Transportation Analysis Framework

Second Edition*

Evaluating Transportation Impacts of State Highway System Projects

California Department of Transportation
Sacramento, California
September 2024

***** Important updates to the Second Edition will be posted to the "Internal Bulletins" and "Hot Topics" section of the Caltrans SB 743 website at https://dot.ca.gov/programs/esta/sb-743/resources.***

ACKNOWLEDGEMENTS

The *Transportation Analysis Framework* (TAF) and *Transportation Analysis Under CEQA* (TAC) were originally prepared by the California Department of Transportation (Caltrans) working with state administration partners and stakeholders from the public, private and non-profit sectors. Second edition contributors include staff and management from the Headquarters Divisions of Environmental Analysis, Transportation Planning, Traffic Operations, and Legal, as well as from the Director's Office of Sustainability. The Headquarters team benefitted from input provided by the Caltrans Executive Team, staff and management from Caltrans districts, stakeholders involved in the SB 743 Implementation Working Group, and interested members of the general public. The second editions of the TAF and TAC include updates and clarifications to elements of the original guidance, but the analysis framework detailed in the first editions remains largely the same.

The first edition documents were the products of a collaboration among state government partners. Throughout the development of the first editions, the Caltrans team worked closely with technical and policy experts from the Governor's Office of Policy and Research (OPR) and the California Air Resources Board (CARB).

We are grateful for the time and effort that contributors generously gave to develop and document Caltrans' approach to analyzing and evaluating transportation impacts of projects on the State Highway System (SHS).

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FOREWORD

The second editions of the TAF and TAC are intended to guide CEQA transportation impact analysis for projects on the SHS. They include clarifications and updates to the guidance published over the last four years in Bulletins and Hot Topics on the SB 743 Implementation Resources webpage hosted by the Director's Office of Sustainability. Caltrans prepared these documents to guide implementation of Senate Bill (SB) 743 (Steinberg, 2013). The TAF and TAC establish Caltrans guidance on how to analyze induced travel associated with transportation projects and how to determine impact significance under CEQA, respectively. These documents guide transportation impact analysis for projects on the SHS only. The non-capacity-increasing maintenance projects like re-paving and filling potholes are unaffected, as are many safety improvements, including traffic calming measures to slow traffic, and transportation projects that create facilities for pedestrians and cyclists and transit projects.

The first editions of the TAF and TAC were released in September 2020 and underwent extensive discussions and reviews. For the first editions, Caltrans hosted a total of 130 meetings with stakeholders and provided a 60-day informal feedback period on the draft documents. Statewide outreach events included two external webinars attended by over 850 participants, and three external technical roundtables attended by more than 150 participants. These Caltrans events were supplemented by OPR's webinar and Office Hours outreach which reached over 3,500 participants. Additionally, Caltrans met regularly through the guidance development process with key stakeholders including the Self-help Counties Coalition, the ClimatePlan coalition, and the Rural Counties Task Force. Caltrans received feedback on the drafts from 37 agencies including counties, cities, and MPOs as well as from consultants, advocates, coalitions, and other state agencies. Throughout the process, a small number of controversial issues stood out. To address the difference of opinions around key technical issues, Caltrans convened an expert panel of academics and practitioners through the University of California, Berkeley Tech Transfer. The panel chair presented the group's conclusions to stakeholders at a virtual Technical Roundtable prior to finalizing the group's recommendations. Caltrans and state partners accepted the panel's recommendations, which are reflected in the guidance documents. The Caltrans TAF and TAC guidance documents reflect a cultural shift for how Caltrans interprets, analyzes and mitigates transportation impacts. This shift impacts the entire project delivery process and shapes the future of California's transportation system. These documents reflect the best available analytical tools and guidance.

This September 2024 iteration of the TAF and TAC serves as the second edition of the guidance. Members of the SB 743 Implementation Working Group, composed of stakeholders from the public, private and non-governmental sectors, provided input and recommendations to inform efforts. In addition, the TAF and TAC were distributed through the Caltrans SB 743 email list to provide interested members of the public the opportunity to review the draft guidance documents. While much of the content remains the same, minor changes have been informed by the Hot Topics and Bulletins that were previously posted to the Caltrans SB 743 website. The purpose of the Hot Topics and Bulletins were to provide important practitioner updates to the first editions of the TAF and TAC as issues arose during project delivery. The updates reflect an evolving understanding of SB 743 implementation since September 2020. All updates have thus been consolidated into this second edition, along with other minor clarifications and edits.

Caltrans continues to engage with partner agencies to explore emerging methodologies and strategies to address VMT. As SB 743 continues to be implemented, we anticipate opportunities to make refinements in future editions and/or through interim guidance updates via the Hot Topics and Bulletins on the Caltrans SB 743 website at https://dot.ca.gov/programs/esta/sb-743/resources.

1 INTRODUCTION

1.1 OVERVIEW OF GUIDANCE DOCUMENTS

This document, the second edition of the TAF, is one component of a set of materials prepared by Caltrans to guide the implementation of SB 743 (Steinberg, 2013) in 2020. The TAF is a companion to the TAC, which describes changes to the environmental review process for many projects on the SHS. These changes better align the analysis of transportation impacts with state objectives for greenhouse gas emissions reduction, preservation of the environment, and public health. Caltrans is committed to providing a safe and reliable transportation network that serves all people and respects the environment. Practitioners should consult both documents in conducting a transportation analysis.

Additionally, OPR has prepared a *Technical Advisory on Evaluating Transportation Impacts in CEQA* ("OPR Technical Advisory") in 2018 to assist agencies conducting a transportation impact analysis for both land use and transportation projects based on Vehicle Miles Traveled (VMT). Caltrans adapted information from OPR in developing the second edition of this guidance. Practitioners should consult the TAF and TAC when evaluating transportation impacts of transportation projects that are on the SHS, regardless of lead agency.

1.2 PURPOSE OF THE TRANSPORTATION ANALYSIS FRAMEWORK

The purpose of the TAF is to assist Caltrans district staff and others responsible for assessing likely transportation impacts as part of environmental review of proposed projects on the SHS by providing guidance on the preferred approach for analyzing the VMT attributable to proposed projects (induced travel) in various project settings. The TAF and TAC together provide the guidance needed to implement amendments to the 2018 CEQA Guidelines and Caltrans policy for analyzing transportation impacts. The policy states:

Consistent with the language of Section 15064.3 of the CEQA Guidelines, Caltrans concurs that VMT is the most appropriate measure of transportation impacts under CEQA. The determination of significance of a VMT impact will require a supporting induced travel analysis for capacity-increasing transportation projects on the SHS when Caltrans is lead agency or when another entity acts as the lead agency.

Many types of projects will be unaffected by the use of VMT as the metric for determining transportation impacts because they are assumed not to lead to a substantial increase in vehicle travel. See Section 5.1 of the TAC for further details regarding screening. Note that for transportation projects not on the SHS, per the CEQA Guidelines, local agencies have the discretion to select a different metric for determining transportation impacts. However, teams delivering transportation projects that are on the SHS, regardless of lead agency, should follow this guidance.

This Framework focuses on the analysis of transportation impacts only. It is not intended to supersede guidance for analysis under CEQA of other resources (such as air quality or noise) or under the National Environmental Policy Act (NEPA). Those analyses have their own distinct requirements.

The TAF is to be used in conjunction with the guidance provided in the TAC. The flow chart provided in Figure 1 illustrates the steps for transportation impact analysis using the TAC and TAF. As shown, if a project is determined to be of a type that is likely to induce travel, the analyst follows the framework described in the TAF. The TAF framework should be applied to the proposed project and all project alternatives. The results of applying the TAF's analytical framework is intended to provide the substantive information from which significance determinations under CEQA can be made, as further described in the TAC.

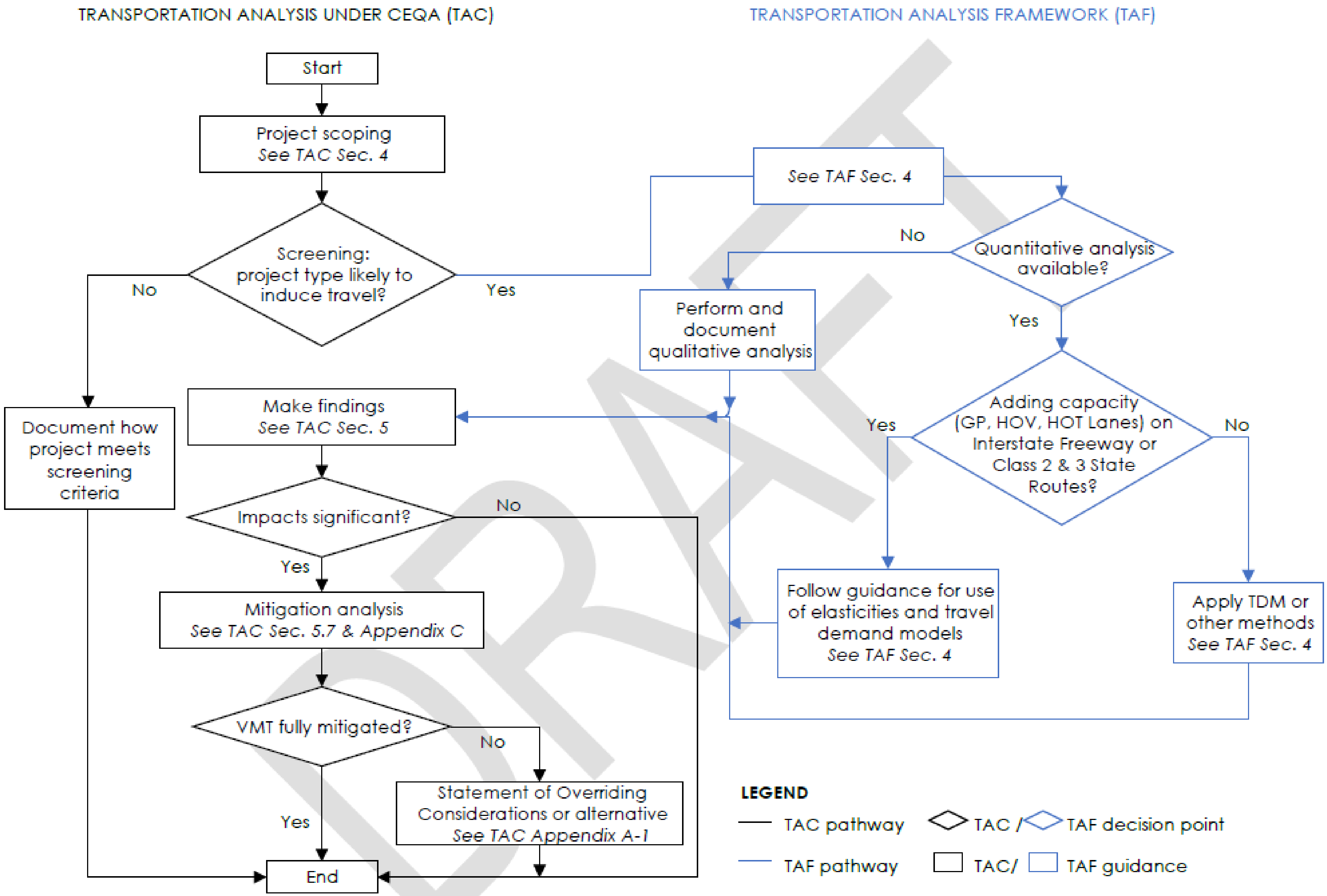

Figure 1. Steps in CEQA Transportation Impact Analysis for SHS Projects

2 FUNDAMENTALS

2.1 FOCUS OF TRANSPORTATION IMPACT ANALYSIS

Caltrans CEQA analysis of transportation impacts of proposed projects on the SHS focuses on the amount of driving attributable to the proposed project, measured as change in VMT when compared to the future No Build scenario. CEQA requires identifying, assessing, and disclosing potentially adverse environmental impacts resulting from a project, i.e., impacts that would not occur but for the project. Generally stated, the transportation impact of a roadway project is the overall increase in VMT that is attributable to the project, distinct from any background changes in VMT due to other factors such as population or economic growth. The transportation impact is the difference in VMT with the project and without the project. The difference in VMT may be negative for some projects that reduce VMT; zero for projects which do not affect VMT or positive for those projects which are associated with an increase in VMT. The analysis reflects the phenomenon of induced travel, which is discussed below.

Generally, the project types associated with an increase in the total amount of driving are projects that add passenger vehicle and light-duty truck capacity to the SHS. Many project types, including maintenance and rehabilitation projects as well as most safety projects, will be identified as unlikely to induce travel, requiring only screening and a narrative documenting that analysis and conclusion. Such projects are identified through the screening process depicted in Figure 1 and discussed in Section 5 of the TAC. Other types of projects are specifically excluded from transportation impact analysis process. These types of projects typically include pedestrian, bicycle, and transit infrastructure projects.

2.2 INDUCED TRAVEL DEFINITION AND ILLUSTRATION

2.2.1 INDUCED TRAVEL DEFINITION

When transportation system changes effectively reduce the cost of travel to individuals and businesses, there is typically a change in user behavior. Induced travel is the term used to describe this phenomenon, which is illustrated conceptually in Figure 2. The reduction of travel time from T_1 to T_2 ($T_1>T_2$) due to network improvement may lead to increased VMT from VMT_1 to VMT_2 ($VMT_1<VMT_2$). The reduced "cost" may be due to reduced travel time as shown in Figure 2, increased reliability, lower price, or some combination of factors.

The induced travel phenomenon manifests itself in multiple ways:

- <u>Longer trips</u>. The ability to travel a long distance in a shorter time increases the attractiveness of destinations that are farther away, increasing trip length and vehicle travel.

- Changes in mode choice. When transportation investments reduce automobile travel time, travelers tend to shift toward automobile use from other modes, increasing vehicle travel.
- Route changes. Faster travel times attract more drivers to the altered route, which can increase or decrease VMT, depending on whether trips are shortened or lengthened.
- Newly generated trips. Shorter travel times can induce additional trips, which increases vehicle travel. For example, an individual who previously telecommuted or shopped online might choose to accomplish those tasks with car trips as they become quicker and less stressful.
- Location and land use changes. In choosing where to live or where to locate or expand a business, households and investors take travel costs into account. In choosing where to allow development, local governments take available capacity into account, as do investors in new development. Over the long term, changes associated with these decisions lead to further changes in the other aspects of travel (routes, modes, destinations, number of trips made) as people adjust to the choices available at the new location.

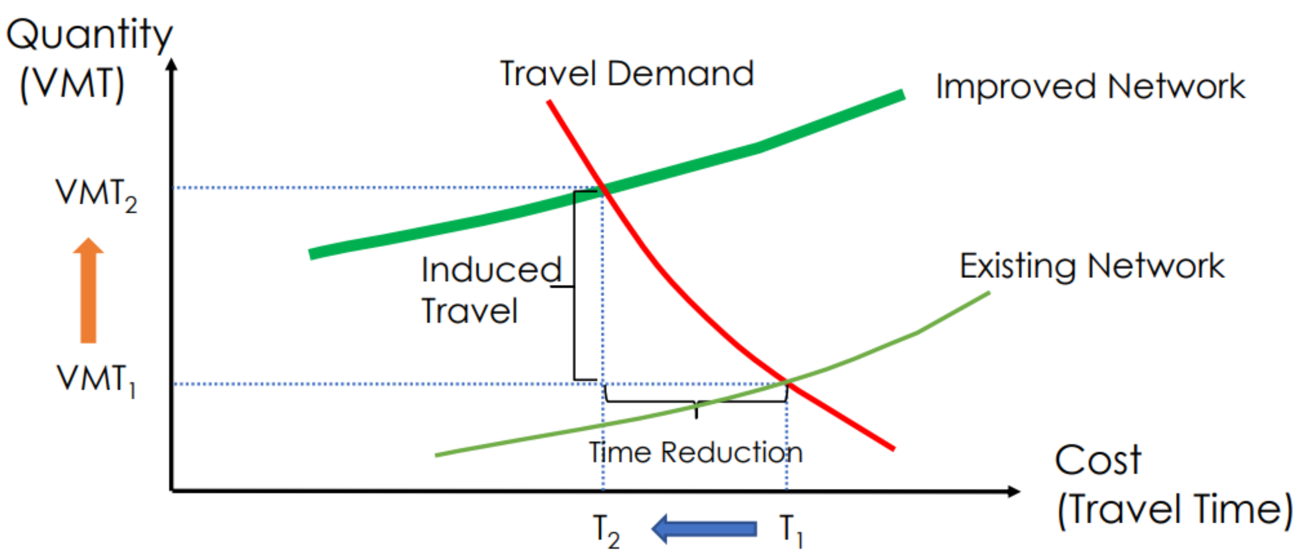

Figure 2. An Illustration of Induced Travel due to Reduced Travel Time

A variety of road project types can create the conditions where induced travel can occur (Noland and Lem, 2002). Importantly, induced travel is not limited to increased travel on the facility that has been changed. Trip-making in a wider area will be affected because of the various types of change described above. As illustrated conceptually in Figure 3a, a new connection across a natural barrier, a river in this case, may not only see increased travel between the points that directly benefit from the new connection (Town A and Town B); but may also alter travel patterns in a wider area. In the longer term, the nearby areas may see new development that would not have occurred in the absence of the increased transportation network capacity. In Figure 3b, the bypass will not only divert traffic away from the town center but may in the longer term generate development along the new connection and alter the travel pattern of the entire area. For example, town center stores may give way to big box stores along the new connection, stimulating additional driving.

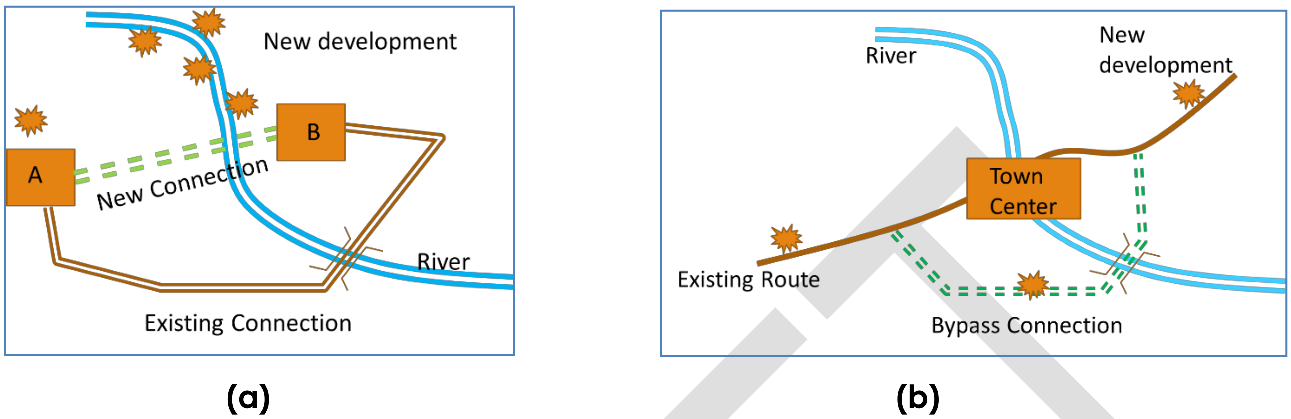

Figure 3. Connectivity and Induced Travel - Conceptual Sketches

As noted above, the changes in travel are not limited to the specific project and its environs, nor do they necessarily appear immediately; some of these changes are seen in the short term and in the project corridor, while others occur over a wider area (potentially, the commute shed and beyond) and play out over a time frame of many years. Some academic studies of the induced travel effect quantify both "short run" and "long run" induced travel effect magnitudes. Generally, "short run" magnitudes measure induced travel that occurs in the first year or two, while "long run" magnitudes measure induced travel that occurs in 5-10 years. The long-run induced travel effect that combines direct impacts with the indirect impacts stimulated by land use change is the full effect of a project. Even roads that simply provide greater access under conditions of no congestion may facilitate development in locations that lead to increased travel.

Additional vehicle travel provides additional mobility benefits to users and may also support expanded access to housing and employment opportunities. However, additional travel also tends to increase negative externality costs. Induced travel will reduce the effectiveness of capacity expansion as a strategy for alleviating traffic congestion and may reduce the benefits of such projects in lowering emissions. Mobility and accessibility increases can still be valuable, but their benefits may be offset partially or entirely by the impacts of added travel.

2.2.2 INDUCED TRAVEL - ILLUSTRATION

With a hypothetical project, Figure 4 illustrates the induced travel effect unfolding over time. The baseline trend, shown in the figure by the line labeled "VMT Without Project", shows the VMT on the network growing over time, perhaps the result of population and/or economic growth. On the other hand, the increase in vehicle travel associated with the increase in network capacity is shown by the line labeled

"VMT With Project". The VMT attributable to the project, or induced travel, is the difference between VMT on the network with the project compared to VMT on the network without the project counted in the horizon year.

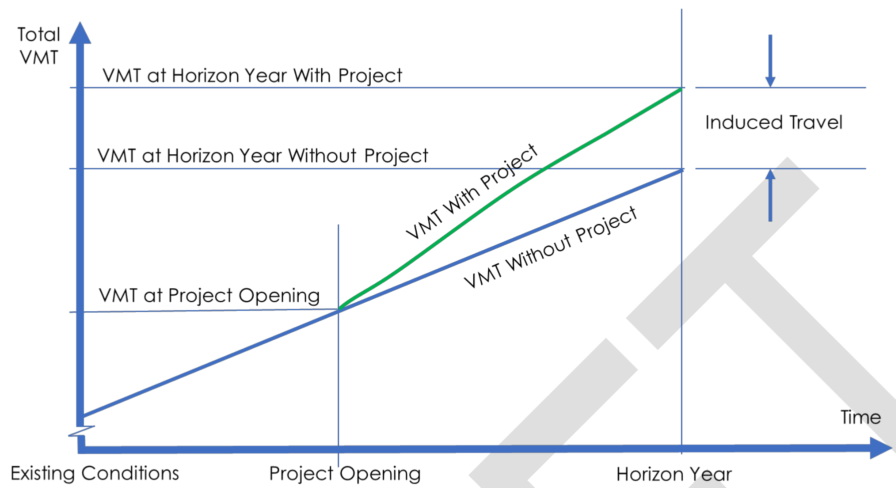

Figure 4. Identification of Induced Travel (VMT Attributable to a Transportation Project)

While the theory behind induced travel is straightforward, empirically estimating this effect has proven to be complicated, as a brief overview of the literature illustrates. The extent to which travel changes occur depends on the elasticity of travel demand, but how to estimate that elasticity and its effects over a network and over time has been debated. The next section of the TAF describes the most common tools for estimating induced travel. Section 4 then provides guidance on selecting the appropriate tools for analysis of specific projects. See, e.g., literature reviews in Cervero, 2002; Noland and Lem, 2002; Duranton and Turner, 2011; Handy and Boarnet 2014a; Handy and Boarnet 2014b; and Milam et al. 2017.

Use of Percentages in Assessing Induced VMT

Projects that add roadway capacity will frequently induce additional motor-vehicle travel, a concern under CEQA. To analyze induced VMT, it is critical to identify the absolute value of the annual increase in VMT from scenarios with and without the project. How induced VMT compares as a percentage to existing, total VMT in a project area is not relevant to the discussion of direct impacts. Most induced VMT from individual projects will be below 1 percent of existing VMT in a county or region. This is to be expected, as induced VMT is a function of new capacity. If a project adds less than 1 percent to the total of lane-miles in a region, it will induce less than 1 percent of new VMT. Using percentages creates an analytical flaw since they also depend on the denominator chosen. A 1 percent change in a place with a lot of existing VMT implies much more absolute VMT – and hence emissions and other adverse outcomes – as compared to the same percentage change in a place with low existing VMT. Therefore, the most important number in analyzing the direct induced VMT from a project is the absolute value of the increase, e.g., 1 million additional annual VMT, not a percent change in VMT.

3 TOOLS FOR ESTIMATING INDUCED TRAVEL

3.1 OVERVIEW

Projecting the amount of induced travel attributable to a transportation project is complex. Travel growth associated with overall population and economic growth need to be separated from the likely effects of system investments, and changes can occur over many years and a large area. It is not a simple matter of monitoring traffic on the particular facility and its immediate environs, because some of the travel changes are likely to affect other elements of the overall transportation system. As described above in Section 2, induced travel can result in trips diverted to different routes, trips switched to different modes, longer trips reflecting the choices of farther destinations, and additional trips. In addition, transportation improvements can affect the relative attractiveness of different locations for both housing and commercial development, leading to land development projects that in the longer term can reshape the pattern of activity and trip making in the region. Because of these complexities, studies of induced travel have turned to a variety of models to help identify the key factors affecting VMT.

Methods used to study induced travel include models specifically investigating the effects of transportation investments on induced travel, travel demand models designed for multiple analysis and forecasting tasks and sometimes used to estimate the share of travel that is induced, and case studies of travel growth and its causes in particular corridors and regions. The guidance provided in Section 4 directs CEQA practitioners to select and apply a single method or a combination of methods based on project characteristics and context and the applicability of the available tools. A general discussion of the two primary tools available for estimating induced travel in connection with infrastructure investments is provided below. Elasticity-based methods including the National Center for Sustainable Transportation (NCST) induced travel calculator are discussed in Section 3.2 and use of travel demand models is discussed in Section 3.3.

3.2 ELASTICITY-BASED METHODS

A key approach in representing the induced travel effect is reporting it as an elasticity based on empirical studies of changes in travel associated with past increases in roadway capacity. Mathematically, the elasticity of VMT is the percent increase in VMT associated with a given percent increase in roadway lane miles. Over time, both short-term and longer-term estimates of the elasticity of VMT with respect to highway improvements (most commonly measured in lane miles) have been produced for different types of facilities and for different geographic scales, with increasingly sophisticated methods controlling for the overall effects of growth and other factors also affecting VMT.

The NCST at the University of California at Davis has developed an online tool, the NCST induced travel calculator, that uses elasticities to estimate induced travel associated with the addition of new general purpose (GP), high occupancy vehicle (HOV), and High Occupancy Toll (HOT) lanes on the SHS. Guidance for the use of the NCST induced travel calculator, (referred to here as "the NCST Calculator" or "the Calculator"), is provided in Section 4. This Section describes strengths and limitations of the Calculator to provide users with a deeper understanding of this tool.

The NCST Calculator incorporates elasticities of VMT with respect to capacity increases, drawing on the best available peer-reviewed papers on the topic; other recent high-quality studies have reported similar elasticities to those used in the Calculator (NCST 2019a; NCST 2019b; and Panel Report 2020). The cited studies used controls for other factors that could confound the estimates. The use of these elasticities in the estimation of induced travel is reasonable. However, analysts need to be aware that they are long-term average elasticities for the particular highway types and contexts studied. Some project-to-project variation is to be expected. Recognizing this, the guidance in Section 4 advises using the Calculator's results to benchmark results from other methods, and it also provides analysts with an opportunity to document why particular projects can be reasonably expected to result in changes that vary more substantially from the Calculator's results.

The panel of academics and practitioners that advised the team developing this guidance concluded that:

- The peer-reviewed studies the Calculator has chosen to rely upon are widely considered to be the best available, and other recent studies have found similar elasticities, adding credence to those used by the Calculator;
- The standard errors for the models estimating the elasticities are reported in the papers and are at acceptable levels;
- The elasticities extracted from the studies account for the full set of possible impacts and distinguish infrastructure-induced VMT impacts from other factors that could be driving observed changes (e.g., general growth in population and economic activity);
- Since the elasticities in the calculator are based on traffic count and lane mileage data and are derived from econometric analyses that use advanced methods to control for possible confounding variables, they are a strong indicator of likely regional average, long-run responses (Panel Report 2020).

The Calculator elasticities are long-term elasticities. Some studies such as Cervero and Hansen (2002) also produce short-term elasticities, either by looking at a short time frame or by omitting factors that tend to appear over the longer term, such as land use changes. ("Short term" in this context means under five years and can be as little as a year or two; "long term" can be 10 years into the future.) While the studies in the literature use differing time frames, there is no clear conclusion to be drawn from the literature regarding how fast the changes occur. Highly congested areas are likely to have considerable unsatisfied demand for travel; and therefore, the response to new capacity may be rapid. Areas at the urban fringe have also been found to generate high levels of induced traffic, more likely to manifest over time, as new facilities alter development opportunities, business and housing locations, and users' overall travel patterns.

NCST Calculator Truck Adjustment

The CEQA Guidelines exclude truck traffic from consideration in calculating induced travel. Section 15064.3, subdivision (a) of the CEQA Guidelines, states, "For the purposes of this section, 'vehicle miles traveled' refers to the amount and distance of automobile travel attributable to a project." OPR further clarified in their 2018 Technical Advisory that "automobile" refers to on-road passenger vehicles, particularly cars and light trucks. The NCST Calculator does not exclude heavy-duty trucks from its elasticity estimates. As such, it is reasonable to allow for an adjustment to the results used in VMT analyses for transportation projects. The corresponding method for adjusting NCST Calculator results to account for heavy-duty trucks has been established since the first edition of the TAF.

Upon consideration of the research associated with the NCST Calculator and input received by multiple stakeholders, both internal and external to Caltrans, VMT analyses related to transportation projects may use the following procedures:

- Reduce the NCST-generated elasticity values for Interstate Freeways (Class 1 facilities) by **0.29** (from 1.0 to 0.71).
- Reduce other highway (Class 2 and 3) NCST-generated elasticities proportionately by **0.22** (from 0.75 to 0.53).

The source of these reduction values is one of the foundational papers used in calibrating the NCST Calculator, Duranton & Turner (2011). However, it is important to note that the above-described procedure applies only to using the NCST Calculator to predict induced travel. If VMT results from a Transportation Demand Model (TDM) are used for benchmarking for comparison to NCST Calculator results, the trucks should be removed from the estimates of induced travel for both methods for consistency. The procedure to exclude heavy trucks from the induced VMT results should be documented specifically for the TDM that is used. Note that this adjustment for truck volumes is only for the purposes of analyzing induced travel under SB 743.

3.2.1 SENSITIVITY TO DIFFERENT PROJECT TYPES

Any project that adds capacity to the SHS has the potential for generating additional travel. The first edition of the TAF stated that the NCST Calculator should not be used to evaluate HOT lane additions to the SHS. The NCST Calculator is now conservatively limited to use for additions of general-purpose (GP), high-occupancy vehicle (HOV), and high-occupancy toll (HOT) lanes; it treats these lane additions identically. It should not be used for additions of pure toll lanes (where all users, even HOVs, must pay a toll). Hundreds of both general-purpose and HOV lane mile additions were included in the two principal studies used to derive the elasticities for the calculator (Duranton and Turner, 2011; Cervero and Hansen, 2002; Legislative Analyst's Office, 2000). While few HOT lanes had been added to publicly owned roadways before the end of the data collection periods for those two studies, studies using data from more recent periods (after more HOT lanes had been opened) have estimated similar induced travel elasticities to new HOV and GP lanes (e.g., Hymel, 2019; Graham et al., 2014; Melo et at., 2012). Furthermore, because HOT 2+ occupancy lanes allow more vehicles to access them than HOV 2+ occupancy lanes (high-occupancy vehicles plus drivers willing to pay to use the lane), they may logically have similar induced travel effects as HOV lanes.

The NCST Calculator can be used for analysis of HOT lane addition projects, either exclusively, or as a benchmark to results from a Transportation Demand Model (TDM). The authors of the NCST Calculator have updated the guidance for the use of the tool at: https://travelcalculator.ncst.ucdavis.edu/about.html. Within the TAF, Table 1. Selection Matrix for Preferred Induced Travel Assessment on page 19 has been updated with this information.

Adding a lane restricted to a special purpose, such as a toll lane, freight, or transit lane, may induce travel by particular users. It may also make capacity available in the GP lanes, in turn inducing traffic into the GP lanes. It can be complex to determine how many additional trips may occur with a managed lane, as its capacity is related to design, operating rules, and driver choices. Features including the number, location and design of entry and exit points can make a difference in facility performance and use. Operating hours, occupancy requirements, toll levels for HOT lanes, enforcement/violation rates may also influence impact on VMT. For more information on the addition of HOT lanes and impact on VMT, refer to the TAC Section 5.7.2 Mitigation on the SHS.

A new HOT lane may attract vehicles from GP lanes where their travel time benefit exceeds their cost. However, the toll option is likely to lead to more complex travel behaviors and operating practices than would an HOV lane. Both HOV and HOT lanes are subject to federal degradation standards, but site specific conditions and speeds between managed lanes and the adjacent general purpose lanes may vary.

Clarification for HOV Lane Additions

The NCST Calculator treats an HOV lane addition as the equivalent of a GP lane addition in terms of induced VMT. This is based on a common scenario, where HOV-2+ lanes are added to multilane facilities, which are already carrying HOV-2s. In that case, the HOVs may simply sort themselves in their own lane, creating more GP capacity in the other lanes rather than prompting new carpool formation. In general, the starting point for considering induced travel from a new HOV+2 lane would be to estimate it as we would a GP lane, with any reduction from that estimate needing justification. As projects have moved through the delivery process, two scenarios have arisen that justified a reduction:

- Addition of HOV lanes to an existing two-lane (one-lane each way) highway. In this case, the project team demonstrated there would be too few HOVs to sort themselves into the new lane in a way that would create a full new lane for GP vehicles. In this case, the modeled result for induced VMT was acceptable, even though it was not within 20 percent of the figure from the NCST Calculator.
- While HOV lanes commonly refer to 2+ persons per vehicle, HOV lanes designated for 3+ persons per vehicle have also existed in California for many years. The original decision to treat HOV lanes similarly to GP lanes did not distinguish between HOV-2+ and higher HOV occupancy restrictions. This issue has arisen in preliminary discussions with project teams, who have reasonably suggested the calculator may overestimate induced VMT for HOV-3+ and higher levels.

In both cases – an HOV lane added to a single existing GP lane or an added HOV-3+ or higher lane – analysis with a TDM that results in an induced-VMT estimate more than 20 percent below the NCST calculator can be acceptable, assuming the required methods and checks of the Travel Demand Models (TDMs) are followed. These clarifications have been updated within this edition of the TAF, Table 1. Selection Matrix for Preferred Induced Travel Assessment on page 19.

3.2.2 SENSITIVITY TO PROJECT CONTEXT

Many practitioners raise concerns about the NCST Calculator's apparent lack of sensitivity to project context. For example, questions have been asked about whether the studies that underlie the Calculator match the background conditions where projects are being proposed - particularly smaller MPOs, and rural areas of larger MPOs. Considerations include land use patterns and densities, modal choices and route options. In fact, similar concerns apply to the TDM, too. The aggregate data and estimated coefficients used in the TDMs reflect heavily the more urbanized, populous, modally diverse portions of the modeled region.

Whether the metropolitan statistical area (MSA) or urban county data apply to the more rural areas of a given county will depend on how integrated the area in question is to the broader urban economy. The MSA designation assumes that they are indeed integrated through commute patterns, which are a significant indicator of interconnectedness. Therefore, the Calculator is applicable throughout MSA areas. It can be used for projecting induced travel for GP, HOV, and HOT lane projects in MSA counties as shown in Table 2. Section 4.4 provides an opportunity for analysts to describe cases where specific conditions make the induced travel effects of a project likely to be substantially different from the estimate derived from the Calculator. It should be noted that the Calculator is not applicable to non-MSA rural counties.

As noted earlier, available studies do not offer a definitive answer about whether outlying areas are more or less likely to experience induced travel resulting from capacity increases. Several such studies suggest that the elasticity of demand may be higher in the outlying areas partly because of the relative percent increase in capacity, and partly because of the potential for location and land use shifts and increased travel to and from other parts of the metropolitan region (Panel Report 2020). Case examples also show that rural areas and areas with limited congestion can still experience induced travel resulting from new capacity because the new capacity improves travel times/ reduces costs and creates new patterns of accessibility and new location and land use opportunities. Available studies such as Duranton and Turner (2011) also indicate that accounting for transit services at the levels of service and geographic scales of availability experienced in most US contexts do not significantly alter the induced travel estimates.

3.2.3 SENSITIVITY TO DIFFERENT REGIONS

The NCST Calculator uses elasticity rates based on facility type combined with county or MSA specific data. However, it accounts for variation in the travel-inducing strength between counties and regions by using the base year level of VMT as an input. Counties and regions that start with more traffic (higher existing VMT per lane mile) experience more induced travel for a given lane-mile addition. For example, a county or region that has twice the existing traffic per lane mile would see twice the amount of induced travel per lane mile added.

3.3 TRAVEL DEMAND MODELS

3.3.1 OVERVIEW

Travel models are often called Travel Demand Models (TDMs), though they also include models of transport supply. TDMs are widely used in California and throughout the United States as transportation system analysis and forecasting tools. Among their many applications, the travel models are used to measure network performance and identify deficiencies, to forecast future levels of service under anticipated levels of growth and change, and to generate the traffic data and projections needed for air pollution emissions estimates.

TDMs vary considerably in their specifications. Some MPOs and a few counties and cities in California have developed advanced activity-based models; many others use trip-based models. Some are run as part of an integrated land use-transportation modeling process while others handle current and future land use as a separate analysis step and use the results as inputs to the travel models. Models also vary in the extent to which they cover such issues as trip scheduling, time-of-day of travel, transit service characteristics (e.g., bus vs. rail), nonmotorized modes, and freight movements. Highway networks usually cover major collector and higher-level roads, but some models also include local roads.

TDMs vary also in their ability to estimate induced travel associated with highway investments. Some models can estimate induced travel reasonably well and some others cannot. For example, some model systems do not have the capability to account for changes in origin-destination patterns, increases in trip rates, and changes in location and land use resulting from transportation investments. In addition, models are not always applied in a way that fully uses their capabilities.

Many improvements have been made to travel models over the last two decades, but there remains considerable variation in the level of detail and the sophistication of the models in use in California and elsewhere. Depending on the specifics of model specification, estimation, and application, travel models may provide a reasonable estimate of induced travel, or they may under- or over-estimate induced travel. As Volker et al. (2020) reported, induced travel estimates set forth in some published environmental documents are well below those estimated by empirical studies, and underestimation is a concern. The likely reasons for such differences include:

- Land use changes and associated travel are a significant component of induced travel, but some transportation planning models treat land use as exogenous and some further assume it is fixed (i.e., land use is not altered as a result of transportation system changes.)
- Some travel models, either in specification or in application, do not include a mechanism to feedback network travel times and travel costs to land use mode choice, destination choice, and trip frequency modeling elements (Marshall 2018)
- Price and income are sometimes treated in limited ways; and therefore, important impacts on travel choice are not well represented in the models
- Reliability is often not represented by the travel model even though it can be important to the traveler: a small reduction in travel time can be accompanied by a large reduction in travel standard deviation, providing a meaningful improvement in reliability.
- Network levels of detail may be insufficient to reflect traffic conditions, available route and mode choices.
- Boundary cutoffs may mean that a portion of travel outside the model's boundaries is not well represented in model analyses, though it may be impacted by system changes.
- Models are not always run to traffic assignment equilibrium where network congestion is minimized.
- Models are often calibrated to observed data such that the alternative-specific constants take a large (outsized) importance in the choice models, rendering them less sensitive to time and cost.
- Finally, models may not have been thoroughly validated over a period of time in which travel times and costs have changed (such that it should be possible to see if the models would have predicted such changes.) (Panel Report, 2020)

A review of the capabilities of available travel demand models and their applications is therefore in order before relying solely on their outputs as a basis for evaluating induced travel impacts of projects on the SHS. The checklist in Section 4.5 provides specific guidance for evaluating whether a travel demand model is appropriate for use in estimating induced travel.

3.3.2 SOURCES FOR MODELING IMPROVEMENT GUIDANCE

Recent reports from the National Cooperative Highway Research Program (Erhardt et al. 2019) provide additional guidance on evaluating errors in models and could be valuable sources of advice. Guidance on modeling has been produced by State of California agencies, including the California Transportation Commission, the Governor's Office of Planning and Research, and the California Air Resources Board.

The Federal Highway Administration (FHWA) has also produced extensive advice on modeling, especially through its Travel Model Improvement Program (TMIP). The FHWA-HEP-10-042 report prepared by Cambridge Systematics, Inc. (2010) discussed the best practices on how to calibrate/adjust and validate/test TDMs, checking them for reasonableness. Note that checking the model can reveal underlying problems that need to be corrected; e.g., if VMT per household is unreasonably high or low, it would be advisable to make sure data errors were not introduced. Data from the US Census and travel surveys such as the National Household Travel Survey (NHTS) (https://nhts.ornl.gov/) provides useful comparisons. (NHTS data covers trip modes, lengths, and purposes, and all areas of the country, urban and rural.)

The TMIP advises that to be useful, tests of reaction to change must be done through applications of the model in full production mode. However, this is not always done in practice. Also, many models are validated on a reserved set of base year data; it would be useful to further validate predictive capabilities against a future year when such data are available

4 GUIDANCE TO PRACTITIONERS

4.1 APPLICABILITY OF GUIDANCE

The TAF should be consulted when a transportation project on the SHS could lead to a measurable and substantial increase in vehicle travel. The TAC states that these projects would "…generally include… Addition of through lanes on existing or new highways, including general purpose lanes, HOV lanes, peak period lanes, auxiliary lanes, or lanes through grade-separated interchanges"). Refer to Section 5.1 of the TAC for the project screening process and the list of project types that would not likely lead to a substantial or measurable increase in vehicle travel, and therefore generally should not require an induced travel analysis.

4.2 SELECTING THE ANALYSIS APPROACH

4.2.1 OVERVIEW

Section 5.1 of the TAC guides the analyst through the process of screening a project on the SHS to determine whether a VMT significance determination is necessary. This process applies to both the project and project alternatives being considered. Such a determination requires analysis of induced travel impacts using one of the analysis approaches described in this section of the TAF.

Following a decision that induced travel analysis is needed, the analyst must select the analysis approach based on project location, facility type, and available tools as described in the following sections. The selection process applies equally to project alternatives under consideration. In a typical document, multiple alternatives will be described and analyzed. Analysis of induced travel may be necessary for each alternative, requiring selection and application of appropriate methods for each.

This guidance provides analysts with the basis for identifying the best available analysis approach for the project and alternatives. Table 1 guides the selection of preferred analysis approaches based on project location, project and facility type, and applicability of tools.

1. **Applicability of tools.** Section 4.3 provides a general discussion of the tools for estimating induced travel. In cases where the NCST Calculator can be directly used, it should either be used exclusively or used to benchmark results from a TDM. Where the NCST Calculator is not applicable and a TDM is suitable for use, a TDM should be used. The TDM should be assessed as adequate for assessing induced travel based on the checklist presented as Table 4 or should

undergo modifications in order to remedy identified deficiencies. Sections 4.4 and 4.5 provide additional detail.

2. **Project location.** Whether the project is in an MSA or a rural county will influence the approach selected, since the NCST Calculator is not applicable in non-MSA counties. For projects in rural counties, the best available method should be selected by analysts and reasons for selecting the method should be documented. This would preferably be a TDM or other quantitative method. A qualitative assessment will be acceptable if it takes into account the potential for capacity additions to induce travel as a result of changes in travel behavior in response to reduced travel cost, improved reliability, or long-term land use change likely to be associated with the project.

3. **Project and Facility Type.** Only projects adding general purpose, HOV lanes, or HOT lanes can use the NCST Calculator directly. Generally, when state- or locally-owned Class 1-4 facilities are being added or expanded in a project involving the SHS, e.g., as part of a new interchange, the new capacity on those facilities should also be analyzed for induced travel. However, the Calculator's applicability varies by facility type as shown in Table 1.

4.2.2 GUIDANCE FOR SELECTING ANALYSIS APPROACH

Table 1 provides a selection matrix to be used in identifying the preferred VMT assessment method(s) based on location and project type. The application of the NCST Calculator and the TDM is described in Sections 4.3 and 4.4, respectively. Table 1 applies only to the forecasting of induced travel associated with projects on the SHS for CEQA analysis. Depending on the method selected, other methods and tools may be necessary to forecast total VMT in the horizon year for other CEQA impact analysis and for NEPA analysis when applicable. Consult with Caltrans Division of Environmental Analysis (DEA) for details.

While the TAF largely focuses use of either the NCST Calculator or TDMs for VMT analysis, Caltrans is open to exploring and continues to actively engage in discussions with partner agencies regarding alternative methodologies to assess VMT. **Any clarifications to existing and addition of new methodologies will be included in future iterations of the TAF or through interim updates in Hot Topics or Bulletins posted to the Caltrans SB 743 website at https://dot.ca.gov/programs/esta/sb-743/resources.**

4.3 APPLICATION OF THE NCST CALCULATOR

The NCST Calculator can be applied to mainline general-purpose lane additions and mainline HOV lane additions and HOT lane additions on Class 1 facilities (Interstate freeways) and Class 2 and 3 facilities (Other Freeways, Expressways, and Other Principal Arterial state routes) as defined by the FHWA. See Appendix A for facility class definitions. Of the 58 counties in California, the Calculator can be applied directly in 37 counties that belong to MSAs but not in the remaining 21 non-MSA rural counties. See Table 1 for choosing the appropriate method of assessment based on project type, location, and facility. See Table 2 for a list of the 37 MSA counties and Table 3 for a list of the 21 non-MSA rural counties.

For a Class 1 facility, the NCST Calculator must be applied at the MSA level; while for Class 2 and 3 types of facilities, the Calculator must be applied at the county level. This is because the NCST Calculator was based on studies that examined only those geographies. As shown in Table 2, the Calculator applies to all Class 1, 2, and 3 facilities in 23 MSA counties. In 14 MSA counties the Calculator applies to Class 2 and 3 facilities only because either there are no Class 1 facilities in the county, or the Class 1 facility mileage is less than one mile in the county.

Table 1. Selection Matrix for Preferred Induced Travel Assessment Method of Projects on the SHS[1]

Project Type/ Location	GP or HOV Lane Addition to Interstate[2]	GP or HOV Lane Addition to Class 2 & 3 State Routes[2]	HOT Lane Addition to Interstate	HOT Lane Addition to Class 2 & 3 State Routes	Other VMT-inducing Projects & Alternatives
County in MSA with Class I Facility	Apply the NCST Calculator by MSA and/ or TDM benchmarked with NCST Calculator[3]	Apply the NCST Calculator by county and/ or TDM benchmarked with NCST Calculator[2]	Apply the NCST Calculator by MSA, TDM, and/or other quantitative methods[3,4]	Apply the NCST Calculator by county, TDM, and/ or other quantitative methods[3,4]	Apply TDM or other quantitative methods[3]
Other MSA County	Apply TDM or other quantitative methods[3]	Apply the NCST Calculator by county and/ or TDM benchmarked with NCST calculator[2]	Apply TDM or other quantitative methods[3]	Apply the NCST Calculator by county, TDM, and/or other quantitative methods[3,4]	Apply TDM or other quantitative methods[3]
Rural County	Apply TDM or other quantitative methods[3]	Apply TDM or other quantitative methods[3]	Apply TDM or other quantitative methods[3]	Apply TDM or other quantitative methods[3]	Apply TDM or other quantitative methods[3]

1. If preferred methods are not available, qualitative assessment is acceptable as shown in Figure 5.
2. Induced VMT estimates from HOV additions to two-lane (one lane per direction) facilities and HOV-3+ or higher additions may be outside the ± 20 percent range of the NCST Calculator estimate.
3. TDMs must be checked for applicability as described in Sections 4.4 and 4.5.
4. TDM may be benchmarked with NCST Calculator.

Freeway ramps and minor arterials or collector-distributor roads associated with a freeway fall outside the scope of application for the NCST Calculator. The VMT inducing effects for ramp, minor arterial, and collector-distributor road capacity projects should be evaluated as “Other VMT Inducing Projects” in Table 1.

The NCST Calculator allows users to quickly gather an estimate of the average increase in VMT resulting from induced travel associated with the planned addition of GP, HOV, or HOT lane miles. The Calculator output represents the increase on area-wide facilities, not solely on the facility that the project would alter. It currently includes 2016 through 2019 lane-mile and VMT data from Caltrans Highway Performance Monitoring System (HPMS) databases (and therefore applies only to California, as currently presented) together with long-term elasticities taken from the literature, specifically the Duranton and Turner (2011) nationwide estimate for Interstate facilities (which the Calculator rounds to 1.0) and the Cervero and Hansen (2002) California county-level estimate for class 2 and 3 facilities (0.75 as implemented in the Calculator). The user specifies the category of facility and lane miles being added and the county or Metropolitan Statistical Area (MSA) of application; the Calculator is only applied to counties for which there are data and for which the studies are applicable (Tables 2 and 3 indicate the Calculator's applicability to California counties).

While use of the online Calculator is the recommended approach to applying the elasticity-based method, the method may also be applied manually by the analyst.

A standard formula for estimating project induced VMT is embedded in the Calculator:

Project-Induced VMT = %Δ Lane Miles x Existing VMT x Elasticity

where,
%Δ Lane Miles = The increase of lane miles expressed as a percentage of the total lane miles in the study area. This must be a positive number.

Table 2. The 37 MSA Counties where the NCST Calculator Applies

23 MSA Counties: The NCST Calculator Applies to Class 1, 2, and 3 Facilities		
Alameda	Merced	San Joaquin
Contra Costa	Orange	San Mateo
Fresno	Placer	Santa Clara
Imperial	Riverside	Shasta
Kern	Sacramento	Solano
Kings	San Bernardino	Stanislaus
Los Angeles	San Diego	Yolo
Marin	San Francisco	
14 MSA Counties: The NCST Calculator Applies to Class 2 and 3 Facilities only		
Butte	San Benito	Sutter
El Dorado	San Luis Obispo	Tulare
Madera	Santa Barbara	Ventura
Monterey	Santa Cruz	Yuba
Napa	Sonoma	

Table 3. The 21 Rural Counties where the NCST Calculator does not Apply

Alpine	Inyo	Nevada
Amador	Lake	Plumas
Calaveras	Lassen	Sierra
Colusa	Mariposa	Siskiyou
Del Norte	Mendocino	Tehama
Glenn	Modoc	Trinity
Humboldt	Mono	Tuolumne

Additional details on application of the Calculator are available online at https://travelcalculator.ncst.ucdavis.edu/about.html and discussed in Appendix A.

As described above, the NCST Calculator uses empirical data to establish elasticities that reflect the likely change in travel volumes associated with a change in roadway capacity. The Calculator's output reflects an average areawide change, not simply the change in volumes on the facility itself. The NCST Calculator reports long-run induced travel results for the horizon year. Estimates for intermittent years can be determined with linear interpolation. The NCST Calculator does not distinguish between GP, HOV, and HOT lanes, so the tool cannot be used to assess any potential difference in induced travel between those three project types.

4.4 APPLICATION OF TRAVEL DEMAND MODELS

As shown in Table 1, TDMs will be used to assess induced travel in the following two situations:

1. Applied in combination with the NCST Calculator as discussed below;
2. Applied alone when the NCST Calculator is not applicable.

Where a travel model is used, often the regional travel model will be the most appropriate scale to capture the entire area over which induced VMT is observed. However, as discussed above, some TDMs lack key elements for assessing induced travel. For example, some model systems do not have the capability to account for changes in origin-destination patterns, increases in trip generation rates, and changes in location and land use resulting from transportation investments. In addition, models are not always applied in a way that fully exercises these capabilities. Analysts should document the models, the calibration steps taken, reasonableness tests performed, and validation tests against later year conditions. Documentation should indicate both verification that the model has the capacity to reflect travel behavior accurately, and that it is run correctly, in order to assess induced travel.

When a travel model is used to assess induced travel, the following steps must be followed:

1. Assess the travel model and off-model processes using the checklist provided in Section 4.5.

2. If the NCST Calculator can be applied to the project, and the travel model passes the checks, apply both methods.
   a) Use the TDM results, if within 20 percent of the value provided by the NCST Calculator.
   b) If travel demand model results differ from that of the Calculator by more than 20 percent, use the Calculator's results exclusively, or use the TDM results and provide specific quantitative evidence explaining this variation. The evidence may include reference to quality academic studies, or analysis of specific project features or context justifying that the project's induced travel could be substantially higher or lower than the average value indicated by the NCST Calculator.

3. If the NCST Calculator can be applied to the project, and the travel demand model does not pass the checks, apply both methods and choose one of three options:
   a) Use NCST Calculator results exclusively.
   b) Adjust TDM input/outputs and disclose model deficiencies before use. If TDM results are still not within 20 percent of the NCST Calculator results, provide specific quantitative evidence explaining the variation. The evidence may include reference to quality academic studies, or

analysis of specific project features or context justifying that the project's induced travel could be substantially higher or lower than the average value indicated by the NCST Calculator.

c) Use TDM results, if within 20 percent of the value provided by the NCST Calculator. No other adjustments are necessary.

4. If the NCST Calculator cannot be applied to the project, and the travel model passes the checks, then apply travel models only.

5. If the NCST Calculator cannot be applied to the project, and the travel model does not pass all the checks, then:

a) Disclose and document the areas of deficiency and make improvements to the model to address those issues. If that is not possible in the timeframe of the project analysis, use other options below.
b) Apply off-model approaches using the best available information or tools to compensate for TDM's deficiencies, making approximations as needed where more precise data or information are not available.
c) Where a quantitative assessment cannot be reasonably undertaken, a qualitative assessment may be undertaken (see Section 4.6).

When both the NCST Calculator and TDMs are used as guided by Table 1, a detailed method selection flow chart is provided in Figure 5 to further facilitate the process of selecting an analysis approach.

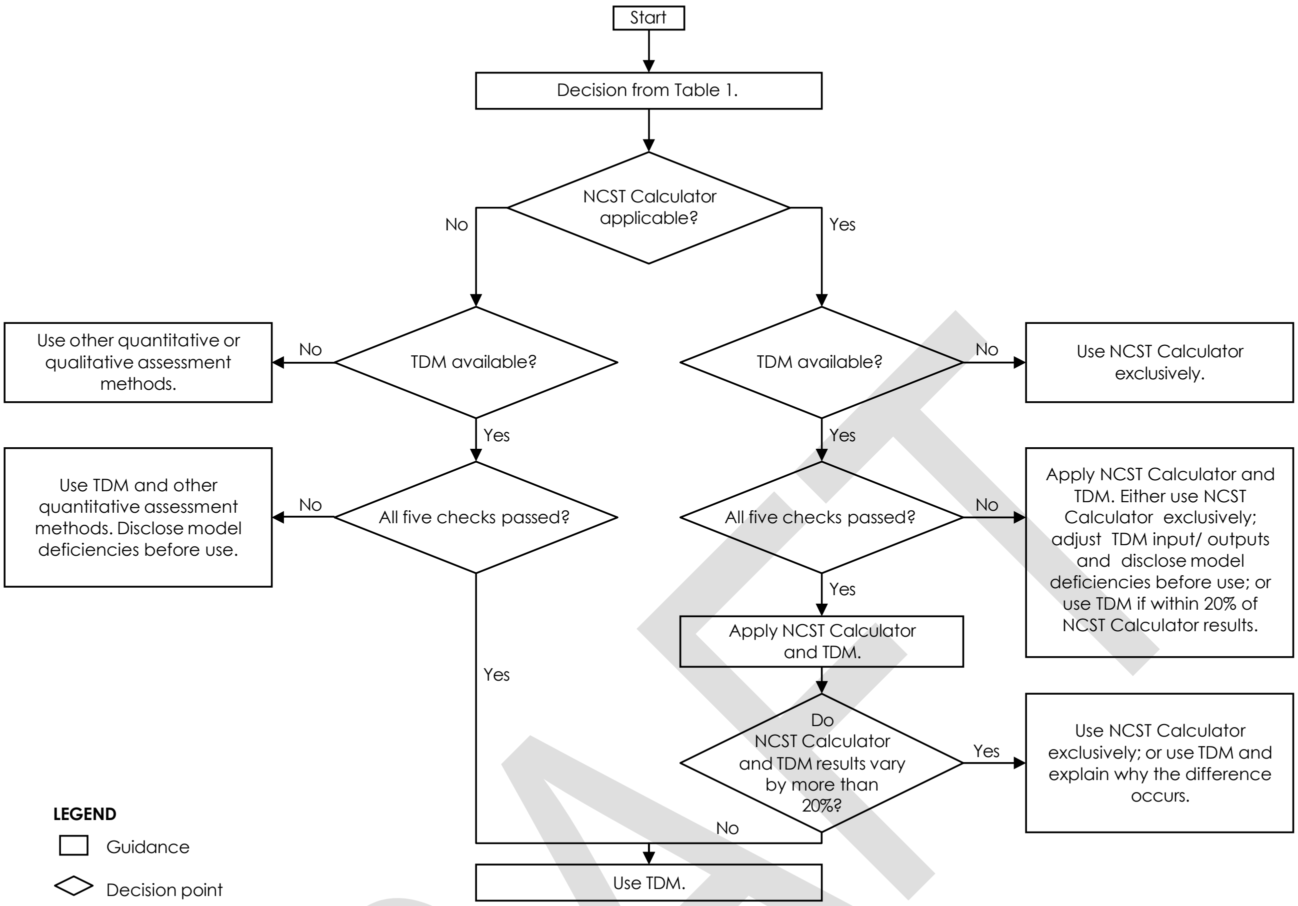

Figure 5. A detailed assessment method selection flow chart.

4.5 THE CHECKLIST FOR EVALUATING MODEL ADEQUACY

The checklist in Table 4 specifies model capabilities required for induced travel assessment. The checklist focuses on both modeling mechanisms and modeling practices. The purpose is to ensure induced travel modeling mechanisms are built in, and established modeling practices are followed in implementing a TDM for induced travel modeling. There are five checks in total. In general, a model should pass all five checks before the analyst concludes that the TDM is appropriate for making projections of induced travel. As noted elsewhere, assessments made using models that do not satisfy all checks should include disclosure of deficiencies, documenting ways in which the deficiencies may affect results.

Table 4. A Checklist for Evaluating Adequacy of Travel Demand Models for Estimating Induced Travel

Check 1. Land use response to network changes[1]. Check the box if the answer to the question is "yes". "Check 1" passes if either box 1a or 1b is checked.	
1a ☐	Is the model's specification of future land use sensitive to travel time and cost, i.e., varying across modeling scenarios to simulate the land use response to network changes?
1b ☐	If future year land use is exogenous to the modeling process, are land use assumptions determined via a Delphi method (Linstone and Turoff eds., 1975; Rand Corp, 1969; Cavalli-Sforza and Ortolano, 1984; and Melander 2018) or through examination of outcomes under a range of modeling scenarios, including both build and no build alternatives*?
[1] Any TDM used to assess induced travel must be paired, or iterated, with an approach for predicting changes in land use caused by the project. OPR's Technical Advisory (*Appendix 2, Induced Travel Mechanisms, Research, and Additional Assessment Approaches*, p. 34) lists options for incorporating land use effects in a travel model-based assessment.	
Check 2. Sensitivity of trip-making behavior to network travel times and travel costs[2]. Check the box if the answer to the question is "yes". "Check 2" passes when box 2a, 2b, and 2c are all checked.	
2a ☐	Do changes in network travel times and travel costs by mode (e.g., vehicle operating costs, tolls, parking costs, transit fares, etc.) influence mode choice, destination choice (including workplace location), route choice, and trip frequency?
2b ☐	Are the network travel times and costs fed back into the mode choice, destination choice, route choice, and trip frequency models so that travel times and costs are roughly consistent with the "converged" travel times and costs from traffic assignment?
2c ☐	Does the modeling reflect the heterogeneity and complexity of travelers' responses to time and cost changes relevant to the examined project?

*An FHWA resource on collaborative judgment can be accessed at: https://www.fhwa.dot.gov/planning/tmip/publications/method_sheets/collaborative_judgement.cfm.

Table 4. A Checklist for Evaluating Adequacy of Travel Demand Models for Estimating Induced Travel (cont'd)

<table>
<tr><td colspan="2">[2]. If the trip generation sub-model is not sensitive to travel time, then the analyst will need to provide for a manual intervention in the trip generation stage of the model to adjust the trip generation rates in the model for off-line computed induced travel effects of the project, its alternatives, and potential mitigation measures.
The analyst can employ activity based travel model parameters that are available from a similar region to manually estimate off-model the effects of the project, its alternatives, and potential mitigation measures on trip generation with and without the project for the desired forecast years (with the land use linkage described above activated) and noting the predicted percentage change in trip generation by purpose predicted by the activity based TDM parameters. These percentages, which will vary by project alternative, may then be applied to the output of the trip generation stage of the trip-based model.</td></tr>
<tr><td colspan="2">Check 3. Sufficiency of detail and coverage of modelled roadway and transit networks[3]. Check the box if the answer to the question is "yes". "Check 3" passes if both box 3a and 3b are checked.</td></tr>
<tr><td>3a
☐</td><td>Are the roadway and transit networks provided in sufficient detail and coverage to reflect the full set of route and mode choices available to the traveler?</td></tr>
<tr><td>3b
☐</td><td>If the project would lead to induced travel extending beyond the model's boundary, has the model been modified to incorporate the larger geography, or has an off-model assessment captured the additional travel generated?</td></tr>
<tr><td colspan="2">[3]. In cases where the project would lead to induced travel that extends beyond the model's boundary, the model should either be modified to incorporate that geography (e.g., by adding "halo zones") or an off model assessment should be made to capture the additional travel (e.g., where that travel is destined for a population center outside the model area, multiply gateway volumes by distance from the gateway to that population center).
For sufficiency of geographical coverage, the analyst should use select link analysis to check whether links that run up to the model's edge show increased volumes as a result of the project. If they do, VMT increases likely continue outside the model's boundary. Where that is the case, one of three approaches can be used to capture that VMT. First, "halo zones" can be added to capture the additional VMT within the model. Second, a reasonable assumption can be made about length of the missing portion of the trip (e.g., use the distance to next major jobs or population center, if trips are likely allocated there), and that distance can be multiplied by the volume. Third, a model with greater coverage, such as the California Statewide Travel Demand Model (CSTDM), can be used for supplemental data.</td></tr>
</table>

Table 4. A Checklist for Evaluating Adequacy of Travel Demand Models for Estimating Induced Travel (cont'd)

<table>
<tr><td colspan="2">For temporal coverage, the analyst should examine the peaking of traffic flows in the area served by the project to determine the needed temporal coverage of the model (weekday peak hours, peak periods, daily, weekends and holidays, recreational seasons, full year), and then check to ensure the model assesses those time periods.</td></tr>
<tr><td colspan="2">Check 4. Network assignment processes[4]. Check the box if the answer to the question is "yes". "Check 4" passes if box 4a is checked.</td></tr>
<tr><td>4a
☐</td><td>Is the modeling guidance published by FHWA (Cambridge Systematics, 2008, 2010) followed, in order to provide a sufficient level of convergence in network assignment such that the differences in outcomes between modeling scenarios can be reliably attributed to the differences in scenario definitions rather than the network assignment process itself?</td></tr>
<tr><td colspan="2">[4]. For static roadway assignment, a relative gap between model runs of 0.001 is a good safe harbor.</td></tr>
<tr><td colspan="2">Check 5. Model Calibration and Validation[5]. Check the box if the answer to the question is "yes". "Check 5" passes if box 5a is checked.</td></tr>
<tr><td>5a
☐</td><td>Has the model been validated across points in time and changes in travel time and cost in order to confirm that it is appropriately sensitive to changes in these factors?</td></tr>
<tr><td colspan="2">[5]. In order to preserve sensitivities, alternative specific constants shall not deviate substantially in overall magnitude relative to the other variables unless the resulting sensitivity is validated based on observed data.</td></tr>
</table>

4.6 QUALITATIVE ASSESSMENT APPROACH

The CEQA Guidelines 15144 specify, "Drafting an EIR or preparing a Negative Declaration necessarily involves some degree of forecasting. While foreseeing the unforeseeable is not possible, an agency must use its best efforts to find out and disclose all that it reasonably can." Specifically addressing transportation impact analysis, CEQA 15064.3 states, "…if existing models or methods are not available to estimate the VMT for the particular project being considered, a lead agency may analyze the project's vehicle miles traveled qualitatively. For many projects, a qualitative analysis of construction traffic may be appropriate." When neither the NCST Calculator nor an appropriate TDM is available, modeling improvement cannot practically be accomplished, and no other quantitative assessment approach can be identified, a qualitative assessment approach may be appropriate.

When a project type is identified from the screen-out list contained in Section 5.1 of the TAC, a simple narrative will generally suffice in terms of induced travel assessment.

4.7 DOCUMENTATION

Documenting the factual and analytic basis for the decisions made throughout the project development process is critical to explaining how those decisions were made. The mandate to document facts and analysis used in reaching a conclusion applies to both the decisions made in analyzing a proposed project for whether a VMT analysis is required and if so, the technical level details as to how it was performed. These requirements apply to CEQA alternatives as well as to the proposed project.

Documentation of each fact relied upon, each inference derived from established facts and the logical approach taken to reach a conclusion are necessary so others, including a court if the matter is litigated, can follow the analytical path taken by the practitioner. The requirement to adequately document the analytical path applies whether the practitioner is a Caltrans staff member, a partner agency staff member or a consultant retained to prepare the analysis.

4.7.1 CALTRANS UNIFORM FILING SYSTEM

Caltrans has established a formal "Uniform Filing System" which must be the framework for documenting the facts, inferences and conclusions reached when reviewing a project's potential impacts. Taken together, the Uniform Filing System's components form the "Administrative Record" for the project. Training for how to apply the Uniform Filing System, and the creation and maintenance of the Administrative Record, is available through the Division of Environmental Analysis. See, e.g., http://etp.dot.ca.gov/env/files/admin-record/presentation_html5.html for additional background. Note that for those projects where NEPA compliance is required, similar procedures for records retention are required. See, e.g., https://dot.ca.gov/programs/environmental-analysis/standard-environmental-reference-ser/volume-1-guidance-for-compliance/ch-38-nepa-assignment#files.

Caltrans, like many other entities, has enterprise-level policies relating to the automatic deletion of emails after a certain amount of time elapses. While those policies generally apply, in order to assure retention of the records which document the analytical path taken in performing an analysis, relevant emails and any attachments should be retained in the project file, either in electronic format or by printing and saving to the project's paper file.

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APPENDIX A. THE NCST INDUCED TRAVEL CALCULATOR

SCOPE OF NCST INDUCED TRAVEL CALCULATOR

The technical documentation for the NCST Induced Travel Calculator states that (see https://travelcalculator.ncst.ucdavis.edu/about.html *accessed September 20, 2023*):

- The calculator is limited to use for capacity expansions. It cannot be used to estimate VMT effects of capacity reductions or lane type conversions.
- The calculator is limited to use for additions of general-purpose (GP),high occupancy vehicle (HOV), and high occupancy toll (HOT) lanes.
    - It should not be used for additions of pure toll lanes without supplemental analysis.
    - Hundreds of both general-purpose and HOV lane mile additions were included in the two studies used to derive the elasticities for the Calculator (Duranton & Turner, 2011); (Cervero & Hansen, 2002). While few HOT lanes had been added to publicly owned roadways before the end of the data collection periods for those two studies, studies using data from more recent periods (after more HOT lanes had been opened) have estimated similar induced travel elasticities (e.g., Hymel, 2019; Graham et al., 2014; Melo et at., 2012). Furthermore, because HOT lanes allow more vehicles than HOV lanes (high-occupancy vehicles plus drivers willing to pay to use the lane), they may logically have similar induced travel effects as HOV lanes.
- The calculator produces long-run estimates of induced VMT, the additional annual VMT that could be expected 5 to 10 years after facility installation.
- All estimates account for the possibility that some of the increased VMT on the expanded facility is traffic diverted from other types of roads in the network. In general, the studies show that "…capacity expansion leads to a net increase in VMT, not simply a shifting of VMT from one road to another" (Handy & Boarnet, Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions Policy Brief, 2014)
- The Calculator currently uses 2016 through 2019 lane mileage and VMT data from the Highway Performance Monitoring System (HPMS), including both passenger and heavy-duty vehicle data. The data will be updated periodically as new data become available.
- Knowledge of local conditions can help contextualize the calculator's estimates.

FHWA FUNCTIONAL CLASSIFICATION SYSTEM

The FHWA functional classification system used in the UC Davis NCST Induced Travel Calculator is defined in an FHWA memorandum (https://www.fhwa.dot.gov/policy/ohpi/hpms/fchguidance.cfm):

Functional Class 1 = Interstate
Functional Class 2 = Other Freeways and Expressways
Functional Class 3 = Other Principal Arterial

A variety of roadway facilities in California are represented within these functional classifications and in the corresponding Caltrans HPMS data, including but not limited to: State Highway System (SHS), local roadways, Department of Defense roads, State Parks roads, and U.S. Forest Service roads.

Note that according to the technical documentation for the NCST Induced Travel Calculator, functional classes 1, 2, and 3 are within the scope of the NCST Calculator.

CONCEPTS

Handy and Boarnet (2014a, 2014b) define "induced travel" as an "increase in vehicle miles traveled (VMT) attributable to increases in capacity." Handy and Boarnet (2014a, 2014b) then state:

> *"Increased highway capacity can lead to increased VMT in the short run in several ways: if people shift from other modes to driving, if drivers make longer trips (by choosing longer routes and/or more distant destinations), or if drivers make more frequent trips. Longer-term effects may also occur if households and businesses move to more distant locations or if development patterns become more dispersed in response to the capacity increase. Capacity expansion can lead to increases in commercial traffic as well as passenger travel."*

Handy and Boarnet (2014a, 2014b) also state:

> *"The induced-travel impact of capacity expansion is generally measured with respect to the change in VMT that results from an increase in lane miles, determined by the length of a road segment and its number of lanes (e.g., a two mile segment of a four-lane highway equates to eight lane miles). Effect sizes are usually presented as the ratio (elasticity) of the percent change in VMT associated with a one percent change in lane miles."*

According to a survey of the literature by Handy and Boarnet (2014a, 2014b), "Elasticity estimates of the short-run effect of increased highway capacity range from 0.3 to 0.6. Estimates of the long-run effect of increased highway capacity are considerably higher, mostly falling in the range from 0.6 to just over 1.0.

RESEARCH BASIS

Handy and Boarnet (2014a, 2014b) provide some of the technical background for six of the studies they included in their policy brief. Key characteristics shared by many of the research studies upon which the elasticity estimates are based are:

- They measure changes in regional, county, or statewide VMT and lane-miles of road in most cases only on freeways. Some focused on state-owned highways. One used sample from the US DOT Highway Statistics database for all road types in that database.
- Data on changes in capacity and traffic volumes for non-freeways, minor roads and arterials was not available to the researchers in most cases, so they could not account for diversion effects, where traffic shifts to and from minor roads and arterials in the region to the freeways. The background documentation for the NCST Calculator states that Duranton estimated this unmeasured diversion effect to be between zero and 10% (which would have no effect or would reduce the reported elasticity).
- The long-term time frames considered varied from 14 years to 22 years.
- Researchers fitted log-linear regression models with lane-miles as one of various explanatory factors for observed changes in regional or county VMT.
- They all included changes in population as one of the explanatory factors but varied in what additional variables impacting VMT were included. Some included income, some employment density, some fuel cost. The additional explanatory factors usually lowered the elasticity with respect to lane-miles.
- They used different approaches to control for demand driven capacity construction, called “simultaneity bias.”
- Three of the studies used only California data. Three used data from around the United States.

APPENDIX B. GLOSSARY OF ACRONYMS AND TERMS

Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CSTDM	California Statewide Travel Demand Model
DOT	Department of Transportation
EIR	Environmental Impact Report (State)
EIS	Environmental Impact Statement (federal)
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GP	General Purpose lane
HCM	Highway Capacity Manual
HOT	High Occupancy Toll lane
HOV	High Occupancy Vehicle lane
HPMS	Highway Performance Monitoring System database hosted by Federal Highway Administration and maintained by Caltrans Division of Research, Innovation, and System Information
IS	Initial Study
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan or Metropolitan Transportation Program
MSA	Metropolitan Statistical Area
NCST	National Center for Sustainable Transportation, University of California, Davis
ND	Negative Declaration
NEPA	National Environmental Policy Act
OPR	Governor's Office of Planning and Research
PA&ED	Project Approval and Environmental Document
PDT	Project Development Team
PEAR	Preliminary Environmental Analysis Report
PRC	California Public Resources Code
SB	Senate Bill
SHS	State Highway System
SOV	Single Occupancy Vehicle
TA	Office of Planning and Research Technical Advisory on Evaluating Transportation Impacts in CEQA (2018)
TAC	*Transportation Analysis under CEQA* (Caltrans guidance document for implementing SB 743)
TAF	*Transportation Analysis Framework* (Caltrans guidance document for implementing SB 743)
TBM	Trip-Based Model
TDM	Travel Demand Model

TMIP	Travel Model Improvement Program
VMT	Vehicle Miles Traveled
Elasticity	Elasticity is a measure of a variable's sensitivity to a change in another variable. In economics, elasticity is the measurement of the percentage change of one economic variable in response to a change in another. In transportation forecasting, an example is elasticity of travel demand, which can be expressed as the percent change in regional VMT divided by the percent change in regional lane-miles of state highways.
Induced Travel	Induced travel (or the VMT attributable to a transportation capacity increase) is the increased amount of vehicle travel on the transportation network that is caused by travel behavior changes associated with decreased cost of travel due to improved travel times, improved reliability, or reduced price of travel. Over the short run, travel behavior changes including longer trips, more trips, mode shift, and route shift all tend to occur as a result of a highway capacity increase. Over the long run, these effects intensify (e.g. as people shift job or residential location to benefit from the infrastructure), and also land use development may become more dispersed, adding additional vehicle travel; for these reasons, long run induced travel is generally greater than short run induced travel.
Latent Demand	Latent demand is the travel that would occur on the transportation network if travel times (or costs) were reduced. Much like any public utility (e.g., electricity or water), consumers will use more of it when its cost or impedance of use is reduced or made free. Note that unless the current price of travel is zero (instantaneous travel at will at no cost), there is always latent demand.
Metropolitan Statistical Area	A U.S. metropolitan statistical area (MSA) is a geographical region with a relatively high population density at its core and close economic ties throughout the area, as defined by the U.S. Office of Management and Budget and used by the Census Bureau and other federal government agencies for statistical purposes.
Transit	Transit generally includes all forms of shared common carrier passenger ground transportation in moderate to high capacity vehicles ranging from dial-a-ride vans to buses, trolleys, light rail, commuter rail, and intercity rail transportation.
Travel Demand Model	A travel demand model is any relatively complex computerized set of procedures for predicting future trip making as a function of land use, demographics, travel costs, the road system, and the transit system. These models may cover an entire metropolitan area, a single city or county, or the entire state.

Trip-Based Model	Trip-based travel models use the individual person trip as the fundamental unit of analysis. Trip-based models are often referred to as "4-step" models because they split the trip making decision process into 4 discrete steps: trip generation by time of day, destination choice, mode choice, and route choice (traffic assignment).
Trucks	Trucks are a subtype of the heavy vehicles category which includes trucks, intercity buses, and recreational vehicles. This Framework follows the Highway Capacity Manual definition of what constitutes a heavy vehicle: "A vehicle with more than four wheels touching the pavement during normal operation." This is consistent with the Caltrans Traffic Census definition of a truck: "The two-axle (truck) class includes 1-1/2-ton trucks with dual rear tires and excludes pickups and vans with only four tires."
Vehicle Miles Traveled	The number of miles traveled by motor vehicles on roadways in a given area over a given time period. VMT may be subdivided for reporting and analysis purposes into single occupant passenger vehicles (SOVs), high occupancy vehicles (HOV's), buses, trains, light duty trucks, and heavy-duty trucks. For example, an air quality analysis may require daily VMT by vehicle class and average speed or vehicle operating mode (idle, acceleration, cruise, deceleration, etc.). For a CEQA compliant transportation impact analysis, automobile VMT (cars and light trucks) may be evaluated.
VMT Attributable to a Project	In the context of a CEQA analysis, the VMT attributable to a transportation project, or induced travel, is the difference in passenger VMT between the "with project" and "without project" alternatives. VMT attributable to a project is equivalent to induced travel in this context.