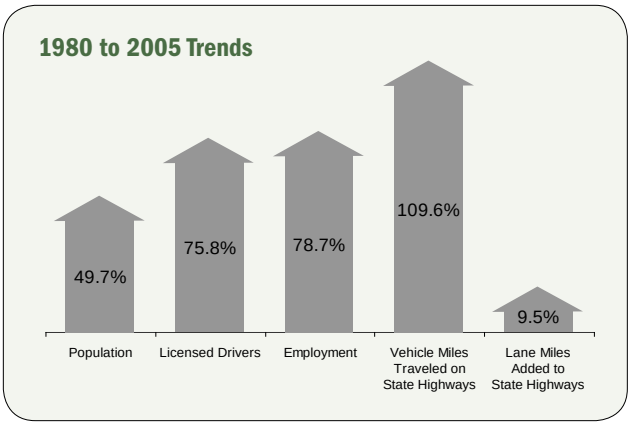
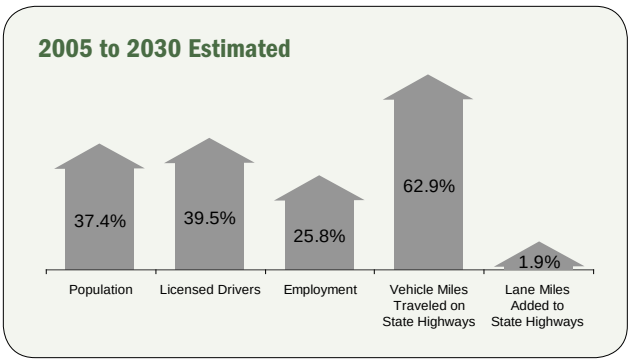
Mobility

Washington State highways carry millions of people billions of miles every year. These highways traverse a variety of geographical areas ranging from densely populated urban areas and suburbs to rainforests, mountain passes and deserts. Bridges carry highway traffic over rivers, lakes and parts of Puget Sound. Where bridges cannot be built, ferries carry travelers and freight.

Looking Back ... to 1980, there were over four million people living in Washington State with nearly three million of them traveling over 15 billion miles per year on the approximately 16,800 lane miles of state highways. Many of these miles were accumulated as people traveled to and from the almost two million existing jobs. Over the next 25 years to 2005, Washington's economy prospered adding over one million new jobs. Population increased to over six million. The combination of more people and more jobs increased the number of licensed drivers making more trips on state highways totaling well over 31 billion miles traveled annually by 2005. This growth used up most of the capacity of the urban and suburban highway system built during the 50s, 60s and 70s. Very little new highway capacity was added during the 80s and 90s. Today many urban and suburban highways have reached capacity and travelers must endure longer commute times.

Looking Ahead ... to 2030, Washington's population will grow to over eight million people, the number of licensed drivers to over six million, the number of jobs to over four million. This continued growth will increase the miles traveled on state highways to over 51 billion by 2030. This continued growth will place even more strain on the already strained network of highways leaving many travelers stuck in traffic longer. The excess urban and suburban highway capacity built before 2005 is nearly exhausted. This means that by 2030, without substantial new capacity or significant changes that affect how and when we travel, users of Washington State's transportation system will experience congestion resulting in less reliable movement of freight and goods, longer travel times, increased delay and higher consumer costs as consequences of a deteriorating system.





Major Factors Contributing to Congestion

The growth in travel demand, especially during peak hours has caused many of the urban and suburban highways in Washington State to operate less efficiently. This decreased efficiency further consumes the capacity of the highway leading to more congestion (recurring congestion). Non-recurring congestion: congestion resulting from weather, roadway construction, collisions, vehicle breakdowns, etc., further reduces the operating efficiency of the highway system. On a fundamental level, failure to price the use of roadway capacity contributes to unconstrained demand and causes congestion. The major factors that contribute to congestion, based on a national summary from the Federal Highway Administration augmented by additional factors* identified by WSDOT, are as follows:

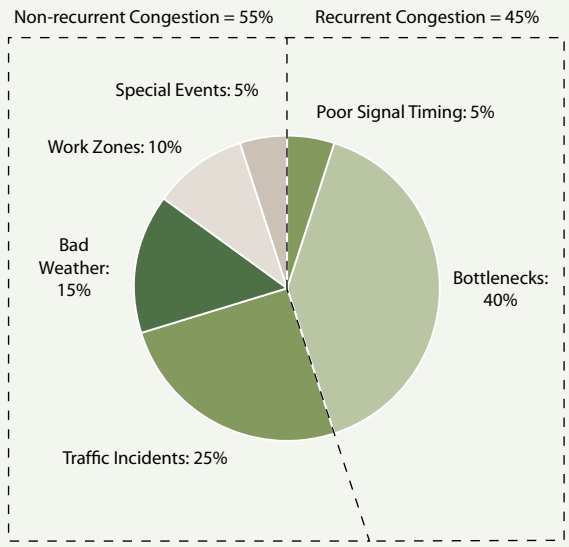
- Bottlenecks
- Traffic Incidents
- Weather
- Work Zones

- Signal Timing
- Special Events
- Land Use *
- Ferry Traffic *
- Fluctuations in Normal Traffic

Bottlenecks

Bottlenecks are places where the physical attributes of a roadway change in a manner that impacts the flow of traffic. Typical bottlenecks are locations where the number of lanes decreases; the roadway physically narrows either in shoulder width or lane width and narrow bridges. WSDOT has separated bottlenecks into two categories, bottlenecks and chokepoints. WSDOT defines chokepoints as places where congestion occurs because of traffic interference and/or the roadway configuration (examples: freeway interchanges; lack of turn lanes at intersections; seasonal road closures). Bottlenecks and chokepoints greatly influence the flow of traffic, whether it be long backups of vehicles trying to exit the roadway, vehicles having to dramatically reduce their travel speeds when leaving one freeway to enter another (freeway to freeway connections) or vehicles slowing down as they cross a narrow bridge.

The Sources of Congestion
National Summary



According to the Federal Highway Administration's 2004 report Traffic Congestion and Reliability: Linking Solutions to Problems, the majority of congestion is caused by bottlenecks. Traffic incidents are the next highest contributor followed by inclement weather.

Traffic Incidents

Traffic Incidents typically include collisions, disabled vehicles, debris on the roadway, spills, and roadside distractions that alter driver behavior (e.g., roadside construction, patrol car with flashing lights or a fire beside the freeway) and other events that impede the normal flow of traffic. For every minute a lane remains blocked, four to ten minutes of congestion may result.

Weather

Weather, such as the recent events in November 2006 where heavy rainfall caused flooding, sink holes and landslides, resulted in the temporary closure of more than a dozen highways in Western Washington for several days. Mountain passes periodically close for avalanche control. Snowfall, ice, heavy fog, and blinding sun can cause delay.

Work Zones

A Work Zone is an area of a highway with construction, maintenance, or utility work activities. A work zone is typically marked by signs, traffic control devices, barriers, pavement markings, and/or work vehicles. It extends from the first warning sign or rotating/strobe lights on a vehicle to the sign indicating end of road work or construction, or the last temporary traffic control device.

Signal Timing

Signals cause additional delay to drivers. In fact, minor side street traffic may experience excessive delay, particularly during off-peak hours. Because of this, drivers may actually avoid the signalized corridors and switch to alternate routes or to residential streets not designed to handle through traffic.

Special Events

Special Events like sporting events, political rallies and parades can cause temporary but major impacts to normal travel conditions expected by motorists.

Land Use

The state transportation system is directly impacted by local transportation and land use choices. Insufficient local street networks, zoning that encourages sprawling development, inefficiently managed access, development encroachment on state transportation

corridor rights of way compromise existing and future capacity and safety of the state transportation system. Preserving corridor capacity by making land use choices that protect the public's investment in the state transportation system will reduce the need for costly improvements.

The responsibility for land use planning and regulation resides with local governments. Most counties and cities plan under the Growth Management Act (GMA). The GMA defines a state policy framework and certain minimum requirements for local comprehensive plans and development regulations. The GMA's intent is to address uncoordinated and unplanned growth and express common goals for the conservation and wise use of land. The GMA also promotes regional coordination by requiring that comprehensive plans be consistent with countywide planning policies and regional transportation plans.

WSDOT's land use role under the GMA is largely advisory. Local comprehensive plans and regulations do not require state approval, with the exception of the Shoreline Master Program. The GMA does require local governments to submit proposed comprehensive plan and development regulation amendments to the state for agency review. WSDOT can use this opportunity to influence local land use decisions by providing technical assistance, oral testimony, or written comment on proposed amendments. Local governments are not, however, required to take action based on agency comments. State agencies can appeal local land use decisions to one of the three growth management hearings boards.

WSDOT influences local land use by reviewing comprehensive plans, regulations, and permitting decisions under the State Environmental Policy Act (SEPA). WSDOT can ask local governments to deny or condition a development permit to avoid or mitigate specific adverse impacts to state highways. Likewise, WSDOT can request that local governments abandon, alter, or mitigate their land use policies or regulations to reduce adverse impacts on state highways. Local governments must consider WSDOT's SEPA requests but are not required to comply with them unless conditioned by the SEPA Hearing Examiner.

Finally, WSDOT can minimize the adverse impacts of local land use decisions through its access control policies. WSDOT has different degrees of influence over access depending on a highway's classification and location. WSDOT is the permitting authority for limited access and managed access highways in unincorporated areas. Cities and towns are the permitting authorities for managed access highways within their boundaries and are required by state law to adopt access standards that meet or exceed WSDOT standards.

Ferry Traffic

Communities that are home to ferry terminals face unique transportation challenges. Holding areas for ferry traffic waiting to load consume considerable space within a community and the ever increasing ferry traffic when off loading from the vessels present a platoon of vehicles that is difficult to merge with or cross through, often bringing local traffic to a standstill. As residential growth continues in communities on the west side of Puget Sound and major job opportunities remain located on the east side of the Sound, additional ferry trips and ferry terminal or operational "land side" improvements will be needed to accommodate the increased travel demand.

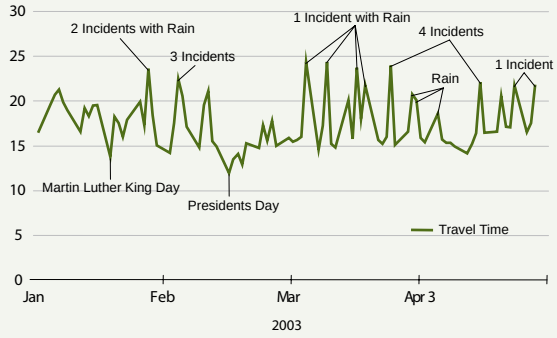
Fluctuations in Normal Traffic

Traffic varies from day to day. Some days, traffic volumes are higher than normal leading to significantly longer travel times, other days traffic volumes are below normal and traffic flows freely without delay.

Any one of the above factors can cause traffic to slow below an acceptable level. When two or more of these factors are combined, traveling on the freeway becomes difficult. This interaction between multiple factors creates a dynamic and unpredictable series of conditions that is rarely the same from one day to the next, one highway to another or even from one hour to another. For example, the travel time that one motorist experiences leaving home at 6:30 a.m. may be completely acceptable, but another motorist who leaves home 30 minutes later experiences a travel time that is more than twice as long. These motorists' experiences can change dramatically if the next day there is a lane blocking collision, or if it is raining.

Weekday Travel Times

5:00-6:00 p.m., on SR 520 Eastbound, Seattle, Washington
Travel Time (in Minutes)



Source: Traffic Congestion and Reliability, *FHWA, 2005*

To make matters even more complex some of these situations can cause other events to occur. Consider the following:

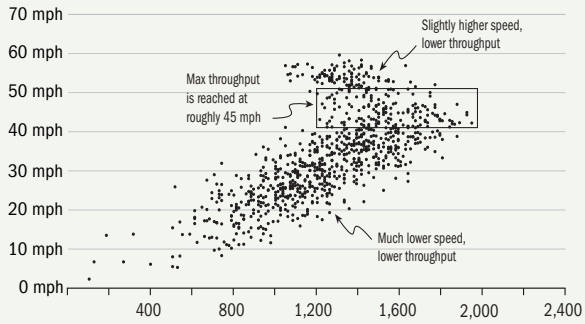
- When traffic volumes are above normal on one highway, many commuters may decide to take an alternate route causing volumes to spike and slowing traffic to a crawl.
- Even moderate congestion can cause an increase in collisions as the following distance between vehicles is reduced and drivers become distracted.
- Signal timing on a major local arterial may cause vehicles on freeway off ramps to backup onto the freeway shoulder, reducing through capacity.
- Weather can cause poor visibility leading to slow downs and potentially more collisions.
- Drivers distracted by a collision may cause additional collisions as their attention leaves the roadway ahead of them.

Identifying Highway Congestion

In past updates to the HSP, WSDOT targeted capital improvements to restore free-flow operating conditions (travel at posted speed 24 hours per day) to the most severely congested highways. This practice limited the ability of WSDOT to address congestion on a statewide basis and subsequently created a situation where less congested roadways have now become congested. Historically, more money was spent to widen roads. However there is not enough state or local money or land to build sufficient highway capacity to match those trends. Therefore, WSDOT has set a goal to get the highest possible performance from our existing transportation investments. From basic maintenance and operations activities to the application of sophisticated technologies, all options are being examined to ensure that people and goods move more reliably and predictably on our present system.

Relating Speed and Volume

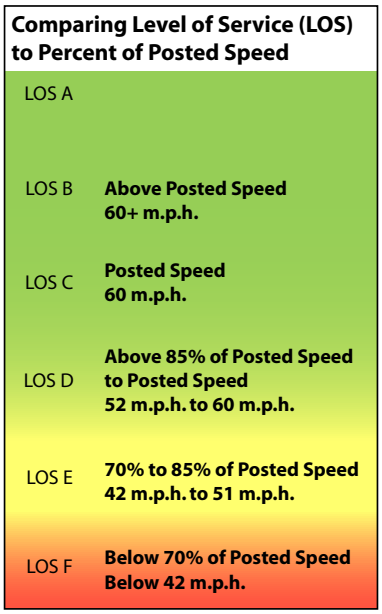
I-405 Northbound at 24th NE, 6-11 am Weekdays in May 2001
Hourly Volume/Lane



Congestion not only causes delay, it also causes lost productivity for the roadway system. Under congested conditions, even though the road is "full" of vehicles, they are moving so slowly that fewer of them actually pass any given point on the road. Currently, maximum traffic throughput is achieved on a typical freeway segment in the Central Puget Sound region at approximately 45 mph. Daily fluctuations to normal traffic, observed conditions reflecting maximum throughput vary between 42 and 51 mph, 70 to 85 percent of the posted speed limit respectively for a freeway with a 60 mph posted speed limit.

The goal is to manage the system to achieve maximum throughput/productivity. When travel speeds fall below 70 percent of posted speed, or about 42 mph, the highway no longer operates efficiently. It is this condition that was targeted by WSDOT as the threshold for determining when a highway requires capital improvements to restore efficient operating conditions.

Traditional highway performance measurement revolves around a grading system using the letters A-F to determine the "Level of Service" (LOS) provided or projected on a roadway. This method is difficult to quantify for many because it is not directly tied to "Travel Speeds" or "Travel Time." The relationship between traditional LOS and the percent of posted speed, used for determining congestion in this HSP update, is graphically represented below.



Bottlenecks and Chokepoints

To identify a bottleneck or chokepoint location for this update, WSDOT regions followed the guidelines established as follows.

First, the location under consideration had to fit the definition of being either a chokepoint or bottleneck as explained on page xx. Second, the observed congestion must be supported with traffic data and analysis models. If congestion is a problem today or anticipated within the next 20 years, it must also satisfy at least one of the following applicable criteria:

- The congestion problem impacts the flow of mainline through traffic.
- The impact on mainline traffic flow is measured as through vehicle peak hour speeds that are determined (measured or modeled) to be equal to or less than 70 percent of the posted speed.
- Traffic flow criteria for ramps will also be considered to determine if the congestion is caused by on/off ramp traffic.

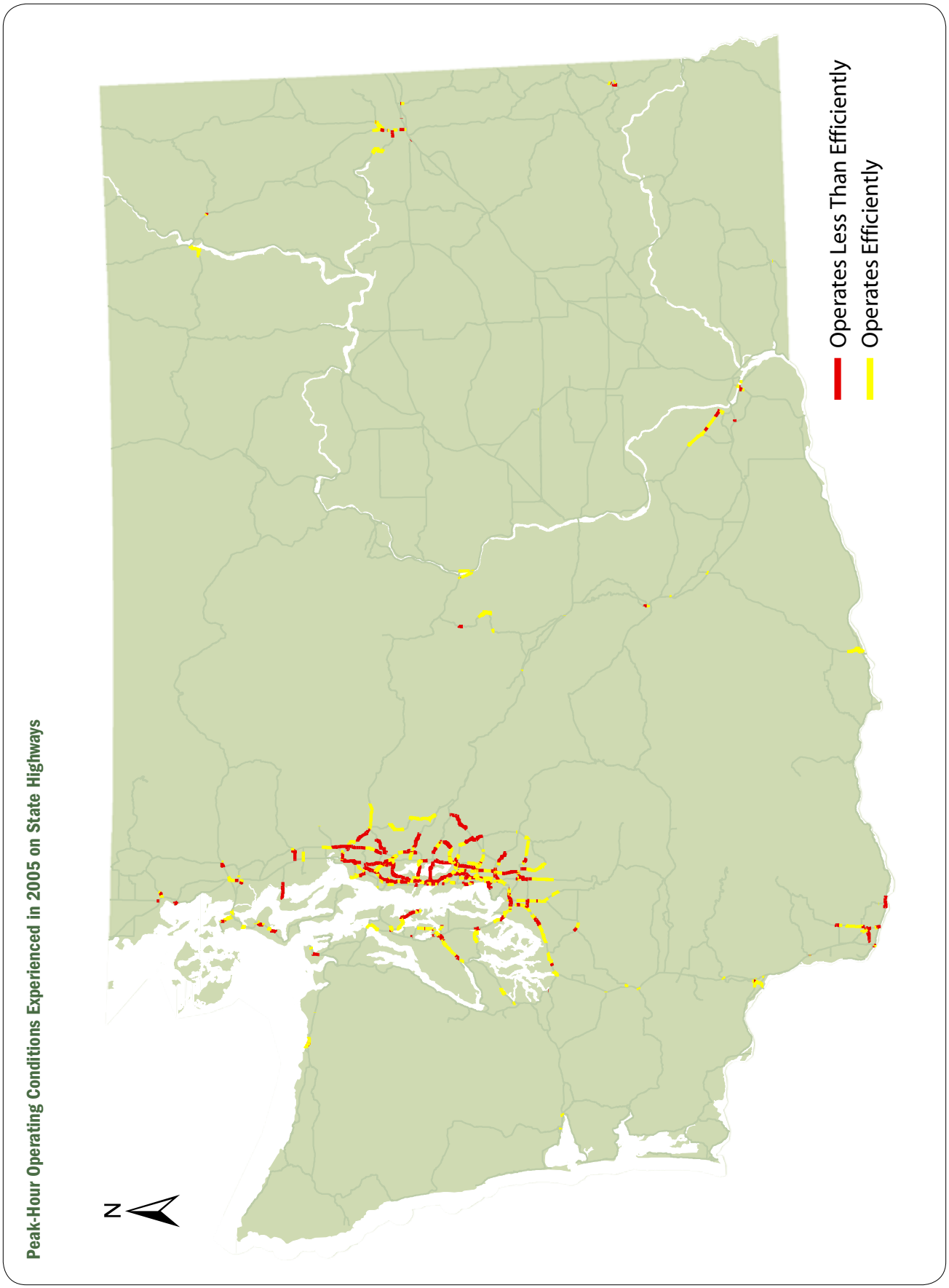
An extensive list of bottleneck and chokepoint locations and solutions has been developed for this update of the HSP (see Appendix: Bottlenecks and Chokepoints). Additional locations will be identified through future analysis for inclusion in updates to the HSP.

Congested Corridors

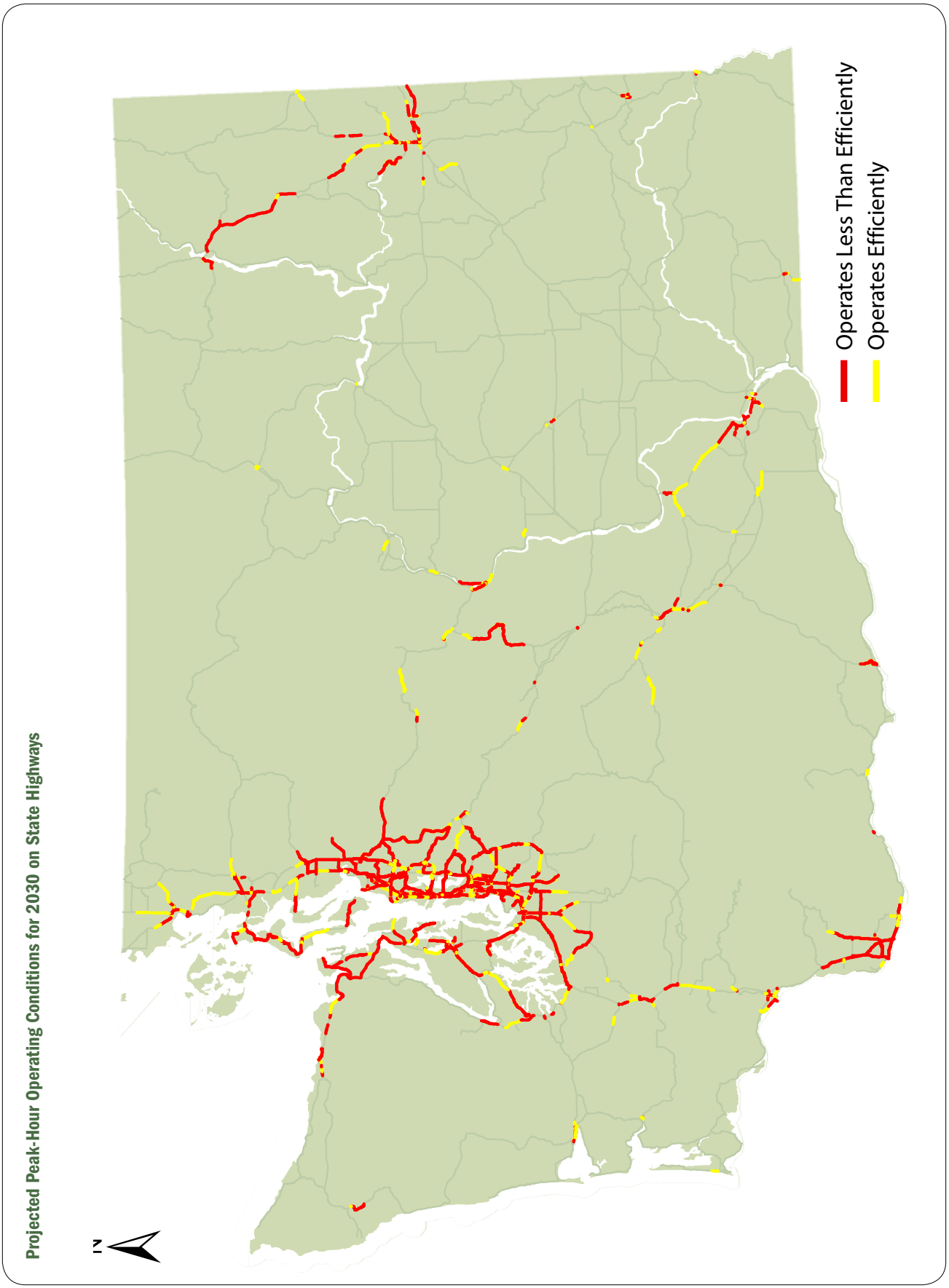
To identify where congestion exists today (2005), computer models were used to identify where vehicles currently travel below 70 percent of the posted speed during the peak hour, as shown in the maps on the next page. However it is important to note that the analysis performed does not reflect the impact of congestion associated with local roads, ramps, interchanges, weather, special events, construction, collisions or incidents. This is the criteria used to determine both Interstate and non-Interstate congested corridors.

For long-range planning purposes, future year conditions must be forecast to determine when and where congestion will occur. Computer analysis was used to forecast 24-hour operating conditions for the year 2030 to identify locations where the peak-hour travel speeds fell below 70 percent of the posted speed. Of those locations, the segments with the most significant delay regionally (or at the county level) were chosen as study corridors for this update. Routes that were identified but not studied will be addressed in future updates. These projected future conditions reflect the completion of the mobility projects included in both the 2003 "Nickel" funding package and the fully funded projects included in the 2005 Transportation Partnership Act (TPA). These projections do not reflect the impact of congestion associated with local roads, additional impacts associated with ramps, interchanges, weather, special events, construction, collisions or incidents.

As population and the economy grow, traffic congestion will get even worse. Dramatic solutions are needed. Future steps will be neither cheap nor politically easy. The best are aimed at increasing the efficiency of the facilities we already have and the new facilities that need to be built.



Peak-Hour Operating Conditions Experienced in 2005 on State Highways



Projected Peak-Hour Operating Conditions for 2030 on State Highways

Addressing Mobility Needs

The 2003 "Nickel" funding package and the 2005 funding package approved by the Washington State Legislature will generate over $11 billion towards mobility projects over the next 16 years. This additional revenue will complete many projects and will begin or continue work on the projects listed (see Figure xx, Location of Projects). With the enactment of these funding packages, the Legislature set the priority for future projects and direction for transportation investments. Therefore the completion of these projects is seen as a high priority for WSDOT's future mobility program.

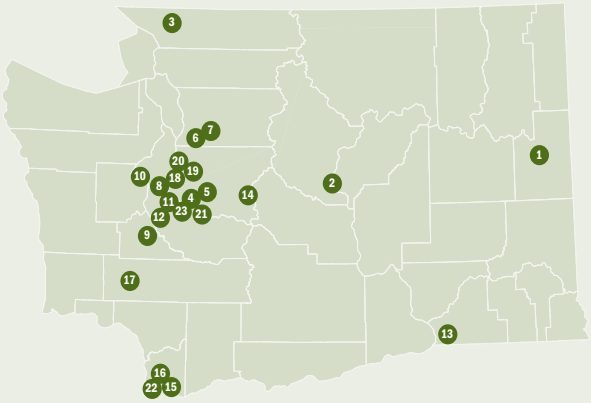
Additional priorities for this update were established by the Transportation Commission and implemented in the WTP. The WTP priorities are as follows.

- Preservation
- Safety
- Economic Vitality
- Mobility
- Environmental Quality and Health

These priorities create guidelines for future investments for Washington State's entire transportation system. This presented WSDOT with a huge challenge to balance funding for all existing and future needs. Given this funding constraint, this update is based on an incremental tiered approach, where every improvement builds upon previous work so that no work is wasted. This approach separates strategies into three investment tiers to be implemented incrementally over the life of the 20-year plan to maximize every dollar invested. The three tiers are as follows:

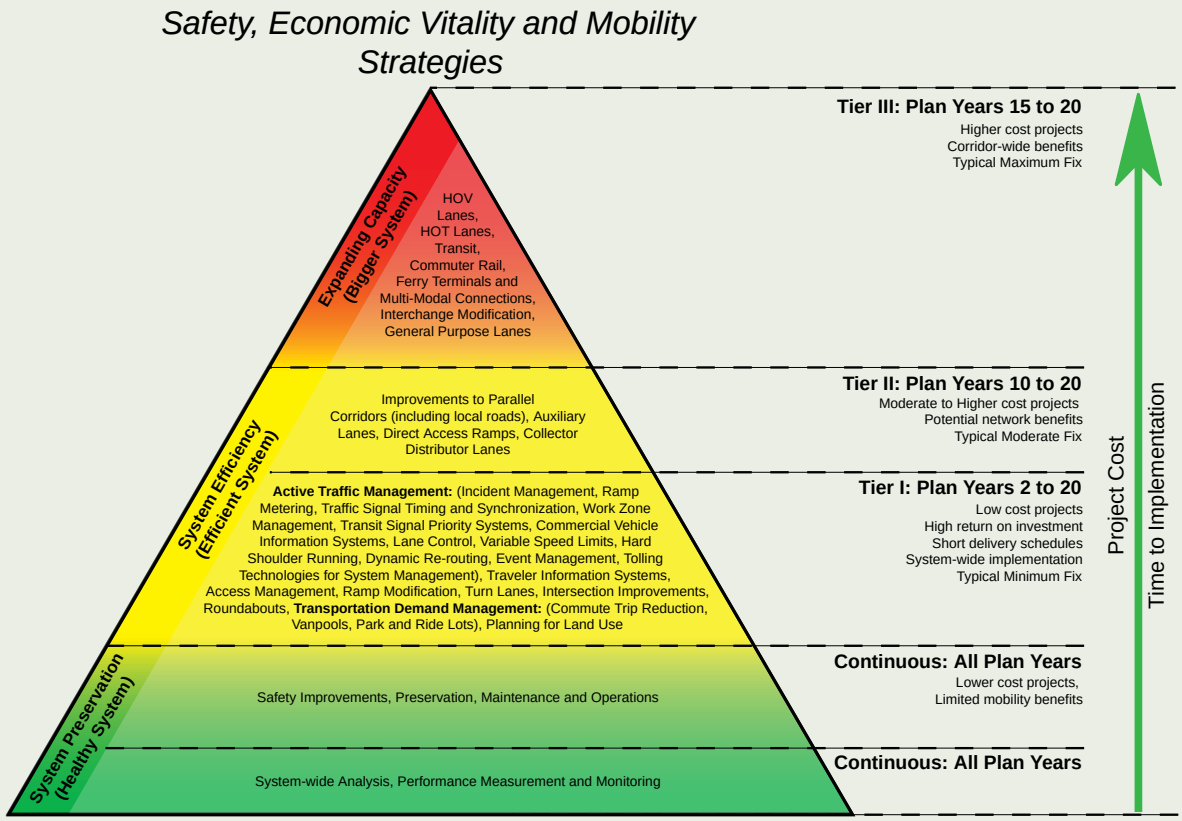
- **Tier I** – to be implemented in years 2 to 20 of the Plan, focuses on low cost projects that deliver a high return on capital investment and have short delivery schedules. These include incident management, ITS, access management projects, ramp modifications, turn lanes and intersection improvements.
- **Tier II** – to be implemented in years 10 to 20 of the Plan, focuses on moderate to higher cost projects that deliver potential network benefits to both highways and local roads. These include improvements to parallel corridors (including local roads), adding auxiliary lanes, and direct access ramps.
- **Tier III** – to be implemented in years 15 to 20 of the Plan, focuses on highest cost projects that can deliver corridor-wide benefits. These include commuter rail, HOV/HOT lanes, and interchange modifications.

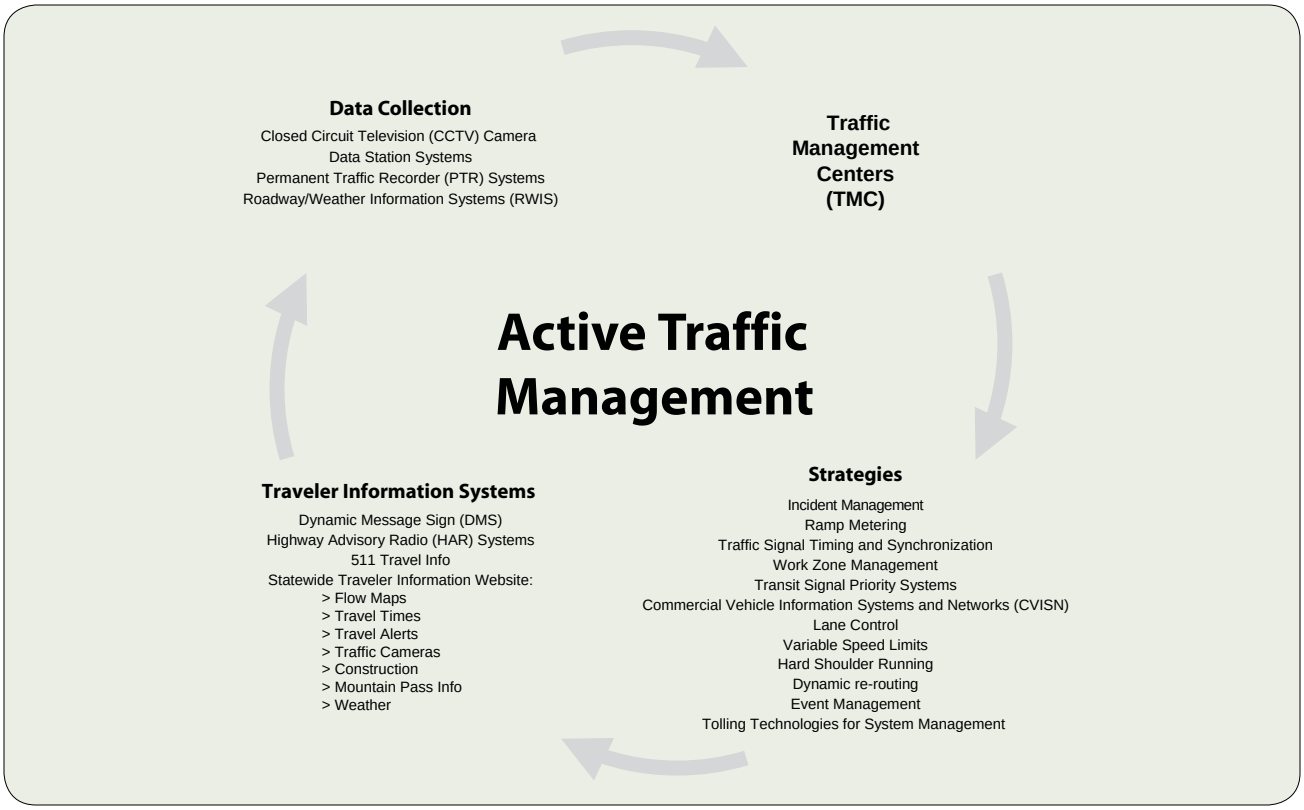
Location of Projects



1 US 395 North Spokane Corridor
2 SR 28 East Wenatchee Corridor
3 SR 539 Lynden to the USA/Canada Border
4 SR 509 Complete SR 509 from I-5 to Des Moines Memorial Drive
5 SR 18 Issaquah Hobart Road to I-90
6 SR 522 Paradise Lake Road to Monroe
7 US 2 Monroe Bypass
8 Completion of Puget Sound HOV System
9 SR 510/SR 507 Yelm Bypass
10 SR 3 Belfair Bypass
11 SR 167: SR 509 at Port of Tacoma to SR 167/SR 512 at Puyallup
12 SR 704 Crossbase Highway
13 US 12 US 730 to McDonald Road
14 I-90 Snoqualmie Pass East
15 SR 14 Camas / Washougal
16 I-205 SR 14 to NE 134th Street
17 I-5 13th Street to Mellen Street
18 SR 518/SR 509 Interchange
19 I-405 Lynnwood to Tukwila - Corridor Improvements
20 SR 520 Bridge Replacement and HOV
21 SR 410 Bonney Lake Vicinity - Corridor Widening
22 I-5 Columbia River Crossing
23 I-5/SR 161/SR 18 "Triangle" Interchange

2007-2026 Washington State Highway System Plan: Implementation Plan





Strategies to Address Congestion

To effectively prioritize State highway system needs an implementation plan was developed to ensure future solutions followed the established WTP priorities and maximized all current and future revenue. Therefore, continuous system-wide analysis, performance measurement and monitoring must be completed to promote a "healthy system." A healthy system must be preserved to prevent deterioration of assets, must provide improved safety and must be maintained and operated efficiently. It draws upon some of the solutions included in Tier I.

System efficiency promotes the optimum operation of the highway system and its connections to local networks and multi-modal facilities including ferry terminals. System efficiency begins with delivering low cost projects with shorter construction schedules to a wide range of high benefit locations (Tier I). It also includes some moderately priced projects to expand upon the previously completed lower cost projects that maintain the operational efficiency of a corridor (Tier II).

Expanding capacity includes the most costly solutions from tier two and all tier three solutions. These solutions would only be considered after all lower cost alternatives have been exhausted. These solutions would also build upon previously implemented solutions so that no work would be wasted. These solutions may include adding general purpose or HOV lanes, passenger rail, transit, multimodal facilities and major interchange modifications.

Tier I Strategies

Tier I strategies are typically lower cost projects that deliver a higher return on capital investments and have the shortest delivery schedules. These strategies bridge the gap between system operation and system efficiency.

Active Traffic Management

Active Traffic Management (ATM) is the integration of multiple strategies that incorporate current and future technologies to provide "real-time" lane management that responds to changing traffic level and roadway conditions to regulate the flow of vehicles to ensure the maximum utilization of existing highway capacity. ATM begins with extensive data collection. WSDOT performs detailed analysis of this data to create new strategies, modify existing strategies, develop new and update existing traveler information systems to provide better:

- Travel Time Reliability
- Vehicle Throughput
- Safety
- Incident Management
- Traveler Information

Initial steps are underway to determine the appropriate application of ATM techniques and where ATM would be most beneficial to implement.

Looking forward … advanced technology will become standard on more vehicles, better roadside technology will be available to WSDOT which will enable vehicles to interact with ATM information systems providing more efficient use of the highways of the future. Imagine having a vehicle that can sense the location of other vehicles on the road and activate variable cruise control and collision avoidance systems. A non-connected train of vehicles such as these, all communicating directly with each other, will allow them to safely travel at close distances and high speeds, while improving current highway system efficiency. There are vehicles available today with smart technologies built-in, such as navigation, and collision avoidance.

Data Collection

Data collection is critical to the operation of an actively managed highway system. The following data collection systems are in use today to help WSDOT manage and plan for creating a more efficient transportation network. These systems include:

- Closed Circuit Television (CCTV) Cameras
- Data Station Systems
- Permanent Traffic Recorder (PTR) Systems
- Roadway/Weather Information Systems (RWIS)

Closed Circuit Television Cameras

TMCs depend on field devices such as the 502 closed-circuit TV cameras used to detect and respond to incidents and congestion as well as monitoring roadway conditions. The camera images are sent to the TMCs for operations monitoring, to the web for travelers and to the media for news broadcasts.

TMC Seattle at Regional Headquarters

Data Station Systems

TMCs also depend on field devices such as the 479 traffic data stations which include Video, Radar and Loop detectors. Data stations provide critical volume, speed, and occupancy data which are used for planning, design, operations, construction, and maintenance activities. This information is also used for measuring performance and providing information to the traveling public, such as travel times. The information obtained through these data stations provides critical information for WSDOT initiatives and is used in benefit/cost analyses.

Permanent Traffic Recorder Systems

The WSDOT Transportation Data Office (TDO) has 162 permanent traffic reporting systems. These sites collect either (or a combination of) volume, classification, speed or weight traffic data depending on the type of sensors and traffic recorders installed at the site. PTR sites, which are managed by the TDO, work together with data stations to complete the picture for WSDOT managed roadways. Due to Federal reporting requirements for PTR system collected data, the data quality standards for these systems are much higher than for data station systems.

Roadway/Weather Information Systems

WSDOT maintains and operates 94 RWIS stations strategically located along the state highway system to provide "live" weather and road condition reports. This information is used to coordinate operational and maintenance activities and provide detailed traveler information.

Percent of Lost Throughput Capacity Due to Lane or Shoulder Blocking Incidents

(Based on 2000 vehicles per lane per hour highway capacity)

		Lanes Blocked		
# of lanes	Shoulder Blocked	1	2	3
2	19%	65%	0%	n/a
3	17%	51%	83%	0%
4	15%	42%	74%	87%
5	13%	35%	60%	80%
6	11%	29%	50%	74%

A semi-truck hauling a large backhoe hit the underside of the 13th Street overpass on I-5 near Exit 76 in Lewis County. The impact sent chunks of concrete flying across the southbound lanes.

Traffic Management Centers (TMC)

WSDOT operates seven regional TMCs; Seattle (Shoreline), Tacoma, Spokane, Vancouver, Yakima, Bellingham, Hyak (Snoqualmie Pass - winter season only) and Wenatchee. In addition, an Emergency Operations Center (EOC) is located in Olympia. This TMC provides a central location for WSDOT executives to help manage traffic operations, incident response, and maintenance during "emergency" events. TMCs are the nerve centers for WSDOT's operations activities. Real-time information is gathered 24 hours a day, 7 days a week from many sources including traffic detectors, CCTV cameras, ramp meters, the Washington State Patrol (WSP), road crews, WSDOT's incident response teams, and media traffic reporters. WSDOT uses this information to coordinate responses to clear accidents, deal with other problems that occur, and notify the public and the media of these events.

Incident Management

Collisions and disabled vehicles disrupt traffic. Much worse than "regular" congestion, traffic disruptions from incidents destroy "reliable travel times." Even a patrol car parking on the shoulder with its lights flashing can cause a significant capacity loss.

Since 1963, WSDOT tow and push trucks have been clearing blockages on the Mercer Island and Evergreen Point floating bridges in a "roving" mode during peak traffic periods. In 1990, Incident Response Teams were highlighted as a pilot program during the Goodwill Games. In 2000, WSDOT implemented a small pilot Service Patrol program (six additional roving units), contracting with Washington State Patrol (WSP) and private tow companies.

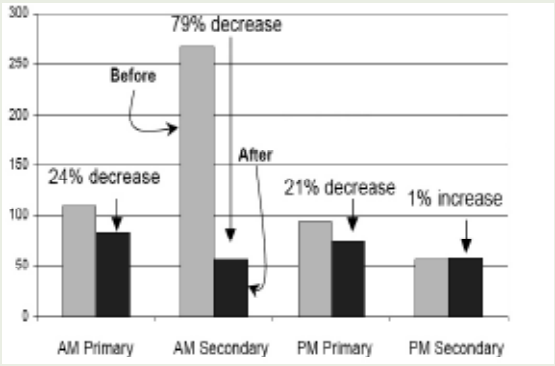
Our program began by improving coordination between State Patrol Troopers and WSDOT's roving incident response drivers. The WSDOT team sets up traffic control, assists in highway clearance and helps coordinate pre-opening clean up operations. Even disabled motorists located on the shoulder get help with a tire change or a couple of gallons of gas. The incident response drivers also remove on-roadway debris. As the program expands, it has reached into:

- Training and drills with local EMS, fire and hazmat responders.
- Implementation of new technologies like digital computer-aided photogrammetry to help state troopers expedite on-scene accidents investigation, sometimes taking hours off closure times.
- Improved communication, coordination and contracting with tow truck operators, local law enforcement and even county coroners.

Faster clearance not only opens travel lanes, but reduces the risk of secondary accidents (rear-enders in the back-ups) that block the roads all over again.

Incident Management is a reactive approach to addressing collisions. Incident Response Teams (IRT) respond immediately to accidents or other incidents such as hazardous material spills to reduce delay caused by these incidents. Incident Response Team members are a specially trained group of WSDOT maintenance employees who respond to blocking

Ramp Meters Improve Traffic Flow Tally of Observed Braking Actions



Merging conflicts at ramp to SR 167
Frequency of braking to avoid other cars at ramp from S 214th Street to NB SR 167.

incidents on our state's freeways and highways. Their main function is to clear roads, help drivers and restore the normal flow of traffic as safely and quickly as possible.

Expansion of the Incident Response (IR) program in July, 2002, mobilized several IRT units from a 24/7 "call-out" mode to a peak traffic period "roving" mode; it also doubled WSDOT's IRT fleet to 38 vehicles, adding 19 new "roving" peak traffic period units. Enhanced incident response patrols were instituted on I-405 which reduced the average clearance time for incidents by over 40 percent.

The 2002 expansion was reauthorized by the 2003 state legislature, enabling the formal establishment of a statewide IR program partnership between WSDOT, WSP, private tow companies, and media sponsored "motorist assistance van". During peak travel periods IR program units "roam" established areas and provide assistance wherever needed to reduce incident clearance times. The expansion has also increased the WSDOT IRT 24/7 call-out capabilities.

WSDOT's Incident Response Team has shown positive results in reducing non-recurrent congestion. Although the number of incidents WSDOT responded to has doubled since July 2002, the average clearance time for all incidents has remained constant. The goal is to maintain or improve that time. For more information about Incident Response please visit the Incident Response web page at: http://www.wsdot.wa.gov/operations/incidentresponse.

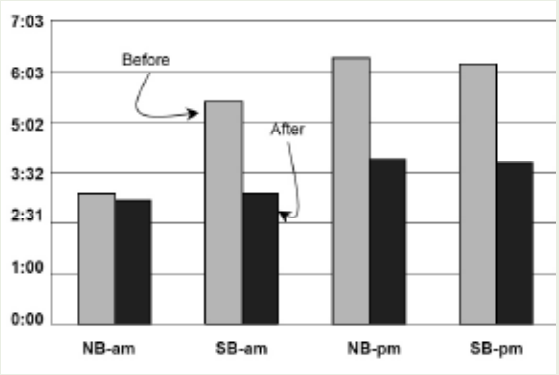
Ramp Metering

Ramp metering has been in place in the Seattle area for years and has proven highly effective in maintaining and even increasing freeway throughput. Ramp meters are stop-and-go signals located on entrance ramps to the freeway. They control the frequency with which vehicles enter the flow of traffic on the freeway.

Ramp meters are a cost-effective method of relieving traffic congestion. By increasing the efficiency of freeway use, ramp meters save taxpayers costs associated with building new lanes. Past ramp meter activations have reduced rear-end and sideswipe collisions by over 30 percent.

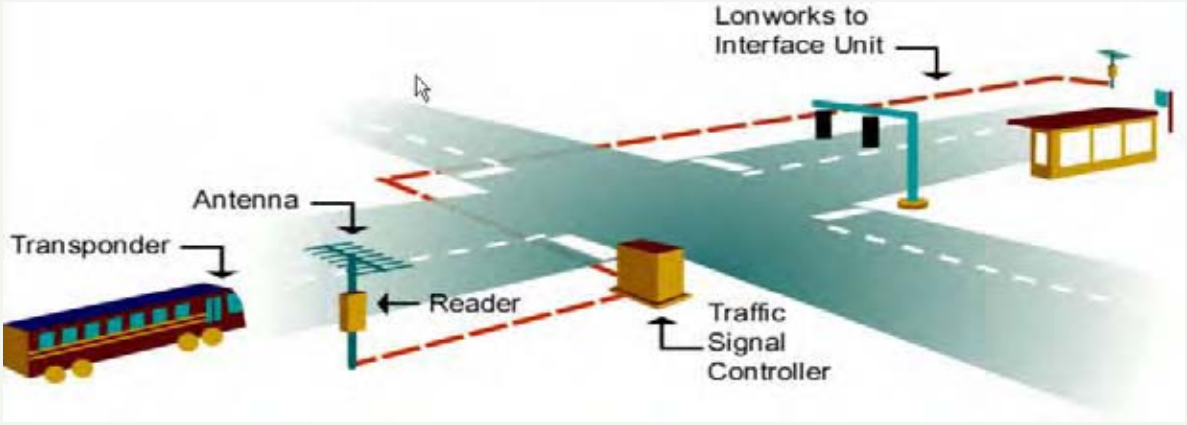
The un-paced, disorganized merging of freeway ramp traffic into the freeway mainline is a chronic contributor to traffic breakdown. Mainline flow collapses as merging vehicles try to squeeze into the flow. Braking and accelerating, no one moves easily and the situation is worsened by frequent minor collision taps and fender benders. Ramp meters pace the incoming flow, so the merging takes on the quality of a smoothly functioning zipper. Mainline flows improve and overall volumes increase both on the mainline and the ramp and their blocking accidents decrease. For more about ramp metering please visit the Ramp Metering web page at: http://www.wsdot.wa.gov/traffic/congestion/rampmeters.

Traffic Light Re-timing Probably Has the Best Cost/Benefit Ratio of Any Dollar Spent



Before and after peak hour travel times (min.sec)
Study conducted by the City of Bothell on retiming traffic signals on SR 527 between 228th Street SE and SR 524.

Transit Signal Priority System
Integration With City of Lynnwood Advanced Traffic Management System (ATMS)



Traffic Signal Timing and Synchronization

Traffic signal synchronization has long been recognized as one of the most effective techniques for cutting traffic congestion on arterials. Studies show that in some locations the benefit of reduced delay compared to the cost of timing may be as high as forty to one. Traffic signal timing works, but it must be constantly adjusted and refined as traffic patterns change. Funding for traffic synchronization work is one of the easiest and most cost-effective ways to help relieve traffic congestion.

Work Zone Management

Highway construction and repair zones cause congestion. Lanes are narrowed, or even closed, and traffic detours and neckdowns are frequent collision locations, making matters worse. Today, program-wide impacts require strategies to be considered starting at the planning stage. In major metropolitan areas it is essential that mobility impacts of all projects be considered at a system level, including coordination between jurisdictions:

- Incentives for contractors to minimize highway traffic disruptions.
- Enhanced law enforcement to reduce inattentive driving and speeding that causes work zone accidents.
- Off peak construction work hours to avoid peak period traffic.
- Total corridor closure for expedited project completion.

In four out of five work zone accidents, it is the driver or passenger that gets seriously injured or killed not the construction worker in the work zones.

Transit Signal Priority (TSP) Systems

Transit Signal Priority (TSP) is a traffic signal control strategy to provide incremental benefits to public transit for the purpose of improving transit speed and reliability. Traffic signal timing is slightly modified to provide a benefit to the transit vehicle. Transit vehicle arrival times are estimated from on-street detection or from a Global Positioning System (GPS) based Automatic Vehicle Location (AVL) system. WSDOT currently operates and maintains 10 TSP systems in the greater Seattle Area.

Commercial Vehicle Information Systems and Networks (CVISN) Program and Weigh-In-Motion (WIM) Systems

The CVISN program was created to meet the common need to move freight safely, legally and economically. Roadside weigh stations have traditionally performed a number of inspection and enforcement functions, including weighing of trucks, safety inspections, and license and operator credential checks. But waiting in line at a weigh station adds time (and therefore expense) to the trucker's trip. The CVISN and WIM system embedded in the roadway, about a half-mile before a weigh station, weighs each truck passing over it. At the same time, trucks equipped with an

Automatic Vehicle Identification (AVI) transponder electronically transmit essential safety rating credentials, weight, size, and other information to the weigh stations. It is estimated the operating cost of a commercial vehicle is $1.25 per minute and that an average stop at a weigh station is 5 minutes. The savings to the industry was approximately 79,000 hours of travel time and six million dollars. As of July 1, 2006, the CVISN program is now providing electronic screening at ten weigh stations statewide to 4,539 trucking companies with 40,998 trucks equipped with transponders. These ten sites include weigh-in-motion (WIM) scales. In addition, there are three WIM sites that are under development. For more about CVISN please visit the CVISN web page at: http://www.wsdot.wa.gov/commercialvehicle/cvisn.

Lane Control

Lane control offers WSDOT the ability to temporarily close a travel lane electronically with a lane control sign for construction, collisions or the clearing of debris. Lane control signs clearly display notification to travelers about lane usage. Lane control signs provide advanced warning about lane closures or to advise travelers to change lanes could greatly reduce the impacts associated with temporary lane closures.

Variable Speed Limits

Variable speed limits would be used when travel conditions warrant slower traffic. Reducing speed limits is a way to manage congestion and road safety. Lowering the speed limit when needed will help maintain an even flow of traffic and prevent further congestion.

Hard Shoulder Running

Hard shoulder running utilizes the highway shoulder as an additional travel lane under ATM when congested conditions call for additional capacity. Hard shoulder running is allowed only when an overhead sign indicates it is available for use otherwise the shoulder should only be used during an emergency.

Dynamic Re-routing

Dynamic re-routing enables WSDOT to re-route vehicles to alternative routes when multiple lane closures exist on a highway.

Event Management

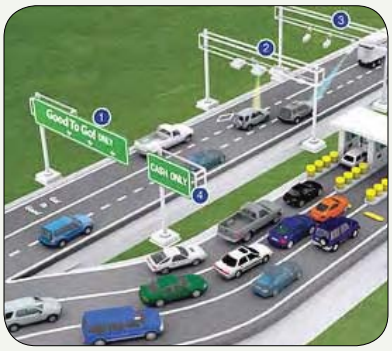
WSDOT works with event planners to determine the amount of impact an event may have on traffic flow and how to address these impacts.

Tolling Technologies for System Management

New technologies and strategies show promise as a means to both affect the level of system use and increase financial support for transportation projects, especially in congested corridors. With the opening of the Tacoma Narrows Bridge in 2007, WSDOT will begin tolling operations for the first time in nearly two decades. This project features electronic toll collection, which is new to Washington, along with traditional toll booths. The electronic tolling system is called “Good To Go” which allows non-stop toll collection at freeway speeds. “Good To Go” utilizes transponders in vehicles to charge accounts when the vehicle travels through the electronic toll booth. “Good To Go” will also be used on the SR 167 High Occupancy Toll (HOT) Lane Project. The potential

Figure 8. Tolling and Electronic Payment Systems

Sample Windshield Pass (Electronic Tolling Systems)



Tacoma Narrows Bridge Tolling Plaza (*Good To Go!* – Pass Holders Bypass Plaza)

SR 167 HOT Lanes

applications of tolling technologies for system management includes several strategies (also called "congestion pricing"):

- System-wide Tolling
- Segment Tolling
- Cordon Tolling
- HOT Lanes

System-wide Tolling

System-wide tolling imposes fees which are based on actual road use throughout the entire system. "Dynamic Pricing" (variable pricing based on demand) may be applied in this form of congestion pricing.

Segment Tolling

Segment tolling is in wide practice in eastern states where entire roadways are tolled. This is a more traditional method of tolling roadways, where toll booths are set-up across the entire width of the road where fees are collected. With systems such as "Good To Go" the large queues that form at toll booths could be eliminated to improve efficiency.

Cordon Tolling

Cordon tolling charges all vehicles a fee based on the time of day to reduce the demand for specific areas such as the Central Business District (CBD). This type of tolling has proven very effective in reducing the congestion experienced in London. In the United States large cities such as New York are considering this form of pricing to ease the daily "gridlock" that cripples the movement of people and freight within several areas of the city.

Photo 15. Dynamic Message Sign (DMS) displaying travel times

HOT Lanes

See HOV/HOT Lanes under Tier III Strategies.

Traveler Information Systems

Traveler Information Systems leverage the data collection efforts of WSDOT to provide motorists with detailed information that allows them to make route or timing decisions before or during their trip. WSDOT makes this information available through multiple delivery systems including:

- Dynamic/Variable Message Signs
- Highway Advisory Radio
- 5-1-1 Travel Information
- Statewide Traveler Information Webpage

Dynamic Message Sign (DMS)

Statewide, 185 dynamic message signs (DMS) are used on roadways to provide motorists with important information about traffic congestion, incidents, work zones, travel times, special events, or speed limits on a specific highway segment. They may also recommend alternative routes, limit travel speed, warn of duration and location of problems, or simply provide alerts or warnings.

Highway Advisory Radio (HAR) Systems

TMCs also operate highway advisory radio (HAR) systems at 64 locations statewide. HAR systems are licensed low-power AM radio stations installed along the roadway to provide alerts and general information regarding traffic and travel conditions. The presence of a HAR transmitter is marked by a roadway sign instructing the motorist to "Tune to 1610 AM". The 1610 frequency is one of several used by HAR radios and identified on the signs.

511 Travel Info

Real time traffic and weather information is available by simply dialing 5-1-1 from most phones. Updated every few minutes, 511 enables callers to get a variety of information:

- Puget Sound Traffic Conditions
- Statewide Construction Impacts
- Incident Information
- Mountain Pass Conditions
- Ferry System Information
- 800 Numbers for Passenger Rail and Airlines
- Weather

State-of-the-art speech recognition technology allows callers to verbally tell the system what they want, such as "traffic" or "mountain pass" information. The requested information is then "spoken" back to the user. Callers can use key words to quickly navigate the system to the specific road segment for the information sought.

Statewide Traveler Information Web Page

The statewide traveler information website delivers "real-time" information about current or expected travel conditions at http://www.wsdot.wa.gov/traffic, including:

- **Traffic Flow Maps** – displays current travel conditions graphically on a dynamic map which is updated every few minutes.
- **Travel Times** – displays current travel times between some of the most heavily traveled routes in Washington State along with the average travel times for the specific time and date. This site is updated every five minutes.

WSDOT Traffic Flow Map Webpage

- **Travel Alerts and Slowdowns** – which combines incidents, construction, events, and anything else that might impede or slow travel on the roads.
- **CCTV Camera Images** – Camera Images are updated every minute providing travelers with a visual or roadway conditions at most critical locations around the state.
- **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.
- **Mountain Pass Information** – with each major pass, such as Snoqualmie and Stevens passes, occupying its own page. These pages allow visitors to view camera images spanning the length of the pass, traction advisories, highway radio messages, and current and forecasted weather information.
- **Weather** – WSDOTs weather page has led the country in using intelligent transportation systems data to provide travelers with real-time road and weather information.

Access Management

Managing access to state highways by limiting driveways and cross traffic preserves highway capacity where growth is expected and maximizes existing highway capacity and safety where development has occurred. For more information about Access Management please visit the Access and Hearings Unit web site at: http://www.wsdot.wa.gov/eesc/design/access.

Ramp Modification

Ramp modifications can vary widely. Ramps can be extended, widened or realigned to reduce the sharpness of a curve. Ramp modifications can also include reconstruction to create braided or loop ramps which can greatly improve efficiency.

Turn Lanes

Turn lanes can be added to intersections, ramps and driveways to allow travelers a place to slowdown before making a turn without causing mainline traffic to slowdown or stop.

Intersection Improvements

Intersection improvements improve the efficiency of traffic movements and can reduce the risk of collisions.

Roundabouts

A roundabout is a circular intersection where traffic flows around a center island. Roundabouts are safe, efficient and less costly than a traffic signal. Since vehicles entering the roundabout are required to yield to traffic in the circle, more vehicles can move through the intersection with less delay. Roundabouts also accommodate the turning radius of large vehicles, like semi-trucks and buses. For more information about roundabouts please visit the Roundabouts web page at: http://www.wsdot.wa.gov/Projects/roundabouts.

Transportation Demand Management (TDM)

Also known as trip reduction, TDM is an umbrella term for strategies that reduce trips or shift use of the roadway to off-peak periods. TDM strategies include:

» **CTR Programs** – The CTR Program uses partnerships between employers and government to encourage change in commuting habits through education and incentives. By encouraging people to ride the bus, train, vanpool, carpool, walk, bike, telecommute, or compress their workweek, the CTR program removes 19,950 vehicles from the state's roadways every morning. This saves space on the roads and reduces air pollution by about 5,000 tons and gasoline consumption by about 6 million gallons each year. Nearly 1,100 worksites in Washington State participate in the program. For more information about transportation demand management and CTR programs please visit the Transportation Demand Management web page at: http://www.wsdot.wa.gov/tdm.

» **Vanpools** – The Puget Sound region leads the nation in vanpooling. There are currently 1,353 vanpools in Puget Sound; they remove approximately 9,400 vehicles from area roads each morning. For more information about vanpools please visit the Commute and Travel Info web page at: http://www.wsdot.wa.gov/choices/rideshare.cfm.

» **Park and Ride Lots** – Park and Ride Lots enhance the convenience of transit, vanpools, and carpools. WSDOT owns 62 lots in Puget Sound, with 12,000 parking spaces. King County park and ride lots have an average occupancy of 91 percent. The WTP has targeted $200 million towards the implementation of a park-and-ride program in coordination with transit systems, including alleviating overcrowding at existing lots, providing safety and security, and accommodating growing demand. For more information about park and ride lots available throughout Washington State please visit the Commute and Travel Info web page at: http://www.wsdot.wa.gov/Choices/ParkRide.cfm.

Planning for Land Use

Using existing highway capacity efficiently, by making land use choices that preserve the public's investment in the state transportation system, can help reduce the need for costly improvements.

WSDOT is striving to more effectively use its review authority under the Growth Management Act (GMA) and State Environmental Policy Act (SEPA) to encourage local governments to make choices that protect the capacity and safety of state highways. Local land use choices include the development of adequate local street networks, the approval of transportation efficient land use policies, the adoption of sufficient access permitting standards and procedures, and the full utilization of SEPA to minimize the adverse impacts of local land use decisions on state highways.

Tier II Strategies

Tier II strategies are typically moderate to higher cost projects that deliver potential network benefits to both highways and local roads. These strategies should be considered only after all applicable Tier I strategies have been implemented. These strategies support an efficient highway system.

Improvements to Parallel Corridors (including local roads)

There are times when widening a congested roadway is not feasible. One approach to add capacity is to widen a parallel roadway which can provide travelers an alternate route to the same destination.

Adding Auxiliary Lanes

Auxiliary lanes can connect two interchanges, add passing opportunities on two-lane highways or provide slow moving vehicles a lane when going up hills or mountains.

Adding Collector Distributor Lanes

Adding a collector distributor lane that begins before an off ramp and extends beyond the on ramp of closely spaced interchanges improves the efficiency of the interchanges and reduces the impact of vehicles entering and exiting the freeway, thus improving vehicle throughput for general purpose lanes.

Direct Access Ramps

WSDOT is building High Occupancy Vehicle (HOV) direct access ramps throughout the Puget Sound area for Sound Transit. Direct access ramps allow buses, carpools and vanpools to directly access the HOV lanes from park and ride lots and local streets. Carpools, vanpools and buses no longer have to weave across the general-purpose lanes when they can connect directly with HOV lanes. Direct access ramps improve safety, reduce congestion, save time, and increase reliability for both HOVs and general-purpose traffic. For more information about direct access ramps please visit the Direct Access Ramps web site at: http://www.wsdot.wa.gov/HOV/directaccessramps.htm.

Tier III Strategies

Tier III strategies are the highest cost projects that can deliver corridor-wide benefits. These strategies should be considered only after all applicable Tier I and Tier II strategies have been implemented. These strategies support system expansion.

HOT Lanes

HOT Lanes are lanes where a toll is charged as a means of regulating use of the facility to maintain travel speed and reliability. HOT Lanes improve traffic flow for all vehicles while preserving the reliable express trips for transit and vanpools, and other users. Toll rates are adjusted automatically to regulate demand ("Dynamic Pricing" or variable pricing based on demand) and ensure HOT lane traffic flows at 45 miles per hour or faster, even when the regular lanes are congested. Almost 20 different projects using or studying HOT lane applications are currently underway in the United States.

The first HOT lane in Washington State will be tested on SR 167 between Renton and Auburn (2008). This pilot project will test the HOT Lane principle for potential application in other parts of the Puget Sound Region. For more information about the SR 167 pilot project please visit the SR 167 Pilot Project web site at: http://www.wsdot.wa.gov/projects/sr167/hotlanes.

WSDOT is examining several future projects for system management strategies that are expected to include value pricing to improve and assure roadway use efficiency. These projects include the SR 520 Floating Bridge, Columbia River Crossing and perhaps others. These projects were also identified as part of the Washington Transportation Commission's 2006 Comprehensive Tolling Study as projects worthy of consideration within the next 10 years.

HOV Lanes

High Occupancy Vehicle (HOV) Lanes, sometimes called carpool or diamond lanes, are freeway lanes reserved for the use of carpools, vanpools, buses and personal vehicles with two or more occupants unless otherwise posted. They are typically separated from the other traffic by a solid white line, and are identified by signs and diamond symbols on the pavement. The freeway HOV system is a key part of our state's highway network, enabling commuters

to get to work with more reliability, and provides an incentive to take the bus, carpool, or vanpool. They are intended to maximize the movement of people rather than vehicles. An average HOV lane often carries 1½ times as many people as the average adjacent lane during rush hours. On I-5 in north Seattle the HOV lane carries almost three times as many people during the afternoon rush hour. The HOV system has been so successful that most of the HOV lanes are now congested during the peak commuting periods. Innovative technology and other system management tools will be necessary to help keep these lanes moving in the future. For more information about HOV lanes please visit the HOV web site at: http://www.wsdot.wa.gov/HOV/#whatareHOV.

Transit

Sound Transit is making it easier to get around Central Puget Sound. Our congestion-fighting alternatives include fast ST Express buses, Tacoma Link light rail and Sounder commuter trains. ST Express buses connect more than 34,000 people every day on fast, direct routes between major population centers in the region. For more information about transit services available throughout Washington State please visit the Commute and Travel Info web page at: http://www.wsdot.wa.gov/choices/bus.cfm.

Commuter Rail

Commuter rail trains provide passenger service between central cities and their suburbs. Commuter rail trains operate in Pierce, King and Snohomish Counties to ease congestion during peak commuting times. These trains run on the same railroad tracks as freight trains and share some stations with Amtrak intercity trains. For more information about commuter rail services available throughout Washington State please visit the Rail web page at: http://www.wsdot.wa.gov/rail/transit/types.cfm#commuter.

Ferry Terminals and Multi-Modal Connections

In Island and Kitsap counties and on Vashon Island, transit service is timed and linked with ferry schedules. In downtown Seattle, there is frequent transit service, but not specifically linked to ferry schedules. New inter-modal connection issues will emerge with the construction of new inter-modal ferry terminals in Mukilteo and Edmonds, which may have connections to commuter rail services.

Washington State Ferries has received funding from the state legislature to move forward with two new multimodal terminal projects in Mukilteo and on Bainbridge Island. Another is in the planning stage in Edmonds and may be a component of a regional transportation ballot measure in November of 2007. These new terminals are needed in order to accommodate additional cross sound ferry trips.

However, additional ferry trips will exacerbate current problems ferry commuters experience on a daily basis. While it may be financially, environmentally, and in some areas, politically unrealistic to suggest the construction of new roadways or widening of existing connections, operational improvements that increase the efficiency of the existing roadway network should be considered. Coordinated signal timing along these routes, better signing to help prevent the blockage of driveways and local intersections, better defined ferry holding lanes, turn channelization at major intersections and transit queue jumps at signalized intersections are strategies that should be considered to help mitigate the adverse effect of ferry traffic platoons. It may also be effective to provide grade separations at strategic locations to provide opportunities for local traffic to cross above or below long lines of ferry traffic.

It is also important that public transit agencies develop their respective schedules so that they are in alignment with ferry schedules. The strain placed on the state highway and the local roadway network can be lessened if more ferry passengers can be convinced to use public transportation to reach their destinations once they have disembarked from the ferry. For this to occur transit service must be convenient and it must effectively convey ferry passengers

to their destination. For more information about ferry services available throughout Washington State please visit the Commute and Travel Info web page at: http://www.wsdot.wa.gov/choices/ferries.cfm.

Interchange Modification

Interchange modifications can range from ramp reconfiguration to full reconstruction with an entirely different design to accommodate projected future traffic patterns.

Add General Purpose Lanes

Adding general purpose lanes to an existing highway increases capacity in either one or both directions.

Performance Measures

Traditional highway performance measurement revolves around a grading system using the letters A-F to determine the "Level of Service" (LOS) provided or projected on a roadway. This method is difficult to quantify for many because it is not directly tied to "Travel Speeds" or "Travel Time." The relationship between traditional LOS and the percent of posted speed, used for determining congestion in this HSP update, is graphically represented to the right.

Some of the performance measurements currently used or under development are explained below.

- **Travel Time** – The amount of time it takes a vehicle to travel between two given points.
- **Delay** – WSDOT uses daily total vehicle hours of delay. This is the difference in travel time where vehicles are traveling below 85 percent of the posted speed subtracted from the travel time of vehicles are traveling at 85 percent of the posted speed.
- **Duration of Congestion** – This number of hours per day in which average weekday travel speeds on a highway falls below 70 percent of the posted speed.

Maximum Throughput: A measure used to demonstrate when a freeway is being fully utilized. Maximum Throughput is the greatest number of vehicles traveling at the optimal freeway speed occurring between 70 to 85 percent of the posted speed limit.