SEATTLE TO PORTLAND
INTER-CITY ITS CORRIDOR STUDY
AND COMMUNICATIONS PLAN

FINAL REPORT

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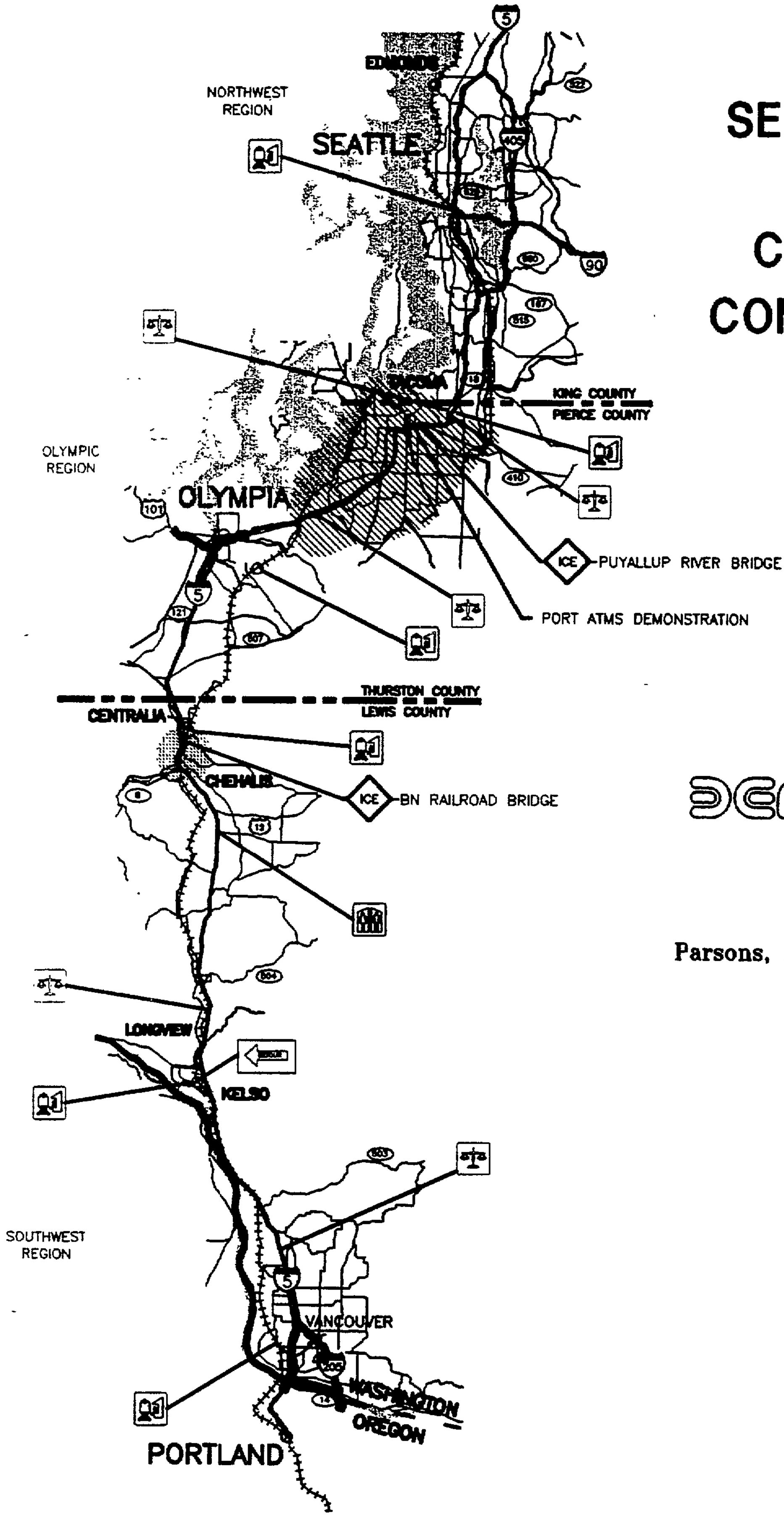

SEATTLE to PORTLAND INTER-CITY ITS CORRIDOR STUDY and COMMUNICATIONS PLAN

Final Report

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SEATTLE TO PORTLAND
INTELLIGENT TRANSPORTATION SYSTEM (ITS)
EARLY DEPLOYMENT PLAN

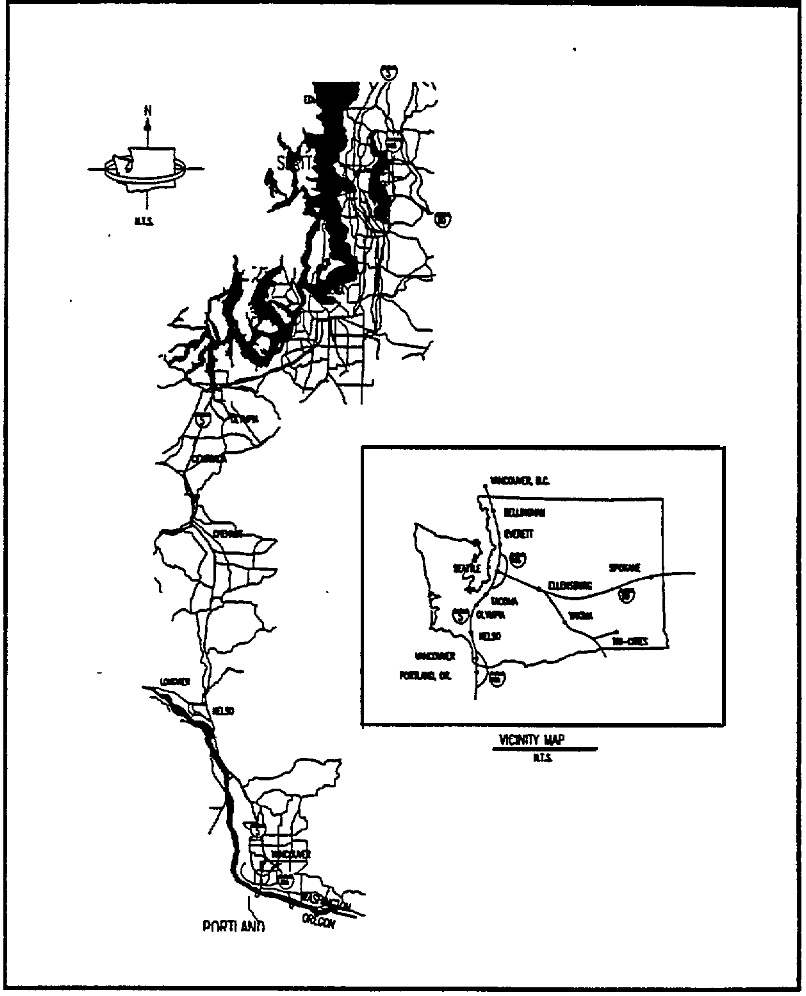
INTRODUCTION

The Intelligent Transportation System (ITS) Seattle to Portland Corridor Plan has identified feasible technology - based solutions for acknowledged needs in the corridor. The ITS Corridor Plan not only recommended solutions, but created prospectuses for each proposed project. The Washington State Department of Transportation (WSDOT) will use the prospectuses to continue the effort to mainstream technology-based solutions into the established project prioritization and programming process throughout the corridor.

The study's primary goal was to devise an early deployment plan for ITS that would make roadways safer, better inform travelers, improve traffic management, and move commercial goods more efficiently. A secondary study objective was to develop a communications plan to support the ITS corridor plan.

Partners in the study included David Evans and Associates, Inc. (Prime Contractor); Parsons, Brinckerhoff, Quade and Douglas, Inc.; PB Farradyne, Inc.; IBI Group; CTS Engineers, inc.; Pacific Rim Resources; and University of Washington faculty Daniel Dailey, research professor of Electrical Engineering, and Mark P. Haselkorn, professor and chair, Department of Technical Communication.

CORRIDOR LOCATION PLAN



FIGURE

The intercity corridor from Seattle to Portland stretches along Interstate-5 for 180 miles as shown in Figure 1. This main west Coast route serves a wide range of transportation demands, including urban travel in the Puget Sound and the Portland-Vancouver regions, intercity passenger movement, and freight movement. Overall 3.43 million people live in the seven counties along the corridor, the majority of them at its north and south ends. Significant population growth is expected along the corridor.

An extensive review of current and future conditions and ongoing planning efforts along the corridor revealed eight transportation needs (Table 1) that must be addressed by a combination of construction, management, and technological solutions. The study analyzed how ITS applications can address these needs over the next 20 years for each segment of the corridor-the Puget Sound region, the Portland-Vancouver region, and the intercity region between them. Potential applications of ITS user services (Table 2) were matched against the transportation needs in each corridor segment and the corridor as a whole. Projects were proposed for implementation during the near-term (1 to 6 years), mid-term (7 to 12 years), and over the long-term (12 to 20 years).

SEATTLE TO PORTLAND TRANSPORTATION CORRIDOR NEEDS

TABLE 1

ITS USER SERVICES

1. **Travel and Transportation Management: Collect** and process information about surface transportation and provide commands to traffic control systems.

2. **Travel Demand Management:** Facilitate and encourage the use of other modes of travel over the use of a single occupant vehicle.

3. **PublicTransportation Operations:** Improve the management, operation, and service delivery of public transportation.

4. **Electronic Payment Services:** Provides electronic funds transfer for transportation services and fees.

5. **Commercial Vehicle Operations (CVO):** Improve the efficiency of commercial fleet operations ranging from operations through regulations for both the public and private sector.

6. **Emergency Management:** Use advanced technology to better manage and respond to emergencies.

7. **Advanced Vehicle Safety Systems:** Provide in-vehicle systems to improve vehicle safety.

TABLE

SEATTLE TO PORTLAND ITS CORRIDOR FRAMEWORK

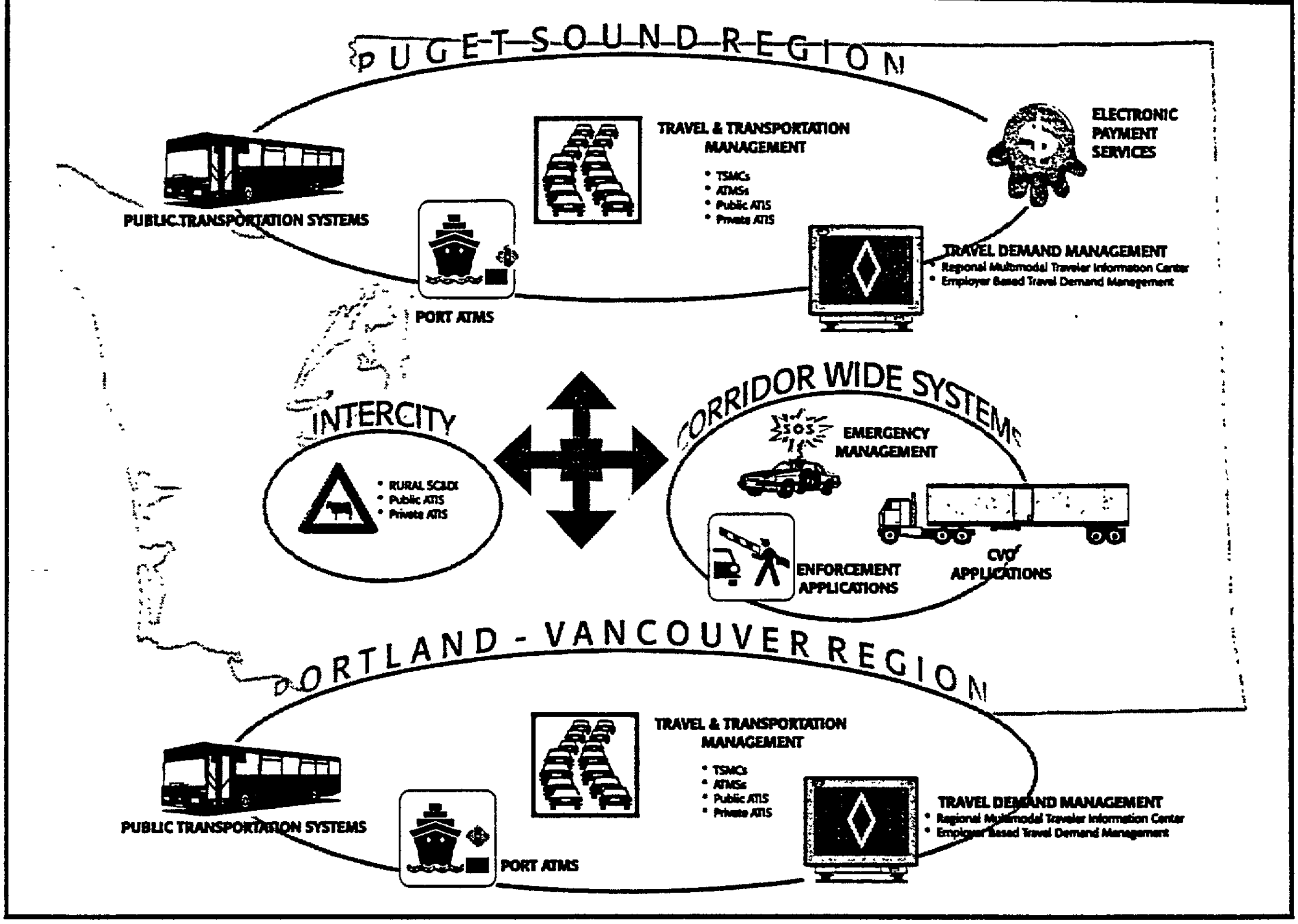


FIGURE 2

CORRIDOR PLAN

The ITS Corridor Plan recommends technology-based solutions for acknowledged transportation needs in the corridor. The transportation needs and ITS solutions in the corridor were found to be categorized by both locational and corridor-wide requirements. **Figure 2** presents the framework for the implementation of ITS solutions in the corridor.

Puget Sound Region

The Metropolitan Transportation Plan for Puget Sound provides a framework for the implementation of an integrated multimodal transportation system which includes:

- Optimize and Manage the Use of Transportation Facilities and Services;
- Manage Travel Demand Addressing Congestion and Environmental Objectives;
- Focus Transportation Investments Supporting Transit and Pedestrian-Oriented Land Use Patterns; and
- Expand Transportation Capacity Offering Greater Mobility Options.

The proposed ITS solutions for the Puget Sound Region offer a set of technology-based projects and programs which support this regional framework and meet the established Statewide ITS goals and objectives defined in the ITS Strategic Plan. This component of the ITS Corridor Plan calls for action in the following areas:

- Traffic Management
- Traveler Information
- Travel Demand Management
- Public Transportation Application
- Electronic Payment Services; and
- Port ATMS

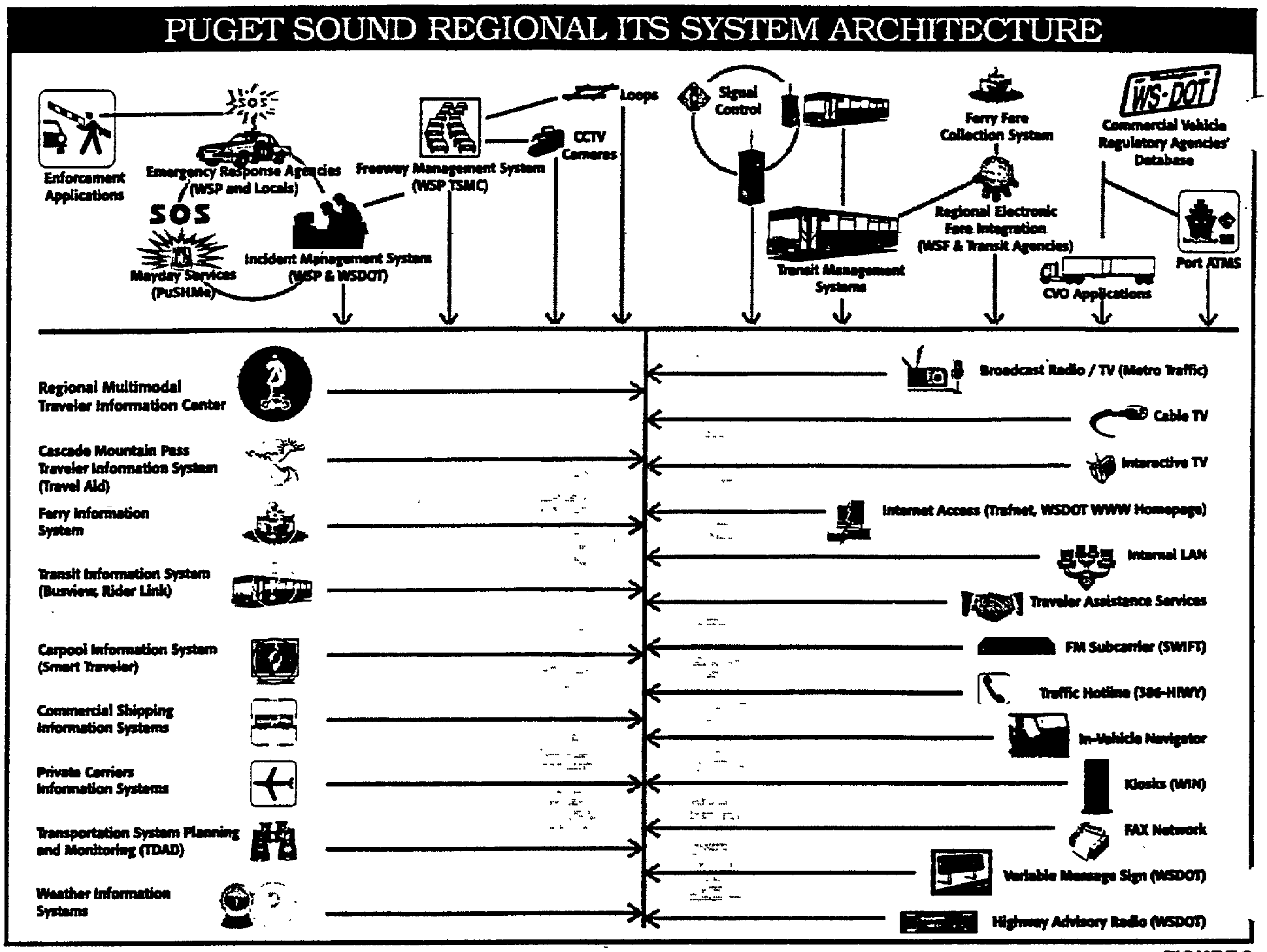


FIGURE 3

The top part of **Figure 3** depicts the ITS core infrastructure recommended for the Puget Sound region. These are key public sector elements required to enable ITS deployment.

The lower left side of the diagram illustrates the wide range of public and private information service providers that are involved with a fully deployed regional ITS system. A key application is the Regional Multimodal Traveler Information Center (RMTIC) which would serve as a virtual center for current traveler information.

The lower right portion of Figure 3 shows potential methods for distributing the information obtained and processed by the various public and private applications.

Travel and Transportation Management. This element will build upon the well established base of the Northwest Region's surveillance, control and driver information (SC&DI) system and the North Seattle advanced traffic management system (ATMS). These installations will provide the primary infrastructure required for further development of advanced traveler information systems. Early deployment projects will include the development of an Olympia, Washington, SC&DI operations plan, deployment of an ATMS in Pierce County, Washington, and in the east and south sections of King County, Washington, and the demonstration of a work zone SC&DI system.

Travel Demand Management. The establishment of a core infrastructure will permit optimal operation and management of roadway and transit resources. A critical element of this ITS infrastructure will be the Regional Multimodal Traveler Information Center, which will connect all of the ITS systems, compile travel information, and redistribute the information through both private and public distribution channels. It will act as a repository of current, comprehensive, and accurate roadway and transit route and performance data, and it will provide a bridge between the general public and transportation systems managers.

Public Transportation. Public transportation operators in the Puget Sound region are continuing the implementation of a range of ITS systems in four areas: transit signal priority

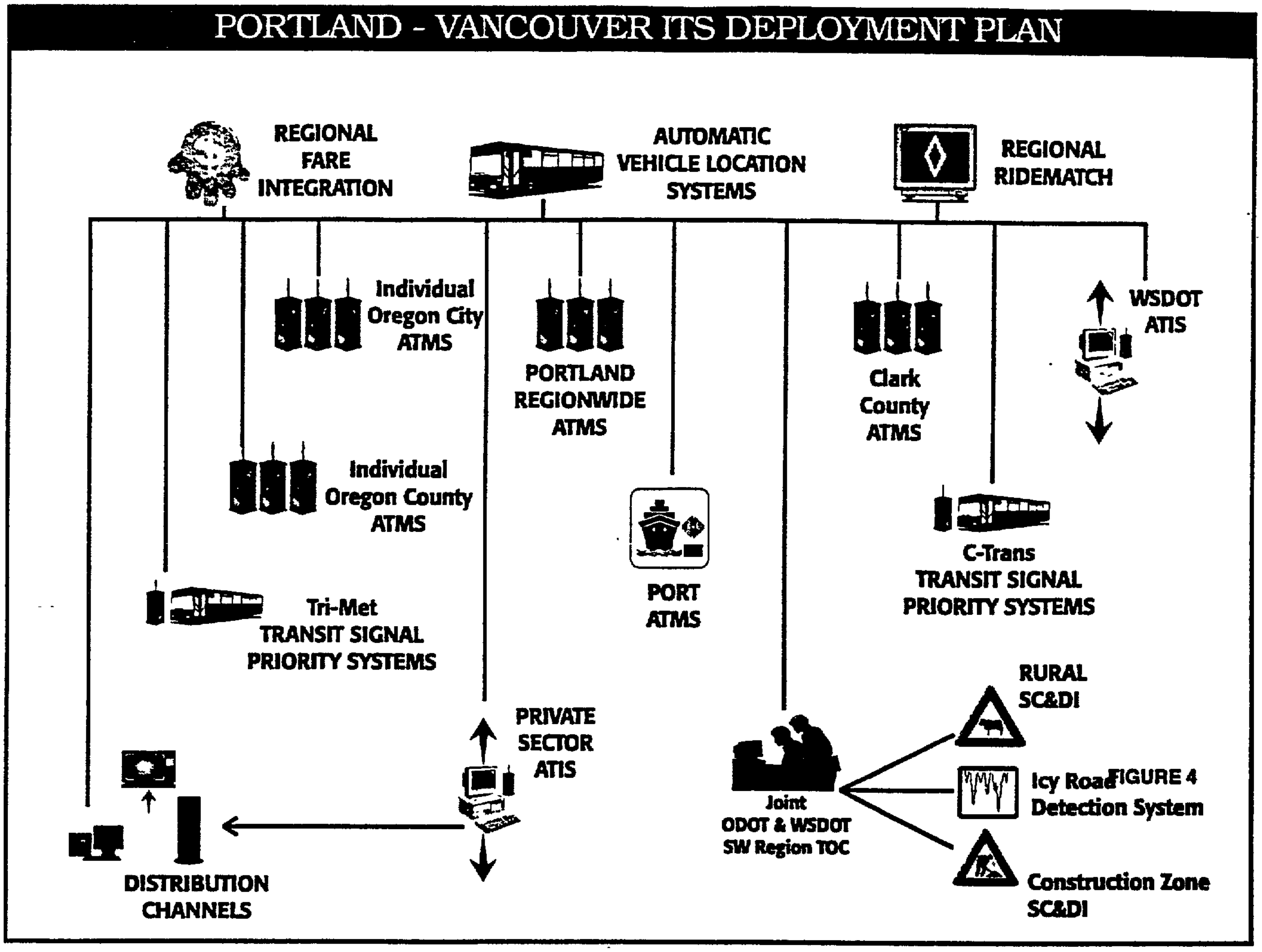


FIGURE 4

automatic vehicle location, fare collection, and information. WSDOT is working closely with local transit agencies to ensure that the emerging systems include standard interfaces to the larger ITS system architecture.

Electronic Payment Services. Electronic payment services are being explored in two ways. First, both Washington State Ferries and King County Metro Transit are preparing for the introduction of electronically integrated transit fare collection throughout the region. Second, WSDOT is examining toll projects on several state highways. These potential vehicle pricing projects would generate sufficient revenue to pay for their own implementation and operation.

ATMS for Ports. Over 25 percent of West Coast port container movements pass through the ports of Tacoma and Seattle. A key initiative is a demonstration project to test an ITS application to improve commercial vehicle access to ports. The system would employ an integrated combination of traffic control, information sources, and communications to provide traffic signal control along arterial routes leading to the port, access to traffic-related information, and an interface to the automated electronic vehicle clearance system.

Non-Motorized Transportation. The project recommended the following actions: improve interaction between traffic control systems and pedestrians and bicyclists, add pedestrian and bicycling information to traveler information services, include non-motorized alternatives as part of transportation demand management efforts, electronically provide public transportation route and schedule information to pedestrians and bicyclists, provide emergency notification and personal security services to non-motorized modes, and include pedestrians and bicyclists in collision-avoidance applications for the medium and long term.

Portland-Vancouver Region

This region faces many of the same transportation issues found in the Puget Sound region, with the added need for interstate cooperation as illustrated in **Figure 4.**

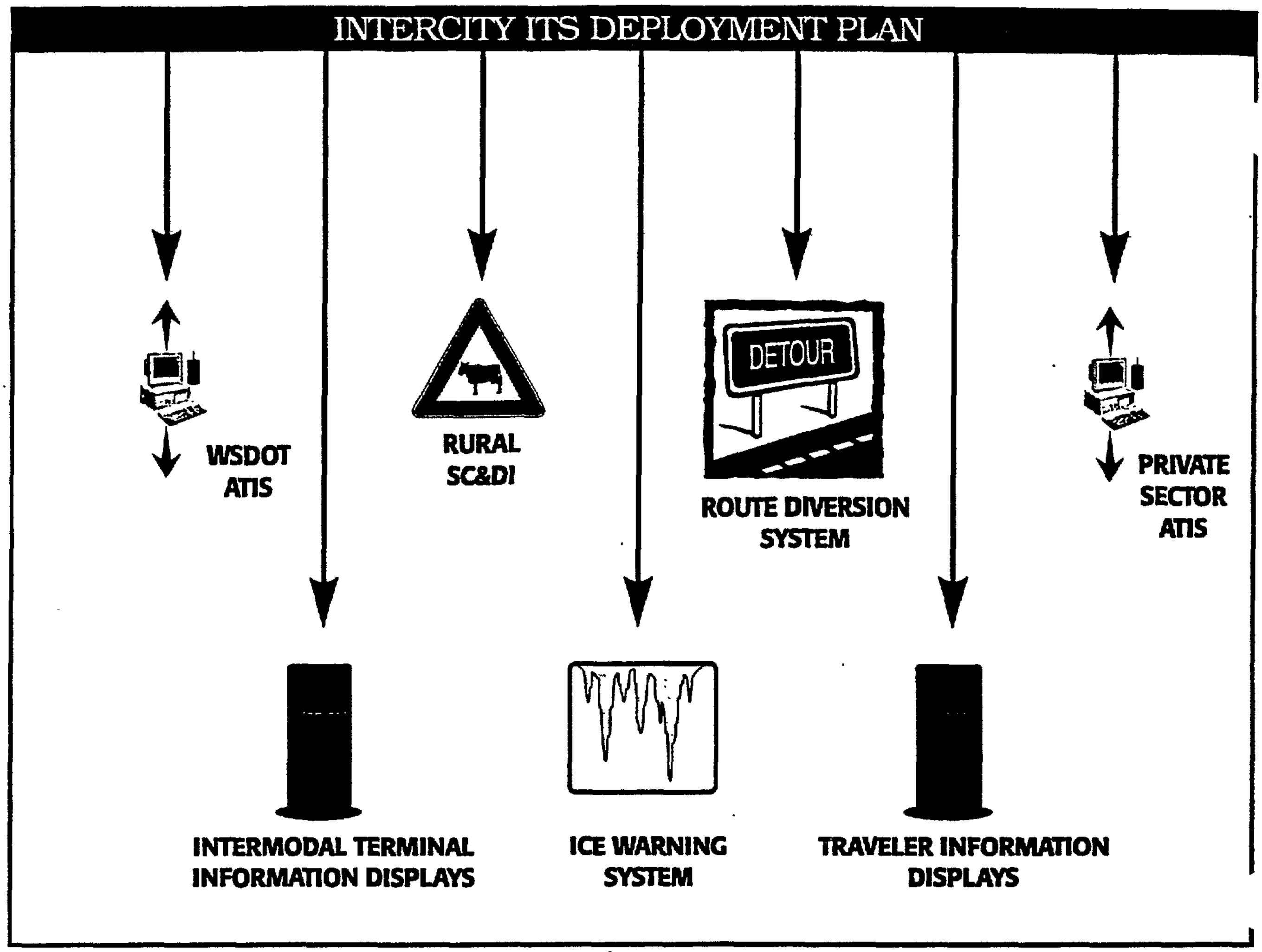


FIGURE 5

Travel and Transportation Management. Both WSDOT and Oregon Department of Transportation (ODOT) are completing incident management plans. They should ensure that these plans include coordination procedures for incidents that affect both sides of the Columbia River. An early WSDOT Southwest Region effort will be the deployment of a regional advanced traveler information system (ATIS). WSDOT also must have the ability to share information distribution channels with ODOT. The recently completed Portland Region-Wide ATMS plan provides an overall framework for implementation.

Public Transportation and Demand Management. The Tri-Met (OR) and C-TRAN (Clark County, WA) transit agencies are planning to implement similar sets of ITS applications. These include systems for transit signal priority, automatic vehicle location, transit information, fare integration, and demand management and operations. Although these activities are not the responsibility of ODOT or WSDOT, the agencies should ensure that standard interfaces to the larger ITS system architecture are built into the emerging systems.

ATMS for Ports. The port access concerns found in the Portland-Vancouver region are similar to those found in the Puget Sound. Upon demonstration of the worth of the port access system, it could be deployed at ports in the region, including Portland and the Washington cities of Vancouver, Kelso, and Longview.

Intercity Region

Traffic congestion will increase between Olympia and Vancouver, WA, along I-5. The ITS corridor plan recognizes the transition of this segment from rural to suburban. The plan calls for demonstrating the effectiveness of a "light infrastructure" SC&DI system in Centralia/Chehalis, WA, that will cover a large geographic area at relatively low cost. Tourists and other travelers will be assisted by two efforts. One will be rest stop information kiosks along U.S. Route 12. The other will be intermodal terminal kiosks at the intercity train stations in Centralia and Kelso. Elements of the plan are shown in **Figure 5.**

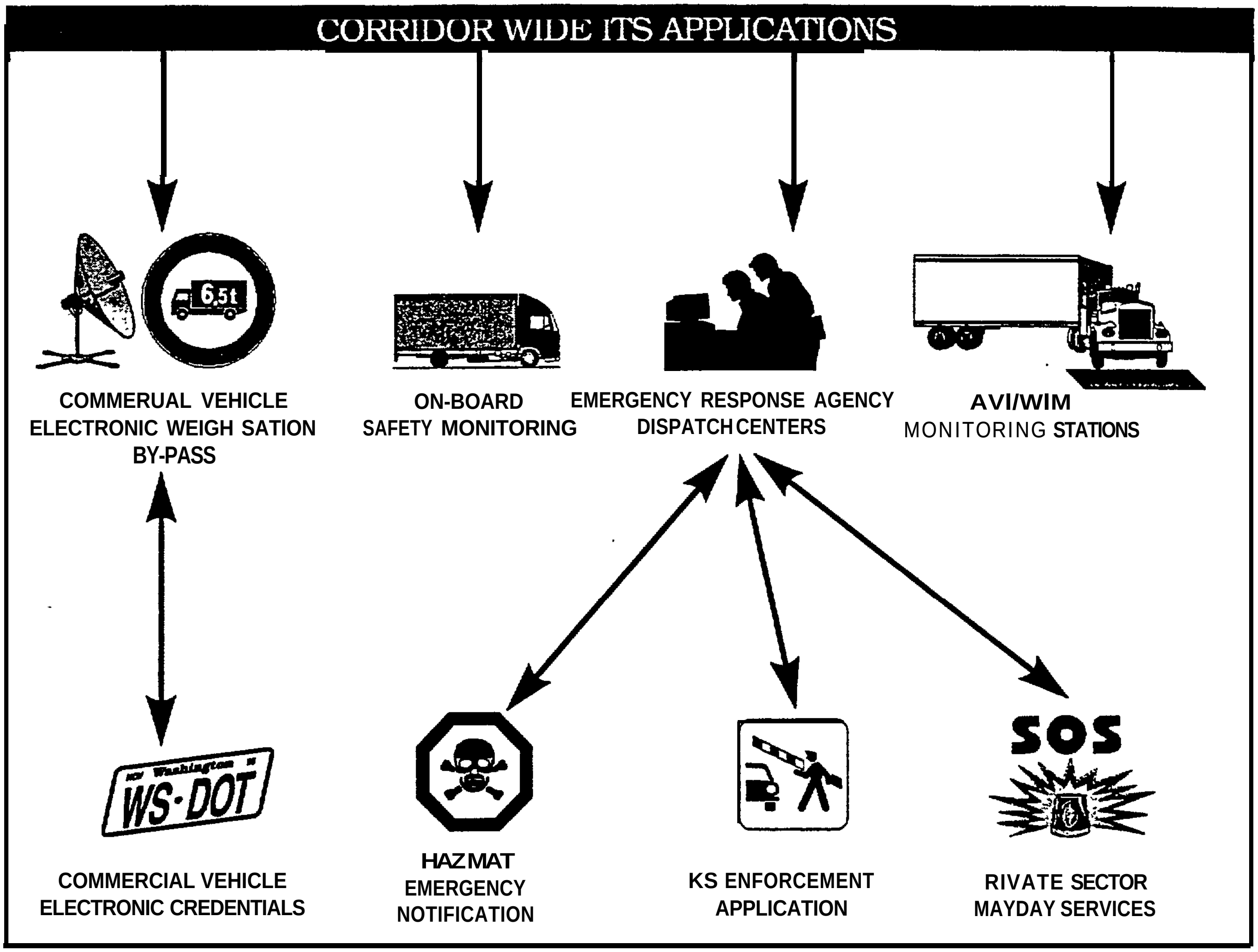


FIGURE 6

Corridor-wide Systems

Several requirements can only be met by coordinated, corridor-wide solutions: commercial vehicle operation (CVO), emergency notification, and ITS-based enforcement. Specific elements are presented in **Figure 6.**

Commercial Vehicle Operation. These are designed to improve the efficiency and safety of commercial fleet operations for both the motor carrier industry and government regulators. Successful implementation of commercial vehicle operation ITS will demand corridor-wide solutions that can be integrated statewide and nationally. The first action recommended for CVO is the formulation of an automated electronic commercial vehicle clearance plan. This plan will serve as the means to resolve intrastate, interstate, institutional, funding, and deployment issues. The next step is the planning and issuance of electronic commercial vehicle credentials and implementation of automated roadside safety inspections.

Emergency Notification. In the near term, the key emergency notification effort is the Puget Sound Help Me (PuSHMe) operational test. This test will determine the feasibility of providing mayday services throughout the Puget Sound region and ultimately through the remainder of the corridor. In addiion, WSDOT should support the deployment of automatic vehicle location technology to improve the management of emergency response vehicles and should provide communication links to provide traffic information to dispatch centers.

ITS-Based Enforcement. The Federal Highway Administration does not define the support of enforcement as an ITS user service. However, enforcing traff ic regulations along the corridor requires significant effort by the Washington State Patrol and other response agencies. ITS technology could support this activity and allow enforcement personnel to focus on priority assignments. Potential technology includes automated speed enforcement, video-based tracking technology, HOV lane enforcement, and trucks equipped with automatic vehicle identification, combined with weigh-in-motion sensors, to identify overweight trucks.

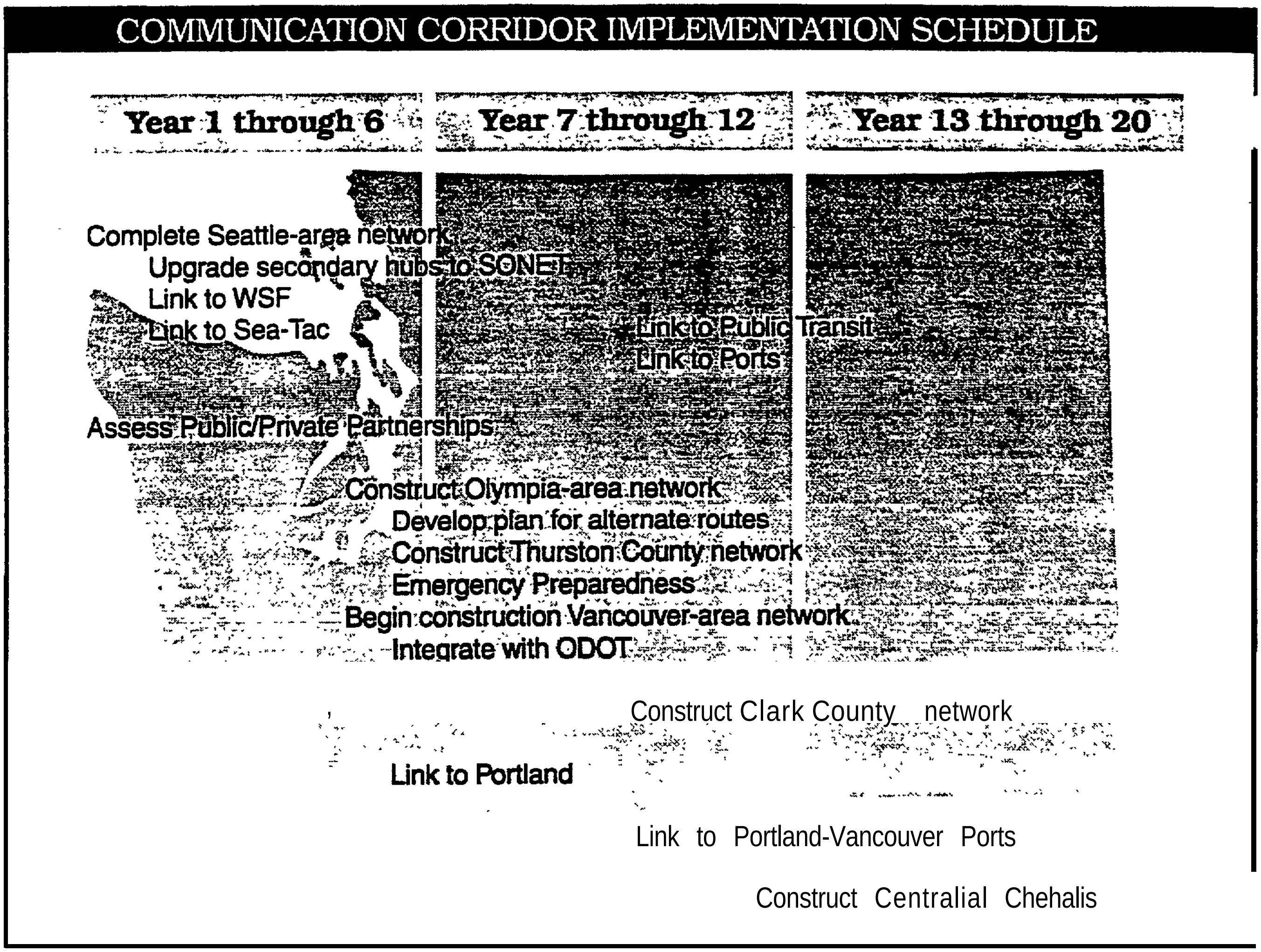


FIGURE 7

System Architecture

The plan recommends that a wide range of ITS applications and technologies be implemented along the corridor. Various public and private sector organizations will be developing these systems. Each will have specific needs and requirements. A central issue for all ITS applications designers is the problem of obtaining traffic information from various sources and making it available to those who need this information. A geographically distributed computing architecture for a traffic management and information system will collect data from disparate sources and provide them to clients who have diiering needs and are located in various geographical locations. The final configuration of the architecture will be compatible with the National ITS System Architecture.

Communication Implementation Plan

The recommended twenty-year communication infrastructure program (Figure 7) includes a six-year tactical plan and identification of goals for mid-term and long-term development. A detailed assessment has revealed that the best match to the corridor requirements is a combination optical fiber and digital microwave radio systems employing the Synchronous Optical Network (SONET). A SONET communication system is already deployed as part of the Northwest Regional SC&DI system.

The six-year tactical plan can be broken into stages as shown in Figure 7: The first stage, beginning in year 1, will include upgrades to the existing communication infrastructure in the Northwest Region and design and implementation of a backbone communication system for the Tacoma area. Two key items for further study are the assessment of Public/Private partnerships to support the development of the communications infrastructure and development of an emergency preparedness plan. The use of private/public partnerships can foster the evolution of new ideas which may provide alternative methods of funding the development of the communications backbone network. Washington State should pursue resource sharing with telecommunications provider6 to help finance such communications backbone network.

Prioritized Projects

A range of beneficial projects are recommended for implementation by the ITS Corridor Plan. Limited funds and resources require that the recommended activities be prioritized. To establish priorities and an implementation schedule for the early deployment projects, the costs and benefits associated with each major component of the ITS Corridor Plan were estimated. These were then compared, along with the role each element would play in the overall deployment concept and the regional benefits that would be produced. Recommended top priorities are listed in Table 3. These activities are recognized as key elements of the recommended core ITS infrastructure and provide demonstrable benefits to travelers throughout the corridor.

SEATTLE TO PORTLAND ITS CORRIDOR PLAN IMPLEMENTATION PRIORITIES

- **Deploy SC&D1 Systems (both urban and rural)**
- **Implement Regional Fare Integratlon**
- **Deploy Regional Multimodal Traveler Information Center (RMTIC)**
- **Deploy Port ATMS**
- **Deploy Regional ATMS (with transit priority)**
- **Deploy Automated Weight Station Clearance**
- **Install the Communications Infrastructure**
- **Demonstrate Work Zone SC&DI**
- **Deploy Enhanced WSDOT ATIS**
- **Deploy Enhanced Regional Transit Management Systems**

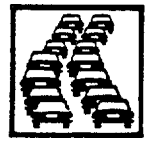


TABLE 3

SEATTLE TO PORTLAND INTER-CITY ITS CORRIDOR STUDY AND COMMUNICATIONS PLAN

FINAL REPORT

Prepared for the
Washington State Department of Transportation

Prepared by

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1.0 INTRODUCTION

1.1 OVERVIEW

This document is the final report presenting the ***Seattle to Portland Intelligent Transportation System (ITS) Early Deployment Plan.*** The final report synthesizes information from Technical Memorandums 1 through 5; including existing and future conditions, as well as ITS needs and requirements. The original work consisted of conducting an Intelligent Vehicle Highway System (IVHS) corridor study and developing a communications plan for the inter-city corridor from Portland to Seattle. In the final report the term IVHS has been converted to ITS, consistent with the industry terminology.

There were two primary purposes for this project.' The first was to develop a recommended plan for implementing appropriate ITS technology to address corridor transportation needs over the next 20 years. The goal of ITS is to provide safer roadways, better informed travelers, improved traffic management, and increased efficiency of commercial goods movements by applying advanced technology to the transportation system. The second purpose was to develop a communications plan that supports the ITS corridor plan, accounts for Washington State Department of Transportation (WSDOT) communication requirements in the corridor, and provides a framework for a statewide WSDOT communications network. The final report presents the Seattle to Portland ITS corridor plan, implementation issues for deployment, and a proposed funding framework.

The technical memorandums documented existing information on current and future transportation conditions in the corridor, and - identified 150 transportation issues and concerns. This assessment serves as a baseline for determining ITS needs and estimating the potential benefit of recommended ITS applications.

Information compiled involved existing data, reports, and interviews with transportation officials along the corridor. Data collected included:

- Forecasted Person Trips;
- Forecasted Inter-City Person Trip Origins and Destinations;
- Current and Forecasted Commercial Trips;
- Current and Forecasted Vehicle Volumes;
- Current and Forecasted Vehicle Classification;
- Accidents;
- Roadside Assistance Calls and Citations;
- Roadway Capacity;
- Current and Predicted Levels of Congestion;
- Weather Conditions;
- Programmed and Planned Highway Improvements;
- Planned Inter-City Transit and Passenger Railroad Improvements; and
- Current and Planned ITS Programs and Projects.

Information was obtained from a wide range of agencies including: WSDOT (both Headquarters and the three Regions located along the corridor), Washington State Patrol, Washington State Department of Licensing, Washington State Trucking Association, Washington State Tourism Development Division, Washington Public Ports Association, Oregon Department of Transportation, Portland Metro, and the Cities of Seattle, Tacoma, Olympia, Chehalis, Centralia, Kelso, Vancouver, and Portland.

1.2 CORRIDOR LOCATION

The inter-city corridor from Seattle to Portland stretches along Interstate 5 (I-5) for nearly 180 miles from Seattle in the north to the Washington-Oregon Border at the Columbia River to the south. **Figure 1-1** shows the location of the corridor within western Washington. The Cascade Mountain Range is to the east. The route generally follows the southeast shore of Puget Sound in the north, proceeds south from Olympia, joins the Columbia River at Kelso, and continues south to Portland. This transportation corridor serves a wide range of transportation demands including urban travel in the Puget Sound and Portland-Vancouver Regions, inter-city passenger movements through the major cities, and goods movements along this main west coast route.

The corridor connects most of the state's larger cities such as Seattle, Tacoma, Olympia, Centralia, Kelso, and Vancouver. **Table 1-1** provides the current and projected populations for the seven counties along the corridor. As expected, the majority of the population is found in the northern portion of the corridor in King and Pierce counties where the cities of Seattle and Tacoma are located. The population density increases again at the southern end of the corridor in Clark County, Washington and Multnomah County, Portland. Overall, 3.43 million persons live in the corridor counties. Projections for the year 2000 indicate an anticipated increase to 3.64 million.

Table 1-1:
Current and Project Population for Seattle to Portland Corridor Counties

County	1992	2000
King	1,621,337	1,704,502
Pierce	648,113	696,572
Thurston	161,238	177,361
Lewis	59,358	62,326
Cowlitz	82,819	87,778
Clark	238,053	249,956
Multnomah (OR)	614,065	662,392
TOTAL	3,426,964	3,642,876

1.3 ORGANIZATION OF THE FINAL REPORT

Following this introduction, the final report is divided into the following seven sections:

- **Current and Future Transportation Infrastructure:** Provides a description of the current and planned highway, transit, rail, and port and communications system along the corridor. (2.0)

- **ITS Infrastructure:** Describes the range of current and future ITS projects and programs taking place within the corridor. (3.0)

- **Current and Future Conditions:** Presents current and future travel demand, volumes, and congestion; freight movements; safety information including accidents and emergency response; and weather. (4.0)

- **Corridor Transportation Needs and ITS Requirements:** Identifies corridor transportation needs and a framework for how ITS can address those needs. ITS needs and requirements are identified to complete an ITS infrastructure. (5.0)

- **Seattle to Portland ITS Corridor Plan:** Presents the ITS Corridor Plan, including system architecture corridor-wide, within the Puget Sound Region, within the Portland-Vancouver Region, and Inter-City areas. (6.0)

- **ITS Deployment Plan Implementation Issues:** Discusses system interconnection, data exchange, and information access and presents a strategy for integration with the planning and programming process. (7.0)

- **Proposed Funding Framework:** Presents an approach, responsibilities, and potential sources as a strategy for funding ITS projects as an element of the transportation infrastructure. (8.0)

2.0 CURRENT AND FUTURE TRANSPORTATION INFRASTRUCTURE

The Seattle to Portland transportation corridor extends nearly 180 miles and provides a significant range of transportation modes including highway passenger and freight, local transit, inter-city bus, freight rail, inter-city passenger rail, ports and airports. **Figure 2-1** illustrates this range of transportation infrastructure provided along the length of the corridor. The map shows the location of:

- State Highways;
- Train Stations;
- Rest Stops:
- Washington State Patrol (WSP) Facilities;
- Ports;
- Major Visitor Information Centers;
- Washington State Department of Transportation (WSDOT) Facilities;
- Weigh Stations: and
- Permanent Traffic Recorders.

The remainder of this section describes the current and future transportation infrastructure within the corridor.

2.1 HIGHWAY SYSTEM

2.1.1 Existing Highway System

The backbone of this transportation corridor is Interstate 5 (I-5), serving as the primary highway connection between Seattle and Portland and a segment of a major interstate route that runs from Canada to Mexico along the west coast of the United States. **Figure 2-2** is a reproduction of the Official Washington State Highway Map showing the highway network along the corridor. Milepost (MP) numbers can be found in the black boxes presented adjacent to I-5. Milepost numbers begin at MP 0.0 at the Washington/Oregon state line and end at MP 276.56 at the Canadian border.. The milepost numbers are used throughout this report for reference to data. The study area extends from the Columbia River (MP 0.0) in the south of the corridor to the King-Snohomish County boundary in the north at MP 177. **Figure 2-3** provides a more detailed map of the Puget Sound region.

Table 2-1 provides the geometric characteristics of I-5. Starting in the south, I-5 provides a direct north-south route through the Portland Metropolitan area. Approximately 13 miles south of downtown Portland, I-205 begins an eastern loop around Portland, acting as a by-pass route around the central core of the city. I-84 begins in downtown Portland at I-5 approximately 8 miles south of the Columbia River. I-84 then proceeds east along the south side of the Columbia River. I-84 is the major southern highway route through the Cascade Mountain Range to the east.

condition of allowing this arrangement, the state may have use of several of the conduits in lieu of lease payments. Shared use of the microwave radio towers with a private sector partner (or partners) is another application of this approach. Either of these approaches would allow the state full use of its rights-of-way without having to fully fund construction of a ductbank and support structures, as well as allowing a private company to provide service through the area and maximize its profits.

Emergency preparedness would consider natural disasters as well as crisis caused by events or circumstances. Western Washington is an area well-known for earthquakes. This study would consider the damage that could be caused to the backbone communications system by a large earthquake and develop recommended alternatives to keep the communication system operational. One of the methods this study would consider is the availability of alternate routes for portions of the communication network. For example, an expanded SONET microwave radio network may act as a backup to the optical fiber SONET network. This additional study effort would also consider developing emergency procedures for notification of equipment failures, response to emergency conditions such as notification to users, as well as methods for returning the network to service. Emergency conditions can be caused by any of the following examples:

- Equipment failure;
- Power failure;
- Failure of telephone company connections;
- Failure of environmental control equipment;
- Construction accidents, (i.e. dig-up);
- Cable penetration by rodents;
- Earthquake;
- Lightning;
- Fire; or
- Flood.

The mid-term development will complete construction of the communication network through the Olympia area and connection of ITS devices in the Pierce County area. Completion of the communication system in the Vancouver area will also be included in the mid-term development. Design of the communication system north from Vancouver into Clark County will begin. Links to agencies will continue to be pursued in several areas. The ports of Seattle, Tacoma, Vancouver, and Portland will be among the agencies contacted. Development of a communication link with the City of Portland and ODOT will be begun.

The long-term development will consist of:

- Completion of Clark County network;
- Completion of the network through Centralia and Chehalis;
- Connection of all ITS devices;
- Completion of links to ports and/or other agencies;
- Completion of any outstanding construction; and
- Upgrades to existing equipment.

Network Alternatives

Alternative 1 would be an all-optical-fiber network using a SONET architecture. This alternative would build upon the communications network already begun by the Northwest Region. The multiple hub, optical fiber, SONET architecture of the Northwest Region would be continued south into the Olympic Region and then on into the Southwest Region to Vancouver. The optical fiber cable would be in a conduit ductbank buried within the I-5 right-of-way.

The objective communications network for Alternative 2 would be a mix of fiber optic cable and digital microwave radio based upon a SONET architecture. The optical fiber based SONET architecture of the Northwest Region would be extended south into the Olympic Region office in Tumwater. From Tumwater to the Southwest Region office in Vancouver, the network would be supported by SONET microwave radio.

Alternative 3 would install an optical fiber cable the length of the I-5 corridor by a direct burial method. The route of the optical fiber would be the same as for Alternative 1 and would use a dispersion shifted optical fiber cable. This network would build upon the system installed in the Northwest Region. The multiple hub system would be extended south to the Olympic Region and then south to the Southwest Region. The optical fiber cable would be installed directly into the ground in the I-5 right of way using a direct bury and plow-in method. Conduit would still be used where the route includes a bridge or other structure.

Technical Evaluation

The alternatives will be compared as to capacity, system reliability, transmission quality, implementation feasibility, ease of maintenance, and compatibility with existing systems. Table 6-2 provides a comparison of the three alternatives in terms of the technical requirements.

The transmission bandwidth, commonly referred to as "capacity", determines the quantity of information which can be transmitted on the communication system. The network protocol and system hardware architecture should allow the system capacity to increase through the addition of devices to the network without adding physical links or redesigning the system. The addition of an ITS device or administrative office should be simple and easy to accomplish without having to disable the network or having to do a major reconfiguration of the network.

Table 6-2
Communication Network Alternatives

Technical Issues	Alternative 1 AH Optical Fiber with SONET Architecture Supported by a conduit Infrastructure	Alternative 2 combination of Optical Fiber Supported a Conduit Infrastructure & Microwave radio with SONET Architecture	Alternative 3 AN Optical fiber with SONET Architecture Using Direct Burial of Ctible
Cspaclty	same as other alternatives In short term easily upgraded from OC-3 to higher - easily accomodate future Installation of additional optical fiber	same as other alternatives In short term - not upgradeable beyond OC-3	same as other alternatives In short term - easily upgraded from OC-3 to higher - additional optical flbsr cables will have to be plowed In.
System quality	- very high quality - not affected by electrical or magnetic fields or weather condltlons - rsqulres high quality Insallation	- comparable to optical fiber network - periodic losses due to weather condltlons - requires high quality installation	- very high quality - not affected bv electrical or magnetic fields or weather conditions - requires high quality installation
Feasibility	- electronic transmission equipment available - right of way available within I-6 corridor	- electronic transmission equipment available - minimizes also development costs	- electronic transmission equipment available - right of wsy available within I-b corridor - bridges/structures require unwanted spilces with direct bury cable
Maintenance	_ requires periodic maintenance of hubs . routine maintenance for Increase in attenuation - requires skilled maintenance staff	- requires periodic maintenance of microwave radio sites _ routine maintenance of connection to freeway hubs and lateral runs - requires skilled maintenance staff	- requires periodic maintenance of hubs - routine maintenance for Increase In attenuation _ additional maintenance due to exposure to moisture and rodents - requires skilled maintenance staff
Compatibility	- compatible with existing systems	- compatible with existing systems	- compatible with existing systems
Economic Issues			
Implementation costs:			
Design costs	- preparation of design documents fur routing the optical flbsr mainline along the length of 1-5	- preparation of design documents for routing the optical fiber mainline from Olympic Region office to King-Pierce County line - preparation of design documents for elecronic transmission equipment - for the southern portion	_ preparation of design documents for routing the optical fiber mainline along the length of I-5 lower costs than alternative 1 since direct bury
construction costs			
Life cycle costs:			
Utility costs	- requires power conncetion at each hub location	- requires power connection at each hub location - requires power connection at each radio site - requires leased telephone line to connect radio site to freeway hub	- rsquires power connection at each hub location
Property lease costs	- constructed within SR 5 right of way (ROW) - require ROW or easement permits for portions outside SR 6 ROW	- constructed within SR 6 ROW - require ROW or easement permits for portions outside SR 5 ROW - 'lease charges for use of WSP radio sites for micorwave radio portion	- constructed wlthln SR 6 ROW - rrequire ROW or easement permits for portions outside SR 6 ROW
Maintenance	- requires periodic maintenance of hubs - routine maintenance for Increase In attenuation - requires skilled maintenance staff	- requires periodic maintenance of microwave radio sites - routine maintenance of connection to freeway hubs and lateral runs - requires skilled maintenance staff	- requires periodic maintenance of hubs _ routine maintenance for increase In attenuation - additional maintenance due to exposure to moisture and rodents - requires skilled maintenance staff

The quality of the received data, video, or voice signals is a direct reflection on the transmission quality of the communication system. The received video signals should be adequate for definition of vehicles, data should have low error rates and should not require re-transmission, and voice transmission should be undistorted. The quality of these signals is directly related to the amount of noise and interference experienced by the system.

It is implicit that implementation of the selected alternative must be feasible. To this end, project feasibility will be based upon availability of equipment, availability of right- of-way, difficulties during construction, and availability of microwave sites and frequencies.

Maintenance concerns include maintaining the electronic equipment, the cable runs and splices, cable vaults, hubs, and microwave radio towers, equipment and antennas. The alternatives are evaluated based on the frequency and complexity of the required maintenance.

The communications network must be compatible with existing communication systems in the regions. The transmission system should appear as one continuous system from the point of view of the user. Compatibility of equipment is critical so as to allow new equipment to be easily added to the system as segments are constructed or in the future.

The alternatives are very close on technical issues. All three alternatives are compatible with existing systems. An optical fiber cable system will have the potential for greater capacity and a higher system quality. The microwave system proposed will be built on existing sites using paths that have already been determined to work making Alternative 2 more feasible. A microwave system will have fewer sites and less electronic equipment to maintain. The plowed-in optical fiber cable in Alternative 3 will introduce additional splices at every bridge crossing, making this alternative less feasible. Alternative 2 appears to be more desirable from a technical standpoint.

Economic Analysis

The alternatives will also be compared in terms of the estimated engineering design and implementation costs, the estimated life cycle costs. These costs are dealt with at a gross level and do not necessarily represent all possible costs that might be associated in fielding each alternative. This principal purpose of this analysis is to direct the focus of WSDOT to the most desirable and cost effective objective communication system that would support ITS requirements in the Seattle to Portland corridor. Table 6-2 also provides a comparison of the three alternatives in terms of the economic issues.

Implementation costs include all costs for design and construction of the system. Preparation of plans, specifications, and contract packages are included in design costs. Construction costs are all costs for constructing the system, including equipment procurement, installation and testing, and costs for obtaining right-of-way and construction permits.

The life cycle costs reflect the costs of owning and operating the system over time. Maintenance costs and any recurring costs are included: such as power or telephone company costs, lease of equipment and real estate, and equipment repair.

Alternative 1 will require the design of the system in great detail over the entire Seattle to Portland corridor. Alternative 3 will have similar design costs but the detailed design of support structures will be less than those for Alternative 1. Alternative 2 is proposing the use of existing radio sites and paths for the southern portion of the corridor. Implementation of an all-optical-fiber system will be much more expensive than the microwave radio system due to the high cost of installing ductbank, optical fiber cable, and the termination equipment. Implementation of Alternative 3 will be less expensive than Alternative 1; however, it will be still greater that that for Alternative 2 due to the use of existing radio sites for the microwave radio system. Comparing the design costs for the three alternatives shows that Alternative 2 will have the lowest costs.

6.9.3 Communication Network Implementation

The corridor communication network will be developed in conjunction with the ITS Implementation Plan for the corridor. Figure 6-19 shows a proposed implementation schedule, This schedule should provide a communication network that will be developed in parallel with the ITS system so that the communication medium is in place when the services are required.

The schedule shows when major portions of the network will be implemented and 'constructed. The schedule also shows activities for future development, primarily emergency preparedness, and the subject of public/private partnerships.

6.9.4 Statewide Communication Plan

A statewide communication plan will present several advantages for WSDOT. Among these advantages would be elimination of recurring costs for leased lines to local operations centers, regional offices, and connectivity for ITS devices on the statewide freeway system. The statewide system will also provide a high quality connection suitable for video transmission. Due to the ability to assign space on the network dynamically, the system will be particularly cost effective for administrative applications.

WSDOT has regional offices in Spokane, Yakima, and Wenatchee, and local offices in Mt. Vernon and Bellingham. This section briefly discusses the provision of a backbone network to these operational centers, thereby providing the beginning of a statewide network. The evolution of a statewide backbone communication network will support the connection of ITS devices installed along the state freeways, as well as be beneficial for connection of selected devices in rural areas.

Expansion to the east and to the north can be accomplished by making use of the existing network of radio sites owned and operated by both the WSP and the WSDOT. The microwave radio system to the east could be developed in stages to spread the costs over a period of years. Future connecting routes to the regional offices in Yakima and

Figure 6-19: Communication Corridor Implementation Schedule

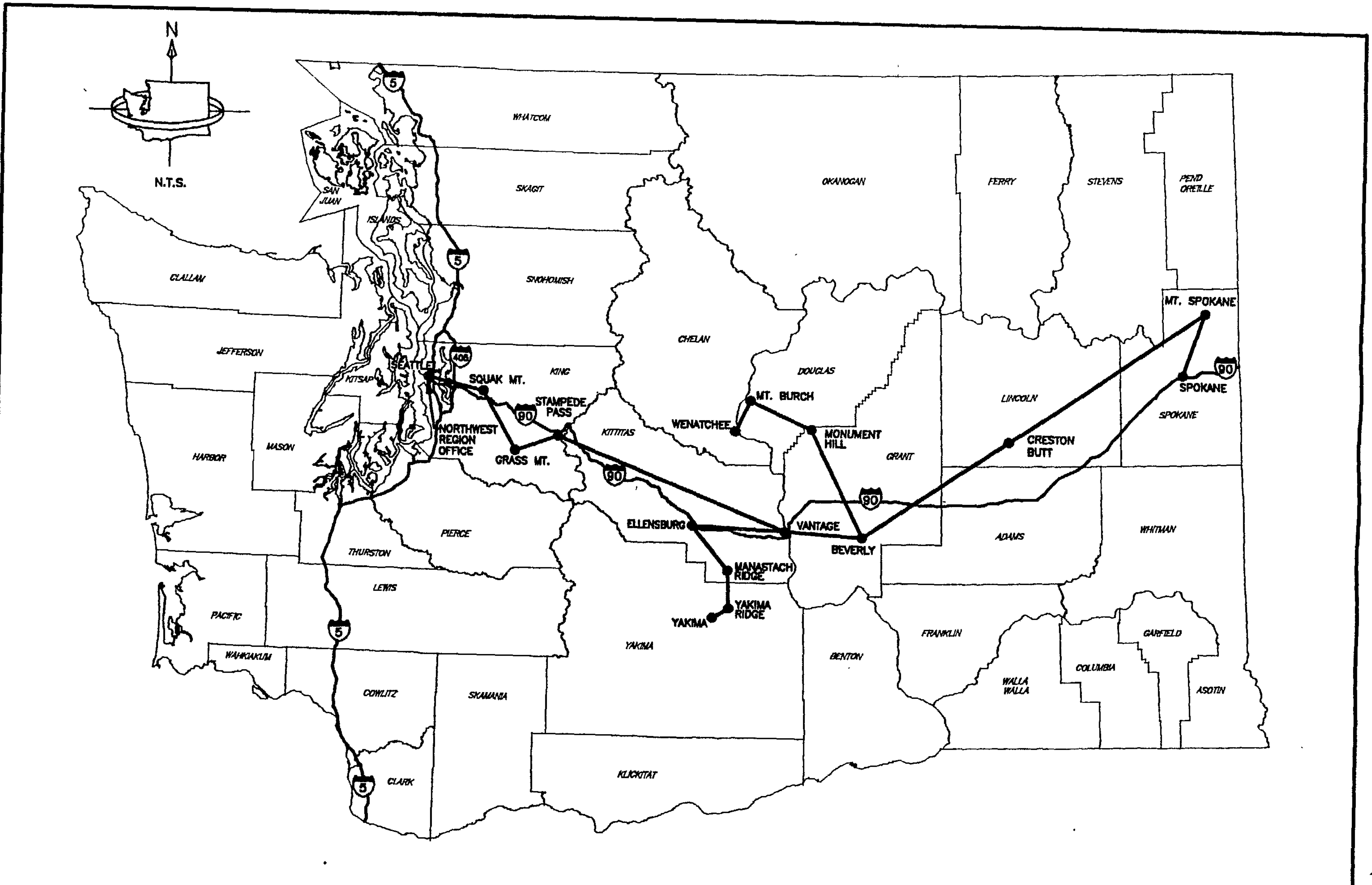
Year 1 to 6	Year 7 to 12	Year 13 to 20
Complete Seattle-area network		
Upgrade secondary hubs to SONET		
Link to WSF		
Link to Sea-Tat	Link to Public Transit	
	Link to Ports	
Assess Public/Private Partnerships		
Construct Olympia-area network		
	Develop plan for alternate routes	
	Construct Thurston County network	
	Emergency preparedness	
Begin construction Vancouver-area network		
	Integrate with ODOT	
	Construct Clark County network	
	Link to Portland	
	Link to Portland-Vancouver- Ports	
	Construct Centralia/Chehalis network	

Wenatchee would help to reduce administrative recurring costs for leased telephone lines by providing a connection to Headquarters over the WSDOT-owned network.

Communication Route to the East

The recommended route to the east would use existing WSP and WSDOT microwave radio paths to establish a backbone SONET communication route to Spokane. Figure 6-20 shows the proposed route to Spokane as well as the future spur routes to Wenatchee and Yakima. The route would begin with a radio path from the Northwest Region office to Squak Mountain. The path would continue east, passing through sites at Grass Mountain and Stampede Pass to reach Vantage. The path at Vantage would continue east to sites at Beverly, Monument Hill, Creston Butte, Mt. Spokane, and into Spokane. The mainline communication route would be accomplished using SONET microwave equipment with a transmission capacity of OC-3.

A spur to the south from the site at Vantage, following Highway 82, would provide a communication link to Yakima and the South Central Region Office. A spur to the west from Monument Hill to Burch Mountain and into Wenatchee would provide a link to the North Central Regional office. These spurs would use SONET microwave with a capacity of OC-1.



SEATTLE TO PORTLAND
INTER-CITY IVHS CORRIDOR
STUDY AND COMMUNICATION PLAN

COMMUNICATION NETWORK – EAST TO SPOKANE
WITH SPUR ROUTES TO YAKIMA & WENATCHEE

FIGURE 6–20

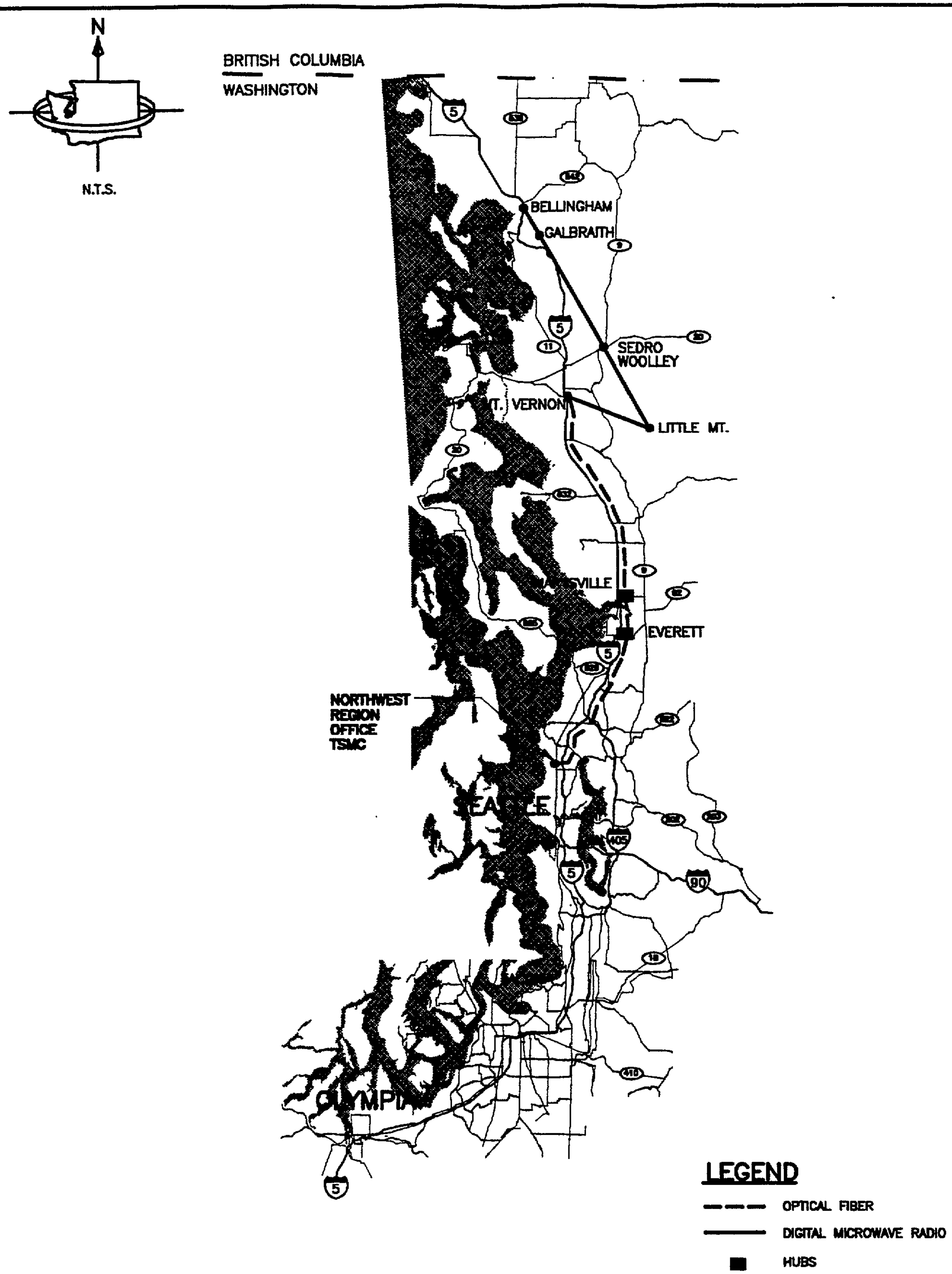
All sites referred to are existing facilities that, with a few exceptions, are believed to require few modifications to accommodate the addition of SONET microwave equipment at the site. The exceptions are Grass Mountain, Stampede Pass, Beverly and Creston Butte.

Communication Route to the North and Border Crossing Needs

The communication route to the north will provide a communication network along I-5 from Seattle to Bellingham for connection to ITS devices, as well as providing a connection from the Northwest Region office to the local WSDOT offices in Bellingham, Mt. Vernon and Everett. Figure 6-21 shows the proposed route from the Northwest Region office to Bellingham. Due to population and traffic densities, the route to the north would not require the same capacity as through the Seattle-Tacoma area. An OC-12 to Everett and OC-3 to Bellingham should adequately handle the capacity for 10 to 15 years. The 20-year plan would consider upgrading the capacity of both routes. The OC-12 to Everett may need to go to OC-48 and the OC-3 to Bellingham would need to go to OC-12.

The current design for the SONET optical fiber system being implemented in the Northwest Region has hubs located in Everett and in Marysville. A lateral optical fiber connection to the Everett hub from the local Everett WSDOT office would provide a link to the communication system. A section of the communication network from 164th to Broadway has an advertising date scheduled for September 1996; however, further design and construction to the north has not been scheduled.

The optical fiber mainline would continue from the proposed Marysville hub in the I-5 right-of-way to the local WSDOT office in Mt. Vernon. An optical fiber or wireless connection from the Mt. Vernon WSDOT office links to the WSP microwave site in Mt. Vernon where the main communication backbone will go from optical fiber to SONET microwave radio to continue north. The SONET microwave radio system would pass through existing sites at Little Mountain, Galbraith, and Bellingham. The local WSDOT office in Bellingham would be connected to the communication network by means of optical fiber, leased telephone lines, or wireless communications.



SEATTLE TO PORTLAND
INTER-CITY IVHS CORRIDOR
STUDY AND COMMUNICATION PLAN

COMMUNICATION NETWORK – NORTH TO BELLINGHAM

FIGURE 6-21

7.0 PROGRAM COSTS, BENEFITS AND PRIORITIES

7.1 INTRODUCTION

A wide range of beneficial projects have been recommended for implementation under the framework of the ITS Corridor Plan. Limited funds and resources necessitate the prioritization of the recommended activities. In order to establish priorities and an implementation schedule for the early deployment projects, the program costs and program benefits need to be quantified and the role that each element plays in the complete deployment concept must be reviewed. This section examines the estimated costs and benefits associated with the major components of the ITS Corridor Plan. The resulting benefit-cost ratios lead to a ranking of recommended actions with consideration for the elements' role within the framework.

7.2. PROGRAM COSTS AND PROGRAM BENEFITS

The ITS Corridor Plan calls for the use of both private and public funding to achieve its goals. Although the private interests will incur costs, these costs and associated benefits are not considered here. Private expenditures include in-vehicle devices and subscription services prices which are difficult to predict and quantify. Only public costs and benefits are considered in this analysis. Although private industry will bear the bulk of the costs associated with private ATIS, coordination between these systems and public systems that will share data and market access will require some public investment. Generally, this will involve WSDOT managerial staff effort to establish standards and data sharing agreements. Some WSDOT technical staff effort will be required to assist with physical data connections to the private interests.

This section estimates the costs and benefits associated with the elements within each of the major components of the ITS Corridor Framework areas including:

- Corridor-Wide Systems
- Puget Sound Region
- Vancouver-Portland Area
- InterCity Systems

Each component consists of several independent elements that contribute to the benefit experienced from the ITS implementation. Each element is examined independently to determine estimated capital, operations costs and maintenance cost. Expected benefits are also developed for each element in order to provide a benefit-cost comparison that will assist in determining priorities for implementation.

One critical component of the ITS Corridor Plan, communications, is considered separately. A communications backbone is required for the corridor to facilitate the exchange of data between the ITS elements corridor wide. For some ITS implementations, special communications requirements or extensions from the corridor backbone will be necessary. In these cases, the communications costs are associated directly with the project under consideration.

The ITS Corridor Plan covers a period of twenty years. In order to estimate the costs for each element, this period is broken into three terms with roughly equal lengths. It is assumed that each element is implemented in the first year of the term in which it is scheduled (see Section 6). The estimate costs consist of capital costs which generally consist of hardware design, software design, procurement and implementation. For the demonstration projects, there is an evaluation required which is considered part of the capital costs. Finally, follow-on activities are planned for each term following implementation in order to keep each ITS element current and effective. These activities generally include system performance evaluation and requirements review, current technology assessment, and system upgrades including integrating the subject project with others in the region. These activities are included in a separate summary cost for each framework component Annual operations and maintenance costs are estimated separately, typically as a percentage of the capital cost estimate.

For the purpose of developing cost to benefit ratios, the all costs are annualized with a 4% discount rate over the period remaining in the twenty year plan. For example, projects in the first term are annualized over twenty years while projects in the medium term are annualized over fourteen years. It is assumed that all initial costs are in 1995 dollars. The benefits are estimated as annual benefits.

Several references were used to develop the estimate cost and benefits for each ITS element including:

- IVHS Strategic Plan for Washington State (November 1993):
- Assessment of ITS Benefits: Early Results (August 19951;
- WSDOT Trips System State Route Annual Vehicle Miles 1994.

This information was supplemented by both discussions with system implementors across the U.S. and a review of miscellaneous papers discussing costs and benefits relating to individual projects. Detail for many estimates is provided in each project prospectus contained in Appendix B.

7.2.1 Corridor-Wide Systems

Within Corridor-Wide Systems, there are three major components including:

- CVO Applications
- Enforcement Applications
- Emergency Management

The derivation of both the system cost estimates and the expected benefits for each element are described below.

CVO Applications

Automated electronic vehicle clearance intends to implement advanced technology to increase safety and speed at weigh stations while improving productivity and regulatory compliance. AVI technology and WIM technology will play a major role in this project. Hardware and software will be provided at the weigh stations to facilitate communication and commercial vehicle preclearance.

The following assumptions were made to develop the cost and benefits:

- private industry will equip commercial vehicles at their cost;
- design and evaluation is estimated to be 20% of the capital cost;
- operations and maintenance is estimated to be 35% of the capital cost; and
- 25% of the 1.6 million trucks now stopping annually at the weigh stations in the corridor will participate, and each stop at a weigh station costs $15;

According to the American Truck Associations, motor carriers expend over $1 billion every year to administratively process the federal, state and local regulatory requirements including vehicle registration and fuel taxes. In Washington State, alone, truckers must deal with four state and three federal agencies. The public sector spends a similar amount administering these regulations. Electronic commercial vehicle credential services would allow fleet operators to electronically file the required information. This approach according to ODOT would reduce paperwork and administrative costs for both the private and public sector by well over $100 per truck per year within their state. Similar results could be expected for the 25,000 heavy vehicles registered in Washington State.

The cost of implementation in Washington State will depend on adopted polices and requirements, and impacts on existing regulatory systems which cannot be quantified at this time. The costs, benefits and requirements-to upgrade current systems to provide this type of service are currently being determined under several federally sponsored ITS field operational tests. Upon the completion of these tests, Washington State should be able to fully assess the costs and benefits of this application. The costs and benefits associated with this application are not included in the corridor program summary.

A Hazardous Material Emergency Notification system will be implemented corridor wide to remove the administrative burden of tracking hazardous materials and detecting hazardous material incidents. This project will coordinate with the electronic credentials system to track hazardous cargo. In addition, automatic notification will be provided through pager-like technology. The following assumptions were used to develop estimate costs and benefits:

- the State will develop a system to follow current operations;
- the State will develop a PC-based central computer at existing facilities to monitor incident calls and access vehicle cargo and location information from the -electronic credentials database;
- private operators will purchase the in-vehicle technology and pay for the commercial wireless service for potential communications;
- operations and maintenance is 10% of the capital cost; and
- the benefit-cost ratio is estimated at 3 to 1.

Enforcement Applications

Enforcement concepts using ITS technologies will be developed for demonstration only. The demonstration shall examine ways of supporting the enforcement of HOV lane usage, speed limits, reckless driving and commercial vehicle operations. Following evaluation of the demonstration, new ITS enforcement policies and technologies will be assessed for potential future applicability.

For the purposes of estimating benefits and costs, it is assumed that:

- the expanded application will have a budget ten times the value of the demonstration project
- operations and maintenance is estimated to be 20% of the capital cost;
- evaluation is estimated to be 20% of demonstration capital costs; and
- the benefits will derive from a reduction in staff assigned to these enforcement roles and an increase in fine revenue will insure that the program will be at least revenue neutral.

Emergency Management

It is recommended that the Mayday operational test and evaluation be completed to determine the feasibility of providing Mayday service covering Puget Sound. The State will track the progress of Mayday service providers and continue to assess potential technologies for applicability. In addition, expanding the Mayday service technology to emergency response vehicles will be supported. No additional public funds would be expended for this effort.

Corridor-Wide Systems Summary

The estimated annualized costs and benefit-cost ratios associated with each element of the Corridor-Wide Systems component of the ITS Framework are summarized in Table 7-1.

Table 7-1:
Corridor-Wide Systems Summary

Project Name	Capital Costs (millions)	Annual O&M Costs (millions)	Annualized Costs (millions)	Annual Benefits (millions)	B/C Ratio
Commercial Vehicle Operations	$3.06	$0.82	$1.05	$6.26	6.0
Enforcement Applications	$3.06	$0.24	$0.46	$0.46	1.0
Total	$6.12	$1.06	$1.51	$6.72	4.5

7.2.2 Puget Sound Region

Within the Puget Sound Region, there are five major elements of the ITS Corridor Plan including:

- Travel and Transportation Management;
- Port ATMS;
- Electronic Payment Services;
- Public Transportation Systems;
- Travel Demand Management.

The derivation of both the system cost estimates and the expected benefits for each element are described below.

Travel and Transportation Management

Travel and Transportation Management consists of systems that monitor and control the transportation network while providing the public access to traveler information. Each of these system types is considered separately below.

SC&DI Systems

A SC&DI system consists of field hardware, communications, a control center with central hardware and software designed to control the field hardware and the operations staff responsible for the system. Monitoring and control devices such as loop detectors, CCTV, VMS, HAR and ramp metering transmitters are-considered part of the SC&DI system for the purpose of develop cost and benefit estimates. In addition, the systems operation design or the Incident Management Plan and Procedures must be completed, and staff trained.

The following assumptions were used to derive the cost and benefits estimates for completing the SC&DI systems in the Puget Sound region:

- the design, implementation, operation and maintenance costs are $1 million per mile (of which operations and maintenance represent 20%);
- 250 miles of new SC&DI will be implemented; and
- the benefits in the form of reduced congestion and improved safety are estimated in the range of 5 to 1.

In addition to fixed SC&DI systems, a portable SC&DI will be deployed to reduce the impact of road work zones on traffic conditions and improve worker safety. A demonstration project consisting of remote monitoring and control equipment will first be deployed and evaluated. After evaluation, it's use will be expanded over the corridor.

The following assumptions were made:

- the work zone covers a five mile section of I-5;
- the evaluation cost is estimated to be 5% of the demonstration capital cost: and

- **ultimate deployment will expand to five concurrent applications with the same costs and benefits as the demonstration.**

ATMS

An ATMS is designed to coordinate with SC&DI systems to improve traffic conditions not only on the freeway, but on the arterial roads and the urban network as well. This is achieved through coordinated systems that monitor traffic conditions and control the network field elements to respond to changes.

The following items impact the cost and benefit impacts:

- there are four ATMS projects (East King County, South King County, Pierce County and North Seattle);
- the benefit received from these systems is a proportion of the benefits quantified in the IVHS Strategic Plan equivalent to the proportion of vehicle-miles traveled in the region that are associated with the ATMS area of coverage;
- the implementation approach follows a light infrastructure concept without the extensive deployment of CCTV, VMS and fiber optics communications;
- existing facilities will be enhanced and upgraded while introducing central control; and
- operations and maintenance are estimated at 10% of capital costs.

Public ATIS

Coordinating with the SC&DI and ATMS, the public ATIS will collect and process traffic information in order to disseminate travel information through such field devices as VMS, HAR, information kiosks and commercial radio. Several projects ranging from demonstration projects to regionally integrated traffic related information systems are planned for the Puget Sound Region.

The design and operation of the regional traffic related information systems for the Northwest and Olympic regions as well as an integrated regional ATIS are similar and are considered together using the following assumptions:

- one ATIS design is required which will then be revised and adapted to each region; and
- the benefits received from these systems represent are a proportion of the benefits quantified in the IVHS Strategic Plan as determined by the proportion of vehicle-miles traveled in Puget Sound that are associated with each region.

A pilot intermodal terminal kiosk system will be implemented in this region. This set of kiosks will provide access to traveler information for all modes at modal transfer points. A pilot project will first be implemented and evaluated. Next, the system will be expanded. The following was assumed while developing the costs and benefits estimates:

- there is one kiosk in the pilot project;
- one central control computer is required for the pilot project;
- the evaluation costs represent 5% of the pilot capital costs; and
- the demonstration project will be expanded to a network of 12 kiosks (the central control computer remains the same).

Port ATMS

A demonstration Port ATMS project will be developed to coordinate the diverse and time-critical traffic associated with a port. This project will monitor and control the traffic near and in the port area using detector loops, CCTV, signal coordination, VMS and communication interfaces to surrounding SC&DI, ATMS and ATIS. The cost and benefit estimates were made with the following assumptions:

- **port operations center will be enhanced with central control for the port ATMS;**
- **design and evaluation is estimated at 20% of the capital cost;**
- **it is estimated that this will provide a 10% time savings to port traffic which is valued at $1.25 per minute; and**
- **this project will be ultimately expanded cover three ports in the Puget Sound Region after the evaluation is complete.**

Electronic Payment Services

Regional transit fare integration is the main focus of the Electronic Payment Services in the ITS Corridor Plan. A demonstration project will first be deployed and evaluated. After 'evaluation, it will be expanded to the entire Puget Sound region. The following assumptions were made to estimate costs and benefits:

- **a current estimate for capital and operations costs for ten years from the fare integration project yields a net present value of $12.8 million with maintenance and operations representing 25% of the capital cost;**
- **demonstration and evaluation represent 10% of the capital cost; and**
- **the expected benefit-cost ratio is 2 to 1.**

Research, standards development and implementation of highway tolls and parking management will be borne by private industry. WSDOT will coordinate with these activities at a policy level only.

Public Transportation Systems

AVI based transit signal priority programs will be completed regionally in Puget Sound, equipping buses operated by Metro Transit, Community Transit, Pier&Transit and InterCity Transit. The following assumptions were made:

- **there are 1800 buses and 600 signalized intersections to be equipped;**
- **the costs are roughly $300 per bus and $5,000 per signalized intersection;**
- **the benefits derive from reduced delays to transit vehicles which have proven to demonstrate an 8% travel time savings in Portland;**
- **the average trip is assumed to be one hour and the bus operating cost is $160,000 annually.**

Incorporating a regional transit AVL system into the Puget Sound area will facilitate the deployment of a passenger information system. Metro transit currently has an AVL

system, however indications are that significant upgrades to this system would be required to provide passenger information. This effort requires hardware and software for the buses and the control center, and attempts to provide benefits through increased productivity, increased service performance, passenger information and reduced operating expenses.

The costs and benefits for the development, procurement and implementation of this system rely on the following assumptions:

- the capital costs for a similar system in Portland with 775 busses was $6.1 million, where the control center accounted for $2 million;
- operating and maintenance represent 25% of the capital cost;
- Kansas City was able to eliminate 3.5% of the buses in its bus system with the implementation of AVL;
- it was assumed that 1800 buses operate in Puget Sound; and
- removing a bus from the system saves $160,000 annually.

Travel Demand Management

Key public efforts in Travel Demand Management will consist of the following:

- Regional Multimodal Traveler Information Center (RMTIC);
- Employer Based Travel Demand Management.

These separate efforts are examined below.

RMTIC

The Regional Multimodal Traveler Information Center represents a clearinghouse of traveler information provided by the complete set of information gathering systems within the ITS Corridor Plan. The RMTIC will connect with all of these systems, compile travel information utilizing data fusion techniques and redistribute the information through both private and public distribution channels.

It is assumed that:

- an existing facility will be renovated to function as the RMTIC;
- the estimate costs cover the central control and data processing design including software and hardware; interface design and implementation at the RMTIC and the participating agencies and systems:
- it is assumed that integrating the information from the corridor in the RMTIC represents 10% of the benefits experienced in Puget Sound as quantified in the IVHS Strategic Plan; and
- RMTIC will utilize the existing communications backbone to interconnect all the corridor information sources.

Employer Based Travel Demand Management

Information kiosks and on-line access will be enhanced to provide better access of multimodal information to commuters and employers. This will facilitate multimodal pre-trip planning and ride-matching services. A demonstration project will be deployed providing selected Puget Sound employers the opportunity to participate.

It is assumed that:

- **the interfaces for the kiosks and other access points will largely be designed in other projects requiring minimal enhancement;**
- **for operation of the system it is assumed that the employer would cover the costs of operating access points at their workplace;**
- **the demonstration system will require two new kiosks and provide access to RMTIC information through home-based and office-based computers;**
- **the evaluation is valued at 20% of the demonstration project capital cost;**
- **the annual operations and maintenance is assumed to be 10% of the capital cost;**
- **it is assumed that full implementation will represent 1% of the benefits anticipated for Puget Sound as stated in the IVHS Strategic Plan; and**
- **the full implementation will expand to 24 kiosks.**

Puget Sound Region Summary

The estimated annualized costs and benefit-cost ratios associated with each element of the Puget Sound component of the ITS Framework are summarized in Table 7-2.

Table 7-2
Puget Sound Summary

Project Name	Capital Costs (millions)	Annual O&M costs (millions)	Annualized Costs (millions)	Annual Benefits (millions)	B/C Ratio
Travel and Transportation Management SC&DI	$213.69	$50.35	$65.33	$329.16	5.0
ATMS	$16.12	$1.61	$2.80	$21.38	7.6
Public ATIS	$2.14	$0.32	$0.48	$2.25	4.7
Port ATMS	$5.09	$0.50	$0.87	$8.25	9.4
Electronic Payment Services	$23.00	$5.75	$7.44	$14.89	2.0
Public Transportation Systems	$15.06	$2.73	$3.10	$10.21	3.3
Travel Demand Management					
RMTIC	$2.15	$0.30	$0.46	$2.90	6.3
Employer Based Travel	$0.22	$0.02	$0.04	$0.29	7.3
Demand Management					
Backbone Communications	$32.80	$1.60	$4.01	n/a	n/a
System Reassessment and Upgrade	$38.70	n/a	$2.85	n/a	n/a
Total	$348.97	$63.18	$87.39	$389.33	4.5

Note:
Backbone communications represent the cost to construct and maintain the system used by the ITS elements with in Puget sound. It is estimated that 250 miles are required at $240,000 per mile as quantified in the IVHS Strategic Plan. Operations and Maintenance for the communications is 10% of the capital costs. System reassessment and upgrade is required for all the project completed under each element. It is assumed that this cost is 15% of the capital cost with no increase in the operations and maintenance.

7.2.3. Vancouver-Portland Region

Within the Vancouver-Portland Region, there are four major elements of the ITS Corridor Plan including:

- Travel and Transportation Management
- Port ATMS
- Public Transportation Systems
- Travel Demand Management

The derivation of both the system cost estimates and the expected benefits for each element are described below.

Travel and Transportation Management

Travel and Transportation Management consists of systems that monitor and control the transportation network while providing the public access to traveler information. Each of these system types is considered separately below.

<u>SC&DI Systems</u>

The development and deployment of the Southwest Region SC&DI encompasses Vancouver and the surrounding area. The design and the operational procedures must be coordinated between WSDOT and ODOT.

The -following assumptions were used to derive the cost and benefits estimates for implementing the SC&DI system in the Vancouver area:

- the design, implementation and operation cost is $1 million per mile;
- the operations and maintenance is estimated as 20% of the capital cost
- 25 miles of new SC&DI will be implemented; and
- the benefits in the form of reduced congestion and improved traveler information are estimated in the range of 5 to 1.

In addition to the fixed SC&DI systems, two portable SC&DI will be deployed to reduce the impact of road work zones on traffic conditions. These will be deployed after successful demonstration in the Puget Sound region. The following assumptions were made when estimating the costs and benefits:

- the work zone covers a five mile section of I-5;
- the capital costs and the operations and maintenance costs do not change from those defined for the demonstration project; and
- the two systems will be operating concurrently.

<u>ATMS</u>

An ATMS is recommended to coordinate with SC&DI systems to improve traffic conditions not only on the freeway but on the arterial roads and the urban network in Clark County as well. This is achieved through system coordinators that monitor traffic conditions and controls the network field elements to respond to changes.

The following items impact the cost and benefit estimates:

- the benefit provided by this system for the Vancouver area is represented by the proportion of vehicle miles traveled in Clark County that are associated with Vancouver's urban areas;
- existing facilities will be enhanced and upgraded as well as the addition of the central control; and
- operations and maintenance are estimated at 10% of capital costs.

Public ATIS

The Vancouver-Portland region will be the center of the Southwest Region traffic related information system. The same design introduced in the Northwest traffic related information system will be adapted to this area. The following assumptions were made to estimate the costs and benefits of the Vancouver-Portland ATIS:

- this system will be integrated into the Corridor Wide set of ATIS and the RMTIC via the communications backbone; and
- the benefits experienced represent a proportion of the benefits quantified in the IVHS Strategic Plan in the Vancouver area that are equivalent to the proportion of the vehicle miles traveled in Clark County that are associated to Vancouver's urban areas.

Rest stop kiosks will be introduced after successful evaluation of the demonstration project. The estimates for costs and benefits assume:

- the backbone communications is convenient and available;
- private interests will maintain the kiosk at the rest stops
- benefits include advertising and promotional fees;
- the rest stop kiosk implementation represents 10% of the rural traveler information benefits as stated in the IVHS Strategic Plan; and
- the rest stop kiosks will ultimately be expanded to six kiosks.

The ice detection system is a special ATIS that monitors roadway conditions and informs travelers when slippery conditions may exist. This project is focused on rural freeways near Vancouver that are prone to icy conditions. The information available from this system shall also be linked with regional information systems.

To generate estimate costs and benefits, it is assumed that:

- the implementation will be at two high incident locations;
- it is assumed that implementation will reduce incidents due to ice by 30% (currently $2.7 million); and
- operations and maintenance is estimated as 10% of the capital cost.

Port ATMS

Following the demonstration and evaluation of a Port ATMS project in the Puget Sound region, a Port ATMS will be implemented in Vancouver's port. It is assumed that the relative costs and benefits for this implementation will not change from the demonstration project in Puget Sound.

Public Transportation Systems and Travel Demand Management

Transit signal priority programs will be completed regionally within the Vancouver area ensuring compatibility between Portland and Vancouver. Tri-Met buses and CTrans buses will be equipped as well as the signals within the urban networks. It is assumed that:

- the benefits received include increased productivity, increased service performance and reduced operating expenses:
- Kansas City was able to eliminate 3.5% of the buses in its bus system with the implementation of AVL;
- removing a bus from the system saves $160,000 annually;
- operating and maintenance represent 25% of the capital cost; and
- there are 800 buses to be equipped.

In the Vancouver-Portland area, an Automated Customer Service will be implemented. This service will provide more transit information with more access which will provide qualitative benefits as well as encourage travelers to use transit by demonstrating the ease of its use.

Vancouver - Portland Region Summary

The estimated annualized costs and benefit-cost ratios associated with each element of the Vancouver-Portland component of the ITS Framework are summarized in Table 7-3.

Table 7-3:
Vancouver-Portland Area Summary

Project Name	Capital costs (millions)	Annual O&M Costs (millions)	Annualized costs (millions)	Annual Benefits (millions)	B/C Ratio
Travel and Transportation Management					
SC&DI	$21.41	$5.14	$6.72	$34.58	5.1
ATMS	$5.56	$0.56	$0.97	$4.85	5.0
Public ATIS	$1.52	$0.17	$0.28	$1.29	4.6
Port ATMS	$1.70	$0.17	$0.30	$1.38	4.6
Public Transportation Systems & Travel Demand Management	$0.38	$0.04	$0.07	$0.11	1.5
Backbone Communications	$8.98	$0.41	$1.07	n/a	n/a
System Reassessment and Upgrade	$4.38	n/a	$0.32	n/a	n/a
Total	$43.93	$6.49	$9.73	$42.21	4.3

Note:
Backbone communications represent the cost to construct and maintain the system used by the ITS elements within Puget Sound. It is estimated that 25 miles are required at $240,000 per mile as quantified in the IVHS Strategic Plan. System reassessment and upgrade is required for all the project completed under each element. It is assumed that this cost is 15% of the capital cost with no increase in the operations and maintenance.

7.2.4 Inter-City Systems

Within -Inter-City Systems, there are three components to the ITS Corridor Ptan including:

- Rural SC&DI
- Public ATIS

The derivation of both the system cost estimates and the expected benefits for each element are described below.

Rural SC&DI

Similar to the urban SC&DI, a rural SC&DI will be implemented as a demonstration project in the Centralia/Chehalis area which will be expanded to more extensive operations after evaluation. The system will consist of wireless links to field devices including vehicle detectors, VMS and HAR. A monitoring and control workstation will be integrated into the regional WSDOT office or local maintenance yard to allow management of the system. The SC&DI will also be capable of exchanging information with the other ITS information systems in the corridor.

The following assumptions were made to estimate the costs and benefits associated with rural SC&DI:

- the demonstration is estimated to be 14 miles long;
- the expected benefits derive from delay savings due to better conditions monitoring (10% of rural traveler information benefits);
- other expected benefits are assumed to be a 10% reduction in incidents in this area (currently $241,128 per mile annually for a section twenty miles long); and
- the backbone communications are both convenient and available;
- the expanded rural SC&DI will be 45 miles long.

Public ATIS

One special ATIS recommended for implementation is the Route 30 diversion. This project will be capable of which recommending diversion to Route 30 when I-5 is determined to be blocked or closed between Kelso and Vancouver. To develop estimate cost and benefits, it is assumed that:

- it is assumed that 36% of the accidents that occur on this area of the road require diversion (i.e. total closure);
- the benefits are derived from time savings experienced by vehicles that are able to divert and avoid severe delay due to road closures;
- it is assumed one extra controller at the TSMC will control several variable message signs that both indicate the diversion recommendation and guide vehicles along the diversion route: and
- operations and maintenance amount to 15% of the capital costs.

A pilot study presenting rest stop information kiosks will be implemented for evaluation and subsequent expansion to other rest stops. The kiosks will be tourist-oriented operating as an electronic yellow pages at remote locations near both attractions and services. These kiosks will also provide access to corridor-wide travel information in terms of guidance and conditions. The estimates for costs and benefits assume:

- the backbone communications are convenient and available;
- private interests will maintain the unit at the rest stop;
- benefits include advertising and promotional fees;
- the rest stop kiosk implementation represents 10% of the rural traveler information benefits as quantified in the IVHS Strategic Plan;
- the demonstration implementation consists of one rural implementation;
- evaluation costs are 10% of the capital costs; and
- the rest stop kiosks will be expanded to six kiosks.

The ice detection system is a special ATIS that uses remote processing units to provide monitoring capability, control remote VMS and interconnect with external information systems including weather and the corridor network. This system will be capable of monitoring roadway conditions and informing travelers when slippery conditions may exist.

To generate estimate costs and benefits, it is assumed that:

- this implementation consists of two independent locations in the rural area;
- it is assumed that implementation will reduce incidents due to ice by 30% (currently $2.7 million)
- operations and maintenance is estimated as 10% of the capital cost; and
- evaluation of the demonstration project is estimated at 20% of the capital cost:

Inter-City Systems Summary

The estimated annualized costs and benefit-cost ratios associated with each element of the Inter-City Systems component of the ITS Framework are summarized in Table 7-4.

Table 7-4:
Inter-City Systems Summary

Project Name	Capital Costs (millions)	Annual O&M Costs (millions)	Annualized costs (millions)	Annual Benefits (millions)	B/C Ratio
Rural SC&DI	$2.48	$0.25	$0.43	$0.50	1.2
Public ATIS	$3.00	$0.30	$0.52	$1.26	2.4
Backbone Communications	$2.00	$0.20	$0.35	n/a	n/a
Total	$7.48	$0.75	$1.30	$1.76	1.4

Note-:
Backbone communications represent the cost to construct and maintain the system used by the ITS elements within Puget Sound. It is estimated that 25 miles are required at $240,000 per mile as quantified in the IVHS Strategic Plan.

7.3 PROGRAM PRIORITIES

Establishing estimates of the program costs and benefits allows one to evaluate the relative importance and feasibility of each ITS element considered in the ITS Corridor Plan. The result of the evaluation is to prioritize the elements into a list of projects that are recommended for implementation. The estimate program costs for the ITS Corridor Plan are summarized in Table 7-5.

There are three key criteria to consider when prioritizing the early deployment projects within an ITS Corridor. These criteria include:

- estimated benefit-cost ratio of element;
- the element is a critical component to FHWA Core ITS Infrastructure Elements for ATMS/ATIS deployment; and
- produces regional benefits.

The selection projects ranked in order of priority are listed below along with a discussion of the rationale of the selection.

- Complete and Implement SC&DI Systems (both urban and rural): SC&DI systems have significant benefit-cost ratios associated with their implementation. In addition, Freeway Management Systems, functionally SC&DI, are recognized as one of the key elements of the core ATMS/ATIS Infrastructure. Finally, the comprehensive coverage of the SC&DI system provides an excellent base of data from which to extract traveler information.

- Complete Regional Fare Integration Effort: The regional fare integration effort is underway and funded. Other implementations have proven beneficial.

Table 7-5
1995 dollars Program Costs (in millions)

Project Name	1 to 6 Years	7 to 12 Years	13 to 20 years	Total
Puget Sound Travel and Transportation Management SC&DI	$473.05	$344.84	$402.80	$1,220.69
ATMS	$19.33	$16.11	$12.88	$48.332
Public ATIS	$2.78	$3.20	$2.56	$8.54
Port ATMS	$5.04	$5.04	$5.02	$15.09
Electronic Payment Services	$50.60	$41.40	$46.00	$138.00
Public Transportation Systems	$29.93	$17.89	$21.84	$69.66
Travel Demand Management RMTIC	$3.31	$2.45	$2.40	$8.15
Employer Based Travel Demand Management	$0.21	$0.25	$0.16	$0.62
Backbone Communications	$29.28	$22.72	$12.80	$64.80
System Reassessment And Upgrade		$19.35	$19.35	$38.70
Subtotal	$613.52	$473.24	$525.81	$1,612.57
Vancouver-Portland Region Travel and Transportation Management SC&DI	$41.55	$41.55	$41.12	$124.21
ATMS		$8.92	$4.48	$13.40
Public ATIS	$1.63	$1.93	$1.36	$4.92
Port ATMS		$2.72	$1.36	$4.08
Public Transportation Systems & Travel Demand Management	$0.51	$0.35	$0.32	$1.18
Backbone Communications		$11.44	$3.28	$14.72
System Reassessment and Upgrade		$2.19	$2.19	$4.38
Subtotal	$43.68	$69.10	$54.11	$166.89
Corridor-Wide Systems Commercial Vehicle Operations	$5.53	$7.06	$6.87	$19.46
Enforcement Applications	$3.28	$2.66	$1.92	$7.86
Subtotal	$8.81	$9.73	$8.79	$27.32
Inter-City Systems Rural SC&DI	$1.50	$1.50	$2.00	$5.00
Public ATIS	$1.80	$1.80	$2.40	$6.00
Backbone Communications				$0.00
Subtotal	$3.30	$3.30	$4.40	$0.00
Total	**$669.31**	**$555.37**	**$593.10**	**$1,817.78**

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- **Develop and Deploy RMTIC: The RMTIC has a good benefit-cost estimate of 5 to 1. In addition, a RMTIC is the critical element of the ATMS/ATIS core infrastructure. Providing the information clearinghouse early in the implementation plan will ensure that a mature, well-established interface is available to draw together the existing sources of information as well as the future ITS systems.**

- **Develop and Deploy Port ATMS: As a port is predominantly a commercial zone of travel, the impact of delay is more severe as the commercial vehicles are associated with greater operating value.**

- **Develop and Deploy Regional ATMS (with transit priority): The ATMS elements display two main benefits. First, the benefit-cost ratio is 6 to 1. Second, the benefit associated with ATMS is regional, providing surveillance on alternate routes as well as the congested routes.**

- **Develop and Deploy CVO Automated Clearance: This weigh station bypass has demonstrated commercial benefits in previous and current applications. Its benefit-cost ratio is 6 to 1.**

- **Construct and Install the Communications Infrastructure: The communication infrastructure is critical to the operation of any of the ITS elements as it provides the connections necessary to transfer data between elements. The greater the capacity and the coverage of the communications network, the greater amount of data that can be transferred.**

- **Demonstrate Work Zone SC&DI: The portable SC&D1 is an appropriate element to introduce early into the network as it can assist in mitigating the impact of congestion. Great benefit is expected from its use as it is an ITS element that can be applied exactly where it is needed (i.e. at unexpected work zones during the peak hour).**

- **Provide Enhancements to WSDOT ATIS: To extend coverage, access and the benefit received from the core infrastructure RMTIC, the WSDOT ATIS enhancements should result in a network of regional ATIS. The improvements will explicitly increase the forms of public access to the information database and increase the interconnection between other information systems.**

- **Provide Enhancements to Regional Transit Management (i.e. AVL): Implementing AVL capabilities within the regional transit centers will improve the on-time performance of the buses as demonstrated by other applications. In addition, traveler safety is improved as the location of the vehicle is better established and emergency crews can be more quickly dispatched. Finally, a system such as this is capable of providing another source of data in the form of link travel times.**

8.0 ITS DEPLOYMENT PLAN IMPLEMENTATION ISSUES

Section 6 described an ITS plan for the Seattle to Portland corridor that defines a corridor vision, specific projects and initiatives over the short, medium, and long terms. This vision recognizes current trends in ITS deployment which include multimodal operations and the integration of multiple systems and geographic areas in order to develop overall solutions that maximize public and other user benefits.

Achieving this vision requires that consideration be given not only to the physical systems and technologies that must be deployed, but also to the development of enabling policies that support this deployment. The purpose of this section is, therefore, to highlight major implementation issues that will need to be considered and addressed, to effect and coordinate ITS deployment in the corridor and achieve the overall vision.

8.1. SYSTEM INTERCONNECTION AND DATA EXCHANGE

The exchange of electronic data and' other information among different systems and agencies is critical to the effective regional and sub-regional operation of ITS in the corridor. Providing a suitable medium for exchanging this information will require:

- Establishment of standard communications interfaces among systems. The plan recommends the development and deployment of an Internet-based system architecture to allow interconnection among the various ITS application and sensors throughout the corridor. The standard protocol should incorporate current work being funded by WSDOT to develop self-defining data protocols for all types of data. "The architecture needs to support a development environment for thousands of users with heterogeneous systems that are tied together using the 'glue' of closely defined open and public protocols at all the ISO network model layers."[24] The suitability of this interface for real-time data exchange and video transmission will need to be addressed in detail as part of the architectural function and detailed design.

- Development of standard interface specifications. Given previous standard interface and the state's direct interest in developing statewide standards, it is suggested that WSDOT assume a leadership role in developing a standard package of interface specifications that can be used by any equipment or system vendor. To promote adherence, these specifications should be included with all ITS bid or procurement documents and contractors should be required to demonstrate adherence with the requirements.

- Compatibility with the National System Architecture effort. Work is continuing on the development of a National System Architecture that is

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24 Memorandum from Daniel J. Dailey, University of Washington, to Bart Cima, David Evans and Associates, Inc., July 27, 1995.

compatible with the architecture recommended for the Seattle to Portland corridor. It is not recommended that the deployment of the system architecture be delayed while the national study is completed. The progress and findings of the national effort should be monitored and resulting recommendations incorporated in the Seattle to Portland corridor efforts.

8.2 SYSTEM INTER-OPERABILITY AND INFORMATION ACCESS

With regards to system inter-operability and information access, it will be important to balance individual agency responsibilities and jurisdictional requirements with overall regional or sub-regional ITS goals and objectives. Given the diversity of the different geographic areas along the corridor, it is important to establish a development and deployment environment through the ITS infrastructure which encourages both the public and private sectors to fully participate. By establishing an open and assessable infrastructure, ITS application developers will willingly cooperate to gain the time and monery[25] advantages provided by the ITS infrastructure. This "enlightened self-interest" approach will lead to coordinated efforts for:

- Developing coordinated operations strategies and plans;
- Defining joint regional or sub-regional ITS goals and objectives;
- Developing coordinated operations strategies and plans;
- Defining required inter-local agreements to support cross-boundary, regional or sub-regional operation;
- Identifying information access and data exchange requirements and structure; and
- Identifying appropriate levels of access and security for local system control by outside agencies.

8.3 INTEGRATION WITH THE PLANNING AND PROGRAMMING PROCESS

A goal of this early deployment plan has been to identify ITS projects and initiatives that can be integrated with the local, regional and state Transportation Improvement Plans (TIPs). This would allow ITS projects to effectively compete with other projects such as infrastructure improvements for state and local funds, and/or federal CMAQ, STP and NHS funds.

This is not a simple task. To date, most ITS projects have been funded through research and development money or through special appropriations. There is, however, growing pressure

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25 Memorandum from Mark Haselkorn, University of Washington, to Bart Cima, David Evans and Associates, Inc., July 25, 1995.

at the national level to "mainstream" ITS into the local or regional planning process and TIPS. Issues associated with doing so include:

- Educating elected officials, commission members, focal agencies, and the general public on the benefits associated with ITS deployment and the opportunities for using ITS as a management alternative to conventional capacity enhancements. This requires more effort at the planning level to quantify or at least define the benefits associated with each ITS projedt. This must then be followed by a well-conceived user-friendly outreach effort to convey these benefits.

- Developing a mechanism within the programming process that explicitly recognizes the unique aspects of ITS technology. Many ITS applications and systems (e.g., (SC&DI) represent proven technologies and have quantified and demonstrated benefits that can be used in the typical benefit-cost project ranking methodology. Many other ITS applications do not have benefits that can be as easily quantified including:

  - new technologies or applications that have not yet been proven and for which quantified benefits data does not exist; and

  - enabling technologies such as central computer and communications systems, traffic systems management centers, etc. that do not provide direct user benefits on their own, yet are essential components for the operation of other systems (e.g., SC&DI, ATIS, incident response, etc.).

  Some alternative or supplemental mechanism is therefore required in order to allow these initiatives to compete effectively.

- Recognizing the unique phasing requirements of ITS. With some exceptions, most of the ITS projects and initiatives recommended in this plan require full deployment and/or integration with other projects in order to provide maximum benefits. A mechanism is required within the planning process that considers not only the immediate benefits associated with limited or initial deployment, but the expected overall future benefits associated with complete deployment and integration. The process must also recognize implementation and phasing requirements so that broader operational or system objectives can be achieved, and projects are not implemented on a partial or "piecemeal" basis.

8.4 IMPLEMENTATION FUNDING

Integration with the standard planning and programming *process is not the only funding mechanism available and as noted above, may not be suitabie for all types of ITS initiatives. The state and other interested parties should work together to identify a multi-faceted coordinated funding program to facilitate deployment of the recommended ITS projects and initiatives. Other funding mechanisms and sources that may be worth considering include:

- Dedicated federal funding for research and development, demonstration projects and support systems. Through ITS research and development, operational test, early deployment, and other programs, the U.S. DOT's ISTEA program has provided significant funds for national ITS deployment. ISTEA is expected to end in 1997 and it is currently unclear to what degree dedicated federal funding will be maintained, although current trends are not favorable.

- Dedicated state funding for research and development, demonstration projects, and support systems. A state or other dedicated local/regional program could be used to provide direct funding for ITS initiatives, or could be used to provide an ISTEA or post-ISTEA federal match. Washington has a state Transportation Systems Management fund which has been used for direct funding of many ITS initiatives and for providing federal match dollars. This will require a successful outreach effort to convince both the State Transportation Commission and the State Legislature of the appropriateness of such funding.

- Integration with other capital improvement projects. SC&DI systems in the Seattle area are often installed as part of HOV or other road widening programs. This offers the advantage that the capital cost of SC&DI systems is typically much lower when undertaken as part of roadway reconstruction than as a stand-alone initiative.

  The disadvantage is that the overall system deployment is subject to the schedule of the roadway reconstruction activities, which may result in somewhat "piecemeal" implementation. Nevertheless, this offers an excellent opportunity for deploying systems in areas where significant capital reconstruction is anticipated, and it is suggested that this process be extended beyond SC&Df to include other ITS initiatives as well.

- Private sector deployment and public-private partnerships. The state has a strong interest in promoting private sector initiatives and for developing public/private relationships. Although ITS deployment may provide good opportunities for involving the private sector, it is important to remember that there must be good opportunity for cost recoup and profit realization, either from direct revenue collection or from product or information selling.

This may conflict with public agency goals and mandates particularly as they apply to proprietary systems or public information access. The establishment of appropriate public/private policies that recognize the needs of both parties will be important in developing and maintaining such relationships.

8.5 RISK MITIGATION

As with any large-scale program, there is an element of risk that must be addressed, and to the extent possible, mitigated. The types of risk associated with ITS deployment include:

- Direct liability. Given that many ITS applications involve the transmission of information or instructions to motorists or other travelers, there are potential liability issues associated with providing information that is incomplete, inappropriate, not timely, incorrect, or misunderstood.

- Product liability. A variation that applies primarily to the private sector is product liability. Product liability will become of increasing concern as more devices are marketed for in-vehicle or personal use. The primary responsibility for addressing this issue should rest with the product provider; however, the state may wish to monitor developments in this area and periodically review any potential need or benefit for public agency involvement.

- Technology risk. There are many unproved or proprietary ITS technologies and devices that may or may not produce expected benefits, may not work as anticipated, or may be supplanted as new technologies and devices emerge. This technology risk can be mitigated:

    - by undertaking a state-of-the-art technology assessment prior to the implementation of a new system to ensure that a range of suitable technologies and devices are available which meet the system needs;

    - by developing system specifications, whenever possible, that can be bid on by a variety of vendors;

    - by setting reasonable system expectations and schedules. Even though the deployment of a new ITS technology may achieve significant benefits and have a benefit-cost ratio greater than one, this technology may be considered a "failure" if it does not meet the original expectations. Schedules should be developed recognizing the time required to resolve issues which invariably arise with first-time implementations, while at the same time avoiding excessive slack, which often becomes a self-fulfilling prophesy;

- by developing and following a staged implementation or incremental approach that allows early experience with the new system to be gained, and the opportunity to modify subsequent stages based on that experience; and

- by following a structured approach to system design, which includes the definition of functional requirements, conceptual design, operations planning, detailed design, system integration, and extensive system documentation preparation.

With regard to the last point, ITS system software development has typically been a prominent source of technology risk, primarily because of the need to develop and integrate functions and processes that may be entirely new. Structured software development practices are particularly important to mitigate this risk and ensure that the final product serves the system needs, can be easily upgraded and updated, and is transportable to new computer hardware.

8.6 ENFORCEMENT

The proposed implementation plan includes a recommendation for the demonstration of an ITS-based enforcement concept. Other initiatives, such as the construction zone SC&DI project, may also present opportunities to use ITS for enforcement purposes, primarily to improve safety. Current WSDOT policy does not specifically address the use of ITS for enforcement purposes. Before implementing these projects, it is suggested that the WSDOT, WSP, and others (as appropriate) further examine the policy issues and implications of using ITS for enforcement purposes, and consider the development of new policies or the modification of existing ones to facilitate the use of ITS for such purposes.

9.0 PROPOSED FUNDING FRAMEWORK

9.1 PROPOSED APPROACH

The ITS plan for the corridor between Seattle and Portland presented in the previous sections provides a road map for the implementation of ITS applications and solutions. The plan has identified key building blocks required for establishing the baseline ITS infrastructure. It describes a system architecture approach for linking this complex blend of WSDOT, ODOT, transit, local government, port, regulatory agency, and private sector applications under an interconnected, distributed network.

These diverse ITS projects will be sponsored, installed, and operated by these multiple agencies to meet their modal and jurisdictional needs. There is no single agency responsible for ITS implementation. Many of these projects are underway or are already included in agency plans for the future. Funding sources have been identified for many of these projects. This is particularly true for most of the public transportation applications and much of the WSDOT SC&DI system in the Puget Sound region.

There is a very limited, dedicated source of funding for ITS applications. Funding must come from ITS, highway, transit, local, private, regulatory and port sources at the federal, state and local levels. The proposed projects must compete with other types of projects within the existing transportation planning and project programming processes for these funds. ITS applications must be brought into the mainstream and not just considered as special, one-time applications of exotic technology.

Therefore, the proposed funding framework is as follows:

- Determine which agency is responsible for a specific application area;
- Determine potential sources of funding for the specific application;
- Determine which projects and programs are ready for implementation;
- Determine which projects and programs are already included in the existing plans of WSDOT and/or other agencies;
- Determine which projects and programs are new ITS initiatives to be sponsored by WSDOT;
- Determine which specific source of funds best meets the characteristics of these new initiatives;
- Identify project/program costs;
- Identify benefits as specifically as possible, including quantification whenever feasible;

- **Prepare a project prospectus, program justification or grant application to secure this funding; and**

- **Submit and compete for project funding.**

The remainder of this section presents an initial application of this approach for consideration. The next section will address points 1 and 2. The proposed plan has identified which projects are ready for short-term implementation (step 3), which are included in existing plans (step 4), and new ITS initiatives to be sponsored by WSDOT. WSDOT would maintain its established role of statewide ITS coordination and work with other organizations to ensure cooperation and interconnection among the various applications.

9.2 ITS AREA RESPONSIBILITIES AND POTENTIAL FUNDING SOURCES

Table 9-1 provides a listing for the ITS plan areas of the potential lead organization and potential funding sources. The left-hand column of the table provides each of the core ITS plan areas for the four primary areas: 1) Corridor-Wide; 2) Puget Sound Area; 3) Inter-City; and 4) Portland-Vancouver. The next column provides the lead organization for that plan area. Items of key interest are the call for the Washington Department of Licensing and WSP to take lead roles in various CVO applications. Private sector leadership would be expected for private sector ATIS applications, emergency notification services, and any private toll facilities, if they are built. The proposed port access system would require agreement by the affected ports with the cooperation of WSDOT and local transportation agencies.

Tab. 3 - I

POTENTIAL FUND SOURCES BY ITS PLAN AREA

ITS PLAN AREA	Lead Organization	POTENTIAL FUNDING SOURCES						
		ITS	Highway	Transit	Local	Private	Regulatory	Port
CORRIDOR-WIDE SYSTEMS								
CVO Applications								
Automated Electronic Vehicle Clearance	WSDOT/WSP		⊙			O	●	
Electronic Credentials	WSDOL					O	●	
Commercial Vehicle Sensor Network	WSDOT		●				O	
Automated Roadside Safety Inspection	WSP					0	0	
On Board Safety Monitoring	WSP					0	0	
Enforcement Applications	WSPNVSDOT		O				●	
Emergency Notification	Private					0		
PUGET SOUND REGION								
Travel and Transportation Management								
TSMC	WSDOT	O	●					
ATMS	WSDOT	⊙	●		O			
Public ATIS	WSDOT	O	●				⊙	
Private ATIS	Private					●	●	
Regional Multimodal Traveler Information Center	WSDOT	●	O			⊙	⊙	
Public Transportation Applications								
Transit Signal Priority Systems	Transit	⊙	O	●				
Automatic Vehicle Location (AVL) Systems	Transit			●				
Demand Management and Operations	Transit	⊙	O	●				
Port ATMS	Port		●				O	●
Electronic Payment System								
Fare Integration	Transit			●				
Electronic Vehicle Pricing	Private/Local				●	●	●	
INTERCITY								
Rural SC&DI	WSDOT		●					
Public ATIS	WSDOT	O	●				O	
Private ATIS	Private					●	●	
PORTLAND - VANCOUVER REGION								
Travel and Transportation Management								
TSMC	WSDOT/ODOT	O	●					
ATMS	WSDOT/Local	⊙	●		O			
Public ATIS	WSDOT/ODOT	O	●				O	
Private ATIS	Private					●	●	
Port ATMS	Port		●				●	●
Public Transportation Applications								
Transit Signal Priority Systems	Transit	⊙	O	●				
Automatic Vehicle Location (AVL) Systems	Transit			●				
Travel Demand Management	Transit	⊙	O	●				
								●

KEY:
- . Primary Source
- 0 Secondary Source
- O Tertiary Source

Primary, secondary, and tertiary sources of potential funding are provided for each ITS plan area. The potential funding sources include:

- ITS: Both federal and state earmarked and competitive sources;
- Highway: Federal highway funding under the Intermodal Surface and Transportation Efficiency Act (ISTEA) and available state funding allocated to highway usage;
- Transit: Federal transit funding under the Intermodal Surface and Transportation Efficiency Act (ISTEA) and available state and transit agency funding allocated to transit usage:
- Local: Local funding for highway, transit, public works, community development and recreational purposes;
- Private: Funds from the private sector;
- Revenue Base: Fees from the regulation of commercial vehicle operations and highway enforcement activities, user fees, subscription fees, and other funds generated by consumer sales; and
- Port: Funds generated by individual ports.

Except for the RMTIC, ITS funds would only. serve as secondary and tertiary sources. Highway funds would be the most prevalent source for potential funding. Transit sources would only be used for public transportation applications. Local funds would be sought for ATMS and a tertiary source for ATIS applications. Private sources could be used in the form of fees or partnerships for CVO applications, electronic toll collection and privately-provided ATIS services. Regulatory system revenue could also fund CVO and enforcement applications. Port ATMS systems would look to the individual ports for support.

9.3 EARLY DEPLOYMENT PROJECT FUNDING REQUIREMENTS AND SOURCES

The draft ITS corridor plan has identified a set of early deployment projects that are not currently underway or planned and could be sponsored by WSDOT through the existing project programming process. Project prospectuses for each of these early deployment projects have been prepared and are found in the appendix of this report. Table 9-2 summarizes the annual cost of these efforts and identifies the most likely source of funding

Table 9-2
Early Deployment Project Costs and Funding Sources

		Estimated Annual Cost (thousands)						PROBABLE SOURCES OF FUNDS	
Plan Area	Project Title	1995	1996	1997	1998	1999	2000	WSDOT Funding Category	Other
CORRIDOR-WIDE SYSTEMS									
CVO Applications	*Deploy Corridor Wide Automated Electronic Vehicle Clearance*		$100	$1,250	$1,000	$787	$787	Study: ITS Implementation: Economic Initiatives or Mobility	Study: Regulatory Fees Implementation: Regulatory Fees, Private/Public Partnership
Enforcement Applications	*Demonstrate ITS Enforcement Concepts*	$100	$200					Study: ITS Implementation: TSM, Mobility	Implementation: Fine Surcharge
PUGET SOUND REGION									
Travel & Transportation Management	*Develop and Deploy Northwest Region Traffic Related Information System*	$580	$380	$192	$192	$192	$192	Mobility, TSM, ITS	
	Develop and Deploy Olympic Region Traffic Related Information System		$54	$126	$36	$36	$36	Mobility, TSM	
	Deploy Seattle-Portland Traffic Related Information System			$80	$400	$48	$48	Mobility, TSM	
	Develop and Deploy Olympic Area SC&DI System				$2,663	$2,663	$7,989	Mobility, TSM	
	Develop East King County ATMS			$1,125	$187	$187	$150	Mobility, TSM	Local Transportation
	Develop South King County ATMS				$926	$2,316	$2,316	Mobility, TSM	Local Transportation
	Develop Pierce County ATMS					$926	$2,316	Mobility, TSM	Local Transportation
	Demonstrate Work Zone SC&DI System		$122	$341	$341			ITS, TSM, Mobility, Preservation	Federal ITS
Travel Demand Management	*Develop Regional Multimodal Traveler Information Center*			$195	$1,956	$300	$300	ITS, TSM, Mobility	Federal ITS
	Pilot Intermodal Terminal Information Kiosks				$211	$264	$48	ITS, TSM, Economic Initiatives, Intercity Rail	Community Development, Recreational, Private Participation
	Demonstrate Employer Based Multimodal Traveler Information System			$36	$180	$22	$22	ITS, TSM, Mobility	Federal ITS
Port Access	*Demonstrate Port ATMS Concept*	$282	$942	$471	$170	$170	$170	ITS, TSM, Economic Initiatives	Port
INTERCITY									
	Demonstrate Rural SC&DI System in Centralia / Chehalis Area				$414	$1,380	$690	ITS, TSM, Mobility	Federal ITS
	Deploy US 30 Route Diversion				$92	$230	$230		
	Pilot Rest Stop Information Kiosks		$8	$38	$5	$5	$5	ITS, TSM, Economic Initiatives	Community Development, Recreational, Private Participation
PORTLAND - VANCOUVER REGION									
Travel & Transportation Management	*Develop and Deploy Southwest Region Traffic Related Information System*		$30	$150	$36	$36	$36	Mobility, TSM	
	Develop and Deploy Southwest Region SC&DI System			$5,922	$5,922	$5,922	$5,922	Mobility, TSM	
	Deploy Ice Detection System					$178	$890	Safety, Preservation	
	Total	$962	$1,836	$9,926	$14,730	$15,662	$22,147		

APPENDIX A

ITS USER SERVICES SUMMARY

INTELLIGENT TRANSPORTATION SYSTEMS

USER SERVICES SUMMARY

U.S. Department
of Transportation
Federal Highway Administration

January 1995

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USER SERVICES

1.0 INTRODUCTION

The national Intelligent Transportation Systems (ITS) program is focused on the development and deployment of a collection of inter-related user services. Twenty-nine user services have been defined to date as part of the national program planning process. The users of these service include travelers using all modes of transportation, transportation management center operators, transit operators, Metropolitan Planning Organizations (MPOs), commercial vehicle owners and operators, state and local governments, and many others who will benefit from deployment of ITS. Detailed plans for each user service are provided in Volume II of the National ITS Program Plan (NPP).

2.0 USER SERVICE DESCRIPTIONS

Although each user service is unique, they share common characteristics and features as described below.

- **Individual user** services are building blocks that may be combined for deployment in a variety of fashions. The combination of services deployed will vary depending upon local priorities, needs, and market forces. Within the NPP, user services have been grouped into "bundles" based on likely deployment scenarios.

- **User services are comprised of multiple technological elements or functions** which may be common with other services. For example, a single user service will usually require several technologies, such as advanced communications, mapping, and surveillance, which may be shared with other user services. This commonality of technological functions is one basis for the suggested bundling of services.

- **User services are in various stages of development** and will be deployed as systems according to different schedules.. Some of the technologies required by various user services are currently available in the market place, while others will require significant research and development before they can be deployed. The development and deployment of an individual service will be guided by the policies and priorities established by both the public and private sector participants. These policies and priorities will evolve based on changing technologies, economic factors, and market conditions.

- **Costs and benefits of** user **services depend upon deployment scenarios. Once the** basic technological functions, such as communications or surveillance, have been deployed for one user service, the additional functions needed by one or more related services may require only a small incremental cost to produce additional. often significant, benefits.

- Many user services can be deployed in rural, suburban and/or urban settings. User services are not specific to a particular location. Rather, the function of the service can be adapted to meet local needs and conditions.

3.0 USER SERVICE BUNDLING

Although it may be possible to deploy a system that provides a single user service, in many cases there are combinations of user services that can be considered related. These combinations of user services have been termed ***"bundles."***

The commonality among user services in a bundle may relate to a number of different factors. In some cases, the institutional perspectives of organizations that will deploy the services provide the basis for arriving at a rationale for bundling. In other cases, the determination of bundles centers around common technical functionalities. The potential for sharing major units of technical functionalities is discussed in greater detail in Chapter V, User Services Integration, of the NPP.

The bundles and user services are shown in Table 1 and are described in the following paragraphs.

Table 1 User Service Bundles

Bundle	User Services
1. Travel and Transportation Management	1. En-Route Driver Information 2. Route Guidance 3. Traveler Services Information 4. Traffic Control 5. Incident Management 6. Emissions Testing and Mitigation
2. Travel Demand Management	1. Pre-Trip Travel Information 2. Ride Matching and Reservation 3. Demand Management and Operations
3. Public Transportation Operations	1. Public Transportation Management 2. En-Route Transit Information 3. Personalized Public Transit 4. Public Travel Security
4. Electronic Payment	1. Electronic Payment Services

Table 1 User Service Bundles

Bundle	User Services
5. Commercial Vehicle Operations	1. Commercial Vehicle Electronic Clearance 2. Automated Roadside Safety Inspection 3. On-board Safety Monitoring 4. Commercial Vehicle Administrative Processes 5. Hazardous Materials Incident Response 6. Commercial Fleet Management
6. Emergency Management	1. Emergency Notification and Personal Security 2. Emergency Vehicle Management
7. Advanced Vehicle Control and Safety Systems	1. Longitudinal Collision Avoidance 2. Lateral Collision Avoidance 3. Intersection Collision Avoidance 4. Vision Enhancement for Crash Avoidance 5. Safety Readiness 6. Pre-Crash Restraint Deployment 7. Automated Highway System

3.1 Travel and Transportation Management

The Travel and Transportation Management *user* services are included in a single bundle because of the information they share about the- surface transportation system. These services collect and process information about the surface transportation system, and provide commands to various traffic control devices, Travel management services disseminate this information to the traveler. When used in concert, these services can provide a comprehensive travel and transportation management system. These services also provide information to support the Travel Demand Management and-the Public Transportation Operations bundles. Thus, the Travel and Transportation Management bundle will be of interest to transportation policy makers, public and private sector operators of transportation management centers, those involved in incident response or travel demand management, and private sector vendors supplying travel information products and services.

- En-Route Driver Information

Provides driver advisories and in-vehicle signing for convenience and safety.

Driver advisories are similar to pre-trip planning information, but they are provided once travel begins. Driver advisories convey real-time information about traffic conditions, incidents, construction, transit schedules, and weather conditions to drivers of personal, commercial and public transit vehicles. This information allows a driver to either select the best route, or shift to another mode in mid-trip if desired.

In-vehicle signing. the second component of en-route driver information, provides the same types of information' found on physical road signs today, directly in the vehicle. The service could be extended to include warnings of road conditions and safe speeds for specific types of vehicles, such as autos, buses, and large trucks, but potential users include drivers of all types of vehicles. This service might be especially useful to elderly drivers, in rural areas with large numbers of tourists, or in areas with unusual or hazardous roadway conditions.

- Route Guidance

Provides travelers with simple instructions on how to best reach their destinations.

The route guidance 'service provides a suggested route to reach a specified destination. Early route guidance systems are based on static information about the roadway network or transit schedules. When fully deployed, route guidance systems will provide travelers with directions to their destinations based on real-time information about the transportation system. The route guidance service will consider traffic conditions, status and schedule of transit systems, and road closures in developing the best route. Directions will generally consist of simple instructions on turns or other upcoming maneuvers. Users of the service include not only drivers of all types of vehicles, but also non-vehicular travelers, such as pedestrians or bicyclists, who could get specialized route guidance from a hand-held device.

- Traveler Services Information

Provides a business directory, or "yellow pages, " of service information.

Traveler services information provides quick access to travel-related services and facilities'. Examples of information that might be included are the location, operating hours, and availability of food, lodging, parking, auto repair, hospitals, and police facilities. Traveler services information would be accessible in the home, office or other public locations to plan trips, and would also be available en-route. When fully deployed, this service will connect users and providers interactively to request and provide needed information. A comprehensive, integrated service could support financial transactions, such as automatic billing for purchases.

- Traffic Control

Manages the movement of traffic on streets and highways.

The traffic control user service provides for the integration and adaptive control of the freeway and surface street systems to improve the flow of traffic, give preference to public safety, transit or other high occupancy vehicles, and minimize congestion while maximizing the movement of people and goods. Through appropriate traffic controls, the service also promotes the safety of non-vehicular travelers, such as pedestrians and bicyclists. It requires advanced surveillance of traffic flows, analysis techniques for determining appropriate traffic signal and ramp metering controls, and communication of these controls to the roadside infrastructure. This service gathers data from the transportation system and organizes it into usable information to determine the optimum assignment of right-of-way to vehicles and pedestrians. The real-time traffic information collected by the Traffic Control service also provides the foundation for many other user services.

- Incident Management

Helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic.

The Incident Management service uses advanced sensors, data processing, and communications to improve the incident management and response capabilities of transportation and public safety officials, the towing and recovery industry, and others involved in incident response. The service will enhance existing incident detection and verification capabilities to help these groups quickly and accurately identify a variety of incidents and implement a response. The improved response-time will minimize the effects of these incidents on the movement of people and goods. This service will also help transportation officials predict traffic or highway conditions so that they can take action in advance to prevent potential incidents or minimize their impacts. While the direct users of this service are the public and private entities responsible for incident detection and response, the'ultimate beneficiaries are commercial and transit operators, and the traveling public.'

- Emissions Testing and Mitigation

Provides information for monitoring air quality and developing air quality improvement strategies.

The Emissions Testing and Mitigation service uses advanced vehicle emissions testing systems to provide information to identify environmental "hot spots" and implement strategies to either reroute traffic around sensitive air quality areas or control access to such areas. Other technologies provide identification of vehicles that are emitting levels of pollutants that exceed state, local or regional standards, and provides information to drivers or fleet operators to enable them to take corrective action. The service also provides transportation planning and operating agencies with information that can be used to facilitate implementation and evaluation of various pollution control strategies.

3.2 Travel Demand Management

The Travel Demand Management user services support policies and strategies that are aimed at reducing vehicle demand by developing and encouraging modes of travel other than the single occupant vehicle. The services in this bundle are designed to increase the use of high occupancy vehicles and transit by providing intermodal information to travelers prior to the beginning of a trip, and by making ride sharing and transit more' convenient and easier to use. These services are also aimed at decreasing congestion by altering the timing or location of trips, or eliminating vehicle trips all together.

From a technical perspective,. these services rely on information collected and processed by the Travel and Transportation Management services and the Public Transportation Operations services. Travel Demand Management services also interact with the Travel and . Transportation Management services in terms of implementing control strategies that can provide incentives, or ***disincentives,*** to change travel behavior.

- Pre-Trip Travel Information

  Provides information for selecting the best transportation mode, departure time, and route.

  Pre-trip travel information allows travelers to access a complete range of intermodal transportation information at home, work, and other major sites where trips originate. Real-time information on transit routes, schedules, transfers, fares, and ride matching services are available to encourage the use of alternatives to the single occupancy vehicle. Information needed for long, inter-urban or vacation trips would also be available. Real-time inform&on on accidents, road construction, alternate routes, traffic speeds along given routes, parking conditions, event schedules, and weather information is also included. Based on this information, the traveler can select the best route, modes of travel and departure time, or decide not to make the trip at all.

- Ride Matching and Reservation -

  Makes ride sharing easier and more convenient.

  The Ride Matching and Reservation service provides real-time ride matching information and reservations to users in their homes, offices or other locations, and assist transportation providers, as well as van/carpoolers, with vehicle assignments and scheduling. This will expand the market for ridesharing as an alternative to single occupant vehicle travel and will provide for enhanced alternatives for special population groups, such as the elderly or the handicapped.

- Demand Management and Operations

Supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion.

The Demand Management and Operations service generates and communicates management and control strategies that support the implementation of programs to reduce the number of individuals who choose to drive alone, especially. to work; increase the use of high occupancy vehicles and transit; and provide a variety of mobility options for those who wish to travel in a more efficient manner, for expamle in non-peak periods. Demand management strategies could ultimately be applied dynamically, when congestion or pollution conditions warrant. For example, disincentives such as increased tolls and parking fees could be applied during pollution alerts or peak travel periods, while transit fares would be lowered to accommodate the increased number of travelers changing modes from driving alone. Such strategies will reduce the negative impacts of traffic congestion on the environment and improve overall quality of life.

3.3 Public Transportation Operations

The Public Transportation Operations bundle reflects the commonality of the transit authority as the most probable provider of these services. The transit authority is responsible for implementing systems that are capable of better managing the public transportation system and providing improved transit and mode choice information.

From a technical perspective, all of these user services will share a common public transit database. The data will be available-for all of the services to customize for their specific function. This data will also support services in the Travel and Transportation Management and the Travel Demand Management bundles.

- Public Transportation Management

Automates operations, planning, and management functions of public transit systems.

The Public Transportation Management service provides computer analysis of real-time vehicle and facility status to improve transit operations and maintenance. The analysis identifies deviations from schedule and provides potential solutions to dispatchers and drivers. Integrating this capability with traffic control services can help maintain transportation schedules and assure transfer connections in intermodal transportation. Information regarding passenger loading, bus running times, and mileage accumulated will help improve service and facilitate administrative reporting. Transit personnel management is enhanced by automatically recording and verifying tasks performed by transit personnel.

- En-Route Transit Information

Provides information to travelers using public transportation after they begin their trips.

The En-Route Transit Information service provides information to assist the traveler once public transportation travel begins. Real-time, accurate transit service information on-board the vehicle helps travelers make effective transfer decisions and itinerary modifications as needed while a trip is underway.

- Personalized Public Transit

Provides flexibly-routed transit vehicles to offer more convenient customer service.

Small publicly or privately-operated vehicles provide on-demand routing to pick up passengers who have requested service and deliver them to their destinations. Route deviation schemes, in which vehicles leave a fixed route for a short distance to pick up or discharge passengers, is another way of improving service. Vehicles can include small buses. taxicabs, or other small, shared ride vehicles. This service can provide almost door-to-door service, expanding transit coverage to lesser populated locations and neighborhoods. Potentially, this services can provide transportation at lower cost and with greater convenience than conventional fixed route transit.

- Public Travel Security

Creates a secure environment for public transportation patrons and operators.

This service provides systems that momtor the environment in transit stations, parking lots, bus stops, and on-board transit vehicles, and generate alarms, either automatically or manually, when necessary. This improves security for both transit riders and operators. Transportation agencies and authorities can integrate this user service with other anti-crime activities.

3.4 Electronic Payment

While this bundle contains only one user service, it supports deployment of many other services, both within and outside the transportation arena. This service will be developed, deployed, and operated by both public and private organizations.

- Electronic Payment Services

Allows travelers to pay for transportation services electronically.

Electronic Payment services will foster intermodal travel by providing a common electronic payment medium for all transportation modes and functions. including tolls, transit fares, and parking. The service provides for a common service fee and payment structure using "smart cards" or other technologies. Such systems could be expanded to become truly multi-use, accommodating personal financial transactions that are made with today's credit/bank cards. The flexibility that electronic payment services offer will also facilitate travel demand management, if conditions warrant. They could, if local authorities so choose enable application of road pricing policies which could influence departure times and mode selection.

3.5 Commercial Vehicle Operations

These user services support the goals of improving the efficiency and safety of commercial fleet operations, and will benefit both the States and the motor carrier industry. Thus the CVO bundle reflects the commonality of using advanced computer and communications technologies to improve the safety and productivity of the motor carrier industry throughout North America.

From a technical perspective, the foundation for all of the CVO user services is information systems. Each service will require some set of information on the motor carrier, the vehicle, the driver, and, in some cases, the cargo. The services are interrelated in terms of the specific types and functionality of information and data required. This network of information will be accessible by States and motor carriers nationwide.

- Commercial Vehicle Electronic Clearance

Facilitates domestic and international border clearance, minimizing stops.

This service will enable transponder-equipped trucks and buses to have their safety status, credentials, and weight checked at mainline speeds. Vehicles that are safe and legal and have no. outstanding out-of-service citations will be allowed to pass the inspection/weigh facility without delay.

By working with Mexico and Canada, a more efficient traffic flow would be provided at border crossings. The depldyment of technologies in these countries could ultimately prevent overweight, unsafe, or improperly registered vehicles from entering the United States.

- Automated Roadside Safety Inspection

- ***Facilitates roadside inspections.***

Automated roadside inspections would allow real-time access at the roadside to the safety performance record of carriers, vehicles, and drivers. Such access will help determine which vehicle or driver should be stopped for an inspection, as well as ensuring timely correction of previously identified problems.

This service would also automate as many items as possible of the manual inspection process. It would, for example, allow for more rapid and accurate inspection of brake performance at the roadside. Through the use of sensors, and diagnostics, it would efficiently check vehicle systems and driver requirements and ultimately driver alertness and fitness for duty.

- On-Board Safety Monitoring

Senses the safety status of a commercial vehicle, cargo, and driver.

On-board systems would monitor the safety status of a vehicle, cargo, and driver at mainline speeds. Vehicle monitoring would include sensing and collecting data on the condition of critical vehicle components such as brakes, tires, and lights, and determining thresholds for warning and countermeasures. Cargo monitoring would involve sensing unsafe conditions relating to vehicle cargo, such as shifts in cargo while the vehicle is in operation. Driver monitoring is envisioned to include the monitoring of driving time and alertness using non-intrusive technology and the development of warning systems for the driver, the carrier, and the enforcement official. A warning of unsafe condition would first be provided to the driver and then to the carrier and roadside enforcement officials. This warning notification would possibly prevent an accident from happening. This service would minimize driver- and equipment-related accidents for participating carriers.

- Commercial Vehicle Administrative Processes

Provides electronic purchasing of credentials and automated mileage, and fuel reporting and auditing.

The Commercial Vehicle Administrative Processes service provides the commercial carrier with the capability to electronically purchase annual and temporary credentials via computer link. It will reduce burdensome paperwork and processing time for both the State agencies and the motor carriers.

For automated mileage and fuel reporting and auditing, this service enables participating interstate carriers to electronically capture mileage, fuel purchased, trip, and vehicle data according to state. It would also automatically determine mileage traveled and fuel purchased in each state, for use by the carrier in preparing fuel tax and registration reports to the State agencies. This service would reduce the significant administrative burden on commercial carriers to collect and report mileage and fuel purchased within each State.

- Hazardous Material Incident Response

Provides immediate description of hazardous materials to emergency responders.

The Hazardous Material Incident Response service enhances the safety of shipments of hazardous materials by providing enforcement and response teams with timely, accurate information on cargo contents to enable them to react properly in emergency situations. The materials or combination of materials involved when an incident involving a truck carrying hazardous material occurs would be provided electronically ***to*** emergency responders and enforcement personnel at the scene so that the incident can be handled properly.

- Commercial Fleet Management

Provides communication between drivers, dispatchers, and intermodal transportation providers.

The Commercial Fleet Management service provides real-time traffic information and vehicle location for commercial vehicles. This service significantly enhances fleet operations management by helping drivers to avoid congested areas and improving the reliability and efficiency of pickups and deliveries. These benefits are particularly important for operators of intermodal and time-sensitive fleets who can use this ITS service to make their operations more efficient and reliable.

3.6 Emergency Management

Police, fire and rescue operations can use emergency management services to improve their management of and response to emergency situations. These user services have common functional elements such as vehicle location, communications, and response.

- Emergency Notification and Personal Security

Provides immediate notification of an incident and an immediate request for assistance.

The Emergency Notification and Personal Security service includes two capabilities: driver and personal -security, and automatic collision notification. Driver and personal security capabilities provide for user-initiated distress signals for incidents such as mechanical breakdowns or car-jackings. When activated by an incident,. automatic collision notification transmits information regarding location, nature, and severity of the crash to emergency personnel.

- Emergency Vehicle Management

Reduces the time it takes for emergency vehicles to respond to an incident.

The Emergency Vehicle Management service provides public safety agencies with fleet management capabilities, route guidance, and signal priority and/or preemption for emergency vehicles. Fleet management improves the display of emergency vehicle locations and help dispatchers send the units that can most quickly reach an incident site. Route guidance directs emergency vehicles to an incident location and signal priority optimizes the traffic signal timing in an emergency vehicle's route. Primary users of this service include police, fire, and medical units.

3.7 Advanced Vehicle Control and Safety Systems

Although each of these services addresses a separate function, they all contribute to the common goal of improving vehicle safety. With the exception of Automated Highway Systems (AHS), all of these user services are characterized by near-term reliance on self-contained systems within the vehicle. The functionality of these user services, however, can be enhanced by supplementing the on-board capabilities with additional sensors deployed in the infrastructure.

Within the vehicle, common functional elements, such as data storage, processing units, sensors or actuators, could be shared among the user services in this bundle, including AHS.

- Longitudinal Collision Avoidance

Helps prevent head-on, rear-&d or backing collisions between vehicles, or between vehicles and other objects or pedestrians.

The Longitudinal Collision Avoidance service helps reduce the number and severity of longitudinal collisions, such as head-on, rear-end or backing. It includes the sensing of potential or impending collisions, prompting a driver's avoidance actions, and controlling the vehicle temporarily.

- Lateral Collision Avoidance

Helps prevent collisions when vehicles leave their lane of travel.

The Lateral Collision Avoidance service provides crash warnings and controls for **lane** changes and road departures. It will reduce the number of lateral collisions involving two or more vehicles, as well as, crashes involving a single vehicle leaving the roadway.

For changing lanes, a situation display can monitor the vehicle's blind spot continuously, and drivers can be actively warned of an impending collision. If needed, automatic control can provide rapid response to a situation. Warning systems can also alert a driver to an impending road departure, provide help in keeping the vehicle in the lane, and ultimately provide automatic control of steering and throttle.

- _Intersection Collision Avoidance

Helps prevent collisions at intersections.

The Intersection Collision Avoidance service warns drivers of imminent collisions when approaching or crossing an intersection that has traffic control (e.g., stop signs or a traffic signal). This service also alerts the driver when the proper right-of-way at the intersection is unclear or ambiguous.

- Vision Enhancement for Crash Avoidance

Improves the driver's ability to see the roadway and objects that are on or along the roadway.

The Vision Enhancement service provides drivers with improved visibility to allow them to avoid collisions with other vehicles or obstacles in the roadway, as well as help them comply with traffic signs and signals. This service requires in-vehicle equipment for sensing potential hazards, processing this information, and displaying it in a way that is useful to a driver:

- Safety Reediness

Provides warnings about the condition of the driver, the vehicle, and the roadway.

Safety Readiness services provide in-vehicle equipment that unobtrusively monitors a driver's condition and provides a warning if the driver is becoming drowsy or otherwise impaired. This service could also monitor critical components of the automobile internally and alert the driver to impending malfunctions. Equipment within the vehicle could also detect unsafe road conditions, such as bridge icing or standing water on the roadway, and provide a warning to the driver.

- Pre-Crash Restraint Deployment

Anticipates an imminent collision and activates passenger safety systems before the collision occurs or much earlier in the crash event than is currently feasible.

The Pre-Crash Restraint Deployment service anticipates an imminent collision by determining the velocity, mass, and direction of the vehicles or objects involved in a potential crash. The service activates safety systems in the vehicle prior to a collision, such as tightening lap-shoulder belts, arming and deploying air bags at the optimal pressure, and deploying roll bars. The response is based on the number, location, and major physical characteristics of any occupants.

- Automated Highway Systems

Provides a fully automated, "hands-of, " operating environment.

AHS is a long-term goal of ITS which would provide vast improvements in safety by creating a nearly accident-free driving environment. In AHS, the vehicle is guided automatically rather than by the driver. Driver error is reduced or possibly eliminated with full implementation. Drivers could buy vehicles with the necessary instrumentation or retrofit an existing vehicle. During the transition period, vehicles that are incapable of automated operation would drive in lanes without automation. AHS benefits include increased roadway capacity, enhanced safety, reduced fuel consumption, and reduced emissions.

4.0 USER SERVICE DEVELOPMENT PLANS

Development plans have been generated for each user service. Each User Service Development Pi' identifies the user's that the user service is designed to meet, presents an operational concept for how the service might function in its fully deployed state, describes the technologies that the service might use, discusses potential costs and benefits, and provides an assessment of the public and private sector roles in developing and deploying the systems that will provide the service. The User Service Plans identify major issues or barriers that might impact development and deployment and the activities and milestones that must be accomplished to fully develop the service for system deployment. Detailed User Service Development Plans that describe the activities needed to bring each service to the point of deployment are contained in Volume II of the NPP.

Features of the User Service Development Plans include:

- **User service development plans address the stated goals of the ITS program** and provide a framework by which user services can be combined, or bundled, into deployable products and services to achieve these goals and objectives.

- **An assessment of the roles of key public and private sector participants** involved in the development and deployment of the service are described in the user service plans.

- **However, the user service development plans do not define development or deployment policies.** The decision to undertake the necessary activities to develop a user service rests with the individual public or private sector entities involved. Similarly, deployment priorities and decisions rest with the responsible deploying entity, private or . public sector provider, and the consumer.

- **The user service development plans are intended to be illustrative** without defining or implying a specific system architecture. The operational concepts and technologies described in the User Service Development Plans present a vision of how the services might be deployed, rather than dictating a deployment scenario. Thus, the activities within the development plans do not dictate the use of specific technologies, but simply present the possibilities as they are known currently.

- **Similarly, the user service development plans do not dictate specific future activities,** but are planning tools to guide and coordinate future activities.

- **The user service development plans are dynamic. They will** evolve as technology and experience change both public and private sector perceptions of the possibilities.

- **Unique safety, human factors, and institutional issues are** covered in each user service development plan, Cross-cutting issues are covered in other sections of the NPP.

- **User acceptance of ITS user services will be the key to their success..** Outreach, education and training, in both technical arid public relations areas, must be addressed throughout all stages of user service development and planning.

- **General information and cost and benefit estimates are** contained in the user service development plans. Benefits and costs are rarely quantifiable for most services at their current stage of development. However, the relationships between costs and benefits are logically supportable.

5.0 USER SERVICES INTEGRATION

ITS planning and deployments are proceeding, despite the absence of a national ITS architecture and the minimal availability of adopted standards. To assist a deployer in planning for the adoption of a system approach, relationships among the user services were analyzed to define what integration options are available. This discussion of User Services Integration is not to imply a system design but to point out how the user services could be integrated. Tools will be presented as templates to be adapted to each deployment situation. Planning organizations should be aware of the benefits of integrating the user services in a system.

5.1 Functional Relationship Among User Services

Each of the 29 user services discussed in Chapter III was analyzed to identify candidate enabling technologies. This analysis is based on a wide range of technologies capable of supporting robust, fully functioned user service implementations. This does not imply that a user service deployment must necessarily include all of the enabling technologies or the functions they provide.

In order to keep the number of technologies at a manageable level, they were grouped into functional areas. In general, each functional area is comprised of one or more separate technologies which can be used interchangeably in system deployment that provides a user service. For example, two-way mobile communications could be provided by either digital cellular telephones or two-way satellite communications.. The functional areas are defined in Table 2.

Table 2 Function Definitions

Function	Definition
Traffic Surveillance	Surveillance technologies that collect information about the status of the traffic stream. Possible technologies include loop detectors, infrared sensors, radar and microwave sensors, machine vision, aerial surveillance, closed circuit television, acoustic, in-pavement magnetic, and vehicle probes.
Vehicle Surveillance	Surveillance technologies that collect a variety of information about specific vehicles. These technologies include'weigh-in-motion devices, vehicle identification, vehicle classification, and vehicle location.
Inter-Agency Coordination	Technologies that connect travel-related facilities to other agencies such as police, emergency services providers, weather forecasters and observers, and among Traffic Management Centers (TMC), transit operators, etc.
1-Way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites but cannot receive information back from those sites. Possible technologies providing this function include Highway Advisory Radio, FM subcarrier, spread spectrum, microwave, infrared, commercial broadcasts, and infrared or microwave beacons.
2-Way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites and allows receipt of information from those same sites. Possible technologies include cellular telephones, 2-way radio, spread spectrum, microwave, infrared, and 2-way satellite.
Stationary Communications	Any communication technology that connects stationary sites. Technologies include fiber optics, microwave, radio, land lines.

Table 2 Function Definitions

Function	Definition
Individual Traveler Interface	Devices that provide information flow to a specific traveler. Technologies meeting this function include touch screens, keypads, graphics displays and computer voices at kiosks; keypads, computer voice, and head-up displays in vehicles; personal communications devices carried with the traveler; and audiotex from any phone.
Payment Systems	Technologies that enable electronic fund transfer between the traveler and the service provider. The technology areas include Automated Vehicle Identification (AVI), smart cards, and electronic funds management systems. This function overlaps with the Electronic Payment user service.
Variable Message Displays	Technologies that allow centrally controlled messages to be displayed or announced audibly to multiple users at a common location such as a roadside display or display board in a transit terminal These technologies would typically be applied to provide information on highway conditions, traffic restrictions, and transit status.
Signalized Traffic Control	Technologies that allow for real-time control of traffic flow. Possible technologies include optimized traffic signals, ramp metering, reversible lane designation, and ramp/lane closures.
Restrictions Traffic Control	Operational techniques that restrict the use of roadways according to regional goals. Techniques include HOV restrictions, parking restrictions, and road use (congestion) pricing.
Navigation	Technologies that determine vehicle position in real time.. Technologies that provide this function include GPS, LORAN, dead reckoning, localized beacons, map database matching, and cellular triangulation.
Database Processing	Technologies that manipulate and configure or format transportation-related data for sharing on various platforms. General purpose data base software currently exists and is currently being adapted to transportation needs such as data fusion, maps, and travel services.
Traffic Prediction Data Processing	Data processing relating to prediction of future traffic situations. Algorithms under development include areas such as real-time traffic prediction, and traffic assignment.
Traffic Control Data Processing	Data processing related to the real-time control of traffic Algorithms under development include optimal control and incident detection, and the interaction of route selection and traffic control.

Table 2 Function Definitions

Function	Definition
Routing Data Processing	Data processing related to routing of vehicles including the generation of step by-step driving instructions to a specified defination. Algorithms under development include the scheduling of drivers, vehicles, and cargo; route selection; commercial vehicle scheduling, and route guidance.
In-Vehicle sensors/Devices	Technologies providing a range of sensing functions to be located within vehicles. Functions addressed by these technologies include monitoring of vehicle performance and driver performance; determination of vehicle position relative to the roadway, other vehicles, and obstacles; improvement of vision in adverse conditions; and on-board security monitoring.

The user service bundles' are the starting point for determining the interrelationship of one user service to another. The bundles provide logical groupings and combinations of the user services. By analyzing a user service's relationship to other user services, a system may be conceived over a period of years in a comprehensive and deliberate manner. This approach makes it possible to optimize the use of funds and resources resulting in a more achievable and affordable system deployment.

The-results of the analysis of functional commonalities are depicted in Figure 3. In the figure, the user service bundle is identified in the upper left hand comer of the chart. The left side of the chart lists the associated functions. The right of the figure lists the user services in the bundle. If a function supports full implementation of a user service, the intersection of the user service row and function column is marked.

In the process of planning system deployments to support user services, deploying organizations will consider a broad spectrum of factors. First and foremost, service providers must consider the requirements and problems unique to their communities. While there is no attempt here to develop a model which factors in all possible considerations representative of urban, suburban, or rural communities, there are some investment related factors which lend themselves to analysis. One of the prime considerations is the return on investments associated with installing systems. Therefore, once a region has made a decision to deploy systems contributing to a user service in response to a specific need, community leaders and/or private sector providers will immediately want to know the implications of such an investment, not only in the near term, but for the duration of their planning horizon. Figure 3 depicts a model derived from an analysis of bundles of user services. Each user service has the complete set of functionalities visualized for a mature service as derived from the appropriate User Services Development chapter in Volume II of the NPP.

1. Travel and Transportation Management

Applicable Functions: Data Base Processing	Stationary Communications	Traffic Surveillance	2-Way Mobile Communications	Individual Traveler Interface	Variable Message Displays	Navigation	1-Way Mobile Communications	Traffic Prediction Data Processing	Inter-Agency Coordination	Routing Data Processing	Signalized Traffic Control	Traffic Control Data Processing	Vehicle Surveillance	In-Vehicle Sensors/Devices	Provide Deployment Basis For These User Services
●	●	●	●	●	●	●	●	●	●	●					En-Route Driver Information
●	●	●	●	●		●	●	●		●					Route Guidance
●			●	●		●									Traveler Services Information
●	●	●			●			●	●		●	●			Traffic Control
●	●	●	●		●	●	●	●	●		●	●			Incident Management
●	●			●	●		●		●		●		●	●	Emissions Testing and Mitigation

2. Travel Demand Management

Applicable Functions: Data Base Processing	Stationary Communications	Individual Traveler Interface	Variable Message Displays	Navigation	1-Way Mobile Communications	2-Way Mobile Communications	Inter-Agency Coordination	Routing Data Processing	Vehicle Surveillance	Payment Systems	Restrictions Traffic Control	Traffic Surveillance	Traffic Prediction Data Processing	Signalized Traffic Control	Provide Deployment Basis For These User Services
●	●	●	●	●		●	●	●			●	●	●		Pre-Trip Travel Information
●	●	●	●	●	●	●	●	●	●	●					Ride Matching & Reservation
●	●	●	●	●	●				●	●	●			●	Travel Demand Management

Figure 3 Functional Relationships Among User Services

3. Public Transportation Operations

Vehicle Surveillance	2-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	Inter-Agency Coordination	Variable Message Displays	Data Base Processing	Traffic Surveillance	1-Way Mobile Communications	Navigation	Traffic Prediction Data Processing	Payment Systems	Routing Data Processing	In-Vehicle Sensors/Devices	Signalized Traffic Control	Provide Deployment Basis For These User Services
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Public Transportation Management
●	●	●	●	●	●	●	●	●	●	●					En-Route Transit Information
●	●	●	●	●	●	●			●	●	●	●			Personalized Transit Information
●	●	●	●	●			●	●					●		Public Travel Security

(Applicable Functions: first fifteen columns)

4. Electronic Payment

Vehicle Surveillance	1-Way Mobile Communications	2-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	Payment Systems	Variable Message Displays	Data Base Processing	Inter-Agency Coordination	Provide Deployment Basis For These User Services
●	●	●	●	●	●	●	●	●	Electronic Payment Services

(Applicable Functions: first nine columns)

Figure 3 Functional Relationships Among User Services (Continued)

5. Commercial Vehicle Operations

2-Way Mobile Communications	Data Base Processing	Vehicle Surveillance	1-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	In-Vehicle Sensors/Devices	Variable Message Displays	Navigation	Payment Systems	Routing Data Processing	Provide Deployment Basis For These User Services
●	●	●	●	●	●		●				Commercial Vehicle Electronic Clearance
●	●			●		●					Automated Roadside Safety Inspection
●					●	●					On-board Safety Monitoring
●	●	●	●	●	●		●		●		Commercial Vehicle Administrative Processes
●	●	●	●			●		●			Hazardous Material Incident Response
●	●	●	●	●	●			●		●	Commercial Fleet Management

6. Emergency Management

Vehicle Surveillance	1-Way Mobile Communications	2-Way Mobile Communications	Navigation	Data Base Processing	Routing Data Processing	Individual Traveler Interface	In-Vehicle Sensors/Devices	Traffic Surveillance	Inter-Agency Coordination	Stationary Communications	Variable Message Displays	Signalized Traffic Control	Traffic Prediction Data Processing	Provide Deployment Basis For These User Services
●	●	●	●	●	●	●	●							Emergency Notification & Personal Security
●	●	●	●	●	●			●	●	●	●	●	●	Emergency Vehicle Management

Figure 3 Functional Relationships Among User Services (Continued)

7. Advanced Vehicle Control and Safety Systems

Individual Traveler Interface	In-Vehicle Sensors/Devices	1-Way Mobile Communications	Traffic Surveillance	2-Way Mobile Communications	Variable Message Displays	Signalized Traffic Control	Stationary Communications	Vehicle Surveillance	Navigation	Data Base Processing	Traffic Prediction Data Processing	Restrictions Traffic Control	Provide Deployment Basis For These User Services
●	●	●	●	●									Longitudinal Collision Avoidance
●	●	●	●										Lateral Collision Avoidance
●	●	●	●	●	●	●		●	●	●	●		Intersection Collision Avoidance
●	●												Vision Enhancement for Crash Avoidance
●	●	●			●		●						Safety Readiness
●	●												Pre-Crash Restraint Deployment
●	●	●	●	●		●	●					●	Automated Highway Systems

Note: the column headings "Individual Traveler Interface" to "Restrictions Traffic Control" are printed under the spanning heading "Applicable Functions".

Figure 3 Functional Relationships Among User Services (Continued)

APPENDIX B

ITS EARLY DEPLOYMENT PROJECT PROSPECTUSES

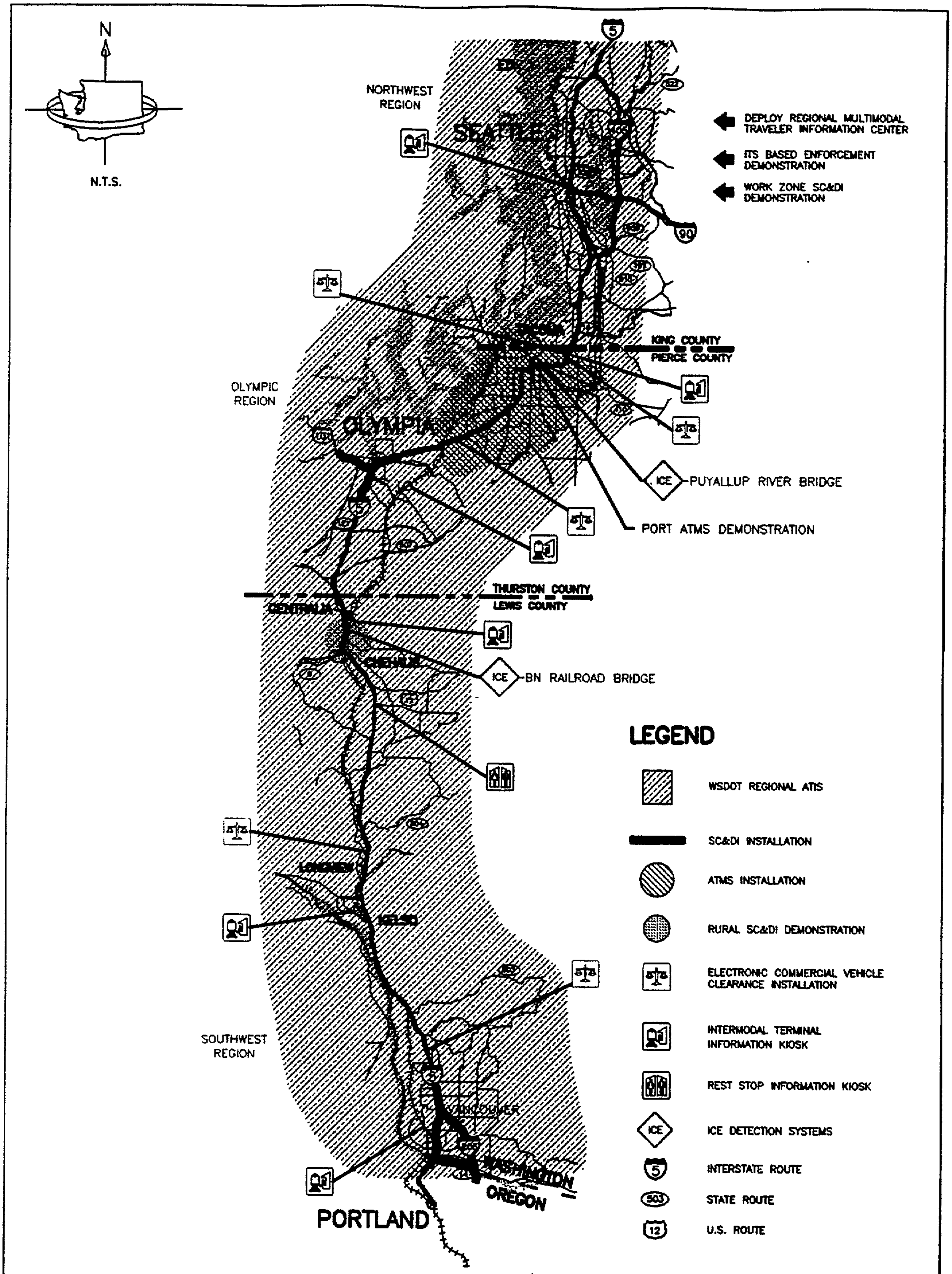
APPENDIX B

ITS EARLY DEPLOYMENT PROJECT PROSPECT USES

This appendix contains the individual project prospectuses identified in the draft Seattle to Portland ITS Corridor Plan. These projects included in this appendix by plan area are listed below. Figure A-1 provides the location of each project in the corridor.

EARLY DEPLOYMENT PROJECTS

Plan Area	***Project Title***
CORRIDOR-WIDE SYSTEMS	
CVO-Applications	*Deploy Corridor wide Automated Electronic Vehicle Clearance*
Enforcement Applications	*Demonstrate ITS Enforcement Concepts*
PUGET SOUND REGION	
Travel & Transportation Management	*Develop and Deploy WSDOT Northwest Region Traffic Related Information System*
	Develop and Deploy WSDOT Olympic Region Traffic Related Information System
	Deploy WSDOT Seattle-Portland Traffic Related Information System
	Develop and Deploy Olympic Area SC&DI System
	Develop East King County ATMS
	Develop South King County ATMS
	Develop Pierce County ATMS
	Demonstrate Work Zone SC&DI System
Travel Demand Management	***Develop Regional Multimodal Traveler Information Center***
	Pilot Intermodal Terminal Information Kiosks
	Demonstrate Employer Based Multimodal Traveler Information System
Port Access	*Demonstrate Port ATMS Concept*
INTERCITY	*Demonstrate Rural SC&DI System in Centralia/Chehalis Area*
	Deploy US 30 Route Diversion
	Pilot Rest Stop Information Kiosks
PORTLA ND - VANCOUVER REGION	
Travel & Transportation Management	*Develop and Deploy WSDOT Southwest Region Traffic Related Information System*
	Develop and Deploy WSDOT Southwest Region SC&DI System
	Deploy Ice Detection System



SEATTLE TO PORTLAND
INTER-CITY MHS CORRIDOR
STUDY AND COMMUNICATION PLAN

PROPOSED EARLY DEPLOYMENT PROJECTS

FIGURE B-1

Project Title: **Deploy Corridor Wide Automated Electronic Vehicle Clearance**

User Services: Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance

Commercial Vehicle Operations:
- Commercial Vehicle Electronic Clearance
- Commercial Vehicle Administrative Processes

Time Frame: Near-Term

Objective: The primary objective of thisproject is to decrease the time required for performing the regulatory checks at weigh stations along Interstate 5 and reduce the number of manual checks. Use of ITS technology can eliminate the requirement for pre-approved commercial vehicles to stop at these weigh stations and increases the number of vehicles that can be checked for with current staff.

Project Background and Needs: Interstate 5 serves as the primary highway connection between Seattle and Portland and is part of the major interstate route which runs from Canada to Mexico along the west coast of the United States. Between Seattle and Portland, there are five weigh stations - three northbound and two southbound. All currently have static scales and are staffed by Washington State Patrol personnel. This corridor carries a significant amount of truck traffic For the six month period beginning January 1, 1994, about 828,900 trucks traveled across the scales at these stations. Truck percentages range from 6.3 percent to as much as 30.2 percent of the total traffic using the corridor. Data collected at the Kelso Weigh Station for ***the 1991 Washington Ports and Transportation System Study*** shows that between 25 percent and 35 percent of all trucks are overweight. Overweight trucks cause increased pavement wear and are often a safety concern as well.

Many weigh stations experience periodic congestion caused by trucks arriving faster than they can be processed. This backlog forces trucks to stop and wait on the ramps leading to the scale house. Where truck volumes are high relative to the processing time, the queue of waiting trucks can extend closed to, or on to, the main highway, interfering with highway operation and safety. To avoid creating hazardous queues, the station either shuts down the station's operation until the queue of trucks has been reduced, or shortens the processing time allocated each vehicle.

The public and private sectors look to advanced technology to increase safety and speed and improve productivity and regulatory compliance. Washington was one of the participants in the first FHWA sponsored operational test of a CVO application under the multi-state Heavy vehicle Electronic License Plate (HELP) program. The Crescent Demonstration Project deployed WIM, AVI, and automatic vehicle classification (AVC) at over 40 sites from British Columbia along I-5 through California and then eastward along I- 10 into Texas. Nearly 4,200 trucks were equipped with AVI devices during the demonstration period. The project confirmed to both the public and privatesectors the utility of allowing AVI equipped commercial vehicles to have their safety status, credentials and weight checked at mainline speeds. Vehicles within the weight limits and with proper credentials could then by-pass the weigh stations without stopping. A quasi-public institution called HELP, Inc. has been formed to market this and other CVO services to the trucking industry for a fee. The initial mainline pre-clearance are being installed at several California weigh stations.

Currently, the following four state agencies regulate CVO in Washington:

- Washington State Department of Licensing (WSDOL);
- Washington State Department of Transportation (WSDOT);
- Washington State Patrol (WSP); and
- Washington Utilities and Transportation Commission (WUTC).

Statement of Deficiency:

The following problem areas have been identified about the current operation of weigh stations along the I-5 corridor:

- congestion at weigh stations;
- delays to trucks at weigh stations;
- administrative complexity;
- limited staffing levels
- competitive advantage for non-compliance or non-participation;
- complexity of driver responsibilities;
- the increasing consumer orientation of the business; and
- the effectiveness of safety programs.

Project Description:

This project would use weigh-in-motion (WIM) and automatic vehicle identification (AVI) technology at corridor weigh stations to allow AVI equipped commercial vehicles to have their credentials, safety status and weight checked for compliance at highway speeds. Commercial vehicles that are legal and safe would be allowed to by-pass these weigh stations. Relevant registration, taxation and safety status information from the four Washington state agencies and three federal agencies having jurisdiction over specific aspects of commercial vehicle matters would need to be accessible at the weight stations to provide this service. Electronic Data Interchange (EDI) of this status information would be required.

The technologies and supporting systems required to implement this project have been successful during the Crescent Demonstration Project under the Heavy vehicle Electronic License Plate (HELP) effort.

In mainline preclearance, a truck equipped with a communication device called a transponder is uniquely identified with AVI equipment as a weigh station is approached. The truck also passes over a WIM sensor imbedded in the pavement which weighs the truck and determines its configuration as it travels at highway speed. This information is checked against a central database to assure that the operating credentials are in order, necessary permits have been issued, required filings have been made, weight is within declared limits, a recent safety inspection has been performed and the carrier's safety and enforcement record is good. If these criteria are not met, the driver is signaled to enter the weigh station. If the criteria are met, the driver is signaled to proceed with entering the weigh station.

System Capabilities:

The proposed electronic credential verification system will have the following three key capabilities:

- Ability to identify and weigh participating commercial vehicles at highway speeds;
- Ability to signal participating vehicles to enter or by-pass the weigh station; and
- Ability to automatically update credentials from the relevant regulatory agencies.

Project Scope: The project will be divided into two phases: development of an implementation plan and implementation of the program. Following is a brief description of the scope of work for each of the two phases.

Phase 1: Implementation Plan

The planning effort will consist of the following activities:

1. Convene a working group of the four primary agencies, HELP, Inc., and the motor carrier industry to determine the scope and definition of a electronic vehicle clearance program for Washington State.

2. Account for CVO programs in other states and the required interfaces.

3. Define roles and responsibilities of each organization including installation, operational and maintenance duties. Determine the potential role of third party, such as HELP, Inc. in the program.

4. Determine functional specifications for the program including AVI requirements and mechanism for obtaining for credential information

5. Reach consensus among the working group and approval from required regulatory agencies.

6. Prepare a detailed work plan for system implementation.

Phase 2: Implementation

During the second phase of this project, the clearance system would be implemented. The major tasks will include the following:

1. Prepare system design documentation including computer, hardware and equipment requirements.

2. Prepare field equipment installation design documentation.

3. Design and develop EDI software for the automated updating of credentials.

4. Develop recruitment and transponder distribution plan.

5. Install, test and integrate computer software, hardware, communications, and field equipment.

6. Train weigh station personnel.

7. Distribute transponders.

8. Begin program and evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

Project Cost:

Table 1 presents a summary of the capital costs in 1995 dollars for the Corridor Wide Automated Electronic Commercial Vehicle Clearance system. The estimate is for the base system which was described above and does not include expansions or upgrades. It is also assumed the program participants would pay for the transponders in a manner to be defined during implementation planning. The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Maintenance cost is estimated at 25 percent of the capital cost due to experience with WIM installation. Operational costs include staff requirements for the distribution of transponders and ensure the smooth communication of the data required for electronic clearance. The cost of operations might be offset by user fees, but this decision would be made during implementation planning.

Total Capital Cost =	**$230,000**
Maintenance Cost/Year =	**$562,500**
Operating Cost/Year =	**$225,000**

Project Benefits:

The project is expected to benefit private motor carriers, state regulatory agencies, and the general public. The savings to the carriers are based upon the waiting time and operating costs saved by using the automated electronic vehicle clearance system. and the potential revenue lost by not using this system. A survey of California trucking firms conducted by HELP, Inc. revealed that 75% of responders estimated the cost of a truck stopping at a weigh station at $15.00. Assuming conservatively that 25% of the 1.6 million trucks now stopping at the weigh stations participate in program, the projected annual savings would be $6.1 million. Administrative savings, reduced costs due to overweight trucks, and additional revenue from fines because more trucks are weighed is not included in the benefit total at this time.

Project B/C Ratio: The benefit/cost ratio is based on a 20 year amortization of capital and O&M costs and the reduced costs to motor carriers in operating costs. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS plan.

Equivalent Uniform Annual Cost	**$953,100**
Annual Benefits	**$6,072,368**
Benefit/Cost Ratio	**6.37**

Project Schedule: The project is proposed as a near-term ITS project (O-6 year time frame). The planning phase (phase 1) of the project would be completed one year after award. The implementation phase (phase 2) would be completed two years after award.

Item	Unit Cost (1995 $)	# Units	Total Costs (1995 $)
Planning Study	$100,000	1	$100,000
Weigh Station Installation	$350,000	5	$1,750,000
System Deployment	$400,000	1	$400,000
Total Implementation Costs			$2,250,000
Maintenance Cost/Year			$562,500
Operations Cost/Year			$225,000
Equivalent Uniform Annual Cost			$953,100

Table 1: Cost Summary

Project Title: **Demonstrate ITS Enforcement Concepts**

User Services: Traffic Management
- Incident Management
- Traffic Control

Enforcement

Time Frame: Near-Term

Objective: The objective of this project is to identify and demonstrate potential ITS-based enforcement concepts

Project Background and Need: The support of highway regulatory enforcement activity is not considered an ITS user service under the current FHWA definitions. However, enforcement action statistics for the Seattle to Portland corridor along I-5 indicate the significant amount of effort is required by Washington State Police (WSP) and other response agencies. For example, 1.2 citations are issued by WSP per mile per day; 3.4 assists/calls are made occur per mile per day; in rural areas, there are an average of 33 annual accidents per mile; and in urban areas, there are an average of 238 annual accidents per mile. ITS technology could provide potential solutions to augment WSP enforcement efforts and allow enforcement personnel to focus on priority assignments.

Statement of Deficiency: Washington State Patrol is primarily responsible for the enforcement of traffic regulations along I-5. Enforcement is required to ensure the safety of all travelers using this highway facility. The amount of enforcement related activity is significant along I-5 requiring a significant commitment of resources that may be useful in other tasks.

Project Description and System Capabilities: The project will first explore potential concepts for using ITS technology to assist in the enforcement of traffic regulations. Areas to be considered include:

- automated speed enforcement where speeders are identified by radar and an image of the vehicle is captured for later processing;

- video based tracking technology which can identify vehicles that are traveling erratically and could indicate an impaired driver;

- automatic vehicle classification and video image processing to enforce HOV violations;

- AVI equipped trucks combined with WIM to identify overweight trucks; and

- emission sensors to detect seriously offending vehicles.

Based upon this assessment, the most promising concepts would be selected for demonstration testing to determine their true potential in field operations. Potential demonstration sites include I-5 in the Puget Sound Region, I-5 in the Centralia and Kelso areas, and I-5 and I-205 in the Vancouver area.

Project Scope:

The scope of work consists of two phases. The first phase involves the identification, and design of the demonstration project. The second phase is the demonstration and evaluation of the most promising concepts. The tasks for each phase are as follows:

Phase 1concept Development and Design of Demonstrations

1. Develop concepts and ideas for using ITS technology for enforcement purposes.

2. Determine technical, legal, operational, and cost feasibility of each concept.

3. Select and gain consensus on which concepts to demonstrate.

4. Develop scope of work for the demonstration.

5. Develop partnerships with private industry to provide product prototypes and conduct the product demonstration.

Phase 2: Demonstration and Evaluation

1. Install field and office hardware, software and equipment.

2. Develop a testing planning including measures of effectiveness and identify data collection requirements.

3. Conduct the evaluation study and develop recommendations for follow-on deployment work.

Project Cost: **Table 1** presents a summary explanation of the project cost in 1995 dollars.

Total Cost = **$300,000**

Project Benefits: The project benefits will be reflected in the evaluation and testing of systems using advanced technology to reduce the cost of enforcement along I-5 from Seattle to Portland. Depending on the effectiveness of the concepts, the applications may vary from speed enforcement to HOV lane enforcement. The project will determine the potential benefits in deploying these systems. The cost effectiveness of field deployment will then be able to be determined.

Project Schedule: The project is proposed as a near-term ITS project (0-6 years time frame). The concept development of demonstration will be completed eight (8) months after award. The demonstration and evaluation of the concepts will be completed eighteen (18) months after award.

Item	**Unit Cost (1995 $)**	**# Units**	**Total Cost (1995 $)**
Phase 1: Research & Development Cost	$75,000	1	75,000.00
Phase 2			
System Costs	$250,000	1	250,000.00
Evaluation	$50,000	1	50,000.00
Private Contribution to Demonstrations	($75,000)	1	-75,000.00
Total Project Cost	-	-	**300,000.00**

Table 1: Cost Summary

Project Title: **Develop and Deploy WSDOT Northwest Region Traffic Related Information System**

User Services:
Travel and Transportation Management
- En-Route Driver Information
- Traveler Services Information

Travel Demand Management
- Pre-Trip Travel Information
- Demand Management and Operations

Time Frame: Near Term

Objective: To develop a traffic related event-based Advanced Traveler Information System (ATIS), and deploy it in the Northwest Region along the I-5 Corridor.

Project Background and Need:

Advanced Traveler Information Systems have proven to be one of the most effective ITS tools for managing traffic reducing congestion, delay, fuel consumption and emissions, and improving safety. This is achieved by informing travelers of the location of incidents, construction and traffic congestion in order to allow travelers to choose alternative routes, modes or departure times.

Currently there exists within the Northwest Region along the corridor a number of sources of traffic related event information such as incident reports, construction and maintenance activities, traffic congestion and location of detours. While some of this information is distributed to the public through variable message signs (VMS), highway advisory radio (HAR) and media reports, much of it is used for internal agency purposes only and/or is not readily accessible by the public.

There is therefore a need to develop a system that can collect and aggregate these various sources of information in order to provide travelers with a comprehensive, single source of traffic related information that can be accessed on a pre-trip or en-route basis using a variety of means and technologies. In addition, such a system would provide a consistent basis for defining traffic events, further improving the value of the information to the public, other transportation agencies and commercial vehicle operations.

Statement of Deficiency:

The management of traffic in a congestion area, in a work zone, or at an incident location requires the timely transmission of event related traffic information to travelers on a pre-trip and en-route basis. Limited access to current traffic event related information hinders the ability to manage traffic in these areas which results in increased congestion levels, decreased mobility, and a subsequent impairment of traffic safety.

Project Description:

This project would involve the development and deployment of a system to collect, process, format and disseminate traffic related information for the Northwest Region. This information could also be consolidated and filtered to provide input to a comprehensive corridor or statewide information system.

Development, implementation, integration and operations costs will be minimized by developing a similar system for all three Regions. This project will include the system design and will expand, enhance and provide long-term support for the Internet-based system developed by the Northwest Region Traffic System Management Center and the University of Washington.

System Capabilities:

The Traffic Related Traveler Information System will manually or electronically gather traffic related event information such as:

- accident and incident reports from such sources as cellular phone or other call-ins, police dispatch, WSDOT mobile vehicles and the bridge tenders;
- pre-planned road closure, construction and maintenance information;
- emergency road closure, construction and maintenance information;
- truck or hazardous material restrictions;
- reversible lane operations;
- traffic speed and congestion information from SC&DI systems;
- weather conditions;
- information on planned recreational events or other activities that may disrupt traffic flow or require traffic re-routing.

All information inputs will need to be geocoded using a common referencing system such as latitude-longitude, highway milepost or major street-cross street.

Information will be stored in a relational database, running as an application on a desktop PC using a multi-tasking operating system such as Windows NT. Maximum use of commercial off-the-shelf (COTS) software, coupled with a modular design approach, will allow for a system that is expandable (both functionally and geographically) and transportable to other applications or to new hardware platforms.

The system will be designed to disseminate the traffic related event information through existing and planned WSDOT motorist information devices (i.e. VMS, HAR and media interfaces). Information dissemination capabilities may also be expanded to include new devices such as:

- automatic fax transmission to WSDOT maintenance yards, commercial radio and television stations, and other public and/or private users in need of regular traffic reports. Subscribers to the fax service would be able to define the type of information they want, the geographical area, the highways and the times (including immediate response) at which faxes should be sent. It would also be possible to charge for this service, which would be part of the subscribers data base.

- alphanumeric pager messages to WSDOT operations and maintenance staff and emergency services;

- a public dial-up information line providing computer-generated voice messages. T'he messages could be structured so that they can be accessed by the highway name for selected geographical areas (e.g. I 5 FROM TACOMA TO SEATTLE);

- linkages to traveler information kiosks;

- computer data feeds to both public and private users through Internet and/or direct dial-up lines;

- data feeds to mobile units using data formats such as International Traveler Information Interchange Standards (ITIS) over radio based communications including subcarrier, CDPD or data broadcast radio;

- electronic data interfaces to value added re-sellers including HELP Inc. for redistribution of the information to truckers along the corridor.

It is expected that this system will be installed in the TSMC and integrated with current traffic management operations. Terminal. feeds from regional maintenance yards and the tunnel operation would also be provided to allow remote access throughout the Region.

Project Scope: Work activities will be divided into 3 phases including:

Phase 1- Developing the Traffic Related Traveler Information System.

Phase 2- Deploying and configuring system for the Northwest Region.

Phase 3 - Facilitating a communications link to the Seattle-Portland Traffic Related Traveler Information System.

This work will not include the deployment of traveler information devices (e.g. VMS, HAR, information kiosks, etc.) in the field. It is expected that these will be installed as part of other initiatives.

It is expected that the design and development of the traffic related traveler information system for the Northwest Region will form the core design for all Regions in the corridor. As such, this project must be initiated before any other Regional Traffic Related Traveler Information System.

Phase 1 - Traffic Related Traveler Information System Development

System development and testing will include:

1. Preparation of a functional design report describing the overall system design and requirements.

2. Detailed design of the software applications to support the functional requirements.

3. Development of all new software applications.

4. Development of hardware/software interfaces to the TSMC central computer.

5. Development of hardware/software interfaces to external users (e.g. media interfaces, BBS or Internet access, etc.).

6. Establishing interagency agreements with each major public and private user agency.

Phase 2. - Deployment in the Northwest Region

1. Hardware and software procurement.

2. Coding and testing of all new software applications.

3. Testing of hardware/software interfaces to the TSMC central computer.

4. Testing of hardware/software interfaces to external users.

5. Overall system testing, configuration and integration.

6. Preparation ofdesign, operations and maintenance manuals;

7. Training of operations staff.

Phase 3 - Ingtegration with Seattle-Portland Traffic Related Information System

This third phase would facilitate a communications link to the Seattle-Portland Traffic Related Traveler Information System Center to assist in providing corridor wide traveler information coverage. This activity could be done concurrently with system deployment of the corridor-wide system, or could be deferred until sufficient experience is gained with stand-alone operation in this Region.

As part of the Northwest Region development, the following tasks are required to integrate the system with the other regions and the corridor-wide system:

1. Preparation of a system design report;

2. Procuring additional software/licenses for the digital maps or GIS to provide corridor wide coverage.

3. Preparing inter-Regional agreements for the sharing and exchange of information, including establishing levels of access.

4. Modifying existing external agency agreements as required to provide corridor information, and establishment of new agreements with agencies having a corridor focus (e.g. private cvo firms).

5. Establishing system-to-system data communications links using the Internet-based corridor system architecture.

6. Modifying system software as required to support corridor wide information collection and dissemination.

7. Update of design, operations and maintenance manuals;

8. Training of operations staff.

Project Cost: Estimated project costs are described in Table 1 and are summarized below. The costs include the software development and limited hardware procurement. These costs do not include additional field equipment such as VMS's, pagers, kiosks, etc. It is expected that these will be provided as part of other initiatives.

It is assumed that the system will be staffed by two full-time equivalent performing both operations and maintenance. It is assumed that the operations and maintenance is 20% of the capital cost. It is assumed that communications will be provided through existing resources (i.e. SCAN or radio).

Total Capital Cost	**$960,000**
Annual O&M	**$192,000**

Project Benefits: The Statewide IVHS Plan identified the potential benefits of ATIS in the Central Puget Sound area at approximately $29,000,000 per year.

The Northwest Region represents roughly 70% of the vehicle-miles traveled within the Central Puget Sound area. Assuming that 5% of these benefits can be achieved through deployment of the Regional Traffic Related Information System, the annual benefits for the Northwest Region can be estimated as:

Annual Benefits	$1,015,000

Project B/C: The benefit/cost ratio is based on a 20-year amortization of capital and O&M costs, and the pro-rated ATIS benefits computed in the Statewide IVHS Plan. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS Plan.

Equivalent Uniform	
Annual Costs	**$262,656**
Annual Benefits	**$1,015,000**
Benefit/Cost Ratio	**3.9:1**

Project Schedule: The Northwest Region Traffic Related Information System is proposed as a high-priority near-term project (O-6 years time frame). The system development would be completed in eighteen (18) months after award. The system deployment would be completed two (2) years after award.

It is expected that the system design and deployment of the system in the Northwest Region be completed first. Deployment of similar system in the Southwest and Olympic Regions is contingent upon the successful deployment in the Northwest Region. The three systems are expected to be integrated into a corridor-wide system after all three systems have been deployed.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
System Development	600,000	1	600,000
System Deployment	200,000	1	200,000
Total Construction. Cost	-	-	**800,000**
Design/Evaluation Cost	-	-	160,000
Total Capital Cost	-	-	**960,000**
O & M Cost/Year	-	-	**192,000**

Table 1: Cost Summary

Project Title: **Develop and Deploy WSDOT Olympic Region Traffic Related Information System**

User Services: Travel and Transportation Management
- En-Route Driver Information
- Traveler Services Information

Travel Demand Management
- Pre-Trip Travel Information
- Demand Management and Operations

Time Frame: Near Term

Objective: To develop a traffic related event-based Advanced Traveler Information System (ATIS), and deploy it in the Olympic Region along the I-5 Corridor.

Project Background and Need: Advanced Traveler Information Systems have proven to be one of the most effective ITS tools for managing traffic reducing congestion, delay, fuel consumption and emissions, and improving safety. This is achieved by informing travelers of the location of incidents, construction and traffic congestion in order to allow travelers to choose alternative routes, modes or departure times.

Currently there exists within the Olympic Region along the corridor a number of sources of traffic related event information such as incident reports, construction and maintenance activities, traffic congestion and location of detours. While some of this information is distributed to the public through variable message signs (VMS), highway advisory radio (HAR) and media reports, much of it is used for internal agency purposes only and/or is not readily accessible by the public.

There is therefore a need to develop a system that can collect and aggregate these various sources of information in order to provide travelers with a comprehensive, single source of traffic related information that can be accessed on a pre-trip or en-route basis using a variety of means and technologies. In addition, such a system would provide a consistent basis for defining traffic events, further improving the value of the information to the public, other transportation agencies and commercial vehicle operations.

Statement of Deficiency:

The management of traffic in a congestion area, in a work zone, or at an incident location requires the timely transmission of event related traffic information to travelers on a pre-trip and en-route basis. Limited access to current traffic event related information hinders the ability to manage traffic in these areas which results in increased congestion levels, decreased mobility, and a subsequent impairment of traffic safety.

Project Description:

This project would involve the development and deployment of a system to collect, process, format and disseminate traffic related information for the Olympic Region. This information could also be consolidated and filtered to provide input to a comprehensive corridor or statewide information system. For example, a Traffic Related Traveler Information System will be developed to facilitate coordination between this region with both the Southwest and Northwest Regions.

Development, implementation, integration and operations costs will be minimized by developing a similar system for all three Regions in the Northwest Region project. Only minor custom tailoring and configuring for this Region would be required to accommodate Region-specific information sources, dissemination methods and operational strategies.

System Capabilities:

The Traffic Related Traveler Information System will manually or electronically gather traffic related event information such as:

- accident and incident reports from such sources as cellular phone or other call-ins, police dispatch, WSDOT mobile vehicles and the bridge tenders;
- pre-planned road closure, construction and maintenance information;
- emergency road closure, construction and maintenance information;
- truck or hazardous material restrictions;
- reversible lane operations;
- weather conditions;
- information on planned recreational events or other activities that may disrupt traffic flow or require traffic re-routing.

All information inputs will need to be geocoded using a common referencing system such as latitude-longitude, highway milepost or major street-cross street.

Information will be stored in a relational database, running as an application on a desktop PC using a multi-tasking operating system such as Windows NT. Maximum use of commercial off-the-shelf (COTS) software, coupled with a modular design approach, will allow for a system that is expandable (both functionally and geographically) and transportable to other applications or to new hardware platforms.

The system will be designed to disseminate the traffic related event information through existing and planned WSDOT motorist information devices (i.e. VMS, HAR and media interfaces). Information dissemination capabilities may also be expanded to include new devices such as:

- automatic fax transmission to WSDOT maintenance yards, commercial radio and television stations, and other public and/or private users in need of regular traffic reports. Subscribers to the fax service would be able to define the type of information they want, the geographical area, the highways and the times (including immediate response) at which faxes should be sent. It would also be possible to charge for this service, which would be part of the subscribers data base.

- alphanumeric pager messages to WSDOT operations and maintenance staff and emergency services;

- a public dial-up information line providing computer-generated voice messages. The messages could be structured so that they can be accessed by the highway name for selected geographical areas (e.g. I-5 FROM TACOMA TO SEATTLE);

- linkages to traveler information kiosks;

- computer data feeds to both public and private users through Internet and/or direct dial-up lines;

- data feeds to mobile units using data formats such as the International Traveler Information Interchange Standards (ITIS) over radio based communications including subcarrier, CDPD or data broadcast radio;

- electronic data interfaces to value added re-sellers including HELP Inc. for redistribution of the information to truckers along the corridor.

For this Region, it is anticipated that the system will be initially integrated into existing traffic engineering and/or roadway maintenance operations. Terminal feeds from regional maintenance yards would also be providedto allow remote access throughout the Region.

Project Scope: Work activities will consist of two phases:

Phase 1- Deploying and configuring the Traffic Related Traveler Information System in the Olympic Region.

Phase2- Facilitating a communications link to the Seattle-Portland Traffic Related Traveler Information System.

This work will not include the deployment of traveler information devices (e.g. VMS, HAR, information kiosks, etc.) in the field. It is expected that these will be installed as part of other initiatives.

It is expected that the design and development of the traffic related traveler information system for the Northwest Region will form the standard for all Regions in the corridor. As such, this project must begin after the completion of the first phase of the Northwest Region project.

Phase 1 - Deployment in the Olympic Region

Upon successful development and testing of the traffic related event information system in the Northwest Region, the system would be deployed and modified in the Olympic Region. Major work activities in this Region will include:

1. Preparation of a functional design report describing aspects of the Northwest Region system that need to be tailored for application in the Olympic Region;

2. Detailed design of modifications to the Northwest Region system software elements to support deployment in the Olympic Region;

3. Hardware and software procurement/additional license agreements;

4. Modification or development, coding and testing of modified or new software applications.

5. Modification and testing of hardware/software interfaces to existing WSDOT systems (e.g. VMS).

6. Development and testing of new hardware/software interfaces to external users. Application or modification of interagency agreements developed for the Northwest Region to each major external user;

7. Overall system testing and integration.

8. Update of design, operations and maintenance manuals;

9. Training of operations staff.

Phase 3. - Integration with Seattle-Portland Information System

This second phase would facilitate a communications link to the Seattle-Portland Traffic Related Traveler Information System Center to assist in providing corridor wide traveler information coverage. This activity could be done concurrently with system deployment of the corridor-wide system, or could be deferred until sufficient experience is gained with stand-alone operation in this Region.

Requirements and provisions for providing corridor wide information will have been considered under the Northwest Region system core design. Work under this phase will consist mainly of relatively minor software and/or hardware modifications including:

1. Preparation of a system design report;

2. Procuring additional software/licenses for the digital maps or GIS to provide corridor wide coverage.

3. Preparing inter-Regional agreements for the sharing and exchange of information, including establishing levels of access.

4. Modifying existing external agency agreements as required to provide corridor information, and establishment of new agreements with agencies having a corridor focus (e.g. private cvo firms).

5. Establishing system-to-system data communications links using the Internet-based corridor system architecture.

6. Modifying system software as required to support corridor wide information collection and dissemination.

7. Update of design, operations and maintenance manuals;

8. Training of operations staff.

Project Cost: Estimated project costs are described in **Table 1** and are summarized below. The costs include the software development and limited hardware procurement. These costs do not include additional field equipment such as VMS's, pagers, kiosks, etc. It is expected that these will be provided as part of other initiatives.

It is assumed that the system will be staffed by one full-time equivalent performing both operations and maintenance. It is assumed that the operations and maintenance is 20% of the capital cost. It is assumed that communications will be provided through existing resources (i.e. SCAN or radio).

Total Capital Cost	$180,000
Annual O&M	$36,000

Project Benefits: The Statewide M-IS Plan identified the potential benefits of ATIS in the Central Puget Sound area at approximately $29,000,000 per year. The Olympic Region represents 30% of the vehicle-miles traveled in the Central Puget Sound. Assuming that 5% of these benefits can be achieved through deployment of the Regional Traffic Related

Information System, the annual benefits for the Olympic Region can be estimated as:

Annual Benefits **$435,000**

Project B/C:

The benefit/cost ratio is based on a 20-year amortization of capital and O&M costs, and the pro-rated ATIS benefits computed in the Statewide IVHS Plan. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS Plan.

Equivalent Uniform
Annual Costs **$49,248**
Annual Benefits **$435,000**

Benefit/Cost Ratio **8.8:1**

Project Schedule:

The Olympic Region Traffic Related Information System is proposed as a high-priority near-term project (O-6 years time frame). The system development would be based core system design developed for the Northwest Region Traffic Related Information System. System development would be completed in six (6) months after award. The system deployment would be completed one (1) year after award.

It is expected that the system design and deployment of the system in the Northwest Region be completed first. Deployment of similar system in the Southwest and Olympic Regions is contingent upon the successful deployment in the Northwest Region. The three systems are expected to be integrated into a corridor-wide system after all three systems have been deployed.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
System Deployment	150,000	1	150,000
Total Construction. Cost	-	-	**150,000**
Design/Evaluation Cost	-	-	30,000
Total Capital Cost	-	-	**180,000**
O & M Cost/Year	-	-	**36,000**

Table 1: Cost Summary

Project Title: **Deploy WSDOT Seattle-Portland Traffic Related Information System**

User Services: Travel and Transportation Management
- En-Route Driver Information
- Traveler Services Information

Travel Demand Management
- Pre-Trip Travel Information
- Demand Management and Operations

Time Frame: Near Term

Objective: To develop a common traffic related event-based Advanced Traveler Information System (ATIS) that facilitates the, information interchange between the Northwest, Southwest and Olympic Regional Traffic Related Traveler Information Systems. In this way, a corridor-wide traveler information system will be created by coordinating the functions of existing systems in neighboring regions.

Project Background and Need: Advanced Traveler Information Systems have proven to be one of the most effective ITS tools for managing traffic, reducing congestion, delay, fuel consumption and emissions, and improving safety. This is achieved by informing travelers of the location of incidents, construction and traffic congestion in order to allow travelers to choose alternative routes, modes or departure time.

Currently there exists within each of the Regions along the corridor a number of sources of traffic related event information such as incident reports, construction and maintenance activities, traffic congestion and location of detours. While some of this information is distributed to the public through variable message signs (VMS), highway advisory radio (HAR) and media reports, much of it is used for internal agency purposes only and/or is not readily accessible by the public. Regional traveler information systems will be deployed to address this issue and will perform as a comprehensive, single source of traffic related information that can be accessed on a pre-trip or en-route basis using a variety of means and technologies.

As many trips within the I-5 Portland to Seattle corridor travel across the borders between WSDOT regions, the pre-trip planning benefits of these systems will be lost on these travelers as access to the information does not extend beyond the regional boundaries. To address this issue and assist travelers that cross regional boundaries, a Seattle-Portland Traffic Related Traveler Information System should be developed to facilitate the corridor-wide traveler information from the existing facilities provided by the regional traveler information systems.

Statement of Deficiency

The management of traffic in a congestion area, in a work zone, or at an incident location requires the timely transmission of event related traffic information to travelers on a pre-trip and en-route basis. Limited access to current traffic-event related information hinders the ability to manage traffic in these areas, with the result that congestion levels are increased, mobility is decreased, and safety is impaired.

Project Description:

This project would involve the development and deployment of a system to facilitate information exchange between the proposed regional traveler information systems in order to provide corridor-wide traveler information through the facilities proposed to be present under the regional systems.

Development, implementation, integration and operations costs will be minimized by developing a "baseline" or "core" system common to all three Regions in the Northwest Region project that anticipates the implementation of this project. This project will provide a data management system that will retrieve filtered data from each of the regional traveler information systems and disseminate this information to the neighboring systems.

System Capabilities:

The traffic related event information system will manually or electronically gather traffic related event information from each of the traveler information system such as:

- accident and incident reports from cellular phone or other call-ins, police dispatch, WSDOT mobile vehicles and the bridge tenders;
- pre-planned road closure, construction and maintenance information;
- emergency road closure, construction and maintenance information;
- truck or hazardous material restrictions;

- reversible lane operations;
- traffic speed and congestion information from SC&DI systems (currently only operational in the NW Region);
- weather conditions;
- information on planned recreational events or other activities that may disrupt trafic flow or require traffic re-routing..

All information inputs will need to be geocoded using a common referencing system throughout the corridor such as latitude-longitude, highway milepost and major street-cross street.

Information will be stored in a relational database, running as an application on a desktop PC using a multi-tasking operating system such as Windows NT. Maximum use of commercial off-the-shelf (COTS) software, coupled with a modular design approach, will allow for a system that is expandable (both functionally and geographically) and transportable to other applications or to new hardware platforms.

The system will be designed to disseminate the traffic related event information to the proposed regional traveler information systems. In turn, these systems will use existing and planned WSDOT motorist information devices (VMS, HAR, media interfaces). Information dissemination capabilities may also be expanded to include new devices such as:

- automatic fax transmission to WSDOT maintenance yards, commercial radio and television stations, and other public and/or private users in need of regular traffic reports. Subscribers to the fax service would be able to define the type of information they want, the geographical area, the highways and the times (including immediate response) at which faxes should be sent. It would also be possible to charge for this service, which would be part of the subscribers data base.

- alphanumeric pager messages to WSDOT operations and maintenance staff and emergency services;

- a public dial-up information line providing computer-generated voice messages. The messages could be structured so that they can be accessed by the highway name for selected geographical areas (e.g. I-5 FROM TACOMA TO SEATTLE);

- linkages to traveler information kiosks;

- computer data feeds to both public and private users through Internet and/or direct dial-up lines;

- data feeds to mobile units using data formats such as the International Traveler Information Interchange Standards (ITIS) over radio based communications including, CDPD and data broadcast radio;

- electronic data interfaces to value added re-sellers including HELP Inc. for redistribution of the information to truckers along the corridor.

It is anticipated that the system will be integrated into the proposed traveler information systems for the Northwest Region. Communications between this site and the neighboring regional systems will complete the Seattle-Portland Traffic Related Traveler Information System.

Project Scope: Work activities will consist of one phase which will be timed to match the final phase of the regional traveler information systems. This work is the corridor-wide integration of the regional systems under this project. This work will not include the deployment of traveler information devices (e.g. VMS, HAR, and information kiosks) in the field. It is expected that these will be installed as part of other initiatives.

This work would involve linking together of the traffic related traveler information systems in each of the three Regions to provide corridor wide coverage. This activity could be done concurrently with system deployment in the Olympic and Southwest Regions, or could be deferred until sufficient experience is gained with stand-alone operation in the Regions.

As part of the regional traffic related information system development, requirements and provisions for providing corridor wide traveler information will have been considered requiring only minor updates to connect to the corridor-wide system. The corridor-wide traveler information system development will include:

1. Preparation of a system design report;

2. Procuring additional software/licenses for the digital maps or GIS to provide corridor wide coverage.

3. Preparing inter-Regional agreements for the sharing and exchange of information, including establishing levels of access.

4. Modifying existing external agency agreements as required to provide corridor information, and establishment of new agreements with agencies having a corridor focus (e.g. private cvo firms).

5. Establishing system-to-system data communications links using the Internet-based corridor system architecture.

6. Modifying system software as required to support corridor wide information collection and dissemination.

7. Update of design, operations and maintenance manuals;

8. Training of operations staff

Project Cost: The estimated project costs are described **in Table 1** These costs are for the central system development and communications equipment only. This system will be co-located with a regional system and operated by the staff for that region. It is also assumed that communication costs between these systems will be covered by other resources such as SCAN.

Total Capital Costs	$480,000
Annual O&M	$48,000

Project Benefits: The Statewide IVHS Plan identified the potential benefits of ATIS in the Central Puget Sound area at approximately $29,000,000 per year, and in the Vancouver area at approximately $7,500,000 per year. Assuming that 5% of these benefits can be achieved through deployment of the Seattle-Portland Traffic Related Traveler Information System, the annual benefits for this system can be estimated at:

	Annual Benefits	$1,825,000

Project B/C: The benefit/cost ratio is based on a 20-year amortization of capital and O&M costs, and the pro-rated ATIS benefits computed in the Statewide M-IS Plan. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS Plan.

Equivalent Uniform	
Annual Costs	$83,328
Annual Benefits	$1,825,000
Benefit/Cost Ratio	**21.9:1**

Project Schedule: The Seattle-Portland Traffic Related Information System is proposed as a high-priority near-term project (O-6 years time frame). The system development based on the Northwest Region Traffic Related Information System design would be completed in six (6) months after award. The system deployment would be completed one (1) year after award.

It is expected that the system design and deployment of the system in the Northwest Region be completed first. Deployment of similar systems in the Southwest and Olympic Regions is contingent upon the successful deployment in the Northwest Region. The three systems are expected to be integrated into the Seattle-Portland Traffic Related Information System after all three systems have been deployed.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
System Deployment	400,000	1	400,000
Total Construction. Cost	-	-	**400,000**
Design/Evaluation Cost	-	-	80,000
Total Capital Cost	-	-	**480,000**
O & M Cost/Year	-	-	**48,000**

Table 1: Cost Summary

Project Title: **Develop and Deploy Olympic Are SC&DI a**

User Services Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Public Transportation Operations:
- Public Transportation Management
- Public Travel Security

Commercial Vehicle Operations:
- Commercial Fleet Management

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near Term

.Objective: The primary objective of this effort is to improve the safety and efficiency of people and goods movement on the urban freeway network through the deployment of a surveillance, control, and driver information (SC&DI) system in the Olympia area along Interstate 5 and US 101.

Project Background and Need:

Interstate 5 serves as the primary highway connection between Seattle and Portland and is part of the major interstate route which runs from Canada to Mexico along the west coast of the United States. US 101 intersects I-5 at I-5 Exit 104 and is the primary land route to the Olympic Peninsula in northwest Washington. The Olympic Peninsula area includes Olympic National Park and numerous state parks. Exit 104 also provides access to the ocean beaches.

Congestion on I-5 and US 101 occurs in two forms: recurrent and non-recurrent Recurrent congestion occurs when peak period traffic demand exceeds the capacity of the roadway. Non-recurrent congestion occurs when an incident reduces the capacity of a roadway by lane blockage or shoulder activity. Incidents include stalls or breakdowns, debris or spilled load on the roadway, some maintenance or construction activities, weather conditions, or special events.

The Olympic Region currently employs a number of variable message signs and has some limited vehicle detection capabilities.

Statement of Deficiency: Traveler delay, caused or exacerbated by congestion, is on the rise in the Olympia area. The potential exists for the number of lane miles of congestion to increase and travel speeds along I-5 and US 101 to decrease.

Project Description: This project would involve the development and deployment of a surveillance, control, and driver information system in the Olympia area along the I-5 corridor between SR 510 and SR 121, and along the US 101 corridor between I-5 and SR 8. The SC&DI will include new vehicle detector stations (DS), closed circuit television (CCTV) cameras, variable message signs (VMS), highway advisory radio (HAR), and ramp meter installations in the Olympia area The control units for the signals, DS, CCTV, VMS, HAR, and ramp meters will be located at the WSDOT Olympic Region Traffic System Management Center (TSMC) in Tacoma.

System Capabilities: The proposed Olympia area SC&DI System will have the following capabilities:

- Monitor real time traffic conditions along I-5 and US 101 using the DS and CCTV systems;
- Control the Olympia area VMS and HAR to display/broadcast either pm-designed messages or other messages in response to regional traffic conditions; and
- Coordinate operations with other WSDOT TSMC's and the Washington State Patrol for regional traffic management.

Project Scope: The project will be divided into two phases: the planning and design phase, and the near-term implementation phase. Following is a brief description of the scope of work for each of the two phases.

Phase · Planning and Design of Olympia Area SC&DI

The planning and design effort will consist of the following activities:

1. Develop a master plan for SC&DI in the Olympia area similar to those currently existing for Seattle and Tacoma.

2. Design the vehicle detector system (DS) which will include developing specifications for the loops, junction boxes, controllers, cabinet modem, detector display panel, auxiliary display panel, loop amplifiers, output/power distribution assembly, load switches, and current monitor, as well as, the display monitor and software at the TSMC. The design will include detennining the exact location and designing the installation

of each DS. Detector stations should be installed at approximately one-half mile intervals along I-5 and SR 101.

3. Design a Closed Circuit Television (CCTV) system which will include developing specifications for the cameras, housing, Pan, Tilt, and Zoom (PTZ) unit and display monitors. The design will include determining the exact location and designing the mounting for each camera unit. Approximately 13 closed circuit television cameras could be installed - 1 per interchange.

4. Design a variable message sign (VMS) system. The design will include developing specifications for the signs and the head-end support system, determining the exact location of the signs, and developing a message library. The signs would be controlled from the TSMC. This effort includes converting two existing VMS to Type 170 based controllers. Six (6) variable message signs could be installed four on I-5 and the other two 0n US 101.

5. Design a highway advisory radio (HAR) system. This effort will include developing specifications for the antenna, control cabinet, AM transmitter, voice storage unit, relay panel, and power supply. This effort includes the developing the head-end support system, determining the exact location of the signs, and developing a message library. The HAR would be controlled from the TSMC. At least two HAR systems could be installed - one along the I-5 corridor and the other along the US 101 corridor.

6. Design the ramp-meter system. This effort will include developing specifications for the loops, signal display, warning signs and flashing beacons, control cabinet, output/power distribution assembly, as well as the display monitor and software at the TSMC. The design will also include determining the exact location and designing the ramp meter installation. Ramp meters should be installed at on-ramps along I-5 and us 101.

7. Design the communication system to interconnect the field equipment to the TSMC. The field equipment includes the DS's, CCTV's, traffic control signals, local controllers, VMS's, and HAR's, to the TSMC. The communication system includes all communication lines (except laterals), HUE3 stations, and power. This effort will also include designing the interface and communications systems requirements between the TSMC, Washington State Patrol, and other WSDOT TSMC's.

8. Plan for interconnections and expansion of the system to include the following:

- interconnection to public transportation systems;
- transit priority system;
- CVO applications;
- emergency notification interface;
- WSDOT baseline advanced traveler information system;
- weather information system;
- port access system; and
- regional multi-modal traveler information center.

All of these additional applications will have the standard interfaces required based on the statewide architecture adopted as part of this project. The TSMC will have the ability to display information provided by each one of these applications using the standardized interface.

Phase Implementation and Evaluation of Olympia Area SC&DI

The second phase of this project is the implementation and evaluation of the Olympia area SC&DI system. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the communications hardware;

4. Construction of the TSMC. This effort would include purchasing and installing the TSMC's equipment;

5. Developing/customizing the software for field equipment and head-end configuration;

6. Integrating the Olympia area SC&DI system into the Puget Sound region ATMS;

7. Develop operational procedures;

8. Testing and evaluating the system; and

9. Evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

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Project Cost Table 1 presents a summary of the capital costs in 1995 dollars for the Olympia area SC&DI system. The estimate is for the base system which was described above and does not include the planned expansions or upgrades. The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capita Cost l	$1,957,200
Annua Ol&M	$3,195,720

Project Benefits The project benefits are expected to be a reduction in traveler delay caused by congestion and a reduction in incidents. The Statewide M-IS Plan identifies the potential benefits in the Central Puget Sound area as approximately $29,000,000 for ATIS, $45,000,000 for VMS, $26,500,000 for HAR $63,600,000 for incident management and $68,900,000 for detection. These benefits total $233,000,000 for the entire region. The urban freeways and major roads in Thurston County represents 3% of the vehicle-miles traveled in the Central Puget Sound area which yields the following annual benefit:

Annual Benefits	**$6,990,000**

Project B/C : The benefit/cost analysis is based on a 20-year amoritization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	**$5,547,77**
Annual Benefits	**$6,990,000**
Benefit/Cost Ratio	**1.3:1**

Project Schedule The project is proposed as a near-term ITS project (0-6 year time frame). Follow-up projects to expand and upgrade the SC&DI system will follow in both the medium-term and long-term time frames.

The planning and design phase (phase 1) of the project would be completed two (2) years after award. The implementation phase (phase 2) would be completed six (6) years after award.

Item	Unit Cost (1995 $)	Number of Units	Total Cost (1995 $)
Data Stations	50,000	38	1,900,000
CCTV	50,000	13	650,000
VMS	178,333	6	1,070,000
HAR	83,000	2	166,000
Ramp Meters	62,500	24	1,500,000
Communication System and TSMC	18,930,000	1	18,930,000
System Expansion	805,000	3	2,145,000
Total Construction Costs			**26,631,000**
Design/Evaluation Cost			5,326,000
Total Capital Cost			**31,957,200**
O & M Cost / Year			**3,195,720**

Table 1: Cost Summary

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Project Title **Develop East King County ATMS**

User Services:

Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Public Transportation Operations:
- Public Transportation Management

Commercial Vehicle Operatons
- Commercial Fleet Management

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near-Term to Medium-Term

Objective: To design and implement an Advanced Traffic Management System (ATMS) for the urban areas of East King County. The ATMS will provide cross-jurisdictional highway traffic monitoring, control and information functions by integrating freeway surveillance, control, and driver information (SC&DI), local traffic signal and transit priority signal systems.

Project Background and Need: The eastside region, including the cities of Bellevue, Kirkland, and Redmond, and east Ring County are experiencing transportation inefficiencies and congestion resulting from the incompatibility of different jurisdiction's traffic wntrol systems. The transportation system on the eastside, including all major arterials and the state highway system, already experience high levels of congestion and with expected continued population and employment growth, these levels of congestion will continue to increase. A large part of the congestion occurs as travelers move from one jurisdiction's signal system to another. Typically, these signal systems do not wmmunicate or coordinate with one another, even adjacent systems on the same arterial. This lack of communication and coordination between each jurisdiction's signal systems result in an inefficient system for all travelers within the region, including transit and freight.

Statement of Deficiency: Eastside transportation inefficiencies and congestion are resulting from the incompatibility of different jurisdiction's traffic control systems.

Project Description This ATMS project will provide a system that allows for the integration of traffic signal control systems to permit the optimization of signal systems and integration of ramp control and signal systems between multiple jurisdictions and between technologies. This system will tie into and expand a similar system currently under development in north Seattle. In addition, the ATMS will be capable of both importing and exporting traveler information data to support regional traffic related information systems.

Any improvements will be limited to upgrading controllers where necessary and installing wmmunication lines to signal wntrol systems that do not already have established communication. The East King County ATMS will be connected to the existing WSDOT Northwest Region's TSMC which will contain hardware and software capable of monitoring traffic conditions within east King County, responding to events that degrade the system efficiency, and disseminating traveler information. This will require the upgrading of existing traffic control systems involving activities such as installing vehicle detectors, signal controllers and field communications. The new signal control systems will be monitored and controlled from the TSMC. Transit systems and traffic signal pre-emption will also be incorporated into the ATMS as applicable.

The monitoring and wntrol of the WSDOT SC&DI system will integrate the operations of the ATMS. This integration will involve the implementation of interface hardware and software.

Future expansion can consider the exchange of data with private fleet management operations which will provide data such as travel time that will assist the ATMS in monitoring traffic wnditions in east Ring County.

The design effort will be refined based on the work currently underway to develop and deploy an ATMS in the north Seattle area. Subject to its successful implementation, the east King County ATMS would follow the experience of this effort.

System Capabilities The proposed ATMS will have the following capabilities:

- Monitor real time traffic conditions along I-405, I-90, SR 520 and other state routes through the eastside SC&DI system;
- Control east Ring County major arterial traffic control signals (phase sequence and timing) based on a time of day/day of week criteria or in response to planned events or unexpected traffic conditions;
- Control the Eastside VMS to display either pre-designed messages or other messages in response to regional traffic conditions;

- Coordinate with traveler information systems for the Eastside;
- Coordinate operations with local police for regional traffic management.

Project Scope

The project will be divided into two phases: the planning and design phase and the deployment phase. Following is a brief description of the scope of work for each of the two phases.

Phase 1: Planning and Design of East King County ATMS
The planning and design effort will consist of the following activities:

1. Review North Seattle ATMS evaluation report and the eastside SC&DI program.

2. Design the interconnection and upgrade of east King County's traffic control signal system.

3. Design a control center which will receive field information disseminate information and control field equipment.

4. Design the wmmunication system to interconnect the field equipment to the control center.

5. Plan for future upgrade and expansion of the system to include the following:

   interface to private fleet management operations;
   interface with the state-wide ATIS system to provide traveler information including weather information and traffic conditions.

Phas · Implementation and Evaluation of East King Co-
The second phase of this project is the implementation and evaluation of the East King County ATMS. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the communications hardware;

4. Developing/customizing the software for field equipment and head-end configuration

5. Testing and evaluating the system; and

6. Evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

Project Cost: **Table 1** presents a summary of the preliminary cost estimate. The estimate is based on the proposed *Eastside Advanced Traffic Management System* (Puget Sound Regional Council, Stage 2 Regional Project TIP Evaluation Form, 1995). A more detailed analysis based on the North Seattle ATMS will be required when formally evaluating this project.

The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capital Cost	$ 1,500,000
Annual O & M	$150,000

Project Benefits: The project will provide wmmunication and planning between the incompatible signal control systems operated by each of the jurisdictions and the freeway control system operated by WSDOT. Removing the communication and coordination constraints at jurisdictional boundaries will improve the efficiency of freight and people movement and increase system effectiveness within the project area. It will also collect and distribute real-time traffic data and use priority and pre-emptive systems for transit. This information will be made available to travelers to enable them to make real-time decisions about mode choice, departure time, and route.

The project benefits are expected to derive from a reduction in traveler delay caused by congestion and incidents. The Statewide IVHS Plan identifies potential benefits in the Central Puget Sound area as approximately $36,100,000 for ATMS. The East Ring County region represents roughly 15 percent of the annual vehicle-miles traveled in the Central Puget Sound area which yields:

Annual Benefits	$5,415,000

Project B/C Ratio: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform

Annual Costs	**$260,400**
Annual Benefits	**$5,415,000**
Benefit/Cost Ratio	**20.8:1**

Project Schedule: The project is proposed as a near-term ITS project (0-6 year time frame). Follow-up projects to expand and upgrade the SC&DI system will follow in both the medium-term and long-term time frames.

The plauning and design phase (phase 1) of the project would be completed one (1) year after award. The implementation phase (phase 2) would be completed three (3) years after-award.

Item	Unit Cost (1995 $)	Units	Total Cost (1995 $)
Planning and Design	1,125,500	1	1,125,500
Construction	375,000	1	375,000
Total Capital Cost			1,500,000
O&M Cost / Year			150,000

Table 1: Cost Summary

Project Title: **Develop South King County ATMS**

User Services:
Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Public Transportation Operation:
- Public Transportation Management

Commercial Vehicle Operations
- Commercial Fleet Management

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near-Term to Medium-Term

Objective: To design and implement an Advanced Traffic Management System (ATMS) for the urban areas of South King County. The ATMS will provide cross-jurisdictional highway traffic monitoring, control and information functions by integrating freeway surveillance, control, and driver information (SC&DI), local traffic signal and transit priority signal systems.

Project Background and Need: The southside, including the cities of Tukwila, SeaTac, Des Moines, Federal Way, Renton, Kent, and Auburn and south King County are experiencing transportation inefficiencies and congestion resulting from the incompatibility of different jurisdiction's traffic control systems. The transportation system on the southside, including all major arterials and the state highway system, already experience high levels of congestion and with expected wntinued population and employment growth, these levels of congestion will continue to increase. A large part of the congestion occurs as travelers move from one jurisdiction's signal system to. another. Typically, these signal systems do not communicate or coordinate with one another, even adjacent systems on the same arterial. This lack of communication and coordination between each jurisdiction's signal systems result in an inefficient system for all travelers within the region, including transit and freight.

Statement of Deficiency: Southside transportation inefficiencies and congestion are resulting from the incompatibility of different jurisdiction' s traffic control systems.

Project Description: This ATMS project will provide a system that allows for the integration of traffic signal control systems to permit the optimization of signal systems and integration of ramp control and signal systems between multiple jurisdictions and between technologies. This system will tie into and expand a similar system currently under development in north Seattle. In addition, the ATMS will be capable of both importing and exporting traveler information data to support regional traffic related information systems.

Any improvements will be limited to upgrading controllers where necessary and installing wmmunication lines to signal control systems that do not already have established wmmunication. The South Ring County ATMS will be connected to the existing WSDOT Northwest Region's TSMC which will contain hardware and software capable of monitoring traffic conditions within south Ring County, responding to events that degrade the system efficiency, and disseminating traveler information. This will require the upgrading of existing traffic control systems involving activities such as installing vehicle detectors, signal controllers and field communications. The new signal control systems will be monitored and controlled from the TSMC. Transit systems and traffic signal pre-emption will also be inwrporated into the ATMS as applicable.

The monitoring and control of the WSDOT SC&DI system will integrate the operations of the ATMS. This integration will involve the implementation of interface hardware and software.

Future expansion can consider the exchange of data with private fleet management operations which will provide data such as travel time that will assist the ATMS in monitoring traffic conditions in south Ring County.

The design effort will be refined based on the work currently underway to develop and deploy an ATMS in the north Seattle area. Subject to its successful implementation, the south Ring County ATMS would follow the experience of this effort.

System Capabilities: The proposed ATMS will have the following capabilities:

- Monitor real time traffic conditions along J-405, I-90, SR 520 and other state routes through the southside SC&DI system;
- Control south Ring County major arterial traffic control signals (phase sequence and timing) based on a time of day/day of week criteria or in response to planned events or unexpected traffic conditions;

- Control the Southside VMS to display either pre-designed messages or other messages in response to regional traffic wnditions;
- Coordinate with traveler information systems for the Southside;
- Coordinate operations with local police for regional traffic management.

Project Scope: The project will be divided into two phases: the planning and design phase and the deployment phase. Following is a brief description of the scope of work for each of the two phases.

Phas · Planning and Design of South King County ATMS

The planning and design effort will consist of the following activities:

1. Review North Seattle ATMS evaluation report and the southside SC&DI program.

2. Design the interconnection and upgrade of south King County's traffic control signal system.

3. Design a control center which will receive field information, disseminate information and control field equipment.

4. Design the wmmunication system to interconnect the field equipment to the control center.

5. Plan for future upgrade and expansion of the system to include the following:

   interface to private fleet management operations;
   interface with the state-wide ATIS system to provide traveler information including weather information and traffic conditions.

Phas 1. Implementation and Evaluation of south King Co-

The second phase of this project is the implementation and evaluation of the South King County ATMS. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the wmmunications hardware;

4. Developing/customizing the software for field equipment and head-end configuration;

5. Testing and evaluating the system; and

6. Evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

Project Cost: **Table 1** presents a summary of the preliminary cost estimate. The estimate is based on the proposed *Eastside Advanced Traffic Management System* (Puget Sound Regional Council, Stage 2 Regional Project TIP Evaluation Form, 1995). A more detailed analysis based on the North Seattle ATMS will be required when formally evaluating this project.

The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capital Cost	**$5,559,000**
Annual O&M	**$555,900**

Project Benefits: The project will provide wmmunication and planning between the incompatible signal control systems operated by each of the jurisdictions and the freeway control system operated by WSDOT. Removing the communication and coordination constraints at jurisdictional boundaries will improve the efficiency of freight and people movement and increase system effectiveness within the project area. It will also collect and distribute real-time traffic data and use priority and pre-emptive systems for transit. This information will be made available to travelers to enable them to make real-time decisions about mode choice, departure time, and route.

The project benefits are expected to derive from a reduction in traveler delay caused by congestion and incidents. The Statewide IVES Plan identifies potential benefits in tbe Central Puget Sound area as approximately $36,100,000 for ATMS. The South King County region represents roughly 15 percent of the annual vehicle-miles traveled in the Central Puget Sound area which yields:

Annual Benefits	$5,415,000

Project B/C Ratio: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is

4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	**$965,042**
Annual Benefits	**$5,415,000**
Benefit/Cost Ratio	**5.6:1**

Project Schedule: The project is proposed as a near-term ITS project (0-6 year time frame). Follow-up projects to expand and upgrade the SC&DI system will follow in both the medium-term and long-term time frames.

The planning and design phase (phase 1) of the project would be completed one (1) year after award. The implementation phase (phase 2) would be completed three (3) years after award.

Item	Unit Cost (1995 $)	Units	Total Cost (1995 $)
South King County Signal System Upgrade	2,230,000	1	2,230,000
Signal Interconnect	312,500	1	312,500
Control Center	2,000,000	1	2,000,000
Communication System	90,000	1	90,000
Total Construction Cost			**4,632,500**
Design/Evaluation Cost			926,500
Total Capital Cost			**5,559,000**
O & M Cost / Year			**555,900**

Table 1: Cost Summary

Project Title: **Develop Pierce County ATMS**

User Services:

Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Public Transportation Operations:
- Public Transportation Management

Commercial Vehicle Operations
- Commercial Fleet Management

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near-Term to Medium-Term

Objective: To design and implement an Advanced Traffic Management System (ATMS) for the urban areas of Pierce County. The ATMS will provide cross-jurisdictional highway traffic monitoring, control and information functions by integrating freeway surveillance, wntrol, and driver information (SC&DI), local traffic signal and transit priority signal systems.

Project Background and Need:

Interstate 5 serves as the primary highway connection between Seattle and Portland and is part of the major interstate route which runs from Canada to Mexico along the west coast of the United States. In Pierce County, I-5 is also heavily used by commuters traveling between Seattle and Tacoma. At present, these volumes lead to daily volume to capacity ratios that exceed one. Urban arterials are also congested during peak periods matching the travel on the freeway.

The IVHS vision for Central Puget Sound includes the goal of providing safe and efficient movement of people and commercial vehicles through the transportation system. This requires a coordinated effort to improve the efficiency of each element of the transportation network in Pierce County. For example, the proposed deployment of a surveillance, control, and driver information (SC&DI) system in the Tacoma area along I-5 may benefit from traffic conditions derived from the adjacent arterial roadways. In order to achieve this, a centralized signal wntrol system may be implemented which will collect arterial traffic information for the purpose of sharing the information with regional traveler information system and the SC&DI This signal control system will also offer arterial signal coordination as well as coordination with SC&DI operations.

Statement of Deficiency: Pierce County area traffic congestion is increasing giving rise to greater traveler delay and greater risk of traffic incidents. The congestion is commonly experienced due to volumes exceeding the capacity at intersections within an arterial signal control system, along freeways passing through urban areas and at the boundaries between independent systems. The lack of central control for the signals within the county and lack of capability to coordinate existing systems with proposed systems will contribute to congestion problems as traffic volumes grow.

Project Description: **The** project will include planning, designing, implementing, and evaluating an Advanced Traffic Management System (ATMS) for Pierce County. The ATMS will integrate the existing and proposed traffic management systems in Pierce County. In addition, interfaces with the regional traveler information system as well as other data sources will be made available. These include transit vehicle locations and travel times for example.

The major developments will include the design of a central control center which will contain hardware and software capable of monitoring traffic conditions within Pierce County, responding to events that degrade the system efficiency and disseminating traveler information. This will require the upgrading of existing traffic control systems involving activities such as the installation vehicle detectors, signal controllers and field wmmunications. The new signal control systems will be monitored and controlled from the control center. Transit systems and traffic signal pre-emption will also be incorporated into the ATMS as applicable.

The monitoring and control of the I-5 SC&DI system will be integrated the operations of the ATMS. This integration will involve the implementation of interface hardware and software.

Future expansion can consider the exchange of data with private fleet management operations which will provide data such as travel time that will assist the ATMS in monitoring traffic wnditions in Pierce County.

The design effort will be refined based on the work currently underway to develop and deploy an ATMS in the North Seattle area. Subject to its successful implementation, the Pierce County ATMS would follow the experience of this effort.

System Capabilities: The proposed ATMS will have the following capabilities:

- Monitor real time traffic conditions along I-5 and other state routes through Tacoma SC&DI;
- Control Pierce County area traffic control signals (phase sequence and timing) based on a time of day/day of week criteria or in response to planned events or unexpected traffic conditions;
- Control the Pierce County area VMS to display either pre-designed messages or other messages in response to regional traffic conditions;
- Coordinate with traveler information systems for the I-5 in this region;
- Coordinate operations with other WSDOT TSMC's local and police for regional traffic management.

Project Scope: The project will be divided into two phases: the planning and design phase and the deployment phase. Following is a brief description of the scope of work for each of the two phases.

Phas Planning and Design of Pierce County ATMS
The planning and design effort will consist of the following activities:

1. Review North Seattle ATMS evaluation report and the Tacoma area SC&DI program.

2. Design the interconnection and upgrade of the Pierce County traffic control signal system.

3. Design control center which will receive field information, disseminate information and control field equipment.

4. Design the communication system to interconnect the field equipment to the control center.

5. Plan for future upgrade and expansion of the system to include the following:

   interface to private fleet management operations;
   interface with the state-wide ATIS system to provide traveler information including weather information and traffic conditions.

Phas Implementation and Evaluation of Pierce County ATMS
The second phase of this project is the implementation and evaluation of the Pierce County ATMS. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the wmmunications hardware;

4. Developing/customizing the software for field equipment and. head-end configuration;

5. Testing and evaluating the system; and

6. Evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

Project Cost: **Table 1** presents a summary of the prehminary. The estimate is based on the current estimate for the North Seattle ATMS of roughly $4 ***million. The*** Pierce County infrastructure covers an entire county, but less dense than the North Seattle infrastructure. In addition, tbis project will benefit from the experience of the North Seattle ATMS. The preliminary estimate of capital costs for the Pierce County ATMS presented in Table 1 considered these factors. A more detailed analysis based on the North Seattle ATMS will be required when formally evaluating tbis project

The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capital Cost	**$5,559,000**
Annual O & M	**$555,900**

Project Benefits: The project benefits are expected to derive from a reduction in traveler delay caused by congestion and incidents. The Statewide IVHS Plan identifies potential benefits in the Central Puget Sound area as approximately $36,100,000 for ATMS. Assuming that Pierce County represents roughly 19% of the annual vehicle-miles traveled in the Central Puget Sound area which yields:

Annual Benefits	**$6,859,000**

Project B/C Ratio: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is

4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	**$965,042**
Annual Benefits	**$6,900,608**
Benefit/Cost Ratio	**7.1:1**

Project Schedule: The project is proposed as a near-term ITS project (0-6 year time frame). Follow-up projects to expand and upgrade the SC&DI system will follow in both the medium-term and long-term time frames.

The planning and design phase (phase 1) of the project would be completed one (1) year after award. The implementation phase (phase 2) would be completed three (3) years after award.

Item	Unit Cost (1995 $)	Units	Total Cost (1995 $)
Pierce County Signal System Upgrade	2,230,000	1	2,230,000
Signal Interconnect	312,500	1	3 12,500
Control Center	2,000,000	1	2,000,000
Communication System	90,000	1	90,000
Total Construction Cost			4,632,500
Design/Evaluation Cost			926,500
Total Capital Cost			5,559,000
0 & M Cost / Year			555,900

Table 1: Cost Summary

Project Title: **Demonstration of a Work Zone SC&DI System**

User Services: Traffic Management:
Incident Management
Traffic Control
Construction Management
Traveler Information:
En-Route Driver Information

Time Frame: Near Term

Objective: The objective of the project is to demonstrate a portable Surveillance, Control and Driver Information (SC&DI) System that can be applied to work zone management. This system will be designed to be quickly deployable to respond to work zone boundary changes, to be durable to withstand repeated deployment in work zone conditions and to be capable of interfacing with local and regional SC&DI systems. This demonstration will aim to determine the cost effectiveness of such an application in terms of capital cost, maintenance cost, durability, adaptability and ease of deployment.

Project Background and Need: Construction and maintenance work zones on freeways are inherently dangerous for both the field staff and drivers passing through the work area. The work area reduces the road capacity which requires a reduction in speed to safely negotiate the area. This speed differential and the reduced capacity cause traffic congestion which represents both a safety concern and a source of delay for travelers.

Several Advanced Traffic Management Systems (ATMS), currently in operation world wide have demonstrated that similar systems can improve safety and reduce delay. Examples of successful systems in Washington include FAME and Seattle SC&DI system. These systems achieve their benefits by providing central surveillance and control functionality through a network of variable message signs, highway advisory radio, ramp metering subsystems, lane access control subsystems, and emergency vehicle management subsystems.

This success has lead to the desire to perform these SC&DI system functions for the purpose of work zone management independent of currently operating SC&DI systems. The work zone presents similar safety and congestion problems for which these systems are designed to respond. Furthermore, the agency performing the work will anticipate these problems and will be in a position to manage them. In this way, dynamic work zone management will be available in the immediate work area.

Statement of Deficiency: Work zones on relatively high volume roads cause traffic disruptions that impact both travel time and safety in the immediate area. Traveler information and traffic management in work zones is currently limited to newspaper announcements, radio announcements, temporary signs and field staff. These methods do not provide traffic monitoring or dynamic traveler information dissemination. By not providing these functions, travelers are experiencing avoidable delay and are unaware of alternative routes to avoid the delay.

Project Description: The project will demonstrate a work zone SC&DI system capable of monitoring the volumes and speeds of traffic in a work zone while providing lane control, and traveler information dissemination through the use of variable message signs and highway advisory radio. This portable system will be self-contained in terms of power and communications but will be capable of interfacing with regional SC&DI systems for the purpose of coordination and information sharing.

The architecture of the portable SC&DI system consists of four subsystems: traffic monitoring, communications and control, control center and information. The control center subsystem compiles traffic data collected by the traffic monitoring subsystem and provides control of the information and control field devices. The communications subsystem provides the data connections between the other subsystems as well as external entities including other SC&DI systems and emergency services.

The traffic monitoring subsystem will consist of several traffic detector stations each capable of monitoring traffic in up to four lanes individually. In the interest of being portable, the traffic detector stations will consist of a non-intrusive vehicle detection technology. For example, a pole-mounted CCTV camera with pan-tilt-zoom capability, mounted on a stabilized trailer, located at the side of the road. Each of the traffic detection stations will be equipped with remote processing units (RPUs). The RPUs will interpret the data collected, calculates the traffic volume and speed for each lane and stores this data until the control center subsystem polls the RPUs. The RPUs will also have the functionality to control traveler information and control field devices as described below.

The communications subsystem provides the following:

- a data link between the traffic monitoring subsystem and the control center subsystem;
- a data and voice link between the control center subsystem and the traveler information subsystem; and
- a data and voice link between the control center and the local and regional SC&DI systems.

The first link provides for the means for collecting field data and controlling the traffic monitoring devices, if necessary. The second link facilitates the control of the information and control field devices including VMS, lane control signs, field personnel and HAR. The fmal link allows the portable work zone SC&DI system to coordinate with the local and regional SC&DI systems. Specifically, this link would be used to transmit data or voice information detailing the existing traffic conditions in the work zone to the other systems. However, contact with emergency services will also be possible in the case of a traffic incident in or near the work area. Consistent with the portability goal, all these communications will be wireless such as cellular phone and spread spectrum radio. All RPUs will be capable of interfacing with the communications system to facilitate the communications to the field devices.

The control center subsystem will be located in a trailer at or near the work zone. This trailer will contain the hardware and software required to control the system as well as work zone SC&DI system staff The hardware will consist of a central computer and monitors to collect and display the field data to control the field devices (i.e. operate lane control signals and change messages for VMS and HAR) and to communicate data to other SC&DI system control centers. The central control software will assist the control center operators with interpretation of field data, data management and field device control. Cellular phones and radios will also be provided to allow communications with both field staff and staff of other SC&DI system control centers.

The traveler information subsystem will consist of several trailer-mounted VMS, lane control signals and a portable HAR transmitter. The VMS will be located upstream of the work zone to display lane closure messages, messages indicating either the prevailing speed or the suggested speed and messages indicating estimated delay and possible diversion routes. A set of lane control signals will be located immediately upstream of the work zone to indicate which lanes are open and which lane are closed. These signals will collocated with the first VMS immediately upstream of the work zone. Finally, the HAR transmitter is located to provide coverage at the possible diversion point. The HAR will transmit warning messages providing details of the work zone conditions including lane closures and the estimated delay. In addition, messages will be transmitted providing alternate route navigation information. RPUs will be located with each of theses devices to facilitate communications between them and the central control center.

System Capabilities: The proposed project will have the following capabilities:

- Determine the speed differential between traffic in the work zone and traffic approaching the work zone.

- Estimate delay from speed and volume data collected from traffic approaching the work zone.

- Provide details of lane closures, estimated delay, prevailing (or desired) speed, speed differential and suggested alternate routes through a network of VMS, lane control signals and an HAR transmitter.

Project Scope: The project scope will involve two phases. The first phase will develop the Work Zone SC&DI System. The second phase will implement and evaluate the effectiveness of the system at a field test site The following is a brief description of the tasks of each phase.

Phase Develop Work Zone SC&DI System

The first phase will consist of the following tasks:

1. Developing operations plan.

2. Designing control center software.

3. Designing wireless communications system.

4. Designing field equipment including display technology, mounting and power.

Phase 2: Implementation and Evaluation of Work Zone SC&DI System

Phase 2 will implement and evaluate the Work Zone SC&DI System as developed in the previous phase. The following tasks are included in this phase:

1. Selecting equipment that meets the specifications of the design.
2. Purchasing and assembling all hardware.
3. Developing control center software.
4. Developing communications software.
5. Initial testing of the system.
6. Evaluating performance of the system in a field test.

Project Cost: **Table 1** presents a summary explanation of the capital cost in 1995 dollars for the Work Zone SC&DI System demonstration. The estimate is for the base system which was described above and does not include the planned expansions and upgrades. The design and evaluation cost is estimated at 20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost.

Total Capital Cost	**$730,800**
Annual O & M	**$73,080**

Project Benefits: As the Work Zone SC&DI System will provide traffic and incident management, the project benefits are expected to derive from a reduction in delay experienced by travelers due to congestion and incidents related to work zone activity.

To determine the annual benefits of this project, it is assumed that a five mile long application is located on I-5 within the Central Puget Sound region for one year. The Statewide IVHS Plan identifies the Traveler Information benefits as $29,000,000 and the Incident Management benefits as $63,600,000. King County interstate freeways represent 30% of the annual vehicle-miles traveled within the Central Puget Sound area. A five mile stretch represents roughly 4% of the interstate freeway in King County. The annual benefits resulting from this project are estimated as:

Annual Benefits	**$1,111,200**

Project B/C: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	$126,867
Annual Benefits	$1,111,200
Benefit/Cost Ratio	**8.8:1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 years time frame). The design phase (phase 1) of the project will be completed in twelve (12) months after award . The implementation and evaluation phase will be completed twenty-four (24) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Control System	176,000	1	176,000
Variable Message Sign	30,000	3	90,000
Lane Control Signal Set	36,000	2	60,000
Roadside Data Stations	26,000	3	78,000
HAR System	**31,000**	**1**	**31,000**
RPU Hardware and Software	18,000	9	162,000
Total Construction Cost	-	-	**609,000**
Design/Evaluation Cost	-	-	121,800
Total Capital Cost	-	-	**730,800**
O& M Cost/Year	-	-	**73,080**

Table 1: Cost Summary

Project Title: **Develop Regional Multimodal Traveler Information Center**

User Services: Traveler Information
--- En-Route Driver Information
Traveler Services Information
Route Guidance
Travel Demand Management:
Pre-Trip Travel Information
Ride Matching and Reservation
Demand Management and Operations
Public Transportation Managemet~
En-Route Transit Information
Public Transportation Management
Personalized Public Transit

Time Frame: Near-Term

Objective: The objective of the project is to develop a Regional Multimodal Traveler Information Center (RMTIC). The RMTIC will compile regional roadway and transit performance data from existing and planned sources of data. The RMTIC will serve to process the data (i.e. perform data fusion), packaging the data into various formats for subsequent dissemination. The RMTIC will be capable of distributing the processed data to its customers using various communications modes including: voice or computer services, radio broadcasts and kiosks.

Project Background: A variety of ITS initiatives along the Seattle to Portland corridor are either underway or will be developed in the near future These initiative will generate a wide range of data suitable to provide for ITS user services such as pre-trip and en-route traveler information Collectively, the information can assist travelers within the region with mode, route and time-of-travel choices.

In order to bridge the gap between the varied and widespread data sources and the travelers, a system architecture connecting all ITS initiatives including a communications backbone will also be developed. This will allow for information travel between the customers and the information providers . A regional traveler information center is a key element to this process as it will become thecentral processing center by which the regional multimodal data will compiled, processed and formatted for dissemination to the customers. Potential customers include individuals, business travelers, private sector firms, value-added resellers and public transportation agencies. These entities will also be essential as information providers developing a two-way data exchange.

The system architecture interface standards will be developed under a separate initiative. The Puget Sound regional system architecture deployment will be carried out through the WSDOT regional traveler information project.

Statement of Deficiency: Currently, there are several independent sources of data within the Puget Sound Region that both collect and disseminate data for their own purposes. Several ITS initiatives will increase the number of sources of data available in the network: Although the information is available it is collected and stored in several locations in different formats. A mechanism for interfacing and integrating the data available from these systems and ITS initiatives is required in order to provide more effective and comprehensive traveler information for all modes of travel in the Puget Sound Region.

Project Description: The project will include three main activities:

1. Designing and deploying the Reginal Multimodal Traveler Information Center The RMTIC will interface the WSDOT SC&DI system, public ATIS systems (i.e. from WSDOT TSMC), private sector ATIS systems (i.e. Metro Traffic), transit agencies in the region (i.e. Riderlink), Employer Based Multimodal Traveler Information System, and provide for interface capabilities for other systems in the Region including Port ATMS, Public Transportation Systems, CVO Application Systems, Regional and Local ATMS, Weather Information Systems, Emergency Notification Systems and Transportation Pricing Systems.

   Most of the interface communication requirements will be provided under different projects, however, the RMTIC will provide for any additional communication hardware required for establishing the interfaces. The RMTIC will provide space for the hardware supporting the interface and data fusion requirements. The RMT'IC will also provide space and human interface capabilities to support a systems manager who will maintain the software operation.

2. Establishing policies regarding information access and use. The policies will restrict access to certain information and prevent use for commercial purposes. The policies will also define the level of

information that will be managed by the public sector and that managed by the private sector. The policies will be coded into the system and automatically implemented during the data exchange process.

3. Upgrading existing systems to provide for standard interface capabilities, This will include systems which have already been installed and operational in the Puget Sound Region and which will interface with the RMTIC. This includes such systems as the North Seattle ATMS, the WSDOT SC&DI, the regional transit agencies, and the private sector information service (i.e. Metro Traffic). The effort will include the design and development of the interface requirements.

System Capabilities: The capabilities of the RMTIC can be summarized as following:

- Receive and compile roadway and transit system surveillance and detection information from a variety of sources provided by both the public and private sector entities (i.e. information providers);

- Perform data fusion and other data processing to package the data in various formats; and

- Provide information to a variety of distribution channels (i.e. customers).

Project Scope: The scope of work for the project will include the following tasks:

1. Based on ITS architecture interface standards developed under a separate initiative, establish interface requirements for the existing systems in the Puget Sound Region.

2. Establish information access policies and information dissemination responsibilities for each customer and information provider. In addition, determine the format and frequency of data exchange.

3. Establish the RMTIC system requirements developed from the interface requirements and the data exchange policies.

4. Design the hardware configuration including system interfaces, communications, data storage, RMTIC system data processing and data dissemination.

5. Design the software for the RMTIC including system interfaces, communications, data fusion and other data processing.

6. Design and deploy the RMTIC which will house the hardware and software for the interface and data processing. The RMTIC will also provide space for a system manager for operations monitoring and maintenance purposes.

7. Establish a link to the ITS communication backbone.

8. Conduct system integration tests with each of the customers and information providers.

9. Conduct a complete system operational test.

Project Cost: **Table 1** presents a summary explanation of the capital cost in 1995 dollars for the Regional Multimodal Traveler Information Center. This estimate assumes that communications will be carried by the ITS communications backbone as much as possible. For those information providers or customers where a connection to the backbone is unfeasible, other communications (i.e. modem) will be provided. In addition, it is assumed that the RMTIC will be housed in an existing structure requiring major renovations to accommodate-the facility. The annual Operations and Maintenance (O&M) cost estimate consists of to full-time equivalent operational staff, one full-time equivalent maintenance staff, communications costs and facility supplies.

Total Capital Cost = $2,150,000
Operations and Maintenance Cost/Year = $300,000

Project Benefits: The benefits will derive from the increase in the coverage of comprehensive information exchanged in the region. Travelers will have better access to information covering a greater area. ITS initiatives in the region will also benefit from accurate and timely information that will serve to coordinate between boundaries. The RMTIC will serves as a critical component connecting several systems that each will provide benefit independently. It is assumed that central coordination at the RMTIC represents 10% of the ATIS benefit estimated in the Statewide IVHS Plan. This results in an annual benefit of:

Annual Benefits: $2,900,000.

Project B/C Ratio The benefit/cost analysis is based on a 20 year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are assumed to be uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	**$458,240**
Annual Benefits	**$2,900,000**
Benefit/Cost Ratio	**6.3:1**

Project Schedule: The project is proposed is a near-term ITS project (O-6 years time frame). The project will have a design phase and a construction phase. The design phase will include the establishment of the information access policies, the development of system requirements, hardware design, and software design. The construction phase will include the construction of the facility, hardware installation, software installation and systems integration testing. The design phase will be completed fifteen (15) months after award. The construction phase will be completed in twenty-seven (27) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Link to Communication Backbone	50,000	1	**50,000**
Other Communications	**300,000**	1	**300,000**
RMTIC Facility	**300,000**	1	**300,000**
Interface and Processing Hardware Design, Procurement and Installation	600,000	1	**600,000**
Interface and Processing Software	500,000	1	**500,000**
Existing Systems Interface Upgrade Requirements	400,000	1	400,000
Total Capital Cost	-	-	**2,150,000**
O & M Cost/Year	-	-	**300,000**

Table 1: Cost Summary

Project Title: **Pilot Intermodal Terminal Information Kiosks**

User Services:

Traveler Information:
- Traveler Services Information
- En-Route Driver Information

Travel Demand Management:
- Pre-Trip Travel Information
- Ride Matching and Reservation
- Demand Management and Operations

Public Transportation Management
- En-Route Transit Information
- Public Transportation Management
- Personalized Public Transit

Time Frame: Near Term

Objective: The objective of the project is to deploy traveler information kiosks at major rail stations along the corridor which function as intermodal transfer points. These kiosks will provide schedule information, connection information to other travel modes (i.e. train schedules and transit schedule), schedule variations and local services information (i.e. accommodations, restaurants and tourist attractions).

Project Background and Need: There are several operational tests and Traveler Information System (TIS) implementations across the U.S. that employ or intend to employ kiosks to provide multimodal traveler information. For example, Los Angeles Smart Traveler will be implementing kiosks using audiotex and videotex to provide transit, paratransit and rideshare information. Within Washington State, the Seattle Smart Traveler program executed an operational test providing transit and ride sharing information to commuters from a single kiosk in Bellevue.

Recently, there have been two local public information efforts that will impact this project. First, the Washington State Department of Information Services implemented a pilot project providing public information through kiosks. This project, Washington Information Network (WIN), was established to help the state government serve the people of Washington State better, faster and more cost-effectively. These kiosks provide a public interface to several government databases including transportation and recreation. The impact this effort will have on this project is the local experience gained through its design and implementation; several issues including data security, communications protocol as well as public experience with the kiosks have already been addressed.

Second, WSDOT presently maintains several home pages on the world wide web. They provide information such as real-time traffic congestion information for the greater Seattle area freeways and transit access information for the greater Seattle area. These home pages represent excellent sources of traveler information that have established formats and communications protocol (i.e. TCPAP) which can be accessed as part of this project.

The I-5 Corridor offers a suitable opportunity to implement similar applications. Along the corridor, six major rail stations provide alternate access to regional travelers between Portland and Seattle. In the future, several commuter rail stations will also be suitable candidates for informational kiosks. Both types of rail stations offer an alternative travel mode requiring travelers to change modes. In addition, information on local services such as accommodations, restaurants and tourist attractions will also be useful. Both rail travelers and freeway travelers are expected to benefit from the kiosk network as travel by rail will become more attractive reducing freeway trips and travel times.

Statement of Deficiency: Public access to intermodal information and information about local services is limited at intermodal transfer centers. Limited access to information hinders the smooth transition of travelers from one mode to another which increases their travel time and discourages them from using travel modes other than personal vehicles.

Project Description: The project will develop and deploy a fully operational kiosk network at major intermodal transfer centers (i.e. Amtrak rail stations) along the corridor. The project will involve the development of a customized user interface and format suitable for the static and dynamic information that will be made available as well as the implementation of the kiosk network.

Existing data useful to intermodal travelers will be identified and access to this data will be arranged. This data includes the posted schedules of various modes that serve the intermodal center including rail and transit. In addition to these schedules, route and travel time information will be made available to assist in traveler route and mode selection. The kiosks will also provide instructions detailing access to taxi and shuttle services from the intermodal center. Finally, information detailing local services, such as restaurants, accommodations and special events, will also be made available at the kiosks.

Dynamic data will also be made available to the kiosks. These include schedule variations for both ferries and trains, corridor traffic and road conditions, weather conditions as they affect travel and traveler advisories. Access to other agencies and services that collect this dynamic data will provide this information. Local special events will also be provided to the kiosks as dynamic data.

All data and information will be collected centrally at a WSDOT office. This data will be managed in several databases at that location automating the process for all but local service announcements. From this central location, the kiosks will be updated by modem periodically.

System Capabilities: The proposed project will have the following capabilities:

- Provide a personal and accessible interface by which travelers can request information using a touch screen, a pointing device and a keyboard and view this information using a color monitor, clear sound-generating equipment and a printer;
- Provide static and dynamic traveler information including rail and transit schedules, schedule compliance, connections to taxi and shuttles, and weather information along the corridor;
- Provide local service information including restaurants, accommodations and special events; and
- Provide a gateway to current and future home page information that convey dynamic traveler information.

Project Scope: The project scope will involve two phases. The first phase will develop the kiosk interface, screen format, central database and communications. The second phase will implement and evaluate the effectiveness of the kiosk network. The following is a brief description of the tasks of each phase.

Phas : Develop and Deploy Interface and Format

The first phase will consist of the following tasks:

1. Confiig availability of data from Amtrak, transit services, weather service and local services.

2. Identifying local service displays that will be available on thekiosks. Definition of cost-sharing arrangement for these local services.

3. Arranging for access to both static and dynamic data including communications network and protocol.

4. Coordinating with the Washington Information Network (WIN) design to facilitate possible coordination or possible fusion of both networks.

5. Completing of interface design defining kiosk construction, database format, screen output format and printer output format.

6. Completing design of the central control for the kiosk network including communications, database format, and automation of data queries and updates.

Phase 2: Implementation and Evaluation of Kiosk Network

Phase 2 will implement and evaluate the kiosks as developed in the previous phase. The following tasks are included in this phase:

1. Selecting equipment that meets the specifications of the design.

2. Purchasing, constructing and installing the central computer, communications hardware and kiosks.

3. Developing and customizing the software.

4. Testing and evaluating the kiosk network.

5. Evaluation of performance and use of the kiosk network.

Project Cost: **Table 1** presents a summary explanation of the capital cost in 1995 dollars for the Intermodal Terminal Information Kiosk Network. The design and evaluation cost is estimated at 20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost. Communications to transmit information updates from the WSDOT office to the remote kiosks is provided by the existing communications infrastructure (i.e. SCAN).

Total Capital Cost	**$475,200**
Annual O&M	**$47,520**

Project Benefits: The project benefits are expected to derive from intermodal travel time savings as their transfer will be assisted by the kiosk information. In addition, it is anticipated that local service providers and other commercial interests will provide advertising revenue.

The Statewide IVHS Plan identifies annual benefits due to traveler information systems as $7,457,255 in Vancouver, $29,15 1,690 in Central Puget Sound and $17,880 in other urban areas. Assuming that 1% of this benefit is due to kiosk operation at terminals, the sum of these benefits is $366,268. The annual advertising revenue expected per kiosk is $5,000 totaling to $35,000.

Annual Benefits	$401,268

Project B/C: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance cost are assumed to be uniform over the 20 year period.

Equivalent Uniform	
Annual Costs	**$82,495**
Annual Benefits	**$401,268**
Benefit/Cost Ratio	**4.9: 1**

Project Schedule: The project is proposed as a near-term ITS project (0-6 years time frame). Follow-up projects to expand and upgrade the Intermodal Terminal Information Kiosk Network will follow in both the near-term time frame and the medium-term time frame.

The planning and design phase of the project will be completed in six (6) months after award. The implementation and evaluation phase will be completed in eighteen (18) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Central Control Hardware and Software	200,000	1	200,000
Kiosk Hardware and Software (including CPU, keyboard, pointing device, touch screen color monitor, multi-media capability, modem and printer)	25,000	7	175,000
Kiosk Cabinet	3,000	7	21,000
Total Construction Cost	-	-	**396,000**
Design/Evaluation Cost	-	-	79,200
Total Capital Cost	-	-	**475,200**
O & M Cost/Year	-	-	**47,520**

Table 1: Cost Summary

Project Title: **Demonstrate Employer Based Multimodal Traveler Information System**

User Services:

Traveler Information
- Traveler Services Information

Travel Demand Management:
- Pre-Trip Travel Information
- Ride Matching and Reservation

Public Transportation Management
- Personalized Public Transit

Electronic Payment Services

Weather Surveillance

Time Frame: Near-Term

Objective: The objective of the project is to demonstrate the feasibility of providing Employer-Based Multimodal Traveler Information System in the Northwest Region using kiosks that provide personal computer access to a bulletin board or home page.

Project Background and Need:

Travel demand management is a component of the ITS user services that focuses on reducing demand and encouraging the use of high occupancy modes of travel. These services including pre-trip planning, ride matching and carpool/vanpool management are suitable methods to attempt to attain the goals of the Commute Trip Reduction Law. In addition, as these services are most useful when provided at the travelers' trip origin, they are suitable for implementation as work-based services maintained by the employers. In fact, the new law requires that the employers participate in providing these services.

The means to provide this information to travelers at the office has been limited to the telephone and the radio. However, the means to significantly improve this service is becoming increasingly available as the use of personal computers with modems at the office becomes more widespread. Currently, several businesses rely on their access to the Internet and other "on-line" information services. This also allows businesses access to recent WSDOT and Metro initiatives that provide a traffic information map and bus route information through a World Wide Web home page on the Internet.

This existing infrastructure, together with a market that promises to continue growing, provides an excellent means to provide a Multimodal

Traveler Information System which will be readily accessible to travelers while at the office. To supplement the personal computer access available, kiosks may be located in building lobbies to provide the same access away from the desk.

Statement of Deficiency: There is an increasing need in the Puget Sound area to improve air quality through a reduction in traffic congestion. The adoption of the Commute Trip Reduction Law gave employers partial responsibility of attaining these goals through programs to reduce Single Occupancy Vehicle (SOV) trips to and from work. At present, there are few successful models which employers can pattern there own programs. In addition, no infrastructure is available to provide the transfer of real-time information necessary to assist the employer-based trip reduction programs.

Project Description: The project will involve designing, implementing and evaluating a multimodal traveler information system in an industrialized/commercial park in the Puget Sound Area, The system will be developed in coordination with the employer(s) occupying the park. Potential employers include Microsoft Corporation and the Boeing Company. The follow-up work will involve the wide-spread implementation of the system in the Puget Sound Region.

The system will advise employees at the work site of current transportation conditions and travel options, and help employers achieve Single Occupancy Vehicle (SOV) reduction to comply with the Commute Trip Reduction Law. The system would encompass two major elements:

1. Information kiosks and PC-based software along with interfaces that would provide traffic transit and other information using the Regional Multimodal Traveler Information Center (RMTIC); and

2. Ride matching and carpool/vanpool management services for use by employer administrative staff to facilitate trip and travel reduction. It is anticipated that this would involve a stand-alone, PC-based application program that would allow static semi-dynamic ride matching to be undertaken at the employment location.

System Capabilities: The system will encompass the following capabilities:

- Interface with the RMTIC to receive static and real-time information relating to traffic conditions, construction activities, special events, transit bus schedules and route information, and other information which will be collected and processed by the RMTIC.

- Accept ride-matching requests from employees, process the requests and schedule carpool/vanpool departure times and routes.

- Provide for a human interface to disseminate information from the RMTIC using kiosks and PC computers.

Project Scope: The project scope will involve two phases, with a third phase to be undertaken under a follow-up project. The first phase will involve the deployment of the demonstration system. The second will involve assessing the effectiveness of the system. The third phase, to be conducted under a separate project, will involve the deployment of the system on a larger scale in the Puget Sound Region.

Phase 1: Design and Deployment of the Demonstration System

The following activities will be conducted under this phase:

1. Identify partner employer and develop institutional agreement.

2. Design the system architecture and equipment interface.

3. Design system software.

4. Design kiosk hardware and software.

5. Implement system and interface with RMTIC.

Phase · Evaluate the Effectiveness of the Demonstrations System

1. Develop measures of effectiveness and collect data to support the evaluation.

2. Conduct the evaluation study and develop recommendations for follow-on deployment work.

Project Cost: **Table 1** presents a summary explanation of the capital cost (for the demonstration project) in 1995 dollars for the subject system. The design and evaluation cost is estimated at 20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost.

Total Capital Cost	$216,000
Annual O&M	$21,600

Project Benefits: The expected benefits would be derived from providing a multimodal employer based traveler information system include a reduction in commute travel times, a reduction in Single Vehicle Occupancy (SOV), and reduction in commute trip costs such as vehicle operating cost. The Statewide IVHS Plan identifies the potential benefits in the Central Puget Sound area as approximately $29,000,000 for ATIS. As the benefits depend on the number of people participating, it is estimated that this demonstration will achieve roughly 1% of these benefits; therefore, the annual benefits are estimated as:

Annual Benefits	**$290,000**

Project B/C: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are assumed to be uniform for the 20-year period.

Equivalent Uniform	
Annual Cost	$38,080
Annual Benefit	$290,000

Benefit/Cost Ratio

Project Schedule: The project is proposed as a near-term ITS project (0-6 years time frame). Projects to implement the service on a wider scale in the Puget Sound Region will follow in both the near-term time frame and the medium-term time frame.

Phase 1 of the project will be initiated after the establishment of the Employer Based Multimodal Traveler Information System and will be completed twelve (12) months after award. Phase 2 of the project will commence after the completion of the installation and be completed eighteen (18) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Kiosk	50,000	2	**100,000**
Interface Requirements	10,000	1	**10,000**
Computer Hardware	10,000	1	**10,000**
Computer Software	60,000	1	60,000
Total Construction cost	-		**180,000**
Design/Evaluation cost	-		**36,000**
Total Capital Cost	-	-	**216,000**
0 & M Cost/Year	-	-	**21,600**

Table 1: Cost Summary

Project Title: **Demonstrate Port ATMS Concept**

User Services: Traffic Management:
Traffic Control
Travel Demand Management:
Demand Management and Operations

Time Frame: Near-Term

Objective: To design and implement an Advanced Traffic Management System (ATMS) for the Port of Tacoma. The ATMS will coordinate the operations of the local traffic signal system, port access VMS and CCTV systems and the I-5 freeway SC&DI in an effort to manage the truck activity accessing the port.

Project Background and Need: The Port of Tacoma facilities include terminals for handling all commodity types. In 199 1, the Port of Tacoma handled 1,0 16,000 TEUs which accounted for over 7 million tons of containerized cargo. A significant portion of this cargo is moved by truck. Truck access improvements are critical to the Port of Tacoma operations. The truck routes from Interstate 5 to the Port of Tacoma have three options. Portland Avenue for Southbound traffic at exit 133 and for northbound traffic at exit 136. Exit 137 is also used for Hylebos Waterway terminals from either direction. Container traffic accessing Tacoma Terminals often uses Portland Avenue, while Terminals 3,4 and 7 usually use Port of Tacoma Road.

Several access improvement projects are either underway or being planned. The Port of Tacoma is participating in a major project that will significantly improve vehicular access in the tidal flats area - construction of SR-509. Other projects that are under consideration include the extension of SR 167 from Puyallup at Meridian Street, the capacity expansion of the Port of Tacoma Road which is increasingly congested, and the improvement of Portland Avenue which is currently in poor condition and may limit truck traffic in the future.

In addition to the physical improvements, there is an increasing need to better manage the traffic accessing the Port of Tacoma. The proposed ATMS project will constitute one in a series of projects aimed at building an Intelligent Transportation System for managing truck activities around and within the boundaries of the Port of Tacoma. The ultimate system will be integrated with the I-5 Corridor ITS.

Project Description: The project will include planning, designing, implementing and evaluating an Advanced Traffic Management System for the Port of Tacoma. The ATMS will integrate the existing local traffic signals with planned variable message signs and closed circuit television for the port access area. The existing traffic control signal system will be upgraded and inter-connected. Two (2) variable message signs will be installed on I-5.

The Northbound VMS will be located south of the I-705 interchange, whereas the Southbound VMS will be located north of Exit 137. Four (4) CCTV cameras will be installed at the key truck access routes to the port. A camera will be installed at each of the following intersections to monitor the truck traffic entering the port area: 1) SR 99 and Taylor Way, 2) SR 99 and Port of Tacoma Road, 3) SR 99 and Portland Avenue, and 4) future SR 509 and I-705.

The control units for the signals, VMS and CCTV will be located at a dedicated port operations center. This operations center will also have a two-way communication capability with the (regional) I-5 SC&D1 Operations Control Center for coordination of surveillance, control and port access from the I-5, in particular for coordination of VMS messages at locations upstream of the port exits on I-5, and the one VMS at Exit 133 along the I-5 at Portland Avenue.

System Capabilities The proposed ATMS will have the following capabilities:

- Control the port area traffic control signals (phase sequence and timing) based on a time of day/day of week criteria or in response to planned events (such as special events at Tacoma Dome) or unexpected traffic conditions (such as incidents);

- Control the port access Variable Message Signs (VMS) to display either pre-designed messages or other messages in response to traffic conditions at the port access;

- Monitor real-time traffic conditions along the four major truck access routes into the Port of Tacoma using the CCTV system; and

- Coordinate port truck access information dissemination along the I-5 with the regional SC&DI.

Project Scope: The project will be divided into two phases, the planning and design phase and the implementation phase. Following is a brief description of the scope of work for each of the two phases.

Phase 1: Planning and Design of Port of Tacoma ATMS

The planning and design effort will consist of the following activities:

1. Design the interconnection and upgrade of the port area traffic control signal system. This effort will include analyzing base and projected traffic conditions in the port area, designing optimal signal phasing and timing plans for various operational scenarios (e.g., time of day/day of week), designing the system interconnect and upgrade into a coordinated system, determining the need for additional traffic control signal at uncontrolled intersections and designing the system controls at the port operations center. The design should allow for future upgrade of the system to accept loop detector data for real-time phase adjustment.

2. Develop a variable message sign system which will initially consist of two variable message signs located along I-5. One Northbound VMS will be located south of the I-705 interchange, and one Southbound VMS will be located north of Exit 137. The design will include developing specifications for the signs and the head-end support system, determining the exact location of the signs, and developing a message library. The signs would be controlled from the operations center. The messages displayed on those VMS will be coordinated with the (regional) I-5 SC&DI Operations Control Center.

3. Design a Closed Circuit Television (CCTV) system, which will include four (4) CCTV cameras to be installed at the key truck access routes to the port. A camera will be installed at the following intersection: SR 99 and Taylor Way, SR 99 and Port of Tacoma Road, SR 99 and Portland Avenue, and future SR 509 and I-705. The design will include developing specifications for the cameras, housing, Pan, Tilt and Zoom (PTZ) unit and display monitors. The design will also include determining the exact location and designing the mounting for each camera unit.

4. Design the communication system to interconnect the field equipment, including the VMS, CCTV cameras, traffic control signals and local controllers, to the port operations center. This effort will also include designing the interface and communication requirements between the

port operations center and the (regional) I-5 SC&DI Operations Control Center.

5. Plan and design the Port of Tacoma Operations Center. This effort includes determining a location for the Center, determining the space and personnel requirements and the layout. The Operations Center could be co-located within an existing Port of Tacoma office. The effort will also include the design of both the hardware and software of the main workstations.

6. Plan for future upgrade and expansion of the system to include the following:

   - addition of VMS at port exit locations;
   - addition of the capability to receive loop detector data for real-time traffic adaptive control signals;
   - addition of a truck queuing system;
   - interface to the state-wide CVO program and a weigh-by-pass station; and
   - interface with the state-wide ATIS system to receive traveler information including weather information.

Phase 2: Implementation and Evaluation of the Port of Taco-

The phase 2 of the project is the implementation and evaluation phase of the Port of Tacoma ATMS. This will include the following activities:

1. Selecting equipment that meets the specifications of the design;

2. Purchasing and installing the field equipment;

3. Purchasing and installing the communication hardware;

4. Purchasing and installing the Operation Center's equipment;

5. Developing/customizing the software for field controllers and head-end configuration;

6. Constructing the operations center;

7. Integrating the ATMS;

8. Testing and evaluating the system; and

9. Evaluating the performance of the system in terms of improvements to the port operations.

Project Cost: **Table 1** presents a summary explanation of the capital cost in 1995 dollars for the Port of Tacoma ATMS. The estimate is for the base system which was described above and does not include the planned expansions and upgrades. The design and evaluation cost is estimated at 20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost.

Total Capital Cost =	**$1,695,000**
Operations and Maintenance Cost/Year =	**$169,500**

Project Benefits: The project benefits are expected to concentrate on the net reduction in shipment delays as a result of the coordinated traffic control signal system, supported by the VMS and CCTV systems. The benefits are estimated as a function of percent time savings per truck and the shipper's/trucker's value of time. The following is an estimation of the expected benefits quantified in 1995 $US:

Average Port Access Delay Per Truck (minutes) =	10
Number of Trucks Accessing the Port/Year =	1,100,000
Total Port Access Delays/Year (minutes) =	11,000,000
Expected Port Access Time Savings (%) =	10%
Total Time Savings/Year (minutes) =	1,100,000
Value of Time (shippers)/Minute =	$1.25
Total Savings/Year =	**$1~75,000**

Project B/C Ratio The benefit/cost **analysis is based on a 200-year amortization of** construction and engineering costs plus operations and maintenance. The assumed rate of return is 0%; thus, the cost-benefit analysis is based on the average costs of projects during their life spans, disregarding inflation. This is a reasonable assumption, given the decreasing costs of many ITS technologies as their use expands in the marketplace.

Equivalent Uniform	
Annual Cost	**$294,252**
Annual Benefit	**$1,375,000**
Benefit/Cost Ratio	**4.7:1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 years time frame). Follow-up projects to expand and upgrade the Port of Tacoma ATMS will follow in both the near-term time frame and the medium-term time frame.

The planning and design phase (phase 1) of the project will be completed in eight (8) months after award. The implementation phase (phase 2) will be completed in eighteen (18) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
System Interconnect and Signal Timing	3 12,500	1	3 12,500
Variable Message Signs	170,000	2	340,000
CCTV	45,000	1	180,000
Communications System	30,000	1	30,000
Port Operations Center	530,000	1	530,000
System Expansion	20,000	1	20,000
Total Construction Cost	-	-	1,412,500
Design/Evaluation Cost	-	-	282,500
Total Capital Cost	-	-	**1,695,000**
O & M Cost/Year	-	-	**169,500**

Table 1: Cost Summary

Project Title: **Demonstrate Rural SC&DI System in Centralia/Chehalis Area**

User Services:

Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control

Travel Demand Management:
- Pre-Trip Travel Information

Commercial Vehicle Operations:
- Commercial Fleet Management

Emergency Management:
- Emergency Vehicle Management

Time Frame; Near Term

Objective: The objective of the project is to demonstrate a rural Surveillance, Control and Driver Information (SC&DI) System in the Centralia/Chehalis area. This system will be a "light infrastructure" SC&DI system covering a large geographic area at a relatively low cost. This demonstration will aim to determine the cost effectiveness of a rural SC&DI system in terms of capital and maintenance costs.

Project Background and Need: The Centrakua/Chehalis area of the I-5 corridor is roughly fourteen miles long, bordered by interchanges 68 and 82. This section of the freeway consists of a four lane roadway which carries the lowest traffic volumes in the corridor. The current volume to capacity ratios for this area range between 0.5 and 0.6 and the current percentage trucks ranges between 20% and 30%. In addition to being the key inter-city connector in the corridor, the CentraliaKhehalis area of the corridor provides the main access to the mountain and coastal regions for this area via Route 12 and SR 6.

Currently, there are also potential environmental concerns which pose as congestion and safety threats to travel through this area. Specifically, these threats are flooding and fog. The Centralia/Chehalis area has been identified as a potential flooding area. In addition, a relatively high level of fog-related accidents have occurred along the corridor in this area.

The projected 2012 volume to capacity ratio in this area is greater than 0.8, with the volume to capacity ratio at the SR 6 interchange is expected to approach 1 .0. In addition, it is expected that a higher percentage trucks will be present in this area. This is due both to an expected growth in truck traffic of 28% over 1990 levels in the Puget Sound Region and to lower levels of development and lower commuter trips in the inter-city areas.

The increase in the volume to capacity ratios in this area is expected to result in a decrease in the level of service as well as an increase in the accident rate. As there are four travel lanes on the I-5 in the Centralia/Chehalis area, incidents in this area will cause capacity reductions that represent a significant portion of the of the capacity and will severely impact traffic operations as the volume to capacity ratio will jump significantly.

Considering that a significant portion of this traffic is commercial traffic and that alternative routes are-limited, this situation represents a societal cost which warrants the implementation of an SC&DI system. However, the volumes in this area are relatively low and the geographic area is relatively large making it difficult to justify a comprehensive SC&DI system. Instead, a "light infrastructure" SC&DI system is suggested to help address the anticipated system deficiencies. The main functions of the SC&DI system will be to detect and keep travelers informed of incidents, major congestion, hazardous environmental conditions in the Centralia/Chehalis area.

Statement of Deficiency: As urban areas grow along the corridor, the traffic on rural roads between these urban areas will increase presenting sufficient volume-to-capacity ratios to cause congestion and increase the potential for incidents. An incident or hazardous environmental conditions on these rural roads will have a severe impact on traffic operations as small reductions in capacity represent a significant portion of the design capacity, and will likely result in significant congestion. This increased congestion combined with the limited available alternative routes will further complicate travel in this area.

Project Description: The project will demonstrate a rural SC&DI system capable of detecting major delays and hazardous environmental conditions remotely on the I-5 in the rural Centralia/Chehalis area, transmitting this data to the Southwest Regional Traveler Information System, and transmitting congestion and alternative route information to travelers through the area. This will be achieved by vehicle detector stations (DS), variable message signs (VMS), and highway advisory radio (HAR) all configured to communicate through a wireless infrastructure to a central workstation at a WSDOT Regional or Maintenance office.

The traffic monitoring system will consist of several DS with independent controllers monitoring traffic in all lanes. The DS controllers will interpret the data collected and calculate the traffic speeds, volumes and occupancies for each lane.

The environmental conditions monitoring subsystem will consist of several detectors capable of monitoring fog and flood conditions. Remote controllers will determine when fog or flood conditions exist and will communicate this information to the central control.

The communications subsystem provides the following:

- a data link between the traffic monitoring devices (vehicle detectors) and the WSDOT workstation;
- a data link between the WSDOT workstation and the traveler information subsystem (VMS and HAR); and
- a data link between the WSDOT workstation and other TSMC's in Portland/Vancouver, Tacoma, and Seattle.

The first link provides for the means for collecting field data. The second link facilitates the control of the information field devices including VMS and HAR. The final link allows the rural SC&DI system to coordinate with other regional traveler information systems along the corridor. Mainly, this link would be used to transmit congestion and potential incident information as detected in the Centralia/Chehalis area. Due to the remote nature of the system, field device communications will be wireless such as cellular phone and spread spectrum radio. Communications to other TSMC's will be accomplished through the corridor communications network.

The monitoring and control workstation will be integrated into the regional WSDOT office or local maintenance yard. The subsystem will consist of the hardware and software required to control the system. The hardware will consist of computers and monitors to collect and display the information collected in the field, to control the field-devices (i.e. change messages for VMS and HAR) and to communicate with other control centers.

The traveler information subsystem will consist of several VMS and HAR transmitters. These devices will be located at periodic intervals along the corridor in the Centralis/Chehalis area. The HAR transmitters will be located to provide coverage for the corridor in the Centralis/Chehalis area. The HAR will transmit warning messages providing general details of the traffic operations for the rural area including construction advisories, confirmed incidents, fog, flooding and other major delays. In addition, messages will be transmitted providing alternate route navigation information. Drivers will be notified of traffic advisories with fixed signs and flashing beacons as on other WSDOT roads.

System Capabilities: The proposed project will have the following capabilities:

- Detect incidents and congestion;
- Estimate delay from volume, speed and occupancy data collected along I-5 corridor in the Centralia/Chehalis area;
- Detect hazardous fog and flood conditions;
- Provide details of constructions delays, confirmed incidents, major delays, prevailing speeds and possible alternate routes through a network of VMS and HAR transmitters;
- Maintain a database storing construction information, confirmed incident information, and data for planning purposes;
- Monitor database information to determine if any device state changes are required notifying operations staff when necessary (i.e. confirm construction messages are correct or confirm incidents still exists); and
- Provide a system that will support construction and work zone management for potential freeway widening projects.

Project Scope: The project scope'will involve two phases. The first phase will develop the Rural SC&DI System. The second phase will implement and evaluate the effectiveness of the system in the Centralia/Chehalis area. The following is a brief description of the tasks of each phase.

Phas Develop Rural SC&DI System

The first phase will consist of the following tasks:

1. Developing operations plan.

2. Designing control center software.

3. Designing wireless communications system.

4. Designing field equipment including detection technology, display technology, mounting and power.

Phase 2: Implementation and Evaluation of Rural SC&DI System

Phase 2 will implement and evaluate the Rural SC&DI System as developed in the previous phase. The following tasks are included in this phase:

1. Selecting equipment that meets the specifications of the design.

2. Purchasing and assembling all hardware.

3. Developing control center software.

4. Developing communications software.

5. Initial testing of the system.

6. Evaluating performance of the system in a field test.

Project Cost:

Table 1 presents a summary explanation of the capital cost in 1995 dollars for the Rural SC&DI System demonstration. The design and evaluation cost is estimated at 20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost.

Total Capital Cost	$2,484,000
Annual O&M	$248,400

Project Benefits:

The project benefits are expected to derive from a reduction in delay experienced by travelers due to congestion and incidents. Assuming no road widening improvements takes place in the region, the benefits determined in the Statewide IVHS Plan for other urban areas is applicable.

The Centralia/Chehalis area represents 10% of the freeway for other urban areas covered in the State IVHS Plan. This represents 4025 person-hours of delay of congestion annually. The truck percentage is 24% and it is assumed that 80% of the delay is experienced at peak hour. Considering values of $5.55 for peak vehicles, $2.75 for non-peak vehicles, and $60.00 for trucks, the cost of the delay is approximately $73,225. The functionality of the SC&DI is expected to reduce this cost by 37% yielding an annual benefit of approximately $27,100.

Traffic incidents in this area cost annually $241,128 per mile. Assuming implementation of the SC&DI system reduces incidents by 10% and considering a 20 mile length of the I-5, the benefit received is $482,256.

Totaling these two benefits provides an annual . .

Annual Benefits $5 'i

Project B/C: The benefit/cost analysis is based on a 20-year . construction and engineering costs plus operati . discount rate is 4%. Both the expected benefit: maintenance costs are assumed to be uniform

Equivalent Uniform
Annual Costs
Annual Benefits

Benefit/Cost Ratio

Project Schedule: The project is proposed as a near-term ITS pro The design phase of the project will be comple award. The implementation and evaluation pk. eighteen (18) months after award.

Item	**Unit Cost (1995 $)**	#
Data Stations	50,000	3.
Variable Message Signs	170,000-	4
HAR System	83,000	2
Fog and Flood Detection	70,000	4
Communications System and TSMC	419,000	1
System Expansion	125,000	1
Total Construction Cost		
Design/Evaluation Cost		
Total Capital Cost		-
0 & M Cost/Year	-	-

Table 1: Cost Summary

Project Title: **Deploy US 30 Route Diversion System**

User Services: Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Time Frame: Near-Term

Objective: The primary objective of this project is to use ITS technology to inform travelers of an alternate route when I-5 is closed for significant periods of time between Kelso and Vancouver due to a major incident or planned event.

Project Background and Needs: Interstate 5 serves as the primary highway connection between Seattle and Portland and is part of the major interstate route which runs from Canada to Mexico along the west coast of the United States. The 29-mile segment between Kelso and the I-5/I-205 interchange in Vancouver has no nearby state highway which can be used as a detour route in case I-5 is closed to traffic due to some major incident along I-5. The nearest detour **is** US 30 which parallels I-5 on the Oregon side of the Columbia River. The detour route is approximately 56 miles long, 11 miles longer than the distance between the same two points on I-5. Travel time between the start and end points of the detour is estimated to be approximately 50 minutes along I-5 (a divided multi-lane highway) and approximately 70 minutes along US 30. Any delay which is-longer than 20 minutes would make the detour an effective alternative to waiting for I-5 to be cleared.

Between Kelso and Vancouver, I-5 had an Average Annual Daily Traffic (AADT) volume of 46,000 vehicles per day (vpd) in 1993. Trucks made up approximately 19 percent (5,900 vpd) of the 1993 AADT. The 2012 AADT is projected to be approximately 77,000 vpd of which approximately 14,400 vpd would be trucks. This I-5 segment contains three Hazardous Accident Corridors which have an annual societal cost of approximately $2.8 million per year. For the five-year period ending November 30,1993, there were about 200 accidents per year of which 36 percent of the accidents involved injuries or fatalities along this stretch of I-5. If an injury/fatality accident closes I-5 to through traffic for at least 30 minutes it follows that a detour route should be available for travelers. Since an injury/fatality accident occurs approximately once every five days, a need currently exists for travelers along I-5 to be alerted to the availability of a detour route.

Statement of Deficiency: A need currently exists for travelers along I-5 to be alerted to the availability of a detour route along US 30 whenever I-5 is closed due to a planned event or unexpected traffic conditions.

Project Description: To design and implement a route diversion system from I-5 to US 30 between Kelso, Washington and Portland, Oregon. This project would advise travelers that I-5 is closed at a certain location and direct through traffic to the detour route.

System Capabilities: The proposed US 30 route diversion system will have the following capabilities:

- Control the route diversion system's Variable Message Signs (VMS) to display either pre-designed messages or other messages in response to planned events (such as construction) or unexpected traffic conditions (such as incidents);

- Disseminate the traffic related event information to the proposed regional traveler information services;

- Operational procedures for when the diversion system should be activated and coordination between the affected state and local agencies, i.e. WSDOT, WSP, ODOT, OSP, and county sheriffs; and

- Links to ODOT and WSDOT control centers.

Project Scope: The project will be divided into two phases, the planning and design phase and the implementation phase. Following is a brief description of the scope of work for each of the two phases.

Phase 1: Planning and Design of US 30 Route Diversion System

The planning and design effort will consist of the following activities:

1. Develop a variable message sign (VMS) system which will consist of nine variable message signs: two VMS located along I-5 and seven

VMS marking rhe detour route along US 30. Northbound travelers will be advised to use the detour route by an existing sign located south of the I-405 interchange (Exit 299) in Portland. Four signs will guide travelers along the northbound detour. Southbound travelers will be advised by a sign located north of Exit 37 near Kelso. Three signs will be located at critical locations along the southbound detour route. The design will include developing specifications for the signs and the interface to the Oregon Department of Transportation's Portland Regionwide ATMS Traffic Management Operations Center (TMOC) or WSDOT's regional office, determining the exact location of the signs, and developing a message library. All signs would be controlled from the TMOC.

2. Design the communication system to interconnect the VMS to the TMOC. This effort will also include designing tbe interface and communication requirements between the TMOC and the proposed regional traveler information system.

3. Develop operational procedures for activation of the route diversion system, informing affected government agencies, and informing the traveling public.

Phase 2: Implementation of the US 30 Route Diversion System

Phase 2 of the project is the implementation phase of the US 30 Route Diversion System. This will include the following activities:

1. Selecting equipment that meets the specifications of the design;

2. Purchasing and installing the field equipment;

3. Purchasing and installing the communication hardware;

4. Purchasing and installing the TMOC's equipment;

5. Developing/customizing the software for field controllers and TMOC configuration;

6. Integrating the Route Diversion System into the TMOC; and

7. Testing and evaluating the system.

Project Cost: **Table 1** presents a summary of the capital costs in 1995 dollars for the US 30 Route Diversion System. The estimate is for the base system which was described above and does not include expansions or upgrades. The design cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 15 percent of the capital cost.

Total Capital Cost =	$552,000
Operating and Maintenance Cost/Year =	$82,800

Project Benefits: The project is expected to benefit private motor carriers, state regulatory agencies, and the general public. The savings are based upon the waiting time and operating costs saved by keeping travelers moving instead of waiting for the I-5 to be opened to traffic. The benefits are only calculated in terms of injury/fatality accidents and do not include road closures due to other types of incidents or planned events. The following is an estimation of the expected benefits quantified in 1995 $US:

Number of Accidents/Year =	200
Accidents Requiring Diversion (%) =	36%
Time Savings by Diversion/Year (hours) =	12
Number of Hours/Day =	24
Number of Passenger Vehicles/Day =	40,100
Average Car Occupancy/Vehicle =	1.35
Number of Passengers/Day =	54,135
SOV Cost Parameter ($ per person/hour) =	$6.30
SOV Cost Savings/Year =	$170,525
Number of Trucks/Day =	5,900
Truck Cost Parameter ($ per truck/hour) =	$21.40
Truck Cost Savings/Year =	$63,130
Annual Benefits	$233,655

Project B/C Ratio: The benefit/cost ratio is based on a 20 year amortization of capital and O&M costs and the reduced costs to motor carriers in operating costs. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS plan.

Equivalent Uniform	
Annual Cost	**$123,427**
Annual Benefits	**$233,655**
Benefit/Cost Ratio	**1.9 : 1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 year time frame). The planning phase (phase 1) of the project would be completed one year after award. The implementation phase (phase 2) would be completed two years after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Variable Message Signs - Mainline	150,000	1	150,000
Variable Message Signs - Detour Route	30,000	7	210,000
Communications System	25,000	1	25,000
Control System at TMOC	25,000	1	25,000
Integration	50,000	1	50,000
Total Construction Cost	-	-	**460,000**
Design Cost	-	-	92,000
Total Capital Cost	-	-	**552,000**
O & M Cost/Year	-	-	**82,800**

Table 1: Cost Summary

Project Title: **Pilot Rest Stop Information Kiosks**

User Services: Traveler Information:
- Traveler Services Information
- En-Route Driver Information

Time Frame: Near Term

Objective: The objective of the project is to demonstrate a rest stop information kiosk at a gas station fruit stand along State Route 12 in the I-5 Corridor. This project will be used to assess the operational requirements and feasibility of providing both static and real-time traveler information at remote highway rest stops.

Project Background and Need: There are several operational tests and Traveler Information System (TIS) implementations across the U.S. that employ or intend to employ kiosks to provide multimodal traveler information. For example, Los Angeles Smart Traveler will be implementing kiosks using audiotex and videotex to provide transit, paratransit and rideshare information. Within Washington State, the Seattle Smart Traveler program executed an operational test providing transit and ride sharing information to commuters from a single kiosk in Bellevue.

Recently, there have been two local public information efforts that will impact this project. First, the Washington State Department of Information Services implemented a pilot project providing public information through kiosks. This project, Washington Information Network (WIN), was established to help the state government serve the people of Washington State better, faster and more cost-effectively. These kiosks provide a public interface to several government databases including transportation and recreation. The impact this effort will have on this project is the local experience gained through its design and implementation; several issues including data security, communications protocol as well as public experience with the kiosks have already been addressed.

Second, WSDOT presently maintains several home pages on the world wide web. They provide information such as real-time traffic congestion information for the greater Seattle freeways and transit access information for the greater Seattle area. These home pages represent excellent sources of traveler information that have established formats and communications protocol (i.e. TCP/IP).

Although traveler information kiosks represent relatively well proven technology, they have not been widely used for recreational information applications. As such it is important to first demonstrate the feasibility and evaluate the potential of a recreational kiosk a wider application can be advanced. These kiosks would provide static information providing route instructions to tourist attractions, tourist attraction times of operation and local services information.

Statement of Deficiency: Tourists and infrequent travelers to remote areas are unfamiliar with the services and attractions the area has to offer. In addition, advertisements and signing cannot convey all the desired information. A medium that can provide information on local services, local attractions and route instructions would provide focus for the market interested in that information.

Project Description: The project will demonstrate a tourist-oriented kiosk at a remote location near both attractions and services. This will allow for an evaluation of the feasibility of expanding the scope of this project to rest areas along the I-5 corridor. The project will involve the custom development of a user interface, screen format and control software suitable for providing static tourist information.

With the assistance of groups such as the Lewis County Trade and Economic Development Croup, the United States Forest Service, the National Parks Service, the FHWA, the Western Federal Lands, data will be compiled that will assist tourists in locating tourist attractions and local services. This data will populate the kiosk's database which will be updated infrequently (e.g. once a month) either remotely or by field staff. This data includes attraction locations, operations times, route instructions, and local services (i.e. restaurants, accommodations and tourist-oriented stores).

System Capabilities: The proposed project will have the following capabilities:

- Provide a personal and accessible interface by which travelers can request information using a touch screen, a pointing device and a keyboard and view this information using a color monitor, clear sound-generating equipment and a printer; and

- Provide static tourist information including attraction locations and hours of operation, route selection and local services information.

Project Scope: The project scope will involve two phases. The first phase will develop the kiosk interface, screen format, kiosk database and communications. The second phase will implement and evaluate the kiosk. The following is a brief description of the tasks of each phase.

Phase 1. Develop and Deploy Interface and format

The first phase will consist of the following tasks:

1. Compiling kiosk information from meetings with interested groups and agreements made with local services.

2. Arranging a partnership with a commercial interest in order to locate the kiosk; this commercial interest would receive free advertising in return for space rental and maintenance of the kiosk.

3. Coordinating with the Washington Information Network (WIN) design to facilitate development of similar interface.

4. Completing design of the kiosk including interface, communications, database format, and method to update information.

Phase 2: Implementation and Evaluation of Kiosk

Phase 2 will implement and evaluate the kiosk as developed in the previous phase. The following tasks are included in this phase:

1. Selecting equipment that meets the specifications of the design.

2. Purchasing and installing the kiosk and communications hardware.

3. Developing and customizing the software for the kiosk.

4. Testing and evaluating the kiosk.

5. Evaluation of performance and use of the kiosk.

Project Cost: **Table 1** presents a summary explanation of the capital cost in 1995 dollars for the Pilot Rest Stop Information Kiosk. The estimate is for the base system which was described above and does not include the planned expansions and upgrades. The design and evaluation cost is estimated at

20% of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10% of the capital cost.

Total Capital Cost	**$45,600**
Annual O&M	**$4,560**

Project Benefits: The project benefits are expected to derive from the fact that the number of tourists visiting the tourist attractions and local services will increase due to the kiosks advertising. As a result, local service providers and other commercial interests will provide cost-sharing and other revenue to participate.

The Statewide IVHS Plan identified the potential annual benefits for rural applications of traveler information as $17,880. Considering the proximity of the tourist services to the proposed location, it is assumed that 10% of the benefits apply to this application yielding $1,788 annually. In addition, advertising sales and private cost-sharing will offset the operations of the kiosk. These are anticipated to be $5,000 each annually.

Annual Benefits	$11,788

Project B/C: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are assumed to be uniform for the 20 year period.

Equivalent Uniform Annual Costs	$7,916
Annual Benefits	$11,788
Benefit/Cost Ratio	**1.5:1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 years time frame). The planning and design phase (phase 1) of the project will be completed in six (6) months after award. The implementation phase (phase 2) will be completed in eighteen (18) months after award.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
Kiosk Hardware and Software (including CPU with keyboard, pointing device, touch screen, color monitor, multi-media capability, modem and printer)	35,000	1	35,000
Kiosk Cabinet	3,000	1	3,000
Total Construction Cost	-	-	**38,000**
Design/Evaluation Cost	-	-	7,600
Total Capital Cost	-	-	**45,600**
O & M Cost/Year	-	-	**4,560**

Table 1: Cost Summary

Project Title:	**Develop and Deploy WSDOT Southwest Region Traffic Related Information System**
User Services:	Travel and Transportation Management En-Route Driver Information Traveler Services Information Travel Demand Management Pre-Trip Travel Information Demand Management and Operations
Time Frame:	Near Term
Objective:	To develop a traffic related event-based Advanced Traveler Information System (ATIS), and deploy it in the Southwest Region along the I-5 Corridor.
Project Background and Need:	Advanced Traveler Information Systems have proven to be one of the most effective ITS tools for managing traffic, reducing congestion, delay, fuel consumption and emissions, and improving safety. This is achieved by informing travelers of the location of incidents, construction and traffic congestion in order to allow travelers to choose alternative routes, modes or departure times. Currently there exists within the Southwest Region along the corridor a number of sources of traffic related event information such as incident reports, construction and maintenance activities, traffic congestion and location of detours. While some of this information is distributed to the public through variable message signs (VMS), highway advisory radio (HAR) and media reports, much of it is used for internal agency purposes only and/or is not readily accessible by the public. There is therefore a need to develop a system that can collect and aggregate these various sources of information in order to provide travelers with a comprehensive, single source of traffic related information that can be accessed on a pre-trip or en-route basis using a variety of means and technologies. In addition, such a system would provide a consistent basis for defining traffic events, further improving the value of the information to the public, other transportation agencies and commercial vehicle operations.

Statement of Deficiency:

The management of traffic in a congestion area, in a work zone, or at an incident location requires the timely transmission of event related traffic information to travelers on a pre-trip and en-route basis. Limited access to current traffic-event related information hinders the ability to manage traffic in these areas, with the result of increased congestion levels, decreased mobility, and a subsequent impairment of traffic safety.

Project Description:

This project would involve the development and deployment of a system to collect, process, format and disseminate traffic related information for the Southwest Region. This information could also be consolidated and filtered to provide input to a comprehensive corridor or statewide information system. For example, a Traffic Related Traveler Information System will be developed to facilitate coordination between this region with both the Olympic Region.

Development, implementation, integration and operations costs will be minimized by developing a similar system for all three Regions in the Northwest Region project. Only minor custom tailoring and configuring for this Region would be required to accommodate Region-specific information sources, dissemination methods and operational strategies.

System Capabilities:

The Traffic Related Traveler Information System will manually or electronically gather traffic related event information such as:

- accident and incident reports from such sources as cellular phone or other call-ins, police dispatch, WSDOT mobile vehicles and the bridge tenders;
- pre-planned road closure, construction and maintenance information;
- emergency road closure, construction and maintenance information;
- truck or hazardous material restrictions;
- reversible lane operations;
- weather conditions;
- information on planned recreational events or other activities that may disrupt traffic flow or require traffic re-routing.

All information inputs will need to be geocoded using a common referencing system such as latitude-longitude, highway milepost or major street-cross street.

Information will be stored in a relational database, running as an application on a desktop PC using a multi-tasking operating system such as Windows NT. Maximum use of commercial off-the-shelf (COTS) software, coupled with a modular design approach, will allow for a system that is expandable (both functionally and geographically) and transportable to other applications or to new hardware platforms.

The system will be designed to disseminate the traffic related event information through existing and planned WSDOT motorist information devices (i.e. VMS, HAR and media interfaces). Information dissemination capabilities may also be expanded to include new devices such as:

- automatic fax transmission to WSDOT maintenance yards, commercial radio and television stations, and other public and/or private users in need of regular trafic reports. Subscribers to the fax service would be able to define the type of information they want, the geographical area, the highways and the times (including immediate response) at which faxes should be sent. It would also be possible to charge for this service, which would be part of the subscribers data base.

- alphanumeric pager messages to WSDOT operations and maintenance staff and emergency services;

- a public dial-up information line providing computer-generated voice messages. The messages could be structured so that they can be accessed by the highway name for selected geographical areas (e.g. I-5 FROM TACOMA TO SEATTLE);

- linkages to traveler information kiosks;

- computer data feeds to both public and private users through Internet and/or direct dial-up lines;

- data feeds to mobile units using data formats such as the International Traveler Information Interchange Standards (ITIS) over radio based communications including subcarrier, CDPD or data broadcast radio;

- electronic data interfaces to value added re-sellers including HELP Inc. for redistribution of the information to truckers along the corridor.

For this Region, it is anticipated that the system will be initially integrated into existing traffic engineering and/or roadway maintenance operations. Terminal feeds from regional maintenance yards would also be provided to allow remote access throughout the Region.

Project Scope: Work activities will consist of two phases:

Phase 1– Deploying and configuring the traffic related traveler information system in the Southwest Region.

Phase 2 - Facilitating a communications link to the Seattle-Portland Traffic Related Traveler Information System Center.

This work will not include the deployment of traveler information devices (e.g. VMS, HAR, information kiosks, etc.) in the field. It is expected that these will be installed as part of other initiatives.
It is expected that the design and development of the traffic related traveler information system for the Northwest Region will form the standard for all Regions in the corridor. As such, this project must begin after the completion of the first phase of the Northwest Region project.

Phase 1 - Deployment Southwest Region

Upon successful development and testing of the traffic related event information system in the Northwest Region, the system would be deployed and modified in the Southwest Region. Major work activities in this Region will include:

1. Preparation of a functional design report describing aspects of the Northwest Region system that need to be tailored for application in the Southwest Region;

2. Detailed design of modifications to the Northwest Region system software elements to support deployment in the Southwest Region;

3. Hardware and software procurement/additional license agreements;

4. Modification or development, coding and testing of modified or new software applications.

5. Modification and testing of hardware/software interfaces to existing WSDOT systems (e.g. VMS).

6. Development and testing of new hardware/software interfaces to external users. Application or modification of interagency agreements developed for the Northwest Region to each major external user;

7. Overall system testing and integration.

8. Update of design, operations and maintenance manuals;

9. Training of operations staff

Phase 2 - Integration with Seattle-Portland System

This second phase would facilitate a communications link to the Seattle-Portland Traffic Related Traveler Information System Center to assist in providing corridor wide traveler information coverage. This activity could be done concurrently with system deployment of the corridor-wide system, or could be deferred until sufficient experience is gained with stand-alone operation in this Region

Requirements and provisions for providing corridor wide information will have been considered under the Northwest Region system core design. Work under this phase will consist mainly of relatively minor software and/or hardware modifications including:

1. Preparation of a system design report;

2. Procuring additional software/licenses for the digital maps or GIS to provide corridor wide coverage.

3. Preparing inter-Regional agreements for the sharing and exchange of information, including establishing levels of access.

4. Modifying existing external agency agreements as required to provide corridor information, and establishment of new agreements with agencies having a corridor focus (e.g. private CVO firms).

5. Establishing system-to-system data communications links using the Internet-based corridor system architecture.

6. Modifying system software as required to support corridor wide information collection and dissemination.

7. Update of design, operations and maintenance manuals;

8. Training of operations staff

Project Cost: Estimated project costs are described in **Table 1** and are summarized below. The costs include the software development and limited hardware procurement. These costs do not include additional field equipment such as VMS's, pagers, kiosks, etc. It is expected that these will be provided as part of other initiatives.

It is assumed that the system will be staffed by one full-time equivalent performing both operations and maintenance. It is assumed that the operations and maintenance is 20% of the capital cost. It is assumed that communications will be provided through existing resources (i.e. SCAN or radio).

Total Capital Cost	$180,000
Annual O & M	$36,000

Project Benefits: The Statewide IVHS Plan identified the potential benefits of ATIS in the Vancouver area at approximately $7,500,000 per year. Assuming that 5% of these benefits can be achieved through deployment of the Southwest Regional Traffic Related Information System, the annual benefits for the Southwest Region can be estimated as:

Annual Benefits	**$375,000**

Project B/C: The benefit/cost ratio is based on a 20-year amortization of capital and O&M costs, and the pro-rated ATIS benefits computed in the Statewide IVHS Plan. The assumed rate of return is 4%, which is consistent with the computation methodology used in the Statewide IVHS Plan.

Equivalent Uniform	
Annual Costs	**$49,248**
Annual Benefits	**$375,000**
Benefit/Cost Ratio	**7.6:1**

Project Schedule: The Southwest Region Traffic Related Information System is proposed as a high-priority near-term project (O-6 years time frame). The system development would be based on the core system design developed for the Northwest Region Traffic Related Information System. System development would be completed in six (6) months after award. The system deployment would be completed one (1) year after award.

It is expected that the system design and deployment of the system in the Northwest Region be completed first. Deployment of similar system in the Southwest and Olympic Regions is contingent upon the successful deployment in the Northwest Region. The three systems are expected to be integrated into a corridor-wide system after all three systems have been deployed.

Item	Unit Cost (1995 $)	# Units	Total Cost (1995 $)
System Deployment	150,000	1	150,000
Total Construction Cost	-	-	**150,000**
Design/Evaluation Cost	-	-	30,000
Total Capital Cost	-	-	**180,000**
0 & M Cost/Year	-	-	**36,000**

Table 1: Cost Summary

-- **Project Title:** **Develop and Deploy WSDOT Southwest Region SC&DI System**

User Services:

Travel and Transportation Management:
- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Commercial Vehicle Operations:
- Commercial Fleet Management

Public Transportation Operations:
- Public Transportation Management

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near Term

Objective: The primary objective of this effort is to improve the safety and efficiency of people and goods movement on the urban freeway network through the deployment of a surveillance, control, and driver information (SC&DI) system in the Vancouver area along Interstate 5, Interstate 205, and State Route 14.

Project Background and Needs: Interstate 5 serves as the primary highway connection between Seattle and Portland and is part of the major interstate route which runs from Canada to Mexico along the west coast of the United States. I-5 travels through downtown Portland and crosses the Columbia River (state line) via two 3-lane bridges entering Clark County. Approximately 13 miles south of downtown Portland, I-205 begins an eastern loop around Portland acting as an important bypass route around the central core of the city. I-205 crosses the Columbia River six miles to the east of I-5. I-5 and I-205 intersect at I-5 Exit 7. Washington State Route 14 (SR 14) connects both interstate facilities along the north shore of the Columbia River:

The Portland Regionwide Advanced Traffic Management System Plan (Oregon Department of Transportation, 1993) is part of an intelligent transportation system (ITS) strategy to address regional growth and its impacts on the transportation system. This regional planning effort was undertaken to develop a master plan for the implementation of an Advanced Traffic Management System. The project steering committee included representatives from ODOT, WSDOT, FHWA, Portland, and METRO

(Metropolitan Planning Organization). The ATMS integrates the management of various roadway functions including freeway SC&DI and arterial signal control. This plan developed an 18-year implementation plan which calls for the establishment of a centralized Traffic Management Operations Center (TMOC). The TMOC would be the center for communications among the agencies in both Washington and Oregon.

Statement of Deficiency: Traveler delay, caused or exacerbated by congestion, is on the rise in the Portland-Vancouver region. The potential exists for the number of lane miles of congestion to increase 300 percent and travel speeds on Portland-Vancouver region's travel corridors to decrease nearly 30 percent.

Project Description: This project would involve the development and deployment of a surveillance, control, and driver information system in the Vancouver area along the I-5, I-205, and SR 14 corridors. This effort would be coordinated and integrated with the Oregon Department of Transportation's Portland Regionwide Advanced Traffic Management System (ATMS). The SC&DI will provide closed circuit television (CCTV) cameras, variable message signs (VMS), and ramp meter installations in the Vancouver area.

The control units for the signals, CCTV, VMS, and ramp meters will be located at the Traffic Management Operations Center (TMOC) in Portland, Oregon. Direct data lines would also be provided in the TMOC that would allow direct monitoring and control of the Vancouver VMS, CCTV and ramp meters. The Southwest Region has indicated that they would consider providing this capability in order to assist with regional traffic management initiatives.

System Capabilities: The proposed Vancouver Area SC&DI System will have the following capabilities:

- Monitor real time traffic conditions along I-5, I-205, and SR 14 using the CCTV system;
- Control the Vancouver area VMS to display either pre-designed messages or other messages in response to regional traffic conditions;
- Coordinate operations with the Portland TMOC and the Washington State Patrol for regional traffic management; and
- Coordinate operations with other WSDOT TSMC's.

Project Scope: The project will be divided into two phases: the planning and design phase and the near-term implementation phase. Following is a brief description of the scope of work for each of the two phases.

Phase1: Planning and Design of Vancouver Area SC&DI

The planning and design effort will consist of the following activities:

1. ***Review of the Portland Regionwide Advance Traffic Management System Plan in the*** context of new initiatives. The plan would be updated if required.

2. Design a Closed Circuit Television (CCTV) system which will include developing specifications for the cameras, housing, Pan, Tilt, and Zoom (PTZ) unit and display monitors. The design will include determining the exact location and designing the mounting for each camera unit. The ***System Plan*** suggests that 28 CCTV cameras be installed along I-5 (10 cameras), I-205 (11 cameras), and SR 14 (7 cameras) over the next 20 years.

3. Design a variable message sign (VMS) system. The design will include developing specifications for the signs and the head-end support system, determining the exact location of the signs, and developing a message library. The signs would be controlled from the TSMC. This effort includes converting two existing VMS to Type 170 based controllers. The messages displayed on the VMS will be coordinated with Portland's TMOC. At least two (2) variable message signs would be installed over the near and mid term time frames - one on I-5 and the other on SR 14.

4. Design the ramp-meter system. This effort will include developing specifications for the loops, signal display, warning signs and flashing beacons, control cabinet, output/power distribution assembly, as well as the display monitor and software at the TSMC. The design will also include determining the exact location and designing the ramp meter installation. ***The System Plan*** suggests that twenty (20) ramp meters be installed at 13 on-ramps along I-5 and 7 on-ramps along I-205 over the next 20 years.

5. Design the communication system to interconnect the field equipment, including the CCTV's, traffic control signals, local controllers, and VMS's to the TSMC. This effort will also include designing the interface and communications systems requirements between the TSMC and the Portland TMOC, Washington State Patrol, and other WSDOT TSMC's.

6. Plan and design the Vancouver area Traffic System Management Center (TSMC). This effort includes determining a location for the TSMC, determining space and personnel requirements, and the layout. The effort will also include the design of both the hardware and software of the main workstations.

7. Plan for interconnections and expansion of the system to include the following:

   - interconnection to public transportation systems;
   - transit priority system;
   - CVO applications;
   - emergency notification interface;
   - WSDOT baseline advanced traveler information system;
   - weather information system;
   - port access system; and
   - regional multi-modal traveler information center.

All of these additional applications will have the standard interfaces required based on the statewide architecture adopted as part of this project. The TSMC will have the ability to display information provided by each one of these applications using the standardized interface.

Phase 2: Implementation and Evaluation of Vancouver Area SC&DI

The second phase of this project is the implementation and evaluation of the Vancouver area SC&DI system. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the communications hardware;

4. Construction of the TSMC. This effort would include purchasing and installing the TSMC's equipment;

5. Developing/customizing the software for field equipment and head-end configuration;

6. Integrating the Vancouver area SC&DI system into the Portland region ATMS;

7. Develop operational procedures;

8. Testing and evaluating the system; and

9. Evaluating the performance of the system in terms of reductions in traffic congestion, fuel consumption, travel time, and accidents.

Project Cost: **Table 1** presents a summary of the capital costs in 1995 dollars for the Vancouver area SC&DI system deployment over the next 20 years. The estimate is for the base system which was described above and does not include planned expansions or upgrades, The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capital Cost	$35,533,200
Annual O&M	$3,553,320

Project Benefits: The project benefits are expected to be a reduction in traveler delay caused by congestion and a reduction in incidents. The Statewide IVHS Plan identifies the potential benefits in the Vancouver as approximately $7,500,000 for ATIS, $9,200,000 for VMS, $5,400,000 for HAR, $5,400,000 for CCTV, $16,300,000 for incident management, and $ 17,600,000 for detection. These benefits total to roughly $6 1 ,OOO,OOO for the Vancouver region. Urban roadways (the Vancouver area) represent 75% of the vehicle-miles traveled in Clark County. This yield an annual benefit of:

Annual Benefits	$45,750,000

Project B/C: The benefit/cost analysis is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4%. Both the expected benefits and the operations and maintenance costs are uniform for the 20 year period.

Equivalent Uniform	
Annual Costs	$6,168,564
Annual Benefits	$45,750,000
Benefit/Cost Ratio	**7.4:1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 year time frame). Follow-up projects to expand and upgrade the SC&DI system will follow in both the medium-term and long-term time frames. These costs have been included in the cost estimate.

The planning and design phase (phase 1) of the project would be completed eighteen (18) months after award. The implementation phase (phase 2) would be completed six (6) years after award.

Item	**Unit Cost (1995 $)**	**# Units**	**Total Cost (1995 $)**
Data Stations	50,000	44	2,200,000
CCTV System	50,000	28	1,400,000
Variable Message Signs	195,000	2	390,000
Ramp Meters	55,000	20	1,100,000
Communication System	24,521,000	1	24,521,000
Total Construction Cost			**29,611,000**
Design/Evaluation Cost			5,922,200
Total Capital Cost			**35,533,200**
O & M Cost / Year			**3,553,320**

Table 1: Cost Summary

Project Title: **Deploy Ice Detection System**

User Services:

Travel and Transportation Management:
- En-Route Driver Information
- Incident Management

Travel Demand Management:
- Pre-Trip Travel Information

Emergency Management:
- Emergency Vehicle Management

Time Frame: Near Term

Objective: To plan, design and implement ice detection and warning systems at selected locations along Interstate 5. These systems would be integrated into the three regional surveillance control and driver information (SC&DI) systems. This effort should reduce vehicle accidents along I-5 by providing timely and road-specific weather information and forecasts to drivers, WSDOT maintenance personnel, and the Washington State Patrol.

Project Background and Need: Analysis of accident data reveals two locations along I-5 between Seattle and Portland which experience a relatively high level of ice-related accidents. The first location is in the vicinity of the bridge across the Burlington Northern Railroad tracks at MP 83 near Centralia. The other location is in vicinity of the Puyallup River bridge at MP 135 in Tacoma. At these two locations, ice-related accidents make up about 17 percent of the total number of accidents. These accidents result in fatalities, injuries, and property damage and are also a primary cause of non-recurrent congestion in the corridor. The societal cost of ice-related accidents at each of these locations is approximately $210,000 per year.

At this time, decisions regarding ice build-up on roadways result from a reaction to current conditions, or at best, a supposition based on a media forecast of inclement weather or other indications. Forces are mobilized, perhaps first by instituting patrolling to check conditions or by changing shift schedules. Often a supervisor will get word that roads have become icy. The supervisor sends out crews to respond to problems as they occur, and these crews remain in the field until the problems have subsided.

Statement of Deficiency: Current weather forecasting is not effective in predicting when ice forms at two bridges along I-5. Ice-related accidents result in fatalities, injuries, and property damage as well as delays to roadway users.

Project Description: The project will include planning, designing, implementing and evaluating ice detection and warning systems along I-5 at the following locations:

- BN Railroad Bridge MP 86 (Southwest Region)
- Puyallup River MP 135 (Olympic Region)

Major components include the Road Weather Information System,. the Value-Added Meteorological Service (VAMS), and the Communications System link to the two planned regional Traffic System Management Centers (TSMC).

Road Weather Information System (RWIS)

The RWIS will detect and monitor road weather conditions through field sensing equipment, processing software, and communications equipment that are linked by dial-up leased telephone company lines to a central computer located at the regional TSMC.

Within the RWIS internal communication scheme, the combination of sensors, microprocessor, power supply, and modem is called a remote processing unit (RPU) station. The RPU **processes raw data** from each of the sensors available at each site. This data is then transmitted automatically from the RPU via dial-up leased telephone **company lines** to a workstation located at the planned TSMC. The workstation transmits data to WSDOT's maintenance offices and the VAMS for archiving and display.

Value-Added Meterological Service (VAMS)

Tailored weather forecasts will be provided by a VAMS via the communications system to the three regional TSMC's The VAMS would develop site-specific forecast models for each of the two locations. The models will use data provided by the National Weather Service's Next Generation Weather Radar (NEXRAD) Information Dissemination System and real-time RPU data to provide tailored forecasts for the coming twenty-four hours with scheduled updates and/or updates whenever the conditions or the forecast changes. Tailored weather forecasts will be provided by VAMS via the communications system to the users.

Communications System

RPU's will be stand-alone systems. The RPU will be connected to the workstation by dial-up leased telephone company lines. Sensor data will be sent to the workstation at regular intervals and updates whenever the conditions change. The workstation will be able to poll the RPU. When ice is detected on the road surface, the RPU will signal the VMS to display the required message to drivers and signal the workstation about the change in weather conditions. The workstation will also be able to signal the VMS to display messages and/or to override the RPU's commands to the VMS.

The ITS Backbone is an important component of the RWIS and will be used for disseminating and acquiring RWIS information. Communication includes:

- the transmission of data from regional workstation to regional workstation and workstation's to users;
- the dissemination of road condition information to police, road users, and the traveling public;
- the acquisition of weather information by VAMS, which includes National Weather Service-disseminated data, RWIS data, and data from other remote monitoring sources; and
- the communication of RWIS forecasts and information between forecasters (VAMS) and users.

SC&DI System

The ice detection and warning system will be integrated into the planned regional SC&DI systems. The RWIS would be controlled and operated by personnel located at the Southwest and Olympic Region's planned TSMC's. Operators would use the workstation's access capabilities to ensure that the RPU's and sensors are operating and providing satisfactory data in relation to each other. These operators also provide data about weather and roadway conditions, personnel, equipment, and materials problems to the next higher level of administration

Information regarding road conditions would be disseminated to drivers, WSDOT maintenance personnel, and the Washington State Patrol. Travelers would be informed of road weather conditions by variable message signs (VMS). VMS would be installed in advance of problem locations. These VMS would be controlled by RPU with override capabilities provided to the workstation. At some locations, VMS which are part of the regions' SC&DI system, will be utilized. These VMS will be integrated into the ice detection and warning system. Highway maintenance personnel would be contacted by radio, telephone or via the communication system. The Washington State Patrol would be informed of weather conditions via their liaison at the TSMC.

System Capabilities: The proposed Ice Detection and Waming System will have the following capabilities:

- the transmission of data from sensors to RPU's, RPu's to workstation's, and workstation's to users;
- the dissemination of road condition information to drivers, WSDOT maintenance crews, and the Washington State Patrol;
- the acquisition of weather information by VAMS, which includes National Weather Service-disseminated data, RWIS data, and data from other remote monitoring sources;
- the communication of RWIS forecasts and information between forecasters (VAMS) and users; and
- the development of an archival data base for each RPU.

Project Scope: The project will be divided into two phases: the planning and design phase and the near-term implementation phase. Following is a brief description of the scope of work for each of the three phases.

<u>Phase 1: Planning and Design of RWIS-Ice Detection</u>

The planning and design effort will consist of the following activities:

1. Develop the user information needs and associated data requirements.

2. Design the remote processing unit (RPU) stations. The design will include designing the sensor suites; developing specifications for sensor suites, RPU's, and the head-end support system at the planned TSMC or to workstations at the regional offices; and determining the exact locations for sensors and RPU's at the two locations. The effort will include designing power connections for each RPU. At least two (2) remote processing unit stations would be required - one for each bridge.

3. Design a variable message sign (VMS) system. The design will include developing specifications for the signs and the head-end support system, determining the exact location of the signs, and developing a message library. The signs would be controlled from the RPU's with override powers provided to the regional TSMC. The messages displayed on the VMS will be coordinated with the regional TSMC. VMS would be in advance of potential ice hazards. Approximately four (4) variable message signs would be required - two for each bridge.

4. Design the central processing unit (workstation). This effort will include the design of both the hardware and software requirements of the main

workstations. This design includes detennining the space and personnel requirements for operating the workstation in the regional TSMC. Two (2) central processing units would be required - one for each region.

5. Develop and design the Value-Added Meteorological Service (VAMS). This effort includes developing the site-specific weather forecast models for the two locations. Hardware and software requirements for the VAMS will also be designed. The design includes determining a location for the VAMS, determining the space and personnel requirements, and the layout. The VAMS will be connected to all three workstation's at each of the regional TSMC. One (1) Value-Added Meteorological Service would be required.

6. Design the communication system to interconnect the field equipment, including the sensors, RPU's and VMS's to the workstation located at the regional TSMC. This effort will also include designing the interface and communications requirements between the workstation and the VAMS, WSDOT maintenance crews, and the Washington State Patrol. The VAMS will be connected all three TSMC's.

7. Plan for future upgrade and expansion of the system to include the following:

   - integration with the flood detection and warning systems;
   - integration with the fog detection and warning systems;
   - addition of highway advisory radio (HAR);
   - addition of RPU's at a spacing of 20 miles along I-5;
   - interface with the state-wide ATIS system to provide traveler information including weather information and road conditions; and
   - interface with public transit operators to provide information about weather and road conditions.

Phase2: Implementation and Evaluation of RWlS-Ice Detection

The second phase of this project is the implementation and evaluation of the ice detection and warning system. This will include the following activities:

1. Selecting equipment that meets the specification of the design;

2. Purchasing and installing field equipment;

3. Purchasing and installing the communications hardware;

4. Purchasing and installing equipment for the two TSMC's;

5. Setting up a VAMS. This includes purchasing and installing equipment;

6. Developing/customizing the software for field equipment and head-end configuration at the TSMC's and VAMS;

7. Testing and evaluating the system; and

8. Testing and evaluating the system in terms of reducing ice-related accidents and improving the efficiency and effectiveness as well as reducing the cost of highway winter maintenance practices.

Project Cost: **Table 1** presents a summary of the capital costs in 1995 $ for the Ice Detection and Warning System. The estimate is for the base system which was described above and does not include the planned expansions or upgrades, The design and evaluation cost is estimated at 20 percent of the construction cost. The annual Operations and Maintenance (O&M) cost is estimated at 10 percent of the capital cost.

Total Capital Cost	**$1,068,000**
Annual O&M	$106,800

Project Benefits: The project benefits are expected to concentrate on the net reduction in accidents and reduced costs in the highway winter maintenance program. The benefits are estimated as a function of the reduction in accidents. The proposed improvements would result in a reduction of about 30 percent in the number of ice-related accidents at these two locations. The societal benefits would be equivalent to about $914,000 per year.

Annual Benefits	$914,000

Project B/C: The benefit/cost is based on a 20-year amortization of construction and engineering costs plus operations and maintenance. The discount rate is 4 percent. The following costs are in 1995 dollars.

Equivalent Uniform	
Annual Costs	$185,400
Annual Benefits	$914,000
Benefit/Cost Ratio	**4.9: 1**

Project Schedule: The project is proposed as a near-term ITS project (O-6 year time frame). Follow-up projects to expand and upgrade the ice detection and warning system will follow in both the near-term and medium-term time frames.

The planning and design phase (phase 1) of the project would be completed twelve (12) months tier award. The implementation phase (phase 2) would be completed twenty-four (24) months after award.

Item	**Unit Cost (1995 $)**	**Number of Units**	**Total Cost (1995 $)**
RPU Station	70,000	2	140,000
VMS	120,000	4	480,000
Workstation	10,000	2	20,000
VAMS	200,000	1	200,000
Software	100,000	1	100,000
Interface Requirements	50,000	1	50,000
Communications	100,000	1	100,000
Total Construction Cost			**890,000**
Design/Evaluation Cost			178,000
Total Capital Cost			**1,068,000**
O & M Cost / Year			**106,800**

Table 1: Cost Summary