

TECHNICAL MEMORANDUM

Project: WSDOT 2009/2011 Truck Priorities for Central Puget Sound
Subject: Candidate Projects
Date: June 20, 2008
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A. Background and Approach

This memorandum presents information about candidate truck mobility projects in the Central Puget Sound region that WSDOT could include in its 2009/2011 biennial budget. These candidate projects reflect low to modest cost improvements that would have a relatively large benefit for truck mobility and accessibility.

The candidate projects were compiled from the WSDOT website, the Freight Mobility Strategic Investment Board (FMSIB) project lists, direct communication with WSDOT project managers, communications with staff at the WSDOT Freight Systems office, and contacts within the trucking community. When local agency and WSDOT staff were asked about their top freight priorities, almost all first listed major corridor projects such as SR 167, SR 509, Spokane Street Viaduct, and the SR 519 projects. These full corridor projects were deemed to be too large for this request; however, key elements of some of those corridor projects are included as candidates.

B. Candidate Projects

Seven candidate truck projects are listed below and then described in detail. The candidate projects span a wide range, including new freeway ramps, improvements to existing freeway ramps, signage enhancements, and intelligent transportation systems (ITS) for trucks. The following lists the candidate projects:

1. Ramp meter by-pass for heavy trucks
2. Improved signage for truck movements
3. Geometric improvements for trucks at freeway ramps
4. Truck advanced traveler information system
5. SR 167/SR 18 eastbound-to-southbound ramp
6. SR 167/SR 18 northbound-to-westbound ramp
7. I-5 Connector to South 228th Street

1. Ramp Meter By-Pass for Heavy Trucks

Project Description: This candidate project seeks to conduct up to three demonstration studies to test the operational benefits or disadvantages of either allowing trucks to bypass the ramp meter using the HOV lane or relocating the ramp meters to increase the acceleration distance. Several potential ramp locations were identified that have inclined ramps and high volumes of trucks. These include:

- Corson Avenue southbound on-ramp to I-5 (Consider moving the ramp meter since this ramp has ample vehicle queue area.)
- Northbound West Valley Highway (SR 181) on-ramp to northbound I-405. This ramp has a steep uphill grade with the ramp meter at the top of the hill. Trucks must accelerate from a stop position at the meter and merge into the mainline flow within approximately 1000 feet.
- Central Avenue northbound on-ramp to SR 167. Truckers recommended that the ramp meter end at 9:00 A.M. Alternatively, a ramp meter by-pass for heavy trucks could be implemented.
- Leary Way/West Lake Sammamish Parkway westbound on-ramp to SR 520. This ramp is a long, relatively steep uphill grade that continues to climb along the SR 520 mainline. It is one of the primary access points for industrial areas of Redmond located along the Willows Road corridor. The ramp meter shortens the merge distance to less than 1,200 feet.
- SR 516 on-ramps to northbound and southbound SR 167. The ramp meters shorten the acceleration distance to about 1,000 feet. Neither ramp has an HOV bypass lane; therefore, the ramp meter bypass is not yet possible. Changing the hours or conditions that the ramp meter is in effect could improve merging conditions for trucks.

Project Background:

Most on-ramps to major freeways in the urban areas of Central Puget Sound are metered. All freeway ramp meters shorten the effective acceleration length of the on-ramp. While most passenger vehicles can still attain freeway speeds before merging into mainline traffic, the shortened ramps do affect the speed that trucks can reach before the merge point. It is most pronounced for inclined ramps because the uphill grade further impedes a truck's ability to accelerate. During congested conditions when freeway speeds have decreased to below 20 mph, slow-moving trucks have little effect on mainline traffic flow. However, in the periods just before unstable flow begins and freeway speeds are above 35 mph, slow-moving trucks that merge into traffic can then reduce the speed of the entire mainline. A typical heavy truck can accelerate to 42 mph in 1,000 feet on a flat grade. On a 5% grade, common on uphill ramps, a truck can accelerate to 24 mph in 1,000 feet.¹ In addition, the differential in truck versus general traffic speeds increases the risk of a crash. The average crash rate for trucks at 10 mph below average running speed is 900 crashes per 100 million vehicle miles of travel. The crash rate increases to 3,800 crashes per 100 million vehicle miles when truck speed is 20 mph below average running speed.²

Current Project Status:

None.

¹ 2004 American Association of State Highways and Transportation Officials (AASHTO), Exhibit 3-56

² 2004 American Association of State Highways and Transportation Officials (AASHTO), Exhibit 3-58

1 (continued). Ramp Meter By-Pass for Heavy Trucks

Summary of Benefits:

- Improves mainline capacity for general-purpose traffic by increasing the speed that trucks can merge into traffic.
- Improves truck mobility by improving acceleration and merge conditions.
- Reduces truck delay in queue at ramp meters.
- Reduces the risk of crashes and improves safety.
- Low cost

Estimated Cost:

Pilot Study in 2009/2011 - \$400,000

Identify three pilot locations, collect detailed speed, vehicle classification and meter function data for both the ramp and the mainline before and after ramp meter change. Compile data to show the influence that merging trucks have on mainline speeds without and with the change.

Ramp meter changes at additional locations 2011/2013 - \$300,000

2. Improved Signage for Truck Movements

Project Description: There are various locations where improved signage could reduce confusion for truck drivers that are unfamiliar with the area, and enhance safety by increasing the decision time that a truck driver needs in advance of changing lanes to follow their intended route. In addition, at some locations, the size and volume of trucks block visibility of advance guide signing for general-purpose traffic. This project would require a comprehensive review of signage issues and potential improvements, evaluate and prioritize signage improvements based on truck movement benefit, and develop a uniform design practice and protocol for truck signage throughout the state. The following are examples of directional signage concerns:

- Southbound I-5 directional signage to the Express Lanes near NE 130th Street. This signage does not say that there is no access to I-90. Drivers have complained that they get trapped in the southbound express lanes if they do not exit downtown. The next exit to turn around is at S Forest Street.¹
- Southbound I-5 to I-90 needs improved advance direction as to which lane trucks (and cars) should be in to travel to I-90 eastbound. Currently “Exit Only” signage causes drivers to weave to the one lane signed as “Exit Only,” and then once they discover that two lanes feed I-90, they often perform a second weave to return to the less congested lane.¹
- There are currently no signs that truck drivers can follow when hazardous materials are prohibited from using I-5 under the Convention Center or the I-90 tunnels. The prohibitions are signed with the variable message signs along I-5. The VMS message should indicate the proper off-ramp detour, and then fixed signs should be used along alternative route.²
- At freeway ramps located along multi-lane arterials, truck drivers may need advance guidance to get into the appropriate access lane.¹
- On I-5 southbound approaching downtown Seattle, there is a sign informing drivers to use exit 154 for SeaTac, which is 15 miles downstream. The necessity of this sign is unclear.¹

Sources:

1. E-mail from Dale Tabat, Truck Freight Program & Policy Manager, WSDOT May 23, 2008.
2. E-mail from SDOT, May 23, 2008.

Current Project Status:

WSDOT regional traffic operations maintain signage. However, signage improvements on limited-access facilities typically involve sign bridges and a higher cost solution than can be absorbed by the operations budget.

Summary of Benefits:

- Improves safety by improving driver guidance.
- Minimizes weaving and sudden lane changes by trucks and/or general-purpose traffic.
- Minimizes excess travel time due to wrong directional decisions.
- Minimizes driver frustration and improves WSDOT image.

Estimated Cost:

A \$750,000 budget is recommended to address truck movement signage improvements on state highways in the Central Puget Sound Region, and \$750,000 is recommended for signage improvements for trucks in Greater Washington. In addition, 1 FTE should be allocated to hire a design specialists tasked with providing a uniform statewide practice related to truck signage.

3. Geometric Improvements for Trucks at Freeway Ramps

Project Description: There are many freeway on and off-ramps throughout the region that could be improved to better accommodate trucks. These improvements could include widening the turning radii where the ramp connects to the local arterials; enlarging the radius of a loop ramp; or extending a ramp to increase the acceleration distance before the merge point. The following lists candidate locations where improvement needs have been identified:

- SR 167 at 15th Street SW southbound on-ramp. Lengthen the ramp to increase speeds and sight lines at the merge point. ¹
- SR 167 at 8th Street E southbound on-ramp and northbound on-ramp. Lengthen the ramps to increase speeds at the merge points. ¹
- SR 167 at S 212th Street northbound on-ramp. Lengthen the ramp to increase speeds at the merge point. ²
- I-5 at Kent-Des Moines Road (SR 516) southbound on-ramp. Lengthen the ramp to increase speeds and sight lines at the merge point.
- SR 99 at S Cloverdale Street northbound on-ramp. Improve signage, lighting and the turning radius at the intersection. ³
- I-5 Spring Street southbound on-ramp. Enlarge the turn radius for the northbound right turn from 6th Avenue onto the ramp. ³

Sources: 1) *SR 167 Valley Freeway Corridor Plan*, Potential Bottleneck Projects, April 19, 2006
 2) *SR 167 Valley Freeway Corridor Plan*, Freight Survey Findings, March 7, 2008, Heffron Transportation, Inc.
 3) E-mail from Seattle Department of Transportation, May 23, 2008.

Current Project Status: Ramp geometric improvements are typically addressed during design and construction of a larger project rather than as a stand-alone project. However, with funding committed to other larger projects, these beneficial geometric improvements will not occur without specific funding. These improvements have been identified by the trucking community.

Summary of Benefits:

- Radius improvements enhance truck mobility and safety by reducing chance that turning trucks ride up on to a curb or fall off the pavement edge.
- Lengthened ramps increase truck speeds at merge points, which reduces merge-induced congestion along a freeway's mainline.
- Lengthened ramps improve safety by increasing distance that vehicles have to merge, and reducing the differential in speeds between the merging and mainline traffic.

Estimated Cost:

2009/2011 – Identify needs and design to 30% - \$500,000

2011/2013 – Final design and construction - to be determined

2013/2015 – Final design and construction - to be determined

4. Truck Advanced Traveler Information System (ATIS)

Project Description: This project would expand WSDOT's existing advanced traveler information system to provide information specifically tailored to the needs of the trucking community. The information would be provided via web and phone, and could also be "pushed" out via subscription email alerts. WSDOT is currently contracting with a third-party subscription alert system that could be used to disseminate truck information.

WSDOT already has truck-specific information available in various locations on the web. This project would consolidate these data so that they can be accessed from a single website. The project would also maintain the data and add new information as needs arise. The Commercial Vehicle Services website at WSDOT (www.wsdot.wa.gov/CommercialVehicle) provides most of the information that the trucking industry now needs, including:

- Permits for oversize and overweight vehicles;
- Information related to the legal weight limits and calculators to determine truck weights;
- Information to obtain a transponder to bypass state weight stations through the Commercial Vehicle Information System and Networks (CVISN);
- News related to major construction;
- Links to traveler information for the three-state I-5 Corridor.

The utility of this website could be enhanced by consolidating other functions, including:

- Signing up for subscription e-mail alerts for various regions or highway corridors.
- Linking to the Puget Sound Region travel information (not just the I-5 corridor)
- Providing information about public and private parking locations (rest stops) for truckers.
- Providing more detailed information related to construction projects that could cause congestion.
- Linking to border and ferry wait time information.

In addition, previously-conducted focus groups have revealed that the trucking community is not fully aware of the traveler information that is already available. Therefore, this program should also include an outreach and public information effort to inform the trucking industry of the tools and information available.

Project Background: WSDOT operates a traveler information web site (<http://wsdot.wa.gov/traffic/>) that provides construction alerts, incident alerts, real time road conditions, weather, and camera images. The corresponding 511 phone system provides Puget Sound traffic conditions, statewide construction & incident information, mountain pass conditions, ferry system information, 800 numbers for passenger rail and airlines, weather, and a connection to Oregon's 511 system. WSDOT's Commercial Vehicle Services has a website that provides truck-specific information. In addition, WSDOT is contracting with a third-party subscription alert system to send real-time alerts. This project would consolidate and maintain the information pertinent to truckers. It would also develop an outreach program to educate trucking firms about the information available.

Current Project Status: None.

Summary of Benefits:

- Improved truck mobility due to increased knowledge of construction activity, incidents, and border congestion that allows trucks to plan routes and schedule travel.
- Reduced local impacts with improved information about truck parking options.
- Improved safety due to increased compliance with weight and permitting restrictions

Estimated Cost:

1 FTE (ongoing) to consolidate and maintain web-based information.

½ FTE in 2009/2011 to develop and implement training program for trucking industry.

5. SR 167/SR 18 Eastbound-to-Southbound Ramp

Project Description: The SR 167/SR 18 interchange is missing two ramps, one of which would serve the eastbound SR 18 to southbound SR 167 movement. In order to make this connection today, vehicles exit eastbound SR 18 to West Valley Highway S, go south on West Valley Highway S, turn east on 15th Street SW and then use the southbound on-ramp to SR 167. There are currently about 790 large trucks per day that make this movement.

Project Background: The WSDOT and the SR 167 Corridor Working Group have completed the draft recommendations to improve safety and relieve congestion on 27 miles of SR 167 between Renton and Puyallup. The draft recommendations are part of the *SR 167 Valley Freeway Corridor Plan* report, which was scheduled to be published in Winter 2007/2008.



Source: Google Maps, May 12, 2008

Current Project Status: The recommendations have been approved by the Steering Committee. The SR 167 Corridor Plan project is currently unfunded. Source: *SR 167 Valley Freeway Corridor Plan Draft Recommendations*, <http://www.wsdot.wa.gov/Projects/SR167/ValleyFreewayCorridorPlan/recommendations.htm>, May 8, 2008. Project Manager: Carol Hunter, WSDOT Urban Corridors Office, 206-464-1219.

Summary of Benefits:

- Provides direct connection between SR 18 eastbound and SR 167 southbound to replace the circuitous route along local streets.
- Travel time benefit for heavy trucks over a 20-year period is estimated at approximately 179,200 hours. Daily truck volumes on the ramp would be an estimated 790 daily trucks in 2008 increasing up to approximately 1,400 in 20 years. Additional travel time benefit would accrue for passenger vehicles.
- Improves local intersection operations by shifting freeway-to-freeway traffic to the proposed ramp.

Estimated Cost:

Not available.

6. SR 167/SR 18 Northbound-to-Westbound Ramp

Project Description: The SR 167/SR 18 interchange is missing two ramps, one of which would serve the northbound SR 167 to westbound SR 18. To make this movement, vehicles exit 15th Street SW (Supermall Way), turn west on 15th Street SW, north on West Valley Highway S, and then right onto a tight loop ramp to westbound SR 18. It is estimated that 830 trucks per day now make this movement. A flyover ramp from northbound SR 167 to westbound SR 18 is proposed.

Project Background: The WSDOT and the SR 167 Corridor Working Group have completed the draft recommendations to improve safety and relieve congestion on 27 miles of SR 167 between Renton and Puyallup. The draft recommendations are part of the SR 167 Valley Freeway Corridor Plan report, which was scheduled to be published in Winter 2007/2008.



Source: Google Maps, May 12, 2008

Current Project Status: The recommendations have been approved by the Steering Committee. The SR 167 Corridor Plan project is currently unfunded. Source: *SR 167 Valley Freeway Corridor Plan Draft Recommendations*, <http://www.wsdot.wa.gov/Projects/SR167/ValleyFreewayCorridorPlan/recommendations.htm>, May 8, 2008. Project Manager: Carol Hunter, WSDOT Urban Corridors Office, 206-464-1219.

Summary of Benefits:

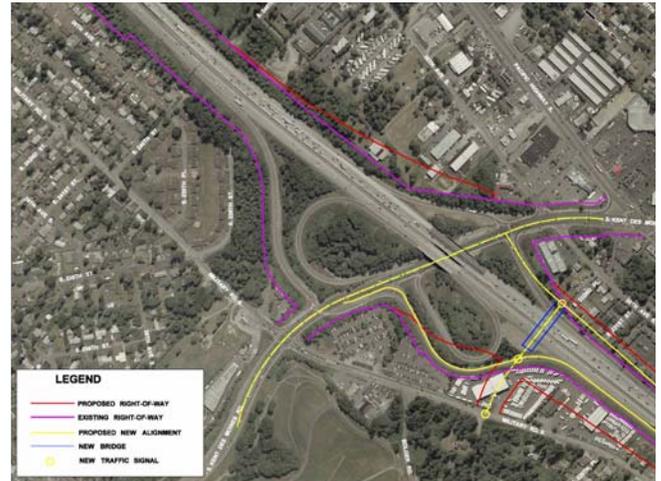
- Provides direct connection between northbound SR 167 and westbound SR 18 to replace the circuitous route along local streets.
- Existing on-ramp to westbound SR 18 from West Valley Road is difficult for trucks because of its tight radius. The new direct-connection ramp would have a larger radius for trucks.
- Travel time benefit for heavy trucks over a 20-year period is estimated at approximately 324,000 hours. Daily truck volumes on the ramp would be an estimated 830 daily trucks in 2008 increasing up to approximately 1,500 in 20 years. Additional travel time benefit would accrue for passenger vehicles.
- Improves local intersection operations by shifting freeway-to-freeway traffic to the proposed ramp.

Estimated Cost:

Not available.

7. I-5 Connector to South 228th Street

Project Description: This project results from the design work underway for the *SR 509 Corridor Completion and Freight Improvement Project* including the *I-5 South Access Road Project*. One element of the South Access Road Project can be constructed independently, and would improve truck access between I-5 and the Kent Valley. This project element includes a new overcrossing of I-5 at S 228th Street, just north of SR 516, and two new ramps that connect to and from the north on I-5. The candidate project is shown in the figure below. The City of Kent recently completed the new S228th Street corridor between Military Road and the valley. It was constructed to provide freight access from the primary industrial and warehousing area in Kent to I-5 and the planned SR 509 project. However, because SR 509 and its improvements along I-5 have not been constructed, the new S 228th Street corridor is underutilized. The current access route to this corridor is circuitous using portions of SR 516 and Military Road. The recommended over-crossing of I-5 would enhance the investment already made on S 228th Street



Source: WSDOT SR 509 Design Team May 21, 2008

Project Background: The *SR 509 Corridor Completion and Freight Improvement Project* is a long-range improvement project that is unfunded. The design team recommended this project element as a high priority and high benefit truck freight project. Source: *Telephone conversation with Susan Everett, SR 509 Project Manager, Paul Johnson, and Jason Riggs, WSDOT, May 16, 2008.*

Current Project Status: All environmental clearance is complete. Design is at approximately 30%. Right of way needs have been identified, and the primary real estate needed (the former Poulsbo RV site) is for sale.

Summary of Benefits:

- Provides direct connection to S 228th Street, a new five-lane arterial constructed as a freight corridor between I-5 and the Kent Valley.
- Increases utilization of S 228th Street and reduces traffic and congestion on SR 516.
- Eliminates circuitous route through the SR 516 interchange.
- Travel time benefit for heavy trucks over a 20-year period is estimated at 376,000 hours.

Estimated Cost: The project office estimates a cost of \$150 to \$180 million including right-of-way. The cost is estimated based on a review of overall SR 509 cost; costs for this specific project element as a stand-alone project should be re-estimated.

C. Truck Travel Time Benefit

The WSDOT requested that proposed projects include an estimate of travel time benefit over 20 years. Projects 5 through 7 listed above are new ramp and interchange projects that would improve system connectivity. The direct travel time benefit for these projects can be estimated. The ramp meter and ramp improvements described in Projects 1 and 3, however, would provide travel time benefits to both traffic on the ramp as well as possibly on the freeway's mainline. The full travel time benefit for these projects can only be estimated using detailed simulation modeling for each project once its design features are known. The signage and information enhancements described in Projects 2 and 4 may provide travel time benefits to truckers who might otherwise take the wrong route or for truckers that use information to choose a more efficient route. It is not possible to estimate the travel time benefit for these projects since it could vary day to day or even hour to hour as truckers avoid non-recurrent congestion due to incidents. The following sections briefly describe the projects and estimates of the travel time benefits that can be quantified. The travel time advantage is presented only for large trucks; additional travel time benefits would accrue for other traffic.

1. I-5 Connector to South 228th Street

This project would provide a direct link between I-5 and S 228th Street. S 228th Street is a relatively new arterial that connects to the major industrial and warehousing district in the Kent Valley. Vehicles that now use this arterial exit or enter I-5 at SR 516 (Kent-Des Moines Road) and use Military Road to S 228th Street. The proposed connector, which is a portion of the full SR 509 project, would provide a direct link to new ramps at S 228th Street for traffic to and from the north on I-5.

WSDOT requested analysis of the cumulative delay over the course of a 20-year period. In the first year of this period (2010), the cumulative delay would be lower because both the volume of traffic and level of congestion along the existing route would be lower. The increase in truck volume was estimated from the truck growth rates on SR 167 which expect total truck volumes to increase by an average of 2.9% mid-day and 2.3% during peak periods between 2010 and 2030. These rates were presented in the technical memorandum; *Recommended Methodology for forecasting Future Truck Volumes, SR 167 Corridor, Plan*, October 9, 2006, Heffron Transportation, Inc.

The SR 509 design team's VISSIM traffic simulation model was used to determine the potential travel time benefits of the new connection. Vehicles that travel southbound I-5 to eastbound SR 516 would save time because each trip would be shorter, and would avoid several traffic signals along SR 516. Vehicles that travel westbound SR 516 to northbound I-5 would save travel time due to the shorter distance. In 2030, it is estimated that 2,400 trucks per day would use the new route. During the peak hours, each vehicle from I-5 southbound to eastbound S 228th Street would save an average of about 5.8 minutes using the new ramps and new link across I-5. During the off-peak hours, the average travel time savings is estimated to be just over 3 minutes per vehicle. Each vehicle returning from westbound S 228th Street to northbound I-5 would save an estimated 49 seconds based on the shorter route (signal delay is approximately the same for the old and new route). Weighted over the course of the day to account for reduced congestion in the off-peak hours, it is estimated that trucks would save a cumulative 55 hours of delay each day in the year 2010. Multiplied by 260 days per year and adding in the growth in traffic for the next 20 years, and the cumulative travel time savings for just trucks is estimated at about 376,000 hours. Additional travel time savings would accrue for light trucks and passenger vehicles.

Large trucks could save a cumulative of 376,000 hours of travel time over the next 20 years with the 228th Street Connector Project. Additional travel time savings would accrue for light trucks and passenger vehicles.

2. SR 167/SR 18 Eastbound-to-Southbound Ramp

The SR 167/SR 18 interchange is missing two ramps, one of which would serve the eastbound SR 18 to southbound SR 167 movement. Currently, trucks traveling eastbound on SR 18 to southbound on SR 167, exit to West Valley Highway S, go south on West Valley Highway S, turn east on 15th Street SW and then use the southbound on-ramp to SR 167.

Traffic volume data were collected on West Valley Highway as part of the SR 167 Corridor Plan. The data include 24-hour volumes collected on August 22, 2006. Daily truck volumes on the southbound ramp were estimated for each of the next 20 years starting in 2009. Two forecast rates were applied, 2.9% per year for mid-day conditions and 2.3% per year for PM peak hour conditions. These rates were presented in the technical memorandum; *Recommended Methodology for forecasting Future Truck Volumes, SR 167 Corridor, Plan*, October 9, 2006, Heffron Transportation, Inc. Currently, 790 large trucks use this ramp, and that volume is expected to increase to 1,400 trucks per day in 20 years.

The travel time benefit was estimated using both the time savings of avoiding signalized intersections plus the time saved because the ramp would provide a shorter connection. The average delay values for the movements through each signal were estimated. On average, each truck is expected to save approximately 2 minutes of travel time if the new ramp were provided.

The annual travel time savings was estimated assuming the growth rates listed above and assuming 260 days per year because most truck travel is on weekdays. However, to be conservative, no additional travel time has been assumed to account for increased congestion along West Valley Highway in the future. The cumulative travel time benefit for 20 years is estimated to be over 184,000 hours for just the trucks on this corridor. Additional travel time benefits would accrue for passenger vehicles.

Large trucks could save a cumulative of 184,000 hours of travel time over the next 20 years with the proposed EB to SB ramp at the SR 167/SR 18 interchange. Additional travel time savings would accrue for light trucks and passenger vehicles.

3. SR 167/SR 18 Northbound-to-Westbound Ramp

The travel time estimating methodology for this ramp is the same as the eastbound-to-southbound ramp. The daily ramp volume is estimated at 830 large trucks per day in 2008 increasing up to approximately 1,500 trucks per day in 20 years. The proposed ramp is expected to save each truck about 3 minutes, 20 seconds in travel time. The cumulative travel time benefit over 20 years is estimated to be over 333,000 hours for just the trucks; additional travel time benefits would accrue for passenger vehicles.

Large trucks could save a cumulative of 333,000 hours of travel time over the next 20 years with the proposed NB to WB ramp at the SR 167/SR 18 interchange. Additional travel time savings would accrue for light trucks and passenger vehicles.

4. Ramp Improvements for Trucks

The capacity of a freeway is substantially affected by the capacity of its interchanges. Recurrent congestion often occurs at ramps with a high volume of merging or weaving traffic. Even during lighter traffic conditions, if the traffic merging into the mainline cannot attain the free-flow speed of the mainline, then the merging traffic will cause slowdowns on the mainline. The effect is to increase congestion along a mainline even before normal volume conditions would near capacity.

Trucks are the main culprit of slow traffic at merge points. Trucks are longer and heavier; require longer distances for acceleration and deceleration; are affected more significantly by steep grades; and are more limited in mobility around tight, super-elevated curves. If ramp meters are active when mainline speeds are still relatively high, the meter will further reduce the acceleration distance for trucks and decrease the speed that they can merge onto the mainline.

Table 1 presents select speed-distance relationships for trucks accelerating on an uphill grade from a stop condition. For a typical ramp design with a 3% uphill grade and 1,000 feet of ramp length, heavy trucks are entering the freeway at about 29 mph. At some ramp meter locations trucks are starting from a stop condition less than 1,000 feet from the merge point.

Table 1. Speed-Distance for Acceleration of a Typical Heavy Truck

3% Grade		5 % Grade	
Distance (feet) ¹	Speed (mph)	Distance	Speed
500	27	500	22
1,000	29	1,000	24
1,500	31	1,500	25

^a Source: AASHTO, *A Policy on Geometric Design of Highways and Streets, 2004, Exhibit 3-56*

1. Distance from a stop condition

Three types of improvements at freeway ramps are recommended: geometric improvements, moving the ramp meter location, and ramp meter by-pass for trucks. Specific improvements could include:

- Increasing the length of the ramp.
- Providing an acceleration lane parallel to the mainline.
- Increasing the radius and decreasing the super elevation of loop ramps.
- Reducing the grade of on-ramps

The concept of ramp meter by-pass for heavy trucks would increase the length of acceleration for trucks on ramps, provide an acceleration lane, and achieve a merge speed closer to that of the mainline traffic. This concept is proposed as a demonstration project.

As described previously, the benefits of ramp improvements could extend well beyond the travel time advantage for just the trucks. Reduced congestion during the shoulder hours would also reduce delay and improve safety for all mainline traffic. The full time advantage would require detailed analysis of specific improvements using a micro-simulation model such as Corsim or Vissim that evaluates freeway interchange operations. The benefits would differ at each ramp location.

5. Improved Signage and Truck Traveler Information

Improving signage specific to truck drivers may provide travel time benefits to truckers who might otherwise take the wrong route. Similarly, traveler information for truckers would help truck drivers or dispatchers choose a faster route. However, it is not possible to estimate the travel time benefit for these projects since it could vary day to day or even hour to hour as truckers avoid non-recurrent congestion due to incidents.

MCH/mch