SAN MATEO US 101 EXPRESS LANE FEASIBILITY STUDY

San Mateo County, California

Prepared for:

Metropolitan Transportation Commission

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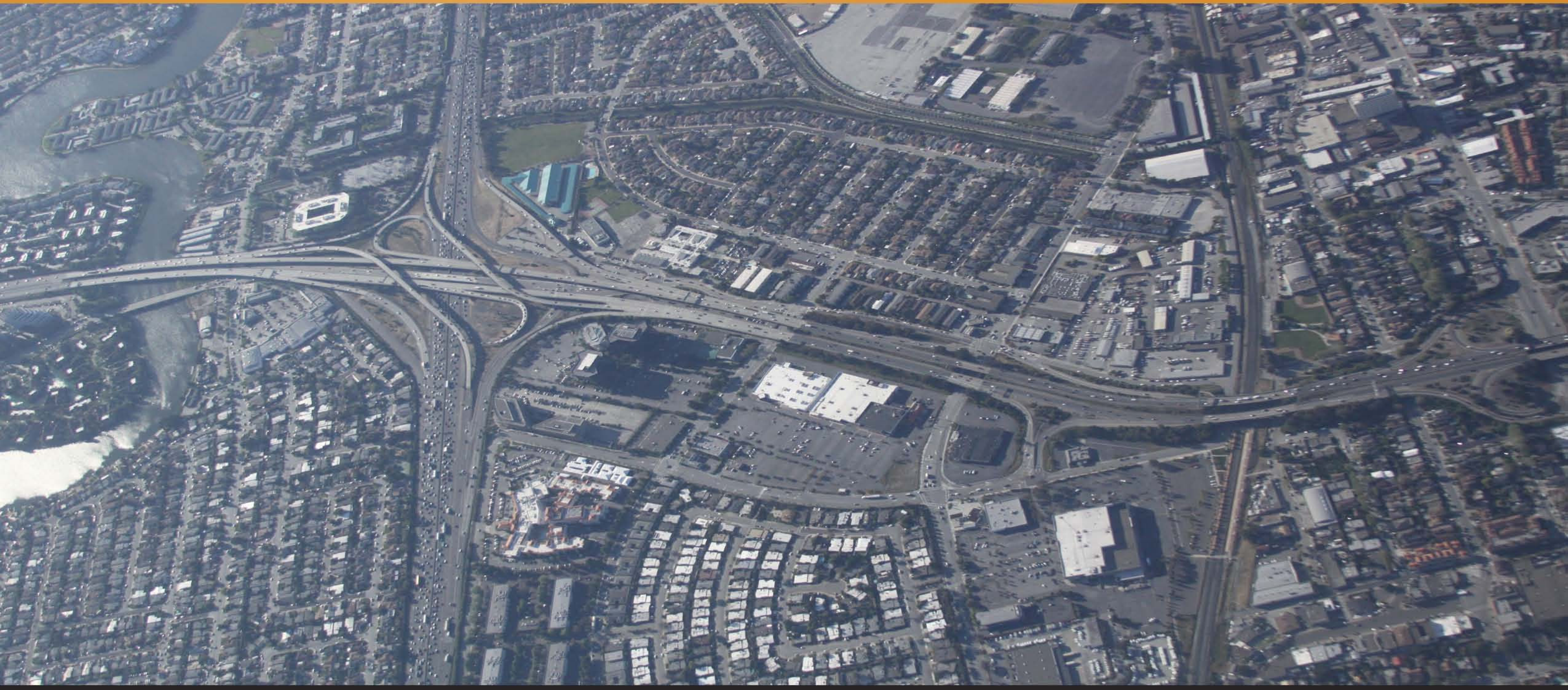

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October 7, 2014 Project #: 17826

Ms. Winnie Chung
Metropolitan Transportation Commission
101 Eighth Street
Oakland, CA 94607

RE: San Mateo US 101 Express Lane Conceptual Feasibility Study
Deliverable 4A – Technical Report (Draft)

Dear Ms. Chung:

Kittelson & Associates, Inc. (KAI) is pleased to submit this Conceptual Feasibility Study of various options for the San Mateo US 101 Express Lane project. This is Deliverable 4 of the project.

We would like to thank the stakeholder's team for their contributions and suggestions throughout the study, including staff from: MTC, Caltrans, C/CAG and San Mateo County TA.

Our subconsultants: Karsten Adams and Tommy Cho of Mark Thomas & Company provided conceptual cost estimates, and Jia Hao Wu from W & S Solutions provided transit evaluation.

We would like to give credit to the engineers at KAI who contributed to this effort: Jorge Barrios and Chirag Safi.

Please call me at 510.839.1742 if you have any questions.

Sincerely,
KITTELSON & ASSOCIATES, INC.

Rick Dowling, PhD, PE
Senior Principal Engineer

Kevin Chen, PE
Associate

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EXECUTIVE SUMMARY

In June 2012, a Staged Hybrid HOV Lane Study was completed that analyzed the feasibility of extending the HOV lane on US 101 from Whipple Avenue in Redwood City to I-380 in San Bruno, a distance of approximately 13 miles. The City/County Association of Governments of San Mateo County (C/CAG) is moving forward on a Project Study Report – Project Development Support (PSR-PDS) for the project. The purpose of this study is to perform a preliminary high level conceptual feasibility assessment of two express lane options for the same segment of US 101, to help determine if these additional options might have some fatal flaws that might preclude them from meriting further detailed analyses.

The two concepts are:

- Concept 1: HOV-to-Express Lane Conversion (Hybrid HOT). This concept assumes the same freeway cross section as the proposed Staged Hybrid HOV Lane option from the feasibility study (which involves limited lane additions to the freeway), and converts the HOV Lane into an Express Lane.
- Concept 2: Optimized Express Lane (Convert HOT). This concept retains the current freeway cross section (i.e. no additional widening), and converts the number one (leftmost) general purpose lane directly into an Express Lane.

ASSUMPTIONS AND APPROACH

Since this was a conceptual feasibility study to determine if the two concepts had potential fatal flaws that might preclude them from consideration for further analysis, the general approach for this study was to use available data, information, and traffic models from the 2012 study, so that the new results can be compared to the older results on a consistent basis. This includes applying the previous 2040 traffic forecast developed for the Staged Hybrid HOV Lane for Concept 1, and extrapolating the previous 2030 convert HOV lane traffic forecast to 2040 conditions, for Concept 2. In addition, traffic operations analysis was focused primarily along the US 101 mainline, with a high-level assessment of other major roadways using information produced by the C/CAG travel demand model.

The study began with an assessment of available capacity in the HOV/express lane to carry additional tolled single occupancy vehicles. Next, freeway traffic operations analysis was conducted using previously calibrated FREQ models for the two concepts.

A secondary assessment was then conducted to determine what demand shifts would be necessary under Concept 2 to achieve the same freeway performance improvements as Concept 1, should the objective of the reviewing agencies be to maintain the performance benefits expected under Concept 1. Using the operations analysis results, a sensitivity analysis was conducted to estimate the needed mode, route and time shifts for Concept 2 to achieve freeway performance that is similar to Concept 1.

Finally, preliminary conceptual cost estimates for both concepts were developed for comparison purposes.

KEY FINDINGS

Under both concepts there is not a great deal of excess capacity in the express lane during the AM and PM peak periods that could be sold to single occupant vehicles. In general, available capacity for tolled vehicles would occur during the shoulder peak hours, such as before 7 AM, after 9 AM, before 3:30 PM, and after 6:30 PM. In addition, some sections of the express lane would have no capacity for the entire peak period. Availability for tolled vehicles is summarized as follows:

- Northbound AM: up to 450 vph (for 2 hours out of the 4 hour AM peak period).
- Northbound PM: up to 280 vph (for 2 hours out of the 5 hour PM peak period).
- Southbound AM: up to 870 vph (for 2 hours out of the 4 hour AM peak period), not available south of Holly Street.
- Southbound PM: up to 200 vph (for 2 hours out of the 5 hour PM peak period), not available south of Holly Street.

In terms of freeway operations results, compared to the Staged Hybrid HOV Lane option that is currently in the PSR-PDS stage, Concept 1 would provide improvements for the mixed-flow lanes. Concept 2 would result in both longer queues and higher delays for the mixed-flow lanes in most cases. Exhibit 1 provides a summary of US 101 corridor-focused mobility performance results for Year 2040 conditions.

Exhibit 1: 2040 Freeway Corridor Performance Comparison

Performance Measures	2040 Baseline	2040 Staged Hybrid HOV	Concept 1 - Hybrid HOT	Concept 2 - Convert HOT	Concept 1 vs Staged Hybrid HOV	Concept 2 vs Staged Hybrid HOV
VMT – vehicle miles of travel	4,925,100	5,145,600	5,166,500	4,836,400	0.4%	-6.0%
VHT – vehicle hours of travel	196,000	187,000	184,000	187,400	-1.6%	0.2%
VHD – vehicle hours of delay	120,400	107,800	104,400	113,000	-3.2%	4.7%
PMT – person miles of travel	5,197,700	5,839,900	5,901,700	5,573,000	1.1%	-4.6%
PHD – person hours of delay	120,600	109,200	105,800	113,400	-3.2%	3.8%
Average vehicle speed (MPH)	25.1	27.5	28.1	25.8	2.1%	-6.2%
Average person speed (MPH)	25.9	29.3	30.0	28.0	2.3%	-4.6%

Source: FREQ analysis, both HOV and mixed-flow lanes, AM and PM peak periods combined.

In summary, comparing Concept 1 to the 2040 Staged Hybrid HOV lane option:

- Overall US 101 freeway productivity would be slightly improved with a 0.4% increase in VMT, and a 1.1% increase in PMT.
- Vehicle hours of travel and vehicle hours of delay would be reduced by 1.6% and 3.2%, respectively.
- Average peak period speeds for both vehicle and person trips would be increased more than 2%.

Comparing Concept 2 to the 2040 Staged Hybrid HOV lane option:

- Overall US 101 freeway productivity would be degraded with a 6% decrease in VMT, and 5% decrease in PMT. This is primarily related to the reduced capacity through the corridor, as well as the predicted effect of the reduced capacity on future peak period traffic demand for the US 101 freeway.
- Vehicle hours of travel and vehicle hours of delay would be increased by 0.2% and 4.7%, respectively.
- Average peak period speeds for both vehicle and person trips would be reduced by 4% to 6%.

In terms of the time it would take to travel the entire length of study corridor on the mixed-flow lanes, Concept 2 would result in longer travel times of about 20 minutes than under Concept 1 in the northbound direction during the AM peak hour, and up to about 99 more minutes than under Concept 1 during the PM peak hour. In the southbound direction, Concept 2 would require about 55 minutes longer during the AM peak hour. Travel times would be reduced by 31 minutes during the PM peak hour.

To achieve the same improved freeway performance with Concept 2 as is predicted for Concept 1, ways must be found to discourage approximately 6,250 vehicle trips during the AM and 1,160 vehicle trips during the PM peak period from using the US 101 freeway. This is above and beyond the demand shifts already forecasted by the C/CAG demand model due to the freeway capacity constraints implicit in Concept 2.

Based on existing information provided by BART, Samtrans and Caltrain, both BART and Caltrain are near or have reached capacity during the peak commute time periods. Alternate routes, such as El Camino Real and I-280 may not have the spare capacity to accommodate additional route shifts. Assuming all trip reductions on US 101 would be shifted to buses as a worst case assessment, up to 38 additional express buses would be required during the AM peak hour, and up to 14 additional express buses during the PM peak hour to accommodate these trip reductions on US 101.

Preliminary cost estimates were developed for both concepts and are summarized as follows:

- Concept 1: approximately $259 million, which includes costs associated with building the HOV lane ($156 million), and with conversion from HOV to express lane ($103 million).
- Concept 2: approximately $346 million, which includes costs associated with conversion from an existing mixed-flow lane to express lane ($108 million), and required operations and maintenance cost for additional transit services ($238 million, over a 20-year period). Potential capital cost required to provide these additional services were not included in this cost estimate.

In summary, Concept 1 would provide potential traffic operational benefits for the corridor, while for Concept 2, there would be higher costs associated with providing the level of transit services required to match the freeway travel time improvements provided by Concept 1. In addition, Concept 2 would also result in increased traffic demands on other major roadways within the county, including El Camino Real and I-280.

FURTHER CONSIDERATIONS

This study was a conceptual feasibility study designed to identify potential fatal flaws with either Concept 1 or Concept 2 that might suggest one or both should be dropped from further study. As such, this conceptual study was conducted as cost-effectively as possible by using information from previous studies, with the objective to conduct a comparison on a consistent basis with the 2012 Staged Hybrid HOV Lane study.

Based on this conceptual study, Concept 1 demonstrated better overall benefit than Concept 2, in terms of overall travel time on the US 101 mainline as well as total costs. If project budget allows, further analysis, as listed below, may provide a more comprehensive analysis to better inform decision makers.

During the study, it was discovered that there were some limitations in primarily using information from previous studies, for example, there was no feedback process between the travel demand model and the operations analysis model on travel times, which may have artificially resulted in low demand volumes on US 101 under concept 2, and in turn, the operations analysis could understate its potential effects. Also, existing traffic conditions on US 101 has changed since the 2012 study, for example, in the southbound direction during the PM peak period, additional bottlenecks have arisen along the study corridor, which in turn, could result in further operational impacts for Concept 2. Based on this initial evaluation, further analyses are suggested:

- Update existing conditions analysis and previously calibrated traffic operations models for US 101;
- Update traffic forecasts using the current bi-county C/CAG-VTA model;
- Conduct traffic operations analysis for US 101 and assess potential impacts on other alternate routes;
- Provide cost estimates to potential capital costs associated with the additional transit services for Concept 2, and also provide detailed logistics for the provision of additional transit (i.e. additional park-and-ride facilities, shuttle services to and from transit centers, etc.);
- Origin/Destination analysis of transit trips;
- Assess potential effects of private company shuttles along US 101, and their effects on future needs for additional transit busses in the corridor;
- Develop O&M (operations and maintenance) costs, and revenue analysis of the proposed express lane options.

INTRODUCTION

In June 2012, a High Occupancy Vehicle (HOV) lane study was completed that analyzed the feasibility of extending an HOV lane approximately 20 miles on US 101 north from Whipple Avenue in Redwood City to Beatty Road near the San Francisco County line. The 2012 study evaluated four options for the HOV Lane:

1. HOV Add – Add a new lane in each direction for HOV
2. HOV Convert – Convert an existing general purpose lane each direction to HOV
3. Hybrid HOV – Combine features of HOV Add and HOV Convert
4. Staged Hybrid HOV – A shorter (13 miles) segment of the Hybrid HOV, extending to I-380 in San Bruno. This would be accomplished by widening the freeway in some segments and converting in others

The City/County Association of Governments of San Mateo County (C/CAG) is moving forward on a Project Study Report – Project Development Support (PSR-PDS) for the Staged Hybrid HOV lane project.

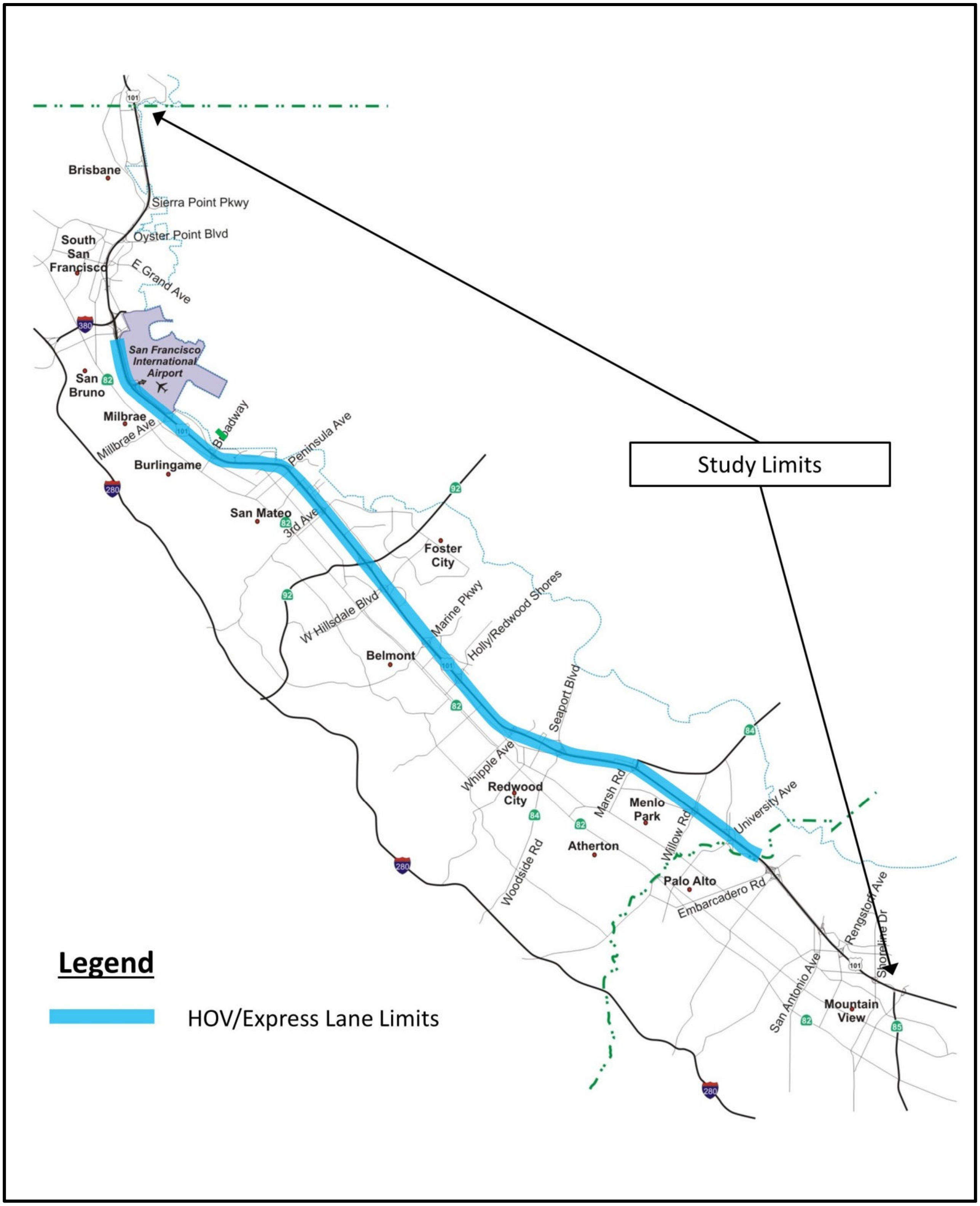
The purpose of this study is to perform a preliminary high level conceptual feasibility assessment of two express lane options, to help determine if these additional options might have some fatal flaws that might preclude them from meriting further detailed analyses.

The two concepts are:

- Concept 1: HOV-to-Express Lane Conversion (Hybrid HOT). This concept assumes the same freeway cross section as the proposed Staged Hybrid HOV Lane option from the feasibility study (which involves limited lane additions to the freeway), and converts the HOV Lane into an Express Lane.
- Concept 2: Optimized Express Lane (Convert HOT). This concept retains the current freeway cross section (i.e. no additional widening), and converts the number one (leftmost) general purpose lane directly into an Express Lane.

The HOV/express lane would extend between the San Mateo – Santa Clara county line and the I-380 interchange. In order to capture potential corridor effects, the study limits are extended to the SR 85 interchange to the south, and to the San Mateo – San Francisco county line to the north. Exhibit 2 provides a map of the study limits.

Exhibit 2: Study Limits



STUDY APPROACH

Since this was a conceptual feasibility study to determine if the two concepts had potential fatal flaws that might preclude them from consideration for further analysis, the general approach for this study was to use available data, information, and traffic models from the 2012 study, so that the new results can be compared to the older results on a consistent basis. This includes applying the previous 2040 traffic forecast developed for the Staged Hybrid HOV Lane for Concept 1, and extrapolating the previous 2030 convert HOV lane traffic forecast to 2040 conditions, for Concept 2. In addition, traffic operations analysis was focused primarily along the US 101 mainline, with a high-level assessment of other major roadways using information produced by the C/CAG travel demand model.

The study began with an assessment of available capacity in the HOV/express lane to carry additional tolled single occupancy vehicles. Next, freeway traffic operations analysis was conducted using previously calibrated FREQ models for the two concepts.

A secondary assessment was then conducted to determine what demand shifts would be necessary under Concept 2 to achieve the same freeway performance improvements as Concept 1, should the objective be to maintain the performance benefits expected under Concept 1. Using the operations analysis results, a sensitivity analysis was conducted to estimate the needed mode, route and time shifts for Concept 2 to achieve freeway performance that is similar to Concept 1.

Finally, preliminary conceptual cost estimates for both concepts were developed for comparison purposes.

TRAVEL DEMAND FORECAST

This section presents the assumptions and methods in developing the Year 2040 traffic forecast volumes, as well as estimated available capacity in the proposed HOV/express lane for tolled single occupancy vehicles.

ASSUMPTIONS

Assumptions used to develop adjusted demand profiles for the express lane are summarized as follows:

- Under both concepts, the Express Lane would extend from the Santa Clara County line to I-380 in San Bruno. The occupancy requirement for free use of the express lane would remain 2+ persons.
- Express lane capacity is 1,650 vehicles per hour (vph).
- Express lane is a continuous-access type facility (as opposed to limited access)
- Source of the original proposed HOV lane demand volumes are:
  - **Concept 1:** The source of HOV lane demand volumes was extracted from the Staged Hybrid HOV Lane Study, which reflects 2040 conditions. These 2040 forecast volumes were developed by extrapolating 2030 forecast volumes developed previously. No additional mode shift, route shift, or time of day shifts, and no change in transit service were assumed beyond those already built into the forecast by the C/CAG model run used to develop the original forecasts.
  - **Concept 2:** The original HOV demand volumes developed for this scenario reflect 2030 conditions, and therefore, a linear extrapolation technique was applied to estimate 2040 demand volumes. No additional mode shift, route shift, or time of day shifts, and no change in transit service was assumed beyond those already built into the forecast by the C/CAG model run used to develop the original forecasts. In addition, no additional mode, route, or time of day shifts were assumed between 2030 and 2040.
- Since a continuous-access configuration is assumed, and that the actual toll collection interval and enforcement locations are to be determined, in order to avoid illogical short trips that enter and exit the express lane over a very short distance, available capacity was evaluated every 3 miles. This provides a reasonable distance for vehicles to change lane(s) to enter and exit the express lane, and stay in the express lane for a certain length to realize potential benefits. To maintain express lane operating conditions, the minimum available capacity of each 3-mile section is identified.

POTENTIAL EXPRESS LANE VOLUMES

The first task of this analysis was to determine the changes to the demand volume profiles to represent shifting of the Single Occupancy Vehicle (SOV) drivers into the express lane where there is available capacity under each concept.

Available express lane capacity for both concepts is summarized in Exhibit 3 through Exhibit 6. Detailed original HOV lane demand volume and potential total express lane volume for all detailed segments along the corridor are included in Appendix 1. It includes results for both Concept 1 and Concept 2, for the northbound and southbound conditions. AM conditions were evaluated for a 4-hour period, and PM conditions were evaluated for a 5-hour period.

Note that as highlighted in the tables in Appendix 1, the original HOV demand volumes (without additional tolled SOVs) would already exceed the presumed 1,650 vph capacity in some cases. Available capacity for tolled vehicles is higher during the shoulder peak hours, and is also higher in the southbound direction. The tables below summarize the anticipated available capacity in the express lane for toll paying vehicles during the peak hours. In addition, a final adjustment was made to computed values based on 2011 information available from Caltrans HOV Lane Degradation Determination Report (July, 2013), where HOV lanes currently operate at degraded conditions were identified.

Exhibit 3: Available Capacity in Express Lane – Concept 1 (Hybrid HOT) AM Peak Period

Segment	Southbound				Northbound			
	6 – 7 AM	7 -8 AM	8 – 9 AM	9 – 10 AM	6 – 7 AM	7 -8 AM	8 – 9 AM	9 – 10 AM
I-380 to Millbrae Ave.	814	299	405	607	210	0	0	139
Millbrae Ave. to Poplar/ Peninsula	857	370	491	618	161	0	0	63
Poplar/ Peninsula to SR 92	702	266	463	566	118	0	0	24
SR 92 to Holly	664	138	327	426	386	0	0	0
Holly to Woodside	0 *	0 *	0 *	0 *	450	0	0	0
Woodside to Marsh	0 *	0 *	0 *	0 *	449	0	0	0
Marsh to Santa Clara County Line	0 *	0 *	0 *	0 *	406	0	0	0

Shaded cells indicate HOV lane demand volumes exceed capacity of 1,650, and therefore, there would be no capacity available for additional tolled vehicles.
* Additional adjustments were made based on information available from Caltrans HOV Lane Degradation Determination Report (July, 2013)

Exhibit 4: Available Capacity in Express Lane – Concept 1 (Hybrid HOT) PM Peak Period

Segment	Southbound					Northbound				
	2:30 – 3:30 PM	3:30 – 4:30 PM	4:30 – 5:30 PM	5:30 – 6:30 PM	6:30 – 7:30 PM	2:30 – 3:30 PM	3:30 – 4:30 PM	4:30 – 5:30 PM	5:30 – 6:30 PM	6:30 – 7:30 PM
I-380 to Millbrae Ave.	153	142	0	0	9	0	0	0	0	189
Millbrae Ave. to Poplar/ Peninsula	40	0	0	0	0	0	0	0	0	144
Poplar/ Peninsula to SR 92	77	6	0	0	23	0	0	0	0	98
SR 92 to Holly	0	0	0	0	139	0	0	0	0	122
Holly to Woodside	0	0	0	0	0 *	49	0	0	78	238
Woodside to Marsh	0 *	0 *	0 *	0 *	0 *	178	38	0	38	276
Marsh to Santa Clara County Line	0 *	0 *	0 *	0 *	0 *	191	64	0	91	230

Shaded cells indicate HOV lane demand volumes exceed capacity of 1,650, and therefore, there would be no capacity available for additional tolled vehicles.
* Additional adjustments were made based on information available from Caltrans HOV Lane Degradation Determination Report (July, 2013)

Exhibit 5: Available Capacity in Express Lane – Concept 2 (Optimized HOT) AM Peak Period

Segment	Southbound				Northbound			
	6 – 7 AM	7 -8 AM	8 – 9 AM	9 – 10 AM	6 – 7 AM	7 -8 AM	8 – 9 AM	9 – 10 AM
I-380 to Millbrae Ave.	818	320	453	639	291	0	0	144
Millbrae Ave. to Poplar/ Peninsula	872	409	547	651	148	0	0	122
Poplar/ Peninsula to SR 92	656	205	472	509	98	0	0	44
SR 92 to Holly	605	46	246	333	385	0	0	103
Holly to Woodside	0 *	0 *	0 *	0 *	421	0	0	0
Woodside to Marsh	0 *	0 *	0 *	0 *	363	0	0	0
Marsh to Santa Clara County Line	0 *	0 *	0 *	0 *	315	0	0	0

Shaded cells indicate HOV lane demand volumes exceed capacity of 1,650, and therefore, there would be no capacity available for additional tolled vehicles.
* Additional adjustments were made based on information available from Caltrans HOV Lane Degradation Determination Report (July, 2013)

Exhibit 6: Available Capacity in Express Lane – Concept 2 (Optimized HOT) PM Peak Period

Segment	Southbound					Northbound				
	2:30 – 3:30 PM	3:30 – 4:30 PM	4:30 – 5:30 PM	5:30 – 6:30 PM	6:30 – 7:30 PM	2:30 – 3:30 PM	3:30 – 4:30 PM	4:30 – 5:30 PM	5:30 – 6:30 PM	6:30 – 7:30 PM
I-380 to Millbrae Ave.	179	207	13	0	71	63	0	0	0	252
Millbrae Ave. to Poplar/ Peninsula	63	17	0	0	28	14	0	0	0	211
Poplar/ Peninsula to SR 92	93	57	0	0	65	0	0	0	0	161
SR 92 to Holly	0	31	0	0	157	107	0	0	0	233
Holly to Woodside	0	0	0	0 *	0 *	99	0	0	143	279
Woodside to Marsh	0	0 *	0 *	0 *	0 *	102	0	0	0	221
Marsh to Santa Clara County Line	0 *	0 *	0 *	0 *	0 *	118	0	0	15	158

Shaded cells indicate HOV lane demand volumes exceed capacity of 1,650, and therefore, there would be no capacity available for additional tolled vehicles.
* Additional adjustments were made based on information available from Caltrans HOV Lane Degradation Determination Report (July, 2013)

Under both concepts there is not a great deal of excess capacity in the express lane during the AM and PM peak periods that could be sold to single occupant vehicles. In general, available capacity for tolled vehicles would occur during the shoulder peak hours, such as before 7 AM, after 9 AM, before 3:30 PM, and after 6:30 PM, and not available during the worst peak hours within the peak period. In addition, some sections of the express lane would have no capacity for the entire peak period. Availability for tolled vehicles is summarized as follows:

- Northbound AM: up to 450 vph (for 2 hours out of the 4 hour AM peak period).
- Northbound PM: up to 280 vph (for 2 hours out of the 5 hour PM peak period).
- Southbound AM: up to 870 vph (for 2 hours out of the 4 hour AM peak period), not available south of Holly Street.
- Southbound PM: up to 200 vph (for 2 hours out of the 5 hour PM peak period), not available south of Holly Street.

The potential tolled vehicle volumes were estimated from an available capacity perspective, and depending on the traffic operational conditions in the mixed-flow lanes (i.e. congested vs free-flow), the actual number of vehicles willing to pay into the express lane may vary. However, based on other existing express lane corridors (such as I-680 southbound corridor in Alameda County, and the I-95 corridor in Miami), it was observed that SOVs were willing to pay into the toll lane even though the mixed-flow lanes were not congested, as drivers may have a preference for the perceived reliability of an express lane.

FREEWAY OPERATIONS ANALYSIS

This section presents assumptions, methods and results of the freeway traffic operations analysis.

ASSUMPTIONS

Assumptions used to develop adjusted demand profiles for the express lane concepts are summarized as follows:

- For Concept 1 (Hybrid HOT): lane configuration previously assumed for the Staged Hybrid HOV FREQ Model was used.
- For Concept 2 (Convert HOT): lane configuration previously assumed for the HOV Convert Lane FREQ model between Whipple Road and I-380 was used, north of I-380, lane configuration is assumed to be the same as baseline conditions.
- The on-going construction of second HOV lanes in each direction between Oregon Expressway/Embarcadero Road and SR 85 was assumed to be part of the 2040 roadway network under both concepts.

TRAFFIC OPERATION ANALYSIS AND RESULTS COMPARISONS

Freeway operations analyses were conducted using FREQ models developed and calibrated for the Staged Hybrid HOV Lane Study, to maintain consistency in tool selection and methodologies. Results for both the Baseline and Staged Hybrid HOV Lane conditions were extracted from the previous 2012 Staged HOV Lane Analysis.

Traffic forecast results and estimated toll vehicles from the previous section were applied to the traffic operations models for the analysis. An opposite adjustment was applied to the mixed-flow lane demand volumes for traffic operations analysis (i.e. reduce the total mixed-flow lane demands by the estimated toll paying vehicles).

Freeway Performance Measures

In terms of freeway operations results, compared to the Staged Hybrid HOV Lane option that is currently in the PSR-PDS stage, Concept 1 would provide improvements for the mixed-flow lanes, while Concept 2 would result in both longer queues and higher delays for the mixed-flow lanes in most cases. The corridor-wide mobility performance results for Year 2040 are summarized in Exhibit 7.

In summary, comparing Concept 1 to the 2040 Staged Hybrid HOV lane option:

- Overall US 101 freeway productivity would be slightly improved with a 0.4% increase in VMT, and a 1.1% increase in PMT.
- Vehicle hours of travel and vehicle hours of delay would be reduced by 1.6% and 3.2%, respectively.

- Average peak period speeds for both vehicle and person trips would be increased more than 2%.
- These performance improvements are primarily due to the available capacity provided by the HOT lane to serve tolled vehicles through the corridor.

Comparing Concept 2 to the 2040 Staged Hybrid HOV lane option:

- Overall US 101 freeway productivity would be degraded with a 6% decrease in VMT, and 5% decrease in PMT. This is primarily related to the reduced capacity through the corridor, as well as the predicted effect of the reduced capacity on future peak period traffic demand for the US 101 freeway.
- Vehicle hours of travel and vehicle hours of delay would be increased by 0.2% and 4.7%, respectively.
- Average peak period speeds for both vehicle and person trips would be reduced by 4% to 6%.
- The increase in both the vehicle hours of travel and vehicle hours of delay, and the reduction in speeds are primarily due to the reduced capacity through the corridor, which in turn, resulted in more congestion.

Exhibit 7: 2040 Freeway Corridor Performance Comparison

Performance Measures	2040 Baseline	2040 Staged Hybrid HOV	Concept 1 - Hybrid HOT	Concept 2 - Convert HOT	Concept 1 vs Staged Hybrid HOV	Concept 2 vs Staged Hybrid HOV
VMT – vehicle miles of travel	4,925,100	5,145,600	5,166,500	4,836,400	0.4%	-6.0%
VHT – vehicle hours of travel	196,000	187,000	184,000	187,400	-1.6%	0.2%
VHD – vehicle hours of delay	120,400	107,800	104,400	113,000	-3.2%	4.7%
PMT – person miles of travel	5,197,700	5,839,900	5,901,700	5,573,000	1.1%	-4.6%
PHD – person hours of delay	120,600	109,200	105,800	113,400	-3.2%	3.8%
Average vehicle speed (MPH)	25.1	27.5	28.1	25.8	2.1%	-6.2%
Average person speed (MPH)	25.9	29.3	30.0	28.0	2.3%	-4.6%

Source: FREQ analysis, both HOV and mixed-flow lanes, AM and PM peak periods combined.

Freeway Travel Times

Exhibit 8 provides a summary of freeway travel times.

Comparing Concept 1 (Hybrid HOT lane option) to the 2040 Staged Hybrid HOV lane option:

- Mixed-flow lane travel times for northbound AM, northbound PM, and southbound PM peak periods, would improve slightly (less than 1%). This is primarily due to the HOT lane not having substantial capacity for tolled vehicles.
- Southbound AM maximum peak hour mixed-flow lane travel times would be reduced by 12 minutes, or 15%, as a result of this scenario having the most capacity available for tolled vehicles.

Comparing Concept 2 (Convert HOT lane option) to the 2040 Staged Hybrid HOV lane option:

- Substantial increases to mixed-flow lane travel times would occur in the northbound AM, northbound PM, and southbound AM peak periods.
- During the AM peak period in the northbound direction, maximum travel times would be increased by about 20 minutes (or 12%).
- During the PM peak period in the northbound direction, maximum travel times would be increased by about 98 minutes (or 51%).
- During the AM peak period in the southbound direction, maximum travel times would be increased by about 43 minutes (or 52%).
- During the PM peak period in the southbound direction, travel times would be reduced by 32 minutes (or 21%).

For Concept 2, travel time increases in the northbound AM, northbound PM, and southbound AM peak periods are primarily associated with additional congestion caused by converting a mixed-flow lane (with a capacity of 1900 vehicles per hour) to a HOT lane (with a target operating capacity of 1650 vehicles per hour). Under the southbound PM peak period conditions, mixed-flow lane travel times are reduced primarily due to two reasons:

1. Lower travel demand volumes for US 101 with Concept 2, which results in less congestion north of the Oyster Point Boulevard bottleneck.
2. No freeway bottlenecks are expected to develop between I-380 and Whipple Road, where the lane conversion would occur.

Note that this analysis does not consider impacts to other travel modes or alternative routes.

In terms of the time it would take to travel the entire length of study corridor on the mixed-flow lanes, Concept 2 would result in longer travel times of about 20 minutes than under Concept 1 in the northbound direction during the AM peak hour, and up to about 99 more minutes than under Concept 1 during the PM peak hour. In the southbound direction, Concept 2 would require about 55 minutes longer during the AM peak hour. Travel times would be reduced by 31 minutes during the PM peak hour.

Exhibit 8: Year 2040 Freeway Travel Time Comparison

Dir/Peak	Average Peak Period Travel Time												Comparison of Mixed-Flow Travel Times vs Staged Hybrid HOV Option	
	Baseline			Staged Hybrid HOV Lane			Concept 1 Hybrid HOT Lane			Concept 2 Convert HOT Lane				
	Mixed-Flow (mins.)	HOV (mins.)	HOV TT Savings (mins.)	Mixed-Flow (mins.)	HOV (mins.)	HOV TT Savings (mins.)	Mixed-Flow (mins.)	HOT (mins.)	HOT TT Savings (mins.)	Mixed-Flow (mins.)	HOT (mins.)	HOT TT Savings (mins.)	Concept 1 (Hybrid HOT) % (mins.)	Concept 2 (Convert HOT) % (mins.)
Northbound AM	108.6	54.5	54.1	110.2	47.3	62.9	110.1	47.3	62.8	127.4	41.7	85.7	0% (-0.1)	16% (17.2)
Northbound PM	169.0	61.4	107.6	135.6	50.8	84.8	133.8	50.8	83.0	168.1	41.5	126.6	-1% (-1.8)	24% (32.5)
Southbound AM	70.5	69.6	0.9	63.7	43.2	20.5	57.3	41.0	16.3	79.9	40.1	39.8	-10% (-6.4)	25% (16.2)
Southbound PM	95.6	61.6	34.0	100.2	61.9	38.3	99.5	61.9	37.6	82.9	46.8	36.1	-1% (-0.7)	-17% (-17.3)

Dir/Peak	Maximum Peak Hour Travel Time													
	Baseline			Staged Hybrid HOV Lane			Concept 1 Hybrid HOT Lane			Concept 2 Convert HOT Lane				
	Mixed-Flow (mins.)	HOV (mins.)	HOV TT Savings (mins.)	Mixed-Flow (mins.)	HOV (mins.)	HOV TT Savings (mins.)	Mixed-Flow (mins.)	HOT (mins.)	HOT TT Savings (mins.)	Mixed-Flow (mins.)	HOT (mins.)	HOT TT Savings (mins.)	Concept 1 (Hybrid HOT) (mins.)	Concept 2 (Convert HOT) (mins.)
Northbound AM	161.8	63.3	98.5	169.3	52.1	117.2	169.3	53.0	116.3	188.9	42.8	146.1	0% (0)	12% (19.6)
Northbound PM	249.7	75.5	174.2	189.9	65.0	124.9	188.2	64.2	124.0	287.4	43.1	244.3	-1% (-1.7)	51% (97.5)
Southbound AM	105.9	105.9	0.0	82.5	47.3	35.2	70.2	43.8	26.4	125.3	42.9	82.4	-15% (-12.3)	52% (42.8)
Southbound PM	139.8	88.4	51.4	149.9	79.9	70.0	148.8	90.2	58.6	118.4	56.4	62.0	-1% (-1.1)	-21% (-31.5)

Source: Peak period average travel times from FREQ analysis, including congestion beyond study limits south of SR 85 interchange (13 miles), and north of the San Francisco county line (9 miles). Total distance is approximately 43 miles for the northbound direction, and 39 miles for the southbound direction.
Note: travel times presented for HOV/HOT lane includes travel times for the full length of the greater study corridor beyond study limits. In the northbound direction, carpool vehicles on the HOV lane is assumed to be in free-flow conditions upstream of the study area, or south of SR 85, based on evaluation of HOV demand volumes. In the southbound direction, there is no HOV lane upstream of the study area at Harney Way interchange, therefore carpool vehicles are assumed to experience the same amount of travel as the mixed-flow traffic upstream of the study area.

Freeway Bottlenecks and Queues

Bottleneck and queuing results are shown on Exhibit 9 and Exhibit 10, for the AM and PM peak periods, respectively.

Concept 1 Hybrid HOT Lane Option

Northbound AM Peak – During the AM peak period, 7 bottlenecks would develop in the following freeway segments:

- Rengstorff Avenue loop off-ramp to on-ramp
- Willow Road diagonal off-ramp to loop on-ramp
- Woodside Road off-ramp to on-ramp
- Kehoe Avenue on-ramp to 3rd Avenue off-ramp
- 3rd Avenue on-ramp to Dore Avenue off-ramp
- Broadway on-ramp to Millbrae off-ramp
- Bayshore Boulevard off ramp to Sierra Point Parkway off-ramp

By the height of the peak period (when delay or travel time through the corridor is the longest), it would take approximately 169 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 128 minutes are associated with delay due to bottleneck and queuing effects. Three of the bottlenecks, Rengstorff Avenue, Kehoe Avenue, and Broadway, will have become hidden by queues from the downstream bottlenecks. The Rengstorff Avenue bottleneck will be hidden by queues extending south approximately 10 miles beyond the SR-85 study limit from the Willow Road bottleneck, resulting in a total queue length of 16.3 miles. The Kehoe Avenue bottleneck will be embedded in a 2-mile queue extending to the Hillsdale Boulevard interchange from the 3rd Avenue bottleneck. Similarly, the Broadway bottleneck will be embedded in a 6-mile queue extending to south of the Broadway on-ramp from the Bayshore Boulevard bottleneck. The Woodside Road bottleneck would result in queues extending to the Marsh interchange, or approximately 1.7 miles.

Northbound PM Peak – During the PM peak period, 8 bottlenecks would develop in the following freeway segments:

- Rengstorff Avenue loop off-ramp to on-ramp
- Marsh Road loop on–ramp to diagonal on-ramp
- Kehoe Avenue on-ramp to 3rd Avenue off-ramp
- 3rd Avenue on-ramp to Dore Avenue off-ramp
- Anza Boulevard on-ramp to Broadway off-ramp
- Broadway on-ramp to Millbrae Avenue off-ramp
- Sierra Point Parkway on-ramp to Harney Way off-ramp
- Harney Way on-ramp to 3rd Street off-ramp

By the height of the peak period, it would take approximately 188 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 148 minutes are associated with delay due to bottleneck and queuing effects. The Rengstorff Avenue bottleneck will be hidden by queues extending south approximately 11 miles beyond the SR-85 study limit from the Marsh Road bottleneck, resulting in a total queue length of 19 miles. The Kehoe bottleneck would result in queues extending to south of the Whipple Avenue interchange, or approximately 6.4 miles in length. Queues associated with the 3rd Avenue and Broadway on-ramp bottlenecks would be relatively short and would be contained within the interchanges. The Anza Boulevard bottleneck would result in queues extending to south of the Peninsula interchange, or approximately 2 miles in length. The Sierra Point bottleneck would result in queues extending to south of the San Bruno on-ramp, or approximately 3 miles in length. The short queues resulting from the Harney Way on-ramp would develop earlier in the peak period and dissipate by the height of the peak.

Southbound AM Peak – During the AM peak period, 7 bottlenecks would develop in the following freeway segments:

- Beatty Road on-ramp to Sierra Point Parkway off-ramp
- SFO Airport on-ramp from international terminal to on-ramp from domestic terminal
- Poplar Avenue on-ramp to 3rd Avenue off-ramp
- Hillsdale Boulevard loop on-ramp to diagonal on-ramp
- Willow Road loop off-ramp to diagonal on-ramp
- University Avenue off-ramp to on-ramp
- Oregon Expressway on-ramp to San Antonio Road off-ramp

By the height of the peak, it would take approximately 70 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 32 minutes are associated with delay due to bottleneck and queuing effects. The Beatty Road bottleneck would result in queues extending approximately 1.2 miles beyond the study limit into the San Francisco County. The SFO bottleneck would result in queues extending to south of the I-380 on-ramp, or less than 1 mile. The Poplar Avenue bottleneck will become hidden by the 7-mile queue from the downstream bottleneck at Hillsdale. The Willow Road bottleneck will become hidden by the 1-mile queue from the downstream bottleneck at University. Queues associated with the Oregon Expressway bottleneck would be relatively short and would extend to just north of the interchange.

Southbound PM Peak – During the PM peak period, 2 bottlenecks would develop in the following freeway segments:

- Oyster Point Boulevard on-ramp to Miller Avenue off-ramp
- Rengstorff Avenue on-ramp to Old Middlefield Way on-ramp

By the height of the peak, it would take approximately 149 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 111 minutes are associated with delay due to bottleneck and queuing effects. For the bottleneck at Oyster Point Boulevard, queues would extend approximately 10 miles beyond the study limit into San Francisco County, resulting in a total queue length of 14 miles. Queues resulting from the Rengstorff Avenue bottleneck would extend to the Holly Street interchange, or approximately 11 miles.

Concept 2 Convert HOT Lane Option

Northbound AM Peak – During the AM peak period, 4 bottlenecks would develop in the following freeway segments:

- Rengstorff Avenue loop off-ramp to on-ramp
- Willow Road loop off-ramp to loop on-ramp
- 3rd Avenue off-ramp to on-ramp
- Broadway on-ramp to Millbrae off-ramp

By the height of the peak (when delay or travel time through the corridor is the longest), it would take approximately 189 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 149 minutes are associated with delay due to bottleneck and queuing effects. Two of the bottlenecks, Rengstorff Avenue and Willow Road, will have become hidden by queues from the downstream bottleneck at 3rd Avenue. The combined queues would extend south approximately 12 miles beyond the SR-85 study limit from the Willow Road bottleneck, resulting in a total queue length of 30 miles. Queues associated with the Broadway bottleneck would develop earlier in the peak period and will have dissipated by the height of the peak.

Northbound PM Peak – During the PM peak period, 5 bottlenecks would develop in the following freeway segments:

- Rengstorff Avenue loop off-ramp to on-ramp
- Marsh Road loop on–ramp to diagonal on-ramp
- 3rd Avenue off-ramp to on-ramp
- Peninsula Avenue off-ramp to on-ramp
- Millbrae Avenue off-ramp to SFO off-ramp

By the height of the peak, it would take approximately 287 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 247 minutes are associated with delay due to bottleneck and queuing effects. Similar to the AM peak period conditions, two of the bottlenecks, Rengstorff Avenue and Marsh Road, will have become hidden by queues from the downstream bottleneck at 3rd Avenue. The combined queues would extend south approximately 12 miles beyond the SR-85 study limit from the Willow Road bottleneck, resulting in a total queue length of 30 miles. Queues associated with the Peninsula bottleneck would extend approximately 1 mile to north of the 3rd Avenue interchange. Queues associated with the Millbrae Avenue bottleneck would extend approximately less than one mile to the Broadway interchange.

Southbound AM Peak – During the AM peak period, 1 bottleneck would develop at:

- Hillsdale Boulevard loop on-ramp to diagonal on-ramp

By the height of the peak, it would take approximately 125 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 87 minutes are associated with delay due to bottleneck and queuing effects. Queues associated with the Hillsdale Boulevard bottleneck would extend approximately 10 miles to south of the Airport Boulevard on-ramp.

Southbound PM Peak – During the PM peak period, 2 bottlenecks would develop in the following freeway segments:

- Sierra Point Parkway on-ramp to Bayshore Boulevard off-ramp
- Rengstorff Avenue on-ramp to Old Middlefield Way on-ramp

By the height of the peak, it would take approximately 118 minutes for mixed-flow lane vehicles to travel through the entire corridor, of which about 80 minutes are associated with delay due to bottleneck and queuing effects. Queues associated with the Sierra Point Parkway bottleneck would extend approximately 4 miles beyond the study limit into San Francisco County, resulting in a total queue length of 6 miles. Queues resulting from the Rengstorff Avenue bottleneck would extend to the Whipple Avenue interchange, or approximately 10 miles.

Exhibit 9: Freeway Bottleneck and Queues Comparison – 2040 AM Peak Period

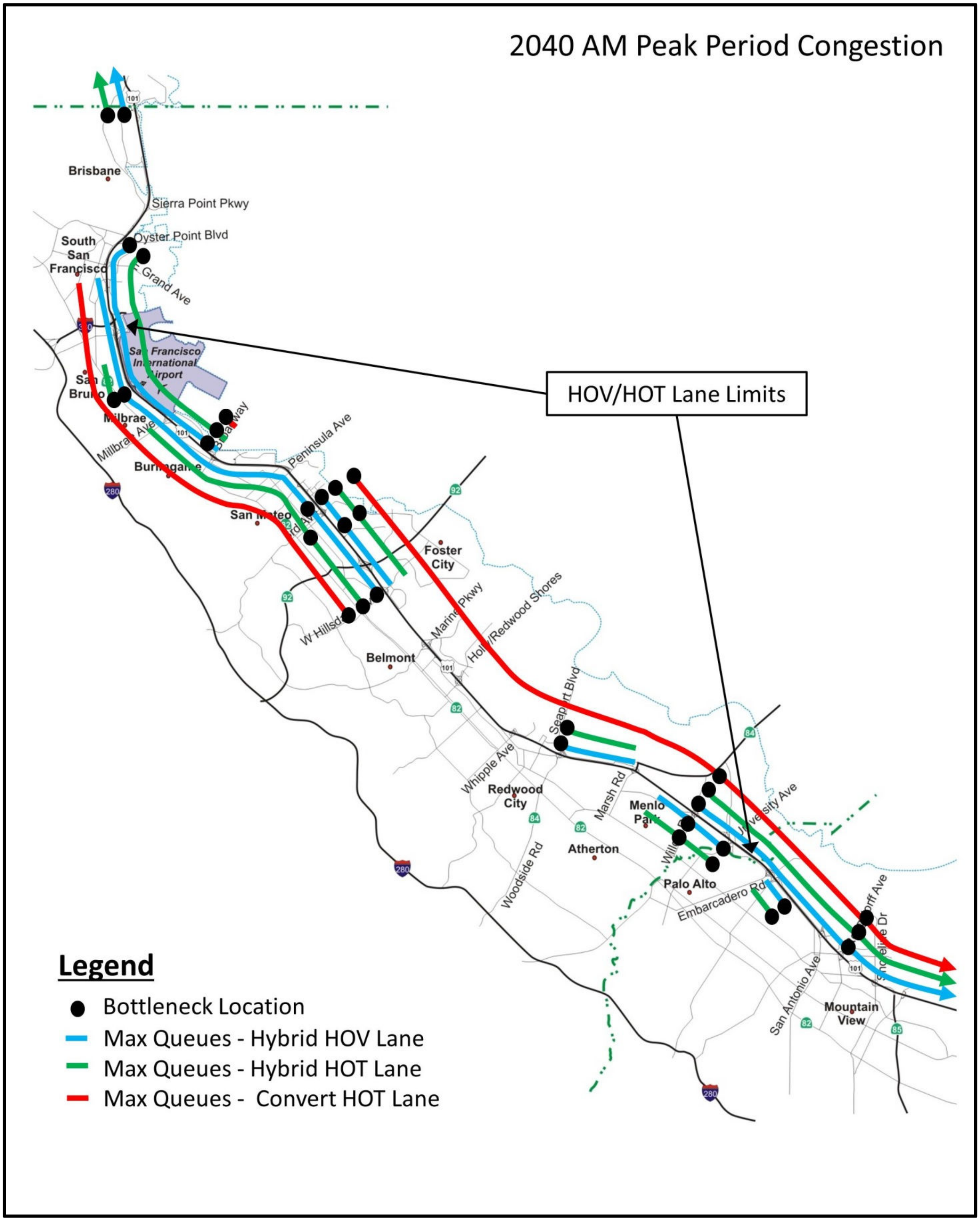
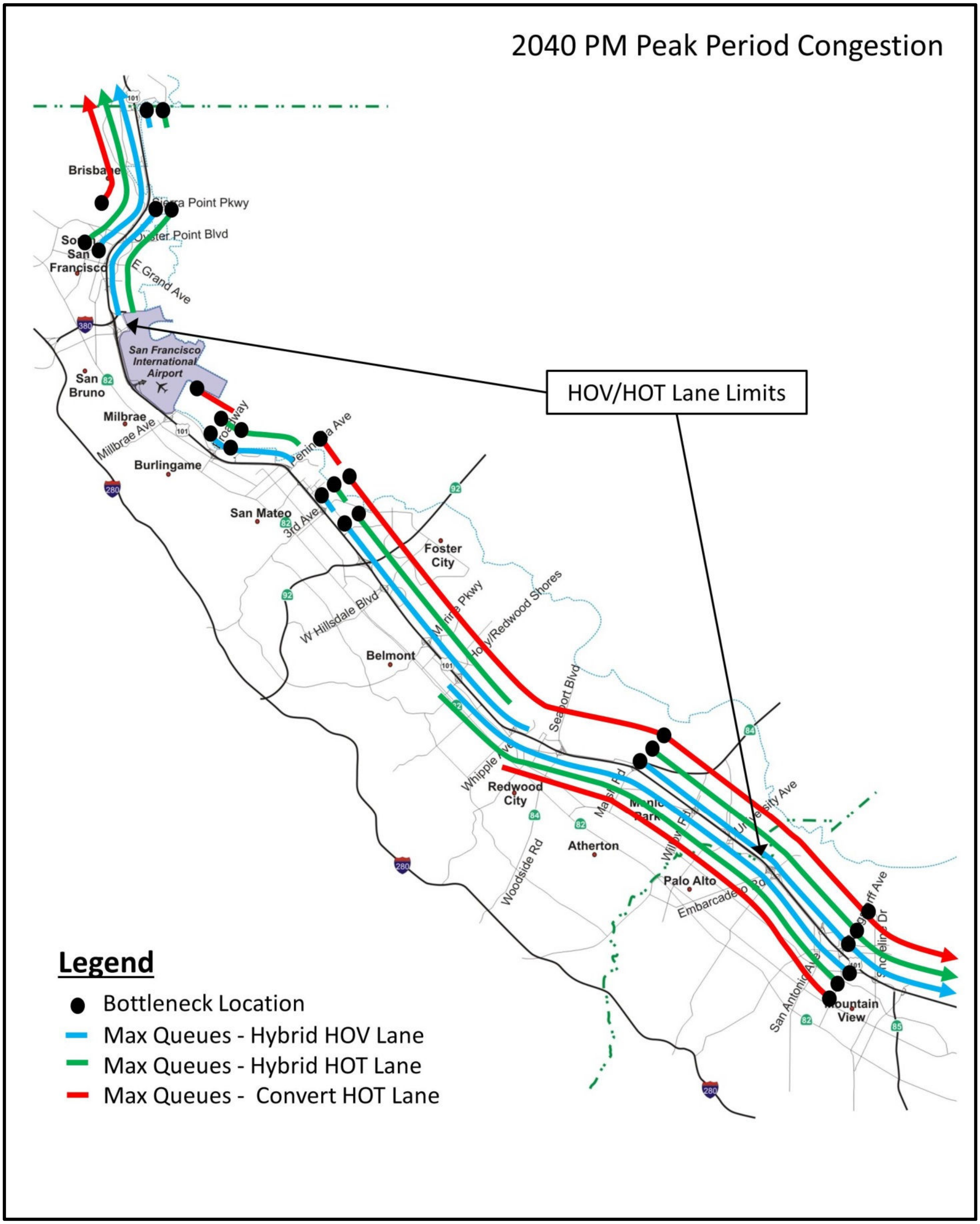


Exhibit 10: Freeway Bottleneck and Queues Comparison – 2040 PM Peak Period



MODE SENSITIVITY ANALYSIS

As shown in the freeway operations analysis results in the previous section, Concept 1 (Hybrid HOT lane) would result in slight improvements compared to the Staged Hybrid HOV lane option, with shorter travel times and improved freeway productivity (as demonstrated with an increased vehicle- and person-miles traveled). Concept 2 (Convert HOT lane) would operate with slower travel times through the corridor with a lower freeway productivity (as demonstrated with a reduced vehicle- and person-miles traveled) compared to both the Staged Hybrid HOV lane and the Hybrid HOT lane options, for the northbound AM, northbound PM, and southbound AM peak periods.

To achieve the same improved freeway performance with Concept 2 as is predicted for Concept 1, ways must be found to discourage vehicle trips from using the US 101 freeway during the peak period. This is above and beyond the demand shifts already forecasted by the C/CAG demand model due to the freeway capacity constraints implicit in Concept 2.

This section presents an analysis of the combined level of mode/route/time of day shift from SOV to transit/vanpool (and from US 101 to El Camino Real or I-280, and from peak period to off-peak), required to achieve freeway performance similar to Concept 1, in terms of mixed-flow travel time comparison.

MODE/ROUTE/TIME OF DAY SHIFT ANALYSIS RESULTS

Based on a comparison of travel time results from the freeway operations analysis between Concept 1 and Concept 2, an analysis was conducted to determine the combined level of mode, route, and time of day shift of vehicle trips away from US 101 required for Concept 2 to achieve freeway performance similar to Concept 1. This analysis was conducted using the FREQ traffic operations model for the mainline. Through an iterative process of adjusting the entry and exit volumes of Concept 2, hour by hour, until the travel times for the entire study corridor under Concept 2 generally matched to that of Concept 1. This includes shifts from vehicle trips to transit and vanpool, from US 101 to El Camino Real or I-280, and from peak period to off-peak period. Exhibit 11 provides a summary of the peak period vehicle trip reductions required on US 101, with detailed hourly distribution illustrated Exhibit 12. Note that southbound AM peak period would require substantially more trip reduction on US 101 compared to northbound AM and PM peak periods, and based on the hourly distribution of trip reductions required, it is possible that further trip reductions are required between 10 AM and 11 AM, which was outside of the study period.

These vehicular trip reductions on US 101 are comprised of many vehicle trip lengths, including both short trips and long trips along the corridor. Potential trip reductions on US 101 would be required where Concept 2 results in more congestion than Concept 1 along the corridor, including northbound AM and PM peak periods, and southbound AM peak period. Exhibit 13 provides a map showing where vehicle trips would be required to shift away from the US 101 corridor.

Exhibit 11: Summary of Vehicle Trip Reduction Required on US 101

Direction	Time Period	No. of Vehicle Trip Reduction on 101	Total Trips on 101	% Trip Reduction
Northbound	AM Peak Period Total	1,704	34,073	5%
	AM Peak Hour	443	8,856	5%
	PM Peak Period Total	1,163	41,359	3%
	PM Peak Hour	764	8,487	9%
Southbound	AM Peak Period Total	4,551	25,771	18%
	AM Peak Hour	1,697	7,380	23%
	PM Peak Period Total	Not Required		

Exhibit 12: Hourly Distribution of Vehicle Trip Reduction Required on US 101

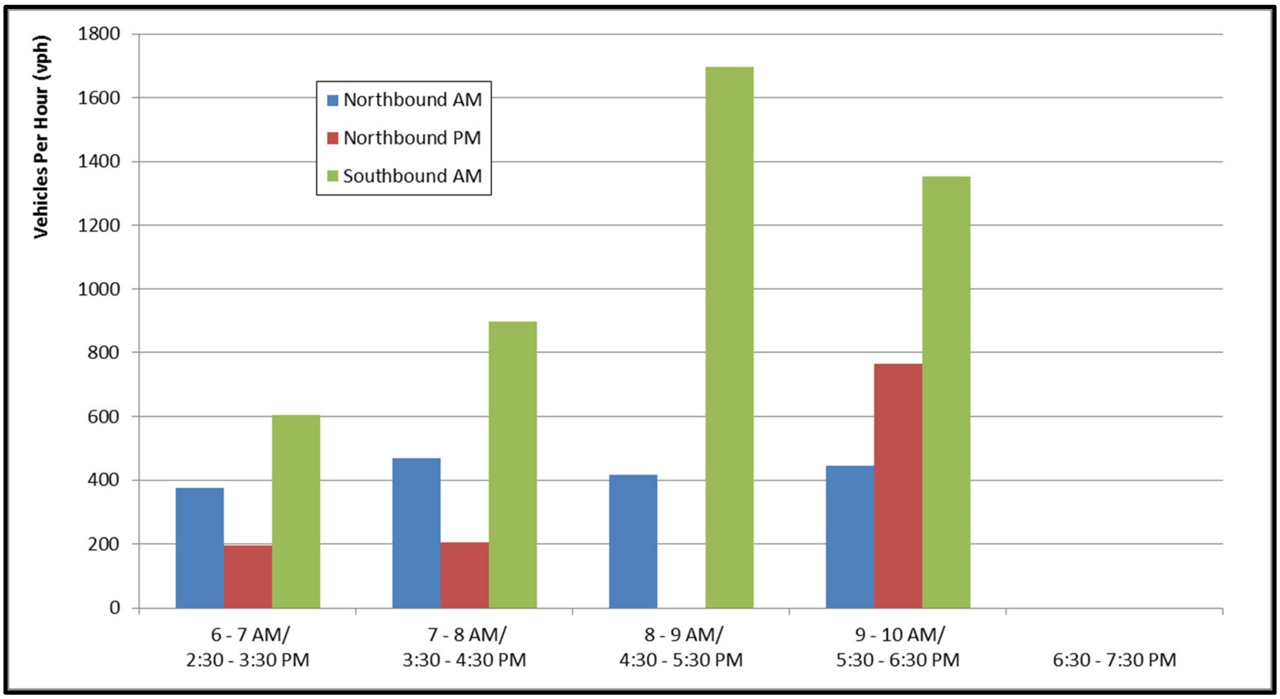
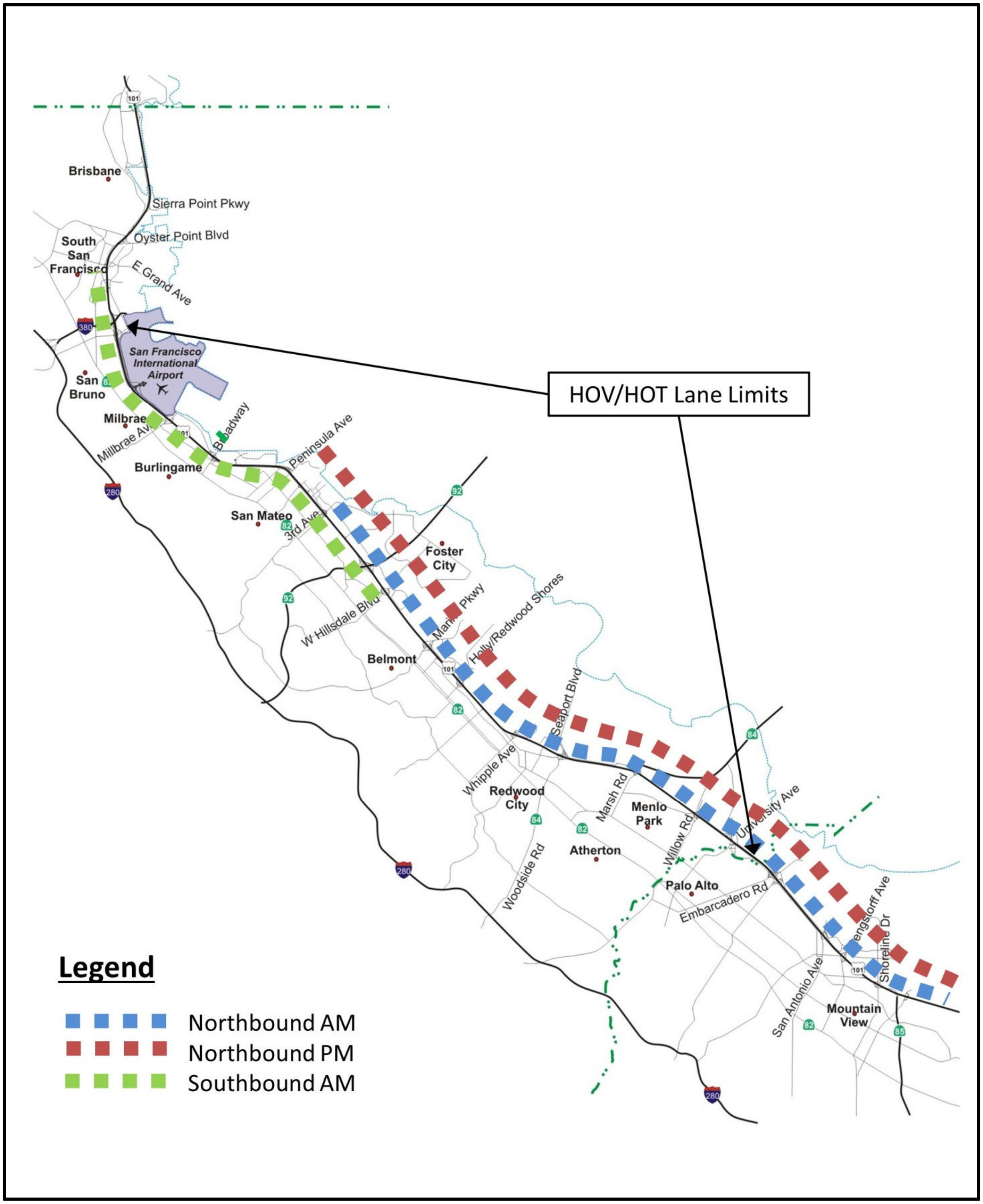


Exhibit 13: Location of Vehicle Trip Reductions Required Along US 101

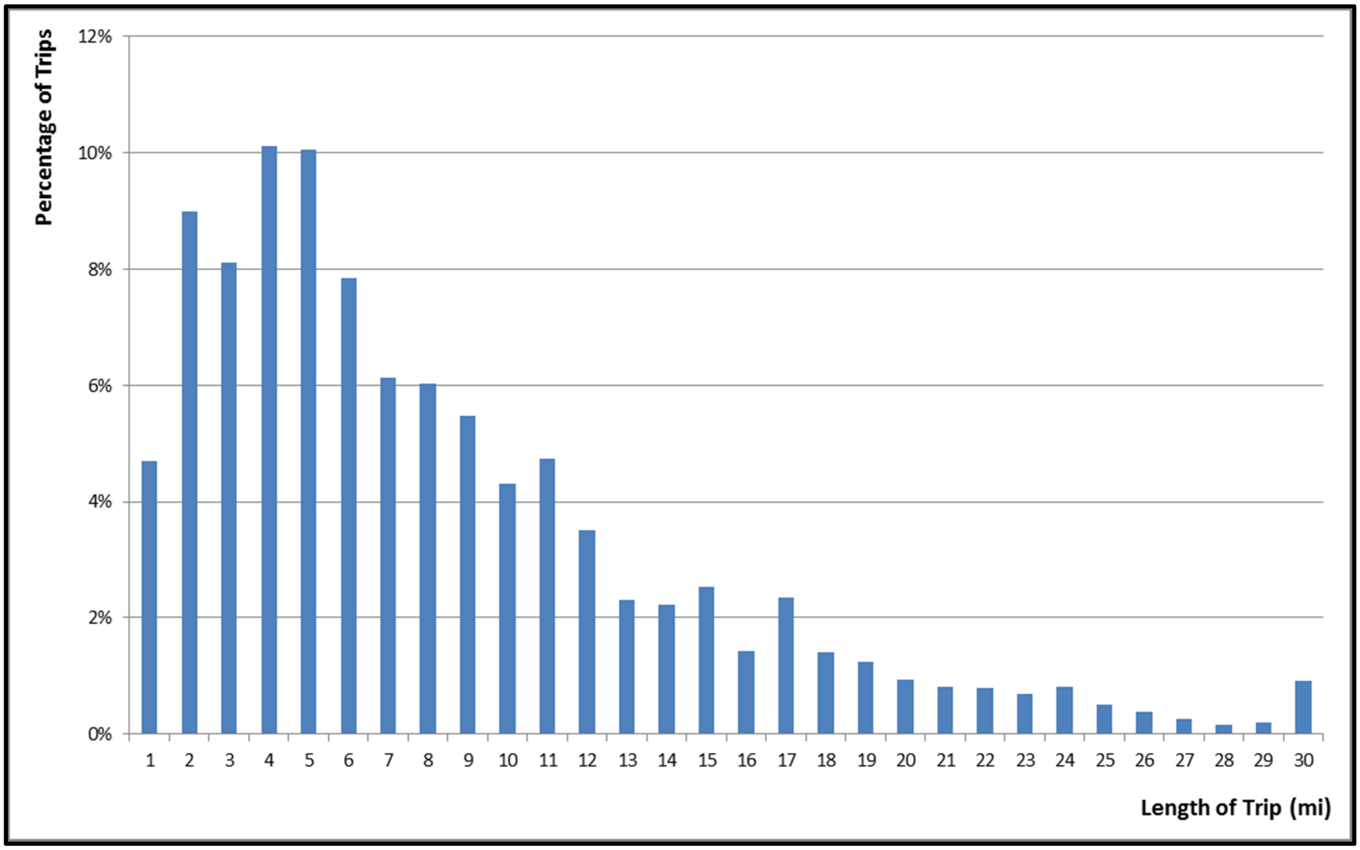


Vehicle trip reduction required on US 101 would be accomplished by several means, including mode shifts, route shifts, and time of day shifts. Mode shift includes potentially changing from driving to transit trips, and potentially changing from drive alone to two-person shared-ride, and from two-person shared-ride to three-plus shared-ride. Along the study corridor, the three primary transit operators include Samtrans buses, Caltrain and BART commuter rail systems. Potential route shifts include parallel north-south corridors in the study area, which are I-280 and El Camino Real. As a conservative assessment of potential effects on these alternative routes and transit options, it is assumed that there would be no time of day shift (away the predefined study peak periods) for this analysis. In addition, since the analysis peak periods already includes 4-hours during the AM, and 5-hours during the PM, the probability for further peak-spreading would be low.

As a first step to assess the effects of these vehicle trip shifts, it is important to consider the origin-destination trip table, which relates to trip lengths, and is a primary factor in mode choice selection.

Average vehicle trip lengths along the US 101 corridor were extracted from the freeway traffic operations model (FREQ model) developed and calibrated for this corridor. Exhibit 14 shows a summary of the origin-destination trip lengths along this 30-mile corridor between SR 85 and the San Mateo-San Francisco county line. Note that these trip lengths account for distances travelled on US 101, and do not include the entire origin to destination trip length (i.e., additional travel distances on the surface streets).

Exhibit 14: Average Trip Lengths Along US 101



General trip lengths could be characterized as follows:

- Based on the Transportation 2035 Plan for the San Francisco Bay Area, average home-based work trip lengths are in the order of 11 to 12 miles.
- Based on national average data reported by the American Public Transit Association, in 2004, the mean trip length for bus passenger trips was 3.7 miles. This reflects that bus transit trips tend to be relatively short trips.

As shown in the Exhibit 14, approximately 32% (just under one third) of all trips are 4 miles or shorter; approximately 80% of all trips are 12-miles or shorter, with the remaining 20% of the trips longer than 12 miles in length. Thus, approximately 32% of the vehicle trips currently using the US 101 freeway are candidates for shifting to bus transit. Commuter rail corridors such as Caltrain and BART typically have longer trip lengths.

POTENTIAL EFFECTS ON OTHER ROUTES AND MODES

Based on the vehicle trip lengths information presented above, location of traffic congestion along US 101, forecasted trends for volume-to-capacity ratio of other parallel routes, as well as available transit options and stop locations, an assessment was made to potential effects on other routes and modes, and results are summarized in Exhibit 15. While both Samtrans bus and Caltrain services are provided throughout the majority of the study area, BART service is only available in the northern section between Millbrae and South San Francisco. Therefore, since there would be no congestion north of Millbrae under Concept 2 in the northbound direction, diversion of vehicle trips from US 101 to BART would not achieve the goal of matching Concept 1 freeway performance for the NB direction. In the southbound direction, BART would help achieve the goal of matching Concept 1 freeway performance by absorbing a percentage of the vehicle trip shifts away from US 101, for the congested section between South San Francisco and Hillsdale. Therefore we have allocated the necessary vehicle trip reduction to achieve Concept 1 operations to bus and to trains in proportion to the percent of US 101 trip lengths that fall below 4 miles and above 4 miles. Between the other two transit options, Samtrans buses and Caltrain, it is assumed that the shorter trip riders (4 miles or shorter), would prefer to use buses, and longer trip riders would prefer to take Caltrain.

Exhibit 15: Summary of Potential Effects on Other Routes and Modes

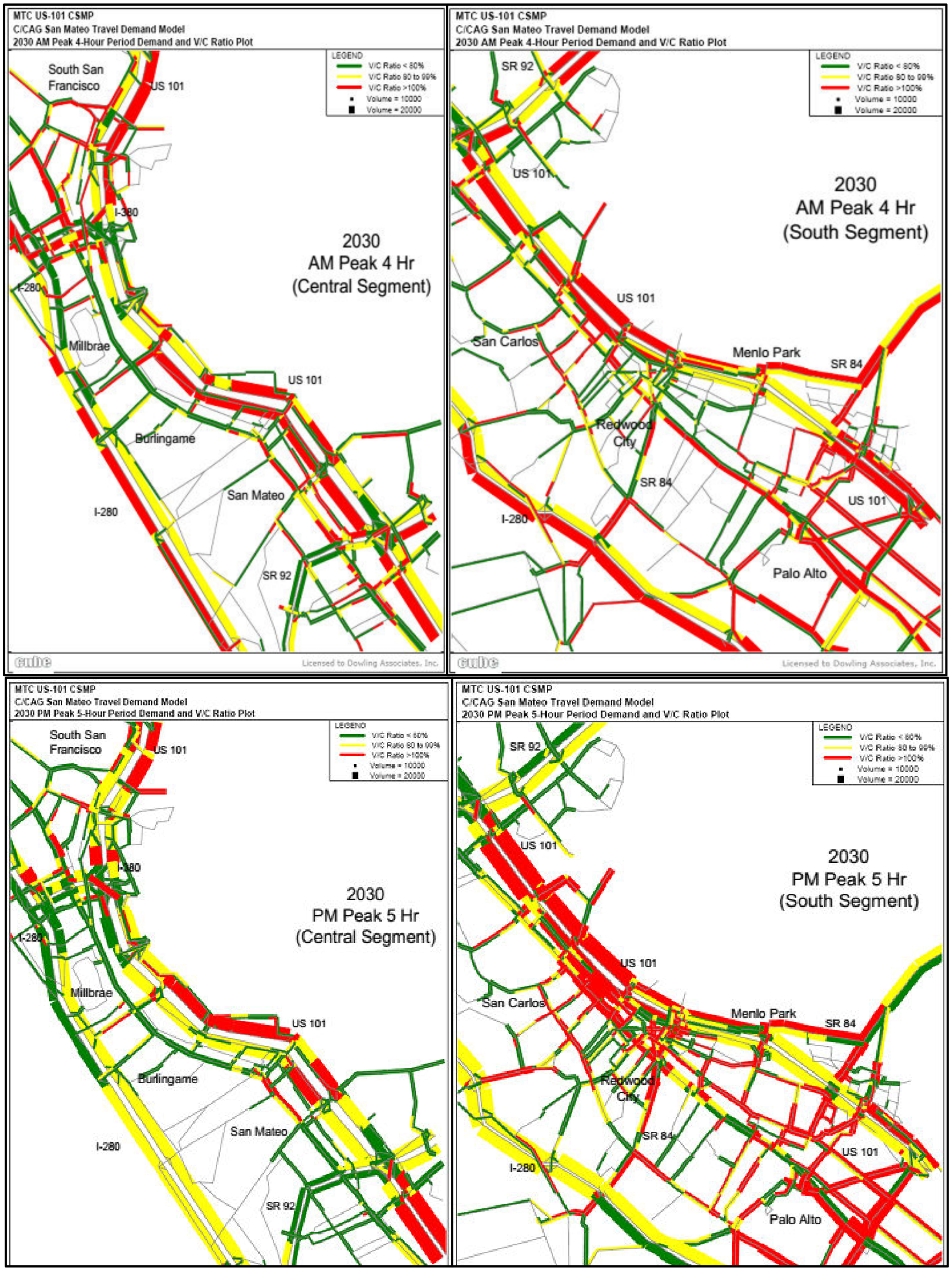
Direction	Time Period	No. of Vehicle Trip Reduction on US 101	Additional Trips *			
			Alternate Routes (El Camino Real)	Samtrans Buses **	Caltrain	BART
Peak Period Total						
Northbound	AM (6 - 10 AM)	1,704	0	545	1,159	0
Northbound	PM (2:30 - 7:30 PM)	1,163	0	372	791	0
Southbound	AM (6 - 10 AM)	4,551	1,138	1,092	1,741	580
	Total	**7,418**	**1,138**	**2,010**	**3,690**	**580**
Maximum Hour						
Northbound	AM (7 - 8 AM)	468	0	150	318	0
Northbound	PM (5:30 - 6:30 PM)	764	0	244	520	0
Southbound	AM (8 - 9 AM)	1,697	424	407	649	216
	Total	**2,929**	**424**	**802**	**1,487**	**216**

* As a conservative assumption to evaluate potential effects to other routes and transit options, no trips reductions were assumed for different time of day (i.e. no additional peak spreading is assumed).

** Based on the assumption that short trips with 4 miles or shorter will use buses.

Available capacity from alternate routes to absorb traffic from US 101, such as I-280 and El Camino Real, was assessed based on previous C/CAG model results created for the San Mateo US 101 Corridor System Management Plan. As shown in Exhibit 16, in the northbound direction during AM and PM peak periods, both I-280 and El Camino Real would be near or over capacity for a majority of each respective corridor by 2030 conditions (as shown by yellow and red bands), and therefore, would not be able to accommodate additional traffic from US 101. In the southbound direction, while I-280 would not have excess capacity, El Camino Real would be available to accommodate some traffic shift from US 101, as shown by green bands, between I-380 and 3rd Avenue interchange.

Exhibit 16: Year 2030 Peak Period Volume-to-Capacity Ratios



(Source: C/CAG Model, ABAG Projection 2005 version)

Exhibit 17 provides an assessment of the potential effects to BART, Caltrain and Samtrans buses. BART system's daily ridership would experience minor increase of less than 1%, while both Caltrain and Samtrans buses would experience an increase of approximately 8%. Note that the additional daily riders would occur during the AM and PM peak commute time periods, the percentage increase during the peak periods would be higher for all transit operators.

Exhibit 17: Effects of Daily Ridership on Transit Operators

Transit Operator	Projected Daily Riders*	Additional Daily Riders	Difference
BART	304,038	580	+ <1%
Caltrain	47,791	3,690	+ 8%
Samtrans	25,445	2,010	+ 8%

* Source: C/CAG Model 2030 conditions, ABAG Projection 2005 version. However, based on the most recent ridership information provided by BART, during FY 2013, average daily ridership is approximately 392,300. For Caltrain, the recorded average daily ridership for 2013 was 52,611. Both exceeded prior 2030 projected ridership from the C/CAG model.

Corresponding effects to each transit operator's annual operating expenses are summarized in Exhibit 18. Note that these expenses do not account for additional revenue that would be generated from the new riders. Transit service capacity were not considered in this analysis, therefore, potential additional costs, including capital costs required for new buses or train cars, would require further evaluations.

Exhibit 18: Effects of Operating Cost Effects on Transit Operators

Transit Operator	Additional Daily Riders	Operating Expense per Passenger Trip	Additional Annual Operating Expense *
BART	580	$4.12	$622,000
Caltrain	3,690	$7.50	$7,196,000
Samtrans	2,010	$7.73	$4,039,000
Total	6,280	N/A	$11,900,000
20-Year Operating Cost			**$238,000,000**

* Based on National Transit Database (2012 data)

**Annual operating expensed is estimated based on 5 days per week, 52 weeks per year.

Based on existing information provided by BART, Samtrans and Caltrain, both BART and Caltrain are near or have reached capacity during the peak commute time periods, while Samtrans buses generally have spare capacity on its services. In addition, based on current traffic conditions on El Camino Real, there is unlikely available capacity to accommodate trip diversions from US 101.

Therefore, as alternate options for El Camino Real, BART and Caltrain to accommodate the additional passenger trips, additional Samtrans express buses would be required along US 101, to represent a worse-case scenario. This includes up to 2,165 passengers during the AM peak hour and 764 passengers during the PM peak hour. Assuming a standard seating capacity of 58 passengers per bus, up to 38 additional express buses would be required during the AM peak hour, and up to 14 additional express buses during the PM peak hour. Potential capital, operation and maintenance costs would require further assessment.

COST ESTIMATES

Planning level cost estimates were prepared for the two concepts for express lane operations: Cost for express lane tolling infrastructure and equipment associated with converting HOV lanes to express lane under Concept 1, and converting the General Purpose Lane to Express Lane under Concept 2.

ASSUMPTIONS

Assumptions used to develop cost estimates for the express lane concepts are summarized as follows:

- Continuous access to and from the Express Lane were assumed along the entire project limits.
- The demarcation between the Toll System Integrator (TSI) and the civil contractor is as shown in the BAIFA's Request for Proposal dated November 7, 2013.
- The cost estimate does not include costs associated with installing the Express Lane Backhaul Network (assumed cost may be in the neighborhood of $1M, depending on where MTC has existing communication connection points along this segment of US 101). The cost does include supplemental lighting at the beginning, end and zone changes along the proposed express lanes.
- No cost is included for operations and maintenance of the Express Lane Tolling Systems after it is constructed.
- The cost estimate for the Express Lane Tolling Systems are based on the estimated cost provided by BAIFA for the I-80 West Segment Express lane and I-680 Express Lane projects which convert HOV lanes to Express Lanes.
- The layout of the Express Lane signs and tolling equipment is based on the BAIFA's design concept. The toll reader will be installed within 1,000' of the beginning of the Express Lane and placed at approximately 1 mile spacing intervals. The Variable Toll Message Sign (VTMS) will be placed at approximately 2 mile spacing intervals. The advance Express Lane signs, advance price signs and entrance signs will be placed per MUTCD.
- The communication for tolling system equipment along the project corridor is assumed to be wireless.
- No significant environmental reviews, permits or issues are created by the construction of the Express Lanes.
- Express Lane overhead signs are placed a minimum of 800' apart from or aligned adjacent to existing overhead signs per latest Caltrans guidance.

Three median CHP enforcement areas are assumed along US 101 near Millbrae Avenue, Hillsdale Boulevard, and Willow Road.

COST ESTIMATES RESULTS

Based on preliminary analysis, the cost associated with converting HOV or mixed-flow lane to express lane is estimated to range between $103 million and $108 million, as summarized in Exhibit 19 and Exhibit 20, with detailed cost estimates spreadsheets included in Appendix 2. All location segment costs are generally the same between Concept 1 and Concept 2 except for Location Segments 8 and 13. At locations 8 and 13 a median CHP enforcement area would already be an existing condition for Concept 1, but a new median CHP enforcement area would need to be installed for Concept 2.

Exhibit 19: HOV to Express Lane Cost Estimate Summary – Concept 1 (Hybrid HOT Lane)

Location Name	Roadway Subtotal	Toll System subtotal	Soft Costs Subtotal	Total Costs
1. Embarcadero Road to University Avenue	$5,410,000	$2,080,000	$2,010,000	$9,500,000
2. University Avenue to Willow Road	$2,050,000	$1,600,000	$760,000	$4,400,000
3. Willow Road to Marsh Road	$4,910,000	$2,720,000	$1,820,000	$9,500,000
4. Marsh Road to Woodside Road	$3,290,000	$3,040,000	$1,220,000	$7,600,000
5. Woodside Road to Whipple Avenue	$2,040,000	$1,920,000	$760,000	$4,700,000
6. Whipple Avenue to Holly Street	$3,400,000	$2,880,000	$1,260,000	$7,500,000
7. Holly Street to Ralston Avenue	$2,210,000	$1,760,000	$820,000	$4,800,000
8. Ralston Avenue to Hillsdale Blvd.	$3,450,000	$2,560,000	$1,280,000	$7,300,000
9. Hillsdale Boulevard to Route 92	$2,380,000	$1,280,000	$890,000	$4,600,000
10. Route 92 to 3rd Avenue	$2,920,000	$2,560,000	$1,090,000	$6,600,000
11. 3rd Avenue to Peninsula Avenue	$3,090,000	$1,920,000	$1,150,000	$6,200,000
12. Peninsula Avenue to Broadway	$3,160,000	$3,040,000	$1,180,000	$7,400,000
13. Broadway to Millbrae Avenue	$3,070,000	$2,240,000	$1,140,000	$6,500,000
14. Millbrae Avenue to SFO Conn.	$2,570,000	$1,920,000	$960,000	$5,500,000
15. SFO Conn. to San Bruno Avenue	$3,290,000	$1,920,000	$1,220,000	$6,400,000
16. San Bruno Avenue to I-380	$2,540,000	$480,000	$950,000	$4,000,000
Category Totals	$49,800,000	$33,900,000	$18,500,000	
	Grand Total			**$103,000,000**

Exhibit 20: Mixed-Flow Lane to Express Lane Cost Estimate Summary – Concept 2 (Convert HOT Lane)

Location Name	Roadway Subtotal	Toll System subtotal	Soft Costs Subtotal	Total Costs
1. Embarcadero Road to University Avenue	$5,410,000	$2,080,000	$2,010,000	$9,500,000
2. University Avenue to Willow Road	$2,050,000	$1,600,000	$760,000	$4,400,000
3. Willow Road to Marsh Road	$4,910,000	$2,720,000	$1,820,000	$9,500,000
4. Marsh Road to Woodside Road	$3,290,000	$3,040,000	$1,220,000	$7,600,000
5. Woodside Road to Whipple Avenue	$2,040,000	$1,920,000	$760,000	$4,700,000
6. Whipple Avenue to Holly Street	$3,400,000	$2,880,000	$1,260,000	$7,500,000
7. Holly Street to Ralston Avenue	$2,210,000	$1,760,000	$820,000	$4,800,000
8. Ralston Avenue to Hillsdale Blvd.	$4,460,000	$2,560,000	$1,660,000	$8,700,000
9. Hillsdale Boulevard to Route 92	$2,380,000	$1,280,000	$890,000	$4,600,000
10. Route 92 to 3rd Avenue	$2,920,000	$2,560,000	$1,090,000	$6,600,000
11. 3rd Avenue to Peninsula Avenue	$3,090,000	$1,920,000	$1,150,000	$6,200,000
12. Peninsula Avenue to Broadway	$3,160,000	$3,040,000	$1,180,000	$7,400,000
13. Broadway to Millbrae Avenue	$5,950,000	$2,240,000	$2,210,000	$10,400,000
14. Millbrae Avenue to SFO Conn.	$2,570,000	$1,920,000	$960,000	$5,500,000
15. SFO Conn. to San Bruno Avenue	$3,290,000	$1,920,000	$1,220,000	$6,400,000
16. San Bruno Avenue to I-380	$2,540,000	$480,000	$950,000	$4,000,000
Category Totals	$53,700,000	$33,900,000	$20,000,000	
	Grand Total			**$108,000,000**

Combining the cost associated to construct the HOV lane, and to provide the level of additional transit services required, the cost is estimated to range between $259 million and $346 million, as summarized in Exhibit 21. As denoted under the exhibit, the potential capital cost required to provide these additional services were not included in this estimates. Therefore, the actual cost of Concept 2 would be higher than this estimated cost.

Exhibit 21: Combined Cost Estimates Summary

Options	Cost Item	Subtotal	Total
Concept 1	Stage Hybrid HOV Lane Construction Cost	$156 mil*	**$259 mil**
	HOV to Express Lane Conversion Cost	$103 mil	
Concept 2 **	Mixed-Flow Lane to Express Lane Conversion Cost	$108 mil	**$346 mil**
	Additional Transit O & M Cost (20-Year)	$238 mil	

*Based on Staged HOV Lane Analysis Memorandum, June 15, 2012.

** Note that capital costs associated with providing additional bus services are not included in this analysis. Therefore, the actual total cost for Concept 2 would be higher.

FURTHER CONSIDERATIONS

This study was a conceptual feasibility study designed to identify potential fatal flaws with either Concept 1 or Concept 2 that might suggest one or both should be dropped from further study. As such, this conceptual study was conducted as cost-effectively as possible by using information from previous studies, with the objective to conduct a comparison on a consistent basis with the 2012 Staged Hybrid HOV Lane study.

Based on this conceptual study, Concept 1 demonstrated better overall benefit than Concept 2, in terms of overall travel time on the US 101 mainline as well as total costs. If project budget allows, further analysis, as listed below, may provide a more comprehensive analysis to better inform decision makers.

During the study, it was discovered that there were some limitations in primarily using information from previous studies, for example, there was no feedback process between the travel demand model and the operations analysis model on travel times, which may have artificially resulted in low demand volumes on US 101 under concept 2, and in turn, the operations analysis could understate its potential effects. Also, existing traffic conditions on US 101 has changed since the 2012 study, for example, in the southbound direction during the PM peak period, additional bottlenecks have arisen along the study corridor, which in turn, could result in further operational impacts for Concept 2. Based on this initial evaluation, further analyses are suggested:

- Update existing conditions analysis and previously calibrated traffic operations models for US 101;
- Update traffic forecasts using the current bi-county C/CAG-VTA model;
- Conduct traffic operations analysis for US 101 and assess potential impacts on other alternate routes;
- Provide cost estimates to potential capital costs associated with the additional transit services for Concept 2, and also provide detailed logistics for the provision of additional transit (i.e. additional park-and-ride facilities, shuttle services to and from transit centers, etc.);
- Origin/Destination analysis of transit trips;
- Assess potential effects of private company shuttles along US 101, and their effects on future needs for additional transit busses in the corridor;
- Develop O&M (operations and maintenance) costs, and revenue analysis of the proposed express lane options.

LIST OF APPENDICES

Appendix 1A – Concept 1 Hybrid – Adjusted Demands

Appendix 1B – Concept 2 Convert – Adjusted Demands

Appendix 2 – Cost Estimates Detailed Spreadsheets