Executive Summary

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The authors are indebted to the personnel of ODOT’s Motor Carrier Transportation Division, who have provided information and data to the evaluation team throughout the project. We are particularly indebted to Ken Evert, Gregg Dal Ponte, Randal Thomas and David Fifer. Ken’s untimely death in 1998 meant that he did not see his vision completed. The evaluation team is forever indebted to him for his support and for the opportunity to participate in the deployment.

DISCLAIMER

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# 1 INTRODUCTION

## 1.1 BACKGROUND

This Report is the Executive Summary for the independent technical evaluation of the Oregon Green Light CVO project. The Oregon Department of Transportation (ODOT) is near completion of the implementation of their Intelligent Vehicle Highway System Strategic Plan for Commercial Vehicle Operations (now referred to as ITS/CVO).

Through Green Light, Oregon has installed twenty-one mainline systems featuring weigh-in-motion (WIM) devices and automatic vehicle identification (AVI) at the major weigh stations and ports-of-entry in the state. In addition, certain sites have been equipped with safety enhancements that regulate road conditions and speed. Examples are the Downhill Speed Information System at Emigrant Hill, and the installation of weather stations at three other locations.

The purpose of this report is to present a summary of the findings of all the Detailed Test Plans conducted for the evaluation. The Detailed Test Plans were published in 1997, "The Oregon 'Green Light' CVO Evaluation -Detailed Test Plans" [1]. Earlier documents providing essential background to the Evaluation are the Evaluation Plan [2], and, Individual Test Plans (ITP) [3].

Each of the tests conducted by the research team for the evaluation of Green Light addressed one of five goals of the evaluation as documented in the Evaluation Plan [2]. These are:

- Assessment of Safety
- Assessment of Productivity
- Assessment of User Acceptance
• Assessment of Mainstreaming Issues
• Assessment of Non-Technical Interoperability Issues

The objectives associated with each goal are given in detail in The Oregon “Green Light” CVO Project - Individual Test Plans (ITP) [3]. The detailed test plan documents [1] expand on the information provided in the ITP and provide in detail the activities planned for each evaluation measure.

1.2 PURPOSE AND SCOPE

The purpose of this Executive summary is to summarize the principal findings from each Detailed Test Plan (DTP). Each of the DTP’s is summarized in Exhibit 1-1.

As the evaluation progressed, some simplifications were made as it became clear that some elements of Green Light would be modified or eliminated. For example, objective 2.6 was eliminated because vision technology was eliminated from ODOT’s plans. Also, a major change was implemented for DTP #7 where a simulation tool was developed to enable benefits of electronic screening to be evaluated. Simulation was necessary because the evaluation was proceeding concurrently with deployment, and, it was not possible to collect data that would enable measurement of impacts. Because the impact of pre-screening on fuel consumption was also determined using the simulation, that study (DTP #9) is reported with DTP #7. Exhibit 1-2 shows a summary of the DTP’s that were completed.

The findings will be presented in Chapter 2, in the order of the detailed test plans. A general discussion regarding the success of the Green Light project is given in Chapter 4. Conclusions and Recommendations are given in Chapter 4.
**EXHIBIT 1-1 Summary of Detailed Test Plans as Planned**

<table>
<thead>
<tr>
<th>Detailed Test Plan</th>
<th>Objective</th>
<th>Measure</th>
<th>Hypothesis / Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTP #1</td>
<td>1.1 Determine change in safety compliance with the Federal Motor Carrier Safety Regulations</td>
<td>1.1.1 Proportion of compliant (with FMCSR) trucks / carriers of total inspected and total processed per month.</td>
<td>The proportion of compliant trucks will eventually increase.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.2 Proportion of non-compliant (with FMCSR) trucks-carriers of total inspected and total processed per month.</td>
<td>The proportion of non-compliant trucks will eventually decrease.</td>
</tr>
<tr>
<td>DTP #2</td>
<td>1.2 Determine change in truck behavior due to the Road Weather Information System</td>
<td>1.2.1 Ratio of mean speed in inclement weather to that in good weather, before &amp; after installation.</td>
<td>Truck speeds will decrease in inclement weather.</td>
</tr>
<tr>
<td>DTP #3</td>
<td></td>
<td>1.2.2 Ratio of accidents before &amp; after installation if sufficient data exists.</td>
<td>Accident risk will decrease with better information available on weather conditions.</td>
</tr>
<tr>
<td>DTP #4</td>
<td>1.3 Determine change in truck behavior due to the Downhill Speed Information System</td>
<td>1.3.1 Ratio of mean speed on downhill sections, before &amp; after installation.</td>
<td>Mean speeds will decrease.</td>
</tr>
<tr>
<td>DTP #5</td>
<td></td>
<td>1.3.2 Ratio of accidents before &amp; after installation if sufficient data exists.</td>
<td>Accidents will decrease.</td>
</tr>
<tr>
<td>DTP #4</td>
<td></td>
<td>1.3.3 Comparison of mean speeds with advisory speeds</td>
<td>Mean speeds will converge towards advisory speeds.</td>
</tr>
<tr>
<td>DTP #6</td>
<td>2.1 Determine changes in tax administration costs</td>
<td>2.1.1 Determine the change in the resources required in the collection process, i.e., hardware, software, staff etc.</td>
<td>Tax collection will become more automatic and costs reduced (refer to the 1994 Green Light Document).</td>
</tr>
<tr>
<td>DTP #6</td>
<td></td>
<td>2.1.2 Determine the change in the resources required in the auditing process (government and carrier).</td>
<td>Audit process will become more automatic.</td>
</tr>
<tr>
<td>DTP #6</td>
<td>2.2 Determine changes in tax evasion</td>
<td>2.2.1 Determine changes in highway use tax revenues collected &amp; why.</td>
<td>Oregon Green Light will support changes.</td>
</tr>
<tr>
<td>DTP #6</td>
<td>2.3 Determine changes in vehicles processed at each site</td>
<td>2.3.1 Compare total vehicles processed (cleared &amp; not-cleared).</td>
<td>Number processed will increase.</td>
</tr>
<tr>
<td>DTP #7</td>
<td></td>
<td>2.3.2 Compare no. of interruptions per shift &amp; total time.</td>
<td>Interruptions will decrease.</td>
</tr>
<tr>
<td>DTP #8</td>
<td></td>
<td>2.3.3 Observe system availability.</td>
<td>Availability will be approximately 95%.</td>
</tr>
<tr>
<td>DTP #8</td>
<td></td>
<td>2.3.4 Observe system availability for long combination vehicles at Farewell Bend</td>
<td>The system availability for LCVs at Farewell Bend will be approximately 95%.</td>
</tr>
<tr>
<td>DTP #7</td>
<td>2.4. Determine productivity to motor carriers</td>
<td>2.4.1 Compare truck flow on the mainline before &amp; after installation.</td>
<td>Truck flow will increase.</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>DTP #9</td>
<td>2.5. Determine impacts on energy</td>
<td>2.5.1 Estimate changes in fuel use before and after using I-75 experience.</td>
<td>Fuel consumption will decrease.</td>
</tr>
<tr>
<td>DTP #10</td>
<td>2.6. Determine the ability of vision technology to support 100 percent electronic screening service</td>
<td>2.6.1 Evaluate the accuracy of the vision system by comparison of vision readout with actual plate numbers.</td>
<td>Vision system will be accurate at least 90% of the time.</td>
</tr>
<tr>
<td>DTP #11</td>
<td>3.1. Assess motor carrier acceptance</td>
<td>3.1.1 Determine attitude towards electronic screening, including perceived impacts.</td>
<td>The majority of carriers will have a positive attitude.</td>
</tr>
<tr>
<td>DTP #11</td>
<td></td>
<td>3.1.2 Determine attitude towards new services, e.g., select carriers-vehicles for inspection based on inspection and compliance status.</td>
<td>The majority of carriers will have a positive attitude.</td>
</tr>
<tr>
<td>DTP #11</td>
<td></td>
<td>3.1.3 Evaluate motor carrier acceptance of mainline electronic screening.</td>
<td>Carriers will demonstrate acceptance by installing transponders.</td>
</tr>
<tr>
<td>DTP #12</td>
<td>3.2. Assess agency acceptance</td>
<td>3.2.1 Determine agency attitude towards electronic screening, including perceived impacts.</td>
<td>The majority of agency personnel will have a positive attitude.</td>
</tr>
<tr>
<td>DTP #12</td>
<td></td>
<td>3.2.2 Determine agency attitude towards new services, e.g., select carriers-vehicles for inspection based on inspection and compliance status.</td>
<td>The majority of agency personnel will have a positive attitude.</td>
</tr>
<tr>
<td>DTP #13</td>
<td>4.1. Document regional and national mainstreaming issues</td>
<td>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.</td>
<td>Knowledge of pertinent regional and national issues will increases the effectiveness of the Green Light program.</td>
</tr>
<tr>
<td>DTP #13</td>
<td>4.2. Document approaches attempted to solve mainstreaming issues and final resolutions</td>
<td>4.2.1 Document approaches attempted to solve regional and national mainstreaming issues as they arise, and final resolutions.</td>
<td>Participation in pertinent regional and national issues will contribute to the effectiveness of the Green Light program.</td>
</tr>
<tr>
<td>DTP #14</td>
<td>5.1. Document non-technical interoperability issues</td>
<td>5.1.1 Identify, assess and document pertinent non-technical interoperability issues as they arise for customers and providers.</td>
<td>Knowledge of pertinent non-technical issues will increases the effectiveness of the Green Light program.</td>
</tr>
<tr>
<td>DTP #14</td>
<td>5.2. Document approaches attempted to solve interoperability issues and final resolutions</td>
<td>5.2.1 Document approaches attempted to solve non-technical interoperability issues as they arise, and final resolutions.</td>
<td>Documentation of participation in, and approaches used to resolve pertinent non-technical issues will contribute to the effectiveness of the Green Light program.</td>
</tr>
</tbody>
</table>
## EXHIBIT 1-2 Summary of DTP’s as Completed

<table>
<thead>
<tr>
<th>DTP</th>
<th>Test Measure</th>
<th>Description</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Executive Summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DTP #1</td>
<td>1.1.1 and 1.1.2</td>
<td>Inspection Compliance</td>
<td>Completed as Planned</td>
</tr>
<tr>
<td>DTP #2</td>
<td>1.2.1</td>
<td>RWIS – Speed Study</td>
<td>Combined and Reduced in Scope</td>
</tr>
<tr>
<td>DTP #3</td>
<td>1.2.2</td>
<td>RWIS - Accidents</td>
<td></td>
</tr>
<tr>
<td>DTP #4</td>
<td>1.3.1</td>
<td>DSIS - Speed Study</td>
<td>Combined and Reduced in Scope</td>
</tr>
<tr>
<td>DTP #5</td>
<td>1.3.2</td>
<td>DSIS – Accidents</td>
<td></td>
</tr>
<tr>
<td>DTP #6</td>
<td>2.1.1, 2.1.2 and 2.2.1</td>
<td>Tax Collection and Auditing</td>
<td>Completed as Planned</td>
</tr>
<tr>
<td>DTP #7</td>
<td>2.3.1, 2.3.2, and 2.4.1</td>
<td>Simulating the Impact of Electronic Screening</td>
<td>Completed as Planned Combined with DTP #9</td>
</tr>
<tr>
<td>DTP #8</td>
<td>2.3.3 and 2.3.4</td>
<td>System Availability</td>
<td>Completed with Reduced Scope</td>
</tr>
<tr>
<td>DTP #9</td>
<td>2.5.1</td>
<td>Fuel Consumption</td>
<td>Completed as Planned Combined with DTP #9</td>
</tr>
<tr>
<td>DTP #10</td>
<td>2.6.1</td>
<td>Assess Vision Technology</td>
<td>No Evaluation Conducted</td>
</tr>
<tr>
<td>DTP #11</td>
<td>3.1.1 and 3.1.2</td>
<td>Assess Motor Carrier Acceptance</td>
<td>Completed as Planned</td>
</tr>
<tr>
<td>DTP #12</td>
<td>3.2.1 and 3.2.2</td>
<td>Assess Agency Acceptance</td>
<td>Completed as Planned</td>
</tr>
<tr>
<td>DTP #13</td>
<td>4.1.1 and 4.2.1</td>
<td>Mainstreaming Issues</td>
<td>Combined and Completed as Planned</td>
</tr>
<tr>
<td>DTP #14</td>
<td>5.1.1 and 5.2.1</td>
<td>Non-technical Interoperability Issues</td>
<td>Completed as Planned</td>
</tr>
</tbody>
</table>
2 SUMMARY OF FINDINGS

This chapter summarizes the findings from each of the detailed test plans.

2.1 DTP #1 – Inspection Compliance

Out-of-service violations found during a series of random inspections (in 1998 and 1999) were used as an indicator of change in vehicle safety. The study found no significant changes in compliance rates at sites where Green Light technology was deployed. However, there was a significant increase in the total number of violations per inspection at non-GL, fixed sites. The most consistent pattern observed was a decrease in violation rates at non-fixed (or mobile) sites. The number of violations, the number of OOS violations, and the number of vehicle OOS violations per inspection decreased. Combining data across site types, the only significant difference was an increase in violations per inspection between 1998 and 1999.

It is important to note that over the course of the evaluation period, from January 1998 to July 1999, there was a low transponder penetration in relation to the total traffic bypassing the Green Light facility at Woodburn POE. At the end of the data collection period for this study in July 1999 there were approximately 3000 transponders in the field, less than the amount needed to actually show a change in compliance as a result of Green Light. This number increased substantially to over 10,000 transponders in the field in July 2000. Green Light bypasses also increased dramatically from about 28,000 in July 1999 to approximately 60,000 by July 2000.
This study established a baseline for future studies that should show that safety compliance increases as Green Light is fully deployed and a significant truck population carry transponders. It is strongly recommended that ODOT conduct random inspections annually so that it can be clearly demonstrated that safety of the truck fleet is improving.

2.2 DTP #2 – Road Weather Information System – Speed Study

ODOT’s travel advisory web page has underwent several upgrades in during the last 12 months of the evaluation. In January of 2000, a test version of TripCheck was launched, a high-powered web interface that brings together several mediums of information for travelers. Information from the Green Light RWIS sensors are combined with 13 other weather stations across the state to provide timely weather and road conditions to motorists. In addition, TripCheck offers general information such as a listing of construction projects that could pose delays, public transportation services and schedules, rest area locations, and scenic byways.

The RWIS installations were successful in meeting the goal of providing real-time weather data for public use through the Traffic Management Operations Center in Portland. The server installations in La Grande, The Dalles and Ashland relay the information quickly and efficiently, enhancing the existing infrastructure used to provide weather conditions in these three areas known for their high occurrence of truck crashes.

The interface with truck traffic through the use of variable message signs was not accomplished before the evaluation was completed, due to the incompatibility of the
existing hardware interfacing with the signs in Ladd Canyon. Combined with the
prohibitive costs of retrofitting signs with compatible hardware and/or purchasing new
signs, this led to an incomplete evaluation of the motor carriers adjusting speed to
adverse weather conditions.

Detailed test plan #11, the Motor Carrier Survey, provides additional insight into how
motor carriers feel about the RWIS system as intended by ODOT. The survey found
that 60% of carriers agree that RWIS would benefit their company (14% disagree and
26% have no opinion).

Recommendations for future work would be to pursue the dissemination of real time data
to the roadside, rather than solely through the Internet. With the advent of wireless data
communications, trucks could be equipped with palmtop computers that can query road
conditions via the Internet. Until such technology is mainstream, information kiosks at
rest areas, truck stops, and weigh stations, could be incorporated into ODOT’s existing
infrastructure without a great deal of capital expense, and would reach all carriers,
regardless of their technological advancements.

2.3 **DTP #3 – Road Weather Information System – Accident Study**

Available accident data has given a good baseline approach to continued monitoring of
accidents in the Ladd Canyon area. It is strongly recommended that ODOT continue to
collect data so that the impact of the RWIS can be measured.
2.4  DTP #4 – Downhill Speed Information System – Speed Study

Although the Emigrant Hill DSIS was not been deployed, the evaluation indicates that DSIS is a valuable tool that will be beneficial to the trucking community. Emigrant Hill continues to be listed as a high truck crash corridor in the state of Oregon, with 62 crashes occurring in 1999 due to speed and improper overtaking. The DSIS could aid in reducing these numbers through a warning system of advised speeds and personalized signing as proposed in the Green Light Project.

OSU recommends that ODOT continue to pursue deployment of this technology, and if possible, conduct an evaluation of its effectiveness.

2.5  DTP #5 - Downhill Speed Information System – Accident Study

Available accident data has given a good baseline approach to continued monitoring of accidents at Emigrant Hill. It is strongly recommended that ODOT continue to collect data so that the impact of the DSIS can be measured.

2.6  DTP #6 – Tax Collection and Auditing

The impact of Green Light increases the capacity of a weigh station to observe motor carriers’ operations. For each truck that uses a transponder, a space is created in the
weigh station queue. Assuming that the ODOT maintains the volume of traffic currently processed through the static scales, the total number of observations will increase equal to the rate of growth in transponder-equipped trucks. For trucks that have transponders, observations will be recorded at every pass by the weigh station. For trucks without transponders, the likelihood of having to stop at the static scale, thus being observed will increase.

Observations or third party data are an integral part of the weight-mile tax auditing process. Weight-mile tax reports are generated by the motor carrier on a monthly or quarterly basis. Reported trips are compared to observations within the state. Observations are currently made at the weigh station through vehicle weighing, safety inspections, and traffic citations. Weigh station observations are by far the most prevalent observations.

The increase in the number of observations enabled by Green Light will allow the audit unit to more effectively select motor carriers for audit. By having more observations, there is a greater chance of detecting unreported trips. Additional observations will also improve the accuracy of motor carrier audits. The additional information will allow the field auditors to more precisely and assuredly estimate a vehicle’s pattern of operation with the boundaries of Oregon. This will also serve as a deterrent to weight-mile tax evasion.

Green Light will lead to an increase in the number of observations, improved accuracy, and, allow for a better selection of files to be audited. However, it will have little effect on the process of auditing. The auditing process calls for manual review of all files by the Pre-audit staff. A few lines of additional data might add a few seconds to the pre-audit
staff review. Conversely, the additional data might allow the pre-audit staff to more quickly identify unreported operations, flag the files for audit, and move along to the next file. If either or both scenarios prove to be correct, the effect on the efficiency of the pre-audit process, measured in the amount of resources that it takes to review a file, will be negligible.

Field auditors use weigh station observations to piece together a vehicle’s pattern of operation within Oregon. Because weigh station observations are more easily accessed than motor carrier records, the time that it takes to conduct an audit might be shortened. However, unless a truck is observed in several locations on all trips, review of data from a variety of sources will continue to be the norm. The effect that electronic clearance will have on the efficiency of the desk and field audit processes, measured in the amount of resources that it takes to conduct a desk or field audit, will be negligible.

With regard to tax collection, the “Oregon Weight-Mile Tax Study” of 1996 concluded that the “evasion rate of the weight miles tax is approximately five percent of the total tax liability, or ten million dollars per year.” Although the amount of revenue lost to evasion each year is quite significant, it is only a small portion of motor carriers are actually submitting incomplete or inaccurate tax reports. To meet the objectives set forth in Measure 2.2.1 “Determine the changes in highway use tax and why”, the study team focused on the effect that Oregon Green Light technology has on the behavior of these motor carriers and the ability of the audit branch to detect and adjust inaccurate and/or incomplete tax reports. For example, the Woodburn Port of Entry currently allows all vehicles that weigh less than 62,000 lbs. on the ramp weigh in motion scale to take the

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ramp bypass lane and thus avoid direct observation. Consistently, 60 percent of trucks that pass through Port of Entry are not directly observed. Assuming that the number of transponder-equipped vehicles increases as is expected, a substantial percentage of trucks will be checked electronically on the mainline and the static scales will no longer be operating at or near capacity. The weigh station will then be able to lower the threshold weight of the ramp bypass and pull in a higher percentage of non-transponder equipped trucks for static scale weighing and observation.

According to Motor Carrier Auditors, motor carriers are quite cognizant of the fact that the audit branch uses weigh station observations. For those motor carriers that are tempted to report only those trips in which they are observed, the additional observations will serve as a direct deterrent resulting in greater tax receipts per registered motor carrier.

Deterrence alone will not eliminate tax evasion. As one auditor stated during the group interviews, “Tax evasion is more often an act of omission than an act of commission.” Poor record keeping and/or a lack of understanding of reporting procedure results in inaccurate or inadequate tax filings. The increase in the number of observations resulting from the introduction of electronic clearance will allow the pre-audit team to detect and adjust inaccurate and/or incomplete tax reports. By having more observations, there is a greater chance of catching unreported trips in both in pre-audit and field audit. While Green Light will provide more observations to assist auditors, this analysis did not determine significant changes in the processes.
2.7 **DTP #7 – Simulating the Impact of Electronic Screening**

The simulation findings indicate that electronic screening will reduce travel time and fuel consumption for trucks participating in the electronic screening programs, or transponder equipped trucks. Findings also indicate that electronic screening will decrease the occurrence of unobserved bypasses resulting from full queues and increase the percentage of trucks being screened for safety and compliance. The effectiveness of electronic screening will be situational. Several variables, including truck traffic volumes at the weigh station, the percentage of motor carriers participating in the electronic screening program, and Oregon’s commercial vehicle enforcement policies and procedures will determine the degree to which the electronic screening program meets its objectives.

An advantage of the simulation model is that the ODOT is not limited to the analysis of the scenarios selected for this report. ODOT staff can run the model on any personal computer with the Windows 95 or higher operating systems. With the Arena Viewer, users are able to alter input parameters such as traffic level, transponder rate, and number and length of inspections, to perform "what if" scenarios. ODOT can also analyze the impact that changes in operational procedure and/or staffing levels would have on the functionality of the weigh station. For example, ODOT could examine the impact of changing the threshold weight for the bypass lane or closing the ramp bypass lane entirely. Also, it can be shown that if the ramp bypass lane were closed, electronically screened vehicles would realize greater time savings than vehicles not participating in the program.
In the scenario described above, closing the ramp bypass lane would also serve the objectives of ODOT’s motor vehicle enforcement objectives. At the time of data collection, the ramp bypass lane allowed vehicles weighing less than 75 percent of the legal limit to bypass the static scale and return to the mainline. By bringing all vehicles to a stop at the static scale, the Woodburn staff would have the opportunity to visually check all vehicles not participating in the electronic screening. The ramp bypass lane serves the purpose of reducing congestion within the weigh station and thus minimizing unobserved bypasses, while maintaining weight screening on all vehicles that enter the weigh station. With enough vehicles participating in the program, electronic screening will give ODOT more flexibility in setting operational procedures. The simulation model will assist ODOT in assessing the impact of proposed changes in procedures.

Although closing the ramp bypass lane would result in the most dramatic changes in travel time savings for participating vehicles and would allow for a visual check of all vehicles, it is more likely that operational procedures would change incrementally. The simulation package gives the end user the ability to vary the percentage of vehicles and determine the threshold weight that would bring the greatest number of vehicles to the static scale without resulting in unobserved bypasses.

For this evaluation of weigh station efficiency, the Arena Viewer software "packed" with the Woodburn model is considered a deliverable equal in and of itself. Not only does the simulation provide a robust medium for evaluation but the powerful animation capability makes it possible to demonstrate the functionality of the weigh station and the impact of electronic screening to a broader audience.
2.8 DTP #8 – System Availability

The evaluation was designed to take place over a two-year period after the roadside systems were deployed. However, at the time the evaluation contract was completed, only seven of the twenty-one sites had been deployed, and had not been functioning for two years. The data collected were analyzed and indicated that the system was available at least 95% of the time to Weighmasters and Motor Carriers at the seven sites, when considered in aggregate. The data collected at Farewell Bend indicate that the system availability for long combination vehicles was nearly 100%.

It is strongly recommended that ODOT continue to evaluate data available in the Trouble Report Master Log and publish the results on an annual basis.
2.9 DTP #11 – Assess Motor Carrier Acceptance

A questionnaire survey was designed to monitor and assess motor carrier acceptance of Green Light technologies. Two surveys (“before” and “after”) were sent to carriers who operate in Oregon. The first survey was conducted in 1998, and the second in 2000.

The main goal of the questionnaire surveys was to obtain the following:

- User attitudes to electronic screening and its perceived impacts on the motor carrier.
- User attitudes to new services such as Road Weather Information System (RWIS) and Downhill Speed Information System (DSIS).

The survey design was based on the method described in the “Mail and Telephone Surveys – Total Design Method” by Don A. Dilliman. Mailing included an initial cover letter, the survey, and a brief description of Green Light components, a follow-up postcard, and finally a second survey identical to the first, but with a slightly different cover letter.

Surveys were mailed to a random sample of carriers registered to operate in Oregon. The population of motor carriers was divided into three strata based on the location of the carriers listed in ODOT’s database. Twelve hundred Oregon carriers made up the first stratum (Oregon carriers). One thousand carriers based in Washington, California, Idaho, and Nevada comprised a second stratum (Pacific Norwest carriers) while 1,000 of carriers of the remaining states and Canadian provinces made up to the third stratum (Other carriers).
The percentage of respondents to the survey was about 10 percent less in the “after” survey than in the “before” survey. The experience level of the participants is evenly distributed across strata with no significant variations in both “before” and “after” surveys. Nearly half (50%) of the respondents had been working in the industry for more than 20 years. Overall, smaller carriers dominated the sample with about three-quarters (75%) having fleet sizes of one to ten trucks. However, the medium fleet size (11 – 99 tractors) showed significant changes in the “after” or second survey.

A summary of findings is listed below:

- 41% of carriers agree (19% disagree) that Mainline Preclearance will benefit their company in the “before” survey while about 32% of carriers agree (25% disagree) with this statement in the “after” survey.
- 60% of carriers agree (that Road Weather Information System (RWIS will benefit their company in the “before” survey and 52% of carriers agree with this statement in the “after” survey. Approximate 15% disagree with the statement in both surveys.
- Over 50% of carriers agree with the policy of screening trucking for possible inspection based on recent compliance with federal safety regulations (nearly 16% disagree) in both “before” and “after” surveys.
- Over 60% of carriers rate the overall performance of ODOT’s Motor Carrier Services as “Good” (nearly 26% rate it “Fair” and about 4% rate it “poor”) in both “before” and “after” surveys. 9% rate it “Excellent” in the “before” survey and 6% in the “after” survey.

The evaluation of motor carrier acceptance by tracking transponder penetration since they were introduced in 1997 showed that, after a slow start, the industry embraced the
technology. At the time the evaluation was completed, nearly 12,500 transponders were in use.

2.10 DTP #12 – Agency Acceptance

The purpose of this study was to gain insight about how Green Light met its initial objectives in the eyes of the personnel that work with the system as well as those that developed and deployed it. The interviews provided an opportunity to document the lessons learned during Green Light’s deployment. The study used an interview process tailored to focus on both Green Light’s benefits, and the obstacles that may have hindered the development of the system’s integration into the ODOT’s business and operations. It was intended that the results of this part of the evaluation would provide a valuable resource to those deploying similar projects.

The interviews consisted of asking up to nine questions of a targeted group of ODOT’s leadership and personnel involved closely with the Green Light deployment. The summary of responses shows a high level of agency acceptance as well as an understanding of the benefits gained and recognition of lessons learned. The last question dealt with lessons learned and is repeated below, followed by a summary of the responses:

“What have been some lessons learned in the inception of Green Light, and what have been deterrents to its complete and successful operation?”

Interoperability was commented on as a problem, specifically regarding the differing business models between different systems and the competitive politics surrounding the issue. It was stated that only the federal government has the power to enforce cooperation, but they have not. The technology is not a real problem, but the political
The program also has had installation and assimilation problems because of the lack of a central coherent training or marketing plan. Training was done piecemeal all over the state, so the same battles were fought over and over again. A comprehensive and organized introduction and training program would have increased early acceptance and eased the transition. The trucking industry as a whole is not an early adopter of technology, and a solid, timely marketing program should have been implemented. Some of the marketing that was done was done prematurely, which let carrier interest fade before the system was up and running. An important lesson is that by giving out free transponders to new members, the startup risk of new technology was shifted away from the truckers, so they became much more agreeable to the program. While this method may not be appropriate everywhere, it is important to note that carriers want to save time and money, but an untried system that fails will cost them more than it saves, so they are wary about investing in it. Reducing transponder costs as much as possible will diminish this reluctance. Ultimately, the system should be nationwide. This will reduce the costs to truckers the most, and so will be the most accepted, used, and useful. The Oregon system is up and running, but at present multiple transponders must be purchased to use systems in multiple states. Overcoming the barriers between systems is necessary for the system in any state to fully mature and achieve its potential.
2.11 **DTP #13 & #14 - Mainstreaming and Non-technical Interoperability Issues**

This part of the evaluation was weighted heavily towards interoperability issues, because those issues proved to be significant in delaying market penetration of mainline technologies. Mainstreaming proceeded in a steady and non-controversial way. The literature supports this conclusion; there are many articles that report on the widespread adoption of the technologies.

It is clear that achieving interoperability between different programs is very difficult. Even the MAPS and Advantage CVO states (with very similar business models) took four years from the start of Green Light to form an agreement.

Although a one-way interoperability agreement was reached between NORPASS and PrePass, it was unsatisfactory to Oregon, and, caused them to withdraw from NORPASS. Green Light carriers are still interoperable with NORPASS (they must pay the $45 enrollment fee) and, NORPASS carriers operate in the Green Light system free of charge. As yet, no satisfactory agreement has been reached between Green Light and Prepass for one-way interoperability.

A positive outcome of Oregon's withdrawal from NORPASS is that it transferred ownership of transponders to the carriers, and, distributed an additional 7,500 transponders in three months. There are now 12,500 trucks equipped with Green Light transponders. This is half their original target, but, considering the current progress, they could reach their target before 12/31/2000.
A satisfactory compromise needs to be reached between Oregon and PrePass before interoperability can be achieved. Oregon should hold to its principles, which are endorsed by other states and by many in the trucking industry. However, they will likely need to compromise, but, only to the degree to which their customers agree. The major principle is regarding HELP’s limitation of the use of PrePass transponders.

An issue for many Green Light carriers is the fee structure used by PrePass. However, the market will determine if carriers are prepared to pay PrePass’s fees. PrePass may need to introduce alternative fee schedules to attract a diverse range of customers.

A longer term issue is reaching an interoperability agreement that will enable PrePass carriers to operate in Green Light. At this time there is an impasse with regard to PrePass obtaining some cost recovery as well as protecting there carrier’s data privacy. However, there are several examples of PrePass carriers that have requested enrollment in Green Light (and NORPASS) and have been refused by PrePass. Carriers can enroll in each system separately and obtain a transponder for each, but, there are problems when a truck has two transponders in the cab. Since the Green Light and PrePass transponders are the same, this situation is unnecessary!

Oregon was very successful in the distribution of transponders after opting to withdraw from NORPASS and deciding to act as their own transponder administrator. The two significant changes that Oregon introduced (as the administrator) were: a) transferring ownership of transponders to the carrier, and, b) providing new transponders at no cost. At the time the evaluation was concluded 12,500 transponders had been distributed. Another 12,500 will be distributed free of charge, before a carrier must purchase their own transponder. It is strongly recommended that ODOT continue the successful
practice of targeting those carriers that would benefit the most from mainline, i.e. those that operate most in the Green Light corridors.

It is likely that ODOT will reach its goal of issuing a total of 25,000 transponders during 2001. The state should consider continuing free distribution of transponders. A market survey may be appropriate to guide this decision. It is certainly likely that those enrolled in the program would be willing to pay (if they had to do over) but enrolling new carriers will become difficult at some point. Removing the best incentive (free transponders) may halt the rapid progress that has been made in market penetration.
3 DISCUSSION

This chapter provides a general discussion of issues relating to the evaluation but not specifically addressed in any of the detailed test plans.

The Green Light Project was initiated in 1995 to fulfill Oregon’s vision of creating an automated and intelligent truck transportation system. As the project nears completion, it has proved successful, by improving the safety and efficiency of the commercial trucking industry while at the same time increasing the performance of roadside facilities without physically expanding them, and protecting the public investment in the infrastructure.

Through the Green Light weigh station modernization program, Oregon has installed Mainline Systems at 21 weigh stations to electronically screen trucks as they approach at highway speeds. The deployment at all 21 sites was completed and fully operational by March 2001. Weigh-in-motion (WIM) systems check the vehicle’s weight and height, and, automatic vehicle identification (AVI) systems check records for registration, tax status, and safety inspection status. The driver is signaled with an in cab device to either Report to the station or to Bypass.

During 1999 nearly 280,000 mainline bypasses occurred at completed sites, and, in 2000 this number rose to more than 640,000. All 21 sites were fully deployed by March 2001, and, the number of bypasses will continue to increase as more carriers enroll, freeing weigh site personnel and facilities to process only those trucks that need their attention, and, saving considerable time (and money) for trucks that bypass. Calculable savings occurred in several ways:
(1) The cost of physically expanding 11 of the 21 weigh stations was avoided,

(2) The cost of building five replacement weigh stations for facilities that would otherwise be rendered obsolete was avoided,

(3) The cost of early repair to the infrastructure as a result of increased overweight truck traffic was avoided, and

(4) The trucking industry operates more efficiently and avoids costs it would have incurred in a strictly conventional, time-consuming stop-and-weigh process.

Each of these cost saving mechanisms is addressed in more detail below.

Truck traffic increased almost 40 percent in the I-5 corridor between Portland and Salem from 1990-1998. The two weigh sites in this area were designed in the mid-1980’s to weigh about 2,500 trucks a day, but today the traffic load has increased to more than 5,000 trucks a day. Truck traffic along the I-84 corridor has increased by similar amounts. To accommodate these increases in truck traffic 11 weigh stations would require expansion including extension of the off-ramps and added static scales. The total estimated cost for extending the ramps and adding a static scale at each site was $2,262,700. Through the Green Light mainline system, Oregon avoided spending millions on facility expansion at major weigh stations.

An additional five weigh stations would soon be rendered obsolete, and, there is no room to physically expand them at their current location. If replacement stations could be built, within appropriate proximity to each station, the cost of construction would be a minimum of $14.5 million. However the biggest cost consideration would be in land acquisition. If electronic screening were not available at these locations Oregon would
be forced to close the stations, thus removing any visible enforcement, and, forced to
accept compromises to its size and weight enforcement effort.

By implementing Green Light systems, Oregon identified and stopped more overweight
tucks than previously. Without Green Light these trucks would proceed with the
potential to cause millions in highway pavement damage. In a model developed by
researchers in Idaho, the benefit in prevented damage can be estimated for a weigh
station in a typical highway application. The study indicated that a single weigh station,
covering an area of 160 miles, would prevent approximately $46 million in pavement
damage during an average life span of 10 years. An earlier Federally Funded study
indicated that overloaded truck axles cost up to $670 million per year (nationally) in
pavement damage. Thus with 21 improved weigh stations enhancing the ability to
minimize overloaded vehicles, Oregon could save well in excess of $200 million during
the next 10 years. Although there is no generally accepted way to calculate the actual
amount, the savings realized are related to costs associated with: (1) the effect of
deteriorating pavement conditions on fuel economy, tire wear, and other related
maintenance costs, (2) time delays suffered during pavement resurfacing,
reconstruction, rehabilitation, and maintenance, and, (3) time delays suffered due to
traffic control related to remodeling, upgrading, and/or reconstruction of weigh stations.

Finally, by utilizing Green Light the trucking industry enjoys efficiencies and avoids costs
that are built into the conventional weigh station operation. What’s it worth to a truck
driver to pre-clear a weigh station at highway speeds? Operating a heavy truck has
been estimated by the American Trucking Association to cost $1.92 per mile. Assuming
an average hourly speed of 39 miles-per-hour (from departure to destination), a cost of
$1.24 per minute is realized. Truck drivers save at least three minutes per weigh station.
bypass. Therefore it is conservatively projected, based on the current rate of about 60,000 bypasses a month in Oregon, that in the next 10 years the Green Light mainline system is expected to pre-clear 7.2 million trucks. This will save the industry more than $25 million in operating costs as it saves 360,000 hours of travel time. However, it is anticipated that the number of bypasses will increase substantially as more carriers enroll, resulting in much larger savings.

In summary, the Oregon Green Light project has been immediately beneficial, yet designed for the future; the system will continue to provide financial benefits in the form of cost avoidance to the taxpayer and to the trucking industry. The model deployment has clearly demonstrated the benefits of mainline . It has also demonstrated that achieving interoperability (see sections 2.10 and 2.11) is a difficult process that may prove more difficult to achieve than providing technically excellent systems.
4 CONCLUSIONS AND RECOMMENDATION

The independent evaluation was initiated in August 1995 and concluded in June 2000. Oregon State University was prime contractor, with Iowa State University as a subcontractor, and, WHM Transportation Engineering as a consultant. Fourteen test plans were developed to evaluate: safety, productivity, user acceptance, mainstreaming issues and interoperability issues. At the time the evaluation was concluded, the Green Light sites were not fully deployed; the Conclusions and Recommendations are therefore based on tests conducted on an incomplete system. Nevertheless, they are a strong indicator of future performance.

4.1 Conclusions

Safety: Out-of-service violations found during a series of random inspections (in 1998 and 1999) were used as an indicator of change in vehicle safety. At the time of these inspections there were few transponders distributed and, therefore, no significant changes were observed. However, the study established a baseline for future studies that should show that safety compliance increases as Green Light is fully deployed and a significant number of trucks carry transponders. Evaluation of the Road Weather Information System (RWIS) and the Downhill Speed Information System (DSIS) could not be completed as planned because the systems were not fully deployed. However, the methodology for the evaluation should be applied once deployment is completed.
Productivity: A study of the auditing and collection processes for the weight–mile tax indicated that Green Light technology significantly increases the level of auditing possible. Ability to do this will improve productivity but not result in any changes to the processes. A simulation model was also developed for sites. The model clearly demonstrated that system capacity increased as transponder penetration increased, and, provides a powerful tool (because of the animation capability) to demonstrate impacts of electronic screening to a broad audience. A third productivity study of seven functional sites indicated that the system will be available at least 95% of the time. This suggests a very high productivity when all 21 sites are deployed.

User Acceptance: Before and after surveys were conducted in 1998 and 2000 to assess motor carrier acceptance of Green Light technologies (electronic screening). There was little difference in the results of the 2 surveys. However, in both surveys, the majority of motor carriers were supportive of electronic screening and were satisfied with ODOT's Motor Carrier Services. The steady increase in transponders issued is the strongest indicator of user support; 10,000 were issued in 2000 after a slow penetration in 1998 and 1999. The indication is that ODOT will reach its goal of issuing 25,000 transponders in 2001, largely due to growth in user acceptance.

Agency Acceptance: Interviews were conducted with ODOT leaders as well as with personnel involved closely with the Green Light deployment. The responses showed a high level of agency acceptance as well as an understanding of the benefits gained and recognition of lessons learned. Interoperability was commented on as a problem, specifically regarding the differing business models between different systems and the competitive politics surrounding the issue. It was stated that only the federal government has the power to enforce co-operation. However, this was not done and a
solution has not yet been found.

**Mainstreaming and Interoperability Issues:** Mainstreaming proceeded in a steady and non-controversial way. However, there have been many interoperability issues. It is clear that ODOT and PrePass must reach a satisfactory compromise before interoperability can be achieved. ODOT should hold to its principles, which are endorsed by other states and by many in the trucking industry.

In summary, the Oregon Green Light project has been immediately beneficial, yet designed for the future; the system will continue to provide financial benefits in the form of cost avoidance to the taxpayer and to the trucking industry. The model deployment has clearly demonstrated the benefits of mainline. It has also demonstrated that achieving interoperability (see sections 2.10 and 2.11) is a difficult process that may prove more difficult to achieve than providing technically excellent systems.

### 4.2 Recommendation

Because the evaluation contract was concluded before all elements of the Green Light project were fully deployed, the evaluation was incomplete. Nevertheless, the evaluation conducted demonstrated that the project was successful as indicated in the foregoing sections of this Executive Summary. However, it is strongly recommended that ODOT continue evaluation of Green Light using the framework established in the evaluation contract.
5 REFERENCES

