Other Highway Assets

This section contains several different types of projects. Each is unique and is treated differently for planning and budgeting.

These types of projects are:

- Safety Rest Area Preservation
- Major Drainage System Rehabilitation
- Highway Slopes and Embankments
- Major Electrical System Rehabilitation
- Weigh Station Replacement and Preservation

In each section that follows, we will define the issues, identify the need, describe strategies to address the needs, and discuss performance measures used to evaluate the effectiveness of the strategies. We will also provide a brief overview of the prioritization process and list projects included in the 07-09 Capital Improvement and Preservation Program (CIPP).

Maintenance Strategies and Goals

Our overall goal of maintenance is to "retain the highway system in a condition as near as possible to the condition of its initial construction or subsequent improvement." In addition, the February 2002 WSP/WSDOT "Joint Operations Policy Statement" was developed to stress the importance of the agencies' responsibility to do whatever is reasonable to reduce delays associated with incidents.

With these goals and the policy in mind, WSDOT's Maintenance will:

- Clear roadways of rocks or other debris
- Build up embankments
- Maintain rest area facilities until they reach the point of failure
- Temporarily patch pavement over failing culverts
- Replace electrical parts
- Patch weigh station pavements

These activities are done in an ongoing effort to reduce delay to the traveling public and until a permanent fix can be applied.

Photo 1. Toutle River Safety Rest Area (northbound Interstate 5)

Emergency Preparedness

Emergency preparedness and response are important elements in the operation of the highway system. A key element of this is planning for traffic movement in the event that highways are damaged and unusable. For immediate response purposes, the designation of alternate routes and the development of evacuation plans are important issues. For longer term planning, any substandard structures on evacuation routes should be identified and targeted for improvements. Mitigation measures defined through the vulnerability assessment process should also be implemented to protect critical infrastructure across the highway system. For all of these issues, communication systems and equipment are critical.

Safety Rest Area Preservation

Washington's safety rest areas are conveniently located. They also provide the opportunity for traveler's to rest and take a much-needed break to ensure alertness and safety during long trips.

WSDOT strives to prioritize planned facilities based on locations where accidents due to fatigue are occurring, and where no nearby rest facilities (public or otherwise) are present. Sleepy driving and inattentive driving are two of the leading causes for car accidents in Washington State, together accounting for 20 percent of all fatal accidents from 1993 to 2001. Unfocused drivers are a danger to themselves, their passengers, and other drivers.

Safety rest areas offer an opportunity for sleepy and inattentive drivers to get off the road and rest along highways that otherwise have no good stopping points such as all-night restaurants.

Over 20 million travelers stop at Washington's 42 safety rest areas annually. All safety rest areas are handicapped accessible and provide a wide range of motorist services with most providing car, truck, and recreational vehicle parking; clean restrooms; drinking water; traveler information; picnic areas; vending machines; and pet exercise areas.

Twenty-six of Washington's safety rest areas offer travelers a unique welcome service called the Free Coffee Program which allows non-profit organizations to provide travelers with coffee and light refreshments at no charge.

The Washington State Legislature established the Recreational Vehicle Program in 1980. The program annually collects $3.00 per recreational vehicle (camper, travel trailer, and motor home) licensed in the state of Washington. Funds are deposited into a dedicated account that supports construction, maintenance, and operation of recreational vehicle sanitary disposal systems at safety rest areas. WSDOT administers the Recreational Vehicle Program and works with the Recreational Vehicle Citizen's Advisory Committee to define and prioritize recreational vehicle owners' needs.

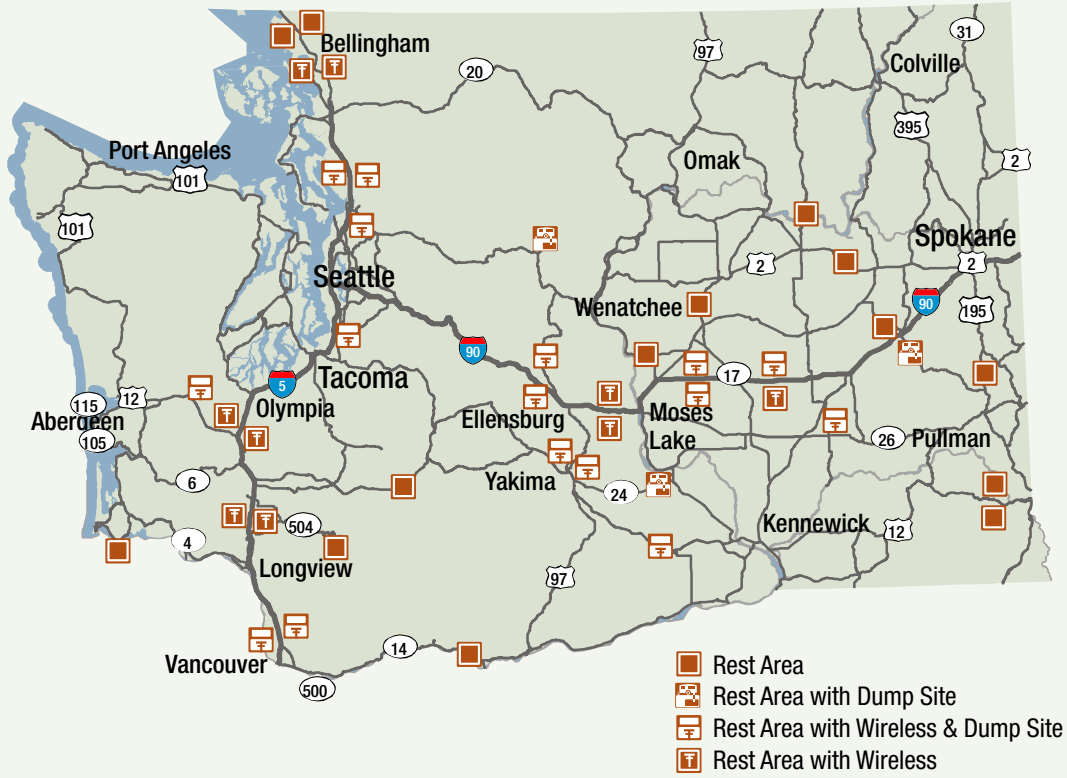
The RV Dump Program provides the traveling public with an environmentally safe repository for RV waste and potable drinking water in WSDOT safety rest areas. WSDOT owns, operates and maintains 19 RV Dump Stations within the 42 safety rest areas statewide.

Needs

Inventory of Safety Rest Areas

WSDOT is responsible for 42 safety rest areas; 27 of which are located on the Interstate system. These facilities contain a total of 555 acres, 83 buildings, 29 on-site public drinking water systems, 36 on-site sewage treatment/pretreatment systems and 19 recreational vehicle dump stations.

Figure 1. WSDOT Safety Rest Areas



With the exception of one facility requiring winter closures all are open 24/7.

» Blue Lake on SR 17 at milepost 89 in Grant County.

WSDOT performs a building and site condition assessment biennially to identify functional component deficiencies. We place a numerical rating based on guideline criteria on each functional component, and we give critical functional components a weighted multiplier in the overall evaluation. The combined total building and site ratings are used to define each facility's overall condition and helps with strategic planning and program prioritization.

Strategies

Approaches to Rest Area Preservation

Washington's safety rest area program began in 1967, with most of the construction completed by 1978. Many of these facilities are approaching 30 years of life. Some need to be updated for compliance with current sewer and water standards. Others need replacement because of high maintenance costs due to age and high usage.

We maintain rest areas between preservation treatments and reconstruction projects. As much as possible, our maintenance activities are conducted to maximize the lifespan of rest area facilities. As rest areas are added to the highway system through the facilities program, they will need to be maintained in order to keep them in good, working condition. This typically includes minor building repair, plumbing and electrical system maintenance, and janitorial and grounds-keeping activities.

Preservation of a Safety Rest Area consists of the following:

1. Utilities include replacing, refurbishing or rehabilitating sewer, water and electrical systems to meet regulatory requirements or reduce maintenance costs.
2. Building consists of replacing, refurbishing or rehabilitating building components (roof, doors, surfaces, and fixtures) to meet regulatory requirements or to extend service life.
3. Site (parking, lighting, landscaping) includes replacing, rehabilitating or refurbishing site components and systems to meet regulatory requirements, meet demand, improve security and safety or minimize maintenance costs.

Prioritization Process for Selecting Projects

The life, health, and safety of the traveling public is WSDOT's highest priority. The safety rest area program has three primary deficiency groups. Emphasis is placed on utility (sewer, water, and electrical) needs first with building second and site work last.

Rest Area Projects

Photo 2. Interstate 90 Indian John Hill Safety Rest Area – Sewer Rehabilitation Work

Photo 3. Interstate 5 Custer Safety Rest Area – Sewer Rehabilitation Work

In addition, maintenance and operational costs and the number of visitors are factors in the prioritization process.

Performance

For the 2003-05 (actual) and 2005-07 (planned) biennia, maintenance, operation, and preservation costs at safety rest areas average about $6.5M per year. With 21.3 million visitors to Washington State Safety Rest Areas in 2005, this works out to about $0.31 per visitor in 2005. By contrast, according to figures from the Federal Highway Administration, the cost to society per each fatal collision is $3.9 million, and $325,000 per each disabling injury collision.

WSDOT has maintained Interstate safety rest areas at a rating of "good condition" (Level of Service) since 1999. The safety rest area is considered in good condition if all features (such as soap dispensers or RV dump stations) are in working order, landscaping is trimmed, with only a small amount of litter, weeds, or minor defects in sidewalks or parking areas present.

Safety rest areas close for varying reasons, some seasonal. Out of a total of 15,695 days (the number of rest areas multiplied by number of days, December 1, 2005 through November 30, 2006), rest area closures occurred on 546 days, or 3.5 percent of the time. Normal seasonal closures accounted for 468 days or 3 percent. The remaining 78 days (0.5 percent) of closures were due to various problems with water and sewer systems in the older facilities, and scheduled maintenance shutdowns of the Gee Creek and Toutle River rest areas.

20-Year Investment Plan

The 20-year target allocation for the Safety Rest Area Preservation Program is $50 million, of which $35 million is funded. Of this $50 million, half is needed in the first 10 years.

The investment plan is in three sections: Utilities, Building and Site. Utilities comprise 40 percent of the investment, Building is 50 percent and Site is the remaining 10 percent.

Several high priority projects are: Interstate 5 – Maytown Sewer Rehabilitation at Maytown, Interstate 5 – Toutle River Water System Repair at Castle Rock, and added truck parking at Interstate 5 – Scatter Creek NB.

Major Drainage System Rehabilitation

A drainage control system is a complex system which may include:

- Connected streams in the watershed
- Wetlands
- Culverts or other structures
- Ditches
- Manmade detention or retention basins
- Pervious and impervious surfaces

Pipe Inspection by Rovver©

Photo 4. Envirosight Inc. Rovver© 900 pipe inspection crawler with lights and camera as purchased by WSDOT.

Photo 5. The first culvert to be inspected using the new crawler and camera.

Photo 6. Crew with motorized cable reel which is attached to the crawler and camera, supplying video feed to the monitor and recorder.

» Other means of controlling and mitigating stormwater runoff and impurities from roadway surfaces.

To improve safety, we design roadways to carry rainwater off the pavement where motorists travel. However, when stormwater flows off roads and through roadway drainage systems, it carries pollutants from motor vehicles, the atmosphere, and other sources into surface water bodies. Sediments and pollutants (nutrients, oil, grease, and metals) are carried into rivers and streams, affecting the quality of water. Controlling the amount of flow is also important as high flows can damage habitat, property, and transportation infrastructure. We manage stormwater flowing over and under transportation facilities through use of runoff treatment and flow control technologies and methods.

Stormwater management for WSDOT transportation facilities has two main objectives:

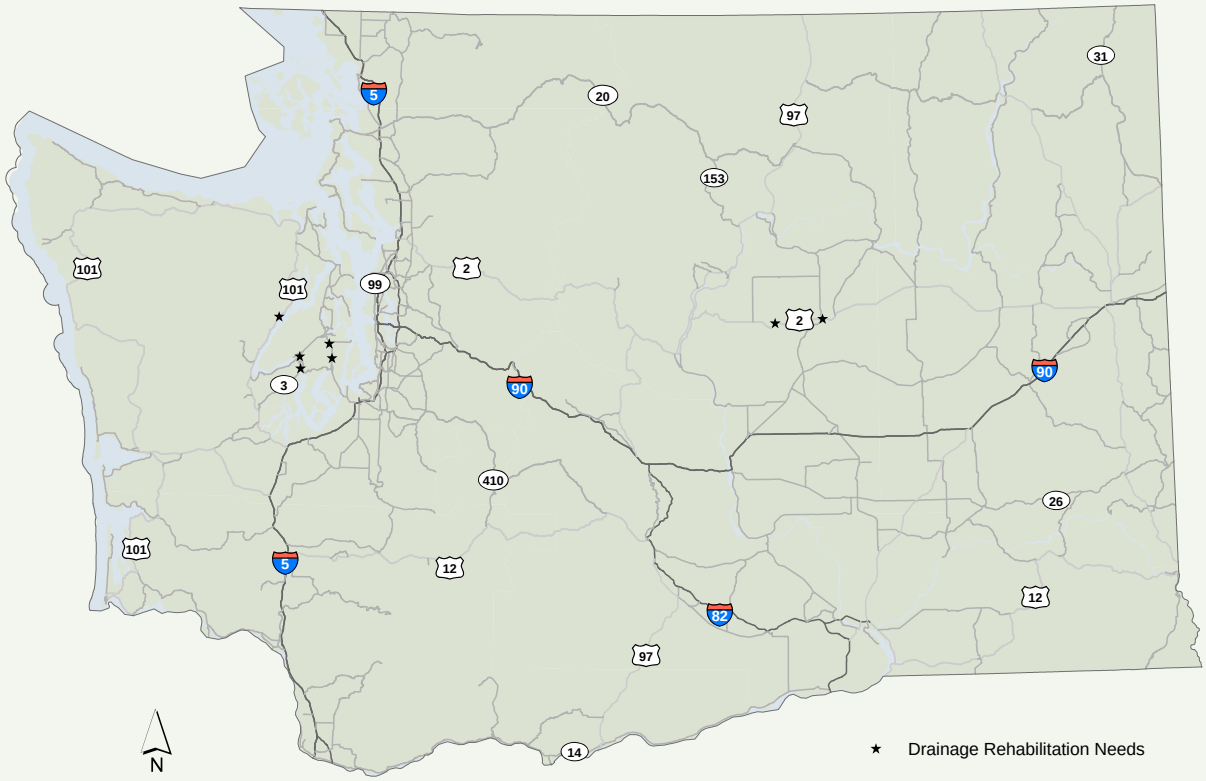
» Protect the functions of the transportation facility

» Protect ecosystem functions and the beneficial uses of receiving waters.

Photo 7. The culvert under the highway at Pyramid Creek (SR 20 – North Cascades Highway) plugged up in 2003. With nowhere else to go but through the road, the creek washed out a large chunk of highway leaving the guardrail suspended in the air.

A drainage system as defined by this discussion is that portion of the overall system that lies within the roadway embankment.

Drainage Rehabilitation Needs



Needs

Inventory of Drainage Systems at Risk of Failure

WSDOT is early in the process of developing a statewide inventory of drainage system conditions. With this information readily accessible, along with the tools described below, we will be able to more easily keep track of problem areas. Currently a short list of needed drainage rehabilitation work has been developed as shown in the table below.

As we add drainage systems to the highway system through the construction program, we must also plan for their eventual replacement in order to keep the highway system in good working condition. Drainage system rehabilitation may also be addressed by other highway construction projects at that location.

Strategies

Approaches to Preventing Drainage System Failure

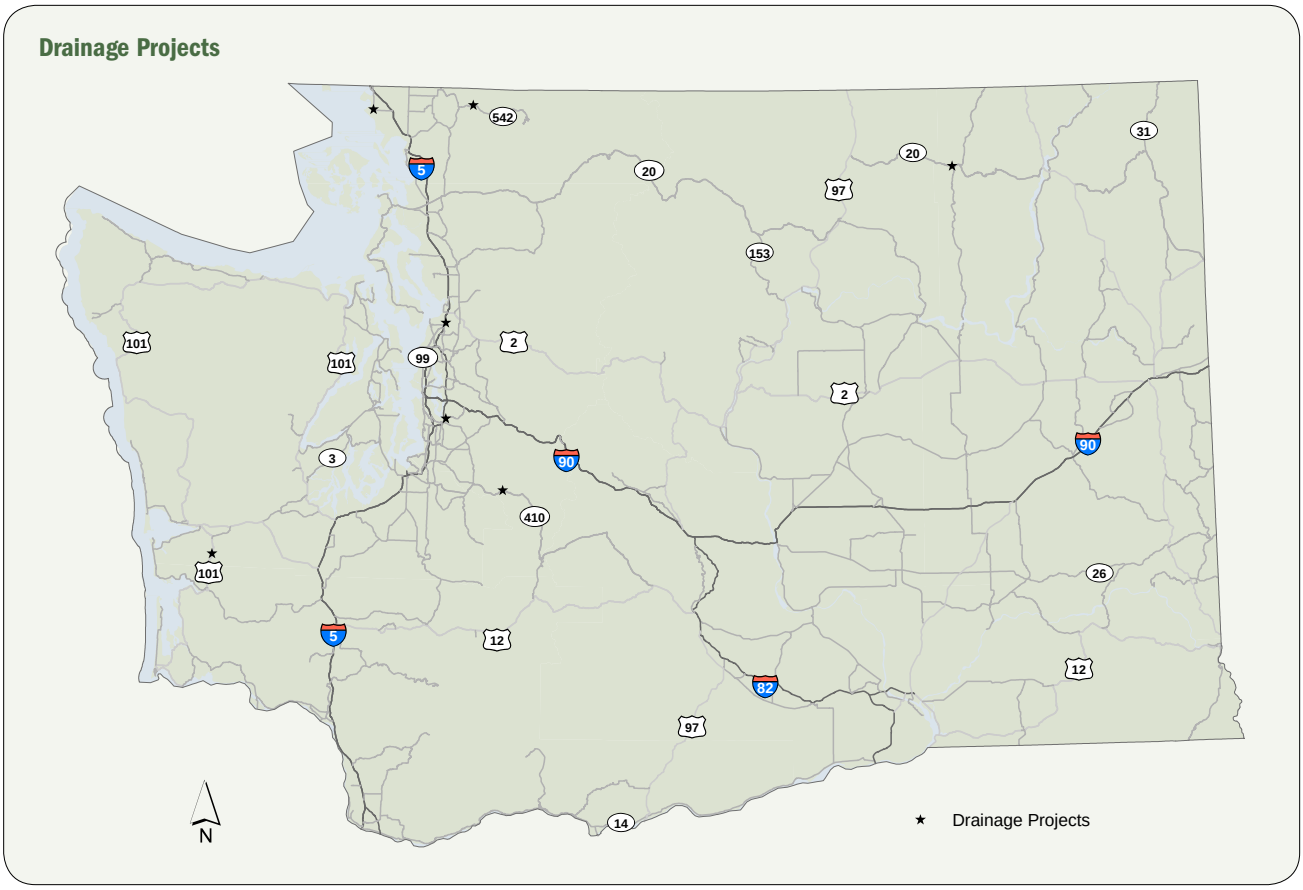
WSDOT inspects drainage systems at least once a year. We may perform additional inspections during heavy storms and periods of high runoff in order to determine the effectiveness of the system. During an inspection, our staff examines the inlet and outlet condition, as well as the culvert interior as best they can with what equipment they have. Recently we purchased new camera equipment (see Photos 4-6) specifically for culvert inspection which will make the process more efficient.

Pavement failure above a culvert is an indicator of impending failure due to water getting around or through the culvert wall, washing soil out of the embankment and causing the settlement.

Flows from upstream may also overwhelm a structure, plugging it, and causing water to back up behind the roadway embankment. This can result in water running through or over the roadway, causing a washout. (This scenario is little controlled by WSDOT or others.) See Photo 7.

Prioritization Process for Selecting Projects

In the past, WSDOT Region Maintenance would provide a list of drainage locations in need of rehabilitation or repair to Region Program



Management who then proposed a project for programming. WSDOT Systems Analysis and Program Development would then work with HQ Hydraulics who reviewed the drainage needs in order to prioritize these projects.

WSDOT is currently in the process of collecting drainage location, kind and general condition in a Roadside Inventory database as mentioned above. In approximately one year, enough data should be collected to make the system functional. WSDOT Maintenance will be collecting data in the field and downloading into the database. WSDOT Systems Analysis and Program Development will continue to work with HQ Hydraulics to prioritize the locations in need. This should result in a more comprehensive list of needs that will reduce the incidence of sudden drainage failures.

Photo 9. A large wedge failure involving up to 500 cubic yards occurred on September 11th, 2005 on Interstate 90 west of Snoqualmie Pass resulting in debris covering all three lanes and a single vehicle – triple fatality accident. In addition to the slope area from where the wedge failure initiated, similar wedge features in the adjacent slope areas were stabilized with slope scaling and rock anchors.

Table 1. Unstable Slope Numerical Rating System

Category	Points = 3	Points = 9	Points = 27	Points = 81
Problem Type: Soil	Cut or Fill Slope Erosion	Settlement or Piping	Slow Moving Landslides	Rapid Landslides or Debris Flow
Problem Type: Rock	Minor Rock fall Good Catchment	Moderate Rock fall Fair Catchment	Major Rock fall Limited Catchment	Major Rock fall No Catchment
Average Daily Traffic	< 5,000	5,000 to 20,000	20,000 to 40,000	> 40,000
Decision Sight Distance	Adequate Sight Distance	Moderate Sight Distance	Limited Sight Distance	Very Limited Sight distance
Impact of Failure on Roadway	< 50 Feet	50 to 200 Feet	200 to 500 Feet	> 500 Feet
Roadway Impedance	Shoulder Only	1/2 Roadway	3/4 Roadway	Full Roadway
Average Vehicle Risk	< 25% of the Time	25% to 50% of the Time	50% to 75% of the Time	> 75 % of the Time
Pavement Damage	Minor - Not Noticeable	Moderate - Driver Must	Severe - Driver Must Stop	Extreme - Not Traversable
Failure Frequency	No Failures in Last 5 Years	One Failure in Last 5 Years	One Failure Each Year	More Than One Failure
Annual Maintenance Costs	< $5,000 per year	$5,000 to $10,000 per year	$10,000 to $50,000 per year	> $50,000 per year
Economic Factor	No Detours Required	Short Detours < 3 Miles	Long Detours > 3 Miles	Sole Access No Detours
Accidents in Last 10 Years	0 to 1	2 to 3	4 to 5	> 5

Performance

The economic and societal impacts of drainage failure can be enormous. Road closures and detours are a direct result of pavement failure due to drainage failures, sometimes lasting several days to weeks. The Pyramid Creek failure, pictured above, lasted several days as it and multiple other locations along SR 20 were hit by slides and other culvert failures.

A single culvert failure can close a roadway for a day. Multiple failures such as happened on SR 20 in 2003 could cause the roadway to be closed for several days but rarely if ever more than a week. Weeks or months long closures are attributed more to river washouts such as SR 123 within Mount Rainier National Park in 2006.

20-Year Investment Plan

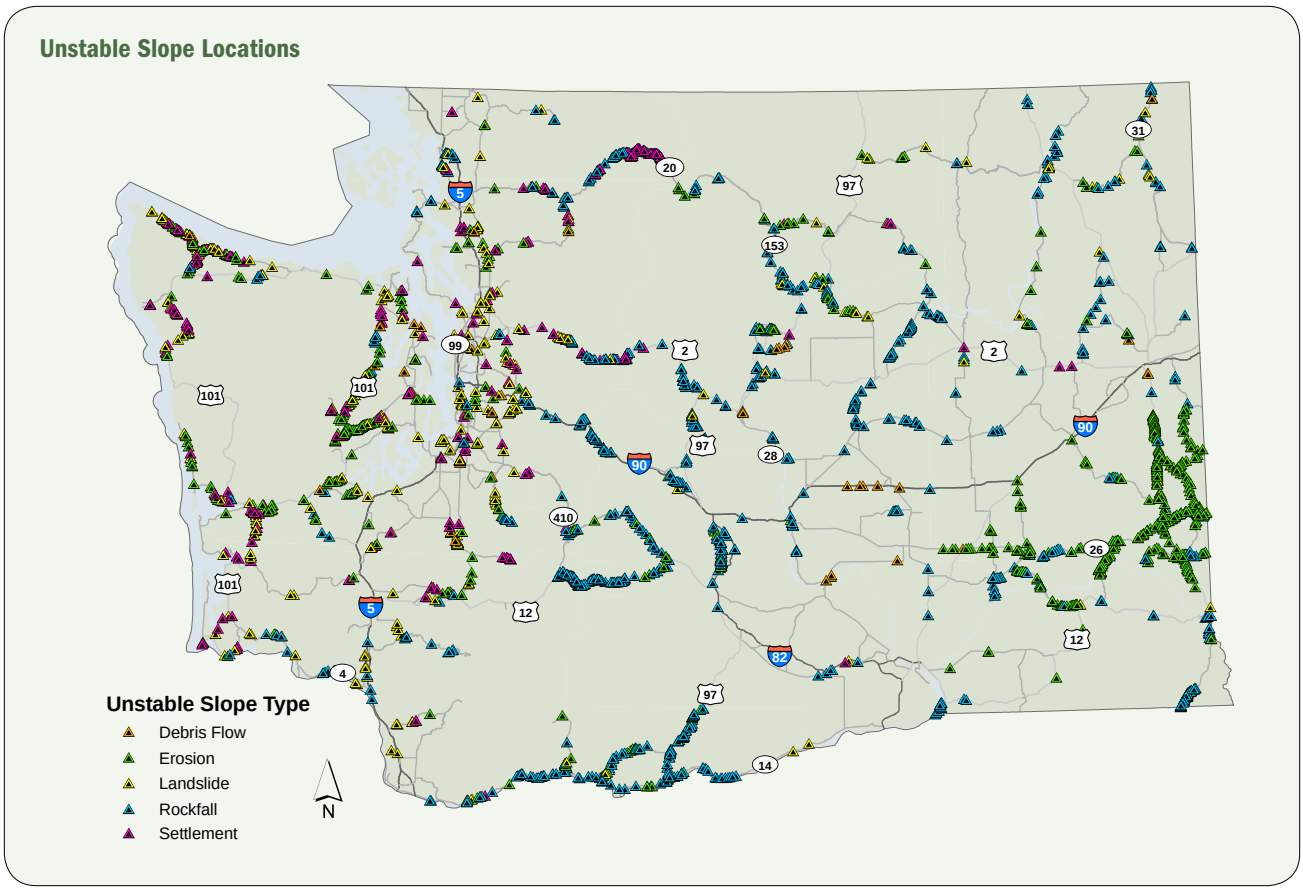
$60 to 80 million is planned over 10 years (07-09 through 15-17) with $24 million to be spent in the next four years.

Table 2 lists those drainage projects as listed in the 07-09 Construction Improvement and Preservation Program (CIPP).

Overview of Highway Slopes and Embankments

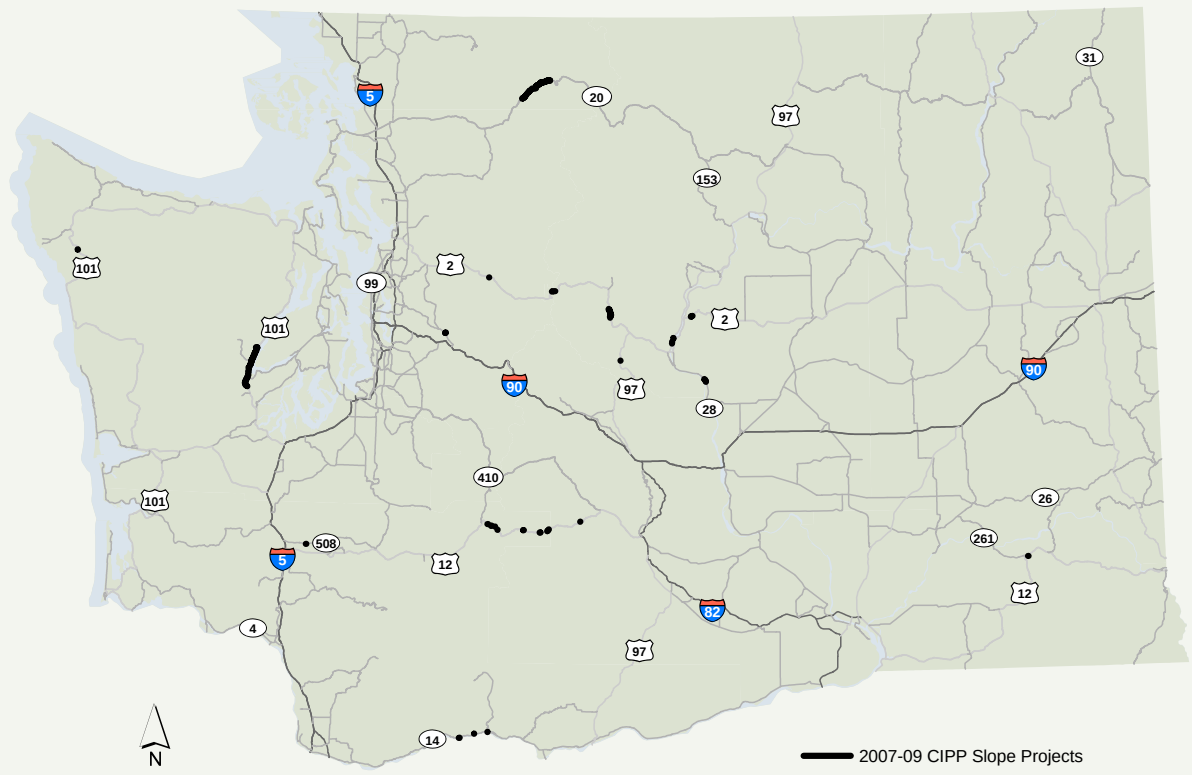
WSDOT is responsible for 7,048 miles of roadway. To date, we have identified 2,630 slopes along these state highway miles that have the potential to adversely affect state highway travel. WSDOT's Unstable Slope Management System began in 1995 to collect information about and to mitigate unstable slopes that present potential hazards to the state highway system. The Unstable Slopes Preservation Sub-program (P3) funded by the Legislature provides funding for projects over a course of years to correct conditions and mitigate risks presented by such hazards.

Slope instability is determined from the problem type: rock fall, landslides, debris flow, settlement, and slope erosion.



- **Rock fall** is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock fall descends mostly through the air by free fall, bouncing or rolling. Movements are very rapid to extremely rapid, and may not be preceded by minor movements.
- **Landslides** are the vertical and horizontal displacement of a soil mass, under the influence of gravity, within a slope or embankment. Generally landslides can be divided into two categories based on failure geometry. Those landslide categories are circular and sliding block failures. The rate of movement of landslides can vary from very slow moving to very rapid and vary in size from small cut slope failures to large failures many miles in area.
- **Debris flows** are a rapidly moving fluid mass of rock fragments, soil, water, and organic material with more than half of the particles being larger than sand size. Generally debris flows occur on steep slopes or in gullies and can travel long distances. Debris flows may result from unusually high rainfall, or rain on top of snow events and are characterized by fluid mixtures of water, soils and vegetative matter including trees.
- **Settlement** is the vertical displacement of a soil mass not associated with a horizontal movement within a slope or embankment. Generally movement is slow. Soil piping occurs when erosion of the subsurface soil, associated with groundwater flow, causes failure of the soil. (Soil piping is a particular form of soil erosion that occurs below the soil surface. It is associated with levee and dam failure as well as sink hole formation.)
- **Slope erosion** is the wearing away of a soil mass by the actions of running water. On slopes this process can result in the overland flow of water in an un-concentrated sheetwash, or the development of rills (e.g., small grooves or channels in soil slopes). Along streams or rivers the process can cause the near vertical undercutting of the adjacent stream or river bank.

2007-09 CIPP Slope Projects



WSDOT uses a database called the Unstable Slope Management System which helps manage all known unstable slopes. A numerical rating assigns a score from 33 (lowest) to 891 (highest). Slope rating is based on 12 variables as shown in Table 1.

Unstable Slope Numerical Rating System

Once geotechnical specialists complete the slope rating, we develop an approach to stabilizing the highest rated slopes. We then prepare a cost estimate to mitigate the slope from which a benefit cost analysis can be performed. Unstable Slopes are prioritized statewide based on descending numerical rating by functional class highway categories, and benefit cost. The unstable slope must have a benefit cost ratio greater than one to be on the prioritized list.

What are the risks involved with a slope failure? As a comparison with other types of risk, between January 1, 1970 and September 30, 2005 there were 19 reported fatal motor vehicle collisions resulting in 21 deaths caused by falling or fallen rocks or trees. Of these, eight fatal collisions with a total of 10 fatalities were determined most likely to have involved falling or fallen rocks. To place this in context, 26,993 traffic fatalities occurred on all (state, local and other) roadways in Washington State during this same time frame. Of 13,722 traffic fatalities occurring on state highways, 21 people were killed in collisions with wildlife.

As a comparison, from January 1, 1970 to September 30, 2005, there were no reported fatal vehicle collisions involving snow slides. For the time period January 1, 1999 to September 30, 2005, there were two collisions, one Property Damage Only and one injury. Both occurred on US 2; one mile west of Stevens Pass (milepost 63.21), an injury, and seven miles west of Leavenworth (milepost 92.15), a Property Damage Only collision.

From this data it can be concluded that the overall risk of fatalities or injuries by a slope failure is small.

In addition to the targeted slope stabilization program, slopes are also addressed as part of other projects. For example if a highway is being widened to accommodate the traffic volumes, any unstable slopes within the project limits would be addressed as part of the widening project. A good example of this is the "I-90/Snoqualmie Pass East" project due to start in 2010.

Needs

Inventory of Unstable Slopes

Of the unstable slopes in the Unstable Slope Management System, 43 percent are rock fall, 28 percent are slope erosion, 16 percent are landslides, nine percent are settlement and debris flow is four percent. The map below shows location of unstable slopes by type of deficiency.

Traffic Signal Systems

Photo 10. Vehicle Signal Display (LED)

Photo 11. Signal Controller Cabinet

Ramp Meter Systems

Photo 12. Typical Ramp Meter – Seattle Area

Strategies

Approaches to Slope Stabilization

Mitigation measures vary for each type of failure:

- **Rock Fall** – Scaling (removing rock), bolting or doweling, installing drainage, installing wire mesh fabric and constructing catchment ditches (enlarged ditch) or walls, or avoiding the area by realignment of the roadway.
- **Landslide** – Reducing driving forces by removing material from the upper portion of the unstable slide mass (slope flattening by regrading) and replacing with lightweight materials. Increase the resisting forces by construction in the toe area of shear keys, buttresses, berms or retaining walls with or without ground anchors. Improve surface and subsurface drainage by installing horizontal drains, or avoidance by realignment of the roadway.
- **Debris Flow** – Contain the flow using oversized drainage structures or avoidance by realignment of the roadway.
- **Settlement** – Excavate the fill material and replace with low density lightweight materials such as cellular concrete or polystyrene blocks or avoidance by realignment of the roadway.
- **Slope Erosion** – Problems are not presently addressed within the unstable slope program but are included in the database. Bioengineering methods of mitigation (planting vegetation) are being implemented through research projects.

Prioritization Process for Selecting Projects

One of our primary goals of priority programming is to maximize return on investment dollars. To ensure to the greatest extent possible that transportation dollars are being spent in those areas that have the highest return on investment, slopes are sorted and prioritized by rating. If there is a slope with a lower rating but is in the vicinity of a higher rated slope, it may make sense to move the lower rated slope up in the list in order to fix it at the same time and save on construction costs.

Average Daily Traffic (ADT) is also used during this process to help refine the list. If the ADT is low, the risk is lower (fewer vehicles on the roadway, fewer vehicles within the limits of a slope and hence the chance of a slope failure while a vehicle is in the vicinity is smaller.)

WSDOT's senior geotechnical staff review a "first cut" slope to make sure the order of slopes makes sense and that no slopes were left out, and that any slope omissions are corrected. If necessary, we conduct new field reviews to update slope ratings and refine the list of slopes.

With the slope rating complete, we can prepare a cost estimate to mitigate or fix the slope. The WSDOT Geotechnical Division develops the slope mitigation designs and the regions add on such things as traffic control, mobilization and other bid items. Using the slope rating and the estimate, a benefit/cost ratio can be calculated.

With this information we can assemble a list of slopes needing mitigation and their associated costs, and make decisions regarding programming.

Performance

The economic and societal impacts of slope failure are enormous. Since 1985 the state highway system has experienced 21 slope failures that resulted in roadway closures in excess of one week. The minimum closure was one week with the maximum closure of one year. Landslides typically cause the longest closures. The longest closure by a rock slide (two months) was the SR 20 – Newhalem occurrence in 2003.

Photo 13. South 317th HOV Direct Access & I-5 (Continuous High Mast and 50-foot Light Standard Illumination System)

The winter of 1998 and 1999 was an especially bad year. For over six months, western Washington experienced record-breaking rainfall. In February 1999, large scale landslides began to occur in much of the region. Six routes were closed that winter and spring for up to six months.

Performance is based on reduction in the risk of accidents and roadway closures due to slope instability.

20-Year Investment Plan

The Unstable Slope Management Program has a historic expenditure level of $34 million per biennium over the last 10 years. Of this $34 million, $17.5 million has been for emergency relief work. Since emergency work is an unknown, $8 million per biennium is shown in the plan as a placeholder based on history. Based on risk, with an average expenditure over the last 10 years of $17 million, the investment plan is for $20 million per biennium to be expended for at-risk planned slope work for a total of $28 million per biennium.

Rock scaling (forcibly removing loose rock before it falls) is an inexpensive way to reduce risk. One and one-half million dollars per biennium has been reserved for the next three biennia to perform this work.

Since the majority of the slopes are in the mountains and the state receives substantial rainfall during the winter months, construction seasons for this type of work are short. Typically only a few slopes each year can be addressed due to weather and available funding.

Photo 14. SR 520 Floating Bridge in Seattle (midspan opening)

A typical winter can include slope failure on slopes not currently scheduled for work. This results in dollars targeted for slopes high on the priority list getting reallocated to mitigate immediate slope failures. As such, every year the priority list needs to be updated.

Currently, we have 57 slopes prioritized for the 2007 construction season and beyond. Top priorities include Interstate 90 – Snoqualmie Pass, US 12 – White Pass, SR 101 – Hood Canal, US 2 – Stevens Pass, US 14 – Columbia River Gorge, US 2 – Pine Canyon Waterville and SR 97A – South of Entiat. The CIPP (Capital Improvement and Preservation Program) list addresses part of these.

Major Electrical Preservation

The following list represents the types of major electrical systems that WSDOT is responsible for maintaining and operating. In general, these items encompass the WSDOTs Illumination and Intelligent Transportation Systems (ITS). By definition, ITS refers to “electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.”[23 Code of Federal Regulations (CFR), Section 940.3] The “Major Drainage & Electrical” category is a subcomponent of “Other Facilities” of the Preservation Program, referred to as “P3”. The Major Electrical System Items listed below are not entirely maintained and preserved by the P3 program. Facilities, structures, appurtenances or components that are necessary to keep those facilities or structures functioning are not part of “P3”. The primary purpose of the Major Electrical System Rehabilitation program is to keep the Systems functioning through complete system replacement or replacement of specific electronic components as necessary to maintain current operational levels.

Major Electrical System Items

- Traffic Signal Systems
- Ramp Metering Systems
- Illumination Systems
- Tunnel and Bridge Electrical Systems
- Dynamic Message Signs (DMS) Systems
- Highway Advisory Radio (HAR) Systems
- Closed Circuit Television (CCTV) Camera Systems
- Data Station Systems

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

- Permanent Traffic Recorder (PTR) Systems
- Animal Warning System
- Automatic Anti-Icing System
- Fiber Optic Communication Systems
- Communication Hubs
- Other Communication Systems, (Emergency Telephone, Ethernet, DSL, T1)
- Wireless Communication Systems
- Roadway Weather Information Systems (RWIS)
- Transit Signal Priority (TSP) Systems
- Commercial Vehicle Information Systems and Networks (CVISN) Program / Weight In Motion Systems
- Statewide Traveler Information Systems (Web, 511, Traffic TV)
- Traffic Management Centers (TMC), (Electronic Equipment, Communication Media and Systems necessary to operate and obtain information from field devices)
- Tolling and Electronic Payment Systems
- ITS Systems for Freight Mobility (Ports/Border Crossings/On Board Trucks)
- Reversible Roadway System, (I-5 & I-90, Seattle Area)

WSDOT has applied ITS to transportation problems since the 1960s, when CCTV Cameras were installed during the construction of I-5. In the 1980s, freeway ramp meters were deployed to decrease urban freeway congestion, and in the 1990s, incident response teams, using and providing information to ITS systems began operating on I-5 in the Puget Sound area. Through experience and expertise gained over nearly 5 decades, WSDOT has become a national leader in implementing ITS solutions that ultimately save time, dollars, and lives.

The following section will briefly define each of the Major Electrical System Items. The purpose is to provide a high level scope of the existing system along with basic needs for preservation at current performance levels. The final sections will present the strategies performance monitoring efforts that are related to or affected by funding levels of the P3 program.

Traffic Signal Systems

WSDOT owns and is responsible for maintaining 965 traffic signals (including pedestrian signals, temporary signals and emergency signals) statewide. All signals use micro-processor based controllers with active vehicle and pedestrian detection. A portion of these signals are maintained and operated by others through agreement. In general, signals

Photo 16. Closed Circuit Television (CCTV) Camera Systems

Photo 17. Roadside Animal Warning Systems (AWS)

systems have a life expectancy of 25 years. Many components of a signal system must be replaced or upgraded more frequently during the overall life cycle due to changes in technology or as necessary to maintain system operational performance.

Ramp Meter Systems

Over 138 ramp meters monitor occupancy levels on freeway ramps and help smooth freeway traffic by regulating vehicle entrance rates. Metering rates are automatically adjusted by the system based on prevailing freeway traffic conditions. In general, ramp metering systems have a life expectancy of 25 years. Similar to a traffic signal, many components of a ramp meter system must be replaced or upgraded more frequently during the overall life cycle due to changes in technology or as necessary to maintain system operational performance.

Illumination Systems

WSDOT maintains approximately 2,933 illumination systems statewide. Most are in the vicinity of interchanges, intersections, chain-up areas, and transit flyer stops, with continuous illumination placed along some roadway sections as a result of congestion and safety issues. Some systems contain 1 or 2 lights while others may contain 100 or more lights on 40-50 ft light standards or 100 ft high mast poles. As part of the illumination system WSDOT maintains 199 sign-lighters statewide which provide increased visibility for overhead signs. In general, the life expectancy of an illumination system is 25 years. During this period, various preventative maintenance activities, such as re-lamping luminaires and inspecting anchor bolts, are necessary to maintain performance and safety. These types of preventative maintenance activities are funded separately through the maintenance program.

The primary purpose of lighting a roadway at night is to increase the visibility of the roadway and its immediate environment, thereby permitting the driver to maneuver more efficiently and safely. The justification for highway lighting is in terms of cost savings due to accident reduction. Although estimates vary, the savings can be enough to pay for a lighting installation in a few years. Estimates by Box (1989) indicated that lighting can reduce the ratio of night-to-day accidents by as much as 14 percent of total accidents. In a more recent analysis by Griffith (1994), the safety benefit was found to be much higher, with an accident reduction of 32 percent (for property damage only accidents).

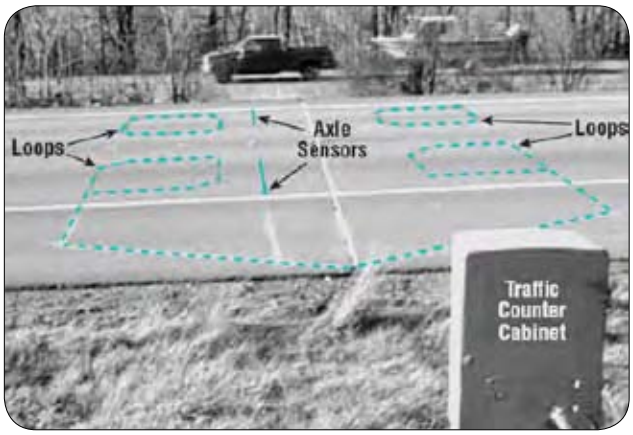


Photo 18. PTR Site on SR 16 near Burley

Tunnels and Bridge Electrical Systems

Tunnel Systems

The systems in the tunnels can be either complex or simplistic depending on the system. Tunnel system may be as basic as only having roadway lighting systems. They also may be very complex and have some or all of the following systems:

- Fire Control, Alarm and Suppression
- Ventilation
- Air Quality (CO Sensors or other)
- Traffic Control (signals, electronic signs, etc.)
- Traffic Surveillance (CCTV)
- Traffic Detection (induction loops, video detection, radar, etc.)
- Lighting (roadway - day levels, night, emergency. faculty - day, night, egress)
- Power Distribution
- Emergency or Standby Power (generators, battery, redundant electrical services)
- Radio Re-broadcast.
- Communication (phone, emergency phone, public address)
- Security

WSDOT currently operates and maintains many tunnel systems. Three of the most complex systems are on I-90 in Seattle and Mercer Island; and on I-5 under the convention center in downtown Seattle. In general, tunnels systems have a life expectancy of 20 years.

Bridge Systems

All mechanical and electrical preservation work on bridges that are directly related to opening and closing the spans are funded under the P2 subprogram. All other electrical items on bridges, such as roadway illumination, navigation lights, interior lighting, water sensors, intercom systems, fire systems, etc., are funded under the P3 subprogram.

Bridge Systems that fall under the P3 subprogram consist of the electronics, communication media, and equipment necessary to monitor and perform traffic operations functions; ventilation; fire protection, surveillance and security; navigation lighting; and roadway lighting. WSDOT Northwest Region currently operates and maintains the following bridges:

Photo 19. Installation of HDPE conduit for Fiber Optic Cable

Movable and Floating Span Bridges

- I-90
- 90/25 N & S Homer Hadley & Lacey Murrow
- SR 99
- 99/530 E & W 1st Ave. So.
- SR 513
- 513/12 Montlake
- SR 520
- 520/8 Evergreen Point
- SR 529
- 529/10E & W Snohomish River
- 529/20 E & W Steamboat Slough
- 529/25 Ebey Slough
- SR 536
- 536/15 Skagit River (out of service since 1979)

Bridges With Navigation Lights

- SR 2
- 2/3S Snohomish River
- 2/5N Snohomish River
- I-5
- 5/570 Ship Canal
- 5/645 E & W Snohomish River
- 5/648 E & W Steamboat Slough

WSDOT also operates and maintains the Hood Canal movable bridge and 10 other bridges with navigation lighting and bridge obstruction systems statewide. In general, bridge systems have a life expectancy of 20 years.

Wireless Communication Systems

Photo 20. Microwave Tower and Communications Building Equipment Inside Skyline Lake at Skyline Lake, 1.5 miles above Stevens Pass Communications Building

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. In general, the life expectancy of a HAR system is 20 years.

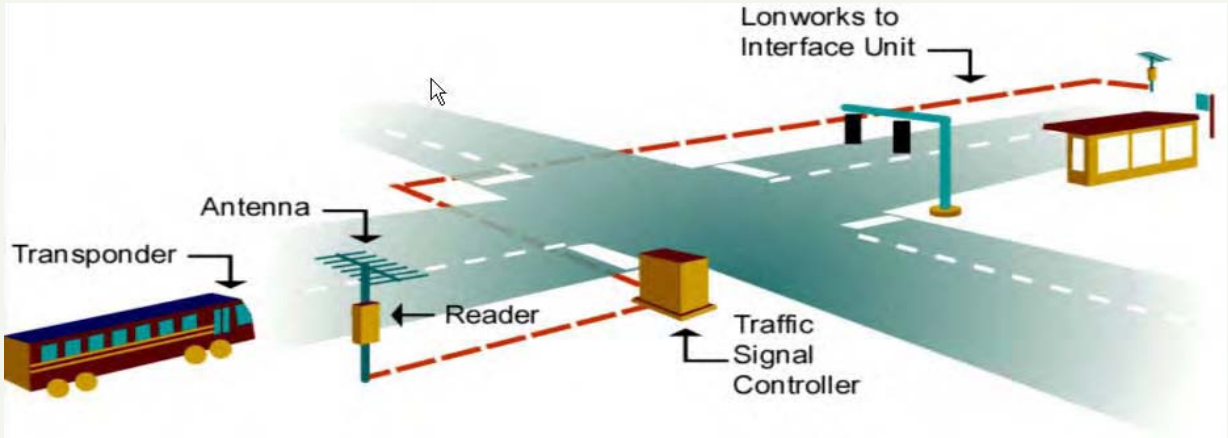
Dynamic Message Signs (DMS)

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 problem, or simply provide alerts or warnings. In general, the life expectancy of a DMS system is 20 years. Periodic DMS system upgrades are necessary. Upgrades include control software and electronic components upgrades as technology advances with more advanced communication protocol such as National Transportation Communication for ITS Protocol (NTCIP).

Closed Circuit Television (CCTV) Camera

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. In general, the life expectancy of a CCTV Camera system is 20 years.

Figure 5. Transit Signal Priority System



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

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. In general, the life expectancy of a data station is 15 years. Depending upon the roadway condition at the data station location, periodic replacement of in-pavement loops may be necessary to maintain current performance.

Photo 22. Typical WIM Installation (Enlargement of Transponder in Truck)

Permanent Traffic Recorder (PTR) 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. As a result, the life expectancy for a PTR system is estimated at ten years.

Figure 6. CVISN / Weight in Motion (WIM) Deployment Site Map

WSDOT maintains six animal warning systems (AWS) installed or planned statewide. These systems are designed to inform drivers of animals entering or in the roadway along select rural roadway section. In general, the life expectancy of an AWS system is 10 years.

Automatic Anti-Icing System (AAIS)

WSDOT maintains eight Automated Anti-Icing Systems (AAIS) statewide with a life expectancy of ten years. The primary purpose of winter highway maintenance is to provide vehicular traffic with a roadway surface that can be safely traveled. Roadway geometrics and an icy surface may create specific locations that are particularly susceptible to snow and ice related accidents. Revisions to roadway geometrics are very expensive, so problem areas typically become the responsibility of highway maintenance to mitigate the hazard by winter maintenance operations. AAIS greatly improves WSDOTs ability to address icy roadway conditions at problems areas. A 2001 WSDOT study of an AAIS system on I-90 in North Central Region indicated the following: "The analysis indicates that the proposed automatic anti-icing system is a viable and cost effective method of reducing the snow and ice related accidents in the Interstate 90 High Accident Location (HAC) under evaluation. Benefit cost ratio is greater than two (2.36) and the net benefit is over one million dollars ($1,179,274)."

Fiber Optic Communication Systems

The primary backbone of the WSDOT ITS communication network is fiber optics. WSDOT currently owns and maintains more than 220 miles of fiber optic cable. Fiber optic cable allows traffic information to be shared in a timely manner. Where these cables are not used, information travels over telephone lines at slower rates and higher costs. Fiber optics allow real-time streaming video of traffic cameras, images that help traffic managers make real-time decisions, rather than a delayed view which occurs when the information travels through telephone lines. Fiber Optic Cable has proven to be very reliable with an average life expectancy of 20 years. Periodic replacement of electronic equipment used to transmit and receive data along the fiber line, along with repair at splice points and patch panels, are necessary to maintain peak system performance.

Advantages of Fiber Optics

Why are fiber-optic systems revolutionizing video communications? Compared to conventional metal wire (copper wire), optical fibers are:

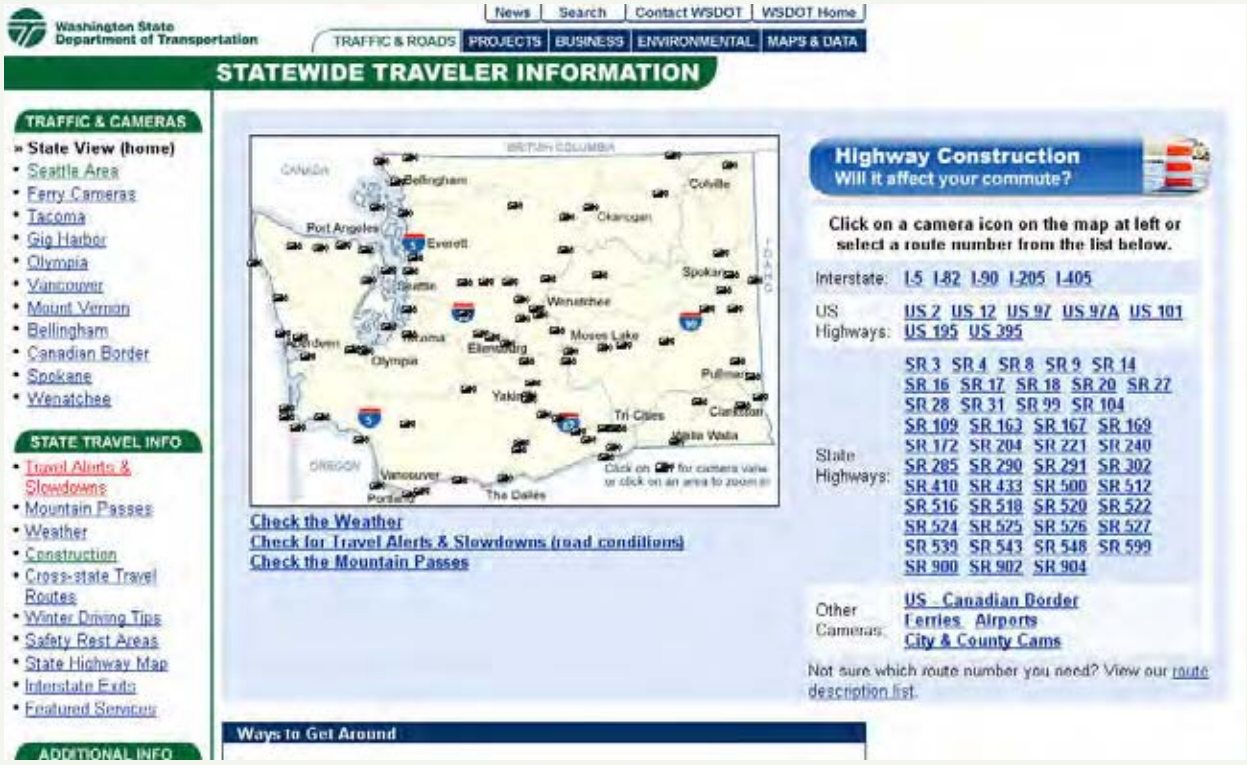
- **Less Expensive** – Several miles of optical cable can be made cheaper than equivalent lengths of copper wire.
- **Thinner** – Optical fibers can be drawn to smaller diameters than copper wire.
- **Higher Carrying Capacity** – Because optical fibers are thinner than copper wires, more fibers can be bundled into a given diameter cable than copper wires.
- **Less Signal Degradation** – Optical fiber signal loss is less than in copper wire.
- **Light Signals** – Unlike electrical signals in copper wires, light signals from one fiber do not interfere with those of other fibers in the same cable.
- **Low Power** – Because signals in optical fibers degrade less, lower-power transmitters can be used instead of the high-voltage electrical transmitters needed for copper wires.
- **Digital Signals** – Optical fibers are ideally suited for carrying digital information, which is especially useful in computer networks.
- **Non-Flammable** – Because no electricity is passed through optical fibers, there is no fire hazard.
- **Lightweight** – An optical cable weighs less than a comparable copper wire cable. Fiber-optic cables take up less space in the ground.

Installation of High Density Polyethylene (HDPE) Conduit for Fiber Optic Cable

Communication Hubs

Statewide there are approximately 30 communication Hubs that support the ITS communication systems. Communication Hubs are basically an above or below ground structure where ITS communications systems from multiple systems interconnect as information from field devices is brought back to the TMC and vice versa. These hubs house large amounts of electronic equipment and allow for fiber optic cable

Figure 7. WSDOT Statewide Traveler Information Page



and other communication media to be spliced. Temperature and humidity control are critical for extending system life expectancy which is estimated at 20 years, although this kind of field environment is prone to periodic replacement of some electronic equipment due to failure.

Other Communication Systems

(Emergency Telephone, Ethernet, DSL, T1)

The WSDOT manages a large communication network primarily made of copper cable. Many of the ITS systems that are operated on the highways today communicate to TMCs through copper connections. The copper connections assist in the operation of Traffic Signals, HARS, DMS, Data Stations, Ramp Meters, Illumination, CCTV Cameras and other electrical devices. The installation cost for copper systems is less expensive than the fiber optic alternative; however, the operating costs is far more expensive over time. In general, the life expectancy of WSDOT's 250 miles of copper communication is 20 years with periodic equipment replacement.

Wireless Communication Systems

WSDOT provides wireless communications in support of the department's Intelligent Transportation Systems (ITS) and Traffic Management Centers (TMC). The Wireless communication system has two primary missions; to provide 24 hour emergency communications to the departments personnel via the TMC's, and to provide the traveling public with real time information on the conditions of the state's highway system via the ITS program.

There are over 125 communication sites included in the system statewide. The facilities used are a variety of owned, shared with sister agencies, and leased from private companies. These facilities have a life expectancy of 50 years. Within the facilities is a combination of support equipment that has a life expectancy of 15 years.

Roadway/Weather Information Systems (RWIS)

WSDOT maintains and operates 94 Road/Weather Information Systems (RWIS). These systems are installed along the roadway with instruments and

Photo 23. TMC Seattle at Regional Headquarters

equipment that provide weather and road surface condition observations. This information is used to facilitate decisions on maintenance strategies and to provide information to drivers.

A typical RWIS system may measure air and road surface temperature, barometric pressure, humidity, wind speed and direction, precipitation, visibility, and road surface condition (dry, wet, freezing). In general, the life expectancy of an RWIS system is 25 years although periodic replacement of select electronic components is necessary to maintain current performance.

ARROWS (Automated Realtime ROad Weather System) takes current weather data received from RWIS systems and generates forecasts for roadway temperatures which allows WSDOT to anticipate de-icing needs. This system is also managed and maintained by two meteorologists at the University of Washington.

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.

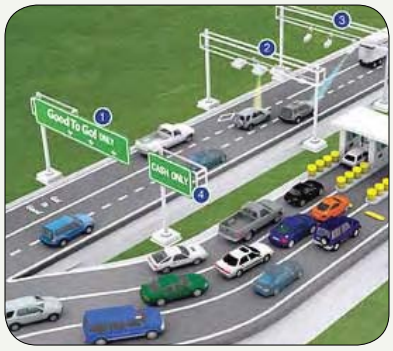
WSDOT current operates and maintains ten TSP systems in the greater Seattle Area. In general, the life expectancy of a TSP system is ten years with periodic electronic component replacement.

CVISN Program / Weigh-In-Motion (WIM) Systems

As of July 1, 2006, the Commercial Vehicle Information Systems and Networks (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. In general, the life expectancy of a WIM system is ten years with periodic replacement of select electronic components.

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

Photo 24. Canadian Border Crossing, E-Seal (Transponder Readers)

Statewide Traveler Information Systems (Web, 511, Traffic TV)

The Washington State Department of Transportation (WSDOT) continues to provide valuable on-line traveler information to the public in creative and effective ways.

- **Web** – The current web site has information available on the following:
  - **CCTV Camera Images** – Camera Images are updated every minute providing travelers with a visual or roadway conditions at most critical locations around the state.
  - **Travel Alerts and Slowdowns** – which combines incidents, construction, events, and anything else that might impede or slow travel on the roads.
  - **Consolidated 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.
  - **Dedicated Weather Pages** – WSDOTs weather page has led the country in using intelligent transportation systems data to provide travelers with real-time road and weather information.
- **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.
- **511** – What is 511? Real time traffic and weather information is available by simply dialing 5-1-1 from most phones. The system builds upon the highly successful Washington State Highway hotline previously accessed through 1-800 toll free numbers. Updated every few minutes, 511 allows 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

Photo 25. Reversible Roadway System (I-5 & I-90, Seattle Area)

Photo 26. Reversible Roadway – Center Lanes (I-90 Floating Bridge, Seattle Area)

Table 2. Historical Major Electrical Systems Funding
(Sub Component of P3)

Biennium	Cost
1995 – 1997	$2 M
1997 – 1999	$6 M
1999 – 2001	$9 M
2001 – 2003	$28 M
2003 – 2005	$16 M
2005 – 2007	$7 M
2007 – 2009	17 M (est.)

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.

Table 3. Major Electrical System Inventory / Funding Needs

Major Electrical System Item	Unit	Projected Inventory (As of June '07)	Average Cost (Dollars)	Expected Life-Cycle (Years)	Replacement Cost (During Next 20 Years)
Traffic Signal Systems	ea.	965	$240,000	25	$185,280,000
Ramp Meter Systems	ea.	138	$50,000	25	$5,520,000
Illumination Systems	ea.	2,933	$125,000	40	$183,312,500
Tunnel and Bridge Electrical Systems	ea.	5	$2,000,000	20	$10,000,000
Dynamic Message Signs (DMS) Systems	ea.	185	$175,000	20	$32,375,000
Highway Advisory Radio (HAR) Systems	ea.	64	$50,000	20	$3,200,000
Closed Circuit Television (CCTV) Cameras Systems	ea.	502	$35,000	20	$17,570,000
Data Station Systems	ea.	479	$45,000	15	$28,740,000
Permanent Traffic Recorder (PTR) Systems	ea.	162	$30,000	10	$9,720,000
Animal Warning Systems	ea.	6	$70,000	10	$840,000
Automated Anti-Icing Systems	ea.	8	$700,000	10	$11,200,000
Fiber Optic Communication Systems	miles	220	$150,000	20	$33,000,000
Communication Hubs	ea.	30	$200,000	20	$6,000,000
Other Communication Systems, (Emergency Telephone, Ethernet, DSL, T1)	miles	250	$50,000	20	$12,500,000
Wireless Communication Systems	ea. (# sites)	125	$100,000	15	$16,666,667
Roadway/Weather Information Systems (RWIS)	ea.	94	$50,000	25	$3,760,000
Transit Signal Priority (TSP) Systems	ea.	10	$20,000	10	$400,000
CVISN Program / Weigh in Motion(WIM) Systems	ea. (# sites)	13	$50,000	10	$1,300,000
Statewide Traveler Information System, (Web(traffic/roads), 511, Traffic TV)	ea.	1	$1,000,000	10	$2,000,000
Traffic Management Centers (TMC), (Electronic Equipment, Communication Media and Systems necessary to operate and obtain information from field devices)	ea. (# sites)	8	$2,000,000	10	$32,000,000
Tolling and Electronic Payment Systems	ea.	2	$1,000,000	10	$4,000,000
ITS Systems for Freight Mobility (Ports / Border Crossings / On Board Trucks)	ea.	1	$3,000,000	10	$6,000,000
Reversible Roadway System (I5 & I90, Seattle Area)	ea. (# sites)	2	$3,000,000	25	$4,800,000
Total Replacement Cost for All Major Electrical Systems Items					$610,184,167
Total Cost per Biennium for All Major Electrical System Items (Not Adjusted for Inflation)					$61,018,417

What does 511 offer?

- Ease of use and convenience
- Real-time, accurate, quality road and traffic conditions
- Avoiding traffic congestion and road construction
- Information to help users make informed travel choices

Technology permits fully automated conversions of traffic congestion and incident data into everyday speech. Road sensors identify traffic volumes that are converted into levels of congestion for each highway section. Incidents are identified by video camera observations or information from the Washington State Patrol.

The traffic volume data are then converted into speech, and using voice recognition, traffic reports on a specific road segment are played back. In Washington State within the greater Seattle area, prerecorded speech is being used to provide real-time traffic congestion reports within a few minutes of their detection. Text to speech technology is being used to provide statewide incidents and construction reports. In these most sophisticated systems, a caller connects to 511 and can speak their request at any time, interrupting the prompts to receive specific information by route and direction.

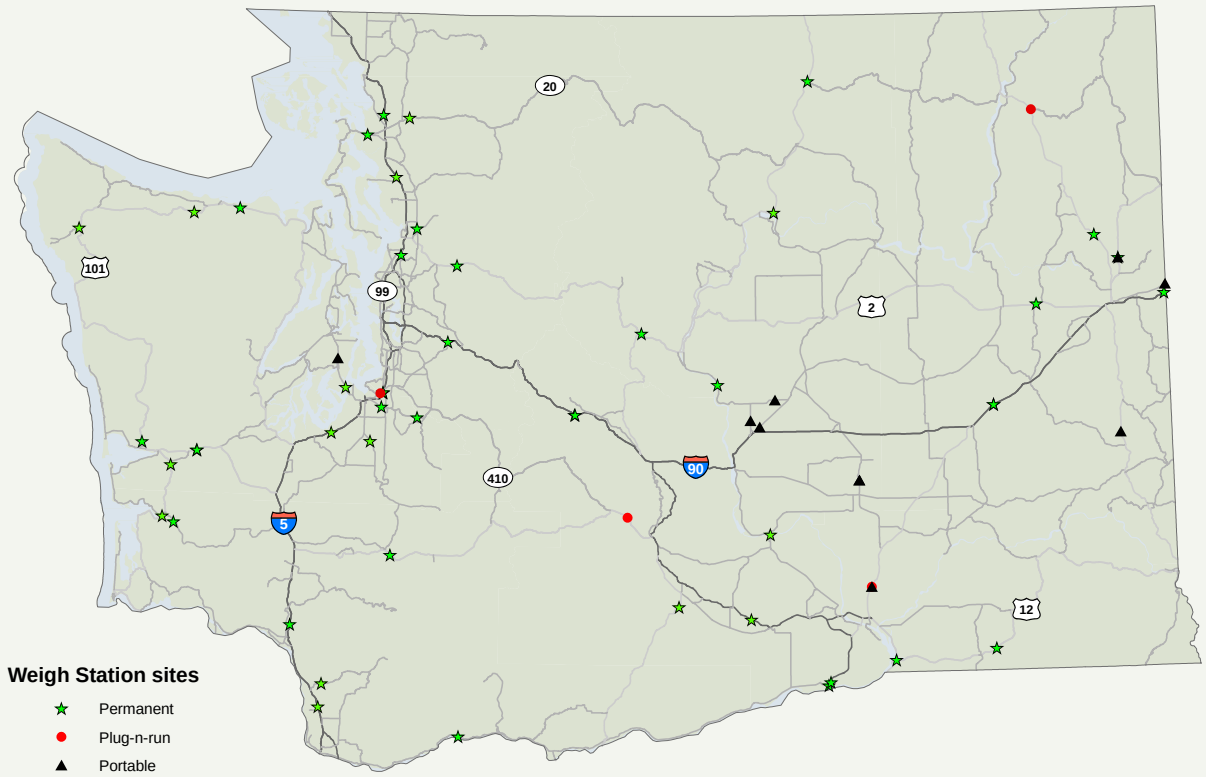
- **Traffic TV** – Traffic camera images and the vehicle speed flow map for the Seattle area are available on select local cable channels.

Statewide Traveler Information Web Page

www.wsdot.wa.gov/traffic

It goes beyond saying that the web site has been extremely popular with the traveling public, with the site receiving record visits during extreme weather. In general, the electronic equipment and software necessary to operate the statewide traveler information system has a life expectancy of ten years with more frequent replacement of select components to maintain peak performance.

Figure 9. Locations of Permanent and Plug-n-Run Sites



Traffic Management Centers (TMC)

(Electronic Equipment, Communication Media and Systems necessary to operate and obtain information from field devices)

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.

Although the TMC facility itself is outside the scope of the P3 program, the extensive electronic equipment, media and software that is required to communicate with and operated the field ITS equipment is a critical component of the Major Electrical System portion of the preservation program. The life expectancy of these items is estimated at ten years in order to maintain current performance and maintain pace with technological advancements.

Tolling and Electronic Payment Systems

In the near future WSDOT will begin maintenance and operations of two significant tolling and electronic payments systems for the new Tacoma Narrows Bridge and the SR 167 High Occupancy Toll (HOT) lanes pilot. In general, the life expectancy of the electronics, software and communication media portion of the Tolling and Electronic Payment System is estimated at ten years with periodic replacement of select components.

Good To Go! – Is the new, convenient, easy-to-use electronic toll collection program that gives motorists the power to pay tolls on the new Tacoma Narrows Bridge span and SR 167 HOT lanes without stopping.

ITS Systems for Freight Mobility

(Ports / Border Crossings / On Board Trucks)

WSDOT has deployed a number of ITS Systems designed specifically to improve and monitor freight mobility. ITS transponder reading equipment located at the Ports of Tacoma and Seattle and at the Canadian border has been installed to monitor the movement of containers and trucks. These systems use electronic container door seals that are also transponders on container doors that are designed to reduce the number of customs inspections and paperwork for trucks crossing the border with British Columbia. The transponder readers from this system,

Weigh Stations

Photo 27. Weigh Station on Interstate 90 Tokio Road (milepost 231)

Photo 28. A typical shoulder weigh site (similar to a portable site although it is not separated from traffic)

Photo 29. A Department of Highways weigh station circa 1940 on what was most likely SR 101. The truck (a '35 or '36 Ford) was owned by Walter Plumb Company, Copalis Beach

along with data-only and weigh station CVISN readers along I-5, I-90 and I-82, can also be used to provide near real-time travel time estimates for trucks. This transponder based tracking information, along with GPS tracking devices in volunteer, probe trucks can provide significant information about freight mobility in Washington State. WSDOT, working with several Canadian transportation agencies has developed an Internet-based system that archives data from these devices. In general, these types of ITS Systems have a life expectancy of ten years, with periodic replacement and updating of some electronic equipment.

Reversible Roadway System

(I-5 & I-90, Seattle Area)

WSDOT maintains two reversible roadway systems; one from downtown Seattle North along I-5; one from downtown Seattle East along I-90. The reversible roadway system consists of 129 gates, 17 gate control systems, and a large number of mechanical overhead drum signs that help regulate the flow and direction of traffic at different times each day. In general, the life expectancy of these systems is 25 years with periodic electronic equipment replacement.

Needs

Continuous use of these major electrical systems; aging equipment; difficulties in acquiring older parts due to evolving technology; reduced safety of degrading insulation and corrosion due to environmental factors has presented WSDOT with the dilemma of how to plan for ongoing rehabilitation and the ultimate replacement of these systems as they approach their life expectancy. The traveling public and nearly every component of WSDOT planning, design, construction, operations and maintenance has become accustomed to and relies heavily upon the information and services these systems provide. As shown in Table 1, WSDOTs major electrical system inventory has an approximate replacement cost of $610 Million dollars. Planned rehabilitation and replacement of these systems helps maintain current performance. The current rehabilitation and replacement cost of these systems is estimated at $61 Million dollars per biennium in order to maintain current performance. This estimate does not take into account the front load costs for systems that are currently past their life expectancy. As presented in the strategies subsection, preventative maintenance actives are funded through the maintenance program NOT the preservation program. The current maintenance program is under funded to the point where multiple systems have failed and are currently offline. The overall picture of WSDOTs Major Electrical Systems will only continue to deteriorate, especially as additional systems are implemented, unless significant funding is allocated to this portion of the preservation program.

Over the past 12 years, Major Electrical System Rehabilitation funding through the preservation program has been well below the estimate of $61 million dollars per biennium as outlined previously. Further system expansion, which is necessary to increase capacity or maintain efficiency of the existing infrastructure, will continue to amplify these issues.

Table 4. Site Alternatives

Siting Criteria	I-90 Vic Tokio Interchange	I-90 Vic Port-of-Entry
Average Daily Truck Traffic	6	6
Forecast Average Daily Truck Traffic	6	6
Site Bypass Potential	6	3
Inspection Violation History	6	6
Traffic Conflicts	6	3
Accident History	3	6
Hazardous Materials	3	6
Environmental Impacts	6	3
Right-of-Way Availability	3	6
Telephone Service Availability	3	6
Electrical Service Availability	6	6
Fiber-Optic Service Availability	3	6
Redundant Facilities	3	6
Pavement Condition	4	4
Operating Speeds	4	4
Topography	4	2
Sight Distance	4	4
Land Use Compatability	4	2
Climate	2	4
Availability of Water/Sewage Utilities	2	4
Proximity to WSP Offices	2	4
Seasonal Movements	2	2
Origin and Destination Data	2	1
Highway Improvement Coordination	1	1
Total Score	91	101

Figure 9. Weigh Station Siting Criteria

Average Daily Truck Traffic	Right-of-Way Availability	Sight Distance
Forecast Average Daily Truck Traffic	Availability of Electricity	Land Use Compatability
Weigh Station Site Bypass Potential	Telephone Availability	Climate
Vehicle Inspection Violation History	Fiber Optic Cable Availability	Availability of Water/Sewage Utilities
Weigh Station Site Traffic Conflicts	Redundant Weigh Station Facilities	Proximity to WSP Offices
Accident History	Pavement Conditions	Seasonal Movements
Hazardous Materials Transported	Roadway Operating Speeds	Origin and Destination Characteristics
Potential Environmental Impacts	Topography	Highway Improvement Opportunities

Table 5. Investment Plan

Project Title	07-09	09-11	11-13	13-15	15-17	Future
Other Facilities Project Reserve - Weigh Stations	0	0	5,300,000	5,500,000	5,800,000	19,200,000
I-90/Cle Elum Weigh Station EB - Install Weigh in Motion	200,000	0	0	0	0	0
I-90/Spokane Port of Entry - Weigh Station Relocation	0		0	0	0	0
Total	200,000		5,300,000	5,500,000	5,800,000	19,200,000

Strategies

Preventative Maintenance

Preventative Maintenance (PM) activities are necessary for all Major Electrical Systems. However, PM is funded through the maintenance program, NOT the preservation program, P3. All electrical systems require periodic review in addition to non-scheduled maintenance caused by unpredictable events such as storms, accidents, and equipment failure. The intent of the preventative maintenance program is to diminish the possibility of an abrupt system failure and to allow for emergency or quick replacement of those systems in order to maintain an acceptable level of service to the public. In order to meet this objective it is sometimes necessary to replace select electronic components.

Identifying the Need

WSDOT is continuing to develop and refine the process for developing and documenting the statewide inventory of electrical system infrastructure. Having this information in one central database will greatly improve the efficiency of identifying and addressing problem areas along with defining future funding needs and priorities. By continuing to pursue a central inventory and maintenance activity tracking system, it will become more feasible to predict failures and prioritize preventative maintenance activities.

Prioritizing the Need

The number one priority of the P3 Major Electrical Systems program is to complete the development of our asset management system. In order to accomplish this objective, dedicated funding is required for a group of people with the primary responsibility of administering, maintaining, and operating the system.

At the request of Systems Analysis and Program Development WSDOT maintenance will compile a list of needs around the state. WSDOT Headquarters Traffic then reviews the list in the field with region maintenance staff and prioritizes a draft list. Systems Analysis and Program Development also requests that the regions provide estimates in order to develop a list of needs given available dollars.

Some portions of existing electrical systems may be replaced as part of other projects at that location, but the majority of the systems will be replaced through the Major Electrical Systems Preservation subprogram.

In general, Major Electrical Systems, P3 projects will be prioritized and programmed based on impact to the traveling public and WSDOT initiatives.

Performance

The underlying theme between all Major Electrical System Items is providing information to the traveling public, media and WSDOT planning, design, construction, operations and maintenance programs to support decisions made on the operational condition of the roadway infrastructure. Information provided by major electrical systems is critical for providing data that feeds a number of Gray Notebook performance measures as listed below. In addition, the performance of all the disciplines listed above and the ability for the traveling public to make an informed decision as they plan their trip or commute would be decreased as systems that are maintained through major electrical system P3 funding fail.

To date, measuring performance of the major electrical systems portion of the P3 program is currently accomplished through a variety of Gray Notebook performance measures. Other performance measures, such as Signal Operations, are under development. These performance measures provide insight into the impact major electrical systems have on the traveling public and WSDOT safety and congestion reduction initiatives.

Gray Notebook Performance Measures

The following is a list of Gray Notebook Performance Measures that rely on major electrical systems for data that supports how well the measures are working. The ability to make accurate assessments decreases as electrical system fail.

- Measuring Congestion – Travel Time Analysis
- Measuring Congestion – Lost Throughput Analysis
- Measuring Congestion – Percent of Days When Speeds Were Less than 35 MPH
- Measuring Congestion – Measuring Travel Delay
- Measuring Congestion – HOV Lane Performance
- Measuring Congestion – Case Studies – Before and After Results
- Measuring Congestion – Understanding the Relationship Between Safety and Congestion
- Measuring Congestion – Traffic Data Collection for Arterial Highways
- Incident Response – Number of Responses and Average Clearance Time
- Incident Response – Response Increases to Fatality Collisions
- Travel Information – 5-1-1 (Total Calls to Travel Information)
- Travel Information – Website Usage

Maintenance Accountability Process (MAP) Performance Measures

The Maintenance Accountability Process (MAP) is a tool which measures and communicates the outcomes of the maintenance activities. It provides the tools to link strategic planning, the budget and maintenance service delivery. Twice a year, field inspections are made of randomly selected sections of highway. The results of WSDOT's work are measured, recorded and compared to the MAP criteria to determine the level of service (LOS) delivered. The MAP performance measures relating directly to the Major Electrical Systems that are rehabilitated or replaced by the preservation program are listed below.

- Traffic Signal Systems
- Highway Lighting Systems
- Intelligent Transportation Systems (ITS)

Other Performance Measures

- **Signal Operations** – Time Between Operational Reviews by Signal Type with Specific Review Criteria

Weigh Station Replacement and Rehabilitation

Weigh Stations promote safe travel of commercial vehicles on state highways. This is accomplished by conducting driver and vehicle inspections and enforcing size, weight and load laws.

These inspections help reduce the number and severity of commercial motor vehicle collisions and hazardous material incidents on interstate and state highways. This task is accomplished through comprehensive inspections of commercial motor vehicles and their drivers. Commercial Vehicle Safety Alliance (CVSA) certified inspectors conduct levels 1-5 CVSA North American Standard inspections. These inspections examine the commercial driver's

license, medical certificate, logbook, and vehicle equipment (per RCW 46.32).

WSDOT compliments the Washington State Patrols (WSP) effort to prevent over-height and over-weight trucks from damaging the state's pavements and bridges by rehabilitating deteriorated weigh station facilities and constructing new locations as the needs are identified. Currently, WSDOT's preservation program builds the off and on-ramps, signage and illumination systems, while WSP's budget provides the buildings and utilities.

The current Joint Operating Policy Statement (JOPS) between WSDOT and WSP states that WSDOT will work with WSP and provide "turn key" weighing facilities to WSP. WSDOT will seek the funding and build the mutually agreed scales which are then turned over to WSP to maintain per the Memorandum Of Understanding between WSP and WSDOT. WSP will care for the building, static scales, weigh-in-motion equipment, and pay the utilities for the building. WSDOT maintains signs, pavement, striping, outside lighting and pays to power the outside lighting.

Needs

Inventory of Weighing Facilities

Washington State currently has 48 permanent-scale weigh stations. Seventeen are located on interstate highways. Permanent fixed scales are equipped to detect axle, tandem, and gross weight violations. The Ports of Entry (POE) at Ridgefield, Bow Hill, Plymouth, and Spokane operate 24 hours per day, seven days per week, as does the scale site at Cle Elum, which also serves as an interior POE for traffic east and west bound on interstate 90.

Plug-and-Run sites exist where enforcement officers operate full-sized vans equipped with a desk and work area. The officer drives onto the scale site, removes the scale head from the pedestal, activates an electronic sign, and begins the weighing process. These sites enable officers increased mobility from site to site. Currently, Plug-and-Run sites are operational on SR 99 in Federal Way, SR 12 in Naches, SR 395 in Spring Valley, and SR 395 in North Pasco.

Strategies

Approaches to Preserving Weighing Facilities

It is the responsibility of WSDOT and WSP to jointly develop plans for improving and preserving commercial vehicle enforcement capabilities throughout the state of Washington. This responsibility entails determining and implementing improvements, as needed, in weigh station facilities. In collaboration with the WSP, criteria have been developed to assist decision-makers in determining where funding should be allocated to achieve the goal of effective commercial vehicle enforcement for the least amount of funds possible.

Prioritization Process for Selecting Projects

Project ranking is by category (interstate fixed, non-interstate fixed, portable) relative to each other in accordance with siting criteria. The various siting criteria, as listed in Table 7, is weighted depending on category. (For example, utilities are important for fixed sites but not necessary for a portable site.)

A list of projects developed in coordination between WSDOT and WSP working within available funding is shown in Table 8.

Performance

With the installation of weigh-in-motion at additional sites, down time of trucks is reduced. 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 is approximately 70,000 hours of travel time and five million dollars per year!

The major objective of the Motor Carrier Safety Assistance Program (MCSAP) is to reduce the number and severity of commercial motor vehicle collisions and hazardous material incidents on interstate and state highways. This task is accomplished through comprehensive inspections of commercial motor vehicles and their drivers. The weigh station sites allow WSP to carry out this objective.

20-Year Investment Plan

The twenty year investment plan consists of three projects as shown in the table below. The Project Reserve in the out biennia totals $35,800,000 over the next 14 plus years.

Top priorities are: Interstate 90 – Cle Elum Eastbound and Interstate 90 – Spokane Port of Entry (with a construction start in 2009).