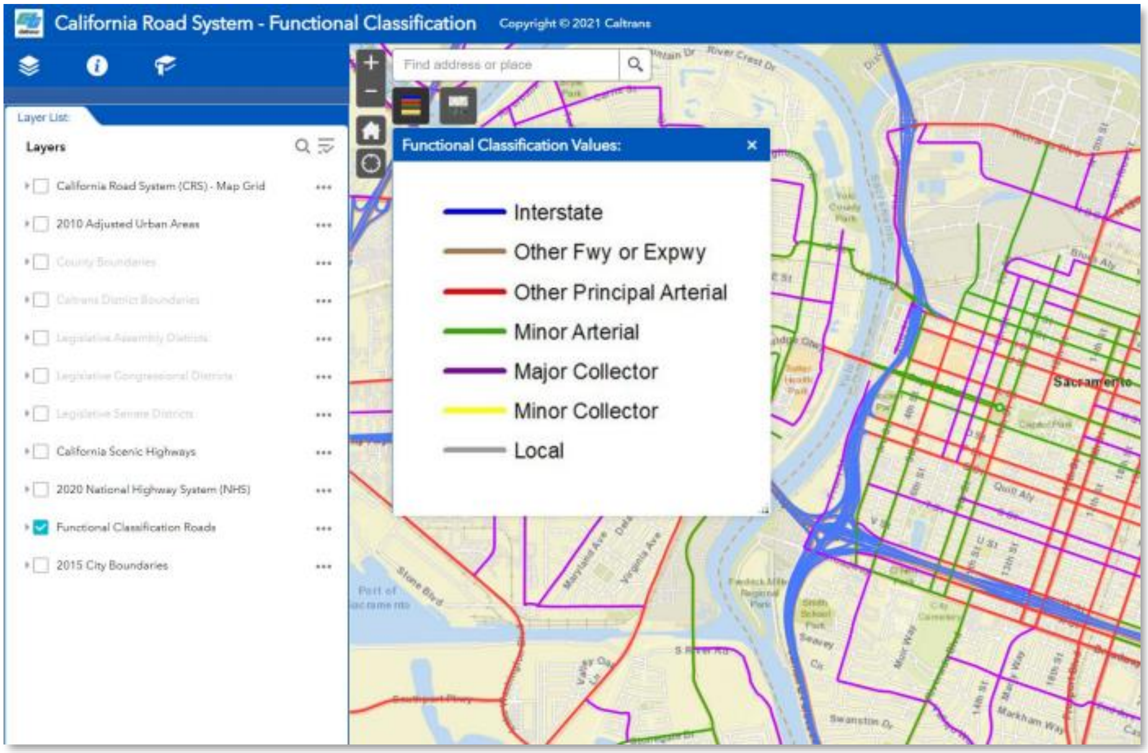

Figure 6: Caltrans Functional Classifications

The elasticities produce a forecast of total VMT attributable to a project, including all VMT (passenger and commercial). This is important because the CEQA Guidelines Section 15064.3(a) states, "For the purposes of this section, 'vehicle miles traveled' refers to the amount and distance of automobile travel attributable to a project." (Emphasis added.)

Given that CEQA only requires evaluation of automobile VMT, the elasticity factor embedded within the likely overstates the VMT that would be necessary to evaluate transportation impacts associated with a project on the SHS. In addition, passenger/automobile VMT is the most closely associated with the legislative intent of SB 743, which aims to influence and encourage infill development, promote public health through active transportation, and enable California to build in a way that allows Californians to drive less.[11]

Modification of the elasticity factor does not solve all the limitations of using an elasticity-based approach and points to the need for a hybrid approach that also deploys a travel demand model to further refine estimates of long-term induced vehicle travel. Specifically, the limitations of the NCST Calculator are noted below.

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[11] CEQA Transportation Impacts (SB 743). Governor's Office of Planning and Research. Retrieved from https://opr.ca.gov/ceqa/sb-743/.

- Most of the data used in the research studies ranges from the 1980s to the early 2000s, although one study extended its data from 1981 to 2015. This period may not be reflective of current VMT trends and may not produce induced travel elasticities that accurately represent HOT/ExpressLane effects given their limited implementation during this time period in comparison to GP and HOV lanes.

  This limitation is especially problematic for the Los Angeles MSA due to the introduction and expansion of ExpressLanes and rail transit[12] occurring since the early 2000s. Although one of the main research studies utilized in support of the NCST Calculator elasticities (Duranton & Turner[13]) concludes that extensions to public transit are not effective policies with which to combat traffic congestion or reduce VMT, this research only measured public transportation as the daily average peak service of large buses; other forms of transit such as railroads and subways were not accounted for in their estimations. In the Los Angeles MSA, it is possible the combination of rail expansion and ExpressLane implementation have resulted in different outcomes, as demonstrated by the recent HPMS data analysis in the introduction, which stands in contrast to statewide trends (and national trends) that form the basis of the studies that the NCST Calculator relies on.

- The elasticities are not sensitive to network effects associated with some roadway capacity projects such as bottlenecks that may have larger effects on travel times as well as bridges that can substantially reduce the distance between origins and destinations. Bridges that close a network gap have the greatest potential for reducing VMT due to shorter trip lengths.

- The elasticities are also not sensitive to project types (GP/HOV/HOT/Express Lanes), land use context, geographic constraints (e.g., water or topography barriers), or the amount of existing congestion. Without sensitivity to the project corridor context, the calculator results may over- or under-estimate induced VMT effects. Specifically, the Duranton & Turner study concludes that congestion pricing is the main candidate tool to curb traffic congestion and induced VMT, with HOT or ExpressLanes presently operating as congestion pricing in Los Angeles[14], but no adjustments are made to account for these project types in the elasticities. This lack of sensitivity is also inconsistent with recent studies that demonstrated that the removal of HOV policies significantly increases traffic

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[12] The Metro A (Blue), B (Red), C (Green), D (Purple), E (Expo), L (Gold), and K lines entered service starting in 1990, 1993, 1995, 2003, 2012, and 2022, respectively, with the Express Lane network operational in 2012.
[13] The Fundamental Law of Road Congestion: Evidence from US Cities, Gilles Duranton and Matthew A. Turner, American Economic Review 101, October 2011.
[14] Congestion Pricing: Examples Around the U.S. Available at https://ops.fhwa.dot.gov/congestionpricing/resources/examples_us.htm

congestion[15] and project context, including project type and project location, result in large variations in elasticities.[16]

- Application of elasticities at the statewide level functionally penalizes projects in low-VMT areas by imposing additional mitigation costs to the project development process. This is directly in conflict with the legislative intent of SB 743, which is intended to encourage project development in areas that have low-VMT patterns, including infill areas. Local refinement to reflect observed VMT patterns is appropriate and consistent with SB 743 and is supported by recent research that concludes that to truly minimize the bias in the elasticity measurements, it is necessary to observe MSAs on a case-by-case basis[17].

- The VMT forecast represents the project-generated effect and does not include information about the No Project condition. This is one of the bigger limitations of elasticity methods because understanding what would otherwise happen without the project is required for CEQA/NEPA impact analysis and essential information for decision making.

- The VMT forecast does not include a distribution of VMT by speed bin, which is commonly needed for air quality and GHG analysis.

- The VMT forecasts do not include potential VMT effects beyond the MSA or county boundaries.

- The elasticity values were derived from research data representing a period when substantial socioeconomic changes were contributing to increasing VMT per capita (e.g., 1980s to early 2000s). This period was also prior to widespread use of transportation network companies (TNCs), substantial internet shopping, expanded food delivery, and recent COVID-19 travel disruptions.

- In uncongested suburban areas, the VMT forecasts from the calculator may be unreasonably high and would not be compatible with observed trip rates and trip lengths. Without congestion, vehicle trip rates and lengths are not influenced or suppressed in these areas. This lack of sensitivity to corridor land use and congestion context means

[15] R. Hanna, G. Kreindler, B. A. Olken (2017.) Citywide Effects of High-Occupancy Vehicle Restrictions: Evidence From "3-In-1" In Jakarta. Available at https://dspace.mit.edu/bitstream/handle/1721.1/114521/CITYWIDE%20EFFECTS%20OF%20HIGH%20OCCUPANCY%20VEHICLE%20RESTRICTIONS.pdf

[16] M. L. Anderson and L. W. Davis (2021). Estimating Induced Travel from Capacity Expansions on Congested Corridors. Available at https://ww2.arb.ca.gov/sites/default/files/2021-04/18RD022.pdf.

[17] J, Wang. G. Leovan. E. Arroyo (2022). The Fundamental Law of Road Congestion: Is it Truly Fundamental?

that adding lane miles in a suburban area with no congestion will have the same proportional effect as adding lane miles in an urban area with multiple hours of congestion. As additional evidence to the lack of latent demand for travel in suburban environments, residential vehicle trip rates in suburban areas have been stable over time across multiple versions of the Institute of Transportation Engineers (ITE) Trip Generation Manual.

- The most recent input data for the calculator reflect 2019 conditions. Given CEQA Guidelines expectations that the baseline year is normally the year in which the notice of preparation (NOP) is released for a project, the induced vehicle travel analysis would be strengthened by using the most recent input data available. More current VMT and lane-mile estimates will become available in the future from the Caltrans Highway Performance Monitoring System (HPMS) and PeMS websites below.
  - https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system https://dot.ca.gov/programs/research-innovation-system-information/highwayperformance-monitoring-system
  - https://dot.ca.gov/programs/traffic-operations/mpr/pems-source

- Finally, Per the UC Davis NCST (the developers of the NCST Calculator) own research effort published in September 2022[18], a "true validation (of the NCST calculator) may not be possible, given the long periods of time over which projects are constructed and induced travel effects occur, as well as the challenge of isolating the effect of a single capacity expansion from the effects of other capacity expansions as well as other factors in real-world settings (e.g., population changes, income changes, shifts in industries and job types, and global pandemics like we have seen with COVID-19)." This inability to validate the Calculator over the long-term time period it purports to measure could very likely result in mitigation investments that far exceed what is actually necessary to reduce a project impact to a level less than significant under CEQA.

Travel Demand Models

Travel demand models estimate travel forecasts by inputting socio-economic data into Transportation Analysis Zones (TAZs) and setting up networks that accurately reflect roadway conditions (number of lanes, functional classification, capacity, speeds, availability of turns, etc.). When looking at different scenarios with a model, such as No Project and With Project, it is vital that comparable data and methods are used for inputs in both.

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[18] Updating the Induced Travel Calculator, 2022, p22. Retrieved from https://escholarship.org/content/qt1hh9b9mf/qt1hh9b9mf.pdf

When utilizing a travel demand model (possibly with off-model post-processing), the full impacts of induced vehicle travel from a capacity-increasing project should include changes in VMT due to changes in:

- Trip length (generally increases VMT)
- Mode shift (generally shifts from other modes toward automobile use, increasing VMT)
- Route choice (can increase or decrease VMT but is likely to decrease emissions because more direct or preferred facility routing occurs)
- Newly generated trips (generally increases VMT)

Travel demand models forecast short-term VMT changes based on variables such as population and employment growth, and income changes, and therefore can reflect context sensitivity for land use and transportation network features. They can be locally calibrated and validated to observed local VMT conditions. Travel models vary in their setup, whether they are activity or trip based, and whether they are able to estimate induced travel related to highway projects.

Travel demand models more often underestimate rather than overestimate induced vehicle travel and are more complicated and time-intensive to run than an elasticity-based calculator. In general, a major issue related to using the travel demand model approach in impact analysis is that most models in California, and the rest of the U.S., do not have feedback processes that influence trip generation rates or land use growth allocation.[19] Hence, these components of the models tend to be 'fixed' versus being dynamically linked to changes in accessibility associated with a transportation network modification. Models also tend to lack dynamic validation to help users understand their level of sensitivity to small network changes. Additional processing is required to handle these limitations of a model before applying to VMT analysis, which are described in the following section.

Travel Demand Model Review

For the purpose of this project, two regional travel demand models were reviewed related to the VMT analysis competence, which are Metro's Travel Demand Model (TDM) (version CBM18B) and the SCAG 2020 ABM. Additional models were considered for review, including the City of Los Angeles, City of Culver City, and City of Pasadena models, but were eliminated early due to their inconsistency with the most recent 2020 SCAG RTP/SCS and the lack of county-wide geographic coverage.

[19] For further discussion of model improvements, see page 18.

Metro's TDM

The Metro TDM has a sophisticated mode choice procedure that estimates the mode shift due to changes in accessibility. The model assignment procedure is capable of reflecting the change in routing/path choice when the roadway congestion level varies.

From the perspective of induced travel, the Metro TDM can estimate induced travel demand due to mode shift between auto modes and other modes, and path shift (using different roadways). However, the Metro TDM does not have any module to estimate potential new trips due to a project, nor changes in origin-destination patterns of person trips due to a project. The overall travel demand (person trip tables) is initially derived from the SCAG Model (using a method that combines results from the 2016 RTP base year model and the 2020 RTP model inputs).

Given this relationship between the SCAG Model and the Metro Model, the evaluation of the Metro Model against the CEQA Guidelines is closely tied to the evaluation of the SCAG 2020 ABM, detailed further below.

SCAG 2020 ABM

Model Assessment

Based on the CEQA Guidelines, the following specific criteria were developed to assess the SCAG 2020 ABM performance related to SB 743 VMT analysis for highway projects on the SHS.

- *Capable of producing regional, jurisdictional, and project-scale VMT estimates* – VMT analysis for air quality, GHG emissions, energy, and transportation impacts requires comparisons to thresholds at varying scales.

- *VMT estimates that do not reflect truncated trip lengths at model or political boundaries* – The OPR Technical Advisory states that lead agencies should not truncate any VMT analysis because of jurisdictional or model boundaries. The intent of this recommendation is to ensure that VMT forecasts provide a full accounting of project effects.

- *Model's Sensitivity in VMT changes from various model inputs*, such as auto operating costs, transit services, transit fare, work from home/telecommute, freeway capacity, principal arterial capacity, household income, neighborhood household density, neighborhood bike lane density, job center parking price, and toll pricing.

- *Inclusion of trip generation and land use feedback process* – The TAF identified the checklist for evaluating model adequacy and stated that the travel demand model should have the capability to predict land use changes and trip generation changes resulted from transportation improvements projects.

The specific assessment findings for the SCAG 2020 ABM are contained in Table 2.

Table 2: Assessment Summary of SCAG 2020 ABM

Assessment Criteria	***Assessment Results***	***Notes***
Capable of producing regional, jurisdictional, and project-scale VMT estimates.	Regional VMT – yes Jurisdictional VMT – yes Project-scale VMT – uncertain; sensitivity tests have indicated some "noise" in the model	Scale of model may be too large for some project level applications. Subarea model calibration and validation may be required for project-scale VMT analysis.
VMT estimates that do not truncate trip lengths at model or political boundaries.	Depends on TAZ location.	The model includes the Counties of Los Angeles, Orange, Ventura, Riverside, and San Bernardino, but truncates trips leaving this area. TAZs central to the region will tend to have less truncation than TAZs at the model border. Other data sources such as household travel surveys or mobile device data may be required to understand the trip lengths and refine the model results.
Model's sensitivity in VMT changes from various model inputs	The model shows reasonable sensitivity in VMT changes from the tested model inputs. The VMT elasticity is shown to range from 0.28-0.40 for freeway capacity and 0.32-0.48 for principal arterial capacity.	The sensitivity results were obtained from the *SCAG's Travel Demand Model Sensitivity Tests Report* dated August 2020. Sensitivity tests were conducted related to project type and project context and are detailed further in the following section.
Inclusion of trip generation and land use feedback process	The trip generation module is not sensitive to travel time and cost. No land use feedback has not been incorporated into model forecasting process at project level. Based on these limitations, the model results reflect short-term VMT sensitivity only.	The vehicle trip generation rates can be manually adjusted into the model, or off-model processing can be applied to refine the VMT forecasts. Follow OPR's recommendations to incorporate the VMT effects that are caused by the subsequent land use changes.

Case Study Results

To evaluate whether the SCAG 2020 ABM is sensitive to local context and project type, and in response to input from the Project Development Team (PDT), a case study was conducted to evaluate the model's sensitivity using the following two highway projects located in an urban and suburban area.

1. *Interstate 5 (I-5) High Occupancy Vehicle (HOV) Project in Santa Clarita (Suburban)*

This project adds a new HOV lane in each direction along a 14-mile I-5 segment from Newhall Pass to Parker Road. It is currently under construction.

For this case study, three scenarios were evaluated for the I-5 corridor: 1) adding a GP lane in each direction; 2) adding an HOV lane in each direction as currently under construction; and 3) adding an HOT lane in each direction along the study segment.

2. *I-10 Express Lane Project (Urban)*

This project includes the addition of Express Lanes along a 16-mile I-10 segment from I-605 to the Los Angeles County border. It is currently under the project approval/environmental document (PA/ED) phase.

For this case study, three scenarios were also evaluated for the I-10 project: 1) adding a GP lane in each direction; 2) adding an HOV lane in each direction; and 3) converting the existing HOV lane to HOT lane and adding the 2nd HOT lane in each direction as currently proposed.

As a result, the following seven scenarios were assessed for the VMT analysis using the Future Year 2045 SCAG's 2020 ABM. The socioeconomic data was held constant under all analysis scenarios.

1. Baseline Scenario (without I-5 and I-10 projects)
2. I-5 GP Scenario (add the I-5 GP lanes)
3. I-5 HOV Scenario (add the I-5 HOV lanes as currently under construction)
4. I-5 HOT Scenario (add the I-5 HOT Lanes)
5. I-10 GP Scenario (add the I-10 GP lanes)
6. I-10 HOV Scenario (add the I-10 HOV lanes)
7. I-10 HOT Scenario (add the I-10 HOT Lanes as currently proposed)

The VMT results were calculated under each scenario for the combined freeway/expressway/principal arterial roadway facility group (which are equivalent to FHWA Class 1, 2, and 3 facilities) within the counties of Los Angeles and Orange (consistent with MSA). Additionally, VMT elasticity was calculated under Scenarios 2 through 7 using the percent change in VMT divided by percent change in lane miles. The VMT results are displayed in Figure 7 and Table 3.

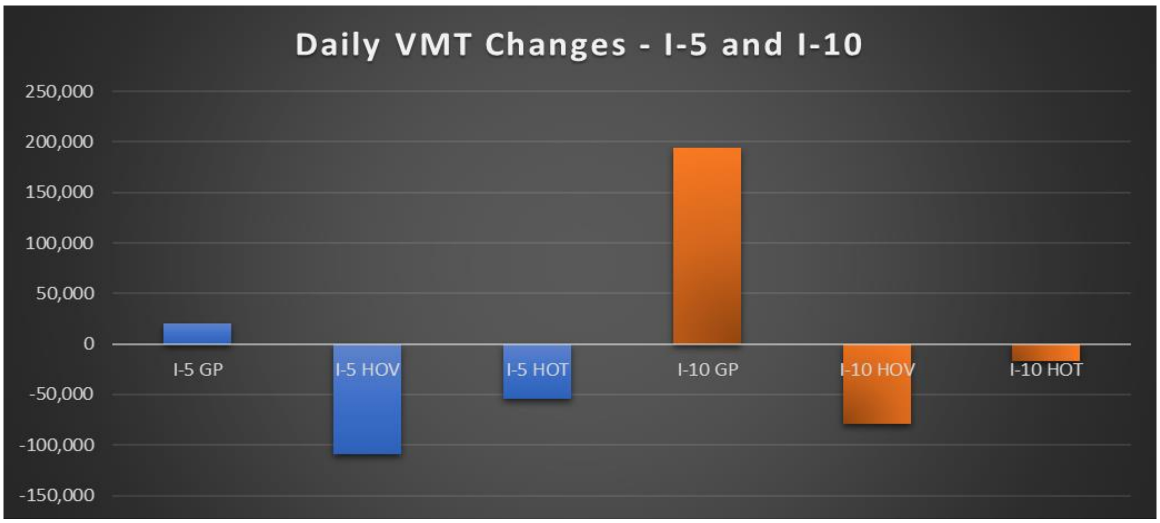

Figure 7: SCAG Model Case Study Results - Daily VMT Changes

Table 3: Daily VMT Results in Los Angeles-Long Beach-Anaheim MSA (LA & OC Counties)

Scenario	Daily VMT	VMT Change	VMT Change %	VMT Elasticity
Baseline	227,046,731	-	-	-
I-5 GP Lane	227,066,754	20,023	0.01%	0.06
I-5 HOV Lane	226,937,209	-109,522	-0.05%	-0.34
I-5 HOT Lane	226,992,941	-53,790	-0.02%	-0.17
I-10 GP Lane	227,240,528	193,797	0.09%	0.48
I-10 HOV Lane	226,967,641	-79,090	-0.03%	-0.20
I-10 HOT Lane	227,029,716	-17,015	-0.01%	-0.04

Source: Fehr & Peers, 2022.

The model shows sensitivity to local context as anticipated, with a greater VMT elasticity for the I-10 corridor in a more urban setting than the I-5 corridor located in a more suburban area. Project type also resulted in a variation in VMT changes, with increased VMT when adding GP lanes (higher in an urban area with latent demand due to currently-congested conditions) and a reduction in VMT with inclusion of HOV or HOT lanes (smaller reduction in an urban area where latent demand exists due to currently-congested conditions). Note, these location-specific and type-specific changes are likely to be different as the land use and transportation network context varies. For example, in hyper-congested environments, demand for travel may not increase with new capacity as rapidly as in areas with less congestion.[20] In these environments, one explanation may be that the available time budgeted for household travel is already expended or over-extended and travel time savings from new managed capacity may not be substantial enough to make a difference in back-filling the new time that was created with new trips.[21]

Model Improvements and Application Considerations

Currently, the SCAG 2020 ABM – and therefore the Metro Model – does not clear the TAF model checklist. The requirements described in the TAF model checklist create a high bar to clear, should an agency prefer to use a model-based approach rather than an elasticity-based approach. Current models in use in California cannot meet all the criteria on the checklist without modification. If SCAG's 2020 ABM is preferred to produce long-term induced travel, the[19] following improvements to the model are recommended to address the limitations identified in Table 1 and meet the TAF model checklist for VMT analysis.

Sensitivity to trip generation – If a trip generation module is not sensitive to travel time and cost, the analyst can manually adjust the vehicle trip generation rates or use off-model processing to increase the VMT forecasts. For example, using an "induced demand" sub-model, trips could be added or removed from the auto trip matrix using a logit equation that compares travel times of future years to travel times of the base year to determine the scale of trip additions/reductions. Other agencies across California have explored the development of such a sub-model to address this feedback loop need but have not yet implemented an approach.

Dowling Associates (1994) conducted a travel behavior survey of residents in San Francisco and San Diego to better understand direct traveler responses to travel time changes.[22] This study found that a five-minute time savings would cause survey respondents to make an extra stop or change their destination for only about 4% of their trips. This paper also cites a Dutch study that found that over 90% of the observed increase in traffic volumes on a new freeway in a congested

[20] RAND and WSP. Latest Evidence on Induced Travel Demand: An Evidence Review (May 2018).

[21] For more information on the concept of a travel time budget, see Stopher, Ahmed & Liu (2016), available at https://link.springer.com/article/10.1007/s11116-016-9694-6.

[22] Dowling Associates for the California Air Resources Board. Effects of Increased Highway Capacity on Travel Behavior (1994).

area are the result of changes in the time a trip is made, and changes in the route taken.[23] Together, these indicate a limited sensitivity to new trips generated as a result of new capacity.

Adjustments may not be appropriate or necessary in suburban or rural areas where congestion is not severe enough to suppress existing vehicle trip making. In these settings, land uses are already generating vehicle trips at full demand levels (i.e., rates similar to those in the ITE Trip Generation Manual). A comparison to ITE rates could be used as evidence to determine whether an adjustment is necessary, and if so, the level of appropriate adjustment.

Sensitivity to land use – OPR's recommendations can be followed to incorporate the VMT effects that are caused by the subsequent land use changes.

- Employ an expert panel, including local agencies' land use planners, to develop a scenario of anticipated land use growth for project alternatives. This process should recognize whether land use effects are intra- or inter-regional. If population is attracted from an adjacent region, the difference in VMT per capita generation rates may also need to be addressed.
- Adjust model results to align with the short-term elasticity research. Note that this is only possible for short-term elasticities, which range from 0.1-0.60 as documented in the California Air Resources Board (CARB) research noted above. Please note that short-term VMT forecasts from travel models are not directly comparable to long-term VMT forecasts based on elasticity factors.
- Employ a land use model, running it iteratively with a travel demand model. A wide range of land use models exist but most are likely to be too time-consuming or costly to apply for an individual project. At the regional scale, options such as the University of California (UC) Davis' UPlan regional land use model, CommunityViz, UrbanSim, and others can incorporate attractors such as highways, highway ramps, major arterial roads, minor arterial roads, transit lines, and existing land use development, assigning future regional growth to the areas around these attractors based on the strength of attraction of each feature and the distance from each feature.

Fixed parameters for IX trips, XI trips, and medium/heavy-duty vehicle trips – The SCAG 2020 ABM uses fixed parameters for internal-external (IX) and external-internal (XI) trips as well as medium/heavy-duty vehicle trips, which does not allow for any feedback to these variables based on changes to other model parameters. This can be rectified through model refinements and modifications.

[23] A. L. Loos, P. H. L. Bovy, and T. Van Der Hoom (1991). The M10 Amsterdam Orbital Motorway: Effects of Opening upon Travel Behavior. Available at https://repository.tudelft.nl/islandora/object/uuid%3A7c6c408c-b90f-4524-9d99-d827dcccb70f.

Static versus dynamic traffic assignment – A final issue that is whether (and how) a model uses static traffic assignment (STA) instead of dynamic traffic assignment (DTA), and how that affects VMT forecasts. One research paper directly comparing STA and DTA estimates revealed how the limited sensitivity of STA over-predicts traffic volumes, which would contribute to overestimates of VMT.[24]

Despite the noted model limitations, a model may still be useful to understand the incremental difference between project alternatives that the NCST Calculator or other elasticity methods will not reveal. The model's forecasts of VMT can also be stratified by speed bin, which is important for emissions analysis, and disaggregated to understand the relative share of VMT that is comprised by light duty (or passenger) vehicles relevant for transportation impact determination, and the relative share of medium or heavy-duty vehicles, reflecting commercial travel. Thus, use of a travel demand model may be useful under the following conditions.

1. Comparisons between no build and build alternatives in the same analysis year are useful for impact-related decisions. This comparison can be used to estimate a short-term induced vehicle travel elasticity that can be compared against the short-term academic elasticity estimates for reasonableness.
2. The NCST Calculator is not applicable due to project type, or has greater limitations than a travel demand model based on substantial evidence about the specific characteristics of the project.
3. VMT by speed bin or vehicle type is needed to evaluate emissions for air quality, transportation, or GHG analysis.

Suggested Quantification Approach for Metro's VMT Mitigation Program

Metro's SHS Project List contains 55 projects at the writing of this memo and includes projects and programs from several sources such as Measure R, Measure M, and the 2020 Long Range Transportation Plan (LRTP). The projects and programs are currently in varying phases, ranging from pre-planning to planning, environmental review, final design, and construction. Due in part to the variety in originating plan and current status, the current level of detail about each project also varies widely. Thus, there is a limit to how accurately presumptions can be made regarding potential impacts at this stage.

Project types on this list include grade separations, soundwalls, interchange and ramp modifications, Intelligent Transportation Systems (ITS) and other technological upgrades, addition

[24] Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment, Research in Transportation Business & Management, Vol. 29, pp 85-92. 2018.

of HOV lanes, HOT lanes, or Express Lanes, auxiliary lanes, collector-distributor roads, various efficiency and safety upgrades, and new highways.

Based on the assessments of VMT quantification tools and SCAG's 2020 ABM, the following quantification approaches are recommended at a program level and at a project level.

Program Level

To refine the NCST Calculator results to align with the CEQA Guidelines and the legislative intent of SB 743, only the induced VMT related to automobile travel at the individual/household level should be included. Furthermore, the induced VMT elasticity factor should be more in line with the results of the SCAG model tests, which demonstrate an over-estimation of induced VMT compared to the observed VMT trends in the Los Angeles MSA.

One of the main research studies used to support the NCST Calculator's approach offers one approach to isolating the induced travel related to individual/household travel changes. Based on Duranton & Turner's analysis, changes in individual or household driving account for 9%-39% of all induced VMT associated with a 10% increase in lane miles.

Concentrating on the induced VMT effects associated only with automobile travel and applying these percentages to a 1.0 starting elasticity (the NCST Calculator's elasticity for Class 1 facilities) produces a range in elasticity values from 0.09 to 0.39 (9% of 1.0 to 39% of 1.0). Applied to a 0.75 starting elasticity (the NCST Calculator's elasticity for Class 2 and 3 facilities), the range becomes 0.07 to 0.29 (9% of 0.75 to 39% of 0.75).

An elasticity of 0.39 – the result of applying the high end of the 9%-39% range described above to the 1.0 elasticity in the NCST Calculator – is also aligned with research by Robert Cervero, who demonstrated a long-term elasticity of 0.39 based on California data and relying on a modeling methodology that accounted for the effect that previous development and roadway capacity investment had on influencing lane mile increases.[25] Other studies have also found an elasticity of lane-miles with respect to total VMT of 0.33 revealing a strong two-way relationship where every 10% increase in VMT, lane-miles grew by 3.3%.[26] Additionally, studies that estimate elasticities of demand with respect to road capacity considering all road types (and therefore controlling for reassignment/trip diversion effects) at the state or regional level find smaller induced demand effects, such that a 10% increase in capacity would result in induced demand in the range 1% to

[25] Road Expansion, Urban Growth, and Induced Travel – A Path Analysis, Robert Cervero, APA Journal, Spring 2003, Vol. 69, No. 2.

[26] Induced Travel Demand and Induced Road Investment: A Simultaneous Equation Analysis, Journal of Transport Economics and Policy, Vol. 36, No. 3, pp 469-490. September 2002.

4%.[27, 28] Finally, where the impact of road capacity that adds to the length of the road network is distinguished from lane capacity increases for the existing network, the former can be interpreted as an accessibility effect.[29, 30] This is associated with a smaller elasticity (approximately 0.3). Finally, these elasticity factors are also more in line with the elasticity factors produced by the SCAG Model sensitivity tests and case studies.

Therefore, a refinement to the 1.0 elasticity factor embedded in the NCST Calculator can be used to generate long-term VMT changes at the MSA level while controlling for variables such as population growth, employment growth, and income changes. Substantial evidence exists across multiple research studies, SCAG Model tests, and observed VMT data to justify an elasticity closer to 0.39 to account only for long-term induced automobile travel for Class 1 facilities and a 0.29 elasticity factor for Class 2 and 3 facilities.

For the VMT Mitigation Program, rather than using the 1.0 elasticity factor for Class I facilities, the suggested approach would start with a modified elasticity factor and incorporate further adjustments from the SCAG 2020 ABM to establish a range of induced vehicle travel using the two available quantification tools discussed in the previous section.

1. Modify Elasticity Factors in the NCST Calculator to Exclude Freight VMT and Reflect Local Conditions

As described above, medium and heavy-duty vehicle VMT is embedded within the data that underpins the NCST Calculator. These vehicle classes capture regional freight and commercial travel which supports not only the Southern California region but the rest of the US as well, is not separated out from the NCST Calculator's elasticity factors and assumptions. In recognition of the regional and national nature of this type of driving, SB 743 only requires lead agencies to consider passenger travel (light duty vehicles and trucks) when determining VMT impacts, as this type of travel is the most influenceable by lead agencies' transportation and land use planning decisions.[31] As such, isolating automobile VMT helps communicate what is likely to be influenced by a project, and similarly, what could be influenced by mitigation actions. The NCST Calculator currently omits this important policy distinction in its calculations.

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[27] Hymel, Kent M., Kenneth A. Small, and Kurt Van Dender. 2010. "Induced demand and rebound effects in road transport." Transportation Research Part B: Methodological 44 (10): pp 1220-1241.
[28] Gonzalez, Rosa Marina, and Gustavo A. Marrero. 2012. "Induced road traffic in Spanish regions: A dynamic panel data model." Transportation Research Part A: Policy and Practice 46 (3): pp 435-445.
[29] Hsu, W-T and H. Zhang. 2014. "The fundamental law of highway congestion revisited: Evidence from national expressways in Japan." Journal of Urban Economics 81: 65–76.
[30] Pasidis, I. 2017. 'Urban transport externalities.' PhD Thesis, University of Barcelona.
[31] Note, total VMT is required for Air Quality, GHG, and Energy impact analysis under CEQA.

The final adjusted elasticity factor is consistent with the high end of the range for changes in VMT due to individual or household driving as presented in Duranton & Turner (2011), or 39% of the total induced VMT, for an elasticity factor of 0.39 or 0.29 depending on the facility classification. The modified VMT elasticity factors are shown in Table 4, in comparison to the original NCST elasticity factors. The modified VMT elasticity factor will then be applied to the total lane mile additions from the multi-modal highway program to calculate the induced vehicle travel.

These factors fall within the induced VMT range used by Metro's *Climate Emissions Analysis: Metro's Indirect Impact on Greenhouse Gas Emissions* (Climate Emissions Study) presented to the Board of Directors in August 2022.[32] The range used in that study was based on a short-term elasticity factor of 0.23 from SCAG-authored sensitivity tests and a long-term elasticity factor of 1.0 from the NCST Calculator. The Climate Emissions Study did not exclude medium or heavy-duty vehicle travel from the analysis.

Table 4: NCST VMT Elasticities & Adjusted Elasticity Factor

Tool	***Elasticity***	***Source***
NCST – Class 1 Facilities (Short + Long Term)	1.0	NCST
NCST – Class 2 and 3 Facilities (Short + Long Term)	0.75	NCST
Modified NCST - Class 1 Facilities (Short + Long Term) ***VMT Only for Passenger (Light-Duty) Cars and Trucks***	0.39	NCST, Cervero, Duranton & Turner
Modified NCST – Class 2 and Class 3 Facilities (Short + Long Term) ***VMT Only for Passenger (Light-Duty) Cars and Trucks***	0.29	NCST, Cervero, Duranton & Turner

The benefit of this method is that it requires a lower effort than a modeling-based approach and can be operationalized through a spreadsheet tool. However, it has the limitations noted in the previous section. Relying on this method alone may not provide a complete picture of potential VMT effects and may over-estimate the impact of induced vehicle travel by not accounting for other factors contributing to long-term traffic increases.

[32] LA Metro. Climate Emissions Analysis: Metro's Indirect Impact on Greenhouse Gas Emissions. August 2022. Retrieved from https://metro.legistar.com/LegislationDetail.aspx?ID=5759433&GUID=230DEBE4-8769-4DE1-B67E-DD79194C2CA6&Options=&Search=

2. SCAG's 2020 ABM

In addition, SCAG's 2020 ABM will be used to develop two model scenarios with and without the highway improvements projects, the VMT results of which will be obtained to determine the short-term induced VMT resulting from the program. As noted previously, this approach provides merits of reflecting the local context, but may underestimate induced VMT due to the revealed limitations. The results of this comparison will allow for further refinement of the elasticity factor used at the program level.

Results from the two quantification methodologies would establish a final range of induced VMT for the highway improvements projects at the program level, which will be used to develop the mitigation program that meets the program objectives and provides flexible and viable mitigation options. As noted in the introduction, this memorandum is intended to articulate the approach, and does not present the quantification results of this methodology. Task 6, development of a VMT Tool, will incorporate quantification results.

Project Level

At a project level, since an elasticity-based approach (such as the modified NCST Calculator elasticity factor approach described above) is not directly applicable for many of the project types contained on Metro's project list, using a hybrid approach is likely to be more appropriate when quantification is required. The steps to estimate induced vehicle travel for a project on the SHS are described below.

Step 1 – Project Screening for Quantification Needs

The first step is to determine whether the project should be presumed to not result in a VMT impact and therefore excluded from needing to perform an induced travel analysis, following the project screening guidance provided in the TAC. The TAC states that the emphasis of this guidance is to identify those projects that will lead to a measurable and substantial increase in vehicle travel. Projects not likely to lead to a measurable and substantial increase in VMT generally should not require an induced travel analysis per OPR's Technical Advisory. While the TAC provides a list of 32 project types that are screened from induced travel analysis, it also states additional project types could be added to the screening list if they are not likely to lead to a measurable and substantial increase in VMT.

The following project types are anticipated to meet this criterion and therefore are recommended to include to the screening project list in TAC.

A. **Auxiliary lanes:** Auxiliary lanes (also known as acceleration/deceleration lanes and speed change lanes), allow drivers to either increase or decrease their speed in an area where high-speed highway mainline traffic is not present and are supplementary to through-traffic movement. The speed difference between the highway mainline and on- and off-ramps or surrounding streets can be significant, introducing turbulence resulting in stop-and-go traffic and increased collision rates. Regardless of length, auxiliary lanes that are designed primarily to improve safety of existing lanes by facilitating weaving may add miles but are not likely to influence travel behavior in terms of number of trips or trip distance because they do not change the fundamental availability of the roadway once the vehicle is on the mainline of the freeway.

B. **Truck only lanes in the urban context:** Adding lane miles for trucks (commercial) travel is not likely to translate meaningfully to additional capacity for the general public such that new travel is induced. Truck only lanes serve to increase truck travel time reliability, increasing efficiency of passenger and transit vehicles on main traffic lanes by removing turbulence introduced by slower moving heavy trucks, and increase safety by removing heavy trucks from main traffic flow. Truck (commercial) travel is also insensitive to roadway capacity with this demand unable to use alternative modes in the absence of new capacity. Truck only lanes primarily serving safety-related goals rather than travel time related goals are not likely to influence travel behavior.

C. **Operational improvements:** Projects that improve operations through and do not add through-traffic lane miles to the freeway mainline, in addition to those operational projects listed in the TAC (such as collector-distributor roads), are not likely to translate meaningfully to additional capacity. These projects may solve bottleneck issues during a peak period and address operational issues of traffic backing up onto neighborhood streets, which both have safety implications, but are not likely to induce new trip-making or change the length of trips already on the network.

D. **Ramp reconfiguration projects:** Projects that add lane miles by reconfiguring on/off ramps but do not change the fundamental availability of the roadway once a person is on the mainline are unlikely to translate to additional capacity and induced VMT. Any additional VMT resulting from the additional length of the reconfigured ramps would be analyzed at the project level and disclosed.

E. **Congestion pricing and lane management projects that are intended to manage traffic to reduce VMT:** While some roadway management projects are designed to maintain certain travel speeds or result in congestion reduction primarily, projects that include pricing and high-occupancy features designed to influence travel behavior can counter-balance induced travel effects.[33]

Step 2 – Identify VMT Quantification Method

If induced vehicle travel quantification is required for a project on the SHS, the appropriate method will be identified based on project types, knowing an elasticity-based approach is not directly appliable to many types. A hybrid method can integrate both the SCAG 2020 ABM, and future iterations of the ABM, and the modified NCST elasticity-based methods. This approach allows the same land uses for all alternatives but should acknowledge the limitation of using fixed land use inputs. Notably, the discussion would describe which alternative the land use forecasts best reflect and how the accessibility differences between the alternatives could affect the allocation of future growth. The SCAG 2020 ABM will be used to forecast the short-term induced travel effect for the build condition of project alternatives, while the modified elasticities from the NCST calculator will be used to forecast long-term VMT effects of the project build alternatives. The elasticity will be modified to address limitations as described in Table 3 above and is anticipated to produce a low-end and high-end of a long-term induced vehicle travel range.

The details of this method are listed below.

1. The SCAG 2020 ABM will be used to generate volume forecasts and VMT information for No Build and Build alternatives with a fixed set of land use forecasts.

    - Metro will inform the analyst whether these land use forecasts represent the build or no build condition.
    - Typically, project development and environmental impact analysis is only performed on projects that have already been included in a regional transportation plan, so SCAG's land use forecasts are most likely to represent build conditions.
    - The environmental document will disclose the limitations of the model with an acknowledgement that the actual land use will likely differ among alternatives. Where appropriate, the analyst can qualitatively explain how the project could affect land use and what the likely outcome would be in terms of the direction of change with respect to vehicle trips and VMT.
    - Short-term induced vehicle travel effects will be generated for each of build alternatives, using the SCAG 2020 ABM.

[33] This type of managed lane has not yet been implemented in California, but has been suggested on at least one project in Caltrans District 4, which had a Draft EIR circulated at the time of writing this memorandum. DEIR available at https://dot.ca.gov/-/media/dot-media/district-4/documents/37-corridor-projects/sr37-draft-eir-ea-1q7600-sears-pt-mare-island-proj-vol1-a11y.pdf, with information about the tolling scenarios described on page 2-56.

- For base year and open year with project scenarios, the Home-based Work and Home-based University/School trips should be held constant as in the corresponding No-Build scenarios, because the work and university/school locations will not change immediately due to the project.

2. A modified long-term elasticity factor will be employed to generate the long-term induced travel effect for VMT, following the steps shown in the flowchart on the next page and described below.

   A. If multiple alternatives are involved, a modified long-term elasticity of 0.39 will be used to generate the long-term induced travel for the "Base" Build Alternative, e.g., the GP Alternative. The elasticity of 0.39 was derived from the "individual and household travel" component part of induced travel only, as described above. This approach represents the GP capacity improvement projects in a typical urban area. In the event that the short term induced vehicle travel effects produced in the step above exceeds a 0.39 elasticity factor, the higher of the two values should be used to ensure all potential long-term impacts are accounted for. An example of these two cases is shown below.
   B. The SCAG 2020 ABM results described in the earlier section (I-5 and I-10 case study analysis) showed there is a difference in the elasticity values between urban and suburban areas when determining the short-term induced travel. However, the recent UC Davis update to the NCST research and Calculator indicated no difference in long-term elasticity values for urban versus suburban context. Therefore, to consider the conservative approach, the same elasticity of 0.39 will be applied to determine the long-term induced travel for both urban and suburban projects.
   C. For projects in which the GP Alternative is not considered, a GP scenario will be introduced only to establish the "Base" Build Alternative for comparison purpose.
   D. For other build alternatives, such as HOV or HOT scenarios, the long-term induced travel effect for VMT will pivot from the "Base" Build Alternative's VMT estimate by applying an incremental difference between each alternative and the "Base" Build Alternative derived by evaluating the alternatives using the SCAG 2020 ABM. That incremental difference will then be applied to the "Base" Build's long-term induced travel estimate to generate the long-term induced travel effects for each other alternative.
   E. The SCAG 2020 ABM results (short-term induced VMT) and the elasticity-factor results (long-term induced VMT) can then be reported as a range, and the environmental assessment could be based on the higher long-range VMT estimate for the purposes of identifying mitigation needs. This minimizes the risk associated with potential underestimation of induced vehicle travel.

Does the project have a GP-only Alt?

N → Introduce a GP Alt for comparison purposes

Y

Long-Term Elasticity for **GP Alt** = 0.39

Long-Term Elasticity for other Alts = Long-Term Elasticity for GP Alt + elasticity delta from SCAG 2020 ABM when compared to GP Alt (no lower than zero)

Induced Travel for each alternative will be presented as a range between **Short-Term Induced Travel** (from SCAG 2020 ABM) and **Long-Term Induced Travel** (from above steps)

Use Long-Term Induced Travel (from above steps) for **environmental assessment and mitigation identification** if needed.

Elasticity Calculations for I-5 Corridor Case Study

Long-Term Elasticity for Alternatives

GP Alt	0.39
HOV Alt	=0.39 – Delta of Elasticity Values from SCAG 2020 ABM (GP Alt – HOV Alt) =0.39 – (0.06 - (-0.34)) =0.39 – (0.4) = **-0.01** Since the calculated value is below zero, the long-term elasticity value is set to be zero under the HOV Alt.
HOT Alt	=0.39 – Delta of Elasticity Values from SCAG 2020 ABM (GP Alt – HOT Alt) =0.39 – (0.06 - (-0.17)) =0.39 – (0.23) = **0.16** The long-term elasticity value is set at 0.16 under the HOT Alt.

Elasticity Calculations for I-10 Corridor Case Study
Long-Term Elasticity for Alternatives

GP Alt	0.48
HOV Alt	=0.48 – Delta of Elasticity Values from SCAG 2020 ABM (GP Alt – HOV Alt) =0.48 – (0.48 - (-0.20)) =0.48 – (0.68) = **-0.20** Since the calculated value is below zero, the long-term elasticity value is set to be zero under the HOV Alt.
HOT Alt	=0.48 – Delta of Elasticity Values from SCAG 2020 ABM (GP Alt – HOT Alt) =0.48 – (0.48 - (-0.04)) =0.48 – (0.52) = **-0.04** Since the calculated value is below zero, the long-term elasticity value is set to be zero under the HOT Alt.

For projects on the SHS, this method should be reviewed with Caltrans staff prior to application given the TAF recommendations and the potential for the TAF to continuously be updated as new information and research is published. Please note that the induced vehicle effects not captured by the travel demand model could influence the peak hour design volumes used in traffic operations analysis and the VMT by speed bin estimates used for emissions analysis. At a minimum, these limitations will be acknowledged and disclosed in the environmental documents.

To help facilitate future Caltrans reviews of the model or induced vehicle travel analysis conducted with the SCAG 2020 ABM, it is suggested that Metro conduct an early review of the model against the TAF First Edition model checklist noted above for each project as it advances through the environmental review process. The intent of this review is to demonstrate the model's ability to meet the sensitivity expectations set forth in the checklist for the specific project under study. This review can be coordinated with Caltrans Headquarters and District 7 staff to build consensus around the findings. If the review reveals any limitations of the model beyond the limitations described here, they could be addressed to help prepare the model for future applications on subsequent projects and/or incorporated into the scoping for the next major project required to apply the model.

Step 3 – Identify VMT Mitigation Opportunities

For projects with significant induced vehicle travel impacts, the final step is to identify appropriate mitigation strategies that match the project needs, which could be specific mitigation opportunities/strategies or through the established VMT Mitigation Program. Where possible, project features may be able to be incorporated as part of an evaluated alternative that may reduce the magnitude of VMT mitigation needed.

Conclusion & Next Steps

This memorandum is intended to provide clarity on an approach to quantifying induced vehicle travel at a program level and at a project level for future environmental review of projects on the SHS in Los Angeles County. Recognizing that the policy and regulatory landscape in this space is evolving, this document outlines a hybrid approach to setting a lower and upper boundary of a range for project-related VMT impacts that is in line with recent applications of the policy guidance.

For the purposes of developing the VMT Mitigation Program, quantifying the magnitude of how much VMT mitigation may be necessary to fully mitigate Metro's SHS project list is difficult to define at this time due to lack of specific details for each potential project alternative, due to the flexibility afforded to subregions in how to scope projects. In addition, project specifics would be defined through upstream phases of project development which would include close coordination and partnership with Metro's subregional project leads and Caltrans. These upstream phases may directly incorporate VMT reduction strategies or may define a Purpose and Need that would influence project approvals regardless of the project's ability to mitigate VMT impacts. Regardless of these upstream project development activities, Metro anticipates a need for future projects to have mitigation options available to them that currently do not exist.

The forthcoming development of the VMT quantification tool in Task 6 will allow individual projects to test ways to mitigate associated VMT through quantified mitigation actions. By the conclusion of the VMT Mitigation Program, the program framework will help provide clarity in quantifying VMT impacts, pathways to mitigation on a project level, and information to help the agency make informed decisions about project alternatives and tradeoffs between the benefits of capacity increasing highway improvement projects and the cost of VMT mitigation.