Technical Memorandum on Energy Impacts

for the

Highway 1 High-Occupancy Vehicle (HOV) Lane Widening Project

From San Andreas–Larkin Valley Road to Morrissey Boulevard
05-SCR-1, PM R7.24/16.13
05-0C7300

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1. Introduction

This memorandum discusses energy impacts for the Highway 1 High-Occupancy Vehicle (HOV) Lane Widening Project from San Andreas–Larkin Valley Road to Morrissey Boulevard. It provides an overview of the energy conservation potential of the alternatives under consideration and discusses what is known at this time about the construction requirements and the vehicle operation requirements. In accordance with California Department of Transportation (Caltrans) Standard Environmental Reference Guidelines, a qualitative energy analysis was conducted because, in considering the energy that would be used during project construction and operation balanced with energy saved by relieving congestion and reducing out of direction travel, the proposed project alternatives would not result in substantial energy impacts.[1]

Energy Planning Context Summary

AB 32 Climate Change Scoping Plan. In December 2008, the California Air Resources Board adopted its Climate Change Scoping Plan, which contains the main strategies that California will implement to achieve reduction of greenhouse gases. The Scoping Plan also includes California Air Resources Board-recommended greenhouse gas reductions for each emissions sector of the State's greenhouse gas inventory. The Scoping Plan calls for the largest reductions in greenhouse gas emissions to be achieved by implementing certain measures and standards. Two of these are transportation-related: (1) improve emissions standards for light-duty vehicles; and (2) implement the Low-Carbon Fuel Standard.

The California Air Resources Board has not yet determined what amount of greenhouse gas reductions it recommends from local government operations; however, the Scoping Plan does state that land use planning and urban growth decisions will play an important role in the State's greenhouse gas reductions because local governments have primary authority to plan, zone, approve, and permit how land is developed to accommodate population growth and the changing needs of their jurisdictions. The California Air Resources Board further acknowledges that decisions on how land is used will have large impacts on the greenhouse gas emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The Scoping Plan states that the ultimate greenhouse gas reduction assignment to local government operations is to be determined (CARB, 2008).

Energy Impacts Summary

The energy impacts of transportation projects are typically divided into two components: direct energy and indirect energy. Direct energy is the energy consumed in the actual propulsion of a vehicle using the roadway. It can be measured in terms of the thermal value of the fuel, the cost of the fuel, or the quantity of electricity used in the engine or motor (in this case, the use of petroleum-based fuels and alternative fuels for motor vehicle travel within the project area). Indirect energy is defined as all of the remaining energy consumed to run a transportation system, including construction energy, maintenance energy, and any substantial impacts to energy consumption related to project-induced land use changes and mode shifts, and any substantial changes in energy associated with vehicle operation, manufacturing, or maintenance due to increased automobile use.

[1] Per the Federal Highway Administration Technical Advisory 6640.8A, a detailed energy study, including computations, is only required for large-scale Environmental Impact Statement projects that would require extensive construction and related energy use, or where differences in energy consumption between the build and no build alternatives are great, such as a rail system project.

Indirect energy under the build alternatives (Transportation System Management [TSM] Alternative and HOV Lane Alternative) would include energy used for construction activities such as excavation, backfill, dredging and material transport, and energy consumed by other elements that aid in construction, such as variable message signs and construction lighting. Indirect energy consumption would also depend on the type of equipment used for construction, vehicle efficiency, and the efficiency of haul roads. Energy used for maintaining the HOV lanes, auxiliary lanes, pedestrian/bicycle overpasses, and other project features of the build alternatives would also be categorized under indirect energy. There would be no induced land use changes or any notable mode changes associated with the build alternatives. The No-Build Alternative would have much less initial construction (i.e., indirect) energy impacts, but it would not be able to accomplish any long-term reduction in energy consumption that improving the roadway operational efficiency may be able to provide.

In the long term, the direct, or operating, energy requirements of a project are usually greater and of primary importance; therefore, this discussion focuses on the direct energy requirements for ongoing Highway 1 operations with and without the proposed build alternatives. Since both the build and No-Build Alternatives involve direct energy use, the analysis tries to determine which is more likely to reduce vehicle energy use by lessening congestion and related travel delays.

2. Conclusion

Under no-build conditions, due to insufficient mainline capacity for the forecast volumes, bottlenecks and queues would develop at certain locations along the mainline. Low travel speeds and long delays would be prevalent during peak hours. Such congested traffic conditions contribute to inefficient energy consumption as vehicles use extra fuel while idling in stop-and-go traffic or moving at slow speeds on a congested roadway.

The lessening of congestion and related traffic delay is associated with faster and less variable average travel speeds, resulting in more efficient vehicle operation under the HOV Lane Alternative compared to no-build conditions. Improved operations are likely to reduce vehicle energy use, whether in the form of petroleum fuels or alternative sources of energy (e.g., biodiesel or ethanol). For these reasons, the HOV Lane Alternative is anticipated to have a beneficial effect on direct energy use compared to the No-Build Alternative. No energy mitigation measures would be needed.

More-efficient vehicle operation would result under the TSM Alternative, but to a lesser extent than under the HOV Lane Alternative because HOV lanes would not be provided. The elements of the TSM Alternative, such as auxiliary lanes and ramp metering, would provide some congestion relief. The TSM Alternative would not adversely affect energy consumption compared to the No-Build Alternative, and no energy mitigation measures would be needed.

3. Project Description

Caltrans, in cooperation with the Federal Highway Administration and the Santa Cruz County Regional Transportation Commission (SCCRTC), proposes to improve Highway 1 (designated State Route 1 or SR 1) in Santa Cruz County a distance of approximately 8.5 miles, from approximately 0.4-mile south of the San Andreas-Larkin Valley Road interchange to 0.3-mile north of the Morrissey Boulevard interchange. The purpose of the Highway 1 HOV Lane Project is to reduce congestion, improve safety, and encourage carpooling and use of alternative transportation modes as means to increase transportation system capacity. Meeting these project purposes would also address the following related needs:

- Several bottlenecks along Highway 1 in the southbound and northbound directions cause recurrent congestion during peak hours;
- Travel time delays due to congestion and related accidents are experienced by commuters, commerce, and emergency vehicles;
- Congestion-related accidents are common along Highway 1 within the project limits;
- “Cut-through” traffic, or traffic on local streets, occurs and is increasing because drivers seek to avoid congestion on the highway.
- There is a lack of supportive facilities and incentive to increase transit service that operates in the Highway 1 corridor because congestion threatens reliability and cost-effective transit service delivery;
- There is a lack of supporting facilities to provide improved level of service for carpoolers/rideshare vehicles over single-occupancy vehicles; therefore, there is a lack of incentives, such as travel time savings and reliability, for people to carpool or participate in rideshare programs.

Three alternatives are currently under consideration, a No-Build Alternative, an HOV Lane Alternative, and a TSM Alternative, as described below.

No-Build Alternative

The No-Build Alternative offers a basis of comparison with the TSM and HOV Lane Alternatives in the future analysis year of 2035. It would not address the project purpose and need. It assumes no major construction on Highway 1 through the project limits other than currently planned and programmed improvements and continued routine maintenance. Planned and programmed improvements included in the No-Build Alternative are the following improvements contained in the 2010 Regional Transportation Plan:

1. Construction of auxiliary lanes between the Soquel Avenue-Soquel Drive and Morrissey Boulevard interchanges (EA 05-0F6500, estimated construction completion 2013).
2. Replacement of the La Fonda Avenue overcrossing of Highway 1, included as part of the Soquel-Morrissey Auxiliary Lanes project (EA 05-0F6500, estimated construction completion 2013).
3. Construction of a bicycle and pedestrian overcrossing of Highway 1 at Mar Vista.
4. Deployment of Intelligent Transportation System technologies on Highway 1, which would include closed-circuit television cameras, vehicle detection devices, and signage.
5. Improvements of roadways and roadsides on Rio del Mar Boulevard from Esplanade to Highway 1, which includes the addition of bike lanes, transit turnouts, left-turn pockets, merge lanes, and intersection improvements. Roadwork includes major rehabilitation and maintenance of road and roadsides.
6. Installation of a Class 1 bicycle and pedestrian facility on Morrissey Boulevard overpass at Highway 1.

HOV Lane Alternative

The HOV Lane Alternative includes the following main project components: changes to the highway mainline to accommodate an HOV lane (in both north and southbound directions) and auxiliary lanes, reconfiguration of highway interchanges, and the addition of two bicycle/pedestrian overcrossings. The HOV Lane Alternative would expand the existing four-lane highway to a six-lane facility by adding an HOV lane next to the median in both directions. Expanding the highway from four lanes to six lanes would be achieved by building the new lane in the existing freeway median width, in addition to widening the freeway footprint where the existing median is not wide enough to fit the new lane. Approximately the southernmost 1.5 miles of Highway 1 can fit the new HOV lane inside the existing median. From approximately Freedom Boulevard to Soquel Drive, the existing median is not wide enough to fit the new HOV lane, so width needed for the new lane would be achieved by a combination of widening in the median and increasing the footprint of the highway as needed to fit the HOV lane, and in most stretches, a new auxiliary lane. Thus, in some locations, this widening would extend outside the existing right-of-way.

The HOV Lane Alternative would modify or reconstruct all nine interchanges within the project limits to improve merging operations and ramp geometry by increasing lengths for acceleration and deceleration, adding HOV bypass lanes, adding through lanes on ramps, and improving sight distances. The Bay Avenue/Porter Street and 41st Avenue interchanges would be modified to operate as one interchange. Where feasible, design deficiencies on existing ramps would be corrected. Ramp metering and unmetered HOV bypass lanes would be provided on all Highway 1 on-ramps. The HOV Lane Alternative would include auxiliary lanes between interchange ramps and Transportation Operations System electronic equipment, such as changeable message signs, highway advisory radio, closed-circuit television, microwave detection systems, and vehicle detection systems.

Retaining walls would be constructed at the most effective and visually appropriate locations to minimize right-of-way acquisition, reduce or avoid environmental impacts, and separate frontage roads from the highway. The project also would include demolition and disposal, excavation, borrow and fill, soundwalls, right-of-way acquisition, and temporary easements.

TSM Alternative

The TSM Alternative proposes to add ramp metering and construct HOV bypass lanes on existing interchange on-ramps, improve existing nonstandard geometric elements at various ramps, and add auxiliary lanes along the mainline between major interchange pairs within the project limits.

The TSM Alternative also would include Transportation Operations System electronic equipment. It would include HOV bypass lanes on interchange on-ramps and auxiliary lanes at five Highway 1 interchanges, but it would not construct HOV lanes or any additional through lanes on the mainline. The following additional project features would be implemented under the TSM Alternative: reconstruction of the north and south Aptos railroad bridges and lowering of the Highway 1 grade in this location to achieve standard vertical clearance beneath the bridges; reconstruction of the State Park Drive, Capitola Avenue, and 41st Avenue overcrossings; widening of the Aptos Creek bridge; construction of new pedestrian/bicycle overcrossings over Highway 1 at Mar Vista Drive, Chanticleer Avenue, and Trevethan Avenue; and provision of California Highway Patrol enforcement areas at on-ramps.

4. Results of Traffic Analysis and Corresponding Impacts on Energy Consumption

Traffic analysis results that would influence energy consumption in the project area are presented in this section. Information for this section is taken from the Traffic Operations Report (Wilbur Smith Associates, 2007 and 2010), which presents traffic analysis and results for the proposed project.

By 2035, without capacity improvements to Highway 1, congested traffic conditions would prevail in the study area, and the freeway would be unable to serve the projected travel demand. Due to insufficient mainline capacity for the forecast volumes, bottlenecks and queues would develop at certain locations along the mainline. Low travel speeds and long delays would be prevalent during peak hours. Such congested traffic conditions contribute to inefficient energy consumption as vehicles use extra fuel while idling in stop-and-go traffic or moving at slow speeds on a congested roadway.

The HOV Lane Alternative would increase capacity, improve roadway operations, and, by the addition of HOV lanes, encourage the use of transit and carpooling along the study area. Average travel time, vehicle delay, and duration of congestion on Highway 1 would decrease considerably compared to no-build conditions. The HOV Lane Alternative would reduce traffic delay on the Highway 1 mainline and at interchanges and many surrounding intersections within the project area. This would result in more-efficient energy consumption. Due to all of the above-mentioned advantages, the long-term impacts of the HOV Lane Alternative on transportation and vehicular traffic energy use would be positive.

The TSM Alternative would also have a positive effect on the traffic conditions and energy consumption compared to the No-Build Alternative, but to a lesser extent than the HOV Lane Alternative.

The following sections discuss the traffic analysis results and the effect on energy consumption in more detail, broken down by highway mainline traffic, street traffic, and transit and HOV lane usage.

4.1 Mainline Traffic Conditions

Existing

Congested traffic conditions exist within the project limits (i.e., study area) during the northbound morning peak hour and the southbound evening peak hour. Peak-hour delays between San Andreas–Larkin Valley Road and Morrissey Boulevard vary from zero to 15 minutes, depending on the peak hour (i.e., morning or evening) and direction (i.e., northbound or southbound).

No-Build Alternative

Under the No-Build Alternative, without highway capacity improvements, substantial delay would occur in the study corridor. Compared to existing conditions, delay within the project limits would nearly quadruple by 2035. Delay within the project limits during peak hours would vary between 19 and 49 minutes, depending on the peak hour and direction.

HOV Lane Alternative

Under the HOV Lane Alternative, the provision of HOV lanes would improve travel conditions for transit users and carpooling commuters using these lanes. The shift of existing HOV users from mixed-flow lanes to HOV lanes, and the shift by additional commuters into HOVs to make use of the high level of traffic service provided by the HOV lanes, would reduce congestion-related delays in mixed-flow lanes and indirectly increase capacity for mixed-flow traffic. While the HOV Lane Alternative would not eliminate all capacity problems in 2035, it would allow the highway to carry more peak-hour travel demand compared to the No-Build Alternative.

The HOV Lane Alternative is expected to improve average travel speeds for HOV lane users by 195 to 473 percent, and for mixed-flow lane users by 129 percent to 200 percent during peak hours, compared to the No-Build Alternative. Improved travel speeds would translate to reduction in travel time and delay. When compared to the No-Build Alternative, there would be a 96 to 100 percent reduction in delay for

HOV lane users and a 76 to 89 percent reduction in delay for mixed-flow lane users under the HOV Lane Alternative.

TSM Alternative

The elements of the TSM Alternative, such as auxiliary lanes and ramp metering, would improve travel conditions. When compared to the No-Build Alternative, the TSM Alternative is anticipated to improve peak-hour travel speeds by 24 percent to 145 percent and reduce peak-hour delays by 24 to 89 percent, with the exception being in the southbound direction during the evening peak hour. In the southbound direction during the evening peak hour, speeds in the traffic study area would decrease by 2 percent, and delay would increase by 2 percent because of a heavy flow of commuters originating from west/ northwest of the project limits. This would include commuters returning home from jobs in the South Bay Area. Because the origin of this heavy southbound traffic is outside the project limits, the ramp metering within the project limits would do little to help regulate the traffic flow within the project limits. The heavy traffic would offset the benefits of the geometric improvements in the southbound direction.

4.2 Traffic Conditions on Local Streets

Traffic diversions near bottlenecks are common and can cause considerable delay. By 2035, as congestion on the freeway increases, traffic diversion to local streets, such as Soquel Drive and Capitola Road, would also increase. This increase in “cut-through” traffic would deteriorate conditions on local streets, increasing delay and energy consumption. To analyze the differences in traffic on local streets, intersection level of service values were compared. Level of Service E and F values are considered unacceptable (HCM, 2000).

Existing Conditions

Existing conditions traffic analysis shows that traffic congestion exists on parts of local roads, such as Soquel Drive, and near major off-ramps. During the morning peak hour, all but 7 of the 25 intersections operate at acceptable Level of Service D or better. During the evening peak hour, all but 5 of the intersections operate at acceptable conditions.

No-Build Alternative

By 2035, due to the population and job growth in the region, traffic on local streets would increase. Without any capacity improvements, Highway 1 would not be able to accommodate the future travel demand, leading to severe traffic congestion during peak hours. When there is severe congestion on a freeway, vehicles attempt to circumvent the congestion by using local roads leading to an increase in the regional vehicle miles of travel. This cut-through traffic, in addition to the increased traffic demand on local streets, would in turn deteriorate traffic conditions on local streets.

Under the No-Build Alternative, other than one intersection that would operate at Level of Service D during the evening peak hour, all of the study intersections would operate at an unacceptable Level of Service E or F during both the morning and evening peak hours. As a result, no anticipated energy savings are associated with the No-Build Alternative.

HOV Lane Alternative

The HOV Lane Alternative would substantially reduce congestion at some of the bottleneck areas and reduce delay through the study area, providing incentive for commuter and through-traffic to remain on the freeway, freeing arterials and other local streets to serve local traffic. Vehicles that took circuitous routes to circumvent congestion under the No-Build Alternative would come back to the freeway, reducing vehicle miles traveled in the corridor. As energy consumed is directly proportional to the vehicle miles traveled, the HOV Lane Alternative would lead to energy savings.

Of the 26 intersections analyzed under the HOV Lane Alternative, 15 intersections would operate at an acceptable level of service (Level of Service D or better) during the morning peak hour, and 14 intersections would operate at an acceptable level of service (Level of Service D or better) during the evening peak hour. As a result, energy savings are associated with the HOV Lane Alternative compared to the No-Build Alternative.

TSM Alternative

Traffic volumes on local streets under the TSM Alternative would be comparable to those under the No-Build Alternative. The 25 intersections analyzed for the TSM Alternative are anticipated to all operate at an unacceptable Level of Service E or F. There would be no improvements in intersection level of service with the TSM Alternative compared to conditions under the No-Build Alternative. As a result, no anticipated energy savings are associated with the TSM Alternative.

4.3 Transit and HOV Lane Usage

The Highway 1 corridor from San Andreas–Larkin Valley Road to Morrissey Boulevard in Santa Cruz is a highly traveled, heavily congested traffic corridor with high transit ridership. While comparable suburban areas typically have transit ridership of approximately 2 percent of the total highway trips, the transit ridership in the project corridor is approximately twice that, showing high existing transit demand (Parsons, 2008).

Currently, buses using the corridor idle on the freeway along with other automobiles because of the congestion on Highway 1. The HOV lanes provided under the HOV Lane Alternative would offer dedicated peak-hour capacity and a high level of traffic service to transit and carpool vehicles. This would substantially improve travel time for intercity buses and carpooling commuters because they would operate at speeds of approximately 63 miles per hour in the new HOV lanes. This compares to speeds as low as 11 miles per hour in congested mixed-flow lanes under the No-Build Alternative. Not only would transit travel time be reduced, but transit schedule reliability would be improved. Carpools and vanpools also would have improved speeds and reduced travel times. The improved speeds and schedule reliability would work as incentives for commuters and other travelers to carpool and/or take advantage of local and express buses that would move freely along the HOV lanes. A transit market study conducted as part of this project shows that reduction in travel time afforded by the HOV Lane Alternative would lead to an increase in express transit ridership in the corridor (Parsons, 2008). A shift by more commuters into HOVs would lead to further energy savings.

While the TSM Alternative would not result in adverse energy impacts, the transit market study shows that the TSM Alternative would have a substantially less beneficial effect on transit ridership compared to the HOV Lane Alternative.

5. References

1. California Department of Transportation (Caltrans), 2010. Standard Environmental Reference, http://www.dot.ca.gov/ser/vol1/sec3/physical/ch13energy/chap13.htm
2. Parsons, 2008. Transit Market Analysis for the Highway 1 Corridor. June.
3. California Air Resources Board (CARB), 2008. Climate Change Scoping Plan. December.

4. Wilber Smith Associates, 2010. State Route 1 HOV Lane Widening Project Traffic Operations Report, Supplemental Report. May.