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 the Puget Sound. Where bridges cannot be built, ferries carry travelers and freight.

Looking Back ... to 1980 (see Figure 40), there were over four million people living in Washington State with nearly three million of them traveling over 15 billion miles per year on over 7,000 miles of state highways. Many of these travel miles were accumulated as people commuted to and from almost two million jobs. Over the next 25 years, Washington's economy prospered adding over one million new jobs by 2005. 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 more than 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 due to slow and unreliable travel speeds.

Description of the Issues

Looking Ahead ... to 2030 (see Figure 41), Washington's population is expected to 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 number of 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. 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 more congestion resulting in less reliable movement of freight and goods, lower travel speeds, increased delay and higher consumer costs as consequences of an overloaded system.

Figure 40. 1980 to 2005 Trends

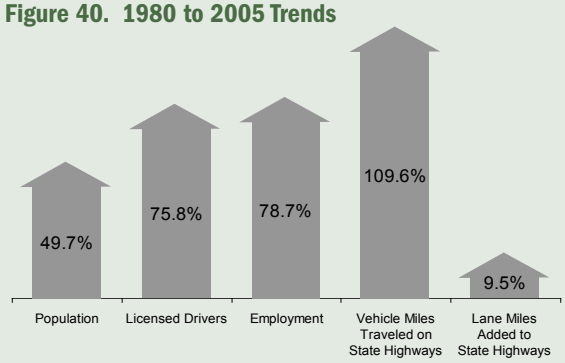
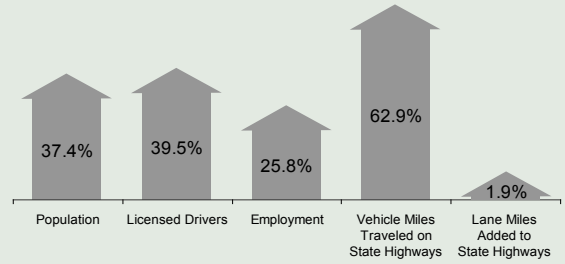


Figure 41. 2005 to 2030 Estimated



Major Factors Contributing to Congestion

(see Figure 42)

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 limited capacity of the highway system, 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

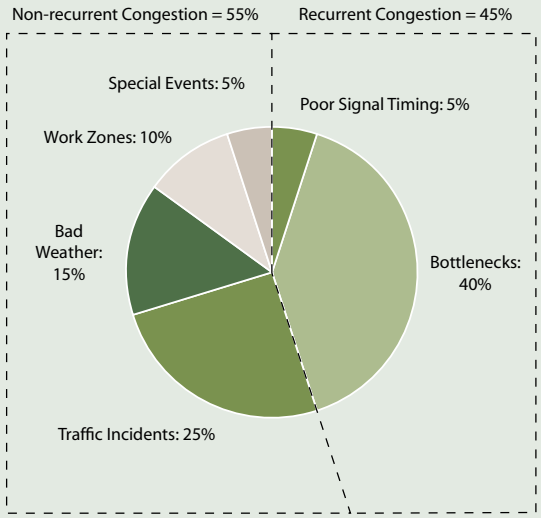
- Work Zones
- Signal Timing
- Special Events
- Land Use *
- Ferry Traffic *
- Fluctuations in Normal Traffic

Bottlenecks

WSDOT has separated congested locations into two categories, bottlenecks and chokepoints. 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 defines chokepoints as places where congestion occurs because of traffic interference and/or the roadway configuration (examples: highway interchanges, lack of turn lanes at intersections, seasonal road closures, etc.). Bottlenecks and chokepoints greatly influence the flow of traffic, whether it be long backups of vehicles trying to exit the highway, vehicles having to dramatically reduce their travel speeds when leaving one freeway to enter another (highway to highway connections) or vehicles slowing down as they cross a narrow bridge.

Figure 42. 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 highway) 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 rain storms in November of 2006 where heavy rainfall caused flooding, sink holes and landslides, resulting 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 may also cause delay.

Work Zones

A work zone is an area of a highway with construction, maintenance, or utility work activities. The impacts to traffic flow from work zones can vary widely depending on the amount of work undersay, the length of time the work zone is in place and any detours, or lane closures caused by construction.

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, and development that encroaches on state highway corridors can 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 to 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 since local comprehensive plans and regulations do not require state approval and local governments are not required to take action based on agency review comments. State agencies can appeal local land use decisions to one of the three growth management hearings boards.

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 consumes considerable space within a community. In addition, off loading vehicles from a ferry create 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, ferry terminal improvements and roadway improvements will be needed to accommodate the increased travel demand.

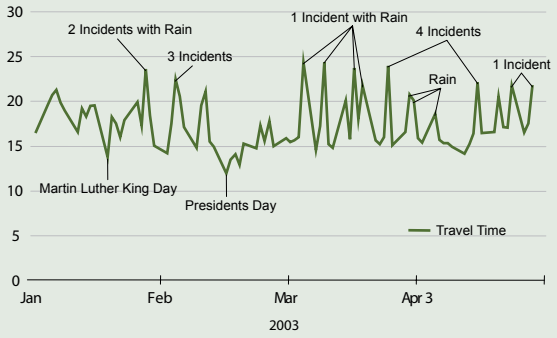
Fluctuations in Normal Traffic

Traffic varies from day to day (see Figure 43). 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 "Major Factors Contributing to Congestion" can cause traffic to slow below an acceptable level. When two or more of these factors are combined, traveling on the highway 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.

Figure 43. 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 results in traffic slowing 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 highway off ramps to backup onto the highway shoulder, reducing through capacity.
- Weather can cause poor visibility leading to slow downs.
- Drivers distracted by a collision generally slow down and may cause additional collisions as their attention leaves the roadway ahead of them.

Needs

In previous updates to the Highway System Plan, WSDOT targeted capital improvements to restore free-flow operating conditions (travel at posted speed 24 hours per day) which created expensive projects that limited the ability of WSDOT to address congestion on a statewide basis and subsequently created a situation where more roadways have now become congested. There is not enough state or local money or land to build sufficient highway capacity to reach free-flow conditions statewide. Therefore, WSDOT has set a goal in the WTP to manage the State Highway system to achieve maximum throughput. Typically, the maximum throughput of vehicles on a highway, about 2,000 vehicles per lane per hour, occurs at speeds of 42-51 mph, or about 70-85 percent of the posted speed. When travel speeds fall below 70 percent of posted speed, or about 42 mph, the highway no longer operates efficiently. WSDOT has targeted this condition as the threshold for determining when a highway requires capital improvements to restore efficient operating conditions.

Bottlenecks and Chokepoints

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

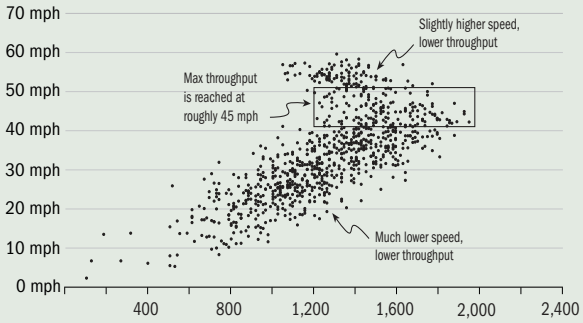
First, the location under consideration had to fit the definition of being either a chokepoint or bottleneck as explained previously under Bottlenecks. Second, the observed congestion must be supported with traffic data and analysis models. If congestion is a problem today or anticipated within the next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

- The congestion problem impacts the flow of mainline through-traffic. Mainline traffic flow is considered to be impacted when through-vehicle peak-hour speeds are equal to or less than 70 percent of the posted speed (see Figure 44).
- 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 I: Bottlenecks and Chokepoints). Additional locations will be identified through future analysis for inclusion in updates to the HSP.

Figure 44. Relating Speed and Volume

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



Congested Corridors

To identify where congestion on corridors exists today, computer models were used to identify highways where vehicles currently travel below 70 percent of the posted speed during the peak hour, as shown in Figures 45 and 46. This is the criteria used to determine both Interstate and non-Interstate congested corridors. 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.

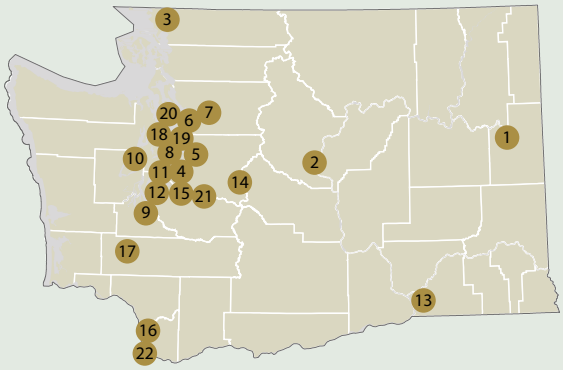
For long-range planning purposes, future-year conditions were forecast to determine when and where congestion will occur. Computer analysis was used to forecast 24-hour operating conditions for the year 2030 to identify locations where the peak-hour travel speeds fell below 70 percent of the posted speed. Of those locations, the highway 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). Again 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.

Strategies

The 2003 "Nickel" funding package and the 2005 TPA funding package will generate several billion dollars toward a specific list of mobility projects selected by the Legislature. This revenue will complete many projects and begin or continue work on the projects listed (see Figure 47). With the enactment of these funding packages, the Legislature set the priority for future projects and direction for transportation investments. Therefore the completion of the projects partially funded is seen as a high priority for WSDOT's future mobility program.

This presented WSDOT with a huge challenge to balance funding for all existing and future needs. Given this challenge, WSDOT needed to develop an approach for completing the partially funded 2003 "Nickel" and 2005 "TPA" projects while minimizing the growth in congestion on other corridors. To manage congestion relief and effectively prioritize state highway system needs, an implementation approach (see Appendix J) was developed to ensure future solutions followed the established Legislative priorities and maximized all current and future revenue. What follows in this update is 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 to maximize every dollar invested. The three tiers are as follows (see Figure 48):

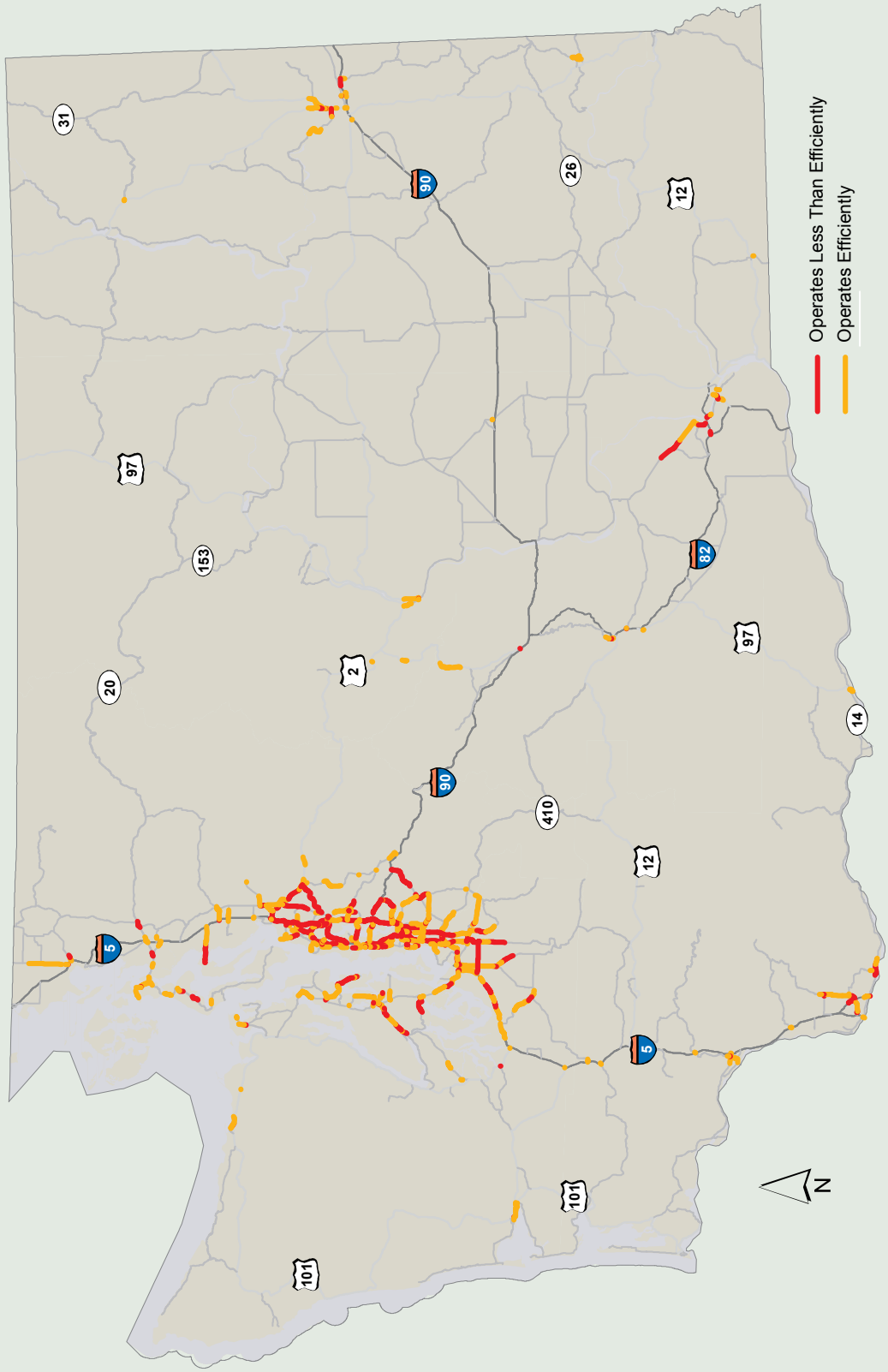
Figure 47. Illustrative List of Project Locations



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. I-5/SR 161/SR 18 "Triangle" Interchange
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

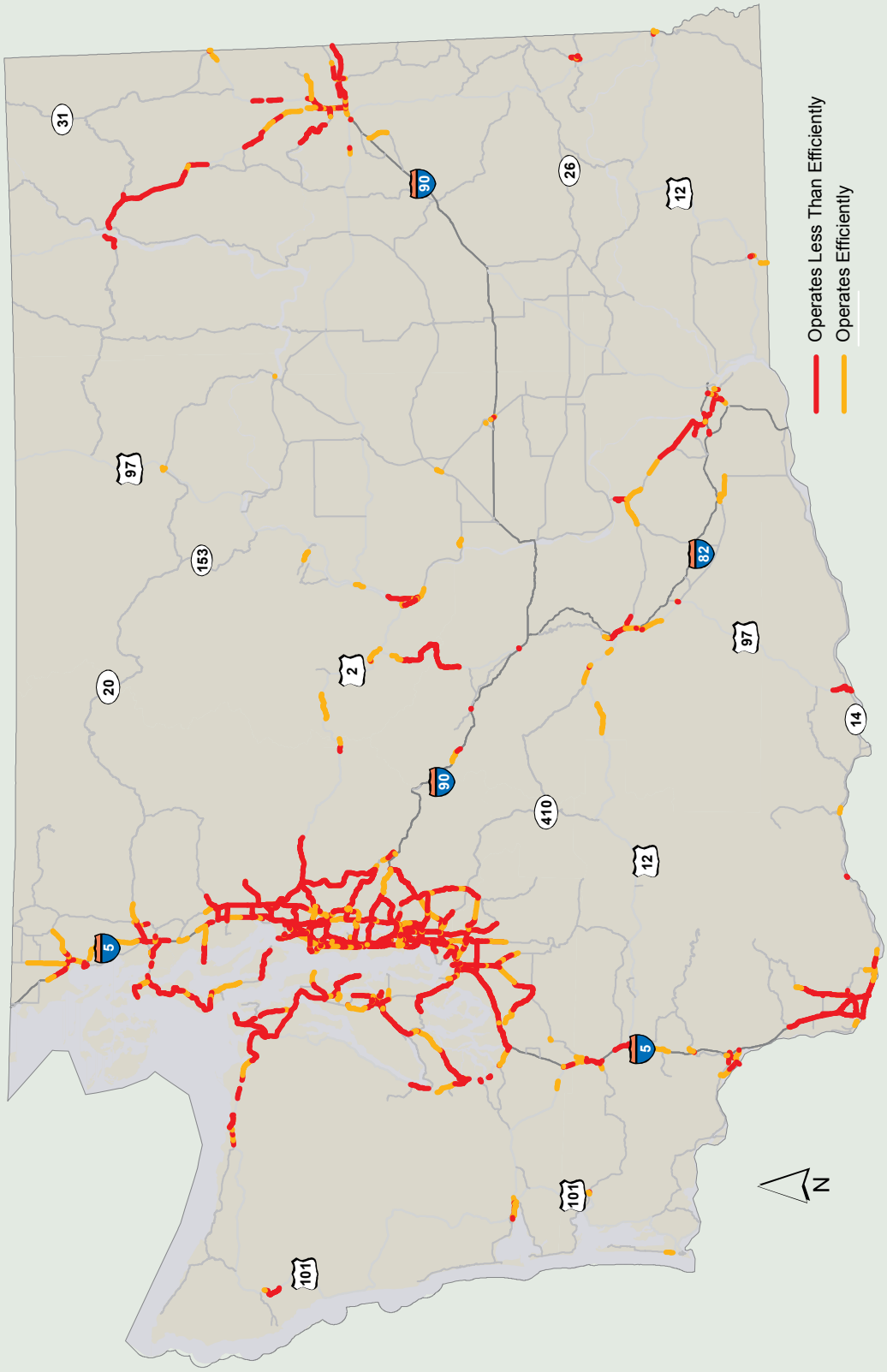
Note: These projects are listed in no particlular order (no ranking method is applied or should be assumed.

Figure 45. Peak-Hour Operating Conditions Experienced in 2005 on State Highways



Note: These conditions do not reflect the impact of congestion associated with local roads, additional impacts associated with ramps, interchanges, weather, special events, construction, collisions or incidents.
Prepared by: Systems Analysis and Program Development (November 2007)

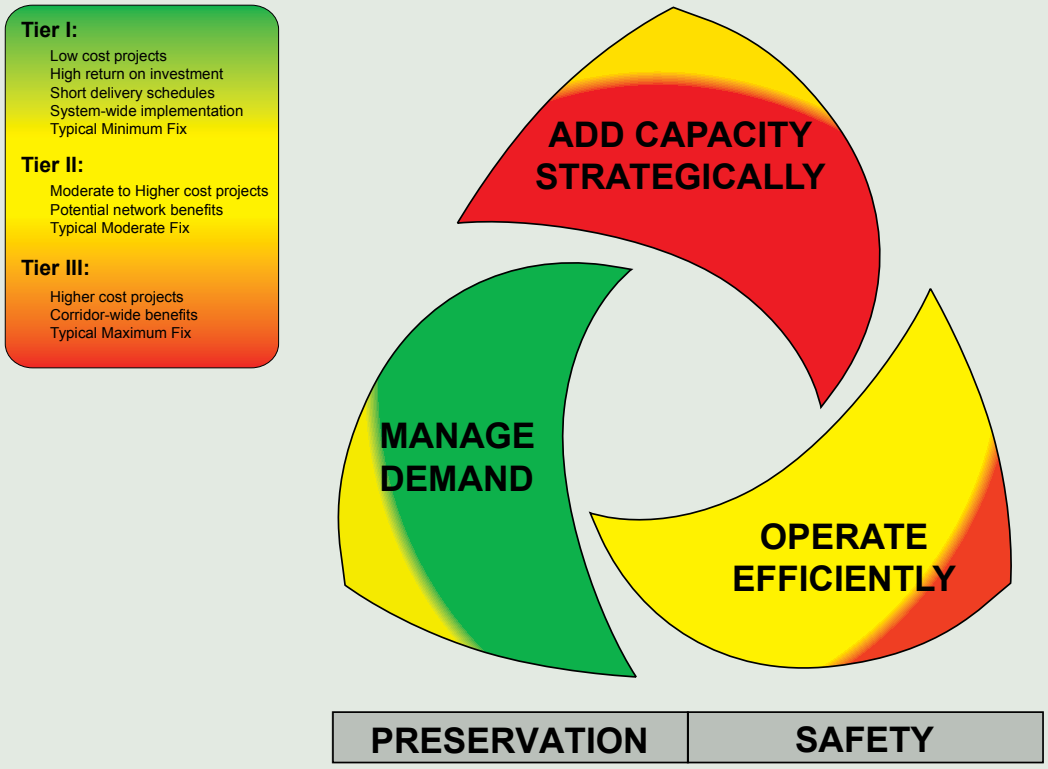
Figure 46. Projected Peak-Hour Operating Conditions for 2030 on State Highways



Note: 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.
Prepared by: Systems Analysis and Program Development (November 2007)

Figure 48. 2007-2026 Washington State Highway System Plan

Mobility Strategies: Moving People, Fighting Congestion, Building Washington's Economy



- **Tier I** – 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** – Will focus on moderate to higher-cost improvements that further reduce congestion on both highways and local roads. These include improvements to parallel corridors (including local roads), adding auxiliary lanes, and direct access ramps.
- **Tier III** – Focuses on the highest-cost projects that can deliver corridor-wide benefits. These include commuter rail, HOV/HOT lanes, adding general purpose lanes and 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.

Active Traffic Management *(see Figure 49)*

Active Traffic Management (ATM) is the integration of multiple strategies that incorporate current and future technologies to provide "real-time" lane management. This management strategy allows WSDOT to respond to changing traffic levels and roadway conditions to regulate the flow of vehicles to get the fullest use 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

Figure 49. Active Traffic Management

- 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, would 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 monitor 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.

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

WSDOT TDO has 162 permanent traffic recording systems. These sites may collect volume, classification, speed or weight traffic data, or any combination of these, depending on the type of sensors and traffic recorders installed at the site. Permanent traffic recorder sites, which are managed by the TDO, work together with data stations to complete the picture for WSDOT managed roadways.

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.

Traffic Management Centers (TMCs)

WSDOT operates seven regional TMCs; Seattle in Shoreline (see Photo 33), 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 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, road crews, WSDOT's incident response teams, and media traffic reporters. WSDOT uses this information to coordinate its response to incidents or emergencies, and notify the public and the media of these events.

Incident Management

Collisions and disabled vehicles disrupt traffic where little or no congestion exists. On congested highways, collisions and incidents can bring traffic to a stand still (see Photo 34 and Table 12).

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 respond to collisions or other incidents, such as hazardous material spills, to reduce delay caused by these incidents. (Incident Response Team (IRT) members are a specially trained group of WSDOT maintenance employees who respond to blocking incidents on our state's 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 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 WSDOT to formally establish a statewide IR program partnership with WSP, private tow companies, and media sponsored

Photo 33. TMC Seattle at Regional Headquarters

Photo 34. 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.

Table 12. 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%

"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 IR program 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: www.wsdot.wa.gov/operations/incidentresponse

Ramp Metering

Ramp meters are stop-and-go signals located on entrance ramps to the highway. They control the frequency with which vehicles enter the flow of traffic on the highway.

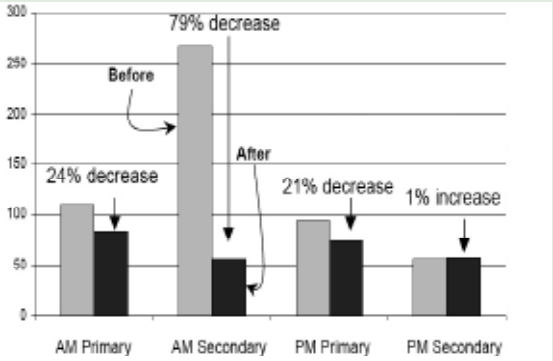
Ramp meters are a cost-effective method of relieving traffic congestion (see Figure 50 and Photo 35). By increasing the efficiency of freeway use, ramp meters save taxpayers costs associated with building new lanes. Ramp meters have reduced rear-end and sideswipe collisions by over 30 percent.

Photo 35.

Traffic Signal Timing and Synchronization

Synchronizing traffic signals (see Figure 51) is 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.

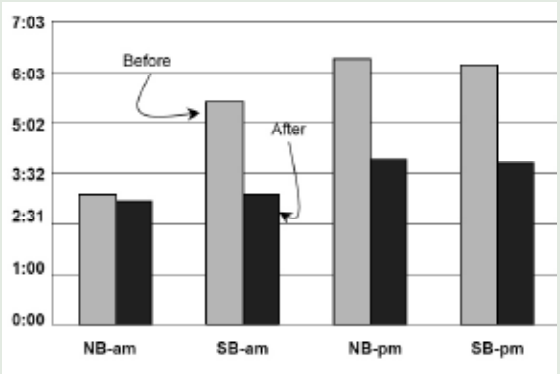
Figure 50. Ramp Meters Improve Traffic Flow Tally of Observed Braking Actions



Merging conflicts at ramp to SR 167

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

Figure 51. 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.

Work Zone Management

Highway construction and work zones can cause congestion. Lanes may be narrowed, or even closed, and traffic detours and neck-downs are frequent collision locations. Construction program impacts require traffic management strategies to be considered starting at the planning stage including:

- 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.

Transit Signal Priority Systems

Transit Signal Priority (TSP) (see Figure 52) is a traffic signal control strategy that benefits public transit by improving transit speed and reliability. Traffic signal timing is slightly modified, allowing the transit vehicle to move through an intersection more quickly. 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.

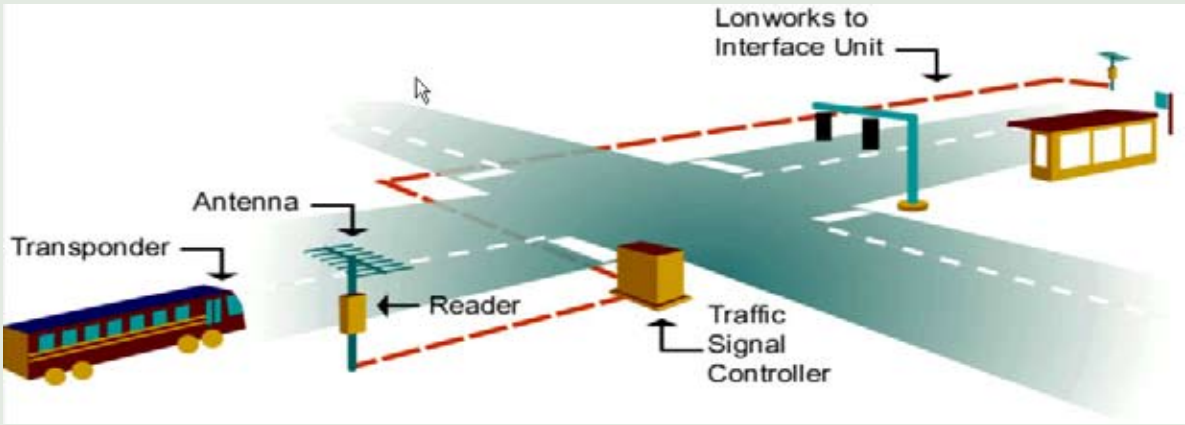
Lane Control

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 give drivers advanced warning about lane closures or advise them to change lanes to reduce the impacts associated with temporary lane closures.

Variable Speed Limits

Variable speed limits can be used when travel conditions warrant slower traffic, such as on mountain passes during winter storms. Reducing speed limits is a way to manage congestion and road safety.

Figure 52. Transit Signal Priority System
Integration With City of Lynnwood Advanced Traffic Management System (ATMS)



Lowering the speed limit when needed will help maintain an even flow of traffic and prevent further congestion.

Hard Shoulder Running

"Hard shoulder running" means using the highway shoulder as an additional travel lane 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. For example, with the opening of the Tacoma Narrows Bridge in 2007, WSDOT began 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 (see Figure 53). "Good To Go" uses 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 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

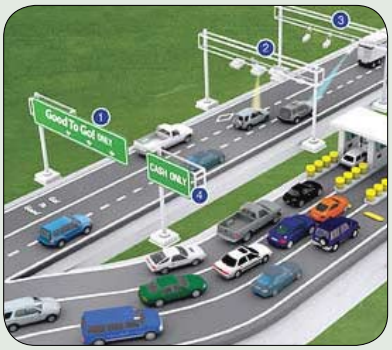
Segment tolling is in wide practice in eastern states where entire roadways are tolled. This is a more traditional method of tolling roadways, with toll booths set-up across the entire width of the road where fees are collected. With systems such as "Good To Go" the large queues that form at toll booths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

Figure 53. 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

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.

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 Web Page

Dynamic Message Sign (DMS)

Statewide, 185 dynamic message signs (DMS) are used on roadways to provide motorists with important information. WSDOT can program these electronic signs (see Photo 36) to relay 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.

Photo 36. Dynamic Message Sign (DMS) Displaying Travel Times

Highway Advisory Radio (HAR) Systems

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

Statewide Traveler Information Web Page

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

- **Traffic Flow Maps** – displays current travel conditions graphically on a dynamic map which is updated every few minutes (see Figure 54).
- **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.
- **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.

Figure 54. WSDOT Traffic Flow Map Web Page

- **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.
- **Mountain Pass Information** –. 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. Each major pass, such as Snoqualmie and Stevens, has its own web page.
- **Weather** – WSDOT's weather page uses 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 movement preserves highway capacity where growth is expected. Access management also 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: 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, such as adding turn lanes improve the efficiency of traffic movements and can reduce the risk of collisions.

Roundabouts

A roundabout (see Photo 37) 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: www.wsdot.wa.gov/Projects/roundabouts.

Photo 37. Roundabout

Transportation Demand Management (TDM)

Transportation Demand Management (TDM) is an umbrella term for strategies that reduce trips or shift use of the roadway to off-peak periods. TDM strategies include:

- **Commute Trip Reduction (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 approximately 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 six 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: www.wsdot.wa.gov/tdm.

- **Vanpools** – The Puget Sound region leads the nation in vanpooling. There are approximately 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: 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. This program would include 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: www.wsdot.wa.gov/Choices/ParkRide.cfm.

Planning for Land Use

Using existing highway capacity efficiently through 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 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 developing adequate local street networks, approving transportation-efficient land-use policies, adopting sufficient access-permitting standards and procedures, and using SEPA to its fullest 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.

Improvements to Parallel Corridors (including local roads)

There are times when widening a congested roadway is not feasible. One approach to adding capacity is widening 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. It also reduces the impact of vehicles entering and exiting the highway, 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: www.wsdot.wa.gov/HOV/direct accessramps.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.

HOT Lanes

High Occupancy Toll (HOT) lanes are lanes that are open to carpools, vanpools and transit and toll-paying solo drivers. Tolls for HOT lanes are set to assure that these lanes keep flowing even when regular lanes are congested. HOT lanes can be built for this purpose or can be converted high occupancy vehicle (HOV) or general-purpose lanes. Toll rates are adjusted automatically to regulate demand ("Dynamic Pricing" or variable pricing based on demand) and to ensure HOT lane traffic flows at 45 miles per hour or faster, even when the regular lanes are congested. HOT lanes provide drivers who are willing to pay for a faster trip an option to avoid congestion. By allowing toll-paying solo traffic to use carpool lanes we could:

- maintain good traffic flow for transit, carpools and vanpools
- make better use of the lanes
- improve service for those who choose to pay a toll
- make the other lanes slightly less crowded
- generate some money to improve transportation

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: 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 highway 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 other traffic by a solid white line, and are identified by signs and diamond symbols on the pavement. The 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: www.wsdot.wa.gov/HOV/#whatareHOV.

Ferry Terminals and Multi-Modal Connections
(see Photo 38)

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.

However, additional ferry trips will exacerbate current highway problems that 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 vehicles from blocking driveways and local intersections, better defined ferry holding lanes, turn lanes 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 build roadways over or underpasses at strategic locations to allow 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 networks can be lessened if more ferry passengers can be convinced to use public transportation to reach their destinations. For this to occur, transit service must be convenient for 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: www.wsdot.wa.gov/choices/ferries.cfm.

Photo 38. Ferry Terminal Traffic

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 is based on 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 in Figure 55.

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 delay is calculated by finding the difference between the travel time of vehicle moving at speeds below 85 percent of the posted speed and the travel time of vehicles that 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 used most efficiently. 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.

Mobility: Funded vs. WTP Unfunded Targets

	Funded ($ in millions)	WTP Unfunded Targets ($ in millions)
Mobility Total (Includes Maintenance and Operations)	$4,894	$8,497
Highway System Plan Total	$15,625	$33,114

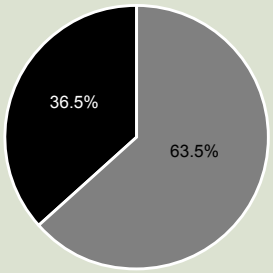


Figure 55. Comparing Level of Service (LOS) to Percent of Posted Speed

LOS A	
LOS B	**Above Posted Speed 60+ m.p.h.**
LOS C	**Posted Speed 60 m.p.h.**
LOS D	**Above 85% of Posted Speed to Posted Speed 52 m.p.h. to 60 m.p.h.**
LOS E	**70% to 85% of Posted Speed 42 m.p.h. to 51 m.p.h.**
LOS F	**Below 70% of Posted Speed Below 42 m.p.h.**