RESEARCH REPORT

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

Assessing the Potential for Densification and VMT Reduction in Areas Without Rail Transit Access

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16. Abstract
While transportation infrastructure and efficiency should inform where to build more housing, little is known about how housing allocation and development processes can be coordinated more systematically with transportation. To date, transportation-housing coordination has often relied on the densification of areas near rail transit stations, putting heavy burdens on these locations and their residents. Much less attention has been paid to how densification can be achieved in a more equitable manner by encompassing other sites. This report directs attention to non-rail locations, specifically low vehicle miles traveled (VMT) areas and bus corridors, and examines the challenges that can arise in promoting densification more broadly. It shows that data uncertainties can make it challenging to identify low VMT locations and that prioritizing only low VMT locations for residential development may have limited effectiveness in expanding housing opportunities in high opportunity areas. The report further explores ways to achieve more inclusive densification of non-rail transit areas and highlights the importance of anti-displacement strategies.

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The California Resilient and Innovative Mobility Initiative

The California Resilient and Innovative Mobility Initiative (RIMI) serves as a living laboratory—bringing together university experts from across the four UC ITS campuses, policymakers, public agencies, industry stakeholders, and community leaders—to inform the state transportation system's immediate COVID-19 response and recovery needs, while establishing a long-term vision and pathway for directing innovative mobility to develop sustainable and resilient transportation in California. RIMI is organized around three core research pillars: Carbon Neutral Transportation, Emerging Transportation Technology, and Public Transit and Shared Mobility. Equity and high-road jobs serve as cross-cutting themes that are integrated across the three pillars.

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Table of Contents

Table of Contents

List of Tables

List of Figures

Executive Summary

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Higher density residential construction, when properly coordinated with transportation improvements, particularly access to public transit, can significantly contribute to alleviating California's housing affordability crisis, while reducing greenhouse gas (GHG) emissions from automobile travel. Although this planning approach, which emphasizes the importance of coordination between transportation and housing, has existed for decades (often in the form of transit-oriented development, or TOD), there are concerns that policies favoring land use densification in already built-up urban areas may unfairly impact low-income neighborhoods and communities of color. Little is known about what challenges can arise in achieving the vision of systematic coordination between transportation and housing development and how densification can be achieved in a more equitable manner. In California, Senate Bill (SB) 743 has made it easier to build more housing in low vehicle miles traveled (VMT) locations by shifting the way traffic impacts from new housing development are evaluated under the California Environmental Quality Act, but what it would entail is largely unknown. Moreover, prior research on densification has typically focused on promoting infill development in rail transit areas without much attention to what can be done in other locations to both improve housing affordability and increase access to employment opportunities.

This report is based on work conducted by a team of University of California researchers seeking to better understand equity issues and other challenges that may arise in pursuing transportation-informed densification. It presents the findings of two investigations: 1) a scenario analysis of the potential impacts of SB 743 that highlights equity concerns, as well as difficulties in identifying low VMT locations, and 2) a qualitative, in-depth investigation, including interviews with policy experts, creators, implementers, and advocates that explore ways to achieve more inclusive densification of non-rail transit areas, which have long been neglected in the literature.

The first investigation (Section 2) shows through a comparison of two sources of VMT information that can be used to identify low VMT areas, 1) per capita home-based VMT estimates from the California Statewide Travel Demand Model (CSTDM) and 2) per capita origin-based VMT estimates derived from StreetLight Data (STL), that the identification of such locations can be quite sensitive to the data sources used. In the case of Orange County, California, specifically, the two data sources—one based on model estimates and the other based on smartphone signals and other forms of real-world observations—differ significantly in explaining how transit and built environment characteristics (other than population density) contribute to reducing per capita VMT. Furthermore, the model-based VMT estimates tend to identify low-income neighborhoods as low VMT locations, suggesting that SB 743 (or other initiatives designed to search for and prioritize low VMT locations for densification), if not guided properly, can disproportionately burden less affluent neighborhoods with larger minority populations rather than contributing to building more affordable housing in high opportunity areas.

The second investigation (Section 3) shows that affordability and anti-displacement strategies are critical concerns for housing policy experts, creators, implementors, and advocates in California as the state aims to

meet its GHG reduction goals through increasing density, particularly near transit nodes. There was some consensus that reducing VMT posed challenges for equity because housing has become increasingly unaffordable in transit-rich locations and sufficient affordable housing is typically not available to meet demand. This suggests that policies aimed at reducing driving by building more housing in these areas could harm lower-income individuals through gentrification without sufficient protections for existing residents or guarantees for affordable housing; housing and transportation must be better coordinated to achieve equity benefits. While there is little empirical evidence of displacement associated with transit-oriented development generally, including along high-quality bus corridors, perceptions that the phenomenon is significant and requires solutions were pervasive among the interviewees for this study

Overall, the findings suggest that transportation-informed densification is a challenging process, and this is particularly true when it comes to implementation and inclusive place-making. More needs to be known about how densification can take place in a way that promotes diversity, equity, and inclusion rather than causing disproportionate impacts on disadvantaged communities and their residents.

Contents

Introduction

Housing costs in many California cities are among the highest in the nation, and researchers have estimated that the state needs to add millions of additional units in order to mitigate housing cost burdens (e.g., Taylor, 2016; Woetzel et al., 2016). Most Californians believe that the state should ease restrictions on housing supply (Bonner, 2023), but city- and neighborhood-level conflicts over development remain intense (see, e.g., Collins, 2021; Curwen, 2024; Mejia et al., 2018; Szabo, 2023).

Despite these longstanding tensions around housing development, for many years there has been widespread consensus that proximity to public transit should be a key consideration when siting new housing in California, as the state has explored ways to reduce greenhouse gas (GHG) emissions and thus create more sustainable communities. The importance of systematic coordination between transportation and housing development has been emphasized in an effort to reduce the need for automobile travel. However, it remains unclear how this rather abstract principle of transportation-housing coordination can be applied to identifying appropriate locations for adding to housing supply on a more concrete level.

A popular approach has been to focus new housing near transit hubs, especially rail stations, that provide convenient access to employment centers. In the past, such infill development projects frequently ran into roadblocks since they were assumed to generate additional traffic congestion, which had to be mitigated under the California Environmental Quality Act (CEQA). Recently, state legislation known as Senate Bill (SB) 743 (Steinberg, 2013) has loosened the requirements for CEQA review to encourage projects that can reduce vehicle miles of travel (VMT), and thus contribute to reducing GHGs, by providing a way to avoid expensive environmental review and mitigation requirements for projects that are proposed in existing low-VMT areas. However, encouraging housing in areas with high transit accessibility might not enable the state to address its housing crisis in an equitable manner. Most areas with high-quality transit access have disproportionately large numbers of lower-income residents, many of whom are members of racial and ethnic minority groups. As a result, proposals to densify these areas have raised concerns about displacement and gentrification (see, e.g., Zuk et al., 2018; Padeiro et al., 2019; Delmelle, 2021; Houston and Zuñiga, 2021). In addition, expediting housing development only in locations where the existing VMT level is low might not spur housing supply in affluent areas with various amenities and opportunities that would benefit lower income residents, given that per capita VMT tends to be high in wealthy neighborhoods, as shown later in this report.

Should California continue to incentivize housing development based on transit availability? What challenges may arise when doing so, and how can the state effectively address concerns about equity?

This report concerns transportation-informed housing allocation and development as a means to accommodate housing needs in California. Specifically, the following two sections examine (i) the ongoing state-wide efforts to search for and prioritize low vehicle miles traveled (VMT) locations for residential development supported by Senate Bill (SB) 743 (Section 2), and (ii) the barriers and strategies for more inclusive development of non-

rail transit areas to which less attention has been paid compared to rail transit areas (Section 3). Through an analysis of data for Orange County, Section 2 highlights some gaps in our knowledge and data as well as equity concerns that deserve more attention from planners and policy makers. Using qualitative methods (without focusing on a single county), Section 3 provides some practical lessons on displacement concerns and anti-displacement strategies in non-rail transit-oriented development (TOD) from expert interviews. Overall, this report shows that transportation-housing coordination in practice is much more challenging than typically assumed and that more should be known about how transportation-informed housing development can take place in a way that promotes equity without causing disproportionate impacts on disadvantaged communities and residents.

Challenges in Promoting Housing Development in Low VMT Areas

Background

In California, local zoning laws and a variety of state laws combine to exert significant influence on land use and development. Local zoning laws define how land can be used within a given jurisdiction, dictating factors such as allowable densities, permitted uses, and the procedures for obtaining building approvals. There is widespread recognition that the high costs of housing in California stem, in part, from the constraints that local zoning frequently imposes on new development (see, e.g., Murray and Schuetz, 2018; Taylor, 2016; Woetzel et al., 2016). Historically, these constraints have included pervasive restrictions on density (e.g., allowing only detached single-family housing) and extensive discretionary review requirements. State laws such as the Housing Element Law (Cal. Gov. Code, §§65580-65589.11), the Density Bonus Law (Cal. Gov. Code §§65915-65918), and the Permit Streamlining Act (Cal. Gov. Code §§65920-65923.8) impose a variety of requirements intended to reduce local constraints on housing development. The California Environmental Quality Act (CEQA, Cal. Pub. Res. Code §21000 et seq.) requires environmental impact analyses that can impede housing development, although revisions to the law – discussed below – are intended to make infill development easier than sprawling development.

Under the Housing Element Law, the state's Department of Housing and Community Development (HCD) "determines regional housing allocations (typically for multicounty areas), and then a regional organization (often a council of governments) assigns portions of the allocation to individual jurisdictions" (Marantz et al., 2024a, p. 3). The intra-regional allocation methodology must further a variety of objectives, including increasing housing supply, promoting infill development, fostering socio-economic equity, protecting environmental resources, encouraging efficient development patterns, and reducing greenhouse gas (GHG) emissions (Cal. Gov. Code §65584(d)). Each local jurisdiction then adopts a housing element as part of its general plan to show how it will accommodate its portion of the regional allocation. Although the law's requirements were widely viewed as toothless for several decades (Dillon, 2017; Lewis, 2003), a series of revisions to the law and related statutes beginning in 2017 have given HCD the authority to rigorously review intra-regional allocations and to require local governments to demonstrate that their zoning ordinances can realistically accommodate the allocated housing units (Elmendorf et al., 2020). Transit-oriented development is one strategy that could satisfy objectives of the Housing Element Law related to infill development, housing supply, environmental protection, and GHG emissions reduction. Although TOD could also promote socio-economic equity, it has raised significant concerns about displacement and gentrification, as detailed in section 3 of this report.

In addition to promoting housing affordability, the state is also committed to fighting climate change. Senate Bill 32 (Pavley, 2016) requires California to reduce GHG emissions 40 percent below 1990 levels by 2030, and

Executive Order B16-12 provides a target of 80 percent below 1990 emissions levels for the transportation sector by 2050. The California Air Resources Board (CARB) has determined that it will not be possible to achieve the state's emissions goals without reducing VMT growth, which will require significant changes to how communities and transportation systems are planned, funded, and built (California Air Resources Board, 2022).

In response to regulatory requirements such as the Housing Element Law and SB 32, metropolitan planning organizations (MPOs) and local governments have adopted a variety of regulatory designations intended to facilitate infill development in areas with high transit accessibility. For example, the 2016 Regional Transportation Plan / Sustainable Communities Strategy (RTP/SCS) from the Southern California Association of Governments (SCAG) designates High Quality Transit Areas (HQTAs) encompassing areas within a half-mile of a major, well-serviced rail or bus transit stop or fixed route, well-serviced bus transit corridors.[1] Jurisdictions within the SCAG region containing HQTAs were eligible for funding from SCAG to support transit planning processes. HQTA designations also affected the number of housing units that SCAG allocated to jurisdictions under the intra-regional allocation process required by the Housing Element Law, and HQTAs have experienced densification in recent years (Kim and Li, 2021).

Policies to incentivize residential development in low VMT areas are supported by research demonstrating a strong relationship between travel behavior and built environment factors, including the 5Ds: Density, Design, Diversity, Destination accessibility, and Distance to transit (Ewing and Cervero, 2010 and 2017). However, it is important to note that the influence of rail transit proximity on VMT has been mixed: it has been associated with both reduced VMT (Bento et al., 2005; Chatman, 2013) and increased VMT (Cervero and Murakami, 2010; Chatman, 2008). Evidence suggests that rail transit's influence on VMT varies depending on the context and that other factors likely also play an important role (Salon et al., 2012; Chatman, 2013).[2] Few studies have explored the impact of proximity to high-frequency bus transit services on VMT, leaving it unclear whether promoting residential development near all types of transit is consistently beneficial.

The Housing Element Law, coupled with regional programs such as SCAG's HQTA designations and local zoning ordinance amendments can facilitate zoning changes to promote development in low-VMT areas, but even when a proposed housing project complies with local zoning laws, it may still have to satisfy the requirements of CEQA, which can empower housing opponents to delay or thwart new development. As Biber

[1] See, e.g., https://gisdata-scag.opendata.arcgis.com/datasets/SCAG::high-quality-transit-areas-hqta-2045-scag-region/about and https://scag.ca.gov/hqta-pilot-project for more information about the SCAG's HQTAs.

[2] Several recent studies draw on the substantial travel behavior literature to design factor-cluster analysis of a range of built environment characteristics associated with VMT and classify census tracts into several place types (see, e.g., Salon et al., 2014; Brown et al., 2021). Marantz et al. (2024b) used this technique to identify four place types that are "transportation efficient." That is, these areas are characterized by lower VMT per capita and higher population density, job accessibility, and commuting by transit. Transportation efficient areas include four types of cluster-derived designations including Core Urban, Non-core Urban, Higher Density Suburban, and Jobs Accessible Suburban. The latter two categories of transportation efficient areas tend to be located farther from the urban core and to have fewer transit-proximate areas designated as an HQTA. Compared to HQTAs in urban core areas which tend to have greater rail transit access, HQTAs in these dense and jobs accessible suburban areas tend to be predominately served by bus transit.

et al. (2024, p. 227) note, "CEQA often requires government decision makers to conduct a thorough review of the environmental impacts of a proposed project, alternatives to the project, and possible mitigation measures. That level of review can be time-consuming, expensive, and full of uncertainty, and it opens the door to political and legal challenges." As a result, in order to expedite projects that would make up for the state's housing shortfall while also reducing VMT, the state legislature has adopted a number of modifications to CEQA, described below (see, e.g., California Office of Governor, 2021 and 2022).

These changes to CEQA could influence the location of housing directly or indirectly. Historically, project reviews under CEQA focused on limiting traffic congestion – in transportation jargon, prioritizing the "level of service" (LOS). SB 743 shifts the analysis of traffic impacts under CEQA from a congestion-focused LOS standard to VMT-based standards. Reliance on the previous LOS standard made it difficult for infill projects to navigate the environmental review process, because such projects can increase congestion. Since some infill projects can reduce per capita VMT, the shift to VMT-based standards may facilitate the approval of infill projects (Barbour et al., 2019). In this way, SB 743 can be a tool to encourage housing development in locations that may lead to GHG reductions.[3]

Despite the potential benefits of permitting new housing in areas with accessible transit, such projects often raise concerns about gentrification and displacement, because lower-income minority households are relatively concentrated in areas with low transportation costs (a proxy for good transit access) (Reina et al., 2019). Empirical evidence demonstrates that new market-rate construction in low-income neighborhoods can decrease the rate of increase in prices for nearby existing units, relative to trend (Asquith et al.,2021). But, as Marantz et al. (2024b, p. 38) explain, [e]ven when new housing reduces pressure on existing housing stock and decreases prices *relative to trend*, this relative decrease may be of little comfort or value for long-time, lower-income residents of neighborhoods confronting gentrification. From a practical perspective, it may make little difference to an economically precarious household if its rent increases by 5% rather than 10%, if both increases are unaffordable."

These concerns could be mitigated by broadening the set of priority development sites to include higher-income areas where new housing development could reduce per capita VMT, even if such areas lack good access to existing (or planned) transit. But there is much confusion about how to identify such areas. In general, it is probably sensible to use current per capita VMT as a proxy for VMT-reducing potential. But, as explored below using data for Orange County, identifying low VMT areas is less straightforward than typically assumed due to data uncertainties. Moreover, using different data sources may have implications for where governments allow or incentivize residential development.

[3] SB 743 is not the only change to CEQA intended to spur infill development. For example, the Housing Accountability Act (HAA), which is part of the Housing Element Law, provides a variety of procedural protections for housing developer. As Marantz et al. (2024b, p. 111) explain, "AB 1633, adopted in 2023, closes a loophole that previously allowed cities to prevent operation of the HAA by delaying completion of environmental review under CEQA. Under the relevant revisions to the HAA, applicants for permits for infill projects of at least 15 dwelling units per acre can now compel the permitting jurisdictions to issue CEQA exemptions when applicable."

Research Approach

As noted above, SB 743 could make it easier to build more housing in low VMT locations by shifting the way traffic impacts from new residential development projects are evaluated under CEQA. Projects proposed in designated areas with low per capita VMT (typically less than 85% of the city/region average or an alternative threshold) can avoid expensive environmental reviews. To examine how such a map-based threshold approach to SB 743 implementation could influence the distribution of housing supply, we devised a set of scenarios and analyzed the characteristics of low VMT neighborhoods compared with those of other areas that failed to meet certain thresholds and thus would not receive the favorable treatment given to low VMT locations. For this analysis, we focused on Orange County, California. The county has a wide spectrum of census tracts (unit of analysis), including many affluent neighborhoods where constructing more housing could possibly contribute to more equitable densification. Furthermore, there is substantial variation in the built environment across tracts in Orange County, providing us with a valuable opportunity to better understand the workings of a threshold approach to identifying low VMT areas and its implications. While the county has 583 census tracts, our results presented in the next section used data for 574 tracts since 9 tracts had incomplete data for our analysis.

Scenarios

We constructed nine scenarios based on two important decision points in the identification of low VMT areas: (i) VMT data sources and (ii) threshold levels, as listed in Table 1. For VMT data sources, we relied on the following two data sources that planners can use to identify low VMT locations:

- CSTDM: Per capita home-based VMT estimates from the California Statewide Travel Demand Model[4]
- STL: Per capita origin-based VMT estimates derived from StreetLight Data[5]

Additionally, we explored what could happen if both of the data sources were used to determine low VMT locations in a more rigorous manner (i.e., a tract would be identified as a low VMT location only when its per capita VMT level, according to both sources, is lower than a pre-determined threshold).

[4] Caltrans has provided the CSTDM VMT estimates as a resource for local/regional planning agencies' SB 743 VMT impact assessment. See e.g., https://dot.ca.gov/programs/transportation-planning/multi-modal-system-planning/statewide-modeling/sb-743-vmt-impact-assessment In this project, we used the Version 2.0. data from the Northern California Section Institute of Transportation Engineers.

[5] StreetLight data products have increasingly been used for SB 743 and related projects. See e.g., https://www.citrusheights.net/DocumentCenter/View/16074/SB-743-Implementation-Guidelines-2-8-21 and https://www.townoftruckee.com/home/showpublisheddocument/19032/637871826569430000 No perfectly comparable "home-based" VMT estimates were available. Therefore, in this project, we used 2019 tract-level VMT estimates (based on "Trip Start") obtained from SCAG.

For threshold levels, we used 85 percent of the county average as the baseline based on the recommendation for SB 743 implementation provided by California Governor's Office of Planning and Research (2018).[6] In addition to the baseline, consideration was given to narrower and broader definitions of low VMT areas by employing alternative cutoffs: 80 percent and 90 percent of the county average. While localities are not necessarily likely to use these specific percentages, they have discretion to set or apply their own thresholds of significance for transportation impacts. They can also use the city or regional average as the basis, making it possible for them to apply a relatively more (or less) restrictive threshold level. The 80 and 90 percent scenarios tested in this study were designed to reflect these possibilities and make the analysis more complete.

Table 1. Nine scenarios.

Scenarios	VMT data sources	Thresholds
1. Baseline-CSTDM	CSTDM	< 85% of the county average
2. Baseline-STL	StreetLight Data	< 85% of the county average
3. Baseline-Both	Both CSTDM and STL	< 85% of the county average
4. Narrower-CSTDM	CSTDM	< 80% of the county average
5. Narrower-STL	StreetLight Data	< 80% of the county average
6. Narrower-Both	Both CSTDM and STL	< 80% of the county average
7. Broader-CSTDM	CSTDM	< 90% of the county average
8. Broader-STL	StreetLight Data	< 90% of the county average
9. Broader-Both	Both CSTDM and STL	< 90% of the county average

Methodology

For each scenario, we identified low VMT tracts and investigated how they differed from the other tracts in the county (non-low VMT tracts). More specifically, this investigation was accomplished in two ways: (i) t-test of

[6] According to the California Governor's Office of Planning and Research (OPR) (2018, p. 12),"Residential development that would generate vehicle travel that is 15 or more percent below the existing residential VMT per capita, measured against the region or city, may indicate a less-than-significant transportation impact."OPR recommends map-based screening of residential and office projects because "[r]esidential and office projects that locate in areas with low VMT, and that incorporate similar features (i.e., density, mix of uses, transit accessibility), will tend to exhibit similarly low VMT. Maps created with data from a travel survey or travel demand model can illustrate areas that are currently below threshold VMT. Because new development in such locations would likely result in a similar level of VMT, such maps can be used to screen out residential and office projects from needing to prepare a detailed VMT analysis" (*Id.*, p.10).

mean differences and (ii) logistic regression. The first method compared low VMT and non-low VMT tracts in terms of each of the built environment and socioeconomic characteristics listed in Table 2, revealing distinct characteristics of low VMT tracts, as identified using one of the two data sources with a specified threshold level for each scenario. The second method, logistic regression, was used to identify distinguishing characteristics of low VMT areas after controlling for other factors.

Table 2 provides a summary of the variables used for this investigation and their data sources. We also constructed and tested additional transit and built environment metrics, such as the availability of bus transit services (captured using General Transit Feed Specification (GTFS) data) and detailed land use compositions in each tract, but ds (e.g., tracts with a high percentage of non-Hispanic whites) would more likely be identified as a low VMT location in each scenario even after controlling for the effects of the 5Ds.

Table 2. Variables and data sources.

Dimensions	Sub-categories	Variables	Data sources
Built environment characteristics (5D variables)	Density	Population.Density	SLD
	Design	Road.Density	SLD
	Design	Street.Intersection.Density	SLD
	Diversity	Land.Use.Mix	SLD
	Destination accessibility	Job.Accessibility	SLD
	Distance to transit	HQTA.2016.Pct	SCAG
	Distance to transit	HQTA.2045.Pct	SCAG
	Distance to transit	Near.Rail.Stations.Pct	OCTA
Socio-demographic characteristics	Race/Ethnicity	Non.Hispanic.White.Pct	ACS
	Race/Ethnicity	Non.Hispanic.Black.Pct	ACS
	Race/Ethnicity	Non.Hispanic.Asian.Pct	ACS
	Race/Ethnicity	Hispanic.Pct	ACS
	Socio-economic	Median.Family.Income	ACS
	Other Demographics	Working.Age.Pop.Pct	ACS
	Other Demographics	Children.Pct	ACS

SLD = US EPA Smart Location Database 3.0; SCAG = Southern California Association of Governments; OCTA = Orange County Transportation Authority; ACS = US Census American Community Survey 5-year Estimates, 2015-2019.

Results

Our results, as detailed below, suggest that low VMT locations tend to be high-density areas where many minority populations reside. The two data sources, however, show nontrivial discrepancies, and the model-based VMT estimates (CSTDM) are more likely to identify non-affluent, transit-rich neighborhoods as low VMT locations.

T-test results

Table 3 and Table 4 present the results of the mean difference tests, showing how low VMT tracts differ from the other tracts in the county, for the first two scenarios: 1) Baseline-CSTDM and 2) Baseline-STL. In both scenarios, it is clear that low VMT tracts are densely populated areas in the county. Although not included in the table, all other scenarios showed a similar relationship. Regardless of the VMT data source used, the negative association between VMT (logged) and population density (logged) was strong as seen in Figure 1 (correlation = -0.60 for CSTDM and correlation = -0.51 for STL). In other words, low VMT areas tend to be denser than non-low VMT areas.

Table 3. Mean difference test results – Scenario #1 (Baseline-CSTDM).

Variables	Low VMT (n=142)		Non-low VMT (n=432)		Comparison	
	Mean	StDev	Mean	StDev	Mean diff.	t-stats
Population.Density	25.5	13.0	13.6	6.3	11.9	10.53 ***
Road.Density	25.5	5.3	24.3	6.3	1.2	2.18 *
Street.Intersection.Density	141.6	57.3	135.8	64.8	5.8	1.01
Land.Use.Mix	0.520	0.132	0.510	0.146	0.010	0.77
Job.Accessibility [(a)]	246.0	130.0	159.5	106.9	86.5	7.17 ***
HQTA.2016.Pct	0.761	0.355	0.166	0.317	0.595	17.8 ***
HQTA.2045.Pct	0.837	0.278	0.224	0.351	0.613	21.3 ***
Near.Rail.Stations.Pct	0.020	0.102	0.012	0.064	0.008	0.83
Non.Hispanic.White.Pct	0.178	0.146	0.520	0.202	-0.342	-21.9 ***
Non.Hispanic.Black.Pct	0.016	0.020	0.016	0.016	0.000	0.21
Non.Hispanic.Asian.Pct	0.191	0.169	0.187	0.146	0.004	0.27
Hispanic.Pct	0.594	0.250	0.238	0.163	0.356	15.88 ***
Median.Family.Income [(b)]	70.7	20.9	119.7	40.0	-49.0	-18.8 ***
Working.Age.Pop.Pct	0.687	0.072	0.660	0.073	0.027	3.82 ***
Children.Pct	0.242	0.071	0.207	0.051	0.035	5.48 ***

*** Significant at 0.1% level. ** Significant at 1% level. * Significant at 5% level. (a) in thousands. (b) in thousands of dollars.

Table 4. Mean difference test results – Scenario #2 (Baseline-STL).

Variables	Low VMT (n=302)		Non-low VMT (n=272)		Comparison	
	Mean	StDev	Mean	StDev	Mean diff.	t-stats
Population.Density	19.9	11.0	12.8	6.9	7.0	9.24 ***
Road.Density	24.9	5.5	24.4	6.7	0.5	0.96
Street.Intersection.Density	138.0	54.0	136.4	71.9	1.6	0.3
Land.Use.Mix	0.457	0.124	0.575	0.136	-0.119	-10.91 ***

Variables	Low VMT (n=302)		Non-low VMT (n=272)		Comparison	
	Mean	StDev	Mean	StDev	Mean diff.	t-stats
Job.Accessibility [(a)]	190.8	122.3	170.0	114.4	20.8	2.1 *
HQTA.2016.Pct	0.379	0.445	0.241	0.367	0.139	4.09 ***
HQTA.2045.Pct	0.444	0.448	0.299	0.388	0.145	4.16 ***
Near.Rail.Stations.Pct	0.006	0.055	0.023	0.092	-0.017	-2.71 **
Non.Hispanic.White.Pct	0.376	0.242	0.501	0.220	-0.125	-6.49 ***
Non.Hispanic.Black.Pct	0.014	0.017	0.018	0.018	-0.003	-2.36 *
Non.Hispanic.Asian.Pct	0.193	0.153	0.183	0.151	0.010	0.82
Hispanic.Pct	0.384	0.268	0.262	0.193	0.122	6.32 ***
Median.Family.Income [(b)]	99.0	39.5	117.1	42.6	-18.1	-5.27 ***
Working.Age.Pop.Pct	0.663	0.079	0.670	0.067	-0.007	-1.15
Children.Pct	0.226	0.060	0.203	0.054	0.023	4.78 ***

*** Significant at 0.1% level. ** Significant at 1% level. * Significant at 5% level. (a) in thousands. (b) in thousands of dollars.

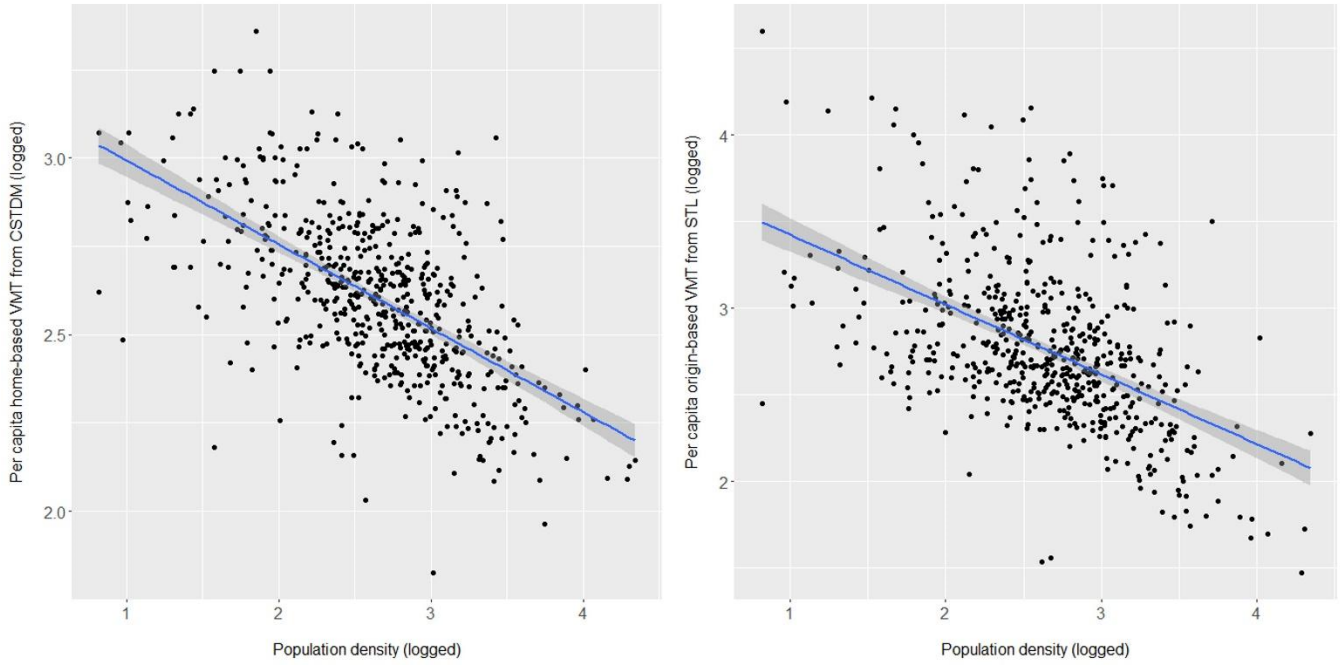

Figure 1. Tract-level density-VM relationships.

The distinct characteristics of low VMT tracts can also be observed through other neighborhood indicators. In both Scenarios 1 (Baseline-CSTDM) and Scenario 2 (Baseline-STL), compared to other locations, low VMT tracts tended to have better job accessibility and more high-quality transit services, captured by the percentage of designated High Quality Transit Areas in 2016 and projected for 2045 (HQTA.2016.Pct and HQTA.2045.Pct, respectively) mainly indicating proximity to high-frequency bus transit services due to the limited availability of

rail transit within the county. In terms of socio-demographics, low VMT tracts had larger percentages of Hispanic residents and children (under 18 years of age). As presented in Table 3 and Table 4, these tracts also exhibited lower median family income levels.

A closer look, however, reveals that there are several notable differences between the results of the first two scenarios. For instance, while both scenarios showed that job accessibility was relatively higher in low VMT tracts than non-low VMT tracts, the mean difference was much larger and statistically more significant in Scenario 1 (Baseline-CSTDM) compared to Scenario 2 (Baseline-STL). This was the case for many other metrics used for comparison, such as the percentage of High Quality Transit Areas in the county in 2016 and 2045 (HQTA.2016.Pct, HQTA.2045.Pct), the percentage of Hispanic residents (Hispanic.Pct), and the median family income (Median.Family.Income). Furthermore, total road network density (Road.Density) and the percentage of those of working age (15-64) in the population (Working.Age.Pop.Pct) showed statistically significant mean differences only in Scenario 1. In the case of Scenario 2, low VMT tracts showed higher levels of mixed land uses (Land.Use.Mix)[7] and proximity to Metrolink rail stations (Near.Rail.Stations.Pct), suggesting that the contribution of land use mix and transit to reducing VMT might be questionable in this study region, although alternative indicators of land use mix and transit can yield somewhat different results.

Similar differences between the two VMT data sources were found when Scenarios 4-5 (low VMT = < 80% county average) and 7-8 (low VMT = < 90% county average) were compared. In fact, the use of CSTDM and STL datasets offered distinct tract-level VMT distributions, as demonstrated in Figure 2. Since the distribution was more skewed when STL data-based VMT metrics were used, this data source made it possible to have a relatively larger number of low VMT tracts for the same percentage-based threshold level. Our logistic regression results presented below provide more information about the differences between the two data sources and resultant discrepancies in identifying low VMT tracts.

[7] For land use mix, in this project, we used the U.S. EPA Smart Location Database 3.0's D2A_EPHHM, an entropy-based indicator that captures the extent to which occupied housing and employment locations (5 types) are mixed.

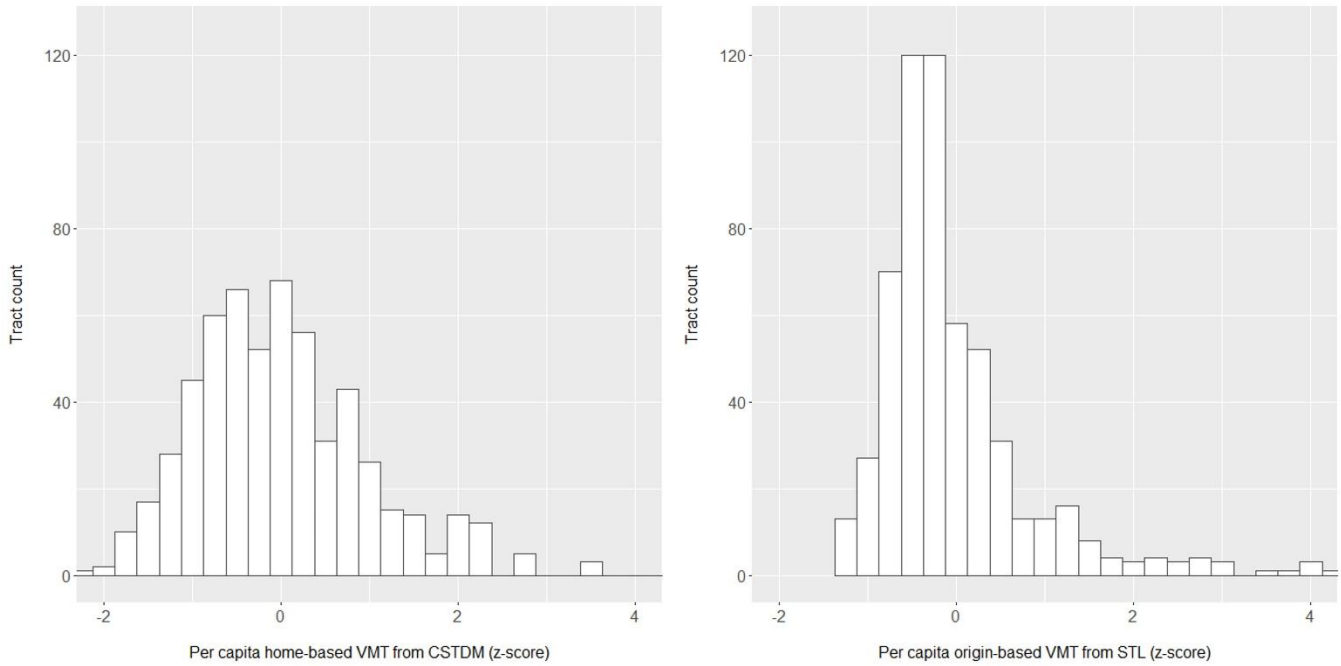

Figure 2. Tract-level VMT distributions.

Logistic regression results

Table 5 and Table 6 present two sets of the logistic regression results with built environment (5D) variables: 1) Baseline-CSTDM and 2) Baseline-STL. Consistent with the t-test results, in both cases, a higher population density was found to significantly increase the probability of a tract being identified as a low VMT area. Specifically, in Scenario 1 (Baseline-CSTDM), a one standard deviation increase of population density (logged) was associated with an increase of 285 percent in the odds of a tract being a low VMT area. In the case of Scenario 2 (Baseline-STL), the odds increased by 170 percent.

Table 5. Logistic regression results – Scenario #1 (standardized coefficients).

Variables	Estimate	Std. Error	Z value	Significance
(Intercept)	-2.188	0.209	-10.47	***
Population.Density	1.348	0.236	5.70	***
Road.Density	0.141	0.290	0.49	
Street.Intersection.Density	-0.570	0.276	-2.06	*
Land.Use.Mix	0.035	0.172	0.20	
Job.Accessibility	0.654	0.149	4.39	***
HQTA.2016.Pct	0.545	0.226	2.42	*
HQTA.2045.Pct	1.037	0.258	4.02	***
Near.Rail.Stations.Pct	-0.041	0.125	-0.33	

*** Significant at 0.1% level. ** Significant at 1% level. * Significant at 5% level.

Table 6. Logistic regression results – Scenario #2 (standardized coefficients).

Variables	Estimate	Std. Error	Z value	Significance
(Intercept)	0.163	0.103	1.58	
Population.Density	0.994	0.165	6.01	***
Road.Density	-0.295	0.193	-1.53	
Street.Intersection.Density	-0.036	0.196	-0.18	
Land.Use.Mix	-1.143	0.134	-8.53	***
Job.Accessibility	0.115	0.104	1.11	
HQTA.2016.Pct	0.194	0.209	0.93	
HQTA.2045.Pct	0.189	0.207	0.91	
Near.Rail.Stations.Pct	-0.252	0.126	-2.00	*

*** Significant at 0.1% level. ** Significant at 1% level. * Significant at 5% level.

Other 5D variables, however, showed dissimilar results. In Scenario 1, job accessibility turned out to have a statistically significant, positive association with the binary dependent variable indicating low VMT tracts even after controlling for population density and other variables. This was the case in Scenario 7 using the same VMT data source (CSTDM) with an alternative threshold (< 90% of the county average). However, job accessibility exhibited insignificant coefficients in all the three scenarios using the STL-based VMT metrics to identify low VMT tracts (i.e., Scenarios 2, 5, and 8).

A similar pattern of discrepancies between the two VMT data sources was detected for high-quality transit service variables. While both the percentage of High Quality Transit Areas in 2016 and 2045 (HQTA.2016.Pct and HQTA.2045.Pct) had significant positive coefficients in Scenario 1, the two variables were insignificant in Scenario 2. This was true when a broader definition of low VMT tracts was employed (i.e., Scenario 7 vs. Scenario 8), although the discrepancies became a bit smaller with a narrower definition (i.e., Scenario 4 vs. Scenario 5). In other words, when the CSTDM estimates were used to identify low VMT locations, the results were more likely to be aligned with the widely held assumption that the 5D factors could reduce VMT, and this might happen because the travel demand model might take all or most of the built environment and transit attributes into account in generating VMT estimates. The STL data, however, appeared to suggest that real VMT patterns might be substantially different from the model estimates at least in our study region, although the results may to some extent be attributable to the way it captured VMT (based on trip origins without differentiating home-based and other types of travel). While population density turned out to be a strong predictor of low VMT locations, the effectiveness of other dimensions of the built environment was unclear.

Table 7 summarizes the results of logistic regression with socio-demographic variables. As mentioned in the Methodology section, these socio-demographic variables were added one by one to our logistic regression model with the eight 5D built environment variables, and the model was estimated for each of the nine scenarios.

Table 7. Summary of logistic regression results with socio-demographic variables (standardized coefficients).

Variables	Scenarios								
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**
Non.Hispanic.White.Pct	-1.30 ***	-0.26	-1.50 ***	-1.25 ***	-0.25	-1.19 **	-1.34 ***	-0.47 **	-1.59 ***
Non.Hispanic.Black.Pct	0.11	-0.36 ***	0.05	-0.38 *	-0.25 *	-0.38	0.05	-0.36 ***	0.00
Non.Hispanic.Asian.Pct	0.23	0.07	0.39 *	-0.26	-0.01	0.02	0.70 ***	0.12	0.59 ***
Hispanic.Pct	0.66 **	0.23	0.43	1.25 ***	0.36 *	0.75 **	0.38	0.42 *	0.34
Median.Family.Income (logged)	-0.59 *	-0.13	0.09	-0.59 *	-0.22	-0.16	-1.06 ***	-0.22	-0.42
Woring.Age.Pop.Pct	-0.03	-0.40 **	-0.10	0.00	-0.51 ***	-0.35	-0.18	-0.47 ***	-0.14
Children.Pct	-0.11	0.15	-0.21	-0.11	0.14	-0.38	-0.21	0.30 *	-0.06

*** Significant at 0.1% level. ** Significant at 1% level. * Significant at 5% level.

As demonstrated in the table, among others, tracts with higher percentages of non-Hispanic whites (Non.Hispanic.White.Pct) were found to have a significant, negative association with the probability of a tract being identified as low VMT areas in seven out of the nine scenarios. The two scenarios where there was no significant difference between low VMT and non-low VMT tracts in terms of percent of non-Hispanic whites were those not using CSTDM estimates but using the STL data (Scenarios 2 and 5). Similarly, affluent tracts (Median.Family.Income) were less likely be identified as low VMT areas with 5D variables held constant. However, this relationship was statistically significant only in the three scenarios using CSTDM estimates (Scenarios 1, 4, and 7).[8] In other words, different VMT data sources lead to different results, and one notable

[8] In Scenarios 2, 5, and 8 using STL, Working.Age.Pop.Pct (aged 15 to 64) was consistently found to be a significant predictor. On average, this population group may drive more than other age groups, and the STL-based VMT metrics seemed to capture this pattern.

pattern found in this study is that using model-based (CSTDM) estimates tends to identify low VMT areas with more low-income residents.

From an equity perspective, these patterns, viewed in light of the favor given to low VMT locations, pose problems. Given the way in which per capita VMT levels, particularly the CSTDM estimates, are associated with certain socio-demographic characteristics, such efforts can disproportionately burden less affluent neighborhoods with larger minority populations by focusing development in these areas. If low VMT areas are simply defined on a per capita basis, this type of problem is somewhat unavoidable as long as certain groups of residents tend to drive more than others. Even more problematic would be if per capita VMT estimates were generated in a way that overestimated inter-group differentials and thus directed attention away from high-income areas as promising locations for more housing.

Expediting residential development might be essential for expanding housing opportunities in a timely fashion, and locations with low per capita VMT levels in the past can be seen as promising targets for expedited development without lengthy reviews. However, as shown in this section, there are data challenges that make it difficult to identify such locations precisely and efficiently. Focusing development in such locations may also have significant equity implications that deserve more attention.

Anti-Displacement Strategies in VMT Reduction Through Non-Rail TOD

Background

The idea supporting transit-oriented development (TOD) is that making housing and mixed-use development available in close proximity to one another and to transit nodes can help reduce VMT in two ways: through creating communities with amenities (shops, essentials, etc.) within walking distance while provide key transit links to the rest of the region. There is some evidence that TOD and other compact development can reduce driving trips (see e.g., Ewing and Cervero 2010; Nasri and Zhang 2014; Ewing et al. 2015; Park et al. 2018), though the effects vary across socioeconomic status with higher-income people tending to reduce their VMT more (Zamir et al. 2014; Chatman et al. 2019). Some studies have also found that just having greater rail access may not by itself result in lower VMT, but that other policies and regulations that make it more difficult to drive or easier to walk likely contribute to less driving (Chatman and Klein 2013).

Because TOD concentrates development, aiming to provide housing, nearby amenities and convenient access to other destinations, there has long been concern that it results in increased land and housing value which has the potential to displace lower-income residents through gentrification (see e.g., Kahn 2007; Rayle 2015). The evidence of such a relationship is not strong: a systematic review of 35 studies conducted between 2008 and 2018 finds mixed evidence that TOD leads to gentrification, with only a few highly rigorous studies (Padeiro, Louro, and Costa 2019). A panel study of low-income movers over 40 years found no evidence of transit-related displacement, but notes that low-income households are more likely to move regardless of where they live (Delmelle and Nilsson 2020). A more recent longitudinal study adds evidence that TOD is associated with proximity to gentrifying areas controlling for neighborhood socioeconomic and design factors (Chava and Renne 2022). An important point to note in this research area is that effects are highly heterogeneous and context dependent.

Most research on TODs and gentrification or displacement focuses on rail-based development. There is comparatively less research examining the relationship between bus-based TOD, where development is located along bus rapid transit (BRT) corridors, and population change. A national scan of BRT systems concluded that development and job locations are associated with the presence of BRT systems, but there was limited change in population or housing characteristics (Nelson et al. 2015). Similar reviews from a global perspective found high variability between land values—a precursor to gentrification—and BRT across the systems analyzed (Stokenberga 2014; Venter et al. 2018), yet most cities had not used BRT to spur or manage development (Cervero and Dai 2014). Along the most highly patronized BRT line in the United States, the Los Angeles Metro Orange Line, signs of gentrification (rising home and rent prices and educational attainment) were stronger compared to nearby control areas (Brown 2016). Recent quasi-experimental evidence shows a lower likelihood of gentrification within BRT service areas compared to rail-transit areas (Qi 2023). Other evidence shows

variation in whether properties appreciate or depreciate near BRT lines, with a higher likelihood of increased value near systems with dedicated bus lanes rather than near "BRT-lite" systems, which have many similar characteristics to full BRT systems but generally operate in mixed traffic (Acton, Le, and Miller 2022). Thus, BRT-based TOD could yield more opportunities for equitable development compared to rail-based TOD, but evidence in the research and practice is too limited to conclude so with certainty.

Research Approach

We began this study with a review of the academic and gray literature for research and practical guidance on anti-displacement strategies within transit-oriented development (TOD) or other urban densification projects and programs. Where possible, we focused on strategies relevant to bus-oriented development. Authors included academic researchers and research centers, regional governments, and non-profit organizations. Findings from the literature review informed the development of our interview guide in the second phase of this work. The literature search included terms related to anti-displacement strategies, gentrification, equitable TOD, vehicle miles traveled (VMT) reduction, and non-rail or bus housing densification. We preferred California-based examples of implemented TOD anti-displacement strategies and policies. However, given the long timelines for demonstrating effects from newer projects, we also analyzed some other state and international examples for their insight.

From the review, we developed a matrix of anti-displacement policy strategies (see Table 8) that included our analysis of their relationship to transit development strategies, barriers to implementation, and an evaluation of their positive and negative aspects. These strategies are not specific to BRT-focused development; instead, they reflect broadly applicable approaches to any major transportation investment that improves access in a particular location.

In the second phase of this research task, we identified housing experts within California to seek their perspectives on strategies to lower vehicle miles traveled through denser development around areas without rail transit, while enhancing anti-displacement efforts. We interviewed eleven respondents identified as subject matter policy experts, policy creators, policy implementers, and policy advocates. The interviewees represented academic institutions; state, regional, and local government agencies; state commissions; development corporations; and community-based organizations. Interviews were tailored to the individual's role, but in general included questions about state goals for vehicle miles traveled (VMT) and greenhouse gas (GHG) reduction, challenges with TOD as an equitable housing solution, and a discussion about early empirical findings from the other tasks in this research. We reviewed our list of anti-displacement strategies for validation with each of the interviewees. Interviews were scheduled for about 60 minutes, were held over Zoom, and auto-transcribed by a video conferencing software service. We reviewed each transcript for salient points, then summarized the set of interviews for themes related to the research questions.

Strategies to Prevent Transit Oriented Displacement

The review we conducted identified 11 strategies that have the potential to mitigate displacement pressures. A summary of the strategies is shown in Table 8.

Table 8. Matrix of anti-displacement strategies presented to interviewees.

Strategy	Definition	Stakeholders
Production of affordable housing units through market leveraging or public investment	Jurisdictions generate affordable housing funds through impact fees, generate units through inclusionary zoning requirements for market-rate developments (ex. density bonus), subsidize development with greater allowable density/height	Government, developers
Preservation of affordable housing units	Extend the affordability of subsidized or unsubsidized rental homes	Government/Housing authority, private owners
Community-controlled affordable housing units	Non-government organization (NGO) acts as a developer and maintains affordability through funding such as a community development financial institution (CDFI)	NGOs
Condominium conversion restrictions	Employ a set of tools (focused on people and place or housing units) so residents can remain in their neighborhood undergoing change	Government agencies, landlords
Just cause eviction ordinances	Limit reasons for which landlords can evict tenants along with rent regulation	Local government, landlords
Rent regulation/control	Policies that set maximum annual rent increases and provide tenants with a clear track/process to dispute rent increases	City/Local Government, landlords
Community land trusts	Land acquired and held by a nonprofit, removed from the real estate market to ensure permanent affordability for residential or commercial tenants	Nonprofit corporations, developers, local government
Develop region-wide funding to fill subsidy gaps (Ex. Transit Oriented AF Fund)	Metropolitan Transportation Commission (MTC)-funded regional housing finance programs that support the production and preservation of affordable housing near high-quality transit	Public-Private Partnership: MTC, CDFI, banks, foundations

Strategy	Definition	Stakeholders
Encourage new housing development by eliminating parking requirements for new housing near transit	Assembly Bill 2097 prohibits a public agency from imposing minimum vehicle parking requirement on residential, commercial, or other development projects that are located within 1/2 mile of public transit	Developers
Develop region-wide funding to fill subsidy gaps (Ex. Transit Oriented AF Fund)	MTC-funded regional housing finance programs that support the production and preservation of affordable housing near high-quality transit	Public-Private Partnership: MTC, CDFI, banks, foundations
Develop affordable housing overlay zones	Local government adds an additional zoning layer over the existing base designation to include incentive packages to encourage developers to include affordable housing in their projects	Local government
Residential community benefit agreements	Contracts between community organizations and developers for the commitment of investments in or to provide benefits for a community in exchange for support for the project	Community organizations, developers (for private community-based agreements (CBAs), government (for public CBAs)

Chapple and Loukaitou-Sideris (2019) summarize TOD-related anti-displacement policies into four categories: production of affordable housing, preservation of affordable housing, neighborhood stabilization, and prevention of commercial displacement. We focused our review on the first three categories, which deal primarily with residential displacement. We also examined emerging literature on zoning and policy mandates related to parking and accessory dwelling units (ADU). We drew on this background information and framework as a starting point to describe these strategies, supplemented with more recent research and policy papers.

Affordable housing production

The production of affordable housing works to prevent displacement by increasing the available supply of subsidized housing units. Development can be subsidized through policy instruments based on market mechanisms or through direct public investment. Common market-related strategies for encouraging affordable housing development include inclusionary zoning requirements, which mandate that a certain

number of units in a housing development be created as affordable, and density bonuses, which offer developers the opportunity to build at higher densities than would be allowed under zoning laws in exchange for providing subsidized housing units (Chapple and Loukaitou-Sideris 2019). For example, evidence and analysis from Los Angeles suggests that the city's Transit Oriented Communities Incentive Program, which includes elements of inclusionary zoning and density bonuses for developments near transit, spurred a significant number of building permits that included affordable housing units (Zhu et al. 2021). However, some have found that public policy mechanisms meant to spur market development in TODs, such as tax-increment financing, do not produce investment in communities of color, excluding long-standing communities from their benefits (Purifoye 2020).

Affordable housing production is not limited to for-profit or large non-profit developers. Community-controlled or community-based organizations may participate in development through community development financial institutions (CDFIs), which may be willing to offer loans to entities which might otherwise have difficulty obtaining financing, because they possess local knowledge that can support more favorable risk assessments (Russak 2015). Government entities may also provide grants and loans for affordable housing in transit-oriented developments. In California, the Affordable Housing and Sustainable Communities program, funded through the Greenhouse Gas Reduction Fund, provides funding for housing development along transit corridors in disadvantaged communities (Russak 2015). Several cities have programs to lower the cost of affordable housing development in support of equitable TOD. Although more common outside the United States, transit agencies in places like Denver, Seattle, and Portland have sold land at discounted prices to private developers or purchased properties themselves to spur affordable housing development near transit (Thomas and Bertolini 2020). In other locations, such as the San Francisco Bay Area, Los Angeles, and Indianapolis, public, non-profit, and private partnerships have established financing programs to help lower the cost of developing affordable housing units (Association of Bay Area Governments 2014; Thomas and Bertolini 2020).

Affordable housing development in conjunction with transit needs higher density to ensure adequate transit patronage, yielding a moderate likelihood of contributing to gentrification. Value increases associated with more accessibility and proximity to transit could mean that affordable housing becomes harder to build without strong regulations and incentives. Affordable housing production thus requires complementary strategies to ensure adequate supply for lower-income residents.

Preservation of affordable housing and neighborhood stabilization

Neighborhood stabilization strategies are concerned with keeping existing residents in place. A wide variety of strategies fall into this category, including affordable housing preservation, eviction and rent control regulations, community benefit agreements, and community land trusts.

One way to preserve affordable housing is to extend the length of time a rent subsidy is in place or to encourage non-profit entities to purchase properties about to become unaffordable because a subsidy is about to expire (Chapple and Loukaitou-Sideris 2019). Limited funding to continue to support affordability

protections is one of the primary challenges to maintaining affordable housing units in transit-rich neighborhoods (Reconnecting America 2012). A detailed case study of the TOD experience in Connecticut shows that limited data on the locations of locally subsidized affordable housing has hindered the ability to assess the need for development and preservation (Ray, Garrick, and Atkinson-Palombo 2022). While preserving affordable units does not increase density at transit nodes or along transit corridors, it is a critical tool in ensuring stable numbers of housing units available for low-income residents.

Rent control regulations limit the rate of yearly rent increases for present tenants, protecting against market-rate increases that might otherwise displace low-income renters. There are conflicting scholarly views on the effectiveness of rent control policies; while they tend to keep residents in place longer than comparable locations without rent control, they also yield market inefficiencies and may encourage landlords to remove rent-controlled units from the rental market altogether, thereby reducing the overall affordable housing supply (Chapple and Loukaitou-Sideris 2019; Diamond, McQuade, and Qian 2019). A study using scenario modeling with an integrated land-use and transportation model suggests that rent control in TODs is less effective than inclusionary housing policies in ensuring a supply of units available for lower-income households (Dawkins and Moeckel 2016).

Like rent control, protection from evictions for reasons other than "just cause" can be an important anti-displacement tool for lower-income tenants. There is limited evidence that evictions are higher in transit-rich neighborhoods, however. A case study of four U.S. cities based on eviction filings yielded limited evidence of transit-induced displacement (Delmelle, Nilsson, and Bryant 2021). Anti-eviction policies appear to be less popular than other housing preservation strategies; in a survey of San Francisco Bay Area cities and counties in 2015, only six percent of jurisdictions had a just cause eviction ordinance (Chapple and Zuk 2020).

Other neighborhood stabilization strategies involve community-centered strategies. Community land trusts (CLTs) are non-profit entities that hold land in trust for a community for purposes of affordable housing development or preserving other community assets. CLTs can be an important means of ensuring affordability near transit as has been done in Atlanta, Denver, and the Twin Cities region, but face challenges in developing new rental housing (Hickey 2013). Partnerships can help ensure the success of CLTs, however. For example, a land trust teamed up with an affordable housing developer in Los Angeles to purchase a development with expiring affordability covenants to ensure affordability in perpetuity on a transit-adjacent site (Kim and Eisenlohr 2022). Community benefits agreements (CBAs) involve coalitions of community residents and the public sector in crafting agreements with a (potentially) transformative project developer to ensure benefits such as jobs and affordable housing are made available to the community (Feinstein and Allen 2011). CBAs may sometimes go hand-in-hand with TOD to ensure some guarantee of affordable housing development on the project site, though this type of development is not always guaranteed by the CBA (Wolf-Powers 2010; Marantz 2015).

Zoning and Parking Reforms

In recent years, California has passed legislation to make it easier to build housing near transit through parking and zoning reforms. Two such laws are AB 2097 (2022), which essentially eliminates parking requirements within a half mile of transit, and SB 9 (2022), which requires cities to permit lot subdivisions that add up to three additional units of housing in single-family residential areas (for a total of four). Together, these laws aim to make more land available for more housing. Some object that removing parking requirements will not guarantee developers will build affordable housing, and that constructing new homes in single-family neighborhoods will have negative parking impacts, but there is scant evidence that either circumstance is true (Manville and Smith 2022; Volker and Thigpen 2022). Parking requirements do add to the cost of low-income housing; evidence suggests that they contribute about $36,000 to per-unit construction costs in California (Reid 2020).

ADUs create opportunities for low-income housing, as they tend to be smaller than single-family homes and therefore more affordable. In the absence of affordability requirements, however, ADUs have tended not to fill actual low-income housing needs (Ramsey-Musolf 2018). Evidence suggests that in Los Angeles, an ADU ordinance helped attract new construction to areas with higher bus transit accessibility (Kim et al. 2023), demonstrating potential for bus-oriented TOD.

Interview Findings

Major issues in transportation and housing

There was a general consensus among the interviewees that the major issues in transportation and housing in California were the twin challenges of climate change and housing affordability. Nearly everyone described the undersupply of housing leading to a limited number of affordable homes for low-income individuals, which has only been exacerbated in recent years as housing costs have increased substantially. Policy goals related to VMT reduction and personal preferences for compact living mean that much effort in planning for new housing is occurring through urban infill, but many interviewees agreed that questions remain about how to develop such housing without the risk of gentrification and displacement of the people who already live in those neighborhoods. Several recognized the need to develop affordable housing near high-quality transit as the need to meet state goals to reduce VMT requires ensuring people can access jobs and other daily needs through alternatives to the private automobile. When housing is unaffordable in highly accessible locations, lower-income individuals must drive more to make up for the lack of walkable and transit-connected destinations.

While affordable housing development in TOD was seen as an important strategy for meeting both housing and climate goals, many agreed that this kind of development has its challenges. One policy creator described the lack of connection between housing and transportation, and the inequities in access to opportunities, as a reflection of the systemic racism embedded in historic urban policy:

> What does equity mean? To have equitable access to things? Housing is by far one of the prime indicators that we're seeing as creating really inequitable processes and access to things. And so when you look back at systemic racism and policies in this state, it is, I would say, through colonization—forced removal of people on ancestral land and forced use of slave labor—and not atoning to those two things and then creating large systemic policies that have really decimated populations and the ability for equitable economic opportunities through housing restrictions, through redlining...and then later, bulldozing and tearing down communities, for the sake of building west and infrastructure and mobility. And so, I see these two kinds of spaces, housing and transportation, as interconnected. The intersections of needs are prevalent.

A policy expert spoke of the multiple tensions in developing affordable housing near transit. Prioritizing housing near high quality transit can provide access by creating a better jobs–housing balance, but evokes a "bifurcated response both in terms of people who are resisting that because they don't want to spoil their views and then also communities who are resisting that because they're concerned about gentrification and displacement." This interviewee noted that merely providing subsidized or permanently supportive housing near transit did not guarantee access to key destinations, particularly if the transit network did not reach the places they needed to go.

Another policy advocate who worked in a low-income, transit-rich community noted that priorities to attract transit riders were sometimes at odds with the needs of existing riders who depended on transit. This person noted that goals to reduce single occupancy driving often meant catering to higher-income "choice" riders by creating service changes that disadvantaged lower-income riders.

GHG reduction

California's aggressive greenhouse gas (GHG) reduction targets have led to a significant policy emphasis on housing–transportation connections. At the local level, policy implementers described efforts to ensure both market-rate and affordable housing were developed in locations near high-quality transit so residents could live "in areas that will connect them to the region." Converting parking lots to housing and mixed-use development was one strategy described to reduce incentives to driving while providing infill housing. At the state level, policy creators described collaborative efforts across agencies to strengthen the housing and transportation links through planning, programming, and policy efforts. Some of these strategies involved ensuring that regional and local agencies paid closer attention to the impacts of land use decisions and their connections to VMT generation or other impacts that may be counter to GHG reduction goals. One policy advocate described their organization's efforts to encourage adoption of electric vehicles, with targeted efforts towards low-income drivers, as a transportation-focused solution to lower GHG emissions, complementing other housing advocacy work. A policy implementer noted the need for parallel policy, such as converting to a VMT tax from the gas tax to ensure that those driving more efficient cars, who tend to be higher-income earners, do not have "an unfair advantage to people who are already disadvantaged."

Yet these goals can come in conflict with equity priorities. One policy expert noted that efforts that attend to the needs of disadvantaged communities may be instead adding burdens in the name of equity:

> One of the ways that equity ends up getting translated—and I would say kind of mistranslated—is putting a focus on disadvantaged communities or low-income communities but really asking, "How do we get them to change their behavior? How do we get them to buy electric vehicles or use public transit?" And that approach doesn't really put as much of the burden on people who maybe have more choices actually making different choices.

A policy creator agreed in sentiment, noting a "disconnect" between VMT reduction goals and equity:

> VMT reduction is also good in theory but in terms of equity, there is a disconnect. People who have the least amount of access need to be dependent on their older vehicles. When we think about VMT reductions, who should actually be reducing VMT? Should we really think about the folks that have been underresourced, underfunded, underserved for eons, then placing restrictions and requirements to reduce VMTs when we don't have adequate public transit systems readily available, or we don't have alignment of our infrastructure that makes it safer for pedestrian and bike infrastructure?

Several interviewees emphasized that siloed thinking at the individual level may be hampering efforts to think creatively about housing–transportation links and GHG reductions. One policy expert noted that many transportation professionals and researchers do not deeply understand the challenges of creating and financing affordable housing or the issues that low-income households face when it comes to housing. This interviewee also discussed the need for societal change in expectations about what kinds of housing they get to live in and how they travel to meet their daily needs. Several interviewees discussed the need for better coordination between state agencies and funding programs to ensure housing in the amounts needed can be provided. However, one policy implementer noted that there may be too much emphasis on VMT reduction as a means to reduce GHGs, and not enough holistic thinking about stationary emitters or other solutions, like broadband access that provides connectivity without transportation.

The role of bus rapid transit and TOD in densification

Policy experts, creators, and implementers agreed on the importance of TOD as a strategy to increase residential density with the aim of reducing driving. Some noted that in addition to providing options for travel via transit, TOD makes it easier to have options for cycling, walking, and multimodal transportation. However, most cautioned that TOD could not be the only strategy to do so. Building more housing near transit makes sense, but housing densification and mixed-use development needs to occur in more places so that people have the option of taking shorter and fewer vehicle trips, or as one policy expert noted, "if we focus solely on transit as a place for housing densification, we are going to fail."

Others noted the complexities associated with development around TOD or other kinds of infill development, whether because it increases apparent displacement pressures on residents who live in such neighborhoods or because there was more incentive to build on the urban fringe where land costs are lower and construction is

easier. Some policy advocates also brought up concerns that the state's goals around housing development and residential density were too much of a "one size fits all" approach; the kinds of development that made sense in transit-ready, middle-income neighborhoods were not as equally likely to work in rural parts of the state or in low-income, dense urban neighborhoods already well-served by transit. As one policy implementer described it:

> The main issue is we need to give people alternatives. In the planning field there is the argument, if you build it and they will come which is not necessarily true. Building TOD in the middle of nowhere, for example, doesn't work. We need to provide transportation alternatives or else it's not going to work.

Most interviewees described the importance of bus rapid transit (BRT) and bus transit more generally in creating places where people can drive less. Several noted the importance of bus service as a particularly critical transportation link for lower-income individuals and people of color. Others described instances in which only bus service might be appropriate; for example, one policy creator noted that even marginally denser development in rural areas would be possible with regional bus services to important nearby destinations, such as grocery stores or healthcare in larger communities.

However, several interviewees described challenges with lifting up bus-oriented development as a strategy. One policy expert noted a professional bias toward investing in rail, noting that "we spend too much money and time on fixed rail and not on other options." A policy creator noted how bus transit has been "stigmatized," which created many "hurdles and challenges [for] folks viewing it as an option beyond transit dependency." Another policy expert described a deep-seated preference against bus transit with broader negative consequences:

> It's a normalized idea that people don't want to ride buses. They're more interested in riding trains. And so if you're trying to bring new users onto transit, then you should be investing in trains. There is evidence that that idea and strategy is harmful in terms of creating disinvestment in areas that rely on bus service which tend to be communities of color and low-income communities.

A policy advocate explained why this preference might be the case, describing how some low-income residents of her community cheered the opening of a light rail line because it was more reliable than the previous bus service along the same route.

Many interviewees saw positive potential for implementing housing development around BRT. When ridership does not merit investment in rail infrastructure, BRT can serve a similar role as a fixed-route transit service on rubber tires. Several policy implementers emphasized, however, that such service would need to be "true BRT," having characteristics such as operation along a separate route rather than in mixed traffic, traffic signal preference, prepaid fares, and level boarding. True BRT in the United States is rare—one policy expert described it as having "had a moment and then set aside"—with rapid, skip-stop service being more likely to be implemented. But in Los Angeles, which has a true BRT service, the city made strides to ensure that development near BRT stops would qualify for affordable housing incentives just as they would around rail nodes, as a policy implementer explained. The state definition of a high-quality bus transit node that the city applied to their Transit Oriented Communities program originally required the intersection of two bus routes, a

requirement that BRT did not meet. Now, BRT does not need to have an intersecting route to qualify, elevating its status above regular bus lines and recognizing the importance of the service. A San Francisco policy advocate noted that even though their city has not had an explicit affordable housing development strategy along bus routes, several high-frequency bus lines that run near affordable housing tend to be highly used, suggesting that dense development along non-BRT routes is possible under certain conditions.

Some interviewees shared that, even if TOD were oriented along BRT, service would have to meet the needs of a diverse audience. Both a policy creator and expert remarked that transit does not always "go to the right places at the right time"; a BRT system that met the needs of lower-income workers would have to shift focus away from commute service to the central business district and connecting people to suburban locations.

Displacement prevention

We asked interviewees about options for preventing displacement when increasing density around transit. A policy expert immediately challenged us on the premise that TOD leads to displacement:

> I think there's a lot we don't know about this. I think that what we do know about this is deeply flawed methodologically. And I think that there's a lot of conflation between different terms. To me there is a distinction to be made between the studies that show that transit investments can increase house costs or house prices—that is different from increasing the density around transit with housing, and I don't believe any of the studies that show that increasing housing supply around transit leads to displacement. I'm open to the idea that that could happen. I have not seen a convincing study that uses a strong methodology to show that when there is an increase in housing supply around a transit station, that there is true evidence of displacement. All the good studies I've seen show that increasing housing supply leads to at least [no change] or some reductions in rents and actually an expansion of the number of families who can move in as opposed to the numbers of families who are pushed out. I don't think we have nearly enough research on it, so I'm sure that the local context matters, the local neighborhood matters. The other policies that are in place matter, all of that's going to make a difference in terms of those outcomes. But I don't think that increasing housing supply around transit necessarily leads to displacement. I think that it often doesn't based on the evidence we know.

Nevertheless, policy creators, advocates, and implementers saw the need to protect against potential transit-related displacement from new development, whether real or theoretical. The high cost of housing warranted attention to ensuring that very low-income to moderate income earners could afford to live and benefit from TOD, as some policy advocates described. A policy creator emphasized the need for transit agencies to pay closer attention to the potential "direct and indirect displacement" effects of their projects, such as through right-of-way acquisition; their agency is planning to add guidelines to project development criteria that requires project implementers to consider those kinds of impacts. Similarly, another policy creator identified the need for "displacement avoidance plans or anti-displacement plans in connection with large capital investments" and to be developed with extensive community input. Many interviewees broadly emphasized the need for extensive community engagement in the TOD process. Other policy creators pointed to the need

for metrics to identify focal areas where anti-displacement efforts should be concentrated. For example, SB 50 (2019), the failed California Senate bill that would have required cities to zone for higher density near transit, would also have protected "sensitive communities" from immediate upzoning. Instead, sensitive communities, defined in terms of poverty rates, residential segregation, and other indicators of disadvantage, could participate in community-led planning processes around housing development. Similar strategies could be employed when proposing TOD in disadvantaged communities.

Even with anti-displacement plans and strategies, some interviewees recognized that market forces can be hard to counteract when developing affordable TOD. As a policy implementer described it, displacement comes with the territory of living in a capitalist society. A policy creator spoke of a particular development challenge:

> Where you are seeing large transformative plans for transit development, the real estate industry comes in and swoops up available land and holds out on that land until they would like to develop it themselves or turn it over for a very large profit, knowing that the entity is going to have to buy that land back. This limits what the entity is able to do if they're having to pay such a high cost for that land to increase housing.

Given the inevitability of the market displacing people through one mechanism or another, a policy implementer noted there is often not enough planning emphasis on meeting the needs of people in the places they get displaced to; more should be done here.

Anti-displacement strategies

As described earlier, we asked our interviewees to reflect on the potential efficacy of the anti-displacement strategies in Table 8. Unsurprisingly, perspectives on efficacy differed according to the roles that the interviewees played. Policy advocates emphasized community-controlled affordable housing development as an important anti-displacement strategy and a positive investment in communities. This approach requires a strong community partner, either with a non-governmental organization as a developing partner or through a community development financial institution (CDFI) as backer. There was also a strong voice for just cause eviction ordinances and reforming rent control as important anti-displacement (rather than affordability) strategies. State law places limits on which units rent control can be applied; one advocate called for using rent control as a developer incentive to protect certain housing units in conjunction with the state density bonus. There was some minor disagreement on the benefits of AB 2097 (eliminating parking minimums in transit areas). While interviewees generally agreed on the benefits of reducing parking spaces, one advocate spoke of the downside of limiting parking availability in certain vulnerable communities:

> Where we see this being a problem, or where we see some pushback from tenants, is in neighborhoods that are experiencing violence or where the sense of community safety is lower. [In places] where people feel unsafe on the street, and therefore tenants are more likely to acquire a car or have a car, there are therefore a handful of buildings where people say, "You need more parking spaces in this affordable housing complex, because I don't feel safe walking on the street."

Another point of disagreement was in the efficacy of using market leveraging to produce affordable housing units. While development of market-rate housing is necessary to increase overall housing supply, there was skepticism that this would actually result in enough affordable units. The policy advocate from San Francisco described the situation this way:

> There's a little bit of a narrative at the state level, and even locally, that therefore, every market rate development is inherently good, because it contributes to the building of affordable housing. Development is good because we should build the housing that we need. If we look at San Francisco, it's an astonishing number of units, but the majority of that have to be accessible to extremely low income and low-income residents. And so we should make sure that we go beyond what we've done in the last two RHNA (Regional Housing Needs Assessment) cycles, which is blow through our market rate goal, and not build enough affordable and middle income housing in San Francisco. And you know we've tried that path where we are like, every development is good because they pay fees. They do things that then help us build affordable. But in reality, what we've seen is we overproduce market rate [units], and we underproduce affordable when it comes to preservation. I think it's one of the most cost-efficient opportunities.

Policy implementers were less vocal about how effective options in our matrix of strategies would be. One planner did speak of the work Los Angeles was doing or proposing to limit displacement and incentivize affordable housing development, such as strong just cause eviction ordinances, an affordable housing zoning overlay, and focused housing replacement policies. This person noted, however, that funding was necessary but limited to carry out these strategies. One spoke of the role of more public housing in guaranteeing affordable places to live for lower-income individuals. Another planner thought that regulating housing speculation was more important than plans to increase density when addressing anti-displacement and affordability concerns. One interviewee thought that AB 2097 could be effective in promoting housing development since eliminating parking requirements would raise developer margins, while another cautioned that reducing available parking without providing good alternatives to driving could yield unintended consequences.

Policy creators stressed the need for coordination in developing and implementing any strategies meant to address displacement pressures. One emphasized "deep-seeded community coordination" to ensure that communities are present and engaged in plan development. Another group emphasized the role of the MPO as a successful partner ("they are the laboratories of what is happening," as one interviewee stated), because they are responsible for both the RHNA and conducting transportation planning and issuing guidelines. However, they agreed the state also needed to coordinate its own policies to ensure consistent guidance to the region. As one policy creator pointed out, our strategies were missing the acknowledgment of certain necessary partnerships, such as those with tribal nations. Partnership and collaboration operate differently in such a case, as the relationship needs to be on a nation-to-nation level; the structures of affordable housing development place additional hardship on tribal communities since they would be forced to give up a land deed for site development.

Among the policy creators, affordable housing production, preservation of affordable units, community-controlled affordable housing units, just cause eviction, and rent regulation were seen as some of the more important anti-displacement tools. State and regional funding was also emphasized as important, as much of the affordable housing production in California has been enabled by these state and regional subsidies. Community land trusts were seen as an interesting idea but not particularly effective in practice. One policy creator also emphasized AB 2097 as a potential "game changer for California" in that it removes a key barrier to development by reducing the cost of housing while creating more efficiencies in land use and development. Another policy creator offered that universal mobility funds or universal basic income could provide important mobility options for low-income individuals. Such programs could reduce the cost of transportation or mitigate increases in housing costs to help keep people in place.

The two policy experts we spoke to offered different perspectives both from each other and compared to the other interviewees, though there was some commonality in certain themes. Both spoke on the importance of community-focused strategies. One expert agreed that community-land trusts, community-owned properties, and community benefits agreements would give a sense of community control and power in anti-displacement efforts. However, as the other expert noted, because a community land trust is a substantial investment in infrastructure and organization, success is predicated on a grassroots effort to grow it which cannot be forced upon the community from the outside.

One of the experts cautioned that there may be misplaced emphasis on strategies to address displacement and not enough on strategies to ensure affordability. Limited housing affordability does not necessarily mean displacement: "You don't need to have displacement to still want strategies that increase affordability, and that increase the ability of more households to move to those neighborhoods." This person pointed to the Fruitvale neighborhood in Oakland, site of a BART station, which is often used as a model example for successful community engagement in TOD. In Fruitvale, there is limited evidence of displacement but substantial evidence of neighborhood change, rising affordability pressures, and more housing insecurity. The policy emphasis therefore needs to be to create opportunities for people to live there and improve affordability through a community development perspective:

> [We are] investing in those neighborhoods, and creating really rich, healthy places to live because we are directing investments that way. But we're both enabling more families to move in and benefit from those investments, as well as lifting up the historical and cultural heritage of those neighborhoods, and that's the piece that often gets lost. You could dump a brand-new luxury condo in [Fruitvale], and that undermines everything about the neighborhood, even if it doesn't lead to displacement.

Discussion and Conclusion

In order to reduce VMT, developed areas of California must add residential density, and to date much of the research on densification has focused on building more housing in areas with existing high-quality transit, frequently including rail. As noted above, however, the rail transit-based densification strategies have raised concerns about displacement and gentrification. Furthermore, little is known about how transportation-informed denser housing development can be achieved in a more effective and equitable manner.

Our findings suggest that successful transportation-housing coordination is an extraordinarily challenging task. As shown in Section 2, there is a considerable degree of discrepancy between the two major sources of VMT information, making it difficult to precisely identify low VMT locations. More importantly, the discrepancies appear to be far from uniform or random. While both of the VMT data sources clearly indicate that higher density is strongly correlated with lower per capita VMT, they are equivocal regarding the effects of transit and other built environment variables. Compared to CSTDM estimates, the STL data are more likely to defy the conventional view that VMT can always be significantly reduced through transit and mixed-use development. This finding may indicate that more attention should be paid to the validation of the VMT estimates used for the implementation of SB 743 as well as the complex (context-dependent) relationships between VMT, transit, and the built environment.

Despite the discrepancies between the two VMT data sources, low VMT areas tend to exhibit some distinct characteristics, such as a lower percentage of non-Hispanic white residents, even after controlling for the effects of density and other built environment attributes. The CSTDM VMT estimates exhibit particularly stronger associations with some socio-demographic variables. This might be because travel demand models took household characteristics into account in a way that could increase the probability of identifying less privileged tracts as low VMT locations. Given this finding, SB 743, specifically its map-based screening for residential and office projects and 85 percent threshold, should be implemented more cautiously since such a simple application may not enable us to build more housing in high opportunity areas.

When it comes to TOD, the challenge of meeting VMT and GHG reduction goals comes into conflict with equity concerns through the general lack of affordable housing in California, according to the policy actors we interviewed. As it stands, transportation policy is not well-equipped to meet these goals because infill development and promoting density does not produce enough housing where people can easily access employment and services without relying on a vehicle. Policies oriented toward changing travel behavior often place burdens on low-income households with few alternatives to driving.

Developing TOD does not automatically lead to displacement; attracting new residents to a neighborhood because of housing and transit access is a separate process from forcing out current residents. BRT-based TOD could bring more opportunities to create density in more places because the transportation infrastructure is cheaper to build. However, while BRT-based TOD was viewed as producing similar neighborhood change or

displacement effects as rail-based TOD, it was seen as a viable opportunity for housing development provided bus transit service met the needs of diverse residents. That said, a variety of anti-displacement strategies to complement TOD were viewed as potentially effective. Commonalities across interviews included community-focused options such as community-controlled housing, rent control and eviction protections, and more affordable housing production. AB 2097, the recent law that eliminates minimum parking requirements in certain transit areas, was seen as a potential "game changer" in promoting development through lowering construction costs.

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