SB 743 Implementation by Local Governments for Land Use Projects

May 2023

A Research Report from the National Center for Sustainable Transportation

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16. Abstract
In 2018, pursuant to Senate Bill (SB) 743 (2013), the Governor's Office of Planning and Research (OPR) and the California Natural Resources Agency promulgated regulations and technical guidance that eliminated automobile level of service (LOS) as a transportation impact metric for land development projects under the California Environmental Quality Act (CEQA), and replaced it with Vehicle Miles Traveled (VMT). The authors investigated how local governments have been implementing the LOS-to-VMT shift for land development projects, and how that differs from past practice. They also explored whether local governments monitor the actual VMT impacts from completed land use developments and what methods are available to do so. Their findings indicate that all responding jurisdictions acknowledged the mandatory LOS-to-VMT shift, but were in varying stages of implementing the shift. For those jurisdictions that had adopted VMT impact significance thresholds, most adhered closely to OPR's recommendations. They also mostly tried to use apples-to-apples methods of calculating baseline VMT levels (for setting thresholds) and estimating project-level VMT, often relying on travel demand model outputs for both. However, most jurisdictions gave short shrift to VMT monitoring. Another important aspect of SB 743 implementation is how LOS will continue to be used outside of CEQA. The authors found that jurisdictions uniformly continue to employ LOS outside of CEQA. However, those LOS analyses are not necessarily as comprehensive and expensive as they would have been for CEQA purposes. The authors found a consensus amongst their interviewees that swapping LOS for VMT could streamline development in urban areas.

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EXECUTIVE SUMMARY

In 2013, then-Governor Jerry Brown signed Senate Bill (SB 743) into law. Pursuant to that direction, the Governor's Office of Planning and Research (OPR) and the California Natural Resources Agency promulgated regulations and technical guidance that eliminated automobile level of service (LOS) – a measure of automobile delay – as a transportation impact metric for land development projects under the California Environmental Quality Act (CEQA), and replaced it with Vehicle Miles Traveled (VMT) – a measure of the amount of vehicular travel. Actual implementation of the LOS-to-VMT shift was left up to lead agencies—the agencies with primary approval authority over a given project, which for land development projects is usually lead a local government (city or county). Agencies were required to start using a VMT-based metric by July 1, 2020.

Using LOS as the guiding metric for transportation impacts prioritizes vehicular flows and speed.[1] As a result, it has had increasingly well-recognized consequences, including increasing the cost of infill development in urban areas (where roadways are typically more congested at baseline, making project-level transportation impacts more likely) and generally making the built environment more auto-centric (Volker et al., 2019a, b). And many planners and policymakers viewed VMT as a more appropriate metric for achieving sustainability goals, like reduced greenhouse gas (GHG) emissions, improved public health and safety, and more streamlined infill development amidst California's ongoing housing crisis (OPR, 2018; Volker et al., 2019b). However, the LOS-to-VMT shift was also expected to create numerous challenges for transportation analysts, given the often-limited resources of local governments, the ingrained nature of LOS in transportation impact analyses, and the perceived lack of established practice with respect to VMT estimation, mitigation, and monitoring.

With those concerns in mind, we undertook this study to investigate how local governments have been implementing the LOS-to-VMT shift for land development projects. We first explored whether and how local governments considered VMT impacts in CEQA analyses prior to the mandated change in transportation impact analysis metrics. We then used document review, direct outreach, and expert interviews to catalogue how each of California's 539 cities and counties have responded to SB 743, focusing on jurisdictions' acknowledgment of the policy shift, thresholds of VMT impact significance, VMT impact estimation methods (and tools), VMT impact mitigation guidance (and tools), VMT mitigation monitoring, inter-jurisdictional collaboration, continued use of LOS, and perceived effect of the LOS-to-VMT shift on land use

[1] LOS is generally assessed using six letter grades, from A (free flow) to F, which denote different levels of vehicular delay for intersections and different combinations of automobile speed, density, and capacity for roadway sections.

development.[2] We also explored whether and how local governments monitor the actual VMT impacts from completed land use developments and what methods are available to do so. This report discusses our findings. We preface those findings with a primer on the CEQA process, a brief history of LOS-based transportation impact analysis, and a summary of SB 743 and the switch from LOS- to VMT-based analysis.

We found from the first phase of the study (Chapter 5 below) that VMT was frequently estimated in CEQA documents prior to SB 743 implementation—64% of the 249 environmental impact reports (EIRs) we reviewed contained VMT estimates, mostly produced using first-generation sketch models like CalEEMod and URBEMIS.[3] However, those VMT estimates were almost solely used to inform the EIRs' analyses of different types of impacts, generally local air quality and/or greenhouse gas emissions. They also generally did not include VMT-specific mitigation measures. And none of the EIRs discussed monitoring the projects' actual VMT impacts after construction.

In the second phase of the study (Chapter 6 below), we found that all 274 responding jurisdictions acknowledged SB 743 and the mandatory switch from LOS to VMT in CEQA analyses—none contested its legality. However, actual implementation was more scattershot. Eighty-one percent of jurisdictions had either adopted their own VMT-based thresholds of significance, were in the process of doing so, or were informally following another jurisdiction's thresholds, and only 66% had adopted or were following specific-enough thresholds for us to summarize.

Most of the 181 jurisdictions with specific thresholds hewed closely to OPR's recommendations in its 2018 Technical Advisory on Evaluating Transportation Impacts in CEQA (Technical Advisory) (OPR, 2018)—most used both screening criteria (to quickly excuse certain projects from in-depth VMT impact analysis) and numeric thresholds (for non-screened projects); and most jurisdictions used numeric thresholds of close to 15% below the baseline average for residential and office projects and a threshold of no-net-increase in total area-wide VMT for retail projects. Less stringent thresholds—less than 15% below baseline for office and residential projects—were more common in jurisdictions with higher baseline VMT, with the lone exception of county thresholds for office projects in unincorporated areas

In terms of VMT estimation, most of the 166 jurisdictions that provided guidance relied on travel demand models to estimate baseline VMT, and used either travel demand models or outputs therefrom (e.g., in maps or sketch tools) to estimate project-level VMT and cumulative VMT impacts. Only one jurisdiction relied primarily on big data (such as location and motion

[2] Note that some of the information we obtained and report on might now be out of date, since not every local government had formalized their SB 743 policies at the time we collected the information and even those jurisdictions with finalized policies could have subsequently changed them. However, we believe that the overall trends remain largely accurate.

[3] Sketch models are intended to quickly and inexpensively produce order of magnitude estimates without necessitating more complicated (and often expensive) modeling.

data from cell phones and other electronic devices), though a number of jurisdictions have used big data to help calibrate their travel demand models or VMT estimation sketch tools.

Fewer (145) jurisdictions provided any guidance on VMT mitigation, and only 104 jurisdictions provided guidance on how to estimate the efficacy of mitigation measures. All 104 jurisdictions that provided guidance on actually estimating the efficacy of VMT mitigation measures relied primarily on the California Air Pollution Control Officers Association's (CAPCOA) Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity—the "CAPCOA Handbook" (CAPCOA, 2021).

Even fewer jurisdictions provided guidance on monitoring the implementation or efficacy of VMT mitigation measures. Only 38% even mention a requirement for VMT mitigation monitoring, and most of those jurisdictions provide almost no substantive guidance on how to achieve it. Only 18 jurisdictions provided some sort of substantive direction on how monitoring could or should be performed. The most commonly mentioned monitoring methods were trip/vehicle counts and mitigation measure inspection (ensuring that the measure was actually implemented, regardless of success). Surveys of project users, parking surveys, and big data were also mentioned.

Across all facets of SB 743 implementation, most jurisdictions collaborated in some form with other entities. Collaborations ranged from simply relying on guidelines developed by another entity to actual collaborative development of VMT impact analysis tools. Collaborations and regional guidance (even just sharing regional travel demand model outputs) helped to alleviate burdens associated with lack of resources and/or expertise, which were particularly common in smaller and more rural jurisdictions. We also found optimism that SB 743 implementation burdens could be further reduced by planning for VMT reduction in higher-level plans or programs, like general plans and climate action plans. Almost half of our interviewees also highlighted the benefits of developing or joining a VMT mitigation in-lieu fee, bank, or exchange program.

Sometimes overlooked in the hubbub of developing VMT impact analysis standards is the fact that while SB 743 and its implementing regulations eliminated LOS as a transportation impact metric under CEQA, they do not prohibit local governments from employing LOS standards outside of CEQA. Indeed, all the jurisdictions for which we found information about their use of LOS continue to employ the metric for planning and project-level review outside of CEQA. However, we found that LOS impact analyses done outside of CEQA are not necessarily as comprehensive and expensive as they would have been for CEQA purposes. And that has implications for the ability of SB 743 to incentivize infill development, one of the law's original goals (OPR, 2018). In that vein, we asked each of our interviewees what impact they thought the LOS-to-VMT shift was having and would have on land use development. The consensus was that swapping LOS for VMT could streamline development in urban areas, but not in more suburban or rural jurisdictions.

In the third phase of the study, we explored methods for monitoring the actual VMT from land use developments, not just the efficacy of particular mitigation measures. Based on our review, we identified four primary approaches to monitoring project-level VMT generation: vehicle trip counts, travel surveys, big data, and odometer data. Trip counts are the simplest and provide the most consistent data over time, while odometer data is likely the least useful in California, though no one method provides a panacea. Going forward, monitoring both the efficacy of VMT mitigation measures and the actual VMT from land use developments will be important for both assessing the accuracy of the VMT analysis methods being employed and selecting the most efficacious mitigation measures. However, we found that local governments are unlikely to pursue rigorous monitoring on their own. State or regional monitoring initiatives—or even just funding—could help. For example, monitoring could be included in the charge of a regional VMT mitigation bank or exchange.

Introduction

Automobile Level of Service (LOS) – a measure of vehicular delay – is the longest-standing and most commonly used performance metric in transportation impact analysis (US Department of Transportation, 2017; Combs et al., 2020; Combs & McDonald, 2021). For nearly 50 years, LOS was also the primary metric of transportation-related environmental impacts under California's state-level equivalent of the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA). But Senate Bill (SB) 743 upended the status quo.

Signed into law by Governor Jerry Brown in 2013, SB 743 directed the Governor's Office of Planning and Research (OPR) to revisit and modify the guidelines for assessing transportation impacts under CEQA to "promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses" (Public Resources Code [PRC] section 21099). Pursuant to that direction, OPR and the California Natural Resources Agency promulgated regulations and technical guidance that eliminated LOS as a transportation impact metric under CEQA, and replaced it with Vehicle Miles Traveled (VMT) – a measure of the amount of vehicular travel rather than the degree of vehicular congestion caused by a project (California Natural Resources Agency, 2019; OPR, 2018).

However, actual implementation of the LOS-to-VMT switch was left up to the various agencies that conduct CEQA analyses. For land development projects, that primarily includes cities and counties. Those agencies were required to stop using LOS to measure land use projects' transportation-related impacts in CEQA reviews and start using a VMT-based metric by July 1, 2020. But the specifics were left up to the local governments, causing considerable uncertainty about how the LOS-to-VMT switch would be implemented.[4]

Studies prior to July 1, 2020 used surveys, interviews, and counterfactual analyses to assess how planners viewed the impending switch, what challenges they might face in implementing it, whether it would streamline the approval process for land development projects or make it more costly, and how LOS might continue to be used outside of the CEQA process (Volker et al., 2019a, b; Barbour et al., 2019). But the question remains—how have local governments actually implemented SB 743? This study helps fill that research gap through a comprehensive inventory of how California's 539 cities and counties are responding to SB 743 and switching from LOS to VMT in their CEQA analyses of land development projects, paired with expert interviews about SB 743 implementation. We also explore whether and how local governments monitor the actual VMT impacts from completed land use developments and what methods are available to do so. We preface those two investigations with a review of whether and how VMT impacts were considered in CEQA analyses prior to the mandated change in transportation impact analysis.

[4] For context, lead agencies generally have discretion to choose their own thresholds of significance and methods of analyzing environmental impacts pursuant to CEQA, so long as they are supported by substantial evidence. It is rare, however, for the state to provide the kind of detailed guidance on analyzing particular impacts that OPR provided in its Technical Advisory on Evaluating Transportation Impacts in CEQA (Technical Advisory) (OPR, 2018).

This report proceeds as follows. The next (second) chapter provides a primer on the CEQA process, which is key to understanding SB 743 and the VMT-based transportation impact standards that local governments are using. The third chapter examines the history of LOS-based transportation impact analysis. The fourth chapter summarizes SB 743 and the switch from LOS- to VMT-based analysis. The fifth chapter reviews whether and how local governments analyzed VMT impacts prior to the LOS-to-VMT switch. The sixth chapter—and bulk of the report—inventories how California's cities and counties are actually implementing the LOS-to-VMT switch. The seventh chapter explores whether and how local governments monitor—or could monitor—the actual VMT impacts from land use developments. And the eighth chapter concludes.

CEQA Process Primer

CEQA is California's foundational environmental review law. It imposes a tiered system of environmental review for non-exempt projects that require discretionary approvals (like conditional use permits, zoning changes, or general plan amendments), which include most larger land development projects. Figure 1 outlines the general process.

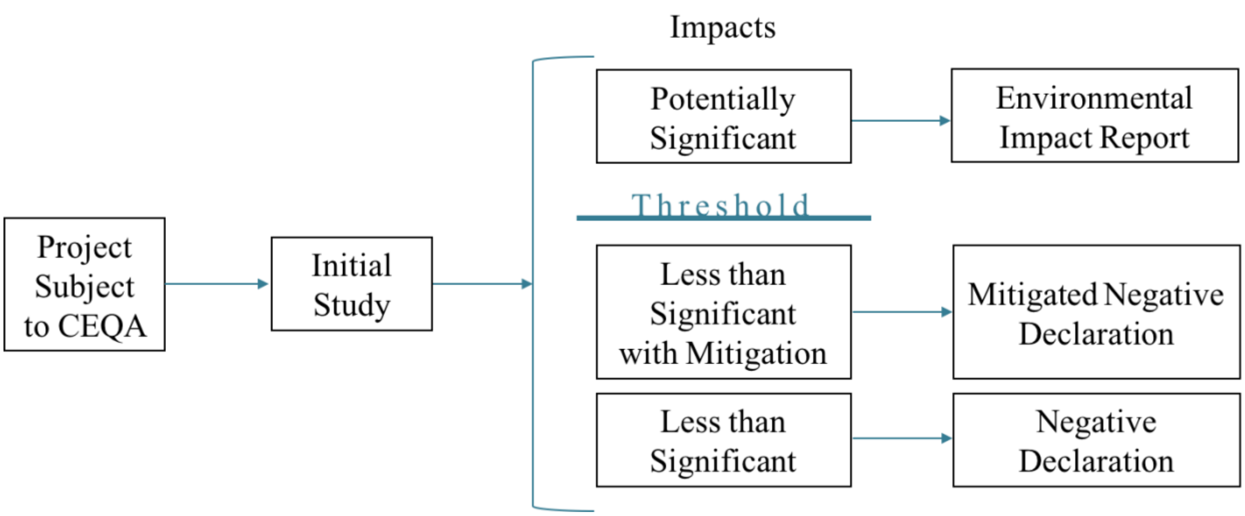

Figure 1. California's environmental review process

Once the lead permitting agency determines that a project is subject to CEQA, it prepares an "initial study" to determine whether the project would have potentially "significant" and unmitigable environmental impacts, including transportation system impacts (14 California Code of Regulations [CEQA Guidelines] Section 15063; CEQA Guidelines, Appendix G). If the agency determines that the project would have no significant environmental impacts, it may prepare a "negative declaration" (PRC Section 21080). If the agency determines that any potentially significant could be mitigated to a less-than-significant level, it may prepare a "mitigated negative declaration" (PRC Section 21080). The agency must prepare a full environmental impact report (EIR) when there is substantial evidence that the project may have a significant and unavoidable impact on the physical environment, i.e., that the impact would exceed the threshold of significance. And it must mitigate or avoid that impact if feasible (PRC Section 21002.1), which mitigation costs are generally borne by the project proponent. If the agency determines in the EIR (or mitigated negative declaration) that the mitigation measures will fully mitigate the project's significant impacts, the agency must also adopt a mitigation monitoring or reporting program to "ensure compliance during project implementation" (PRC Section 21081.6(a)(1)). This monitoring requirement does not apply to any impacts that the agency determines will remain significant even after mitigation. In that case, the agency must adopt a statement of overriding considerations (PRC Section 20181).

The metrics and thresholds for analyzing impact significance—including transportation impact significance—are thus critical in determining whether and to what extent projects must undergo CEQA review, what type of mitigation measures will be required for any significant impacts, and how likely a project is to be challenged in court. Lead agencies—which, for land development projects are frequently cities and counties—generally have discretion to choose their own impact metrics and significance thresholds.

Table 1. Glossary of relevant CEQA terms provides a glossary of some of the CEQA terms of art we use throughout the report.

Table 1. Glossary of relevant CEQA terms

Term	Definition
CEQA Guidelines	Administrative guidelines developed by OPR and the Natural Resources Agency that interpret CEQA and related court decisions.
Environmental Impact Report (EIR)	The most detailed analysis of environmental impacts potentially required under CEQA. Required where the initial study identifies "substantial evidence" that the studied project may have a "significant" environmental impact. The agency must then avoid or mitigate those impacts to the extent feasible.
Exemption	An exemption from CEQA (and its impact analysis and mitigation requirements) for a class of projects generally determined to not have significant environmental impacts ("categorical" exemption) or a specific project or type of project exempted by the legislature for any reason ("statutory" exemption).

Term	Definition
Impact Significance Threshold	The level at which a project impact will be deemed “significant,” thus triggering the requirement for further analysis in an EIR or mitigative negative declaration, and associated impact mitigation. For transportation impacts, the primary significance threshold has historically been a minimum LOS “grade” for a given roadway segment or intersection.
Lead Agency	The agency with the greatest permitting authority over a proposed project, and which has primary responsibility for complying with CEQA.
Mitigated Negative Declaration	A written statement prepared by the lead agency describing why the studied project will not have a “significant” environmental impact after mitigation. Prepared in cases where the initial study identifies potentially significant project impacts, but the project proponent revises the project to mitigate the impacts to a less-than-significant level.
Negative Declaration	A written statement prepared by the lead agency describing why the studied project will not have a “significant” environmental impact. No environmental impact mitigation is required.
Office of Planning and Research (OPR)	Works with the Natural Resources Agency to develop the CEQA “Guidelines.” Maintains the State Clearinghouse, which maintains a database of CEQA documents and coordinates state-level CEQA review.
Statement of Overriding Considerations	A written statement explaining the specific reasons why the benefits of a proposed project outweigh its unavoidable adverse environmental impacts and why that is acceptable to the lead agency.

Level of Service-Based Transportation Impact Analysis

LOS has been engrained in the transportation engineering profession nationwide since soon after its appearance in the 1965 Highway Capacity Manual (US Department of Transportation, 2017; Roess et al., 2014). The same is true in California. Prior to July 1, 2019, LOS had been the principal measure of transportation impact significance under CEQA since at least the late 1990s, when the metric was added as an “explicit part of CEQA analysis” (OPR, 2013). And increased traffic had been recognized as a potentially significant environmental impact under CEQA since at least the early 1970s (City of Orange v. Valenti, 1974; OPR, 2013). In that role, LOS has had a major impact on land use development and the built environment, particularly in urban areas where LOS impacts are more common, more likely to be significant, and more expensive to mitigate, as Volker et al. (2019a) discuss in more detail.

In addition to its central role in CEQA review, LOS has also been otherwise instrumental in land use and transportation planning, development and funding decisions. For example, California law requires that congestion management programs be developed for "every county that includes an urbanized area," and that each program must contain "[t]raffic level of service standards" (California Government Code Section 65089). In turn, those standards and other LOS concerns animate both local and state road design requirements, which are incorporated into local land use development approval conditions, exactions and lobbying (US Department of Transportation, 2017; Deakin, 1989; Los Angeles City Department of Transportation, 2016; Nelson, 1994). For example, Caltrans frequently participates in local jurisdictions' land use planning and decision-making processes to ensure impacts to state highways are considered and mitigated. Until recently, Caltrans "primarily utilized Level of Service to identify [the] impacts to the State Highway System," and "often limited its recommended mitigation to traditional road improvements" (Caltrans, 2016).

Senate Bill 743 and the Shift from LOS to VMT

Senate Bill 743 (Chapter 386, Statutes of 2013) and its implementing regulations made two major changes to CEQA's transportation impact analysis requirements. First, they eliminated LOS as a transportation impact metric under CEQA (California Natural Resources Agency, 2019; OPR, 2018). Second, they replaced LOS with VMT as "the most appropriate metric to evaluate a project's transportation impacts" (California Natural Resources Agency, 2019; OPR, 2018). Local governments were required to stop using LOS and start using a VMT-based transportation impact threshold for CEQA review by July 1, 2020. OPR, in its informal Technical Advisory on Evaluating Transportation Impacts in CEQA (Technical Advisory), provided suggestions on thresholds for land use development projects, land use plans and transportation projects, as well as some guidance on estimating and mitigation VMT impacts (OPR, 2018). However, lead agencies retain discretion to choose their own impact metrics and significance thresholds; they are not required to follow OPR's recommendations.[5]

Even in a post-SB 743 implementation world, project-level LOS analysis and related exactions can still be required for some projects by local ordinances or plans. That said, the non-CEQA-based LOS analysis and mitigation requirements might also change—or be eliminated—if and when local jurisdictions adopt VMT-based transportation impact standards for CEQA review.

[5] For context, lead agencies generally have discretion to choose their own thresholds of significance and methods of analyzing environmental impacts pursuant to CEQA, so long as they are supported by substantial evidence. It is rare, however, for the state to provide the kind of detailed guidance on analyzing particular impacts that OPR provided in its Technical Advisory on Evaluating Transportation Impacts in CEQA (Technical Advisory) (OPR, 2018). It is an open question how courts would view lead agency guidelines for analyzing VMT impacts that conflict with OPR's recommendations.

Pre-SB 743 VMT Analyses in CEQA Documents

While LOS has historically dominated transportation impact analyses in California, estimating VMT was not a foreign concept prior to SB 743. Quantifying VMT has for decades been a key component of analyzing other categories of environmental impacts besides transportation, particularly local air quality impacts and greenhouse gas emissions. To better illuminate the state of VMT analysis prior to SB 743 implementation, we reviewed a sample of EIRs published between 2001 and 2016 (before even most of the "early adopters" had begun using VMT-based significance thresholds for transportation impacts[6]).

We reviewed a total of 249 EIRs for land use developments proposed in the City of Los Angeles (n = 153), the City of Sacramento (n = 49), and San Joaquin County (n = 47). We chose those three locations because they represent a range of both sprawl/compactness and baseline VMT rates across the state's north-south transect. Los Angeles is the most compact/least sprawling of the three (and one of the most compact urban areas in the state) and has the lowest VMT rates both per capita and per worker, while San Joaquin County is the least compact/most sprawling and has the highest VMT rates (Ewing & Hamidi, 2014; Fehr & Peers, 2023; Laidley, 2016). Our sample includes all residential, office, and retail development projects in the three geographies for which (1) there was a draft EIR prepared between January 1, 2001 and December 31, 2016, and (2) we were able to obtain a copy of the draft EIR. We excluded land use plans that did not include specific development proposals, as well as transportation projects (not the focus on this study and often not led by local governments in any event) and public utilities projects that do not include a residential, retail, or office development component (the components most likely to cause operational VMT impacts).

We searched each EIR for the phrases "VMT," "vehicle miles," "vehicle trips," and "trips generated." We then reviewed each section (and the corresponding appendices) in which VMT or vehicle trips were discussed to determine (1) if project VMT was estimated as part of the CEQA analysis, (2) what environmental impacts the VMT estimates were used to assess, (3) how VMT was estimated, (4) whether VMT-based mitigation measures were used, and (5) whether there were any provisions for monitoring the project's actual VMT impacts after construction.

We found that nearly two-thirds (64%) of the EIRs contained VMT estimates. However, only one of those 160 EIRs analyzed VMT as its own impact—a 2016 EIR for a Sacramento project that recognized how VMT impact analysis was soon going to be mandatory pursuant to SB 743. The other 159 EIRs used VMT estimates solely to inform their analyses of different types of impacts, generally local air quality and/or greenhouse gas emissions. Because most EIRs only estimated VMT incidentally, they also generally did not include VMT-specific mitigation measures apart from a few EIRs that listed vaguely defined travel demand management (TDM) programs (mostly employer-based TDMs for office projects) as mitigation for impacts like inadequate LOS

[6] Pasadena was the first city or county to adopt VMT-based thresholds of significance for transportation impacts in 2014 (City of Pasadena Department of Transportation, 2015), followed by San Francisco and Oakland in 2016 (City of Oakland, 2017; San Francisco Planning Department, 2016), and San Jose in 2018 (City of San Jose, 2018).

or parking capacity. And none of the EIRs included requirements for—or even discussed—monitoring the projects' actual VMT impacts after construction. However, most EIRs did identify how their VMT estimates were derived.

Figure 2 shows the methods used in the EIRs to forecast project VMT. Most (86%) of the 160 EIRs that contained VMT estimates used a sketch-level tool, primarily the California Emissions Estimator Model (CalEEMod, developed by the California Air Pollution Control Officers Association) or the Urban Emissions Model (URBEMIS, developed by the California Air Resources Board, though no longer commonly used). Only 3% used a travel demand model to estimate VMT. The other 11% did not specify how they estimated VMT.

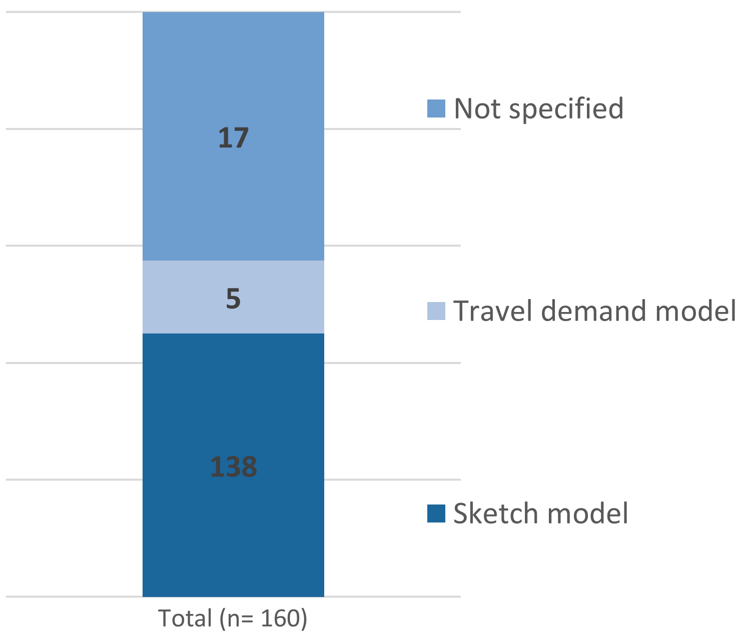

Figure 2. VMT estimation methods used in early EIRs

CalEEMod and URBEMIS—the most commonly used VMT estimation tools in our sample of EIRs—were both developed to project criteria pollutant and greenhouse gas emissions from the construction and operational phases of land use developments, with VMT being one component of those calculations. Both sketch models estimate VMT simply by multiplying trip generation rates by trip lengths, using default trip rates published by the Institute of Transportation Engineers (ITE) and default trip lengths based on either the California Household Travel Survey or more local data (Lee & Handy, 2018; Lee et al., 2017). The default estimates are rough averages that risk overestimating VMT for projects in urban settings—ITE trip rates, for example, are focused on vehicle-oriented suburban sites and are often "not consistent" with projects "located in a downtown setting" (Institute of Transportation Engineers, 2004; Lee & Handy, 2018). However, both models allow users to adjust the default trip rates and lengths, and also account for diverted and pass-by trips, which reduce VMT (Lee et al., 2017; Lee & Handy, 2018). CalEEMod also allows users to go a step further to adjust the VMT estimates based on the characteristics of the project and surrounding area (e.g., distance to transit and nearby employment density), using the empirical research summarized in the California Air Pollution Control Officers Association's (CAPCOA) Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity—the "CAPCOA Handbook" (CAPCOA, 2021).

However, even with context-sensitive functionality, VMT estimates from sketch models like CalEEMod and URBEMIS can be difficult to use for assessing the significance of VMT impacts specifically (using a VMT-based threshold of significance). VMT impact analysis generally entails comparing project-generated VMT to a threshold based on existing VMT levels in the project area. But sketch tools are not well suited for calculating area-wide VMT averages (Lee & Handy, 2018). Instead, baseline VMT is usually estimated using a travel demand model. This can lead to an "apples-to-oranges" comparison in the VMT impact analysis, unless the sketch models use data derived from the applicable travel demand model. This presents a challenge for local governments in assessing VMT impacts, and it segues into the next chapter and the primary focus of our report—how local governments are implementing SB 743.

SB 743 Implementation by Local Governments

In this chapter, we review and catalogue how all 539 cities and counties in California have responded to SB 743 and moved away from using LOS in their CEQA analyses for land use projects. We focus on five main topics: acknowledgment of the policy shift, thresholds of VMT impact significance, VMT impact estimation methods (and tools), VMT impact mitigation guidance (and tools), and VMT mitigation monitoring. We also investigate inter-jurisdictional collaboration, the continued role of LOS, and the perceived effect of the LOS-to-VMT shift on land use development.

We obtained information on those topics by searching through the local governments' official websites for relevant documents, such as resolutions, ordinances, public meeting minutes, transportation impact analysis guidelines, transportation impact analyses, and environmental impact reviews. If we could not locate any documents online or needed additional clarifying information, we contacted public officials from the jurisdictions' planning, transportation, community development, and/or public works departments via email or telephone using available contact information from the websites. We made at least three attempts to contact non-responsive jurisdictions, with our final attempt happening in September 2022. Overall, we found information on SB 743 implementation for 274 cities and counties, a 51% response rate as shown in Table 2 All data we collected for each jurisdiction is available through the Data Summary section. Note that some of the information we obtained and report on might now be out of date, since not every local government had formalized their SB 743 policies at the time we collected the information and even those jurisdictions with finalized policies could have subsequently changed them. However, we believe that the overall trends remain largely accurate.

Table 2. Status of jurisdictions regarding SB 743 implementation in this study

Status	Responded	Total	Response rate
City*	251	482	52%
County	23	57	40%
All	274	539	51%

* San Francisco City and County is treated as a city.

For additional context and insights, we also interviewed 22 governmental officials (from cities, counties, regional transportation authorities, and the California Department of Transportation) and consultants familiar with SB 743 and transportation impact analysis of land use projects. Most of the 22 interviewees (13) worked (or had worked) for one or more cities (14 in total), while three worked (or had worked) for counties, three worked for regional transportation authorities, one worked for Caltrans, and three were consultants who had worked for various clients across the state on the LOS-to-VMT shift. Most were in senior positions within their respective organizations, with at least 10 years of experience. The jurisdictions the interviewees had worked for included three of the top-10 most populous cities in the state, three intermediate-size cities, eight smaller and more suburban or rural cities, two urbanized counties (within a metropolitan statistical area), and one rural county.

Characteristics of the Responding Jurisdictions

We compared the respondent and non-respondent jurisdictions to gauge generalizability and non-response bias. We looked at three factors: urbanization status, average population in 2020, and baseline VMT (both residential and office).

We classified jurisdictions as urbanized if they are located within a metropolitan statistical area. Most jurisdictions (87%) in the state are urbanized, including 430 cities and 37 counties. An even greater percentage (97%) of the responding jurisdictions are urbanized (246 cities and 20 counties); only eight are non-urbanized. As Figure 3 shows, most local governments that provided information on SB 743 implementation are located in the San Francisco Bay Area and Southern California, while most of non-respondent jurisdictions are from rural areas in northern California, as Figure 4 suggests.

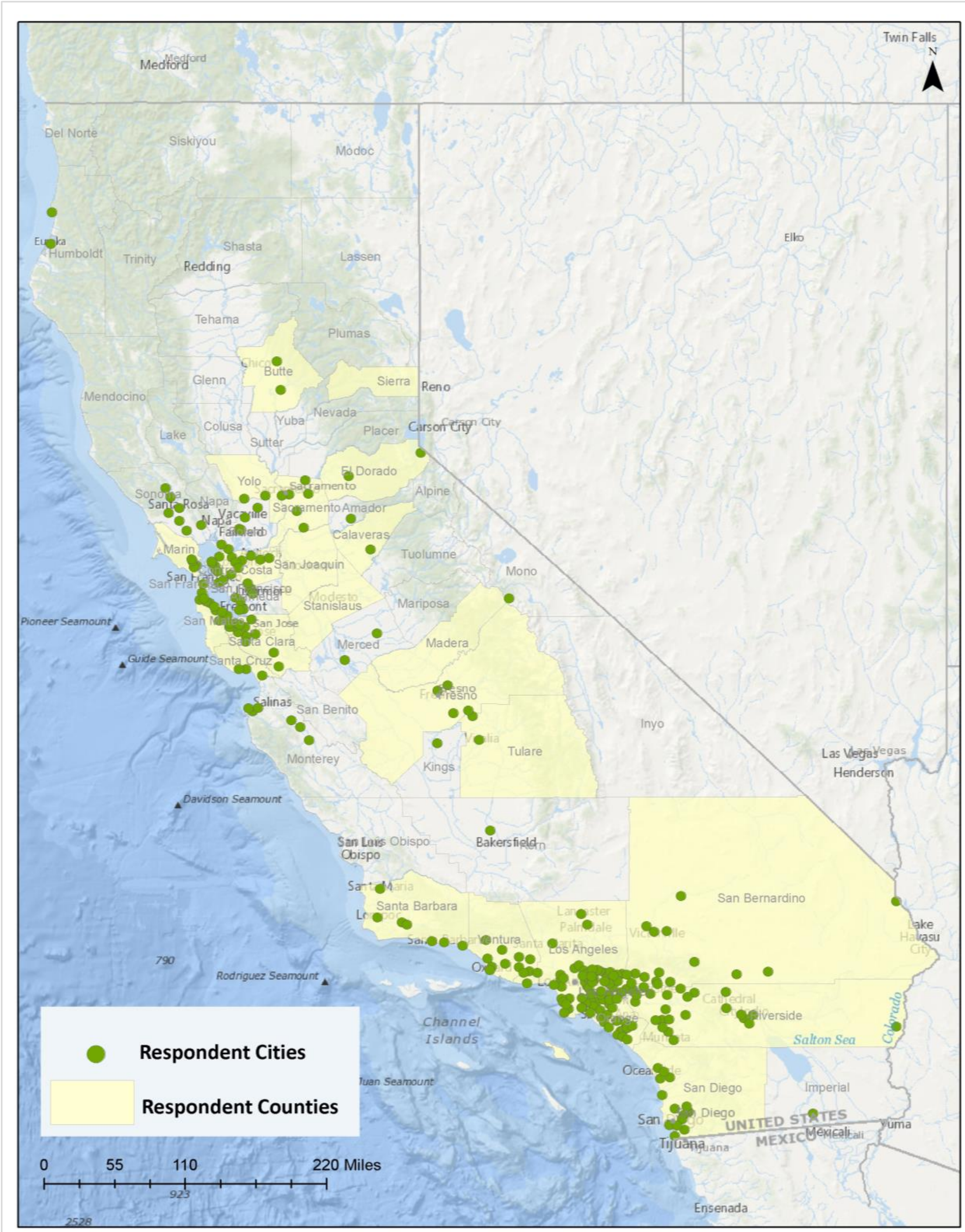

Figure 3. Geographical distribution of the responding jurisdictions

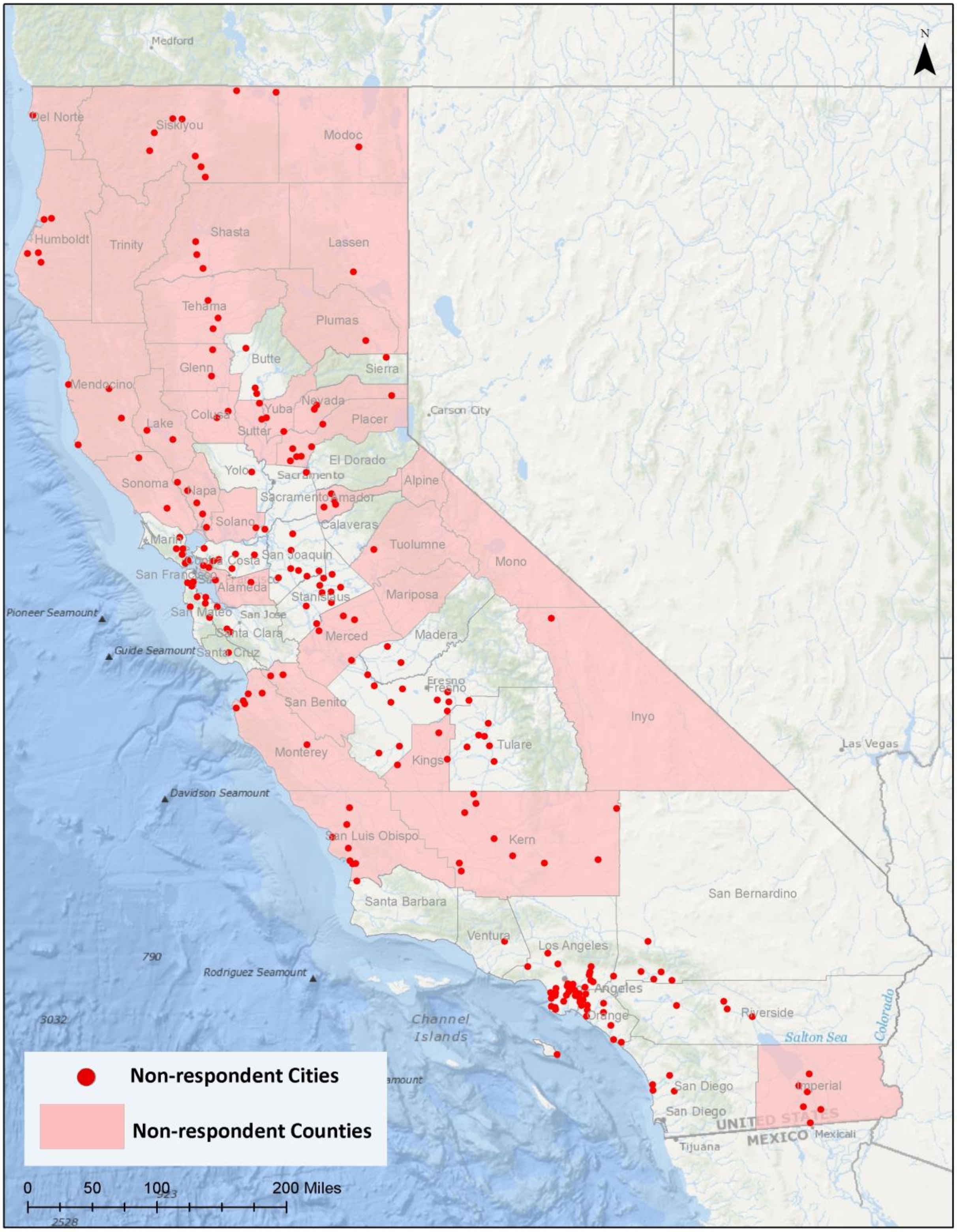

Figure 4. Geographical distribution of the non-responding jurisdictions

The average 2020 population of the responding jurisdictions was 100,765 for cities and 1,391,925 for counties. By comparison, the average 2020 population for the non-responding jurisdictions was 33,372 for cities and 195,587 for counties. Our sample thus somewhat overrepresents more populous and urban jurisdictions, similar to Volker et al.'s (2019b) survey of local government planners about the (then impending) switch from LOS to VMT.

In order to obtain baseline VMT values for the jurisdictions, we used the California State Travel Demand Model (CSTDM) results from 2010. We used an interpolation process[7] to convert the values from Transportation Analysis Zones (TAZs) to the city and county boundaries. All VMT values are expressed as ratios, either home-based VMT per capita or home-based work VMT per employee. The average residential VMT for the responding cities was 13.5 VMT per capita in 2010, while the nonrespondent cities' residential VMT was 13.8 VMT per capita. However, the average office VMT value for the respondent cities (14.4 VMT per employee) was higher than the nonrespondent cities (12.8 VMT per employee) in 2010. Regarding unincorporated county residential VMT, the respondents' average residential VMT was 13.8, and the nonrespondent's VMT per capita was 14.5. The office VMT for unincorporated counties that responded (13.6 VMT per employee) is much higher than the nonrespondents' (11.2 VMT per employee).

Figure 5 shows the residential and office VMT in California in 2010. Note that the county VMTs represent the unincorporated county VMT for both land uses.

[7] Since city borders do not always align precisely with TAZs, we sometimes needed to divide a TAZ between multiple cities. In order to do so, we used the street allocation ratio as the scale for distributing the VMT of a TAZ between multiple cities. We calculated the ratio of a TAZ's street network which is located within each city. Then we used the same ratio to allocate VMT between the cities which share a TAZ. For counties, we used the baseline VMT in the unincorporated areas. We estimated the unincorporated area VMT for each county by subtracting the VMT of all the cities in the county from the cumulative VMT from all TAZs in the county.

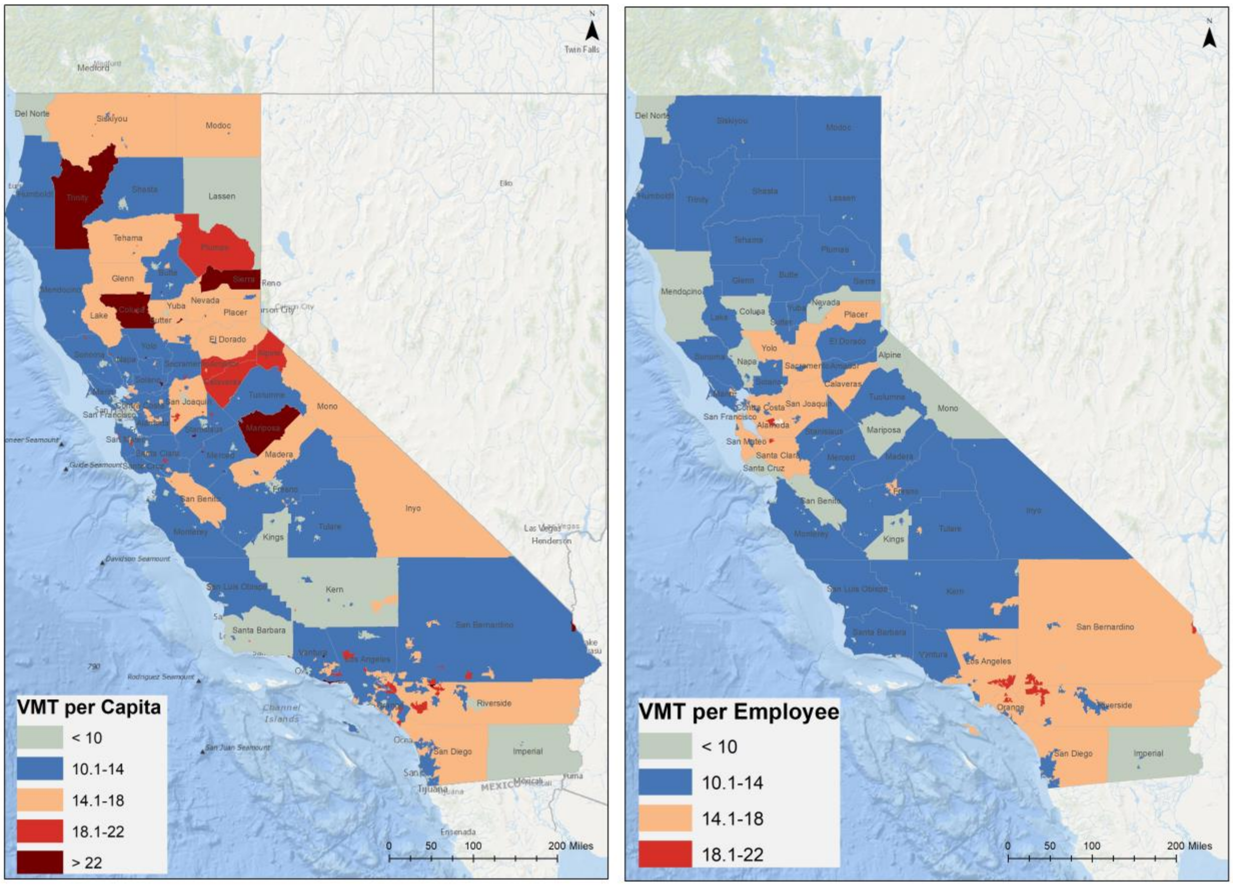

Figure 5. The levels of residential and office VMT (2010)

SB 743 Acknowledgement

SB 743 took a long time to be implemented—approximately seven years between when the statute was enacted in 2013 to when local governments were required to make the shift from LOS to VMT on July 1, 2020. One anecdotal reason for this delay was opposition from numerous local governments and metropolitan planning organizations (MPOs). For example, Volker et al. (2019b) found that nearly 25% of the local government planners they surveyed opined that the LOS-to-VMT switch would not be appropriate in their jurisdiction. We investigated whether that early opposition carried over into a refusal to implement the LOS-to-VMT switch even after it became mandatory in 2020.

We found that no jurisdictions denied the legality or mandatory nature of SB 743 and its implementing regulations. All 274 responding jurisdictions acknowledged SB 743 and the mandatory switch from LOS to VMT in CEQA analysis. Most of those jurisdictions (194) formally acknowledged the LOS-to-VMT switch with a resolution, ordinance, general plan section, or other planning document or impact analysis guidelines of general applicability. The remaining 80 jurisdictions informally acknowledged the switch through email communications or by actually doing VMT impact analysis in project-level CEQA documents. However, as Figure 6 shows, 10 of those 80 jurisdictions indicated that they were unlikely to require much if any VMT impact analysis because of local conditions, including lack of room for new development projects (allegedly being "built out") or limited resources and staff to do the analyses.

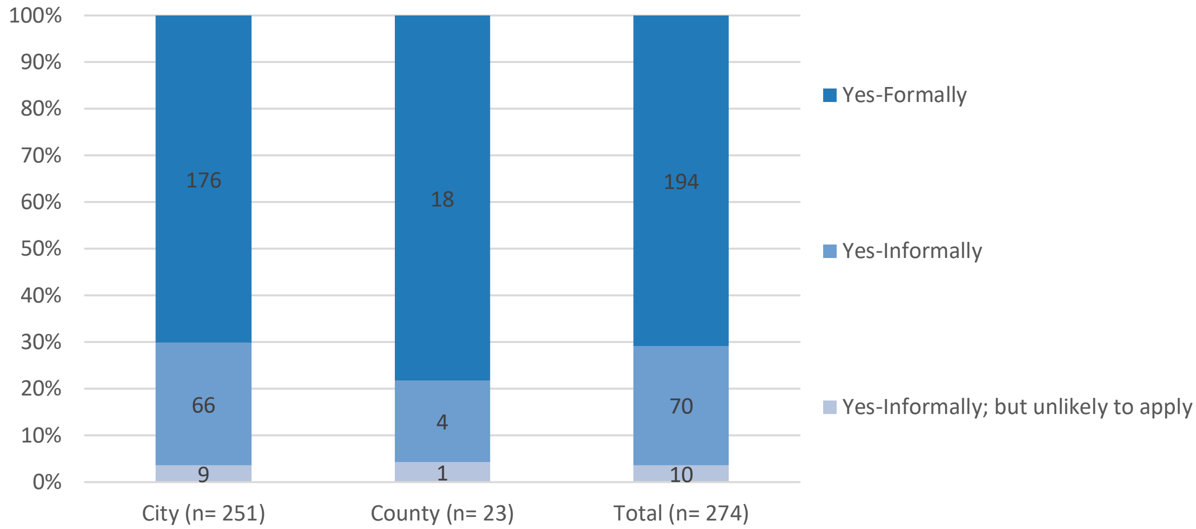

Figure 6. Status of SB 743 acknowledgement in California

VMT-Based Thresholds of Significance

While all 274 responding jurisdictions at least acknowledged the mandatory switch from LOS to VMT in CEQA transportation impact analyses, that does not indicate whether or how they are actually implementing it. A key question with respect to implementation is what types of thresholds of significance local governments are using. We answer that question in this section.

Neither CEQA nor SB 743 and its implementing guidelines mandate that jurisdictions adopt a particular threshold of significance (or indeed, formally adopt any threshold at all). If they choose, lead agencies can take a case-by-case approach to determining the VMT impact significance threshold for land use projects. But most jurisdictions appear to prefer a more predictable approach. We found that 81% (222 of 274) of the responding jurisdictions had either adopted their own VMT-based thresholds of significance, were in the process of doing so, or were informally following another jurisdiction's thresholds. Figure 7 shows the breakdown of threshold adoption status in Californian jurisdictions.

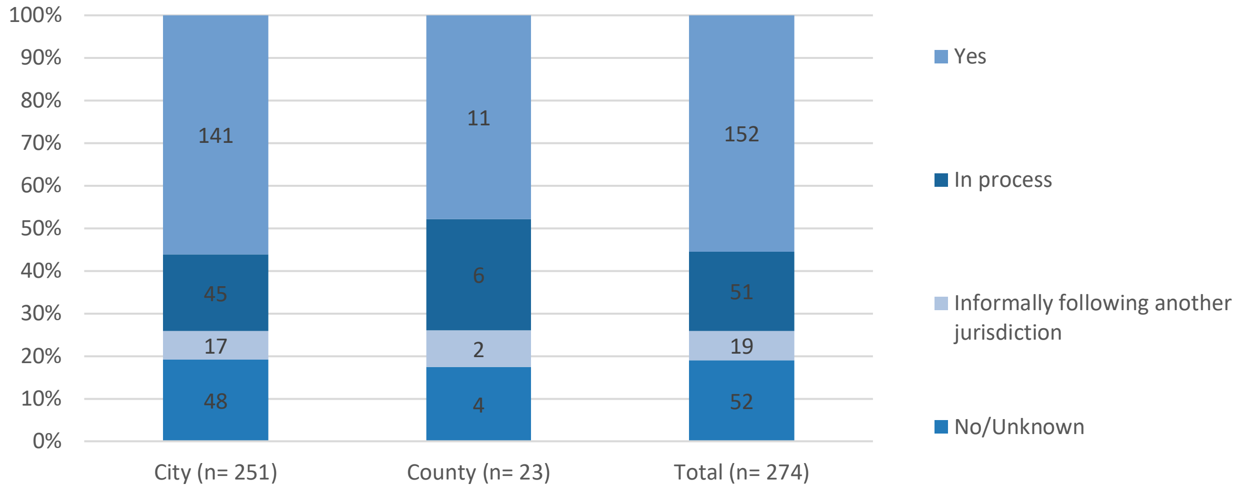

Figure 7. Status of threshold adoption in California

Figure 8 shows the geographic distribution of responding jurisdictions regarding threshold adoption. Figure 9 shows the distribution of jurisdictions with thresholds that are specific enough for us to summarize. Most of those jurisdictions located in San Francisco Bay Area and Los Angeles regions.

Out of the 222 jurisdictions that are at least in the process of adopting thresholds, 181 cities and counties have adopted, drafted, or are otherwise following thresholds that are specific enough for us to summarize, as shown in Figure 7. We discuss those thresholds in this section. We first summarize OPR's recommendations regarding VMT-based thresholds. We then discuss the types of thresholds the responding jurisdictions are using, including screening thresholds, numeric thresholds (based on project-generated VMT and project effect on VMT), and cumulative impact thresholds. We conclude with a discussion of trends and challenges regarding VMT-based thresholds.

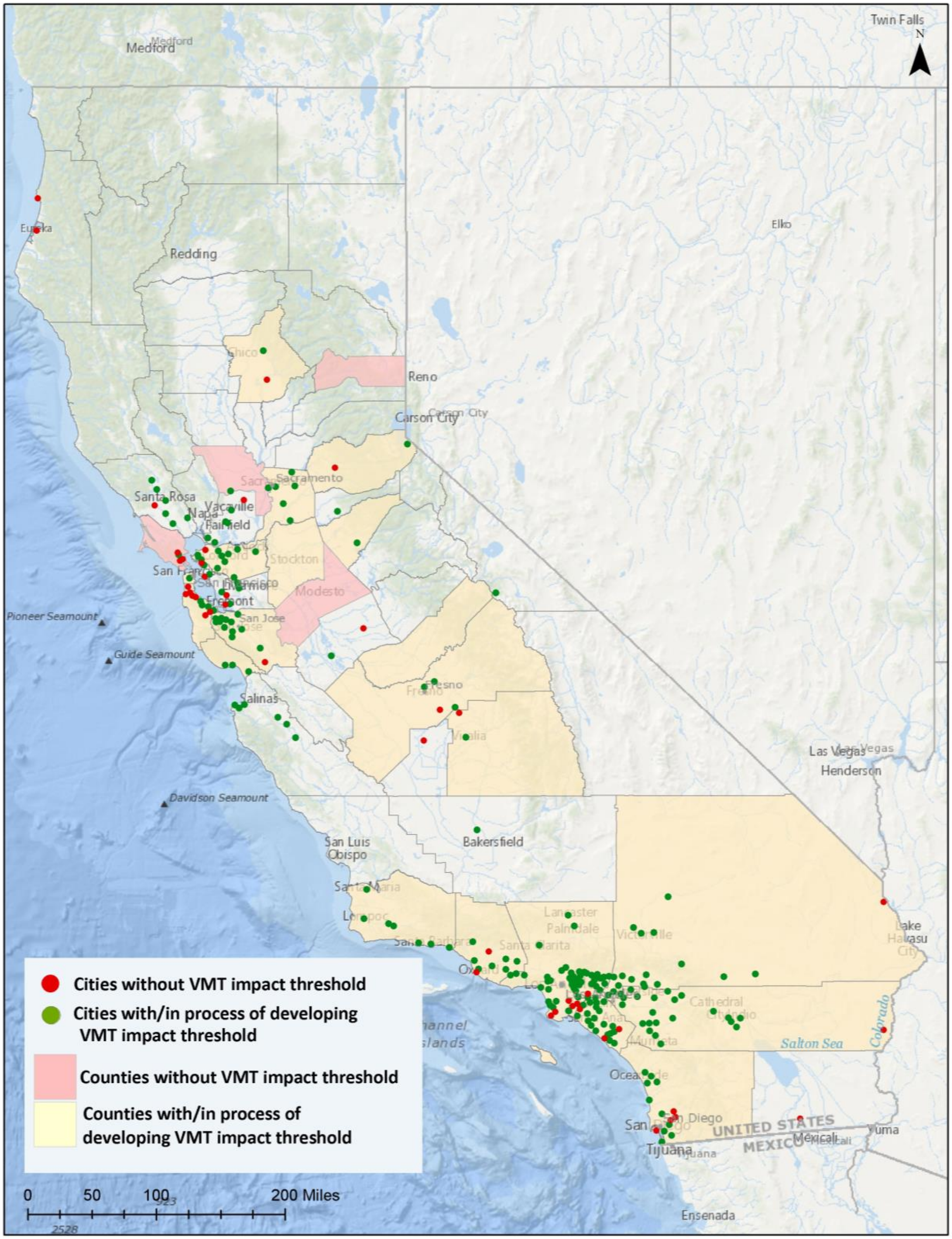

Figure 8. Geographical distribution of threshold adoption

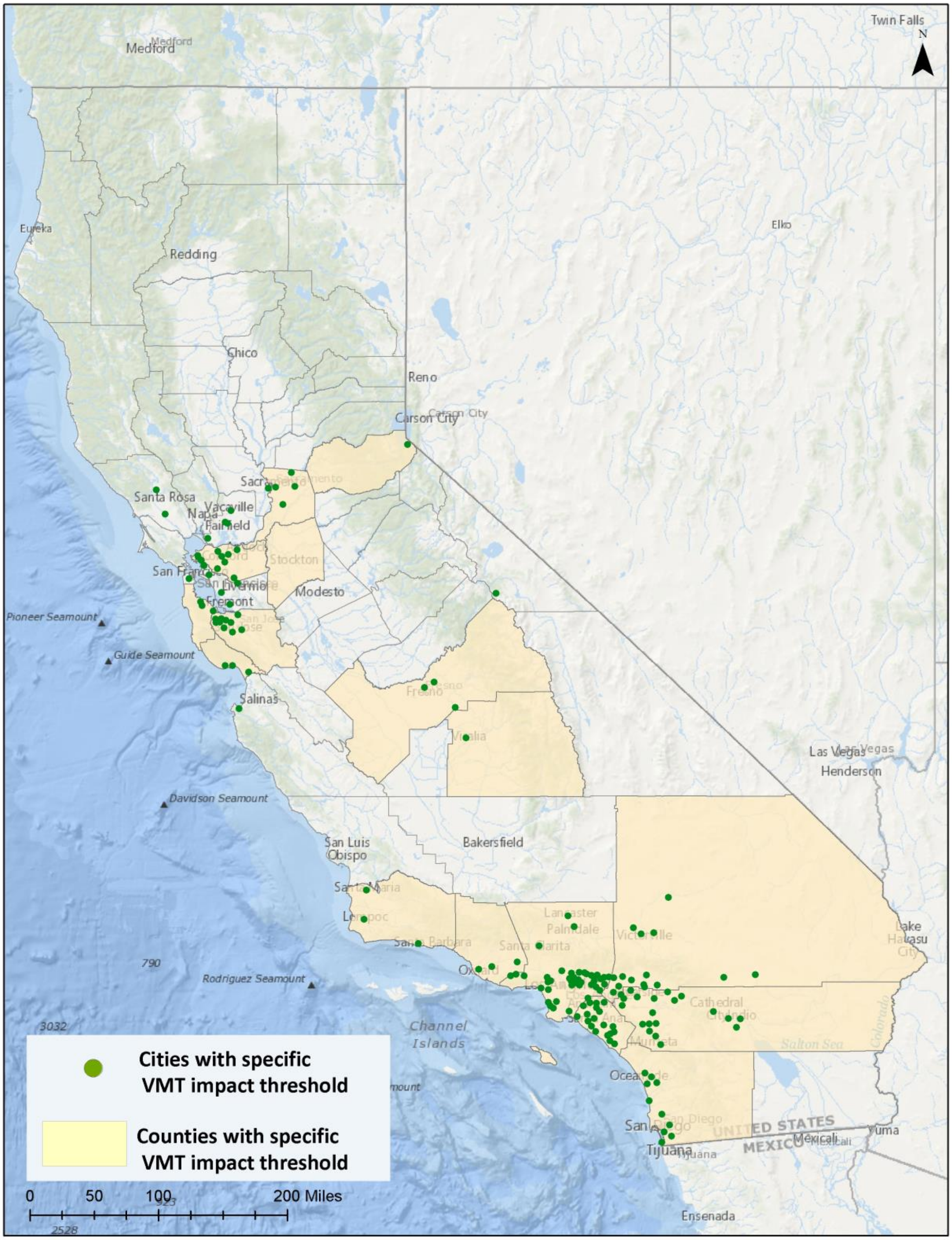

Figure 9. Geographical distribution of jurisdictions with specific VMT thresholds

OPR's Recommendations

The Governor's Office of Planning and Research's Technical Advisory on Evaluating Transportation Impacts in CEQA includes recommendations for setting thresholds of significance for VMT impacts (OPR, 2018).[8] OPR suggests a two-step approach for project-level significance thresholds. First, a screening threshold is used to "quickly identify" when a project can be expected to cause a less-than-significant VMT impact without conducting a detailed study (OPR, 2018, p. 12). Then, if the project does not pass the screening test, the agency conducts a full VMT impact analysis and compares the project's forecasted impacts against a numeric threshold.

OPR recommends five types of screening thresholds: small-project screening, map-based screening for residential and office projects, screening for projects near transit stations (often called "transit priority areas" or "TPAs"), screening for affordable housing projects, and screening for local-serving retail. For the first screening criterion, OPR defines small projects as those that generate or attract fewer than 110 trips per day, which often correlates to projects—like office projects and local-serving retail—in the range of 10,000 square feet. For map-based screening, OPR suggests identifying areas with low VMT (e.g., TAZs with average VMT below the relevant numeric thresholds), and screening out office and residential projects proposed to be located in those areas, so long as the they incorporate similar features (like density, mix of uses, and transit accessibility) to the existing projects in the low-VMT areas. For TPA screening, OPR recommends screening out projects proposed to be built within ½ mile of an existing major transit stop[9] or a stop along a high-quality transit corridor,[10] so long as the projects also have a floor-area ratio of at least 0.75, do not include more parking than required by local ordinance, are consistent with the applicable MPO-adopted Sustainable Communities Strategy, and does not replace affordable housing units with less affordable units or some other kind of use. For the fourth screening criterion—affordable housing—OPR explains that "[e]vidence supports a presumption of less than significant impact for a 100 percent affordable residential development (or the residential component of a mixed-use development) in infill locations" (OPR, 2018, p. 15). Fifth and finally, OPR proposes that retail development of 50,000 square feet or less could be screened because they "improv[e] retail destination proximity" and thereby "shorten trips and reduce VMT" (OPR, 2018, p. 16).

For projects that are not screened out, OPR recommends applying numeric thresholds to determine whether their VMT impacts are significant. OPR suggests separate thresholds for residential, office, and retail projects. For residential projects, OPR proposes a numeric

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[8] OPR's recommendations on thresholds of significance for VMT impacts are based largely on targets outlined in the California Air Resources Board's 2017 Climate Change Scoping Plan (CARB, 2017) for achieving the state's greenhouse gas emission reduction goals.

[9] Defined as "a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods" (PRC Section 21064.3).

[10] Defined as "a corridor with fixed route bus service with service intervals of no longer than 15 minutes during peak commute hours" (PRC Section 21155).

threshold of 15% below the existing VMT per capita (either household VMT or home-based VMT) in the applicable area. OPR recommends that projects located in a city should use either the city's VMT or the region's VMT as the VMT baseline. For projects located in unincorporated county areas, OPR suggests using as the baseline either the region's VMT or the aggregate population-weighted VMT of all cities in the region. OPR also proposes using an efficiency-based threshold for office projects—15% below the existing VMT per employee (either employee work tour VMT or home-based work trip VMT) in either the region or, in areas with smaller commute sheds, the county or other smaller geography. Lastly, for retail projects, OPR proposes using a "net increase in total VMT" threshold, where the project would be deemed to have a significant VMT impact if it would increase the total VMT in the affected area. This represents the project's overall "effect" on VMT, rather than just its "project-generated" VMT, which OPR recommends assessing for residential and office projects. OPR recommends evaluating mixed use projects by either considering each component separately or looking just as the project's dominant use.

In addition to suggesting – and developing a basis of substantial evidence for – project-level thresholds of VMT impact significance, OPR also discusses cumulative impact analysis in its Technical Advisory. CEQA requires that EIRs must discuss a project's cumulative impacts if the lead agency determines that the project-level effects "are significant when viewed in connections with the effects of past projects, the effects of other current projects, and the effects of probable future projects" (CEQA Guidelines Section 15065(a)(3)). OPR advises that a "project that falls below an efficiency-based threshold that is aligned with the long-term goals and relevant plans" in the region, like the Sustainable Communities Strategy, "has no cumulative impact distinct from the project impact" (OPR, 2018, p. 6). Where the project-level impact threshold uses an absolute VMT metric (e.g., no net increase in regional VMT for retail projects), OPR notes that the cumulative impact analysis could use the same metric (e.g., no net increase in regional VMT when considering the proposed project and all other past, current, and probably future projects).

Summary of Adopted Thresholds - Screening

The first step of VMT impact analysis in the CEQA process generally involves determining whether the project needs a complete VMT analysis or can simply be screened out. As discussed earlier, OPR's recommendation includes five main categories of screening criteria for land use projects. Lead agencies can also modify these categories or define new ones supported by the empirical evidence. However, our findings show that most cities use OPR's recommended screening thresholds to screen land use projects.

Out of the 181 jurisdictions that follow specified thresholds, only twelve did not use any type of screening criteria. Table 3 shows that the five most common criteria jurisdictions used to determine whether a land use project can be screened out of a full VMT analysis in the CEQA process: small projects, projects within transit priority areas, local-serving projects, affordable housing, and projects within low-VMT areas. In most cases, the definition of these criteria aligned with OPR's recommendations. However, some jurisdictions required additional conditions under each category to screen out a land use project.

Most jurisdictions also used similar methods for determining whether a project qualifies for screening. A project's trip generation rate was the primary determining factor for small-project screening. Most jurisdictions relied on the Institute of Transportation Engineers' trip generation manual to estimate the number of vehicle trips a project would generate. Project size was the primary determining factor for local-serving project screening (usually any retail component of a project that is <50,000 square feet). Transit priority area[11] (TPA) and low-VMT area screening was generally done using maps (map-based screening; OPR, 2018), which are simple to apply once the maps are created. However, defining low-VMT areas requires jurisdictions to first estimate VMT by zones, which is generally not as simple as determining the qualifying conditions for the other four screening criteria. We discuss how jurisdictions estimate baseline VMT in the VMT Estimation Methods section below. Eligibility for affordable housing screening was based on the percentage of affordable units (usually 100%) and the degree of affordability (e.g., affordable to households making ≤80% of the area median income, though this was often undefined in jurisdictions' guidelines).

Table 3. Screening methods in CEQA analysis

	Low VMT area	Transit Priority Areas	Local-serving	Small projects	Affordable housing
City (n= 165)	128	142	142	151	115
County (n=16)	12	14	13	14	10
Total (n=181)	140	156	155	165	125

Summary of Adopted Thresholds - Numeric Thresholds

If a project is not screened out, it generally must go through a full VMT analysis. The two most common types of numeric thresholds are project-generated VMT and project effect on VMT. Project-generated VMT is simply a measure of how much VMT the users of a project will produce. Project-generated VMT is generally estimated as the change in VMT for a project area (usually the relevant TAZ) after adding a project divided by the number of project users. This is usually represented as an efficiency ratio like VMT/capita (generally used for residential projects), VMT/employee (office projects), or VMT/service population[12] (any type of project, but especially retail). Project-generated VMT thresholds are most commonly used for residential and office projects, like OPR suggested. In contrast to project-generated VMT, project effect on VM is a measure of a project's effect on total VMT within a larger geography, accounting for the effect on trips other than to and from the project in question. It can be represented as either the change in total VMT in the geography after adding a project or the change in a VMT efficiency ratio (e.g., VMT/capita for the region). Project effect on VMT is commonly used in thresholds for larger retail projects and in cumulative VMT impact

[11] Areas within a specific distance of a major transit stop or corridor, usually ½ mile.

[12] "Service population" generally refers to all project's users (residents, employees, shoppers, etc.).

thresholds, as recommended by OPR. Both types of numeric thresholds are defined in reference to a baseline geography, which affects the stringency of the threshold.

Thresholds Based on Project-Generated VMT

Of the 181 jurisdictions with specific thresholds, 174 utilized a project-generated VMT threshold for at least one type of land use project. We discuss each component of project-generated VMT impact thresholds in the following sections—the type of efficiency metric, the baseline geography, and the actual threshold.

Types of Efficiency Metrics

The type of efficiency metric used frequently varies by project type, similar to OPR's recommendation. For example, project-generated VMT thresholds for residential projects often use a VMT/capita metric. We thus organize our summary of efficiency metrics by project type, starting with residential projects.

Out of the 174 jurisdictions that used a project-generated VMT metric, 171 defined a metric to analyze the project-generated VMT from residential projects. Figure 10 shows that VMT per capita and VMT per service population were the two most common metrics, utilized by 97% of jurisdictions. Only four jurisdictions used another type of metric, such as VMT per land use unit[13] and VMT per commute trip.

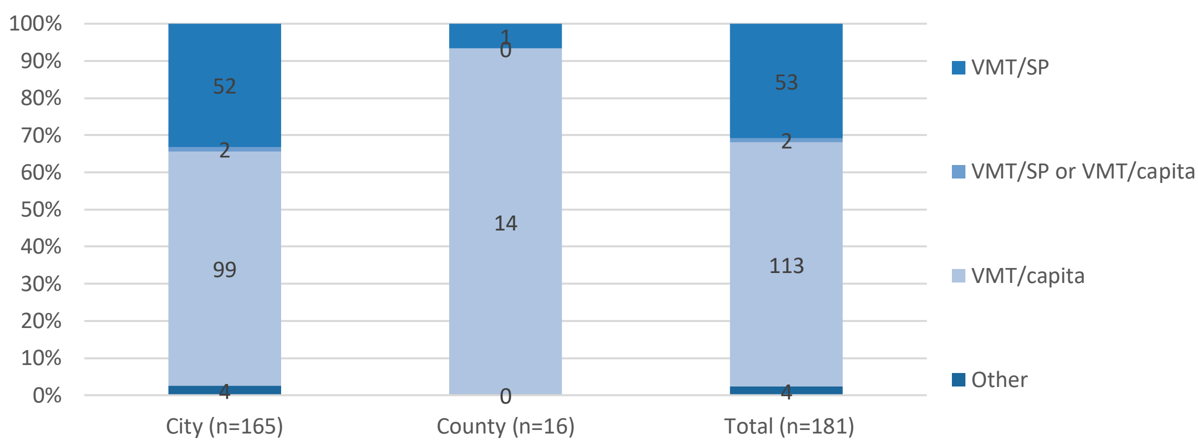

Figure 10. Metrics used for residential projects' threshold of significance

Most (170) of the 174 jurisdictions that used a project-generated VMT metric also defined a project-generated VMT threshold for office projects. Figure 11 indicates that 160 of those jurisdictions used VMT per employee or VMT per service population to assess the impact of office projects. Meanwhile ten jurisdictions incorporated unconventional metrics for this type

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[13] The definition of "land use unit" varies by project type. For example, the land use unit of a residential project generally refers to a dwelling unit. Commercial and office projects' land use units are usually defined by square footage.

of development, such as VMT per capita, VMT per land use unit, and VMT per KSF, adopted a case-by-case approach.

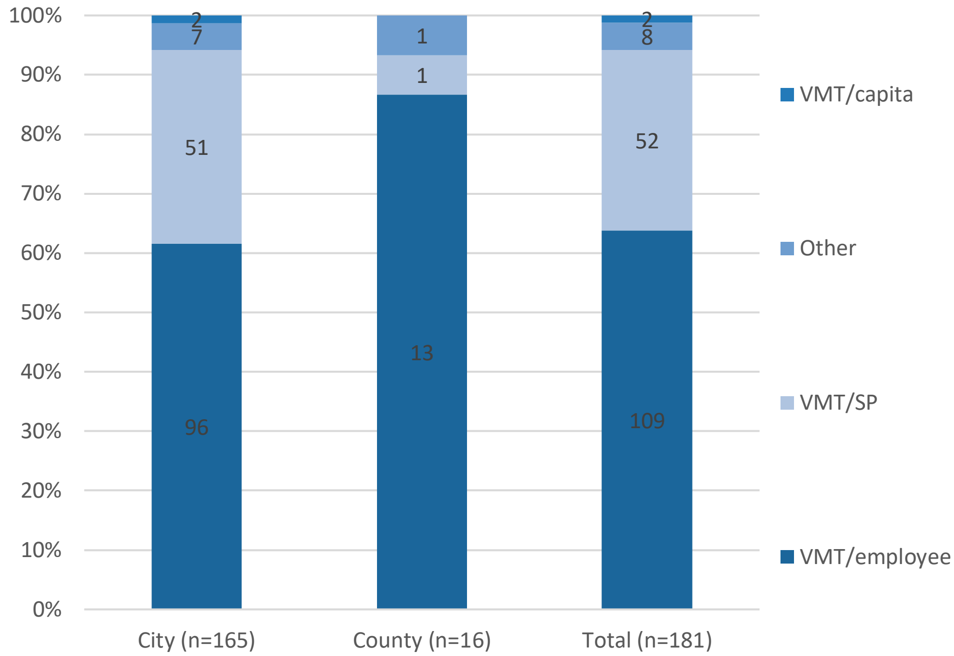

Figure 11. Metrics used for office projects' threshold of significance

Far fewer jurisdictions—only 89—used a project-generated VMT threshold for retail projects, which might reflect OPR's recommendation to set thresholds for retail projects using a project effect on VMT metric. Figure 12 shows that 75% of those jurisdictions used VMT per service population to analyze the VMT impact of retail projects. The remaining 25% (all cities) used VMT per employee, VMT per capita, VMT per visitor, or evaluated retail projects using a case-by-case approach.

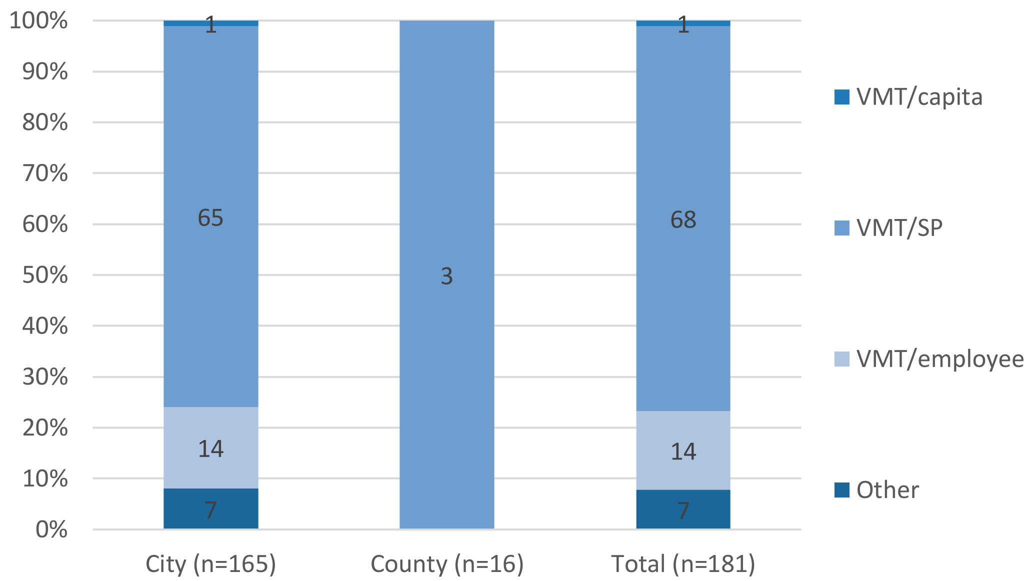

Figure 12. Metrics used for retail projects' threshold of significance

Only 103 of the 174 jurisdictions specified project-generated VMT thresholds for mixed-use projects. Most (73%) of those jurisdictions allowed each land use in a mixed-use development to be evaluated separately, according to the applicable threshold for each land use type (housing, office, retail, etc.). This comports with OPR's guidance that "[c]ombining land uses for VMT analysis is not recommended" (OPR, 2018, p. 6). However, 15% of the jurisdictions used VMT per service population to evaluate mixed-use projects as a whole, regardless of the different land uses included, as shown in Figure 13.

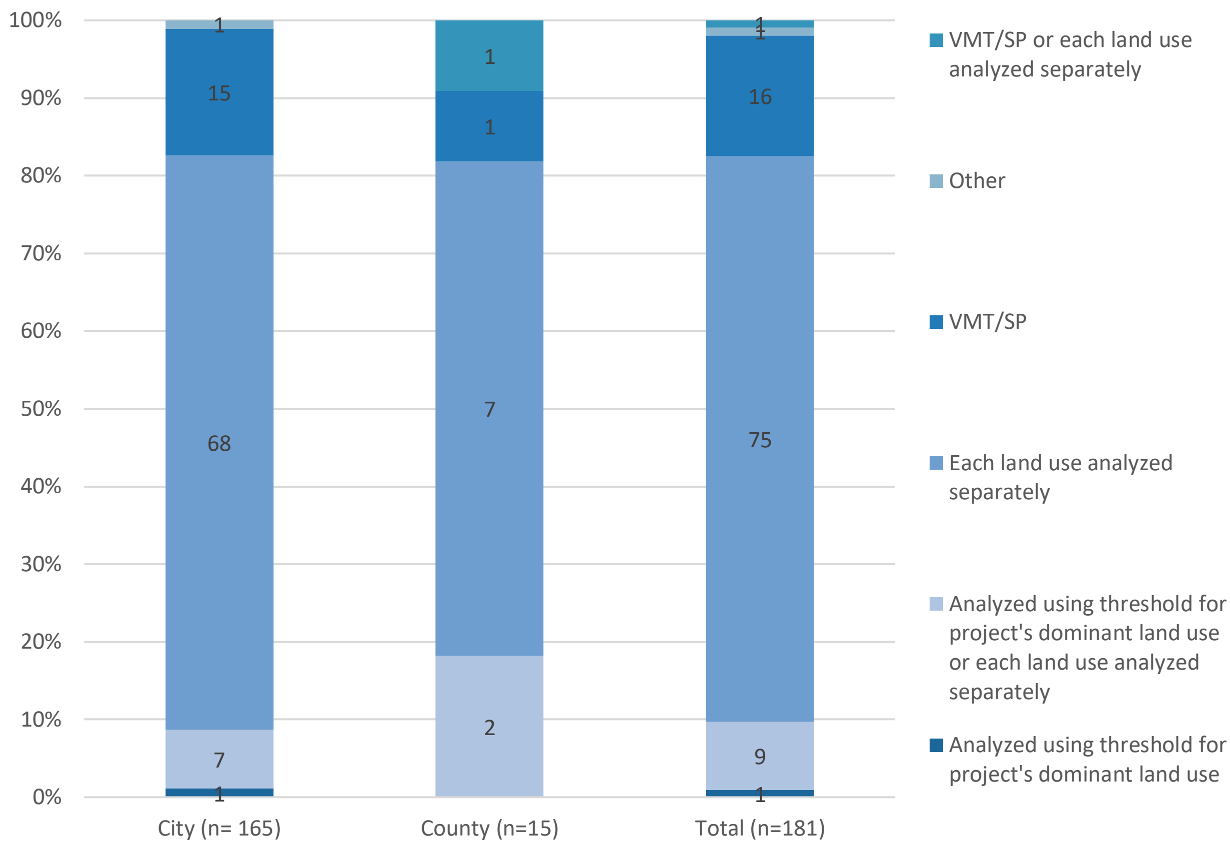

Figure 13. Metric used for mixed-use projects' threshold of significance

Baseline Geographies

As shown in Table 4, most cities used either the applicable county or region as the baseline geography for project-generated VMT thresholds for residential and office projects, while a little over a third of cities used the city boundary as the baseline geography. A few jurisdictions also offered an option—project analyses could use either the city baseline, a regional baseline, or a baseline of the analyst's choice for the threshold—or required that projects meet the more stringent of the two thresholds. For retail projects, about half of cities used the city boundary as the baseline geography and about half used the applicable county or region for the baseline.

Most counties used the entire county (including the incorporated cities) as the baseline geography for project-generated VMT thresholds for both residential and office projects. A few counties used just the unincorporated portion of the county as the baseline geography. A few counties also used the broader region for the baseline. For retail projects, two of the three counties used the unincorporated portion of the county and one used the entire county for the baseline geography.

Overall, most jurisdictions' choice of baseline geographies comports with OPR's recommendations, with some notable exceptions. For one, three counties used the unincorporated portion of the county as the baseline geography for residential projects, which likely creates a higher (less stringent) threshold than OPR's suggested approach—using as the baseline either the region's VMT or the aggregate population-weighted VMT of all cities in the region (OPR, 2018). Another prominent deviation is that over a third of cities used the city boundary as the baseline geography for office projects, while OPR recommended using a regional or county-wide baseline that would likely be more stringent (see the distribution of VMT per employee shown in Figure 5).

Table 4. Geographies of adopted threshold of significance (project-generated VMT)

		TAZ	City	County	Unincorporated County	Sub-region	Same land use in general plan	Region	Other
City (n=160)	Residential		63	51		1	1	34	10
	Office		57	46		1	1	45	9
	Retail		42	24		1	1	21	3
County (n=14)	Residential	1		8	3			2	
	Office	1		7	3			3	
	Retail			1	2				

Thresholds

The last component of project-generated VMT thresholds is the actual numeric threshold that is set in reference to the baseline. OPR recommends using thresholds of 15% below baseline VMT for both residential and office projects, based on targets outlined in the California Air Resources Board's 2017 Climate Change Scoping Plan (CARB, 2017) for achieving the state's greenhouse gas emission reduction goals (OPR, 2018).[14] Most of the jurisdictions we catalogued defined their numeric threshold as such—15% below either the existing baseline VMT (the majority) or the projected VMT at general plan build-out years in the future (one jurisdiction), as shown in Table 5. However, there was some deviation.

The second most used numeric threshold was the baseline VMT itself, which is less stringent than OPR's recommendation. About 60% of jurisdictions used the current average VMT as the baseline, while 40% set the baseline as the average VMT at general plan build-out (usually in 20 or so years). A handful of jurisdictions used thresholds that are somewhere in between—less than the baseline VMT, but greater than OPR's recommendation of 15% below baseline.

A few jurisdictions also went the opposite direction, adopting more stringent thresholds than OPR's recommendation. Six cities, as well as Los Angeles County, have adopted thresholds that are greater than 15% below baseline VMT for residential and office projects.

Two cities used optional thresholds for residential projects, which allows project analysts to set the threshold at either 15% below the regional VMT or below the average city VMT. Only city required meeting both criteria. We included these approaches in "other" category in Table 5.

[14] California Air Resources Board's 2022 Scoping Plan for Achieving Carbon Neutrality is even more ambitious. It calls for reducing per capita VMT by 30% below 2019 levels by 2045 (CARB, 2022).

Table 5. Adopted numeric threshold of significance

		More than 15% below existing baseline	15% below existing baseline	Less than 15% below existing baseline	Below existing baseline	15% below GP build-out	Below GP build-out	Other
City (n=160)	Residential	6	102	5	26	1	17	3
	Office	6	103	7	25	1	17	
	Retail	1	45	4	23	1	17	1
County (n=14)	Residential	1	9	2	2			
	Office	1	9	2	2			
	Retail		2	1				

Thresholds Based on Project Effect on VMT

Of the 181 jurisdictions with specified thresholds, 99 jurisdictions included at least one threshold of significance for project-level analysis that used effect on VMT, and 47 jurisdictions used effect on VMT in their cumulative impact analyses. As shown in Figure 14, most jurisdictions (69 out of 99) used effect on VMT primarily for larger retail and regional-serving projects, which accords with OPR's guidance. Twenty-one jurisdictions required analysis of effect on VMT in addition to project-generated VMT for all types of projects. The remaining nine jurisdictions allowed analysts to use an effect on VMT threshold as an alternative to project-generated VMT.

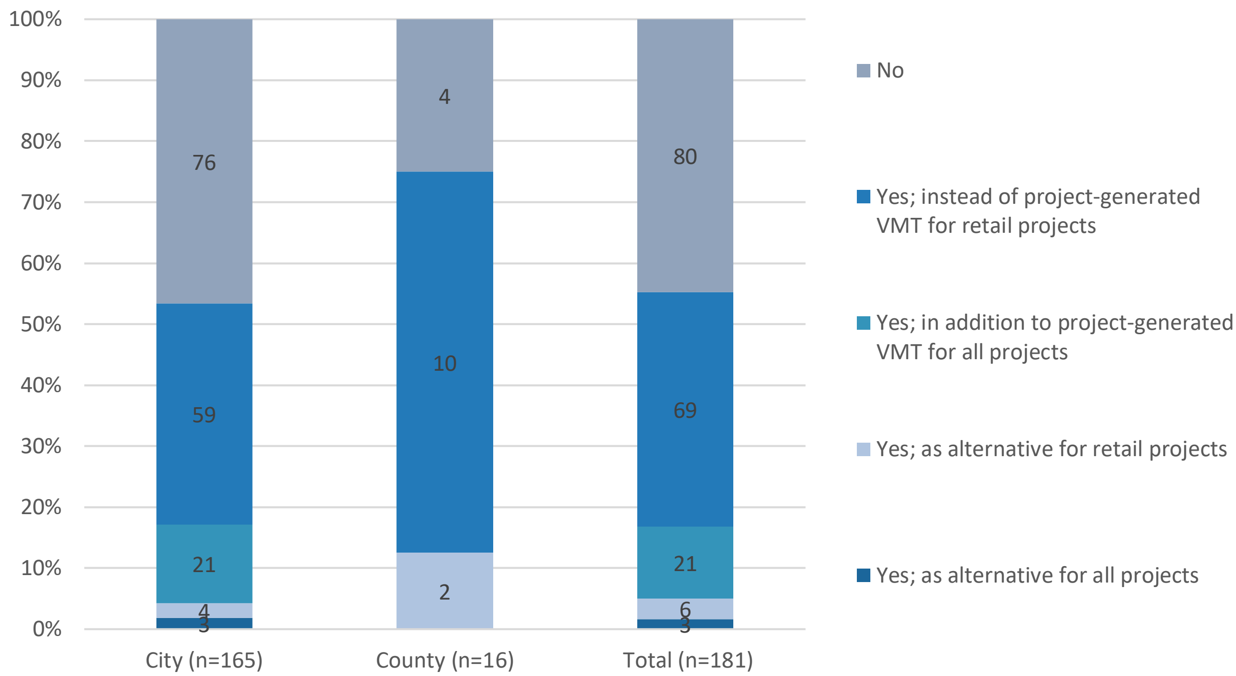

Figure 14. Effect on VMT in threshold of significance

As with thresholds based on project-generated VMT, thresholds using effect on VMT are also set in reference to the baseline VMT (usually total VMT) in a specified geography. Table 6 shows that about half of the cities used the city boundary as the baseline geography for both project-level and cumulative impact analyses, while two-thirds of counties used the county as the baseline geography. Nearly half of cities and one-third of counties used a larger baseline geography for their project-level analyses, though less than 20% of cities used a larger geography (e.g., county or region) for their cumulative impact analyses. About 25% of cities and one county either allowed project analysts to choose between two or more baseline geographies for cumulative impact analyses or required projects to meet thresholds set using two or more baseline geographies.

Table 6. Geographies of adopted threshold of significance (effect on VMT)

		City	City or county sub-area	County	County sub-area	Region	Sub-region	Other
Project-level	City (n=86)	42	3	27	1	10	3	
	County (n=12)			8	2	2		
Cumulative	City (n=44)	22	2	2	1	1	4	12
	County (n=3)			2				1

In terms of metrics, OPR's Technical Advisory suggests using total VMT to evaluate a project's effect on VMT for both project-level analyses (for retail projects) and cumulative impact analyses (if necessary). Figure 15 shows that 79% of jurisdictions followed OPR's guidance and used a total VMT metric. Only 20% of jurisdictions used an efficiency metric—total VMT per service population—and one jurisdiction provided the option of using either total VMT or VMT per service population.

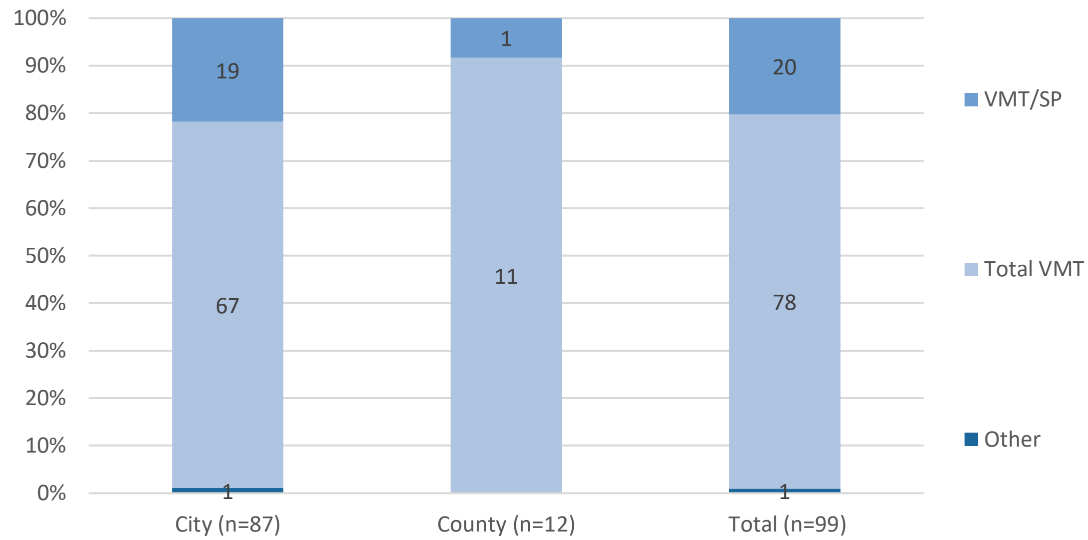

Figure 15. Metrics used in effect on VMT estimation

All jurisdictions set the actual numeric threshold as a net increase in VMT (total VMT or VMT per service population), as shown in Table 7.

Table 7. Threshold of effect on VMT in land use projects

	Net increase over baseline	Total
City	87	87
County	12	12

Summary of Adopted Thresholds – Cumulative VMT Impact Thresholds

CEQA requires EIRs to discuss a project's cumulative impacts if the lead agency determines that the project's incremental effects "are significant when viewed in connections with the effects of past projects, the effects of other current projects, and the effects of probable future projects" (CEQA Guidelines Section 15065(a)(3)). However, OPR advises that a project is unlikely to have a significant cumulative impact if its individual (project-level) impact is less than significant and is "aligned with long-term goals and relevant plans" (OPR, 2018, p. 6).

Consistent with OPR's recommendation, 60% of jurisdictions with specific thresholds required that projects be consistent with relevant plans (particularly Sustainable Communities Strategies) to demonstrate no significant cumulative impacts, as shown in Figure 16.

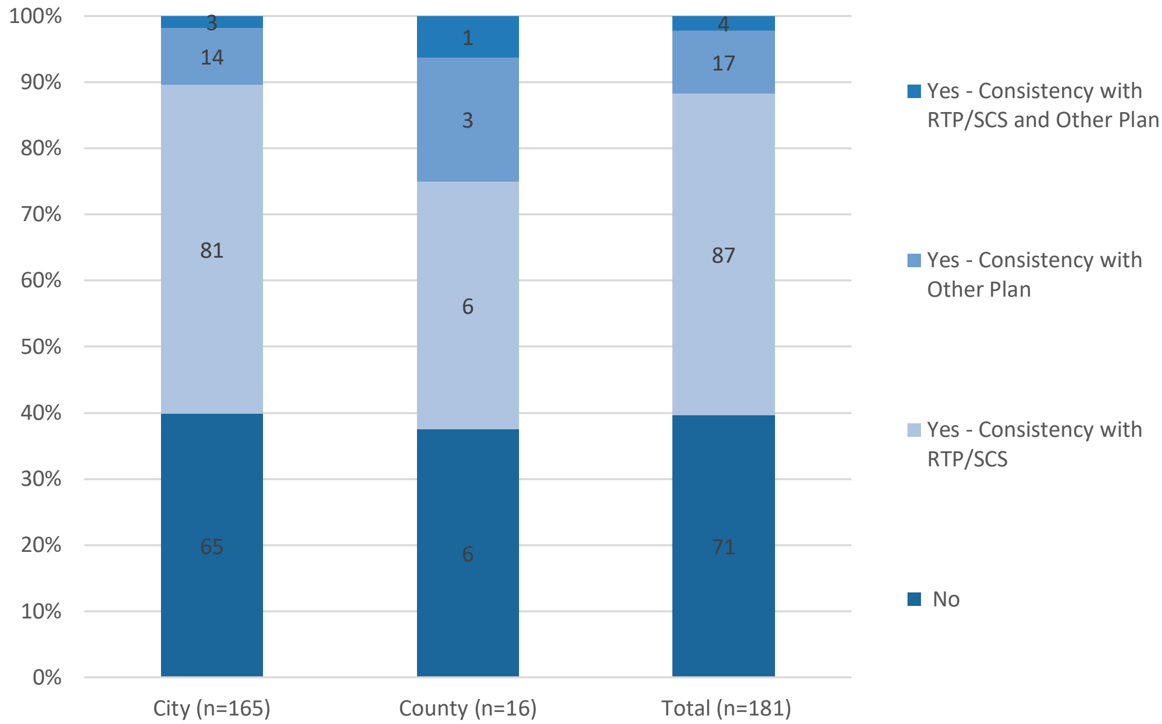

Figure 16. Consistency in cumulative impact of VMT threshold

Fewer jurisdictions explicitly required a quantitative cumulative VMT impact analysis. Figure 17 shows that only 20% of the 181 jurisdictions with specific thresholds required a quantitative analysis in every case. However, another 38% of jurisdictions required a quantitative analysis in certain circumstances, where either the project-level impacts are significant (20%) or the project is inconsistent with relevant plans (18%), particularly Sustainable Communities Strategies.

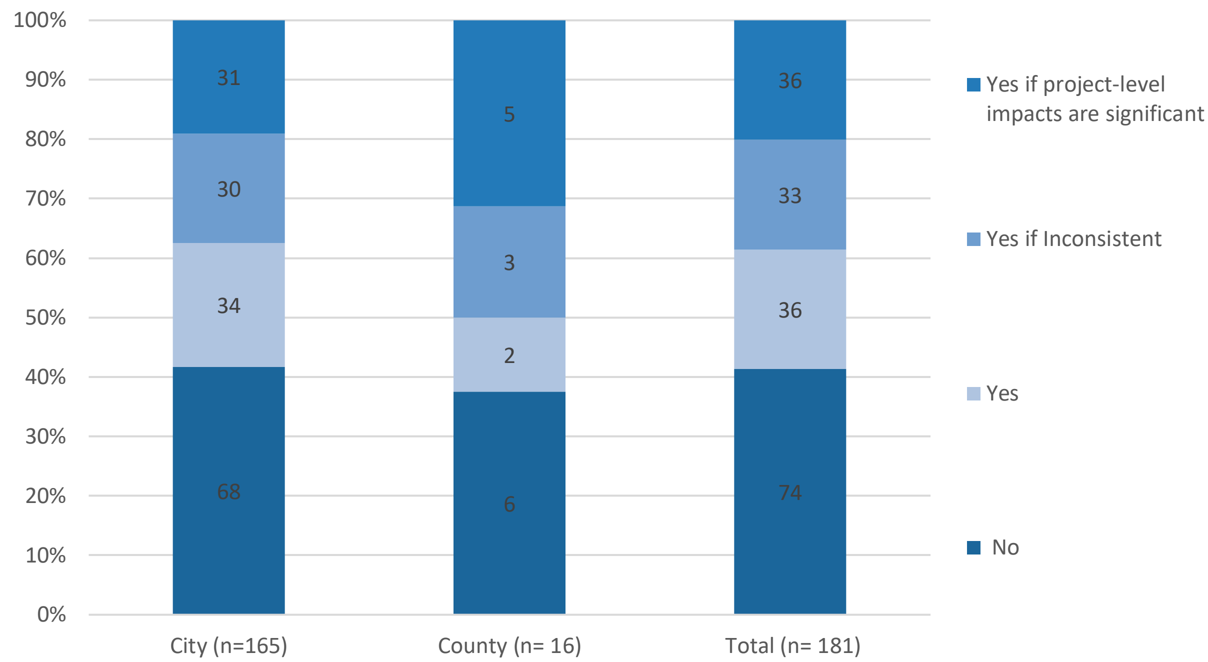

Figure 17.Requirement of quantitative VMT cumulative impact estimation

Trends and Challenges

Empirical studies show that the size of a governmental entity is strongly associated with the entity's likelihood of adopting a new policy (Mohr, 1969, Laurian, 2017, Kraus, 2011). Our results indicate a similar trend—adopting thresholds of significance for VMT impacts has been more challenging for smaller and more rural jurisdictions. Table 8 shows that only eight non-urbanized jurisdictions responded to our inquiries or had some information regarding SB 743 implementation available on their websites. Four of these jurisdictions had not adopted thresholds at the time of our data collection, and the other four were still in the process of developing them.

Table 8. Status of threshold adoption with regards to urbanized/non-urbanized jurisdictions

Urbanized Jurisdiction	Yes	In process	Informally following another jurisdiction	No or Unknown	Total Respondents	Total Jurisdictions
No	0	4	0	4	8	72
Yes	152	47	19	48	266	467
Total	**152**	**51**	**19**	**52**	**274**	**539**

The jurisdictions that had adopted thresholds or were informally following thresholds from another jurisdiction had much larger populations, on average, than other jurisdictions, as shown in Table 9.

Table 9. Status of threshold adoption with regards to population and existing VMT levels

Jurisdiction		Yes	In process	Informally following another jurisdiction	No or Unknown	Total
City	Count	141	45	17	48	251
	Average Population (2020)	147,447	44,444	46,757	45,009	-
County	Count	11	6	2	4	23
	Average Population (2020)	2,293,985	466,782	1,472,456	258,709	-

Our interviewees also highlighted that the difficulties and challenges of the implementation process can be more pronounced for smaller and more rural jurisdictions. The challenges they noted generally fit into four categories: a lack of staff and resources, limited technical support, having higher baseline VMT levels and fewer feasible mitigation measures (leading to a greater risk of unavoidable impacts), and the greater perceived complexity and unfamiliarity of VMT and VMT impact analysis (relative to LOS analysis) for the public and decisionmakers.

Lacking resources for SB 743 implementation was a common theme even for larger and better-funded jurisdictions. Better-funded jurisdictions could hire a consultant to help develop VMT impact thresholds and guidelines if they did not have sufficient staff resources to easily do it themselves. But funding for consultants was harder to come by for other jurisdictions, particularly very small or rural ones. In the absence of external funding assistance, one way that jurisdictions could reduce the cost of developing VMT impact thresholds and guidelines is to join a regional effort or follow regional guidelines adopted by an MPO or other entity. For example, the Contra Costa Transportation Authority led a county-wide effort to develop VMT impact analysis guidelines as part of its growth management program. The effort involved the planning directors for all 19 cities and the county itself. Similarly, a planner we interviewed from a relatively small city in another county mentioned that their jurisdiction had stopped the threshold adoption process until a regional guideline was developed. A few of our interviewees also discussed the trend towards—and benefits of—jurisdictions including VMT standards in and analyzing the VMT impacts from higher-level plans or programs, such as general plans and climate action plans.[15] If the EIRs for those plans adequately analyze (and mitigate) VMT impacts, then future land use projects consistent with the plans could avoid project-level VMT analyses entirely, including the project-level mitigation requirement (CEQA Guidelines Sections 15152, 15183).

With respect to the novelty of VMT impact analysis, one planner we interviewed from a small city explained that "a lot of this is new and a lot of people are not very familiar" with VMT and how to measure and mitigate it, "so there's a certain amount of education or lack of understanding that makes it hard to engage in conversation." He found that "folks . . . still want

[15] The California Air Resources Board (2023) tracks the increasing prevalence of climate action plans with an interactive map.

you to talk about congestion. That's what they understand and are familiar with." And that includes elected officials—"[t]hey don't understand it;" a lot of "blank stares." Another planner for a relatively small city similarly noted how he had a "hard time conveying" to the city council how "VMT will meet the ends that they want to see." They still want to know why they are "sitting in all this traffic." As another interviewee commented, "people see congested streets," not VMT.

Looking beyond the challenges to developing significance thresholds to the substance of the thresholds that have been adopted, most jurisdictions followed OPR's Technical Advisory in setting their project-generated VMT thresholds at 15% below baseline VMT for both residential and office projects, as reported above in Table 5. A sizeable minority (~16%) also set less stringent thresholds. However, only a few jurisdictions (~4%) adopted more stringent numeric thresholds. One of our interviewees—a consultant planner—was helping a small city that was also considering adopting more stringent thresholds. They recounted that "[some of their] Technical Advisory committee members felt even 20 percent [below the baseline] was not enough" to meet our GHG emissions reduction needs. "[S]ome felt [a percentage] that aligns with [the California Air Resources Board's] recommendation [of 16.8 percent below the baseline] is more appropriate."

Less stringent thresholds were more common in jurisdictions with higher baseline VMT, with the lone exception of county thresholds for office projects in unincorporated areas. Table 10 shows the average home-based VMT/capita and home-based work VMT/employee for jurisdictions based on their adopted thresholds for residential and office projects, respectively. A few of our interviewees indicated that this could be due to concerns about the infeasibility and cost of VMT mitigation measures in higher-VMT areas, paired with the associated fear of impeding new development by either imposing costly mitigation or requiring an admission of significant unavoidable impacts.

Table 10. The numeric thresholds and average VMT

		Below existing baseline	Less than 15% below existing baseline	15% below existing baseline	More than 15% below existing baseline	Other
City	Average VMT per capita (2010)	15.1	12.4	12.8	13	15.2
	Average VMT per employee (2010)	16.14	14.2	14.9	13.4	16.5
County*	Average VMT per capita (2010)	12.8	12.6	13	12.5	-
	Average VMT per employee (2010)	13.9	14.4	13.3	15.9	-

VMT Impact Estimation Methods

If a project does not get screened out, it will need a full VMT analysis. The full VMT analysis requires estimating the project's VMT impact and comparing it to the relevant thresholds discussed above. Almost all of the jurisdictions with specified thresholds (166 out of 181) provided some sort of VMT estimation guidance in their implementation guidelines. This section examines that guidance and discusses how jurisdictions estimate the VMT impact of land use developments, including how they derive the baseline VMT numbers they use to set their VMT impact thresholds.

OPR's Recommendations

OPR's (2018) Technical Advisory provides recommendations on which VMT should be included in a VMT impact analysis, with a preference towards focusing on on-road passenger vehicle VMT and using tour-based assessments rather than trip-based measures (because they capture less total travel). However, the Technical Advisory does not provide detailed recommendations about the tools that should be used to actually estimate the VMT (e.g., types of travel demand models, sketch models, or big data). Instead, it offers general guidance, with a focus on (1) using a method that is sensitive to the project's features, including the project's scale and proposed activity, and (2) ensuring that the methods for calculating thresholds and estimating project VMT (including the efficacy VMT mitigation measures) are comparable enough to provide an apples-to-apples comparison.

Baseline VMT Estimation Methods

Before estimating the project's VMT impact, a baseline VMT must be calculated in order to set the thresholds of significance (both screening and numeric). All 166 jurisdictions that provide guidance on VMT estimation included information about how they approach the baseline VMT calculation. All except one of them used travel demand models to estimate baseline VMT.

Travel demand models are sophisticated computational processes that can approximate future travel behavior and demand based on current behavior and patterns. The most common travel demand model is the four-step model, which includes trip generation, distribution, route assignment, and mode choice, and allows trip-based assessment of VMT. Activity-based travel demand models have attracted more attention lately since they build the estimation process based on people's daily activity patterns, which facilitates tour-based assessment of VMT. Aggregate VMT for a jurisdiction and its constituent TAZs is often estimated from travel demand models by multiplying the final assignment origin-destination matrices or production-attraction tables by the trip distance skims.[16] Running both types of travel demand models requires significant knowledge of VMT and demand estimation and is a time-consuming process.

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[16] A skim matrix provides impedances between zones, including distance (as used for VMT estimation), travel time, and cost.

Big data—such as location and motion data from cell phones and other electronic devices—can also be used to estimate VMT-related metrics (like trip generation, trip length, mode share, and even trip purpose) with increasing precision and at increasingly small scales (Wang et al., 2018; StreetLight, 2021). For example, the City of Citrus Heights decided to use big data (StreetLight Data) to calculate the average baseline VMT for residents, workers, and visitors for each Census Block Group in the city. Their methods are described in detail in the city's SB 743 Implementation Guidelines (Fehr & Peers, 2021).

As shown in Figure 18, 90% of jurisdictions calculated baseline VMT using travel demand models maintained by a regional entity, such as a county, congestion management agency, transit authority, or MPO, which again highlights the importance of regional agencies in SB 743 implementation. Just 9% of jurisdictions (all cities) used city-level travel demand models, while none used the California Statewide Travel Demand Model (CSTDM) for calculating baseline VMT. Only one jurisdiction—Citrus Heights—relied on big data instead of travel demand models, though a number of jurisdictions did use big data to help calibrate their travel demand models.

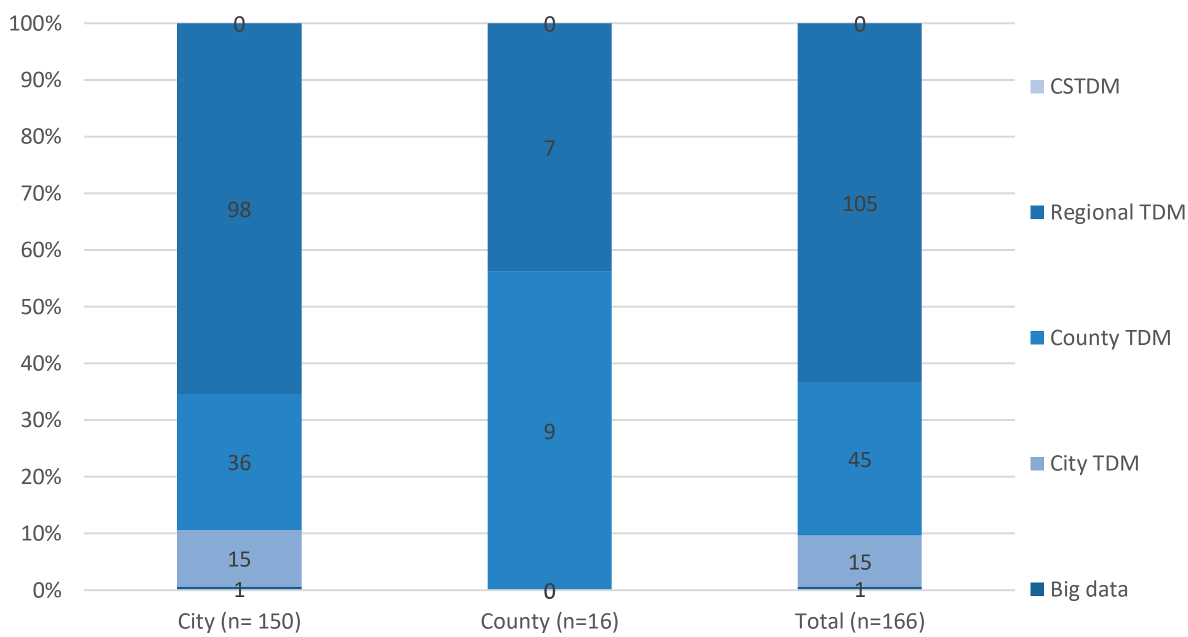

Figure 18. Methods used to estimate baseline VMT

Project-level VMT Estimation Methods

Of the 166 jurisdictions that provided guidance on VMT estimation, 160 specified the method for estimating project-level VMT. As Figure 19 shows, travel demand models are the most frequently used estimation tool. Forty-three percent of jurisdictions used a travel demand model as their sole method of VMT estimation, while 37% provided an option for using either a travel demand model or a sketch model and 14% provided an option of using either a travel demand or a map. Only a handful of jurisdictions used just a sketch model (5%) or just a map (1%).

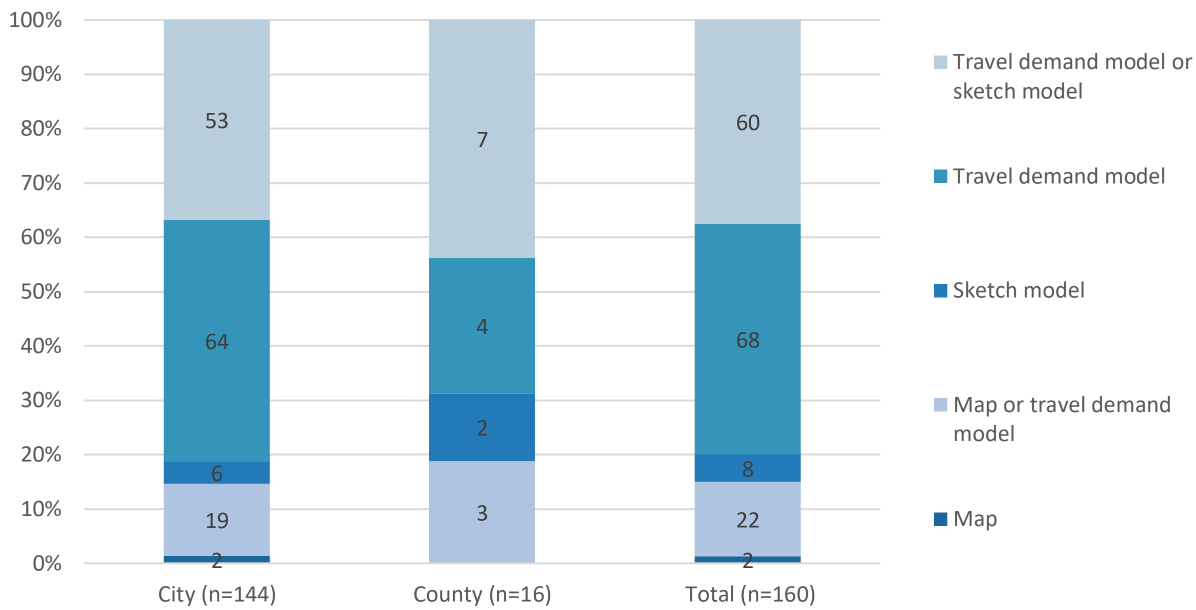

Figure 19. Project-generated VMT estimation methods

Travel demand models can be used to estimate project-level (or cumulative) VMT using the same basic process described above for baseline VMT estimation. The model is generally run once to get a baseline, then run a second time with the project (and/or other cumulative projects) included in the input data. The difference in a variety of VMT metrics after adding the project can then be calculated at various geographic scales, like the TAZ where the project would be located (the most common method for estimating project-generated VMT) or the entire city or larger regional area (which would be more commonly done for estimating a project's effect on VMT for larger retail projects or as part of a cumulative impact analysis).

Sketch tools provide analysts with an easier method of estimating VMT, though they still generally rely on travel demand model outputs. They commonly use the tabular results of travel demand models to estimate VMT for pre-defined land uses based on their location and size. The VMT values are generally presented as an average VMT of projects with specific size and activities in the same location (generally the relevant TAZ). The same average will be assigned to a proposed project in the same TAZ if it has similar size and activity. Another VMT estimation method used in sketch models is calculating a project's VMT by multiplying its trip generation rate (often obtained from the ITE trip generation manual, sometimes with local calibration using big data or another method) by an average trip length for similar types of projects (usually obtained from travel demand models). Sketch tools can be spreadsheet or web based.

Map-based VMT estimation also generally relies on travel demand model outputs, though can also be prepared using big data (like Citrus Heights did) or other data sources. It works similarly to map-based screening (discussed above), where the relevant baseline VMT efficiency ratio for the project area is ascribed to the proposed project. For example, the baseline home-based VMT/capita in the proposed project's TAZ (as shown on a map) could be used as the estimate of a residential project's project-generated VMT.

VMT maps and spreadsheet-based sketch tools are easy to use for estimating project-generated VMT. However, travel demand models are generally preferred for estimating project-generated VMT for large or unique types of land use projects. They are also generally required—and were the only method used by the responding jurisdictions—to estimate a project's effect on area-wide VMT, either at the project level or cumulatively. We provide some examples of VMT analysis sketch tools in a separate section below, after we discuss VMT mitigation guidance.

Trends and Challenges

We discussed many of the overarching challenges facing local governments in implementing SB 743 in the preceding section on VMT impact significance thresholds, including a lack of staff and/or resources, limited technical support, and the general complexity and unfamiliarity of VMT and VMT impact analysis. One interviewee noted how estimating VMT can be "intimidating" for analysts (local government staff or consultants) who are used to conducting LOS analyses and are often either not trained in or do not have access to VMT estimation tools like travel demand models.

One way that jurisdictions have been able to tackle these challenges is to rely on regional entities (and their travel demand models) and coordinated regional SB 743 implementation efforts (e.g., developing standard thresholds, screening maps, and sketch tools), as similarly discussed with respect to adoption of VMT impact significance thresholds. One example is the effort led by the Contra Costa Transportation Authority, as discussed above. Another example is North Orange County Cities collaborative, which was led by the City of Orange and included seven total cities in Orange County (Fehr & Peers, 2020). That collaborative completed an SB 743 implementation study and also developed a project-level VMT estimation tool for the subregion. One of our interviewees noted that the tool had "a lot of problems," but was still useful at the very least for screening purposes. The Santa Clara Valley Transportation Authority (2020) also developed a web-based VMT estimation tool that can be used by any jurisdiction within Santa Clara County. A few of our interviewees also suggested that it would be useful to develop a statewide tool, like a screening map. In that vein, Fehr & Peers recently partnered with StreetLight Data to estimate VMT metrics at the Census Block Group level for the entire state of California (Fehr & Peers, 2023; StreetLight, 2021).

Beyond regional partnerships, many of our interviewees also suggested that another way to simplify VMT impact analysis is for jurisdictions to include VMT standards in and analyze the VMT impacts from higher-level plans or programs, such as general plans and climate action plans. If the EIRs for those plans adequately analyze (and mitigate) VMT impacts, then future land use projects consistent with the plans could avoid project-level VMT analyses entirely, including the project-level mitigation requirement (CEQA Guidelines Sections 15152, 15183).

VMT Impact Mitigation Guidance

Impact mitigation is an integral part of CEQA. If the lead agency determines that any potentially significant could be mitigated to a less-than-significant level, it may prepare a "mitigated negative declaration" (PRC Section 21080). If the agency instead prepares a full EIR, it must mitigate or avoid any potentially significant impacts if feasible (PRC Section 21002.1). If it is not feasible to fully mitigate any of the significant impacts, the agency must adopt a statement of overriding considerations (PRC Section 20181). This section explores how jurisdictions approach mitigating VMT impacts, starting with a summary of OPR's recommendations and the most frequently cited VMT mitigation resource—CAPCOA Handbook.

OPR's Recommendations

OPR (2018) provides a list of potential mitigation measures in its Technical Advisory, but it emphasizes that local governments have the discretion to develop, identify, and innovate new ways to mitigate VMT in their area. OPR also emphasizes the importance of regional measures since VMT is mainly a regional effect. OPR acknowledges the role of in-lieu fee programs where the jurisdiction is committed to collecting the fees and making the mitigation happen. However, it does not provide much specific guidance about how to estimate and to quantify the impact of mitigation measures.

The CAPCOA Report

The California Air Pollution Control Officers Association (CAPCOA) developed and updates the Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity: Designed for Local Governments, Communities, and Project Developers (Handbook). The most recent Handbook was published in December 2021 (CAPCOA, 2021). It provides methods for estimating GHG emissions reductions from nine different categories of project- and plan-level measures, including 30 transportation-related measures across six subsectors (land use, neighborhood design, trip reduction programs, transit, parking or road pricing/management, and clean vehicles and fuels), 16 of which can be quantified at the project scale. For many of the transportation-related measures, the Handbook also provides VMT reduction estimates. These are generally calculated using elasticities derived from empirical studies.[17] In addition, the Handbook provides guidance on locational context (whether a measure would work in an urban, suburban, and/or rural setting), how to combine measures across scales and subsectors (within the transportation sector), and how to apply the VMT reduction estimates in concert with a travel demand model (which frequently already account for measures related to the built environment surrounding a project, like land use mix and densities, transit proximity, and active travel infrastructure).

[17] An elasticity is a measure of how much one variable changes relative to another, like the percentage change in VMT due to a given percentage increase in a city's bike lane network.

Summary of VMT Mitigation Guidelines

As indicated in Table 11, 80% of the jurisdictions with specific thresholds of significance provided at least some guidance on VMT mitigation, including 78% of cities and 100% of counties. That means they at least provided a list or discussion of some mitigation measures—or categories of mitigation measures—that could be considered.

Table 11. Status of mitigation guidance in VMT implementation guidelines

	Yes	Total	Percentage
City	129	165	78%
County	16	16	100%
Total	145	181	80%

However, only 57% of jurisdictions provided guidance on how to estimate the efficacy of mitigation measures. Forty-seven percent of those jurisdictions just provided documentary guidance, like VMT reduction elasticities (such as those provided in the CAPCOA Handbook), as shown in Figure 20. Another 25% provided—or in some cases, prescribe—a VMT estimation tool or model that accounts for mitigation measure effectiveness. The remaining 28% had both an estimation tool and documentary guidance.

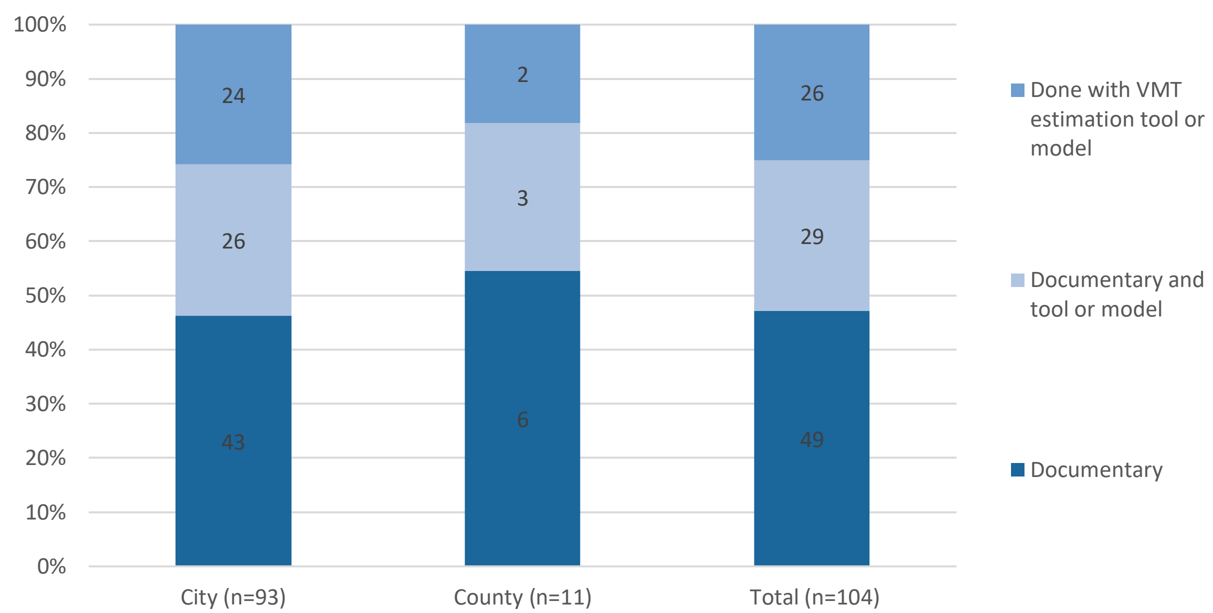

Figure 20. Types of VMT mitigation estimation guidance

Eighty percent of the 145 jurisdictions that provided any mitigation guidance and all 104 jurisdictions that provided guidance on actually estimating the efficacy of VMT mitigation measures relied primarily on the CAPCOA Handbook, though sometimes with adjustments (or advice on making adjustments) to account for local or project-specific conditions. As OPR notes in its Technical Advisory, jurisdictions have the discretion to come up with their own list of applicable mitigation measures in addition to being able to use CAPCOA's guidance. In 80% of cases where mitigation was mentioned in a jurisdiction's guideline, the mitigation list came from the CAPCOA's report with some adjustment at the local level. Some jurisdictions focused on on-site mitigation measures due to the lack of adequate data for measuring the efficacy of off-site measures.

Trends and Challenges

Mitigating significant impacts is one of the most challenging parts of the CEQA process for local governments. Our interviewees identified obstacles to both estimating the efficacy of VMT mitigation measures and actually mitigating the impacts.

With respect to estimating mitigation efficacy, the challenge most frequently cited by our interviewees was estimating VMT reductions from mitigation measures in more suburban and rural areas. The CAPCOA Handbook was the go-to resource for 80% of jurisdictions that provided mitigation guidance, but multiple interviewees expressed reservations about the validity of its VMT reduction estimates outside of urban areas, at least for some mitigation measures. One interviewee suggested developing a similar guidebook for mitigation measures in more suburban and rural areas, which would save jurisdictions the cost and uncertainty of estimating localized adjustments.

Another estimation issue identified by our interviewees related to the CAPCOA Handbook was double counting. As discussed above, the Handbook discusses how to apply its VMT reduction calculations in concert with a travel demand model (which frequently already account for measures related to the built environment surrounding a project, like land use mix and densities, transit proximity, and active travel infrastructure). However, one of our interviewees from a statewide consulting firm noted that double-counting (overestimating the likely VMT mitigation by counting measures twice) still frequently happens, particularly with residential and job density.

In addition to estimation challenges, our interviewees also highlighted the difficulties and costs associated with actually—and fully—mitigating VMT impacts, particularly in more suburban and rural areas that are more auto-dependent at baseline due to longer average travel distances. We interviewed one consultant planner who was helping a smaller suburban city develop its VMT impact analysis policies. They bluntly stated that the typical VMT mitigation measures were "not enough" for the city "because we're sort of this suburban community," where VMT mitigation is not as effective. Another interviewee—the traffic engineer for another suburban city—noted that improving the bike network in a low-density and auto-oriented area would likely be less effective—and more costly per unit of VMT reduced—than in a denser urban area where trip distance is not as much of an impediment to active travel. They explained that their city had "one percent bike share, two percent walking, [so] everyone drives, and the VMT reduction [for bike networks and network gap closure] isn't significant." That same traffic engineer also opined that charging for parking at new residential or office projects would not have much if any impact on VMT:

> For example, we have a new office complex going in, and we could tell them, "Oh, if there was a VMT impact, you could then charge for parking." But there's a mall right next door. And so as opposed to parking and paying, they're just going to park in the mall, right?"

Of course, local governments can still approve land use developments even if they cannot feasibly mitigate their VMT impacts to a less-than-significant level—they would just need to adopt a statement of overriding considerations (PRC Section 20181). Two of our interviewees noted that local decisionmakers were sometimes loathe to adopt statements of overriding considerations due to political backlash or even an increased risk of litigation from environmentally concerned citizens. As one of the interviewees put it:

> If [opponents of a project] see a significant and unavoidable impact in the EIR, that's ripe for a challenge. "Why are you accepting this significant and unavoidable impact? You should just not build a project, and why haven't you considered that?" And that's usually where the lawsuits start.

However, more palatable options are possible. For one, many of our interviewees suggested planning for VMT reduction in higher-level plans or programs, like general plans and climate action plans. If the EIRs for those plans adequately analyze (and mitigate) VMT impacts, then future land use projects consistent with the plans could avoid project-level VMT analyses entirely, including the project-level mitigation requirement (CEQA Guidelines Sections 15152, 15183). However, that approach likely would not absolve developers of paying some kind of VMT mitigation fee to fund any VMT-reducing capital improvements contemplated in the higher-level plan or including TDM measures as part of their proposed developments.

Another option mentioned by nearly half of our interviewees is to develop or join an VMT mitigation in-lieu fee, bank, or exchange program. In-lieu fee programs assign a dollar price to VMT impacts, allow local governments to charge a development fee to pay for VMT reduction credits, and allocate the funds to selected measures within the program's defined boundary (City of San Diego, 2020; Lamm et al., 2022). VMT mitigation banks are similar in concept—allowing developers to pay a VMT mitigation fee rather than implement mitigation measures themselves—but would generally be larger in geographic/jurisdictional scope, with a county, regional, or even statewide entity responsible for allocating the funds to mitigation projects throughout the region (Lamm et al., 2022). A VMT exchange could be local or regional would allow developers to select from a list of pre-approved mitigation projects within the relevant geography (Lamm et al., 2022). A key benefit of these programs is that they could reduce the cost of VMT mitigation by targeting the most cost-effective mitigation projects first, though multiple interviewees cautioned that the equitable distribution of mitigation projects should also be considered.

All three approaches are novel in the VMT mitigation context, as our interviewees and a recent report on designing VMT mitigation banks and exchanges all note (Lamm et al., 2022).

However, many jurisdictions already have similar programs for other types of impacts that they can draw on in developing VMT mitigation programs. In addition, a few jurisdictions have developed or started developing VMT-specific fee programs. For example, the City of San Diego adopted its Mobility Choices Fee Program in 2020, which includes VMT impact analysis thresholds, guidance, and tools, as well as an active transportation in-lieu fee program (City of San Diego, 2020). The initiative divides the city into four mobility zones, the first three of which are deemed VMT-efficient. Projects in zone 1 avoid VMT mitigation altogether. Projects in zones 2 or 3 can either implement on-site mitigation measures or pay the in-lieu fee if they are determined to have significant VMT impacts. Projects in the fourth—VMT-inefficient—zone must pay an in-lieu fee for all VMT they produce over the significance threshold. The in-lieu fee is set at $1,400 per VMT, based on a nexus study the city conducted (City of San Diego, 2020). Barbour (2022) discusses in more detail how some jurisdictions have been modifying their transportation impact fee programs in response to SB 743.

VMT Estimation Sketch Tools

Travel demand models were the most commonly used tools for estimating land use projects' VMT impacts, with 79% of jurisdictions at least providing an option to use them, as discussed above. But sketch tools were also frequently used, with 42% of jurisdictions using them exclusively or as an alternative to travel demand models to estimate project-level VMT. As discussed, sketch tools commonly use the tabular results of travel demand models to estimate VMT for pre-defined land uses based on their location and size. Some are also capable of estimating the effect of project-level mitigation measures. And some just estimate VMT reductions from specified mitigation measures. Sketch tools can be either spreadsheet- or web-based.

Most sketch tools are relatively simple and estimate projects' unmitigated VMT almost directly from travel demand model output tables. For example, the Lake Forest SB 743 VMT look-up table (2020) queries a table of travel demand model outputs to provide geographically applicable VMT per capita and VMT per employee. The VMT value represents the average VMT of the same land use in the same TAZ. Other relatively simple sketch tools are used solely to calculate the possible VMT reduction from a select list of mitigation measures. One example is the Fresno Urban Form VMT calculator, which was in the testing stage at the time of our data collection. The draft version of the Fresno sketch tool that we say was based primarily on the CAPCOA Handbook and included percentage VMT reduction estimates for a selection of measures deemed applicable to the City and County of Fresno.

San Jose was one of the first jurisdictions to develop a more robust sketch tool for estimating VMT(San Jose, 2018). Its spreadsheet-based sketch model uses baseline VMT estimates from its travel demand model. The model provides separate VMT estimates for residential and office projects on every parcel with a unique Assessor's Parcel Number (APN). The model uses a parcel buffering method, which calculates the average VMT[18] of all TAZs within a half-mile distance of the project. That number is then used as the estimate of project-generated VMT. The San Jose sketch model also is capable of calculating the VMT reduction for mitigation measures, using elasticities based on the CAPCOA Handbook[19] (CAPCOA, 2010).They include four tiers of mitigation measures in the tool, including project characteristics, multimodal infrastructure, parking strategies, and TDM programs. Each category has a maximum allowable VMT reduction for the combined measures in the category; a cross-category maximum reduction is also defined to avoid double counts, similar to what the CAPCOA Handbook itself recommends. It should be noted that the city recommends that the sketch tool be used only for small and medium-sized projects. It notes that the tool might not be appropriate for estimating VMT from larger retail projects or other projects where most of the VMT is generated by customers or visitors rather than employees or residents. Instead, for those projects, the city recommends using the city's travel demand model (San Jose, 2018). The Santa Clara Valley Transportation Authority (2020) developed a web-based tool similar to San Jose's tool that that can be used for projects located anywhere within Santa Clara County.

The City of Los Angeles also has a robust web-based VMT calculator used for estimating project-level VMT generated by office and residential land use projects in the city, as well as estimating VMT reductions from TDM mitigation measures (LADOT and LADCP, 2020). The sketch model uses the baseline VMT estimates from the city's travel demand forecasting model for the TAZs in which the project is located. Each TAZ is classified as one of four types of travel behavior zones (TBZs) (suburban, suburban center, compact infill, and urban) to allow for more contextual-specific estimates. They used population density, daytime population density, land use density, intersection density, distance to nearest fixed guideway bus stop or station, and distance to a major bus stop to determine TBZs. The tool can also calculate the VMT reduction rate if any TDM-based mitigation measures are selected. The tool reports the vehicle trip and VMT results tailored to the City of Los Angeles's guidelines and impact criteria.

VMT Impact Mitigation Monitoring

CEQA requires lead agencies to "adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment"(PRC section 21081.6).[20] However, CEQA does not specify a particular type of monitoring or reporting. Nor does OPR's Technical Advisory provide guidance on mitigation monitoring for VMT impacts. Our findings indicate that local governments likewise focus less on monitoring than other aspects of VMT impact analysis.

[18] Home-based VMT per capita for residential projects, home-based work VMT per employee for office projects, and total VMT (current VMT generation for existing buildings in the area as a base point for calculating Project VMT).

[19] We discuss the California Air Pollution Control Officers Association report on quantifying greenhouse gas emissions from select mitigation measures later in the mitigation section.

[20] Note that CEQA does not require monitoring for impacts that remain significant even after mitigation.

Figure 21 shows that 62% of the jurisdictions with adopted thresholds do not mention or explicitly require monitoring for mitigation measures in their VMT impact analysis guidelines. Thirty-seven percent employ a case-by-case approach that allows the jurisdiction to require monitoring based on the project's context, and only three jurisdictions appear to mandate monitoring of mitigation measures for VMT impacts in all cases. An even smaller minority of jurisdictions (~10%) actually suggest how the monitoring could or should be performed. Most jurisdictions that require monitoring (always or on a case-by-case basis) use vague language. One illustrative description used (in some form) by multiple jurisdictions: "Because TDM frequently depends on building tenant performance over time, VMT reduction cannot be reliably predicted and monitoring may be necessary to gauge effectiveness."

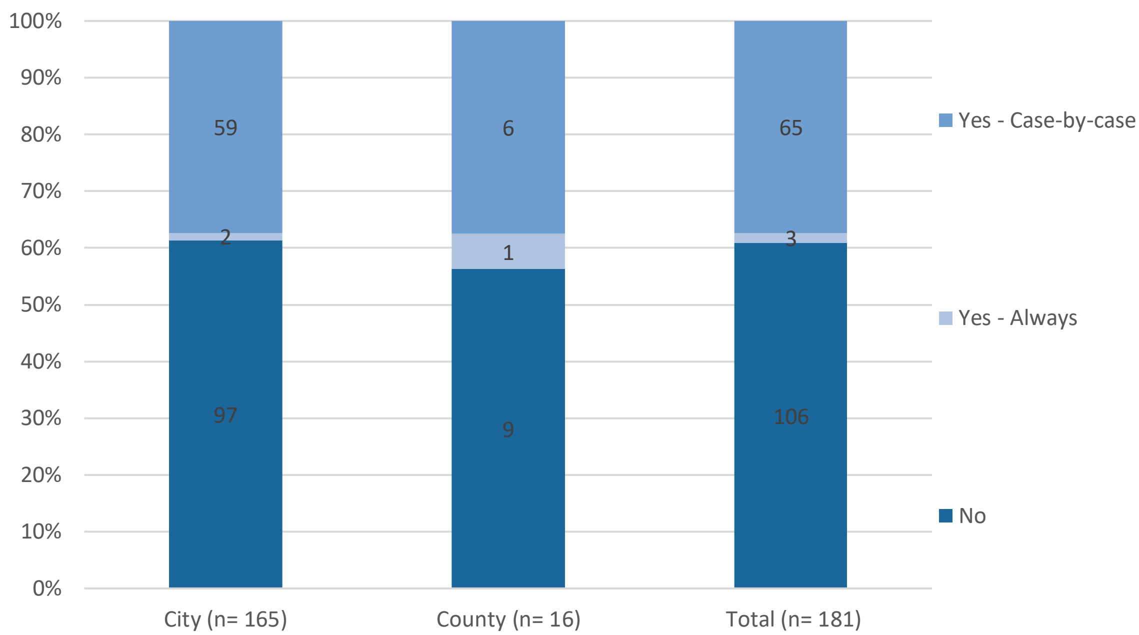

Figure 21. Status of VMT mitigation monitoring in the CEQA process

There are 18 jurisdictions that, either in their policy/guidance documents or through emails with our research team, provided some substantive direction as how the monitoring could or should be performed. None of them specified how to monitor the efficacy of particular mitigation measures. Rather, the guidance focused on the types of monitoring methods that could or would be expected to be used. Five different methods were mentioned.

The most common method—mentioned by 11 jurisdictions—was trip/vehicle counts, e.g., using inductive loops or road tubes. One reason for their prevalence is that driveway counts are already a form of monitoring required through some jurisdictions' TDM ordinances. They appear to primarily be used to monitor compliance with either TDM measures intended to reduce trip generation or explicit trip caps imposed as conditions of project approval. One interviewee noted that driveway counts could also be paired with trip lengths derived from either a travel demand model or big data (like cell phone data) to monitor project-generated VMT.

The second most common method—mentioned by 10 jurisdictions—was mitigation measure inspection. This involves confirming that the stated mitigation measures have actually been implemented. This could be done with either physical mitigation measures (e.g., confirming the installation of bicycle or pedestrian facilities) or TDM-type programs (e.g., certifying that free transit passes have been provided to project residents). Inspection is generally regarded as the easiest and cheapest form of monitoring. One jurisdiction went so far as to say that the "only monitoring that appears feasible is to periodically verify that the agreed upon TDM measures are still being implemented."

The third most common method—mentioned by five jurisdictions—was surveys of project users (e.g., residents, workers, or even patrons or other visitors). These could take the form of full travel surveys with travel diaries and/or GPS trip tracking, which would enable direct trip generation, mode share, and even VMT estimation. Or they could simply ask respondents about participation in project-related TDM measures, like free transit pass usage or employer-sponsored carpooling.

The fourth monitoring method—mentioned by just two jurisdictions—was parking surveys. Parking occupancy can be used as a proxy for vehicle ownership and use, which in turn can used to monitor the success of mitigation measures intended to reduce vehicle ownership and even to estimate project-generated VMT.

The last monitoring method—mentioned by only one jurisdiction—was big data, like cell phone data. Big data—such as location and motion data from cell phones and other electronic devices—can be used to estimate VMT-related metrics (like trip generation, trip length, and mode share) with increasing precision and at increasingly small scales (Wang et al., 2018; StreetLight, 2021).

Trends and Challenges

Our findings indicate that local governments focus less on monitoring than other aspects of VMT impact analysis. One reason is that monitoring is viewed by some as less pressing or important, especially at this relatively early stage in the development of VMT impact analysis policies and guidelines. In addition, dozens of jurisdictions indicated via email, phone, or in our formal interviews that monitoring the implementation and efficacy of VMT-related mitigation measures can be both costly and difficult. One city even stated that monitoring was proving to be the "most problematic" part of implementing SB 743.

With respect to cost, many local governments reported that they simply did "not have the resources"—either money or staff—for monitoring. One of our interviewees, a planner for a self-avowed "well-funded city," confirmed that the cost issue affects even well-resourced jurisdictions like his. Another interviewee from a statewide consulting firm noted that some jurisdictions "struggle with the notion of weighing down projects and limited agency staffing capacity with annual monitoring and reporting requirements sometimes attached to VMT mitigation measures." User surveys and big data can be particularly expensive.

Our communications with dozens of jurisdictions (including formal interviews and other outreach) revealed three ways in which many local governments are tackling the cost issue. One way is to simply not require monitoring. That approach risks violating CEQA's monitoring requirement. However, jurisdictions can avoid that requirement if they treat a project's VMT impacts as significant even after mitigation and adopt a statement of overriding considerations (PRC section 21081.6(a)). A second approach to tackling the cost issue is to forego performance monitoring and only require mitigation measure inspection (ensuring that the measures have been implemented), which is simpler and cheaper. The third way—which works with any type of monitoring—is to require that the project owner or manager perform the monitoring, rather than local government staff. However, pushing the cost onto the development can lead to disputes with developers and even "pro-development" elected officials or community members, as one interviewee from a small city explained. A planner from another jurisdiction conveyed a similar theme via email: "It's important to balance what we're trying to achieve with implementation and approval at city council."

In addition to and related to cost, monitoring—particularly performance monitoring—can be difficult. Logistically, it can be difficult to capture the travel behavior of project users, let alone attribute any trends or changes to a particular mitigation measure. As a traffic engineer for one city put it: "Monitoring VMT impacts is very difficult, especially on a project-by-project basis with current technology, daily/weekly/tenant shifts in travel patterns, and privacy concerns" (with both big data and user surveys). A traffic engineer for another city went so far as to opine that the "only monitoring that appears feasible is to periodically verify that the agreed upon TDM measures are still being implemented," basically forsaking performance monitoring. However, even mitigation measure inspection can be difficult when the mitigation is implemented off-site, as multiple jurisdictions noted. One of the benefits of developing regional VMT mitigation banks (or exchanges) is that they could help facilitate monitoring of off-site mitigation measures (Lamm et al., 2022).

The outcomes of VMT mitigation monitoring can also be difficult to interpret, depending on how the mitigation goals and monitoring metrics are defined. It is often relatively straightforward to measure things like trip generation (e.g., through driveway counts), mode share (e.g., through user surveys), or TDM program participation (e.g., through user surveys or administrator records) and compare those to static benchmarks, like trip caps, target mode shares, or target TDM program participation numbers. It is harder to use those monitoring metrics to gauge success in meeting relative benchmarks, like percentage reductions in trip generation, single-occupant vehicle mode share, or total VMT. A major issue is the lack of baseline travel data with which to make an apples-to-apples comparison with the monitoring data. The VMT impact analysis for a project will provide an estimate of how much VMT the project will produce. But as one city traffic engineer noted, those "VMT values are theoretical instead of measured." It is unknown how project users would have traveled if the project did not include mitigation measures. Nonetheless, monitoring data can provide a baseline with which to measure the effect of mitigation measures that take a long time to implement or measures that are added later. It can also be used to assess the accuracy of pre-construction VMT estimates and inform future baselines for similar projects.

We discuss issues related to monitoring the actual VMT from land use developments (rather than just the effects of specific mitigation measures) in the next chapter of this report.

Role of Collaboration in Implementing SB 743

As mentioned in previous sections, developing VMT impact significance thresholds—and VMT impact analysis guidelines more broadly—can be labor and time intensive. Not all jurisdictions have the capacity and capability of doing so in-house. Collaborating with—or tiering from—other jurisdictions and agencies can help reduce the burden on any one jurisdiction and also facilitate intra-regional consistency in VMT impact analysis. When we were collecting data, a couple of jurisdictions mentioned to us that these types of regional collaborations had helped them to develop their implementation guidelines, which they would have been less likely to develop on their own. A few of our interviewees also noted how useful it was for smaller jurisdictions to have ready access to data, tools, and guidance.

As Table 12 shows, more than 60% of all responding jurisdictions collaborated in some way on SB 743 implementation, i.e., they partnered with at least one other entity to develop their VMT impact analysis guidelines or followed another jurisdiction's specific VMT impact significance threshold. Sometimes the collaboration lead was not even an entity with land use approval authority. For example, as discussed above, the Contra Costa Transportation Authority led a county-wide effort to develop VMT impact analysis guidelines as part of its growth management program, with participation from all 19 cities and the county itself. Similarly, some of the jurisdictions in Santa Clara County adopted a guideline developed by the Santa Clara Valley Transportation Authority. Numerous councils of governments (COGs) have also led collaborative efforts to develop guidelines for their jurisdictions, including Fresno COG, Western Riverside COG, San Bernardino COG, and San Gabriel Valley COG.

Table 12. Jurisdictions that have collaborated with others to implement SB 743

	Yes	Total	Percentage
City	156	251	62%
County	15	23	65%
Total	171	274	62%

Continued Role of LOS

SB 743 and its implementing regulations eliminated LOS as a transportation impact metric under CEQA, but they do not prohibit local governments from employing LOS standards outside of CEQA. Indeed, using LOS is still widely considered to be "good for planning practice," as one interviewee put it, because it is relatively simple to understand and estimate and because auto congestion is such a visible issue for voters and elected officials. Perhaps unsurprisingly, then, all the jurisdictions for which we found information about their use of LOS continue to employ the metric for planning and project-level review outside of CEQA. A couple of interviewees mentioned that they continue using LOS in traffic circulation and network performance evaluation in their congestion management plans.

However, LOS impact analyses done outside of CEQA are not necessarily as comprehensive and expensive as they would be for CEQA purposes. One transportation planner we interviewed from a large city explained that while they still routinely conduct "circulation and queuing analys[es]" they are "scaled down to be more specific to projects that would affect a broader area or when they do the analysis, [they are] typically just the adjacent intersections rather than 30 intersections that would typically have been in the CEQA analysis." This trend of reducing the scope of LOS analyses outside of the CEQA process was echoed by four other interviewees, including one planner who worked for three different cities and a consultant familiar with transportation impact analyses across the state.

Effects of the LOS-to-VMT Switch on Development

One of the main goals of SB 743 was to incentivize infill development. Previous research predicted that the shift from LOS to VMT could potentially reduce the burden of environmental review of developments, especially in low-VMT areas (Volker et al., 2019a). However, the empirical jury is still out on this question. It has only been 2.5 years since local governments were required to switch from LOS to VMT in their CEQA analyses, so the data on the effect of the switch is limited. Nonetheless, we asked each of our interviewees what impact they thought the LOS-to-VMT shift was having and would have on land use development.

The consensus was that swapping LOS for VMT could streamline development in urban areas, particularly where projects are screened out of VMT impact analysis. Previous research suggests that even screened projects are unlikely to avoid CEQA entirely, because in most cases VMT will not be the only potentially significant impact requiring in-depth CEQA review (Volker et al., 2019a). However, the LOS-to-VMT switch can still streamline those projects by reducing the burden of CEQA-related transportation impact analysis and associated mitigation measures. One of our interviewees from a statewide consulting firm estimated that their firm charges 20% less on average to prepare a CEQA VMT impact analysis than they charged to prepare a CEQA LOS analysis, and that does not include the reduced cost of mitigation for VMT impacts versus LOS impacts in urban areas. Another interviewee with experience with transportation impact analyses across the state estimated that in urban areas the total cost of a VMT impact analysis plus any associated mitigation was just 5% or 10% of the cost of what CEQA-related LOS impact analyses and associated mitigation measures had been.

One transportation planner we interviewed from a large city detailed many of the factors involved in reducing the overall cost of development in urban areas: "[T]he main thing that we're solving is that the level of service outcome is not resulting in a CEQA" impact and accompanying mitigation requirement and risk of litigation:

> If we put out a traffic study [in a CEQA document] and then somebody says, "oh, you didn't include this intersection," or, "this jurisdiction says you're not including our intersection," [then] we have a comment letter and then, oh, now they have to recirculate or now the project could be sued because there's differences in how you have baseline and existing and . . . You have all sorts of getting [into the] devils [in the] details of methodology. And that just gives a lot

> of heartburn and uncertainty. So yes. In that sense, [removing LOS from CEQA] does solve a lot. Even if we're still doing the [LOS] analysis. Having that outside of the CEQA process and not contributing to the CEQA conclusion, is still important. Secondly, if we are including analysis, it's not as a heavy lift as it used to be. We're only requiring, in a lot of cases, traffic counts from like three or four adjacent intersections, rather than 30. So, the cost of the analysis has gone down. And then thirdly, the mitigation. Level of service was resulting in mitigation that was expensive and timely. As far as is capital improvements, right turn pockets. Moving traffic signals, moving lights. That's really expensive. Especially if there's infrastructure, you have to relocate a water main or a fire hydrant, that's really expensive. Even if we do do the [LOS] study [now], if CEQA's not forcing us to a specific mitigation outcome that we believe is substandard, that's saving a lot of money.

Four other interviewees similarly noted that LOS-related analyses and exactions outside of CEQA were less onerous than they previously were under CEQA. Another interviewee noted how one of the jurisdictions they had worked for as a contract planner was trying to use VMT mitigation measures that would also work to improve LOS, thereby reducing the combined burden of CEQA mitigation measures and LOS-related exactions outside of CEQA. However, jurisdictions could impose onerous LOS analysis and exaction requirements outside of CEQA that would reduce the overall streamlining for development in urban areas. One interviewee opined that "SB 743 is what you make of it" in urban areas; "cities that want to streamline" can streamline, but they can also "continue using LOS" to "basically make growth just as difficult as it has been."

Development projects are less likely to be streamlined outside of urban areas, according to four interviewees from more suburban or rural jurisdictions. One interviewee even opined that there are "no solutions that are readily available for" high-VMT jurisdictions "that are trying to develop housing and are running into this roadblock with VMT," with the cost and inadequacy of VMT mitigation measures in those jurisdictions. However, they also noted that those obstacles would be reduced if the jurisdictions planed for VMT reduction in higher-level plans or programs, like general plans and climate action plans. If the EIRs for those plans adequately analyze (and mitigate) VMT impacts, then future land use projects consistent with the plans could avoid project-level VMT analyses entirely, including the project-level mitigation requirement (CEQA Guidelines Sections 15152, 15183).

Two of our interviewees also noted equity concerns regarding affordable housing in more suburban and rural areas. The concern is that allowing affordable housing projects to be screened out of VMT impact analysis could incentivize developers to propose those projects in high-VMT areas, where the costs of development (including fewer LOS impacts and associated exactions) are lower. That could perpetuate the "cycle of poverty," as one interviewee put it, because high-VMT areas tend to have lower average income and tend to be farther from job opportunities and certain services. However, one of the interviewees noted that most affordable housing projects are already exempt from CEQA anyway (e.g., under CEQA

Guidelines Section 15194), so VMT impact screening by itself likely would not have much of an impact on project location or feasibility.

VMT Monitoring

In the previous chapter, we examined whether and how local governments are monitoring the implementation and outcomes of VMT impact mitigation measures. In this chapter, we explore the related issue of monitoring the actual VMT from land use developments. Unlike mitigation monitoring, CEQA does not necessarily require jurisdictions to monitor the total VMT actually generated by the project after construction. Nonetheless, VMT monitoring data is essential for assessing the accuracy of pre-construction VMT estimates and informing future baselines for similar projects. It can also be used to assess the efficacy of mitigation measures by comparing the VMT generated by two or more projects that are similar in most respects except the VMT mitigation measures employed.

In the first section of this chapter, we review four approaches that could be used to monitor the actual VMT generated by land use developments. We then discuss trends and challenges regarding VMT monitoring in the second section. Our exploration is based on the document review, interviews with government officials and consultants, and other informal communications with local government staff that we conducted for our investigation into SB 743 implementation in the previous chapter, as well as a review of the literature. To identify sources for our literature review, we searched Google Scholar in 2022 using the following search terms:

> (“vehicle miles traveled” AND “monitoring”), (“vehicle miles traveled” AND “tracking”), (“transportation impact analysis monitoring), and (“vehicle miles traveled” AND “mitigation monitoring”)

We included both peer-reviewed studies and non-peer-reviewed “gray” literature in our review. Even so, we found very few relevant documents. Project-level VMT impacts remain understudied, though monitoring data from SB 743 implementation could help fill that gap.

VMT Monitoring Approaches

Based on our review, we identified four primary approaches to monitoring project-level VMT generation: vehicle trip counts, travel surveys, big data, and odometer data. We discuss each in turn.

Vehicle Trip Counts

Vehicle trip counting is probably the approach most familiar to local governments, since it is already commonly conducted—or required to be conducted—to monitor traffic conditions (on roadways) or compliance with TDM measures (driveway counts at land use developments), as discussed previously. For land use projects, the method involves counting the number of vehicle entries and exits from the project (driveway counts). The counts can be done manually by observers or automatically using inductive loops, road tubes, Bluetooth detectors, or even cell phone data. The most comprehensive approach would be to use automatic detectors to count the vehicles entering and existing the project for an entire calendar year. But counts can also be collected during high-travel periods (generally the AM and PM peak travel hours in the middle of the week in a fair-weather month) and extrapolated to annual numbers using adjustment factors (Clifton et al., 2018; Currans et al., 2020; Institute of Transportation Engineers, 2014). The vehicle counts can then be multiplied by an average trip length to estimate annual VMT from the project. The average trip length can be calculated from a travel demand model for the region (or the California Statewide Travel Demand Model), big data, or travel survey data.

One of the primary advantages of using vehicle trip counts to monitor project-level VMT generation is that it is relatively easy and inexpensive. Plus, an increasing number of local governments already require or otherwise have experience with trip counts, as do Caltrans and academic researchers. One of our interviewees—a transportation planner who has worked or consulted for multiple jurisdictions—opined that trip counts should be required in all TDM programs. Another advantage is that trip count methods are fairly standardized at this point, which enables apples-to-apples comparisons between projects and for the same project over time (at least of the trip generation portion of VMT). In addition, trip count data can be used to update the trip generation inputs for travel demand models and other VMT estimation tools to improve the accuracy of project-level VMT estimates going forward.

A key limitation of vehicle trip counts is that they only represent one part of the VMT equation. Trip lengths (as well as trip purposes) have to be sourced from elsewhere, which can make it harder to replicate and/or compare the VMT estimates with estimates from other projects or future estimates from the same project. Another limitation is that driveway-type counts do not work as well for developments with limited or no off-street parking. Similarly, driveway counts do not capture vehicle trips to or from a development that do not cross the driveway, like curbside drop-offs by taxicabs or ridesharing services (Currans et al., 2020). Counts could instead be conducted on the adjacent roadways, but that raises additional challenges, like parsing out which vehicle trips were associated with the development in question. Vehicle trip counts also do not differentiate pass-by trips, where the traveler is just stopping by the development en route to another location, so they might overestimate trip generation (and thus VMT) without adjustment. The Institute of Transportation Engineers' (2014) Trip Generation Handbook provides general guidance on how to make those adjustments, though site-specific user surveys can be used to calculate more accurate pass-by trip rates.

Travel Surveys

Travel surveys have long been the gold standard for understanding travel behavior and estimating household VMT (Diao & Ferreira, 2014). They can be as simple as asking respondents to self-report their odometer readings or how many miles they traveled by automobile in a single day. Or they can be detailed travel diaries (even multi-day diaries) where respondents report the end points, travel mode, and time of every trip they make, and sometimes even use Global Positioning System (GPS) devices to track their movements. The National Household Travel Survey (NHTS; Oak Ridge National Laboratory, 2018), last completed in 2017, and the

California Household Travel Survey (CHTS; Caltrans, 2013), last conducted from 2010-2012, are prime examples of large-scale travel surveys that employ a varying combination of the aforementioned components. The NHTS and CHTS are frequently used to estimate area-wide VMT (Oak Ridge National Laboratory, 2018; Salon et al., 2014) and model the determinants of household VMT (Salon et al., 2014). However, larger-scale surveys like the NHTS and CHTS generally do not have sufficient sample sizes to estimate VMT from a specific project; that usually requires a project-level travel survey. Numerous local governments already utilize (or require) user surveys to monitor implementation and/or efficacy of TDM or other VMT mitigation measures at the project level, as discussed previously. Depending on the level of detail, those same surveys could also be used to estimate project-level VMT.

The biggest advantage of using travel surveys is the amount of detail they provide. They can provide data on trip generation, trip purpose, trip mode, trip destination, trip distance, trip time, auto ownership, and demographics, among other things. That level of detail allows direct estimation of numerous VMT metrics (not just total VMT) without having to rely on other data sources (Salon et al., 2014). It can also improve the accuracy of the VMT estimates as compared to trip count-based estimates that usually rely on an average trip length value. In addition to facilitating VMT estimation, travel surveys can also use targeted questions to investigate the effects of different VMT mitigation measures (TDM program usage, self-reported reasons for VMT reductions, etc.).

However, travel surveys require a sufficient sample size and sufficient travel information for each respondent to make inferences about project-level VMT, given the significant intra- and inter-personal variation in travel behavior (Diao & Ferreira, 2014; Zhang & He, 2013; Handy, 1996). As with any survey, participation can be difficult to achieve, particularly for smaller residential projects. Among other issues, residents of smaller projects might be more concerned with privacy, since there is less anonymity (results averaged over fewer people than with larger projects). Monetary or other incentives can increase survey participation and endurance (e.g., for longer surveys or multiple travel diary days), but they also increase survey cost. And survey expense is one reason fewer jurisdictions in our study reported using (or requiring) surveys than trip counts, especially for smaller projects. Another issue is reporting bias (Diao & Ferreira, 2014; Zhang & He, 2013). Schipper and Moorhead (2000), for example, found that self-reported VMT was 13% greater than odometer-based VMT estimates in urban areas. Using GPS tracking as part of the survey can reduce reporting bias, and even reduce the sample size needed to make project-level inferences, but tracking raises even greater privacy concerns and also generally increases survey startup costs (Zhang & He, 2013).

Big Data

A more recent source of travel behavior information is big data, such as location and motion data from cell phones and other electronic devices (Wang et al., 2018). It does not yet appear to have been commonly used for project-level VMT impact analyses or monitoring. For example, we identified only one jurisdiction—Citrus Heights—that used big data to develop its VMT impact thresholds (Fehr & Peers, 2021). However, Fehr & Peers recently partnered with StreetLight Data to estimate VMT metrics at the Census Block Group level for the entire state of

California (Fehr & Peers, 2023; StreetLight, 2021). In addition, three of our interviewees recommended big data as an increasingly useful source of data for monitoring project-level VMT generation, as more and more people use cell phones with location and/or motion sensors, and as data vendors like StreetLight Data and Replica, improve their algorithms for analyzing travel patterns.

One advantage of big data is that, like travel survey data, it can provide data on trip generation, trip mode, trip destination, trip time, and trip distance. That level of detail allows direct estimation of numerous VMT metrics (not just total VMT) without having to rely on other data sources. In addition, it is easy for local governments (or other designated monitoring entities) to use, since the big data vendor does the analysis and provides the VMT estimates.

However, big data is not a panacea. Just like travel surveys, big data relies on samples to estimate VMT metrics. Sampling bias remains a risk, particularly in areas with low cell phone use and/or low satellite visibility (for GPS positioning), though the bias should diminish as the use of cell phones (and other devices with location and motion sensors) increases. Big data vendors also rely on proprietary algorithms to process the data, which differ between vendors and change over time even for the same vendor. This adds an element of "black box" uncertainty to their estimates. In addition, the data sources themselves can change, for example as cell phone carriers change their privacy and data sharing policies. That can make big data difficult to use for monitoring how VMT changes over time or differs from project to project. As one of our interviewees familiar with the use of big data for VMT estimation (and monitoring) noted, "you can't really separate the signal through the noise if the algorithms are changing frequently or you lose a big source of your raw data." However, that same interviewee noted that trip length estimates from big data tend to be "a little bit more stable" over time than trip generation estimates. Another issue is privacy. Big data often cannot be used for projects without many users because the data (and resulting VMT estimates) cannot be sufficiently anonymized. Like travel surveys, big data can also be relatively expensive, particularly for smaller projects.

Odometer Data

The most accurate way to monitor VMT is to directly measure it using odometer data (Schipper & Moorhead, 2000). Numerous states record odometer readings when vehicles are registered and/or inspected for safety (as in Massachusetts) or emissions (as in California). In California, the Bureau of Automotive Repair maintains odometer data collected from biennial smog checks and when vehicle ownership changes. This type of odometer data can be used to calculate VMT (Diao & Ferreira, 2014; Holtzclaw et al., 2002). However, it is generally not feasible to use odometer readings for monitoring VMT at the project level. For one, odometer data are associated with the garaging address of the vehicle, which prevents estimation of VMT for non-residential projects and VMT by trip purpose. In addition, the odometer data is only collected every two years and only from certain vehicles (Bureau of Automotive Repairs, 2023), which can cause omission biases. Furthermore, privacy protections can limit the use of odometer data at smaller geographic scales, like project-level analyses.

Other Trends and Challenges

Our findings indicate that most local governments are "loathe" to monitor the actual VMT from land use developments, as one interviewee put it. For one, it is not mandated - unlike mitigation monitoring, CEQA does not necessarily require jurisdictions to monitor the VMT actually generated by the project after construction, as discussed above. In addition, it can be expensive and politically difficult, just like mitigation monitoring. As discussed previously, many local governments reported that they simply did "not have the resources"—either money or staff—to even conduct mitigation monitoring. Another issue raised by one of our interviewees is that jurisdictions might be reluctant to monitor the actual VMT from developed projects because it could cast doubt on their original VMT estimates, which could open their future CEQA analyses to legal challenge. Because forecasting and monitoring methods are often not apples to apples, comparing the results "could be all over the place." A few jurisdictions suggested that one way to alleviate these concerns would be to have regional or state-wide monitoring entities conduct the monitoring, using a consistent methodology and potentially aided with state funding. That is a function that VMT mitigation banks or exchanges could perform if and when they are established (Lamm et al., 2022).

Conclusion

For nearly 50 years, LOS was the primary metric of transportation-related environmental impacts under CEQA. SB 743 upended the status quo, leading to VMT replacing LOS as the primary metric for analyzing the transportation impacts for CEQA purposes. We investigated how local governments have been implementing the LOS-to-VMT shift for land development projects, and how that differs from past practice. We also explored whether and how local governments monitor the actual VMT impacts from completed land use developments and what methods are available to do so. Our findings indicate that SB 743 implementation is very much still a work in progress—all responding jurisdictions acknowledged the mandatory LOS-to-VMT shift, but were in varying stages (and degrees) of implementing the shift. For those jurisdictions that had adopted VMT impact significance thresholds, most adhered closely to OPR's recommendations. They also mostly tried to use apples-to-apples methods of calculating baseline VMT levels (for setting thresholds) and estimating project-level VMT, often relying on travel demand model outputs for both. However, despite the availability of multiple monitoring methods (including relatively simple and inexpensive methods like driveway trip counts), most jurisdictions gave short shrift to VMT monitoring, either monitoring the efficacy of VMT mitigation measures or monitoring the actual VMT impacts of land development projects after construction. Going forward, state or regional monitoring initiatives—or even just funding—could help. For example, monitoring could be included in the charge of a regional VMT mitigation bank or exchange. Another important aspect of SB 743 implementation is how LOS will continue to be used outside of CEQA. We found that jurisdictions uniformly continue to employ LOS for planning and project-level review outside of CEQA. However, those LOS analyses are not necessarily as comprehensive and expensive as they would have been for CEQA purposes. And that has implications for the ability of SB 743 to incentivize infill development, one of the law's original goals. We found a consensus amongst our interviewees that swapping LOS for VMT could streamline development in urban areas, but not in more suburban or rural jurisdictions.

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Data Summary

Products of Research

Our research produced a spreadsheet summarizing how all 539 California cities and counties have been implementing SB 743. That summary spreadsheet is archived on the Dryad data repository, under the dataset name “Summary of SB 743 Implementation Efforts by California’s 539 Cities and Counties”.

Data Format and Content

The data is available in Excel format on Dryad (https://doi.org/10.25338/B8F075).

Data Access and Sharing

Please contact the authors for information on the underlying data sources (local government documents and direct communications with local government staff and consultants).

Reuse and Redistribution

There are no restrictions on how the data can be reused and redistributed by the general public. Please cite the dataset as follows:

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