INNOVATION REQUIRED: MOVING MORE PEOPLE WITH LESS TRAFFIC

How to improve Highway 101 in San Mateo County, save millions, and give commuters more choices
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ACKNOWLEDGEMENTS

Jeff Hobson and Joseph Kott are co-authors of the paper. Joseph Kott, Principal with Kott Planning Consultants and formerly (2008-2012) the Transportation Planning and Programs Manager for the City/County Association of Governments of San Mateo County, planned and executed the analysis at the heart of the paper. Jeff Hobson, TransForm’s Deputy Director, was the project manager, conceptualized the analysis, and contributed significantly to the analysis and writing of the paper. Clarrissa Cabansagan, TransForm’s Community Planner, contributed to research, editing, and photography, and designed the final document. Cullen McCormick designed the infographic. Additional credit is due to Stuart Cohen for key advice throughout the process and to Shannon Tracey for final editing.

TransForm gratefully acknowledges the Climate Change Public Education Program of the Resources Legacy Fund for supporting the analysis that lies at the heart of this report, as well as for production and distribution. We would also like to thank our donors and those foundations that have made our regional transportation work possible this year: The California Endowment, Clarence E. Heller Charitable Foundation, Ford Foundation, The Health Trust, James Irvine Foundation, Flying J Foundation, Kaiser Permanente Northern California Community Benefit Program, San Francisco Foundation, Silicon Valley Community Foundation, Surdna Foundation and the William and Flora Hewlett Foundation.
I. Introduction: We Can’t Build our Way Out of Congestion

San Mateo County has a traffic problem. And if we don’t pursue innovative solutions, traffic will get worse. With ongoing economic growth and a rising population, more and more people are driving farther and farther. We already have massive congestion on Highway 101, overcrowding on Caltrain, and complaints from businesses that their employees can’t reliably get to work on time.

In the past, government agencies have responded by building bigger highways. But after decades of widening our highways, we now know that we can’t build our way out of congestion. When we build wider highways, at first traffic flows faster. But new drivers soon fill that space, especially in congested corridors such as Highway 101. Within a few years, traffic is just as bad as it ever was. This new traffic pours onto local roads and clogs them too. To top if off, spending hundreds of millions of dollars on new highway lanes leaves little to invest in public transit, vanpools, and other alternatives.

People want more and better transportation choices. Caltrain ridership has boomed since the introduction of the Baby Bullet. As the smartphone replaces the car as the teenager’s must-have possession, fewer young people are getting their driver’s licenses. Employers, particularly tech companies such as Google and Genentech, now run private transit systems to meet their employees’ demands. But those company shuttles, some carrying as many as 70 people, are stuck in the same traffic as solo drivers. Meanwhile, our cars remain the biggest emitters of both local air pollution and greenhouse gas pollution. We need better solutions.

San Mateo County has major transportation assets: Highway 101, Caltrain, and Samtrans. The question is how to best use those assets to solve our traffic problems, reduce greenhouse gas and local air pollution, and make the most cost-effective use of limited taxpayer dollars.

But so far, county transportation agencies and Caltrans are stuck in the “building bigger highways” rut. Their proposal to expand Highway 101 would spend $150 million or more to add a high-occupancy vehicle (HOV) lane in each direction, without funding additional transportation choices. That will make traffic worse than it is now while still leaving unused space in the HOV lane. At some point, they may also allow solo drivers to opt into this HOV lane for a fee, to make it into a “high-occupancy toll” (HOT) or express lane. But if the lane is created by widening Highway 101, the high cost of construction will use up the revenues that instead could fund more transportation choices.

This paper analyzes a new option that will make the best use of our highway lanes and simultaneously fund transportation choices to truly reduce congestion. We call it the “Optimized HOT” scenario. Instead of expansion, the county would spend just $18 million to convert the existing left-most general purpose lane into an HOT lane. The county would use the money saved through lower construction costs and the revenue generated by the HOT lane to fund a dramatic expansion of public transit, vanpools, and other alternatives to solo driving in the corridor, potentially including expanded Caltrain service. The following two pages are an infographic (also available as a free-standing document) summarizing how the Optimized HOT scenario outperforms other future scenarios.

This is the kind of innovative solution San Mateo County should try. However, antiquated state policy is in the way. We need the state to allow this innovation. This will not only address San Mateo County’s problem, it can also set an important model for the rest of the Bay Area as the region prepares to create an HOT network over the next twenty years.

If we do things right, we can move more people with less traffic, put solutions in place more quickly than the agency’s standard solutions would allow, and spend less money up front. Let’s get to work.
Bay Area planners are looking to add more capacity to Highway 101 along the Peninsula—but it could be so much better. Consider the four scenarios below to see how Highway 101 is a great place to do HOT lanes right!

<table>
<thead>
<tr>
<th></th>
<th>TODAY</th>
<th>PLANNED HOV</th>
<th>STANDARD HOT</th>
<th>OPTIMIZED HOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOVE MORE PEOPLE</td>
<td></td>
<td>3,200</td>
<td>4,040</td>
<td>5,680</td>
</tr>
<tr>
<td>People/hour in fast lane</td>
<td>1,780</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH LESS TRAFFIC</td>
<td>1,370</td>
<td>1,760</td>
<td>1,660</td>
<td>1,550</td>
</tr>
<tr>
<td>Vehicles/hour in general purpose lanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORE PEOPLE IN TRANSIT AND RIDESHARE</td>
<td>36%</td>
<td>44%</td>
<td>43%</td>
<td>55%</td>
</tr>
<tr>
<td>High-occupancy vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64%</td>
<td>56%</td>
<td>57%</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>Single-occupancy vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOR LESS MONEY, SO IT CAN HAPPEN FASTER</td>
<td>$0 MILLION</td>
<td>$180 MILLION</td>
<td>$180 MILLION</td>
<td>$18 MILLION</td>
</tr>
</tbody>
</table>

**TRANSFORM**

TransForm works to create world-class public transportation and walkable communities in the Bay Area and beyond.

We build diverse coalitions, influence policy, and develop innovative programs to improve the lives of all people and protect the environment.

We’ve won literally billions of dollars and groundbreaking policies in support of public transportation, smart growth, affordable housing, and bicycle/pedestrian safety.

**HOW CAN THIS BE?**


**BUT WAIT, THERE’S MORE...**

SEE THE REVERSE SIDE FOR MORE DETAILS...
WHAT IS HOT?
High occupancy toll (HOT) lanes, also called "express lanes," allow solo drivers to pay a toll to use the carpool lanes. Tolls are dynamically adjusted to ensure a free flow of traffic in the lane. The big question is how revenues from HOT lanes get used. The full report looks at future scenarios for Highway 101 that use HOT revenues in different ways.

If San Mateo County proceeds as planned, it will use scarce taxpayer dollars to build new lanes, leaving less for new transportation choices. The Optimized HOT scenario saves money on construction, allowing the county to keep those taxpayer dollars for other priorities. We can use HOT revenues for express buses, vanpools, and ridesharing, so we can move more people with less traffic.

TODAY

- This stretch of Hwy 101 has auxiliary (AUX) lanes for 80% of its length

PLANNED HOV

- Build new HOV lane by filling in gaps in AUX lane at interchanges
- Construction costs funded by scarce taxpayer dollars

STANDARD HOT

- Build new HOT lane by filling in gaps in AUX lane at interchanges
- Allow solo drivers in the fast lane for a fee
- Construction costs funded by toll revenues and scarce taxpayer dollars

OPTIMIZED HOT

- Convert GP lane to HOT lane
- Allow solo drivers in the fast lane for a fee
- Use revenues for public transit and rideshare

LOCATION

Highway 101 between I-380 and Whipple Road is the study area for this infographic.

LANE lingo

GP: GENERAL PURPOSE
Lane used by all vehicles
AUX: AUXILIARY
Lane that exits and re-enters at interchanges
HOV: HIGH OCCUPANCY VEHICLE
Lane reserved for vehicles with 2+ or 3+ occupants
HOT: HIGH OCCUPANCY TOLL
Lane reserved for vehicles with 2+ or 3+ occupants, as well as solo drivers who pay a toll

PROTECT LOCAL STREETS

EXPANDING HIGHWAYS means even more vehicles will pour onto local streets at rush hour. If we instead move more people with transit and vanpools, as in the Optimized HOT scenario, we can avoid these negative impacts on our local streets.

YOU CAN HELP!

HELP MAKE SURE Highway 101 is a pilot to move more people with less traffic!

Sign up at: www.TransFormCA.org/HOT101

Or visit our Facebook page: www.facebook.com/TransFormCA

MORE PEOPLE!

LESS TRAFFIC!

OPTIMIZE HOT!
II. Overview of this Paper

The San Mateo County Transportation Authority (TA), in cooperation with the City/County Association of Governments of San Mateo County (C/CAG) will soon embark on a detailed study of the feasibility and cost of expanding Highway 101 to create high occupancy vehicle (HOV) lanes. These lanes would be an extension of the HOV lane that already runs along Highway 101 through Santa Clara County to Whipple Avenue in Redwood City.

But it is no longer clear this is the best solution for San Mateo County. The use of HOV lanes varies greatly across the region. In some places the lanes are full and threaten to no longer offer a time advantage. In others the lanes carry fewer vehicles, leaving a lot of unused capacity, even when nearby general purpose lanes are congested.

That is why another alternative is emerging in the Bay Area and across the country. Express lanes, or High Occupancy Toll (HOT) lanes, are carpool lanes that allow non-carpool vehicles to pay to use them when there is excess capacity. The region is forging ahead with an extensive network, and Santa Clara County is leading the way. Express lanes are already in operation connecting I-880 to SR-237 and along I-680 over the Sunol grade. Many more are in the planning stages, including along Highway 101 in Santa Clara County and into San Mateo County up to the Whipple Avenue interchange.

Express lanes hold promise for increasing the number of people, not just vehicles, using Highway 101, but only if they are designed to optimize how many high-occupancy vehicles use the lanes. Some of the region’s network, including parts of Highway 101, will be created by converting existing carpool lanes to HOT lanes. These conversions are cost-effective: if done alone, they would expand travel choices by expediting bus, vanpool and carpool trips and creating a “buy-in” option for those who wish to remain in their solo vehicles but also benefit from using the high occupancy lanes. In turn, the revenue stream created by payments from these drivers can be used to fund improved transit and vanpool alternatives for others.

But the region also plans to spend billions of dollars to expand hundreds of miles of highways. This new construction would use up the revenues generated by the rest of the system and leave nothing left for more transportation choices or for mitigations for low-income families. There is even a chance that a poorly-designed lane could end up carrying even fewer people than an existing lane!

This is why instead of spending $150 million-plus to widen Highway 101, policymakers should consider the dramatically less capital-intensive alternative of the “Optimized HOT scenario”: convert an existing general purpose lane to HOT and use the HOT revenues – plus the money saved in lower construction costs – to invest in better transportation choices. We should also use those funds to ensure low-income families receive equitable benefits from these transportation investments.

This paper conducted some basic analyses to illustrate the potential benefits of this Optimized HOT approach in San Mateo County. The analyses found that the Optimized HOT scenario would:

- move more people,
- have less traffic in the general purpose lanes,
- cost less to put in place and be completed sooner,
- give more people the option to escape traffic and ride in the fast lane, and
- make more efficient use of our highway infrastructure than any of the other alternatives.
Now is a perfect time and place to try this innovative approach that can set a critical precedent for the Bay Area. We also hope the conclusions of this paper inspire state-level policy changes that would be needed to allow this innovation and efficiency to move forward.

This focus on moving more people, not just moving vehicles, is gaining traction at all levels. For example, the secretaries of four California state agencies recently sent a letter to the U.S. Secretary of Transportation recommending that “Person Throughput per Lane Mile” be used as a performance measure for the National Highway System.²

Moving More People with Less Traffic describes different ways to create high-occupancy lanes along one stretch of Highway 101 in San Mateo County. This is followed by a discussion of existing conditions on Highway 101 in San Mateo County and three alternative scenarios for this freeway:

- The “Planned HOV” scenario is the county’s current plan: to create an HOV lane by widening some portions of the highway and using existing auxiliary lanes in other places.
- The “Standard HOT” scenario is the likely evolution of the county’s current plans: it would involve converting the HOV lane created in the first scenario into an HOT lane.
- The “Optimized HOT” scenario is a proposed new option that uses express lane revenues, and savings from less expensive highway construction, to support aggressive investments in transit, vanpools, and other alternatives to solo driving.

The report emphasizes the importance of accommodating high occupancy vehicle demand and of robust transportation demand management efforts along the Highway 101 corridor. Moving More People with Less Traffic offers estimates of future traffic on 101 by lane type and by mode, including solo occupant vehicles, carpools with two passengers, carpools having three or more passengers, vanpools, and buses. Finally, we present a list of recommendations to support moving more people with less traffic by providing more choices on Highway 101 in San Mateo County.
III. HOV and HOT Lanes

High occupancy vehicle (HOV) or carpool lanes are “intended to help maximize the people-carrying (as opposed to the vehicle-carrying) capacity of a roadway segment … by limiting the use of one or more lanes to buses, vanpools, and carpools with a minimum number of occupants.”

High occupancy toll (HOT), also frequently called “express lanes”, allow solo drivers to use the carpool lanes by paying a toll that can be adjusted dynamically based on congestion. Notable California examples of HOT lanes are on I-15 in San Diego and I-680 in Alameda and Santa Clara counties. By current state law, HOT lanes may be implemented as newly constructed lanes or from conversion of existing HOV lanes. There were more than 150 HOV and/or HOT facilities in the United States in 2012.

The Bay Area is developing an extensive HOT or express lane system, beginning with a 550-mile “backbone” network. TransForm previously published Moving People, Not Just Cars with detailed recommendations for how to ensure choice, equity, and innovation in MTC’s Express Lane Network.

MTC’s proposed network includes a short segment on Highway 101 in San Mateo County from the Santa Clara County Line to the Whipple Avenue interchange, but it does not include any portion of Highway 101 north of Whipple. The “Standard HOT” and “Optimized HOT” scenarios in this paper explore two ways San Mateo County could expand that express lane network to more of Highway 101, largely or wholly using existing infrastructure.

Legal authority for HOT lanes is evolving in the U.S., as many regions experiment with ways to manage highway demand and raise revenue to maintain aging highway networks. The Bay Area network’s legal authority is based on several different parts of state law. None of these authorities allows conversion of general purpose lanes to an HOT lane, which is part of the solution this paper proposes as the “Optimized HOT” scenario. Agencies may create an HOT lane by converting an existing HOV lane, but AB 798 prohibits converting an existing non-tolled general purpose lane to an HOT lane. Federal law may also apply, stating that federal funds may be used to create an HOT lane only if the project increases highway capacity or if the project is a conversion of an existing HOV lane. This restriction, however, only applies if a project intends to use federal funds.

These state and federal restrictions, if left unchanged, pose barriers to the “Optimized HOT” solution recommended by this paper. See Section X: Recommendations for ways to address these barriers.

HOT lanes based on dynamic, congestion-based tolls have potential to generate revenues above and beyond what may be needed to pay for the costs of creating and maintaining these facilities. If designed and operated well, they have the potential to generate net revenues. If net revenues are generated, an agency can amplify the beneficial effects of reduced bus and van travel times by distributing these net revenues to higher occupancy mode services, including express bus transit and vanpool programs, as well as to robust travel demand management efforts targeted to the express lane corridor. This can promote further mode shift to higher occupancy vehicles and can create a “virtuous circle” of greater demand for higher occupancy travel, resulting in more efficient provision of HOV travel, which in turn leads to more supply, spurring higher demand. This can only happen, however, if the costs of creating and maintaining the HOT lanes can be contained well enough to allow net revenues.

This paper does not delve into the significant potential equity impacts of congestion tolling that need to be considered by policymakers. It is important to note that availability of better transit options is a benefit across the socio-economic spectrum, especially for lower-income households without access to reliable private motor vehicle transport.

Nor does this paper address in any way the complexities of operating express lanes or the difficulties in predicting revenues. Instead, this paper simply focuses on comparing the creation of an HOV lane to two possible ways of creating an express lane along one corridor in San Mateo County, and of optimizing the people-carrying capacity of the roadway.
IV. Existing Conditions

Highway 101 in San Mateo County is a limited access facility, typically comprising four general purpose through lanes and significant sections of auxiliary lanes in each direction between the San Francisco County Line to Whipple. There are four general purpose through lanes and one HOV lane in each direction from Whipple to the Santa Clara County line. See Figure 2 for a map of the corridor, showing the study area for proposed scenarios discussed below: the portion of Highway 101 from Whipple north to the I-380 interchange.

Figure 2. Map of Highway 101 Corridor

Table 1 displays existing vehicle volumes for this stretch of road, along with existing mode choice characteristics and the number of people carried by the current facility. These data are derived from the technical analysis prepared for C/CAG based on 2009 data collected along the corridor, but with one change: this paper assumes that there has been an increase in the share of bus transit vehicles, based on the reported increase in private transit vehicles since 2009.
For simplicity, this paper presents estimates for one direction of AM peak period travel, based on average traffic across five locations along the corridor. This simplification is used because the directional split of traffic is roughly even, with similar levels of traffic going northbound and southbound during both AM and PM peak periods. Further, the mode split in each direction is also roughly similar. Further details are included in the Appendix. A more complete analysis of these scenarios would require more detailed calculations, considering AM and PM peak periods separately for each direction and considering different traffic levels at different locations.

Based on these estimates and simplifications, the average vehicle occupancy rate (VOR) for existing conditions is 1.30 persons/vehicle (33,920 people / 26,040 vehicles).

![Table 1: Mode Choice, Existing Conditions](image)
V. Future Conditions

**Future Vehicle Demand**

Peak-period traffic is projected to be 31,000 vehicles during the AM peak period, as an average of both directions of travel. PM peak period traffic is projected to grow by similar proportions, representing a roughly 19% growth in traffic from 2005 to 2030.

**Future Roadway Configurations**

An analysis of HOV feasibility completed for C/CAG in June, 2012 identified five alternative future roadway configurations: Baseline (no change), Full Hybrid HOV Lane, Staged Hybrid HOV Lane, Add HOV Lane, and Convert Mixed Flow Lane to HOV Lane. “Hybrid” refers to the strategy of starting with existing auxiliary lanes, and supplementing this with sections of new pavement at interchanges where the auxiliary lane exits, to complete a new continuous general-purpose lane, and then converting the left lane to a high-occupancy vehicle lane.

The Full Hybrid option would create HOV lanes from the Whipple interchange to the San Mateo County / San Francisco County line, a distance of approximately 19 miles. The Staged Hybrid option would begin with the section from the Whipple interchange to the I-380 interchange, about 14 miles in extent. The Add HOV Lane option would create an entirely new lane, although there is no description of precisely how and where room for this additional lane will be created.

The Convert Mixed Flow Lane option would designate an existing lane for high vehicle occupancy use. The preliminary cost estimates for these options vary enormously, as displayed in Table 2:

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert Mixed Flow Lane</td>
<td>$18 Million</td>
</tr>
<tr>
<td>Staged Hybrid HOV</td>
<td>$156 - $180 Million</td>
</tr>
<tr>
<td>Full Hybrid HOV Lane</td>
<td>$285 - $325 Million</td>
</tr>
<tr>
<td>Add HOV Lane</td>
<td>$426 Million</td>
</tr>
</tbody>
</table>

The effects of each option also vary. The three options that add a fourth continuous lane would result in a 4 – 7% increase in vehicle miles of travel, and a proxy for greenhouse gas emissions on Highway 101, while under the Convert Mixed Flow Lane option, VMT would fall by a projected 4%.

Importantly, several factors that could have a significant impact on the performance of the options were not considered in the analysis prepared for C/CAG. The analysis did not consider the potential impact of managing traffic in the high-occupancy lane by operating it as an HOT lane. Moreover, there was no forecast of public and private bus transit demand under each option, nor any consideration of either the effects of future transportation demand management efforts along the 101 corridor or any traffic shift from parallel facilities such as El Camino Real and I-280 onto Highway 101. A more complete analysis would take account of the four convergences that take place with increased highway capacity: from other passenger transportation modes, from off-peak to peak times, from other routes, and from non-travel to travel.

As of fall 2013, C/CAG is moving forward with design plans for the “Staged Hybrid HOV” construction plan. No decision has yet been made to incorporate the resulting HOV lane into the growing Bay Area network of express lanes. But if the rest of the Bay Area’s planned express lane network moves forward, it seems likely that this new HOV lane would eventually be incorporated into it, so it is worthwhile investigating different options that include an express lane along this corridor.
VI. Scenario Planning: Three Future Scenarios

A sketch Scenario Planning framework can provide a more complete picture of the potential of HOV/HOT lanes on Highway 101. This sketch Scenario planning approach is meant to illustrate potential, so is a “thought experiment” intended to inform policy in advance of detailed program development and travel demand forecast modeling.

This analysis considers three future scenarios:

1. **“Planned HOV”** scenario is based on the current focus of planning for Highway 101 in San Mateo County, the “Staged Hybrid HOV” plan. In this scenario, the county would spend $156-180 million to build an HOV lane along the corridor, as described above in Section V: Future Conditions of Highway 101 in San Mateo County. This scenario assumes public funds would pay for construction costs. This scenario does not assume any other efforts to shift mode share, beyond the “baseline” level of mode shift defined in Section VII: Future Mode Shift Efforts.

2. **“Standard HOT”** scenario is based on the same physical change as in the “Planned HOV” scenario. The difference is that the county would operate that new high-occupancy lane as an HOT lane. This scenario further assumes that express lane revenues would be dedicated to construction costs, as is the case with MTC’s existing plans for the overall Bay Area Express Lane Network. As a result, this scenario assumes the same “baseline” level of mode shift defined in Section VII: Future Mode Shift Efforts.

3. **“Optimized HOT”** scenario is a new approach proposed in this paper. In this scenario, the county would spend $18 million to convert the existing general purpose lane to an HOT lane, described as “Convert Mixed Flow Lane” above in Section V. In this scenario, the county would also use the money saved through lower construction costs and the revenue generated by the HOT lane to include a dramatic expansion of new transit service, vanpools, and other alternatives to solo driving, the “aggressive” level of mode shift effort defined in Section VII: Future Mode Shift Efforts.
This paper assumes that in a 2030 horizon year, for all scenarios, high-occupancy lanes will be open to vehicles with 3+ passengers. This is in keeping with regional assumptions about operation of the future express lane network.\textsuperscript{22}

By necessity, this sketch scenario planning does not use the type of travel modeling detail that San Mateo County transportation agencies could and should use to evaluate these proposed scenarios. But at this sketch-level, the results are very compelling and clearly point to the need for more detailed analysis.
VII. Future Mode Shift Efforts

Baseline Mode Shift Effort

The Planned HOV and Standard HOT scenarios both assume that there is no new public investment and only a modest private investment in transit, vanpools, and other alternatives to solo driving. But there will still be a “natural” mode shift due to the availability of a high-occupancy lane and the associated travel time savings potential for higher occupancy modes of travel. New carpools with three or more passengers and new vanpools will form, and some employers will add new bus transit capacity. This paper refers to those changes collectively as the “Baseline” mode shift effort. The term “Baseline” is used to represent the likely effects of high-occupancy lanes without robust mode shift efforts to induce additional use of these lanes by buses, vanpools, and carpools with three or more passengers.

With only these “Baseline” efforts, the benefits of the HOV lanes will degrade over time. This is because there will be a convergence of vehicles from both parallel routes and off-peak travel times onto Highway 101 in San Mateo County in response to an initial rise in average vehicle occupancy, which will open up road space. In the absence of aggressive new transportation demand management efforts, the gains in average vehicle occupancy will erode. This paper estimates that the “Baseline” mode shift will include a substantial increase in the mode share for HOV 3+ vehicles, in large part from people moving from 2-person carpools to 3+ carpools, resulting in an equal portion of 2-person and 3+ carpools. The Baseline mode shift also assumes an increase of 15 vanpools per hour and 15 transit vehicles per hour. The resulting mode shift efforts are shown in Table 4.

Aggressive Mode Shift Effort

By contrast, the Optimized HOT scenario includes an “Aggressive” mode shift effort, building on top of the “Baseline” effort described above. Table 3 shows three hypothetical elements that could be included in this program to induce mode shift within a scenario planning framework for future Highway 101 express lane development:

<table>
<thead>
<tr>
<th>New Bus Transit Services</th>
<th>New Vanpool Formation</th>
<th>Added Annual TDM Program Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 private, 30 public buses per hour, each direction, peak period</td>
<td>60 new vanpools per hour, each direction, peak period</td>
<td>$6.6 M</td>
</tr>
</tbody>
</table>

The Aggressive mode shift assumes for scenario planning one new public or private bus per minute in each direction and one new vanpool per minute in each direction: for a total of 30 new private and 30 new public buses per hour in each direction and 60 new vanpools per hour in each direction, over and above the “Baseline” effort. For buses, this is similar to the existing public bus service along I-80 westbound in Alameda County in the morning peak period. For private buses, this new service would represent roughly a two-fold increase over current conditions.

Private transit already provides a significant share of the transit service along the corridor. As of 2012, Google alone provided 1.8 million trips on their employee shuttles, making it the 6th-largest bus-only operator in the Bay Area. Genentech’s gRide was close behind, with 1.3 million riders in 2012. While Google provides the most rides, many other companies run significant fleets, including Genentech, Facebook, Apple, Yahoo, eBay, Electronic Arts, and others. All this transit is providing significant environmental benefits by adding another transit option that allows commuters to get to work without driving.
Demand for these private transit services is growing and has the potential to grow even more if Highway 101 were to have a traffic-free high-occupancy lane. The estimate for the “Aggressive” mode shift is based on correspondence with several transportation managers at major technology companies along the corridor. In fact, these conversations suggest this two-fold increase may be a conservative estimate— that is, that the continuing growth of the tech sector and increased reliance on private transit may yield a much larger growth in the number of private transit vehicles. However, for the purpose of this scenario analysis, we are using this conservative assumption based on the uncertain impacts of future improvements to Caltrain and public bus competitors to private bus services on the corridor.\textsuperscript{27}

The aggressive mode shift efforts also include a Transportation Demand Management (TDM) program operated according to TDM best practices.\textsuperscript{28} The impact of the TDM program investment would be intended not only to support mode shift to buses, vanpools, and carpools, but also to prevent convergence from other modes, times, routes, or non-travel onto Highway 101 in response to any vacant roadway space created by reductions in solo occupant travel.

The capital costs of public transit service expansion are estimated at $29-33 million, with annual operating subsidies estimated at $13-16 million. Additional funds would likely be needed for an expansion of park and ride lots, both to support ride-sharing and public/private transit. Detail on assumptions for these estimates is shown in the Appendix. Earlier HOT revenue estimates suggest that HOT revenue generated by the corridor would greatly exceed the public investment required to implement the bus, vanpool, and TDM program for this aggressive mode shift effort, but a more complete analysis with up-to-date revenue estimates would be needed to confirm this conclusion. See Appendix for details.

\textbf{Impact of Mode Shift Efforts}

Table 4 displays the potential impact of these Baseline and Aggressive mode shift efforts, in both number of vehicle trips and number of passengers served. See Appendix for details.
Table 4: New High Occupancy Vehicles Supply and Demand, Two Levels of Mode Shift Effort, Each Direction, AM Peak Period

<table>
<thead>
<tr>
<th>Mode Shift Effort</th>
<th>New Buses Trips/Passengers</th>
<th>New Vanpools Trips/Passengers</th>
<th>New 3+ Carpools Trips/Passengers</th>
<th>Total New HOVs Trips/Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>60 / 1,280</td>
<td>60 / 480</td>
<td>2,290 / 8,000</td>
<td>2,410 / 9,760</td>
</tr>
<tr>
<td>Aggressive</td>
<td>300 / 6,410</td>
<td>300 / 2,400</td>
<td>3,150 / 11,040</td>
<td>3,750 / 19,850</td>
</tr>
</tbody>
</table>
VIII. Results of Scenario Planning

The results of this scenario planning are presented below. For each scenario, we estimate the total vehicle volume, predicted mode shares for vehicles and people, traffic levels in high-occupancy, general purpose, and auxiliary lanes, and the number of people and vehicles in the high-occupancy lane.

Results were estimated for the AM peak period traffic conditions forecast for the year 2030, based on the demand projections developed for C/CAG for the HOV feasibility study described above. Detailed calculations, methodology, and references for these estimates are shown in the Appendix.

Total Vehicle Volumes

Table 5 shows total vehicle volume for each future scenario, including the percent change from current conditions. This shows significant differences among the scenarios. The Planned HOV scenario has the future vehicle volume predicted by current planning studies, a 19% increase above 2009 levels. The Standard HOT scenario has an even higher volume, fueled by induced demand in response to the HOT lane’s ability to absorb more traffic. The Optimized HOT scenario has the fewest vehicles, as some drivers switch to transit and vanpools provided by the aggressive mode shift efforts.

Table 5: Total Vehicle Volumes, Existing Conditions & 2030²⁹
AM Peak Period, Average of Both Directions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Vehicle Volume</th>
<th>% Increase from Current Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions</td>
<td>26,040</td>
<td>n/a</td>
</tr>
<tr>
<td>Planned HOV</td>
<td>30,960</td>
<td>19%</td>
</tr>
<tr>
<td>Standard HOT</td>
<td>32,290</td>
<td>24%</td>
</tr>
<tr>
<td>Optimized HOT</td>
<td>28,570</td>
<td>10%</td>
</tr>
</tbody>
</table>

Mode Choices – whole highway

Tables 6-8 display estimated 2030 modal choice distributions for the three future scenarios. Tables 6 and 7, showing the Planned HOV and Standard HOT scenarios, assume the “Baseline” shift in HOV use. Table 8 shows the Optimized HOT scenario, including the “Aggressive” mode shift effort. In all cases, distributions are presented for both people and vehicles in the AM peak period.
Table 6: 2030 Mode Choice, Planned HOV Scenario

<table>
<thead>
<tr>
<th>Solo Driver</th>
<th>2-Person Carpool</th>
<th>3+ Person Carpool</th>
<th>Bus</th>
<th>Vanpool</th>
<th>Motorcycle</th>
<th>Truck</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># Vehicles</td>
<td>24,490</td>
<td>2,570</td>
<td>2,570</td>
<td>180</td>
<td>210</td>
<td>150</td>
<td>770</td>
</tr>
<tr>
<td>% Vehicles</td>
<td>79.1%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.5%</td>
<td>2.5%</td>
</tr>
<tr>
<td># Persons</td>
<td>24,490</td>
<td>5,150</td>
<td>9,000</td>
<td>3,930</td>
<td>1,720</td>
<td>180</td>
<td>870</td>
</tr>
<tr>
<td>% Persons</td>
<td>54.1%</td>
<td>11.3%</td>
<td>19.9%</td>
<td>8.7%</td>
<td>3.8%</td>
<td>0.4%</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

Table 7: 2030 Mode Choice, Standard HOT Scenario

<table>
<thead>
<tr>
<th>Solo Driver</th>
<th>2-Person Carpool</th>
<th>3+ Person Carpool</th>
<th>Bus</th>
<th>Vanpool</th>
<th>Motorcycle</th>
<th>Truck</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># Vehicles</td>
<td>25,580</td>
<td>2,690</td>
<td>2,690</td>
<td>180</td>
<td>210</td>
<td>150</td>
<td>770</td>
</tr>
<tr>
<td>% Vehicles</td>
<td>79.2%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.5%</td>
<td>2.4%</td>
</tr>
<tr>
<td># Persons</td>
<td>25,580</td>
<td>5,370</td>
<td>9,410</td>
<td>3,930</td>
<td>1,720</td>
<td>180</td>
<td>870</td>
</tr>
<tr>
<td>% Persons</td>
<td>54.4%</td>
<td>11.4%</td>
<td>20.0%</td>
<td>8.4%</td>
<td>3.7%</td>
<td>0.4%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Table 8: 2030 Mode Choice, Optimized HOT Scenario

<table>
<thead>
<tr>
<th>Solo Driver</th>
<th>2-Person Carpool</th>
<th>3+ Person Carpool</th>
<th>Bus</th>
<th>Vanpool</th>
<th>Motorcycle</th>
<th>Truck</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># Vehicles</td>
<td>21,800</td>
<td>1,520</td>
<td>3,440</td>
<td>420</td>
<td>450</td>
<td>150</td>
<td>770</td>
</tr>
<tr>
<td>% Vehicles</td>
<td>76.3%</td>
<td>5.3%</td>
<td>12.0%</td>
<td>1.5%</td>
<td>1.6%</td>
<td>0.5%</td>
<td>2.7%</td>
</tr>
<tr>
<td># Persons</td>
<td>21,800</td>
<td>3,040</td>
<td>12,040</td>
<td>9,060</td>
<td>3,640</td>
<td>180</td>
<td>870</td>
</tr>
<tr>
<td>% Persons</td>
<td>43.0%</td>
<td>6.0%</td>
<td>23.8%</td>
<td>17.9%</td>
<td>7.2%</td>
<td>0.4%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

Levels of Traffic

Table 9 shows estimated future traffic flows in the three scenarios: vehicle volumes per hour and per lane in the relevant types of lanes in each scenario.

Table 9: Vehicle Volumes, Existing Conditions & 2030

<table>
<thead>
<tr>
<th>Scenario</th>
<th>HOV / HOT Lane</th>
<th>General Purpose Lanes</th>
<th>Auxiliary Lane (HOT only)</th>
<th>Total Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions</td>
<td>n/a</td>
<td>1,370</td>
<td>1,040</td>
<td>6,510</td>
</tr>
<tr>
<td>Planned HOV</td>
<td>700</td>
<td>1,760</td>
<td>n/a</td>
<td>7,740</td>
</tr>
<tr>
<td>Standard HOT</td>
<td>1,410</td>
<td>1,660</td>
<td>n/a</td>
<td>8,070</td>
</tr>
<tr>
<td>Optimized HOT</td>
<td>1,320</td>
<td>1,550</td>
<td>1,180</td>
<td>7,140</td>
</tr>
</tbody>
</table>

To put this in context, C/CAG defines freeway capacity as 2,200 vehicles per hour for a freeway cross-section like that of Highway 101 in San Mateo County. In contrast, however, the Bay Area HOV Network Study Final Report describes the “useful capacity” threshold for general purpose lanes as 1,600 vehicles per hour, corresponding to stable flow traffic. All three of these scenarios are well within C/CAG’s definition of freeway capacity. The Optimized HOT scenario shows the lowest level of traffic in the general purpose lanes, with a
traffic volume very close to MTC’s definition of the lane’s useful capacity. The Standard HOT scenario has higher traffic while the Planned HOV scenario has the worst expected traffic volumes in the general purpose lanes.

It is also important to note that while Table 9 shows average traffic levels, morning peak hour traffic along Highway 101 in San Mateo County can vary by more than 30%, depending on location, direction, and hour. The range for 15-minute peaks can be even greater.

**Vehicles & People in the High-Occupancy Lane**

Finally, Table 10 shows, for each of the future scenarios, the number of vehicles and people in the #1 or furthest-left lane of the highway, the high-occupancy vehicle lane. For comparison purposes, Table 10 also includes the number of people estimated to be travelling in the furthest-left lane for existing conditions, based on the average vehicle occupancy for the highway as a whole.

**Table 10: Total People Travelling in Left Lane, Average Peak Hour, Existing & Future Scenarios**

<table>
<thead>
<tr>
<th>Scenario</th>
<th># of Vehicles</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions</td>
<td>1,370</td>
<td>1,780</td>
</tr>
<tr>
<td>Planned HOV</td>
<td>700</td>
<td>3,200</td>
</tr>
<tr>
<td>Standard HOT</td>
<td>1,410</td>
<td>4,040</td>
</tr>
<tr>
<td>Optimized HOT</td>
<td>1,320</td>
<td>5,680</td>
</tr>
</tbody>
</table>
IX. Comparative Analysis of Scenarios

This analysis shows that the Optimized HOT scenario can move more people, with less traffic. It succeeds because it makes more efficient use of the high-occupancy lane by filling it with more carpools, vanpools, and buses, while still allowing access to solo drivers that generates revenue and makes efficient use of the roadway.

Moving More People

The Optimized HOT scenario carries 50% more total people than Existing Conditions (50,630 people vs. 33,920), and 8-12% more people than the Planned HOV (45,340) or Standard HOT (47,060) scenarios. Figure 5 shows this study’s estimate for how many people would be traveling during the AM peak period.

![Figure 5: Projected number of people using Highway 101 during AM Peak Period](image)

Less Traffic

The Optimized HOT scenario has less traffic (1,550 vehicles/hour) in its general purpose lanes than either the Planned HOV (1,760) or Standard HOT (1,660) scenarios. Figure 6 shows the estimated traffic in the general purpose lanes for each of the future scenarios, averaged across the AM peak period.

![Figure 6: Traffic in General Purpose Lanes (vehicles/hour)](image)
More People in Carpools, Buses, and Vanpools

In the Optimized HOT scenario, aggressive mode share efforts make it possible for more people to avoid traffic in the adjacent lanes by riding in carpools, buses, and vanpools. Figure 7 shows that the share of people traveling as solo drivers declines sharply across the three scenarios, from 61% in existing conditions to just 43% in the Optimized HOT scenario. The Optimized HOT scenario is the only one in which the majority of people on the highway are traveling in high-occupancy vehicles.

Figure 7: People traveling as Solo Drivers vs. in Carpools, Buses, and Vanpools

More People in the Fast Lane

Putting all these factors together results in many more people traveling in the fast lane, getting the time-savings benefits of the high-occupancy lane. Figure 8 shows the number of people traveling in the fast lane – the far-left lane for existing conditions and the high-occupancy lane for the future scenarios. The results are dramatic – in the Optimized HOT scenario the fast lane carries more than three times as many people as in existing conditions (1,780), and 41%-78% more people than in the Standard HOT and Planned HOV scenarios.

Figure 8: People/hour in the Far-Left Lane
More Efficient Use of the Whole Highway

The result is a much more efficient use of the highway. Figure 9 shows the change in average vehicle occupancy, or number of persons per vehicle, from existing conditions to the future scenarios. The average vehicle occupancy rate (VOR) rises modestly, from 1.30 in Existing Conditions to 1.46 in the Planned HOV and Standard HOT scenarios. In contrast, the Optimized HOT scenario results in a dramatic increase in vehicle occupancy rate to 1.77 people per vehicle, an increase of more than one-third over existing conditions.

**Figure 9: Average Vehicle Occupancy (persons/vehicle)**
X. Recommendations

The Optimized HOT scenario for Highway 101 would:

- move more people,
- have less traffic in the general purpose lanes,
- cost less to put in place and be completed sooner,
- give more people the option to escape traffic and ride in the fast lane, and
- make more efficient use of our highway infrastructure than any of the other alternatives.

Unfortunately, it is also prohibited by state law.

This section describes the needed changes in order to allow San Mateo County to try the innovation of the Optimized HOT scenario.

Lift State Restrictions on Innovation

As described in Section III, AB 798 (Nava), passed in 2009, prohibits converting an existing non-tolled general purpose lane to a tolled lane, although conversions of HOV lanes are allowed.

The California Legislature should remove this prohibition, at least for a few demonstration projects, to test the “Optimized HOT” scenario. There are likely numerous other places across the state where Optimized HOT may be the best solution. And in some places the Optimized HOT approach may be the only way to provide a high-occupancy lane. These places should be allowed to innovate. Such legislation should be designed to require demonstration projects to test the complete Optimized HOT solution. TransForm recommends that legislation specify that at least 50% of the corridor’s HOT revenue be spent on transportation choices, over and above previously-existing service.

San Mateo County Should Lead the Way

While state law currently prevents San Mateo County’s transportation agencies from implementing the Optimized HOT solution on its own, there are some steps the county should take, even in the absence of a change in state law.

The county should conduct a more detailed evaluation of the Optimized HOT scenario, including both the conversion of a general purpose lane and using HOT revenues to invest in transportation choices. This should be done as part of the county’s upcoming feasibility study of
a Highway 101 HOV lane. This evaluation should include forecasting the effects of future public and private transit and vanpool services on Highway 101. C/CAG’s previous study of this corridor was not good enough – it only analyzed the possibility of converting a general purpose lane to an HOV lane, without consideration of the synergistic effects of an aggressive effort to support new choices and significant mode shift.

The study also needs to give careful consideration to equity in HOV/HOT policy-making: do the HOV/HOT lanes result in greater choice in travel options, especially for disadvantaged groups? Or are these groups made less well-off due to HOV/HOT policy? The county should consider incorporating a low-income mitigation program to ensure that low-income families receive an equitable share of the benefits and do not bear a disproportionate share of the burden of the HOT lane. Mitigations may include access to the network itself, as well as investments in transportation choices.

San Mateo County Should Lead the Way
SMCTA and C/CAG should express support for the state (and, if necessary, federal) legislative changes described in this section.

SMCTA and C/CAG, with support from MTC, should conduct a detailed evaluation of the Optimized HOT scenario for Highway 101 in San Mateo County, including both the conversion of a general purpose lane, simultaneous investments in transportation choices funded at least in part by HOT revenues, and low-income mitigations.

Regional Support for Innovation
This analysis also demonstrates that this Optimized HOT scenario could help the region create express lanes more quickly and more efficiently than is currently conceived through the Bay Area Express Lane network.

Recent actions by MTC show that Bay Area transportation decision-makers are ready to look at this scenario. The final Plan Bay Area, the 25-year combined transportation and land use plan adopted by MTC and the Association of Bay Area Governments (ABAG), includes a provision stating that MTC will study the benefits and impacts of converting general purpose lanes to express lanes in order to inform implementation of the express lane network. And in public conversations leading up to the vote, Commissioners sought and received verbal assurance that these analyses would look at how HOT revenues are used, how the lanes impact people of different incomes, and what MTC could do with HOT revenues to offset the consequences of converting general purpose lanes to HOT lanes.

But the written provision in Plan Bay Area does not expressly state that MTC or any relevant county agency will study the full Optimized HOT solution as a package. If MTC only studies converting a general purpose lane to an HOV/HOT lane, without including the synergistic effects of adding transit at the same time, it will not show the same benefits as looking at the full package together.

While this segment of Highway 101 is not currently part of MTC’s Express Lane Network, San Mateo County’s study will be the first to analyze of a high-occupancy lane expansion since the passage of Plan Bay Area in July 2013.

As MTC conducts, or supports county agencies to conduct, other studies across the region to follow up on the commitments made in Plan Bay Area, those studies should use this Optimized HOT scenario approach –
convert an existing general purpose lane and simultaneously invest in transportation choices along the same corridor.

Regional Support for Innovation

MTC should express support for the state (and, if necessary, federal) legislative changes described in this section.

MTC should replicate this paper’s proposed “Optimized HOT” strategy – in more detail using traffic modeling tools – for other highway segments anywhere that new construction is proposed to create either an HOT or an HOV lane. These segments should include any proposed construction of new lanes in the Bay Area Express Lane Network. MTC should also look at optimizing lanes on any highway corridor that has at least 8 mixed-flow lanes and no HOV lanes, such as Highway 24 or 880 through Oakland, even if the corridor is not currently part of the region’s proposed HOT network.

Don’t Let Federal Restrictions Get in the Way

Federal law may also apply, stating that federal funds may be used to create an HOT lane only if the project increases highway capacity or if the project is a conversion of an existing HOV lane. This restriction, however, only applies if a project intends to use federal funds.

As described in Section III, federal funds are not currently allowed to be used to implement the Optimized HOT solution. For Highway 101 in San Mateo County, this may not be a problem for this project. The Optimized HOT scenario has a small-enough capital cost that it should be possible to complete without using any federal funds, particularly given ongoing cuts in federal funding.

Over the long-term, however, it may be necessary to secure federal approval of demonstration projects – as proposed above for the state of California – or a permanent change in law to allow federal funds to be used to implement the Optimized HOT scenario.

Don’t Let Federal Restrictions Get in the Way

Congress should support state and local innovation by allowing a limited number of federally-funded Optimized HOT demonstration projects or by permanently expanding the definition of allowable uses of federal funds.
Appendix

The following provides methodological notes about relevant sections in the paper above. Section headers in this appendix refer to sections in the paper above.

Existing Conditions (Section IV)

Existing Vehicle Demand
Existing conditions are largely based on the San Mateo US-101 Freeway Corridor Technical Analysis for Corridor System Management Plan, completed in 2010 by Dowling Associates for San Mateo C/CAG.41

Total daily bi-direction traffic volumes range from 110,000 to 190,000 vehicles depending on location.42 Peak-period bi-direction traffic varies from 49,000 to 54,000 vehicles during the 4-hour morning peak to 56,000 to 61,000 in the 5-hour evening peak.43

This analysis makes several simplifying assumptions. These include:

- Analyze only one direction of travel, because the directional split along this stretch of Highway 101 is roughly even, as shown on Table A-1. The mode splits in each direction are also roughly similar to each other.44 That is, there is about the same amount of traffic, with about the same mix of vehicles, going northbound and southbound, in both the AM and PM peak periods.
- Analyze AM peak period only. The AM peak period, 6 AM to 10 AM, is chosen because it is a more realistic representation of peak period conditions than data available for the PM peak period, which was defined in C/CAG’s study as 2:30 PM to 7:30 PM.
- Analyze the corridor based on an average traffic volume averaged across five locations along the corridor.

Table A-1: Directional Split on Highway 101 in San Mateo County45

<table>
<thead>
<tr>
<th>Time/Direction</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>42 - 53%</td>
<td>47 - 58%</td>
</tr>
<tr>
<td>PM</td>
<td>46 - 52%</td>
<td>48 - 54%</td>
</tr>
</tbody>
</table>

Average AM peak period vehicle volume for 2009 was 26,037 vehicles per direction.46

Existing Mode Choice
Table 1 presents the average mode choice in existing conditions for the AM Peak Period, using an average of both directions.47 Mode choices presented are a straight average of observed mode splits for 3 different locations, in AM and PM peak periods, for both directions of travel. This paper makes two revisions from those straight-line averages: the fraction of both buses and vanpools in 2013 is assumed to be slightly higher than what was observed in 2009, due to the reported increase in private transit use. As a simplifying assumption, this paper assumes that this very modest shift towards transit and vanpools comes from the share of solo occupant vehicles.

All data are rounded to the nearest ten vehicles or people or to the nearest tenth of a percent.

The number of people is based on average vehicle occupancy rates shown in Table A-2:
Table A-2: Average Vehicle Occupancy Rates

<table>
<thead>
<tr>
<th>Mode</th>
<th># People / Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-occupancy</td>
<td>1.0</td>
</tr>
<tr>
<td>2-person carpool</td>
<td>2.0</td>
</tr>
<tr>
<td>3+ carpool</td>
<td>3.5</td>
</tr>
<tr>
<td>Bus</td>
<td>21.375</td>
</tr>
<tr>
<td>Vanpool</td>
<td>8.0</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>1.18</td>
</tr>
<tr>
<td>Trucks</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Note that for Highway 101 in San Mateo County, this may be a very low vehicle occupancy assumption for buses. Private transit vehicle load factors are often much higher than the standard industry assumptions used here – some tech companies routinely operate buses with 40 and 50 people aboard. A comprehensive summary of 33 HOV facilities nationwide found an average bus vehicle occupancy rate of 35 persons/bus. Since a higher bus VOR would accentuate the benefits of the Optimized HOT scenario, this relatively low VOR is a conservative assumption for the purpose of this analysis.

Existing Traffic Levels, by Lane

Existing traffic levels in each lane are calculated by taking the total vehicle demand and distributing it across the existing highway geometry, with demand absorbed by general purpose and auxiliary lanes based on standard industry assumptions. This stretch of Highway 101 has four general purpose lanes for the entire length of the corridor and auxiliary lanes for 80% of the directional miles, based on a visual inspection of the map of auxiliary lanes. One directional mile of auxiliary lanes is assumed to absorb 95% as much capacity as a through lane. As a result, the existing auxiliary lane on this stretch of Highway 101 is assumed to absorb 76% as much traffic as a full-length general purpose lane (76% = 80% x 95%). Applying that capacity to the existing vehicle volumes produces the per-lane traffic levels reported in Table 9.

Future Conditions (section VI)

Future Vehicle Demand

Baseline future conditions are based on the same San Mateo US-101 Freeway Corridor Technical Analysis for Corridor System Management Plan as was used for existing conditions, using the same simplifying assumptions. Using those same assumptions, the predicted 2030 average vehicle volume for the AM peak period is 30,994 vehicles. This volume is based on an average, across five locations, of the predicted 2030 bi-directional vehicle volumes, divided by two to provide predicted vehicle volumes for one direction of travel. Bi-directional traffic is projected to vary from 57,000 to 70,000 vehicles in the 6 AM to 10 AM morning peak and from 75,000 to 91,000 in the 2 PM to 7 PM afternoon/evening peak, depending on location. These represent morning and afternoon/evening peak period growth rates from 15 – 26% for 2005 to 2030, and 4-10% growth from 2015 to 2030.

Future Mode Shift Efforts (section VII)

Aggressive Mode Shift Effort

Estimated capital and operating costs of the new public transit and vanpool services are estimated as follows: Capital Costs
• Average cost in 2010 and 2011 of an urban bus, >27′6″ in length, 2 doors = $479,585\(^{56}\)
• Average cost in 2010 and 2011 of an intercity bus, >32′6″ in length, 1 door = $543,054\(^{57}\)
• Assumes 60 new transit buses for service along the 101 corridor, 30 in each direction during peak period, resulting in total cost in the range of $29-33 million (60 x $479,585 to 60 x $543,054).
• Vanpool capital costs, roughly $25,000 per vehicle, are assumed to be funded by vanpool participants’ monthly contributions.\(^{58}\)

**Operating Costs**

• Assumes 60 buses, each operating 260 days per year, 8 peak hours a day = 2,080 operating annual operating hours per bus, or 124,800 total operating hours.
• Assumes average bus operating cost in 2009$ per hour = $155.58\(^{59}\)
• Estimated annual bus operating cost in 2009$ = $155.58/hr x 124,800 operating hours = $19,420,000 (rounded)
• Assumes farebox recovery ratios range from 17.9% to 33%\(^{60}\)
• Operating subsidy % range: 100% - 17.9% = 82.1% to 100% - 33% = 67%
• Lower end estimate for annual operating subsidy cost in 2009$ = $19,420,000 * 82.1% = $15,950,000 (rounded)
• Upper end estimate for annual operating subsidy cost in 2009$ = $19,420,000 * 67% = $12,950,000 (rounded)
• Vanpool operations costs are assumed to be funded by vanpool participants’ monthly contributions.\(^{61}\)

Total public investment needed would therefore be roughly $19.6-22.6 million/year.

A more complete analysis would compare these operating costs to HOT revenue estimates for the corridor. Unfortunately, up to date HOT revenue estimates are not available for this corridor, and it is beyond the scope of this analysis to generate them.

In an earlier HOT Network report, MTC estimated annual revenues for the Highway 101 corridor of $3,450,000 to $5,642,000 per mile if the facility were limited to 3+ carpools, depending on the extent of the surrounding HOT network and which direction. Those numbers correspond to $48-79 million in annual revenues, for each direction of HOT lane. These are projected gross revenues, without deductions for capital costs, financing, and operating and maintenance cost.\(^{62}\) Projected net revenues are highly sensitive to capital costs assumed and associated financing costs. MTC has since concluded that these estimates were too high, given changing market conditions, and the revised HOT network study did not include revenue estimates for this corridor.

**Impact of Mode Shift Efforts**

Table 4 uses the same vehicle occupancy rate assumptions as elsewhere in this analysis.

For Baseline mode shift, total mode share of carpooling is not assumed to change, but the share of 2-person and 3+ carpools is assumed to have changed from 15.5% 2-person and 1.1% 3+, in existing conditions, to an even split (8.3% each) in the two baseline scenarios. This assumption is based on the expectation that the 3+ limit in the HOV/HOT lane will drive some carpool formation. We believe this is a conservative assumption, given the difficulty of forming 3+ carpools, as indicated by the very low rate of 3+ carpools currently.

For Aggressive mode shift, total mode share of carpooling is still not assumed to change, but the share is assumed to have two-thirds of the carpools be 3+ while one-third are 2-person (for a resulting share of 5.5% 2-person and 11.1% 3+). This additional shift is assumed to be driven by the existence of the TDM program.

A more detailed analysis would need to investigate the likelihood of these assumptions.
Results of Scenario Planning (section VIII)

The following describes the methodology for analyzing the three future scenarios.

**Planned HOV Scenario**
The baseline future vehicle volume is taken from the estimate presented in section IV, Future Conditions.

The 2030 Mode Choice for Planned HOV Scenario, shown in Table 6, was estimated as follows:

- Start with the mode choice percentages from existing conditions.
- Change the carpool mode splits to be half 2-person carpools and half 3+ carpools.
- Add bus and vanpool trips as described in section VI, Future Mode Shift efforts.
- Subtract a number of single-occupancy vehicle trips equal to the number of cars that would be displaced by adding the bus and vanpool vehicles: 1.5 cars per bus and 1.0 cars per vanpool vehicle. This results in a small decrease from the baseline vehicle volume (Table 5).

Number and share of people traveling is based on multiplying the number of vehicles by the vehicle occupancy rates used throughout this analysis.

The levels of traffic across the whole highway, and the traffic and number of people carried by the HOV lane, shown in Tables 6 and 10, were estimated as follows:

- Assume that the vast majority of high-occupancy vehicles (3+ carpools, buses, and vanpools) use the HOV lane, but not all of them, as at any given point some HOVs will be entering, exiting, or simply operated by a driver who does not wish to use the HOV lane. For the purpose of this analysis, we estimate that 88.7% of 3+ carpools, 86.7% of buses, and 70.1% of vanpools are in the HOV lane. We also assume a 3.6% HOV violator rate, split among single-occupancy vehicles and 2-person carpools according to their relative proportions on the rest of the highway. These rates are based on current experience on I-80 in Alameda County. We also assume all trucks and motorcycles are not in the HOV lane. This yields the total number of vehicles per hour in the HOV lane.

- To estimate traffic in the general purpose lanes (Table 9), subtract the HOV-lane traffic from total hourly volume, and distribute that volume equally across the four remaining general purpose lanes.

- To estimate the number of people carried in the HOV lane (Table 6), apply the standard occupancy rates used throughout this analysis.

- Note that the overall capacity of the Planned HOV scenario is roughly 4.4 = 4 (GP lanes) + 0.4 (how much traffic the HOV lane carries, compared to a typical GP lane).

**Standard HOT Scenario**
The future vehicle volume (Table 5) was estimated as follows:

- Start with the vehicle volume from the Planned HOV scenario (including the small reduction from the Baseline mode shift efforts).

- Instead of assuming that the HOT only has HOVs and violators, we assume that the HOT lane is run efficiently. That is, the HOT lane is priced so that it never has more than 85% as much volume as the neighboring general purpose lanes.

- We estimate that the highway’s capacity is now the equivalent of 4.85 general purpose lanes (4 general purpose lanes + one HOT lane that carries 85% as much volume).
• Distribute the hourly vehicle volume equally among those lanes. This allows us to calculate how many vehicles moved from the general purpose lanes to the HOT lane.

• However, this also frees up space in the general purpose lanes, leaving them less congested than before. Since Highway 101 is a very high-demand corridor, we assume that the well-established phenomenon of induced demand will operate.

• We conservatively estimate that only 50% of the vehicles that move from the general purpose to HOT lane will be replaced by induced demand.

• This adds a total of 331 vehicles/hour in induced demand, or 1,322 vehicles during the AM peak.

• This is a reasonable total: it corresponds to a less than 5% increase in the number of non-HOV vehicles on the corridor.

• This yields a new total vehicle volume that is slightly higher than the vehicle volume for the Planned HOV scenario.

The 2030 Mode Choice for Standard HOT scenario (Table 7) was estimated as follows:

• Start with the Future Mode Choice previously calculated for the Planned HOV scenario, including the small reduction in SOVs and increases in buses and vanpools from the Baseline mode shift.

• Add the induced demand vehicles, apportioned as single-occupancy, 2-person carpools, and 3+ carpools according to their relative proportions on the rest of the highway.

• This yields the number and percentage of trips by mode. Apply standard occupancy rates to yield number and percentage of people.

The levels of traffic across the whole highway, and the traffic and number of people carried by the HOV lane, shown in Tables 7 and 10, were estimated as follows:

• As with the Planned HOV scenario, calculate the number of 3+ carpools, buses, vanpools, and violators in the HOT lane.

• Fill the remaining space with paying customers: single-occupancy vehicles and 2-person carpools, according to their relative proportions on the rest of the highway.

• This yields the total vehicle volume in the HOT lane. Apply standard occupancy rates to get the number of people carried in the HOT lane (Table 10).

• Subtract that HOT lane volume from the total highway volume to get the volume in the general purpose lanes.

• Distribute that traffic equally to estimate the traffic levels in the general purpose lanes (Table 9).

• Note that the overall capacity of the Standard HOT scenario is equal to $4.85 = 0.85 \text{ (HOT lane)} + 4 \text{ (GP lanes)}$.

**Optimized HOT Scenario**

The future vehicle volume (Table 5) and future mode choice (Table 8) was estimated as follows:

• As in the Planned HOV scenario, start with the mode choice percentages from existing conditions.

• Change the carpool mode splits to be two-thirds 2-person carpools and one-third 3+ carpools.

• Add bus and vanpool trips as described in section VI, Future Mode Shift efforts.
• Subtract a number of SOV and 2-person carpool trips equal to the number of drivers removed from the road based on the number of passengers in the added bus and vanpools. To do so, multiply the estimated bus and vanpool trip rates by standard occupancy rates. But assume that only 35% of transit passengers and 25% of vanpool passengers are former car drivers, based on national experience. The reduced vehicles are apportioned between SOVs and 2-person carpools according to their relative proportions on the rest of the highway. We assume that the TDM program will inhibit induced demand from replacing those car drivers who have switched.

• Note that this is a conservative estimate: we do not assume that the additional passengers in 3+ carpools, as opposed to 2-person carpools, cause any reduction in the number of drivers.

• This yields the number and percentage of trips by mode (Table 8) and the vehicle volume for this scenario (Table 5).

• Apply standard occupancy rates to yield number and percentage of people.

The levels of traffic across the whole highway, and the traffic and number of people carried by the HOV lane, shown in Tables 9 and 10, were estimated as follows:

• As with the Standard HOT scenario, calculate the number of 3+ carpools, buses, vanpools, and violators in the HOT lane, and then fill the remaining space with paying customers.

• This yields the total vehicle volume in the HOT lane. Apply standard occupancy rates to get the number of people carried in the HOT lane (Table 10).

• Subtract that HOT lane volume from the total highway volume to get the volume in the remaining general purpose and auxiliary lanes.

• Distribute that traffic according to the capacity of the remaining lanes, which have a total capacity equivalent to 3.76 general purpose lanes (3 general purpose lanes + 0.76 for the auxiliary lane, as in the existing conditions), to show the traffic levels (Table 9).

• Note that the overall capacity of the Optimized HOT scenario is equal to 4.61 = 0.85 (HOT lane) + 3 (GP lanes) + 0.76 (auxiliary lane).
Endnotes

2 Letter from Secretary of California State Transportation Agency, Secretary of California Natural Resources Agency, Secretary of California Health & Human Services Agency, Secretary of California Environmental Protection Agency, and Director of Governor’s Office of Planning & Research to U.S. Secretary of Transportation Anthony Foxx. August 1, 2013.
8 Project Study Report to Support the Bay Area Express Lane Backbone Network. Caltrans, August 2011.
10 California State and Highways Code, section 149. Accessed at: http://leginfo.public.ca.gov/cgi-bin/calawquery?codesection=shc. Section 149.5 authorizes the I-680 Express Lane over the Sunol Grade. Section 149.6 authorizes VTA to create HOT lanes along two corridors in the county. This section specifically authorizes that if Highway 101 is one of the corridors, that VTA may create and operate the HOT lane as far into San Mateo County as the HOV lane in that county existed as of 1/1/2011. Section 149.7 enacts the provisions of AB 1467 (Nuñez), which allowed for four express lane demonstration projects, two each in Northern and in Southern California. This authorization was further modified by AB 798 (Nava), which allowed the projects to be approved by the CTC, without the necessity of approval of the state legislature, and also included the restrictions on converting an existing general purpose lane.
15 See Appendix for details.
For an overview of more elaborate Scenario Planning techniques, see https://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/.

For example, see http://www.ite.org/Membersonly/annualmeeting/2003/AB03H1102.pdf.

A three-fold increase, based on the FY 2012-2013 revenue forecast of $3,315,505 for the Peninsula Traffic Congestion Relief Alliance, the exemplary transportation demand management agency serving employers and their employees in San Mateo County. Peninsula Traffic Congestion Relief Alliance Board of Directors Meeting Agenda Packet, June 21, 2012, p. 81.


Comparison to Bay Area transit operators based on MTC, Statistical Summary of Bay Area Transit Operators, Fiscal Years 2007-08 through 2011-2012, June 2013.


One transportation manager for a major technology company along the 101 corridor, when asked in early July 2013 about this assumption, thought that it was “likely to be too low” as a forecast; two others, who were also asked about this assumption in early July 2013, thought that it was “about right”. All comments were provided under the understanding of non-attribution to specific company.

For examples of such best practices, see www.nctr.usf.edu/pdf/77604.pdf and http://www.vtpi.org/tdm/.

See Appendix for details.

See Appendix for details.

Assumes, heuristically, that the 2-person carpool share falls to 8.3% after implementation of HOV/HOT lanes. See Appendix for discussion.

Assumes, heuristically, that the 3-person carpool share rises to 8.3% after implementation of HOT/HOT lanes. See Appendix for discussion.

See Appendix for details.


See Bay Area HOT Network Study Final Report Appendices, p. 3. The 1,600 threshold for general purpose lanes is described as corresponding to freeway level of service C. Accessed at: http://www.vta.org/expresslanes/pdf/mtc_hot_lanes_study_final_appendices.pdf.


See Appendix for details of this calculation.

See Appendix for details.

“MTC will study the potential benefits and impacts of converting general purpose lanes to express lanes in order to inform implementation of the express lanes network.” MTC Planning Committee, ABAG Administrative Committee Meeting Packet Re: Plan Bay Area – Final Adoption (MTC Resolution No. 4111, ABAG Resolution No. 06-13) dated July 5, 2013, p. 18. http://apps.mtc.ca.gov/meeting_packet_documents/agenda_2089/3c_Final_PBA.pdf.

Conversation during Joint MTC Planning Committee and ABAG Administrative Committee meeting, July 12, 2013, between MTC Commissioner Steve Kinsey and MTC Executive Director Steve Heminger.


San Mateo US-101 Freeway Corridor Technical Analysis for Corridor System Management Plan. Dowling Associates, September 2010, p. 29. Note that the morning peak is from 6 AM to 10 AM and the afternoon/evening peak is from 2:30 PM to 7:30 PM.
48 Assumes average vehicle occupancy rate (VOR) of 3.5 for 3+ carpools.
49 Assumes bus occupancy of 21.375 people/bus, based on an average load factor (% of passenger seats occupied) of 45%, the mid-point of a range estimated for private regional shuttles and 47.5, mid-point for motor coach capacity, both from a recent study by the San Francisco County Transportation Authority, The Role of Shuttle Services in San Francisco’s Transportation System, 2011, p. 9. This yields an average loading of approximately 21 passengers. Note that there is little public bus transit service along Highway 101 at present. The only SamTrans bus service on 101, for example is a portion of the KX route. Telephone conversation with Douglas Kim, SamTrans Transportation Planning Director, May 16, 2013.
50 Assumes average vanpool occupancy of 8.0. Telephone conversation with John Form, Executive Director, Peninsula Traffic Congestion Alliance, May 16, 2013.
61 The second farebox recovery ratio assumption of 33% is an heuristic that assumes a higher farebox recovery ratio on commuter bus service along freeway HOV lanes than on urban and suburban streets. By comparison, the farebox recovery ration for VTA commuter express bus services is approximately 20%. See http://www.westernite.org/annualmeetings/sanfran10/Papers/Session%206_Papers/ITE%20Paper_6C-Scott.pdf.
64 See 2010 Bay Area HOV Lanes. Caltrans District 4, p. 50.
66 Mode shift data from Transit Cooperative Research Program Report 95: HOV Facilities - Traveler Response to Transportation System Changes, Table 2-26, pp. 2-77.
TransForm works to create world-class public transportation and walkable communities in the Bay Area and beyond. We build diverse coalitions, influence policy, and develop innovative programs to improve the lives of all people and protect the environment.

TransForm’s Offices

**Oakland**
436 14th Street, Suite 600
Oakland, CA 94612
510.740.3150 ext. 325

**San Jose**
48 South 7th Street, Suite 102
San Jose, CA 95112
408.406.8074

**Sacramento**
171 K Street, Suite 330
Sacramento, CA 95814
916.441.0204