

The Oregon “Green Light” CVO Project

Evaluation Plan

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We are also indebted to Nancy Brickman and Judith Gray of Oregon State University for their work in preparing and revising several drafts of this document.

DISCLAIMER

This Plan has been prepared in both Word Perfect 6.1 and Microsoft Word 7.0, and has been distributed electronically to interested parties. The appearance of the document produced from an electronic copy may differ from that intended by the authors. A definitive hard copy of the Plan may be obtained from the first author at the address shown on the front cover.

1. FIELD TEST INTRODUCTION

The Oregon Green Light CVO Project Evaluation Plan provides the strategy and methodology to be observed as the technical evaluation is performed for the first phase of the Oregon Green Light CVO project. Chapter 1 provides a synopsis of the purpose, partnership, organization, test goals, and objectives, and a system description. It should be noted that revisions to this plan will be developed as work continues with the Green Light Project.

PURPOSE OF THE OPERATIONAL TEST

The National Program Plan defines operational tests as bridging the gap between research and development activities and full-scale deployment of proven technologies. Furthermore, it states that the emphasis in operational tests is on integrated systems and services. These field tests are conducted under real world conditions in the transportation domain. Although many of the technologies are being transferred from the defense industry, the application in the transportation community still needs to be explored. This is the reason that the evaluation of these field tests is critical to provide information on viability of these technologies and systems as potential ITS applications. The Green Light operational test is to further the knowledge on the feasibility of national deployment of an electronic preclearance system, as well as various other technologies benefiting commercial vehicle operations.

The purpose of the Green Light project is to develop and deploy advanced technology to improve the safety and efficiency of commercial vehicle operations, increase the performance of the highway system, and to protect the public investment in our infrastructure. This will be done by using mainline preclearance systems which will be installed at specific sites throughout Oregon. The resulting network of preclearance sites will serve as a model for national deployment of such technology. In addition, enforcement sites will be developed and installed. Several safety enhancements will also be installed to achieve safety goals. These will include highway warning systems for weather related hazards, downhill truck speed informational systems, and CVO roadside inspection information systems.

OPERATIONAL TEST PARTNERSHIP

One of the most critical elements for a successful operational test and subsequently evaluation is the definition of the roles of all partners and the organization. Exhibit 1-1 illustrates respective areas of involvement that the partners have agreed. The FHWA role also includes the support of their Operational Test and Evaluation Support Contractor, Booz Allen & Hamilton (Booz-Allen).

PROJECT ORGANIZATION

The Green Light project is comprised of a combination of the state of Oregon, university staff, consultants, and industry representatives. Exhibit 1-2 shows the general structure.

GREEN LIGHT OPERATION GOALS AND OBJECTIVES

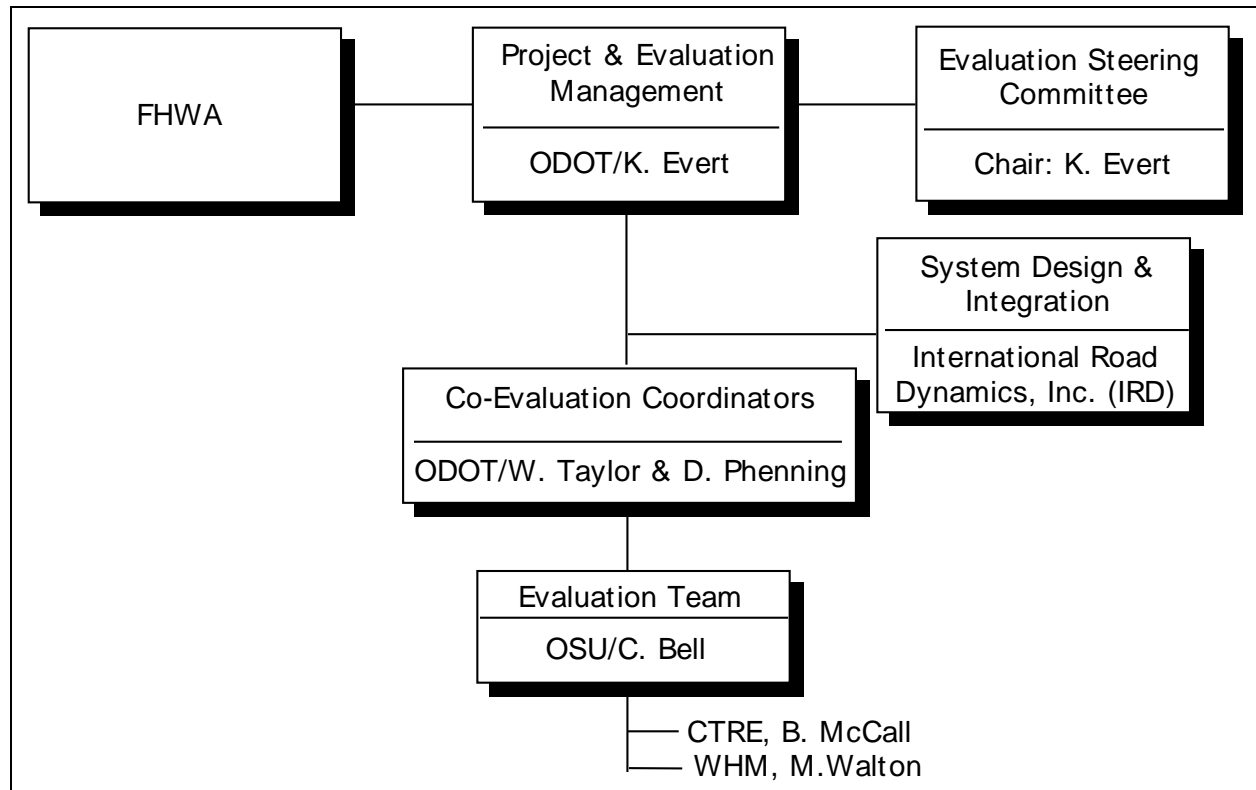
The primary goal of the Green Light CVO project is to automate commercial vehicle operations in Oregon. It is anticipated that the project will be the prototype for the nation and will tie into HELP Inc., I.O.U. (the I-84 corridor from Portland, Oregon to Salt Lake City, Utah), Advantage I-75, and other CVO technologies, such as the Idaho out-of-service project. The objectives developed to support this goal are as follows:

- ☞ To improve the efficiency and safety of commercial vehicle operations
- ☞ To develop and deploy advanced technology
- ☞ To increase the performance of the highway system
- ☞ To protect the public investment in our infrastructure

**EXHIBIT 1-1
Team Partners and Roles**

Partner	Role
FHWA	Oversight and Advisory
Oregon DOT (IRD)	System Design and Development, Program Management, Software Evaluation of System Workability
Oregon State University (OSU) Transportation Research Institute (TRI)	Lead contractor for Evaluation. Coordinate Development and execution of the Evaluation Plan and Individual Test Plans.
Iowa State University (ISU) Center for Transportation Research and Education (CTRE)	Subcontractor for Evaluation. Assist and advise lead contractor.
WHM	Consultant. Assess Institutional and Interoperability Issues.

**EXHIBIT 1-2
General Organizational Structure**



RELATION TO NATIONAL GOALS AND OBJECTIVES

The operational test goal stated in the previous section directly supports four of the six of its National Goals:

- 👉 Improve the safety of the Nation's Surface Transportation System
- 👉 Increase Operational Efficiency and Capacity of Surface Transport
- 👉 Enhance Present and Future Productivity
- 👉 Reduce Energy Costs
- 👉 Develop an Environment where Deployment of Intelligent Transportation Systems can Flourish

SYSTEM DESCRIPTION

The Green Light project consists of the following:

- 👉 Developing the existing preclearance system to a network of mainline sites
- 👉 Upgrading to nationally interoperable automatic vehicle identification (AVI) systems at the mainline sites
- 👉 Develop sites with downhill speed information systems (DSIS)
- 👉 Develop sites with road weather information systems (RWIS)
- 👉 Implementing Vision technology at several sites
- 👉 Upgrading hardware/software of the existing system
- 👉 Developing the Existing Database
- 👉 Developing an Electronic Data Interchange System
- 👉 Acquisition and distribution of approximately 10,000 transponders
- 👉 Developing an Integrated Tactical Enforcement Network

The first phase of funding was for July 1995 through December 1996, and the corresponding independent evaluation contract will proceed through April 1997.

Phase II of the funding will be from July 1996 through December 1997. The corresponding

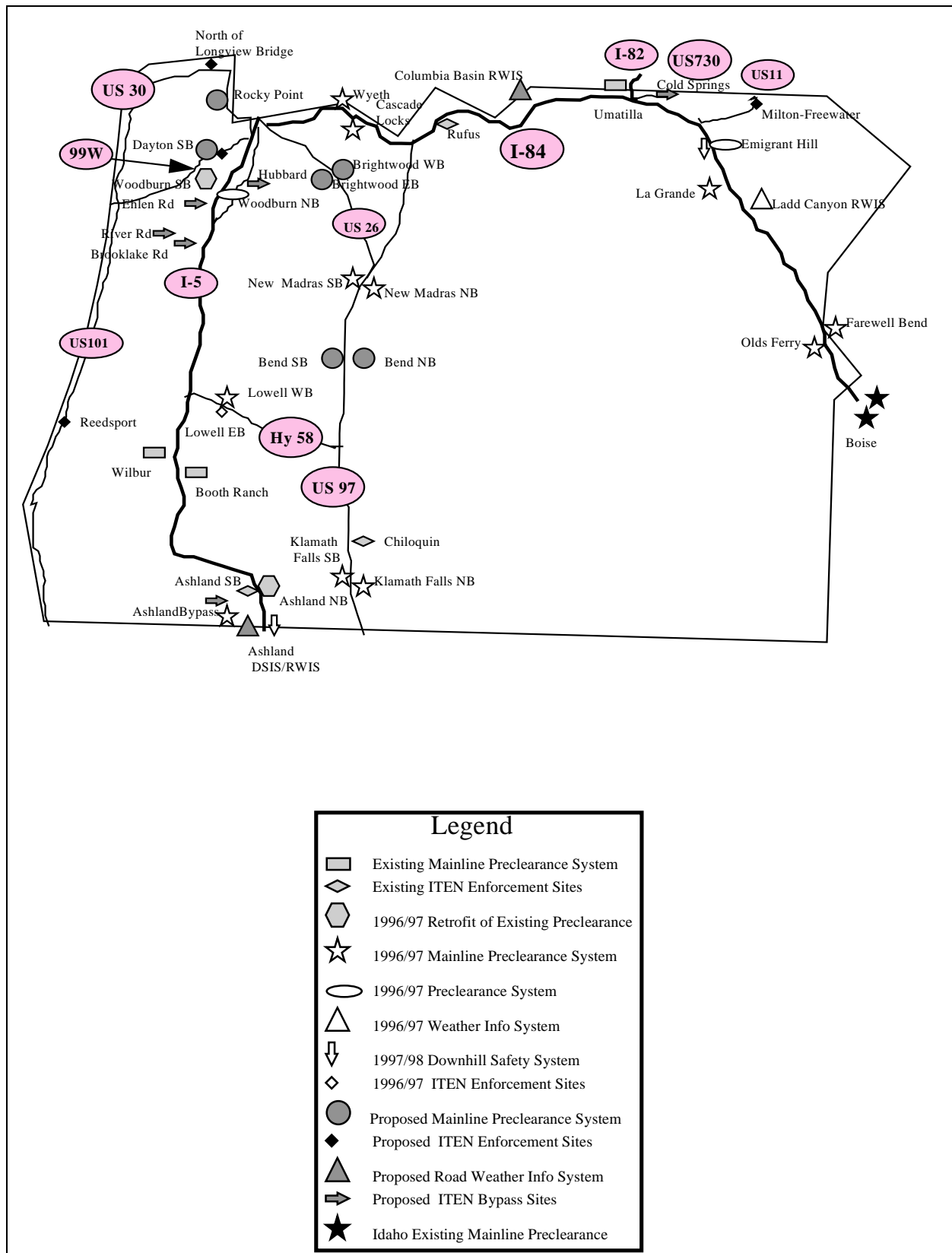
evaluation will continue through June 1998. Phase III of the funding will be from July 1997 through December 1999, and the corresponding evaluation contract will proceed through April 2000.

A list of the sites is given in Exhibit 1-3, and, the sites are shown on an Oregon map in Exhibit 1-4. Exhibit 1-3 shows anticipated completion dates for each site and identifies the phase of funding through which the installations will be accomplished.

EXHIBIT 1-3 Summary of Site Characteristics						
Location	Mainline Preclearance	Vision LPR	RWIS	DSIS	ITEN / Data Collection Sites	Target Completion Date by Quarter
I-5						
Woodburn POE, SB	X	X				2nd, 1997
Woodburn WS, NB	X	X				2nd, 1997
Ashland WS, SB	X					3rd, 1997
Ashland POE, NB	X					3rd, 1997
Wilbur WS, SB	X					2nd, 1997
Booth Ranch WS, NB	X					3rd, 1997
Siskiyou Summit, SB			X			4th, 1997
Siskiyou Summit, SB				X		4th, 1997
I-82						
Umatilla POE, SB	X					3rd, 1997
I-84						
Farewell Bend POE, WB	X	X				2nd, 1997
Olds Ferry WS, EB	X					2nd, 1997
LaGrande WS, EB	X					2nd, 1997
Cascade Locks POE, EB	X	X				2nd, 1997
Emigrant Hill WS, WB	X			X		3rd, 1997
Wyeth WS, WB	X					2nd, 1997
Columbia River Basin			X			3rd, 1997
Ladd Canyon			X			2nd, 1997
Ore. Hwy 58						
Lowell WS, EB					X	3rd, 1997
Lowell WS, WB	X					3rd, 1997
US Hwy 97						
Klamath Falls WS, SB	X					3rd, 1997
Klamath Falls POE, NB	X					3rd, 1997
New Madras WS, NB	X					4th, 1997
New Madras WS, SB	X					4th, 1997
Bend WS, NB	X					1st, 1998
Bend WS, SB	X					1st, 1998
US Hwy 30						
Rocky Point WS, WB	X					1st, 1998

EXHIBIT 1-3 (cont.) - Summary of Site Characteristics						
Location	Mainline Preclearance	Vision LPR	RWIS	DSIS	ITEN / Data Collection Sites	Target Completion Date by Quarter
US Hwy 26						
Brightwood WS, EB	X					1st, 1998
Brightwood WS, WB	X					1st, 1998
Ore. Hwy 99W						
Dayton WS, SB	X					1st, 1998
Dayton NB	X				X	1st, 1998
ITEN - Enforcement Sites						
Ore. Hwy 11						
Milton-Freewater					X	1st, 1998
US Hwy 30						
North of Longview Bridge					X	1st, 1998
US 101						
Reedsport					X	1st, 1998
ITEN - Bypass Sites						
Woodburn Area, East of I-5, Hwy 99						
Hubbard WS, NB	X				X	1st, 1998
Hubbard WS, SB	X				X	1st, 1998
West of I-5, Marion County						
Ehlen Rd WS, EB	X				X	1st, 1998
Ehlen Rd WS, WB	X				X	1st, 1998
River Rd WS, NB	X				X	1st, 1998
River Rd WS, SB	X				X	1st, 1998
Brooklake Rd WS, EB	X				X	1st, 1998
Brooklake Rd WS, WB	X				X	1st, 1998
Umatilla Area, East of I-82, US 730						
Cold Springs Jn. WS, WB	X				X	1st, 1998
Cold Springs Jn. WS, EB	X				X	1st, 1998
Ashland Area, West of I-5, Hwy 99						
Ashland City Limits, SB	X				X	1st, 1998
South of Hwy 66 NB	X				X	1st, 1998
ITEN Enforcement Sites					X	4th, 1999
Additional ITEN By-Pass					X	4th, 1999
One Additional DSIS				X		4th, 1999
Two Additional RWIS			X			4th, 1999
16 Vision LPR Systems		X				4th, 1999

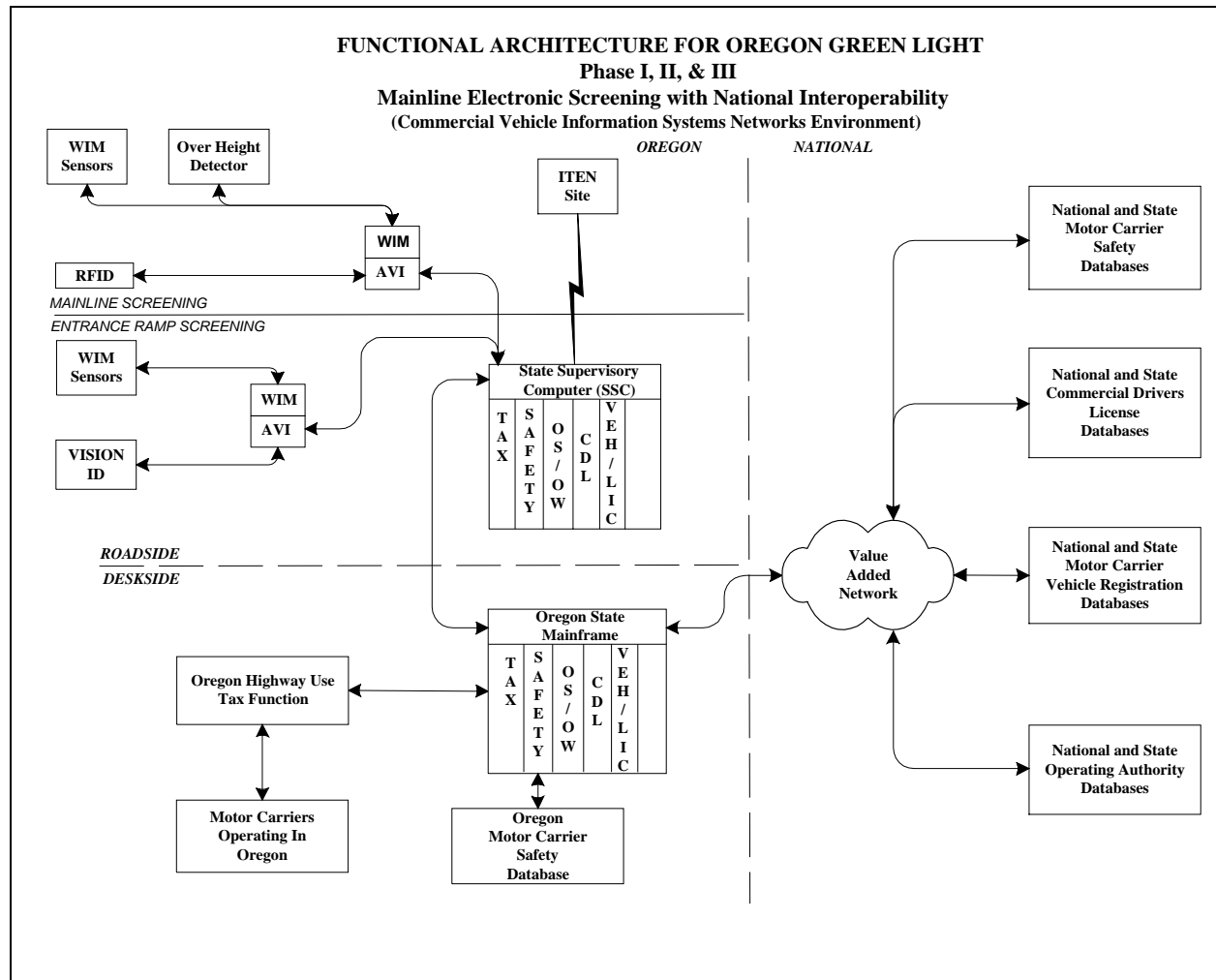
EXHIBIT 1-4 Automated Weight Monitoring Sites in Oregon



FUNCTIONAL ARCHITECTURE

Exhibits 1-5 through 1-7 show schematics for the functional architecture for the preclearance system, DSIS and RWIS respectively.

**EXHIBIT 1-5
Functional Architecture for Mainline Preclearance**



Legend:

- RFI = Radio Frequency Interface
- AVI = Automatic Vehicle Identification
- WIM = Weigh-in-Motion
- OS/OW = Oversize / Overweight
- CDL = Commercial Drivers License

**EXHIBIT 1-6
Functional Architecture for Downhill Speed Information System**

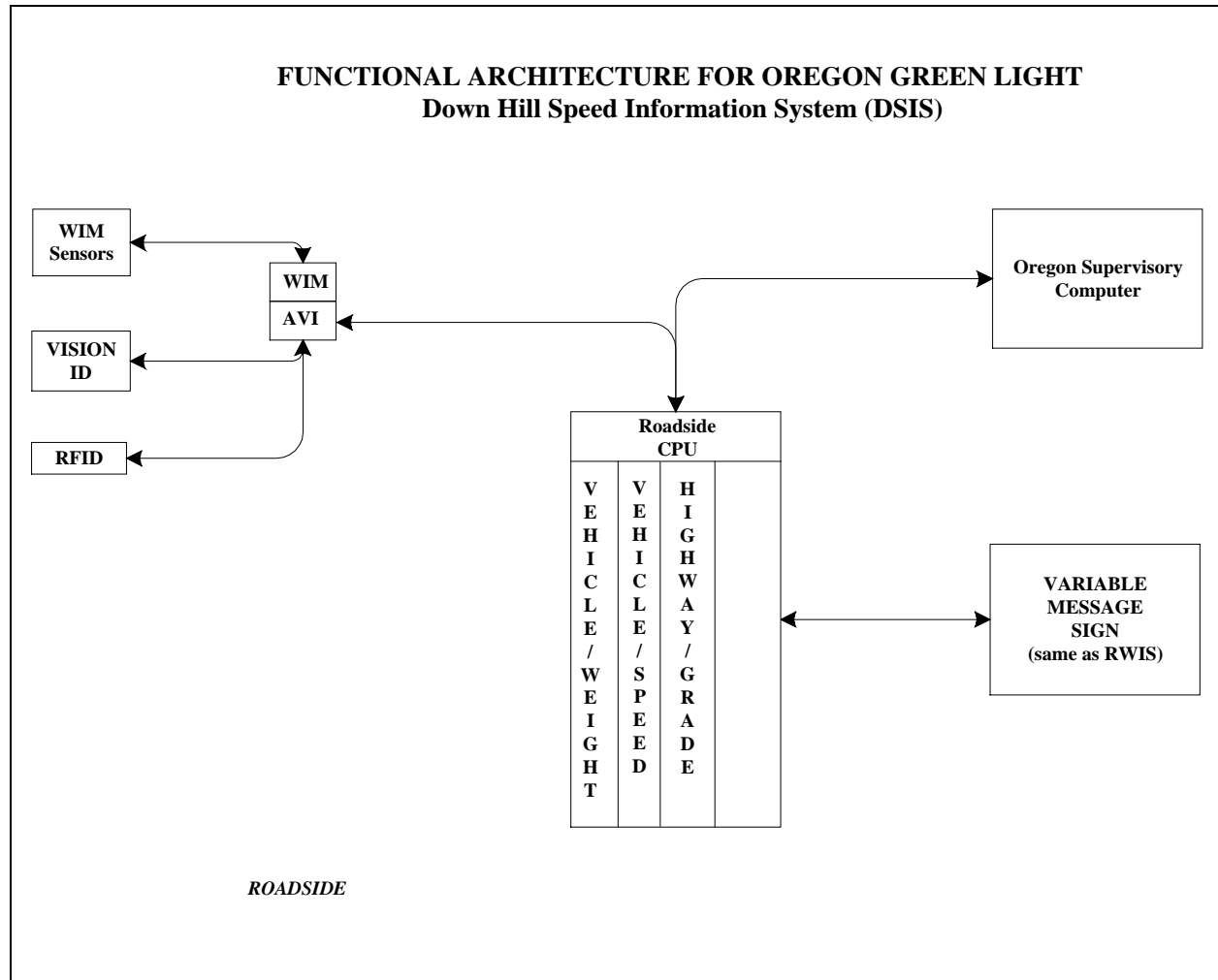
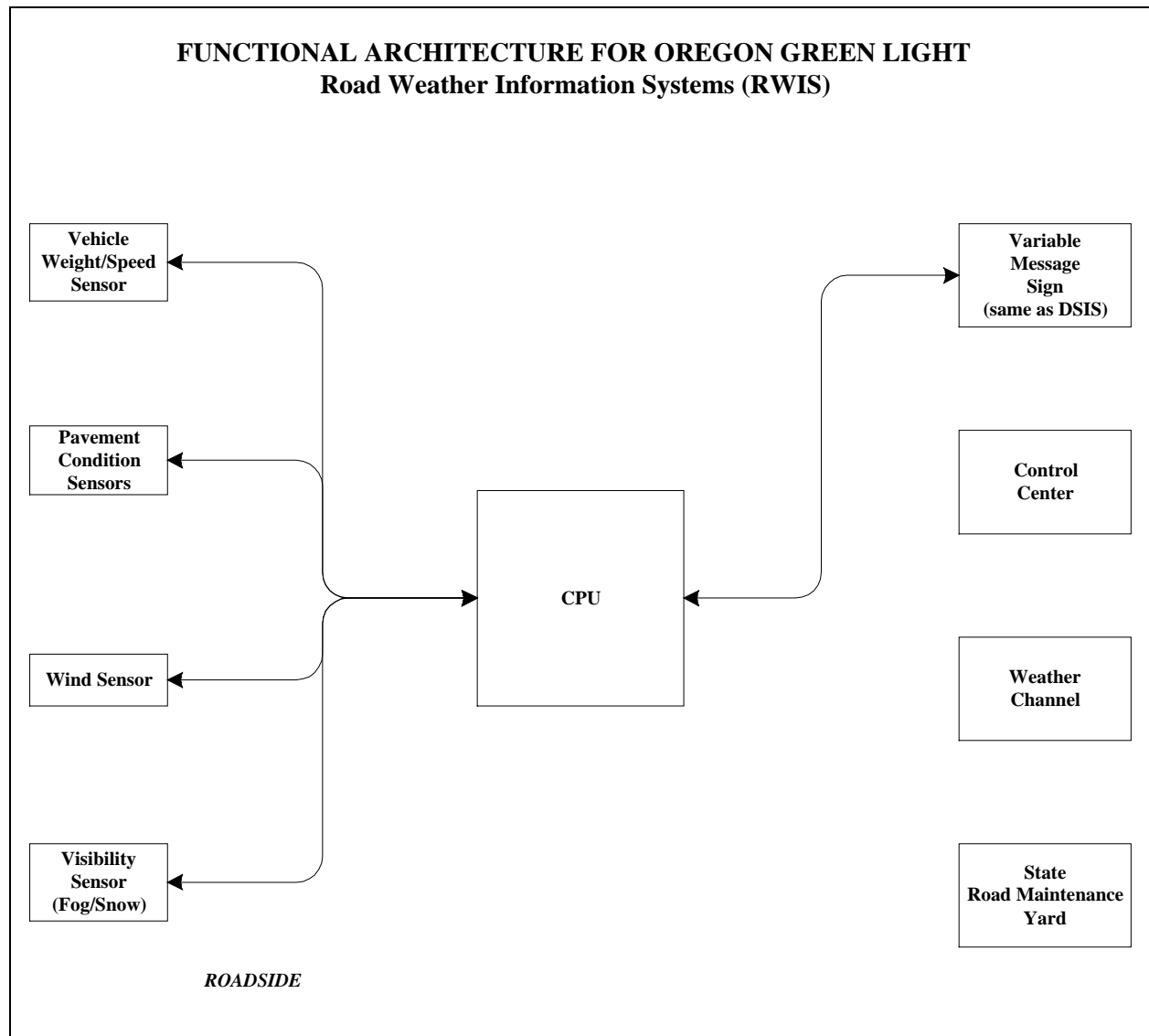


EXHIBIT 1-7
Functional Architecture for Road Weather Information System



A more detailed description follows for each of the elements of the Green Light project.

Mainline Preclearance

Green Light will provide mainline screening for commercial vehicles and will integrate several technologies: weigh-in-motion scales (WIM), automatic vehicle classifiers (AVC), over-height detectors, axle sensors and loops, automatic vehicle identification system (AVI), variable message signs (VMS), vision technology, and supervisory system computer (SSC). This system will enable commercial vehicles, if they meet the necessary legal, safety and tax requirements, to completely bypass the ports-of-entry and weigh stations. As a commercial vehicle approaches the site it is weighed, classified, checked for height violations and identified. This information is then sent to the SSC where it is checked against the Oregon Department of Transportation (ODOT) data. These files contain information on registration, gross weight, tax status, and safety inspection records. If all of the data are in compliance, the vehicle is signaled to either bypass or report for closer inspection.

ODOT has prioritized sites for mainline electronic screening according to their respective role. The sites located on I-5 will have first priority in part due to highest volumes. I-84/82 sites are ranked second because of increasing truck traffic, other on-going Oregon programs, and the IOU project. Third priority sites will be the balance of the state.

Safety Enhancements

Database Enhancements - Exhibit 1-5

Three principal safety enhancements will be implemented as part of the Green Light operational test. Oregon's existing safety inspection program will be augmented by on-line real-time safety inspection data bases available at all inspection sites. This enhancement will increase the data available on motor carriers allowing safety personnel to better evaluate their safety performance and compliance. This system will also provide the necessary link for safety inspectors to identify

suspended or revoked vehicles by the Commercial Vehicle Information Systems and Network Environment (CVISN). The following list outlines the improvements:

- ∃ Ability to select carriers/vehicles for inspection based upon current inspection and compliance status
- ∃ Date and time of last inspection
- ∃ History of out-of-service orders
- ∃ Out-of-service order repair status
- ∃ Driver=s hours-of-service enforcement enhancement
- ∃ Carrier compliance and safety status
- ∃ Interoperability with present and proposed future national CVISN related databases

Downhill Speed Safety System (DSIS) - Exhibit 1-6

This system will be exclusively for commercial vehicles and provide advisory information to the commercial operators. The DSIS will equip mountain passes with technologies that will measure the speed versus the weight of passing trucks. The system will use variable message signs to indicate safe operating speed under existing weather and grade conditions. The first two sites that have been identified for this enhancement are Meacham on I-84 westbound and Siskiyou on I-5 northbound.

Roadway Weather Information System (RWIS) - Exhibit 1-7

The Roadway Weather Information System (RWIS) is another project focused on safety goals. RWIS can measure air temperature, pavement temperature, subsurface temperature, wind speed, wind direction, dew point, humidity, visibility and other information needed by transportation managers. The Green Light project plans to develop the use of a RWIS to provide useful weather information and guidance to motorists with specific application to commercial vehicle operations.

The RWIS will use a two-stage approach for full implementation. The first stage is to install a RWIS in the Ladd Canyon (I-84) area east of LaGrande and integrate it with the existing variable message signs (VMS) that are presently manually activated to relay weather warnings. The primary purpose of this stage is to test and shakedown the interfaces between the RWIS and VMS. The second stage will construct another site with a similar architecture on I-84 in the Columbia River Basin.

Vision Technology - Exhibit 1-5

The primary use of vision technology for the Green Light project will be for automatic vehicle identification. Four sites (at weigh stations with mainline preclearance) have been designated for the vision technology: Woodburn weigh station - I-5 northbound, Woodburn POE - I-5 southbound, Cascade Locks POE - I-84 eastbound, and Farewell Bend POE - I-84 westbound. The vision technology will use license plate readers to read the ODOT tags on commercial vehicles and tie this data in with the weigh-in-motion (WIM) data. The system will be using equipment from Perceptics. The evaluation of this use of Vision technology will consider similar uses in other projects and on-site testing of the accuracy of the system by comparison of vision readout with actual plate numbers.

System Development and Upgrades - Exhibit 1-5

The implementation of the Green Light project will require numerous hardware and software upgrades to the existing system to support the WIM/AVI sorting capability. All software will be upgraded to reflect the most current versions. In addition to the enhancements, several database management and development improvements will take place. A central database containing all pertinent CVO data will be refined and deployed. It will also be necessary to design and develop a system input format for the VISION camera data.

Electronic Data Interchange - Exhibit 1-5

The primary focus of this element of the Green Light enhancements is to provide commercial vehicle operators with a mechanism to enable them to electronically file highway use tax reports via nationally recognized data and formatting standards and existing electronic data interchange methodology. This effort calls for minimal hardware and software investment and a proportionately greater investment in computer programming consulting resources to create the necessary interfaces to existing Oregon data bases and accounting functions.

Transponders

ODOT will purchase approximately 10,000 transponders and a contractor will deliver for distribution to motor carriers. The contractor has not yet been selected.

STRUCTURE OF THIS PLAN

This Evaluation Plan lays out the framework that will be followed in conducting the Green Light CVO Project technical evaluation.

This report is organized into the following five chapters:

Chapter 1 - Field Test Introduction - Provides general information on the purpose, partnership, and organization of the operational test; defines the test goals and objectives and their relation to the national goals; and supplies a general system description

Chapter 2 - Evaluation Design - Provides the evaluation approach including the evaluation goals, objectives, and measures; and defines the technical approach

Chapter 3 - Evaluation Management - Describes the project organization and team members, the evaluation schedule, deliverables, and resource requirements; and provides the management plan

Chapter 4 - Quality Assurance - Contains the approach for configuration and documentation control, data management, data maintenance and security, and operational procedures

Chapter 5 - Institutional/Legal Issues Documentation - Presents the strategy for handling institutional/legal issues in this evaluation.

SYSTEM DOCUMENTATION

The following documents may be referenced:

- 1) The AGreen Light CVO Project, Phase 1, Work Plan, Project ITS - 9541(401) July 31, 1995.
- 2) Oregon Green Light CVO Project Overview and Phase 2, Work Plan, for Office of Motor Carriers, Federal Highway Administration, US Department of Transportation, by I
- 3) Research and New Technology Unit, Policy Research and Auto/Truck Section, Transportation Development Branch, and ITS Scale Maintenance Technical Support Unit, Investigations Safety and Federal Programs Section, Motor Carrier Transportation Branch, Oregon Department of Transportation, July 1996.

2. EVALUATION DESIGN

As noted in Chapter 1, the primary purpose of the Oregon Green Light project is to develop and deploy advanced technology to improve the efficiency and safety of commercial vehicle operations, increase performance of the highway system, and to protect the public investment in our infrastructure. On the National level, evaluations help support further development of ITS system architectures, public sector policy development, private sector product/service development, and decisions to continue, modify, or suspend operational testing. It is anticipated that Green Light will serve as a model for deployment of mainline preclearance systems on a national level. The purpose of this operational test evaluation is to assess the benefits and impacts (positive and negative) of the systems and services being tested. Within this context, Chapter 2 outlines the evaluation goals and objectives adopted by the Green Light project, evaluation measures, evaluation technical approach, and test activity description.

EVALUATION GOALS AND OBJECTIVES

The Green Light Phase 1 proposal contained a preliminary set of evaluation goals. On September 20-21, 1995 a joint meeting of the evaluation team resulted in an updated set of goals, and subsequently, a sub-group of the evaluation team developed a set of revised goals and objectives. The following five goals were finally recommended to guide the evaluation:

- 👉 **Goal #1: Assess Safety**
- 👉 **Goal #2: Assess Productivity**
- 👉 **Goal #3: Assess User Acceptance**
- 👉 **Goal #4: Assess Mainstreaming Issues**
- 👉 **Goal #5: Assess Non-Technical Interoperability Issues**

Accomplishing these evaluation goals will directly support the operational test goals, and in turn

the relevant ITS National Program Plan goals (i.e., *Aimprove safety*, *Aincrease efficiency*, and *Aenhance productivity*).

For the Green Light project, objectives have been developed in support of each of the evaluation goals outlined above. These will be addressed in the next section. Each objective is regarded as having high priority. High priority objectives that will be emphasized in evaluation data collection and analysis activities address the questions most fundamental to the ultimate users for the technology and services being tested: *ADoes the system improve safety?*, *ADoes the system improve productivity?*, *AAre the procedures developed accepted by system users?*, and *AWhat are the key organizational, regulatory, legal, and other challenges that need to be overcome?*.

EVALUATION MEASURES

A formal, repeatable, and supportable research technique will be used to conduct the technical evaluation. This technique begins with the development of the basic items of information that, for the purposes of this evaluation, are generally called *Aevaluation measures*. (In Technical literature these measures are frequently referred to as Measures of Effectiveness [MOEs], Measures of Performance [MOPs], and Measures of Suitability [MOSs].) Evaluation measures are quantifiable or measurable parameters that validate the intended impacts or physical functions required of the object/feature being tested, or, alternatively, the intended capability of the object/feature to be deployed and used in realistic environment. Each evaluation objective is linked to one or more evaluation measures as shown in Exhibit 2-1 (except that there are no measures associated with objective 4.1, 4.2, 5.1, and 5.2 because these involve only documentation of issues and resolutions as they arise). These measures will form the basis for hypotheses statements that will be developed in the individual test plans.

EXHIBIT 2-1
Measures Supporting Evaluation Goals and Objectives

Goal	Objective	Measure	
1. Assess Safety	1.1 Determine change in safety compliance	1.1.1 Proportion of compliant (with the Federal Motor Carrier Safety Regulations (FMCSR)) trucks/carriers of total inspected and total processed per month.	
		1.1.2 Proportion of non-compliant (FMCSR) trucks/carriers of total inspected and total processed per month.	
	1.2 Determine change in truck behavior due to the Road Weather Information System	1.2.1 Ratio of mean speed in inclement weather to that in "good" weather, before and after installation.	
		1.2.2 Ratio of accidents before and after installation if sufficient data exists.	
	1.3 Determine change in truck behavior due to the Downhill Speed Information System	1.3.1 Ratio of mean speed on downhill sections, before and after installation.	
		1.3.2 Ratio of accidents before and after installation if sufficient data exists.	
		1.3.3 Comparison of mean speeds with advisory speeds.	
	2. Assess Productivity	2.1 Determine changes in tax administration costs	2.1.1 Determine the change in the resources required in the collection process, i.e., hardware, software, staff etc.
			2.1.2 Determine the change in the resources required in the auditing process.
2.2 Determine changes in tax evasion		2.2.1 Determine changes in highway use tax revenues collected and why.	
2.3 Determine changes in vehicles processed at each site		2.3.1 Compare total vehicles processed (cleared and not-cleared).	
		2.3.2 Compare no. of interruptions per shift and total time.	
		2.3.3 Observe system availability.	

	2.4 Determine productivity to motor carriers	2.4.1 Compare truck flow on the mainline before and after installation.
		2.4.2 Determine average delay times before and after preclearance.
	2.5 Determine impacts on energy	2.5.1 Estimate changes in fuel use before and after preclearance using I-75 experience.
	2.6 Determine the ability of vision technology to support 100 percent electronic screening service	2.6.1 Evaluate the accuracy of the vision system by comparison of vision readout with actual plate numbers and by literature review and previous test reports.
3. Assess User Acceptance	3.1 Assess Motor Carrier Acceptance	3.1.1 Determine attitude towards electronic screening, including perceived impacts.
		3.1.2 Determine attitude towards new services, e.g., select carriers / vehicles for inspection based on inspection and compliance status.
		3.1.3 Evaluate motor carrier acceptance of mainline electronic screening.
	3.2 Assess Agency Acceptance	3.2.1 Determine attitude towards electronic screening, including perceived impacts.
3.2.2 Determine attitude towards new services, e.g., select carriers / vehicles for inspection based on inspection and compliance status.		
4. Assess Mainstreaming Issues	4.1 Document regional and national mainstreaming issues	4.1.1 Identify, assess and document pertinent regional and national issues (e.g. IOU, HELP, CVISN, ITS Systems Architecture, DSRC) and assess the impacts to Green Light for customers and providers.
	4.2 Document approaches attempted to solve mainstreaming issues and final resolutions	4.2.1 Document approaches attempted to solve regional and national mainstreaming issues as they arise, and final resolutions.
5. Assess Non-technical Interoperability Issues	5.1 Document non-technical interoperability issues as they arise	5.1.1 Identify, assess and document pertinent non-technical interoperability issues as they arise for customers and providers.
	5.2 Document approaches attempted to solve interoperability issues and final resolutions	5.2.1 Document approaches attempted to solve non-technical interoperability issues as they arise, and final resolutions.

EVALUATION TECHNICAL APPROACH

Given the evaluation measures defined, it is possible to determine what types of individual tests are needed to obtain this information and when these tests should be performed within the overall evaluation schedule. Individual tests are essentially the means through which operational test evaluation data is obtained - grouping data needs by the venue in which data will be collected. The purpose of developing separate (i.e., *individual*) tests is to coherently organize the data collection process in a manner that will do the following:

1. Support differences in evaluation planning and design (needed to accommodate differences among venues)
2. Economize on project resources (by combining the data collection effort associated with each venue)
3. Minimize respondent burden (by reducing the number of separate data requests of evaluation participants).

DATA COLLECTION METHODOLOGIES

Six individual data collection methods were identified as potential data for collection methodologies for the Green Light project. Briefly, these are as follows:

System Records - Collect operational data (e.g., number and cycle-time of transactions) manually or automatically from the Green Light project. Data will be recorded for this individual test continuously and collected approximately every other month throughout the Data Collection and Analysis Phase.

User Surveys/Information Request - Collects operational data (e.g., record rejection rates) plus behavioral and attitudinal data (e.g., system preference and ease of use) from motor carrier and state agency users. Data will be collected for this individual test in the first and last months of the data collection and analysis phase.

User Interviews - Probes the motor carrier and state agency user=s responses to survey behavioral and attitudinal questions (e.g., Why was the system not compatible?). Also collects supplementary operational data (e.g., cycle times, costs, configuration requirements). Institutional Issues will also be addressed.

Observation - The evaluators will observe the use of the system to verify system requirement and performance, collect baseline information regarding existing processes, and perform quality assurance regarding survey data recording protocol.

Simulation - Test the Green Light system=s performance (e.g., in terms of accuracy, speed) against predefined benchmarks.

Research- The evaluators will collect recorded historical operational data (e.g., rejection rates, processing times), operational test cost data, and configuration requirements. Data will be collected for this individual test in the first and last months of the data collection and analysis phase.

Many evaluation factors are Acomplex≡ in that a number of pieces of test data must be collected to support calculating the required measure. The data types critical to the evaluation and their sources - what information will be automatically collected directly from the system, what will be collected through surveys and logs, what will be collected through observation and interviews, and what will be simulated or researched - will be presented in the individual test plans.

To make sure that the data collection instruments developed for the individual test plans seek to obtain the right information from the right places, the various data collection methods have been mapped against the evaluation measures presented earlier. This mapping is depicted in Exhibit 2-2. This exhibit also shows the organization that will lead each activity.

EXHIBIT 2-2
Map of Evaluation Measures Against Data Sources

Measures	Data Source		Leader
	During Baseline	During Operational Period	
1.1.1 No. of compliant trucks/carriers processed per month	State Database	State Database	OSU-TRI ¹
1.1.2 No. of non-compliant trucks/carriers processed per month	State Database	State Database	OSU-TRI
1.2.1 Ratio of mean speed in inclement weather to that in Agood weather, before and after installation of RWIS	On-site tests with installed equipment	On-site tests with installed equipment	OSU-TRI
1.2.2 Ratio of accidents before and after installation of RWIS	State Records	State Records	OSU-TRI
1.3.1 Ratio of mean speed on downhill sections, before and after installation of DSIS	On-site tests with installed equipment	On-site tests with installed equipment	OSU-TRI
1.3.2 Ratio of accidents before and after installation of DSIS	State Records	State Records	OSU-TRI
1.3.3 Comparison of mean speeds with advisory speeds of DSIS sites	On-site tests with installed equipment	On-site tests with installed equipment	OSU-TRI
2.1.1 Determine change in the resources required in the collection process	Process Mapping Resource Analysis	Process Mapping Resource Analysis	CTRE
2.1.2 Determine the change in the resources required in the auditing process	Process Mapping Resource Analysis	Process Mapping Resource Analysis	CTRE
2.2.1 Determine change in weight-distance taxation revenue and why	Process Mapping Resource Analysis	Process Mapping Resource Analysis	CTRE
2.3.1 Compare total vehicles processed (cleared and not-cleared)	State Database	State Database	CTRE
2.3.2 Compare no. of interruptions per shift and total time of interruption	State Database Operator Log	State Database Operator Log	CTRE
2.3.3 Observe system availability	System Performance Records	System Performance Records	CTRE
2.4.1 Compare truck flow on the mainline before and after installation	State Database	State Database	CTRE
2.4.2 Determine average delay times before and after preclearance	I-75 findings and on-site verification	I-75 findings and on-site verification	CTRE
2.5.1 Estimate changes in fuel use before and after preclearance using I-75 experience	I-75 findings and on-site verification	I-75 findings and on-site verification	CTRE

¹ OSU-TRI: Oregon State University, Transportation Research Institute
 CTRE: Iowa State University, Center for Transportation Research and Education
 WHM: WHM Transportation Engineering Consultants, Inc.

Measures	Data Source		Leader
	During Baseline	During Operational Period	
2.6.1 Evaluate the accuracy of the vision system by comparison of vision readout with actual plate numbers	State Database and on-site tests	State Database and on-site tests	OSU-TRI CTRE
3.1.1 Determine attitude towards electronic screening, including perceived impacts	Questionnaire Survey	Questionnaire Survey	OSU-TRI WHM
3.1.2 Determine attitude to new services	Questionnaire Survey	Questionnaire Survey	OSU-TRI WHM
3.1.3 Evaluate motor carrier acceptance	n/a	Numbers transponders installed	OSU-TRI WHM
3.2.1 Determine attitude towards electronic screening, including perceived impacts	Questionnaire Survey	Questionnaire Survey	OSU-TRI WHM
3.2.2 Determine attitude to new services	Questionnaire Survey	Questionnaire Survey	OSU-TRI WHM
4.1.1 Identify, assess and document pertinent regional and national issues (e.g. IOU, HELP, CVISN, ITS Systems Architecture, DSRC) and assess the impacts to Green Light for customers and providers.	Minutes, Surveys etc	Minutes, Surveys etc	WHM CTRE
4.2.1 Document approaches attempted to solve regional and national mainstreaming issues as they arise, and final resolutions	Minutes, Surveys etc	Minutes, Surveys etc	WHM
5.1.1 Identify, assess and document pertinent non-technical interoperability issues as they arise for customers and providers.	Minutes, Surveys etc	Minutes, Surveys etc	WHM
5.2.1 Document approaches attempted to solve non-technical interoperability issues as they arise, and final resolutions	Minutes, Surveys etc	Minutes, Surveys etc	WHM

To provide readers with a broad perspective of the work load impacts associated with this strategy, Exhibit 2-3 summarizes the involvement in data collection activities anticipated for each type of evaluation participant. It should be noted that these activities will be staggered across the 6-months operational phase of the test to appropriately account for seasonal work variations and other differences.

EXHIBIT 2-3
Anticipated Operational Test Participant Involvement in
Evaluation Data Collection Efforts

Operational Test Participant	Anticipated Involvement in Evaluation Data Collection Efforts
State Agency Steering Committee Members	Review evaluation data collection instruments Recruit state agency participants
State Agency Recruits	4 personal interviews (about 1 hour each) 1 survey (about 2 pages each) 4 work practice observation sessions (about 1 hour each) Maintain 1 log Respond to information requests (about 1 page)
Motor Carrier Associations OTA, OFPTA	Review evaluation data collection instruments Recruit motor carrier participants
Motor Carrier and Shipper Recruits	4 personal interviews (about 1 hour each) 1 survey (about 2 pages each, all carriers) 2 work practice observation sessions (about 1 hour each) Maintain 1 log for the duration of the test period (all carriers) Respond to information requests (about 1 page each, all carriers) Interviews/questionnaires with drivers and shippers once the project is implemented
System Designers (IRD)	Program software to automatically capture evaluation data Assist in development of appropriate simulations Review evaluation data collection instruments

ANALYSIS METHODOLOGIES

All Green Light quantitative evaluation data (including data obtained through surveys, interviews, log keeping, and system record selection) will be statistically analyzed. (Qualitative information such as institutional issues will be traced and recorded.) The purpose of statistically analyzing quantitative data will be to assess the degree to which the data is representative of the population being tested and to determine whether valid conclusions can be drawn from the data. It is recognized that, due to the sample size and selection criteria, the carrier sample population may not be representative of the motor carrier population as a whole.

Data will be tabulated in two ways:

- ☞ Simple data tabulations, which will entail counting the number of cases that fall into various, separate categories (e.g., the number of users that rated the Green Light system=s effectiveness as excellent).

- ☞ Cross-tabulations, which will entail setting up a matrix with two or more variable before counting responses. This technique will be used to study relationships among variables and to gain insight into the nature of these relationships (e.g., how opinions about the Green Light system=s effectiveness may vary based on either motor carrier size/type or prior experience with automation systems).

Once data has been tabulated, standard statistical techniques will be applied to test hypotheses about samples. The menu of techniques from which the evaluation will draw includes those listed in the Volpe National Transportation System Center=s *A Primer on Consumer Marketing Research: Procedures, Methods, and Tools*, as described in Exhibit 2-4. (Note: only selected analyses will be performed for any one set of data.)

EXHIBIT 2-4
Common Statistical Techniques

	Statistical Technique	Purpose
Difference Test	Chi-Square Goodness of Fit	Compares the observed frequency with the expected frequency of an event; used on two or more categories or groups.
	T-test	Compares the mean scores of two numerical ratings and determine if they are significant.
	Analysis of Variance	Compares the mean scores of three or more numerical ratings and determine if they differ significantly (this test is similar to the T-test in all other ways) .
Association Test	Factor Analysis	A multivariate technique reducing a large number of variables to a set of core, underlying factors; helps to define attitudes about key product/service attributes.
	Regression	Relates changes in one of several variables to changes in another.
	Multidimensional Scaling	Examines relationships among various objects; used to determine perceptions of similarities and differences or for determining the ideal combination of attributes.

Of course, all statistical analyses techniques are subject to error. These errors are generally categorized as sampling and non-sampling errors. Sampling errors are those that may occur because the whole population is not included in the test, while non-sampling errors are those that may occur at any stage in a research project due to mistakes in data collection, manipulation, or analysis. The Green Light evaluation will attempt to control for such errors to the greatest extent possible within the given resource constraints.

TEST ACTIVITY DESCRIPTION

The previous section describes the technical approach to be used in the evaluation, including the data collection methods. A Detailed Test Plan will be developed describing each of the test activities required. This is scheduled for completion in June 1996 (*Document 96-02.doc*).

3. EVALUATION MANAGEMENT

MANAGEMENT PLAN

A technical advisory committee has been formed to provide guidance to the evaluation team. FHWA is the evaluation manager and is assisted in this role by the Booz-Allen team. Oregon State University Transportation Research Institute (OSU-TRI) will conduct the evaluation. The Center for Transportation Research and Education (CTRE), Iowa State University, and WHM Transportation Engineering Consultant, Inc., are subcontracted to OSU and bring considerable experience to the evaluation team. The following section defines the evaluation responsibilities and the primary point of contact for this effort. Exhibit 3-1 defines the general evaluation responsibilities and the primary point of contact for this effort. Exhibit 3-1 defines the general evaluation responsibilities associated with the Evaluators and the Technical Advisory Committee.

EXHIBIT 3-1
Evaluator and Steering Committee Roles and Responsibilities

Evaluation Phase	Evaluators Roles and Responsibilities	ODOT Roles & Responsibilities
1. Evaluation Concept	Coordinate a Mobilization meeting and document results	Review and assist
2. Evaluation Goals Definition	Refine evaluation goals and objectives, develop a preliminary scope of work and schedule	Review and assist
3. Evaluation Definition	Draft the Evaluation Plan while incorporating comments as necessary; include evaluation management structure, quality assurance, data management, and configuration control components.	Review and assist
4. Evaluation Design	Write individual test plans; work with partners to incorporate any necessary adjustments to proceed to data collection and analysis.	Review and assist
5. Data Collection and Analysis	Conduct individual test plan shakedown. Implement any adjustments based on the preliminary results and continue with the conduct of individual tests to produce data; apply all Quality Control procedures defined in the Evaluation Plan; perform analysis, documenting process in interim reports; modify individual test plans as needed.	Provide access to data (<i>provide data</i>)
6. Results Reporting	Prepare individual test reports and Evaluation Report. Forward data to predetermined agency and shut down the evaluation.	Review and assist

EVALUATION ORGANIZATION AND TEAM MEMBERS

Steering Committee - In addition to the evaluation phase specific responsibilities described in Exhibit 3-1, there are several general responsibilities of the Steering Committee. These include providing oversight for all evaluation activities in a proactive manner, reviewing all evaluation documents and providing comments in a timely matter, and monitoring the quality control procedures being used by the evaluators.

Oregon - the Oregon Department of Transportation (ODOT), specifically Mr. Ken Evert, Mr. Paul Henry, Mr. Wes Taylor, and Mr. Milan Krukar represent the state in this project as shown in Exhibit 1-2. ODOT's primary responsibilities are project management, carrier selection, and coordination with Oregon state agencies that will be involved. They will support the evaluation through technical review.

Federal Highway Administration (FHWA) - Mr. Joel Hiatt, Office of Motor Carriers, will be supporting the operational test at the Region 10 regional level. Ms. Victoria Kinne and Mr. Mike Nolan of the Oregon Division Office will also support the project. The FHWA is a special partner that has a national ITS perspective and will be the evaluation manager. Mr. Michael Freitas, of the headquarter ITS division is the primary point of contact. Additionally, the FHWA is responsible for approving the evaluation plan and providing support for evaluation activities.

Operational Test Evaluation Support Contractor - The team of Booz-Allen, WHM, and Battelle is the evaluation support contractor for the FHWA and will aid them in the management of the evaluation. Booz-Allen will provide support to the evaluation team in the production of the evaluation plan, individual test plans, and the final evaluation report.

Oregon State University-Transportation Research Institute (OSU-TRI) - Dr. Chris Bell will be working as the lead in the evaluation for OSU. The primary responsibilities of OSU will be to conduct the evaluation and prepare the individual test reports. They will assist in the preparation of the evaluation plan, individual evaluation test plans including preparation of log, survey, and interview forms, and the final evaluation report. They will be responsible for collecting evaluation data, conducting interviews, performing analyses, and documenting results. Quality control in data collection and analysis will be the responsibility of OSU, as described in Chapter 4.

Center for Transportation Research and Education (CTRE) / Iowa State University (ISU) - Bill McCall will be the lead in the subcontract to support the evaluation of the Oregon Green Light Commercial Vehicle Operations Operational Test. The primary responsibilities of CTRE will be field data collection, functional process mapping, event cost data collection, system evaluation, and operational test analysis. In addition, CTRE will identify and apply previous research and operational test results that are transferable to this Operational Test.

WHM Transportation Engineering Consultants, Inc. - Dr. C. Michael Walton will represent WHM and will address mainstreaming issues as they arise.

EVALUATION SCHEDULE AND DELIVERABLES

This section describes the Green Light technical evaluation schedule, anticipated deliverables, and resources. Exhibit 3-2 presents the evaluation schedule for the first increment of funding, which has been integrated with the first phase of operational test funding. Individual trial tests will be conducted during the Data Collection Phase of the evaluation, which will run concurrently with the operational test's Implementation Phase. More detailed scheduling information, such as the time periods set aside for test shakedown (using sample field tests to verify procedures and determine where corrections need to be made) and data analysis, will be reflected in the Individual Test Plan deliverables.

**EXHIBIT 3-2
Evaluation Schedule through Phase I Funding**

Task	1995				1996												1997				
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	
1. Mobilization																					
2. Evaluation Plan								⑤						④							
3. Individual Test Plans														⑤	④						
4. Evaluate Green Light Elements																					
5. Team Meetings						✕	✕		✕	✕				✕	✕			✕	✕		✕
6. Quarterly Reports				M			M			M				M		M			M	M	
7. Interim Report a. Draft														⑩					⑤		
b. Final																				④	
<p align="center"> ⑤ Draft M At the end of each quarter ⑩ Status ④ Final </p>																					

The planning and reporting deliverables associated with the Green Light project and their scheduled due dates are listed in Exhibit 3-3. It should be noted that because evaluation and operational test activities are necessarily linked, significant delays in operational test progress are likely to affect the evaluation deliverables schedule. A general description of the contents of the remaining deliverables is provided in Exhibit 3-4. Note that while individual test reports might normally be a separate deliverable, due to resource constraints they will be included as a part of the evaluation report.

EXHIBIT 3-3
Deliverables and Due Dates

Deliverables	Scheduled Due Date*
General Evaluation Plan	Included in operational test proposal
Evaluation Plan: Draft Final	Early July 1996 Early September 1996
Individual Test Plans: Draft Final	Late September 1996 Mid-October 1996
Evaluation Status Report	October 1996
Revised Individual Test Plan(s)	As needed
Interim Report Draft Final	Late March 1997 Late April 1997

* Linked to operational test progress.

**EXHIBIT 3-4
Deliverables and Contents**

Deliverable	Contents
Individual Test Plans	Executive Summary <ul style="list-style-type: none"> + Purpose + Management and Responsibility Detailed plan <ul style="list-style-type: none"> + Evaluation approach (including hypotheses to be tested and technical approach) + Test Methodology (including physical description and pre-test activities) + Quality Assurance Scheme (including verification of adherence protocol, data management, storage, and backup provisions, and configuration control) Test Management <ul style="list-style-type: none"> + Detailed test schedule + Detailed cost breakdown
Interim Report (Released during Evaluation Data Collection and Analysis Phase)	Accomplishments to date Interim findings/results Issues and proposed resolutions Activities planned for remainder of test
Final Report	Executive summary Individual test summary Lessons learned of National importance Overall evaluation results (by goals and objectives) Institutional and legal issues, actions, and their resolution Recommendations

Evaluation Resource Requirements

This section describes the resource requirements for the evaluation done in the first phase of funding of the Green Light project. The resources allocated for the first phase was sufficient to cover the requirements displayed in Exhibit 3-5. Further resources will be required for the on-going project evaluation as the second and third phases of funding proceed.

EXHIBIT 3-5
Resource Requirements

Task	Product	Source	Hours	Cost	Travel	Task Cost	Indirect Costs
Evaluation Goal Definition	Goals and Objectives	Booz-Allen	50			\$9,120	\$3,199
		OSU	16	\$1,312	\$100		
		ISU	24	\$1,888	\$1,500		
		WHM	24	\$2,880	\$1,500		
Evaluation Definition	Evaluation Plan	Booz-Allen	300			\$33,222	\$6,806
		OSU	280	\$13,283	\$1,000		
		ISU	208	\$13,426	\$1,613		
		WHM	20	\$2,400	\$1,500		
Evaluation Design	Individual Test Plans	Booz-Allen	300			\$33,221	\$6,806
		OSU	280	\$13,282	\$1,000		
		ISU	208	\$13,426	\$1,613		
		WHM	20	\$2,400	\$1,500		
Data Collection	Data	Booz-Allen	40			\$66,718	\$2,490
		OSU	573	\$30,823	\$2,000		
		ISU	345	\$24,395	\$3,500		
		WHM	34	\$4,000	\$2,000		
Data Analysis	Interim Reports	Booz-Allen	40			\$66,719	\$2,490
		OSU	573	\$30,823	\$2,000		
		ISU	345	\$24,896	\$3,000		
		WHM	33	\$4,000	\$2,000		
Report	Test Reports and Final Report	Booz-Allen	160			\$66,717	\$2,490
		OSU	573	\$30,822	\$2,000		
		ISU	345	\$24,895	\$3,000		
		WHM	33	\$4,000	\$2,000		
Source Subtotals		Booz-Allen	860				
		OSU	2295	\$120,345	\$8,100		
		ISU	1475	\$102,867	\$14,225		
		WHM	164	\$19,680	\$10,500		
TOTAL				\$242,892		\$275,717	\$24,281

Legend: Booz-Allen = Booz-Allen & Hamilton

OSU = Oregon State University, Principal Investigator (C.A. Bell)

ISU = Iowa State University WHM = WHM Transportation Engineers (C.M. Walton)

Note: Booz-Allen effort funded under FHWA ITS Operational Test contract

4. QUALITY ASSURANCE

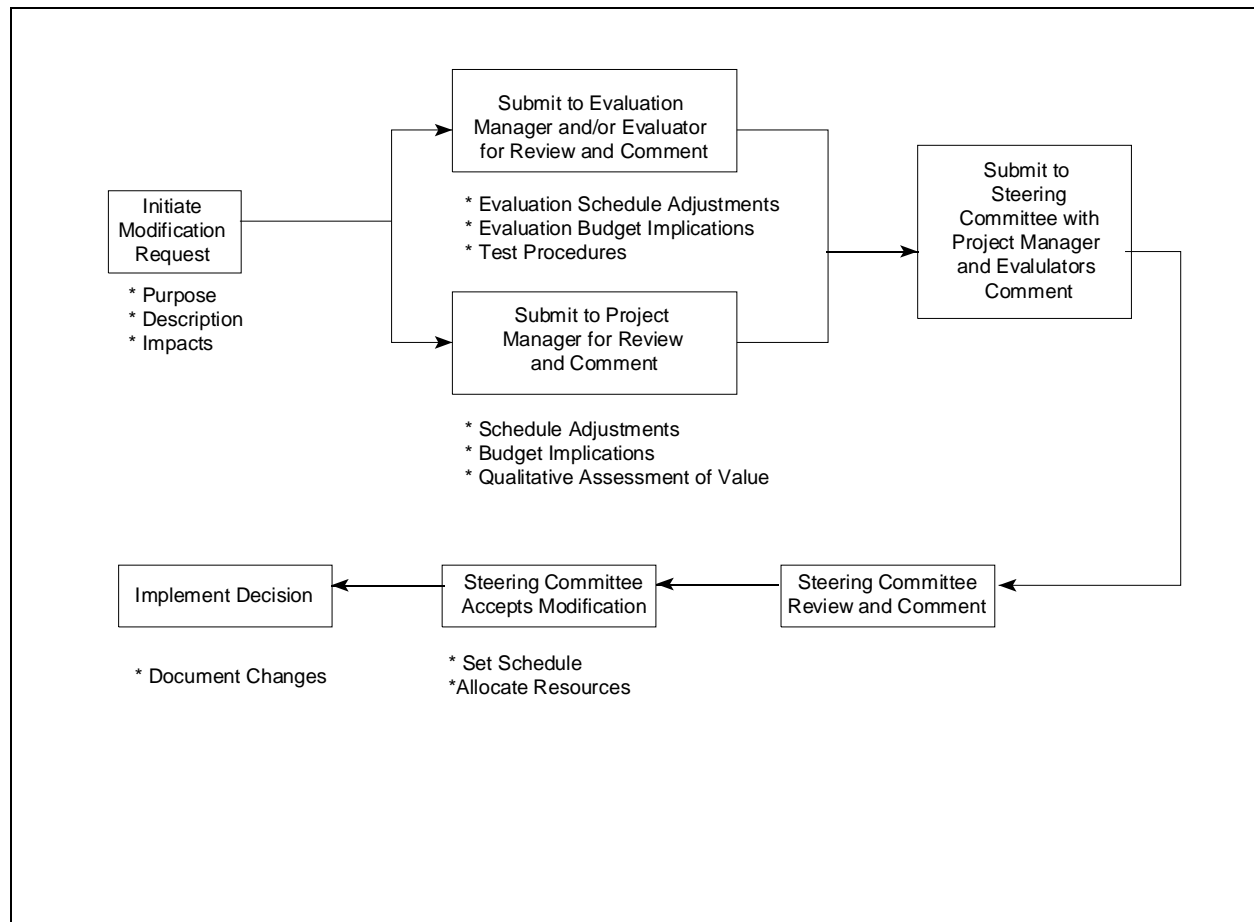
A comprehensive quality assurance approach for the pre-test and post-test activities will be used in the Green Light project. These procedures will ensure that all evaluation activities are appropriately conducted, analyzed, recorded, and documented. The primary focus of quality control are in the following areas:

- OSU will conduct the evaluation work according to the Evaluation Plan and Individual Test Plans, and will coordinate the activities of the evaluation team. All deliverables specified herein will be prepared in a timely matter.
- OSU will be responsible for the collection, handling, storing, distribution, and analysis of the data according to the procedures defined in the individual test plan data management section.
- OSU will periodically brief the Steering Committee on evaluation plans, progress, and current status at regularly scheduled meeting throughout the entire life-cycle of the operational test.
- Booz-Allen/OSU will provide an interim report to the Steering Committee during operational test.
- Booz-Allen/OSU will prepare deliverables for review by all Steering Committee members before submitting for final approval.

CONFIGURATION CONTROL

The importance of maintaining proper configuration control strategies is not only vital to the success of the project, but also to the success of the evaluation. This control applies to system software and hardware as well as evaluation documents. Any modifications made should follow this process before being implemented. It is not intended to inhibit changes, but to provide a consistent means for documenting and implementing any changes that are deemed necessary to the operational test. Thus, no change in the scope or procedures of this operational test should be made without being approved through the process defined in Exhibit 4-1.

EXHIBIT 4-1
Configuration Control



Documents generated during the course of the evaluation will use a numbering scheme that will facilitate their tracking and management. Each document will be numbered as GLEV96XX, where XX refers to the sequence the documents are generated.

DATA MANAGEMENT

The responsibilities for the management of the data collected for evaluation primarily resides with the evaluators. However, it is necessary to train the users in proper data recording to ensure consistency and validity. The following sections define procedures that will be used for all data management.

Data Review and Verification

The data collection efforts of the participants will be regularly monitored and reviewed to ensure the quality of their data. User logs will be periodically collected and reviewed. Any procedural errors or problems identified throughout this review will require immediate corrective action or clarification by the Evaluators.

Survey questionnaires will be tracked and cataloged to ensure timely and appropriate responses. Each completed survey will be reviewed when received and follow-up will be made if necessary for clarification purposes only.

Data Collection and Document Design

The data collection documents-user logs, survey questionnaires, and personal interview summaries will be developed using well established techniques and procedures that have been widely recognized and are successful consumer research and behavioral pattern studies. These documents will be trial tested. The documents will be mapped with the individual evaluation measures and objectives to ensure complete and appropriate coverage.

Data Maintenance and Security

While there are no obvious security or liability issues related to the type of data being collected, there is good reason to believe that the individual carriers and agencies might have some proprietary concerns about access and distribution of their individual databases and documents. Each participant will be assured during the training period that the evaluators will guarantee the confidentiality and restricted distribution of any information they provide.

All the data and survey comments of any one participant will be blended with other participants' information and any individual identity lost in this process. In addition, prior approval by a participant will be obtained before any individual or identifying remarks will be included in any document.

The evaluation databases and documents will be controlled by the Evaluators during the entire evaluation process. Each participant will be instructed and asked to maintain appropriate back-up hard copy and computer files of all records until the evaluator has received and reviewed each record.

When received, it is the responsibility of the Evaluator to maintain adequate hard copy and computer back-up records to ensure the integrity and availability of all evaluation records. Final disposal of all records will be at the direction of the Steering Committee and FHWA.

5. MAINSTREAMING / LEGAL ISSUES DOCUMENTATION

One of the major challenges to the designers of this operational test is to identify and resolve any institutional issues or barriers that might otherwise jeopardize the success of this test. The political/regulatory/financial complexities of the environment in which this test will be conducted provide ample opportunity for structural, jurisdictional, political, or even emotional issues to impede the successful implementation of the operational test.

Given the rather distinctive nature of the relationships of the participants in this test, an essential feature of the evaluation will be to identify and document any institutional and legal issues or barriers that arise during the operational test. Both the impact and the resolutions of these issues will be described. This includes all attempts for resolution whether successful or not.

In addition, a summary of similar institutional issues that arose during the design of the project will be cataloged, along with their methods of resolution. This information will be obtained primarily from ODOT personnel and from IRD, Inc.