ANALYSIS OF OREGON'S RURAL INCIDENT RESPONSE PROGRAM USING ARCHIVED INTELLIGENT TRANSPORTATION SYSTEMS DATA

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SUMMARY

It is well understood that incidents contribute to a substantial proportion of the delay on the nation's highways and adversely affect the safety of our transportation network. As a proactive means of addressing these critical issues, the Oregon Department of Transportation (ODOT) has initiated an innovative incident management program outside of a major urban area. The Region 2 Incident Response (IR) Program is a tool used to assist disabled vehicles along freeway and highway corridors. The work accomplished by the IR team helps relieve non-recurrent congestion through quick incident detection, verification, response, and removal/clean up. In addition, the IR team can notify the proper authorities, through the computer aided dispatch (CAD) center, of other types of roadway problems which currently or will prospectively impact traffic flow. The Region 2 IR program has evolved over the past six years and is the first rural incident management program in the state. The IR program is administrated by ODOT in cooperation with the Oregon State Police and many other local agencies. This paper summarizes the results of an analysis of this program for two representative corridors along Interstate 5 and Highway 18 during the period 1995 – 2000.

The research concentrated on two corridors using archived CAD data for Highway 18 (McMinnville to Lincoln City) and Interstate 5 within the Lane County limits in the Eugene area. The methodology consisted of a statistical analysis of incident using data from two distinct phases since the IR program's inception. This analysis has characterized the benefits of the IR program, which are contrasted with the costs of administrating and operating the program. Quantitative comparison of potential benefits has included consideration of possible reductions in accidents, traffic congestion, pollution and requirements for ODOT and law enforcement resources. The evaluation of these benefits aims to provide threshold levels of inputs (e.g., traffic volumes, number of incidents, etc.) that would indicate that an IR program should be created or expanded for a particular route. In addition, qualitative benefits derived as a result of the IR program were also identified. Although these benefits are not directly measurable, their presence increases the value of the IR program making it more cost effective than that actually presented.

INTRODUCTION

Incidents are defined as accidents, breakdowns and other random events that occur on our highway system. It is well understood that incidents contribute to approximately 50 percent of the congestion delay on the nation's highways, lead to major road closures and adversely affect the safety of our transportation network. Further, incidents increase drivers' exposure to hazardous conditions and are known to lead to secondary accidents as well. In Oregon, outside of the Portland metropolitan area, maintenance personnel typically managed incidents on an as-needed or reactive basis. Knowing that incidents do not only occur during the hours when maintenance personnel are working, overtime

charges were necessary for response to major incidents on weekends and overnight. In recent years, growth in traffic volumes and tightening maintenance budgets have led to the need for more proactive operations management strategies. During this same period, more and more diversion of maintenance resources has led to increased overtime costs and increasingly negative effects on maintenance productivity.

As a proactive means of addressing these issues, since 1995 the Oregon Department of Transportation (ODOT) has deployed an innovative incident management program outside its major urban region. Incident management is a proven strategy for reducing the duration of incidents' impact on traffic flow, and provides *eyes and ears* to the highway system. The Region 2 Incident Response (IR) Program is a tool used to assist disabled vehicles along freeway and highway corridors. The Region 2 IR program's continuously patrolling vehicles provide complimentary services such as: changing a flat tire, refilling a radiator, providing fuel, and giving directions. The IR vehicles work with local private towing firms to remove stalled vehicles from the roadway. The work accomplished by the IR team helps relieve non-recurrent congestion through quick incident detection, verification, response, and removal/clean up. This effort in turn will reduce delay, fuel consumption, accident exposure, air pollution and environmental impacts of incidents that occur, as well as improve agency resource allocation. In addition, the IR team notifies the proper authorities, through the traffic operations center, of other types of roadway problems, which have the potential to adversely, impact traffic flow.

The Region 2 IR program has evolved over the past six years and is relatively unique in the western states. The IR program is administered by ODOT in cooperation with the Oregon State Police and many other local agencies. This paper summarizes the results of an analysis *(1)* of this program on two representative corridors along Interstate 5 and Highway 18 during the period 1995–2000.

BENEFITS OF INCIDENT RESPONSE

For the purposes of this study, in addition to the costs of implementing the IR program, a number of prospective IR benefits were identified. *(2)* Some of the benefits accrue to the general public, including:

- Reduced delay
- Reduced fuel consumption
- Improved air quality
- Improved safety and security (avoided accidents and secondary accidents and an improved feeling of security on the transportation system)
- Improved flow of commerce
- Reduced harm to wildlife, soil and water quality

Other IR benefits include those that accrue to ODOT and other agencies, including:

- Reduced maintenance crew cost
- Value of extra maintenance performed
- Increased recovery of Charges Against Others (CAO) from motorists' insurance companies
- Awareness of potentially hazardous items requiring maintenance
- Improved de-icing information
- Improved public relations and good will.

RESEARCH OBJECTIVES

This research included a statistical analysis of archived incident data (available since 1995), estimation of reductions in fuel consumption and delay, calculation of program costs and development of a decision-making tool for design/expansion of IR on future corridors. As shown in Figure 1, the project concentrated on two corridors using archived CAD data for Highway 18 (McMinnville to Lincoln City) and Interstate 5 within the Lane County limits in the Eugene area. These two distinct corridors were selected carefully in collaboration with an ODOT Technical Advisory Committee. Highway 18, between McMinnville and Lincoln City, is a rural highway characterized by heavy weekend/recreational traffic, has no parallel detour routes, is a major truck route to the Oregon coast, and thus imposes an economic impact if the highway is closed for any period of time. In addition, there are few existing emergency response resources

Figure 1 – Study Sites

immediately adjacent to the highway. Interstate 5 within Lane County in the Eugene area is a more typical commute corridor with available nearby emergency resources.

The methodology consisted of a quantitative analysis of archived incident data during two distinct phases since the IR program's inception. As shown in Figure 2, *Phase 1* covers the period between February 1995–March 1997 and *Phase 2* covers the period from March 1997-December 2000. Figure 2 also shows the total amount of IR resources deployed. As shown, during Phase 1 on Highway 18, IR personnel invested approximately 36 hours per month, while during Phase 2 (continuing today), there is one full-time IR staff member deployed (173 hours per month). Figure 2 also indicates that the staffing level has increased over time on Interstate 5. It should be noted that it has not been possible to conduct a true "before and after" study, since it is the IR staff themselves who are the roving data collectors. Thus, the numbers of reported incidents (as opposed to the actual number of incidents—impossible to determine) has increased because the IR personnel are physically monitoring the status of the roadways

This analysis has been used to characterize the benefits of the IR program, which are contrasted with the costs of administering and operating the program. Quantitative comparison of potential benefits has included consideration of possible reductions in accidents, traffic congestion, pollution and requirements for ODOT and law enforcement resources. The evaluation of these benefits provides threshold levels of inputs (e.g., traffic volumes, number of incidents, etc.) that would indicate that an IR program should be created or expanded for a particular route. In addition, qualitative benefits derived as a result of the IR program were also identified. Although these benefits are not directly measurable, their presence increases the value of the IR program making it more cost effective than that actually presented.

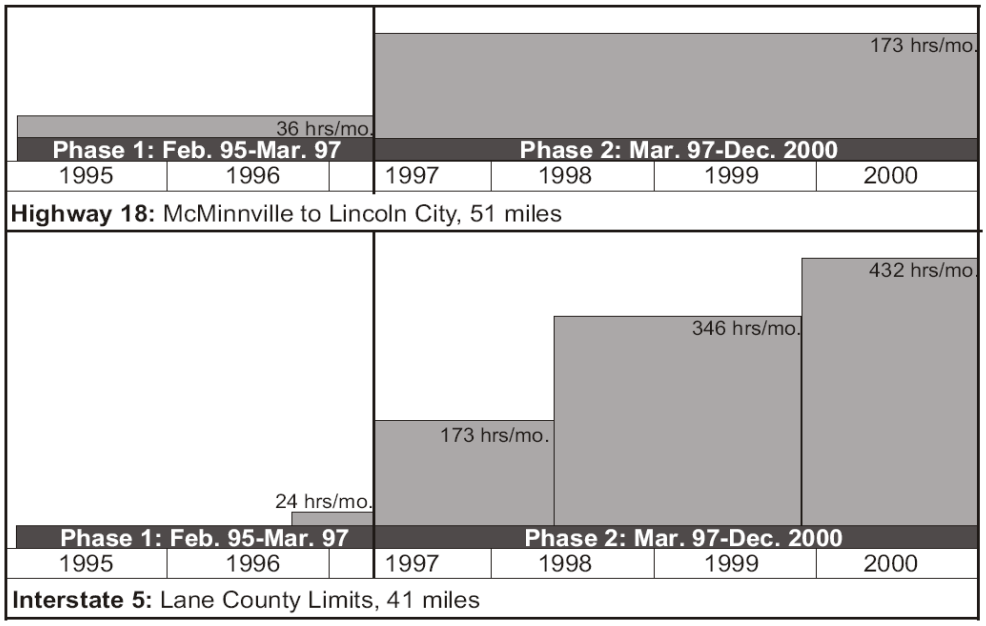

Figure 2 – Incident Response Staffing

DATA ANALYSIS

Incident data collected by ODOT's Region 2 CAD included 15 fields of data for both roadways over the study period, including details regarding the incident type, location, time reported, time cleared and other remarks. There are many incidents that are never reported, and in particular, before the implementation of the IR program, there were far fewer reported incidents. Now, IR personnel report incident data via radio, and so in addition to the improvement in reporting frequency, there have been improvements in reporting accuracy and timeliness due to the presence of the IR program itself. In addition, since 1995, the prevalence of cellular phones had increased the public reporting rate. Therefore, the reported incident frequency tracks with increases in IR coverage.

These raw CAD data were expanded into a database describing the incidents for Highway 18 and Interstate 5. The database includes information on more than 67,000 unfiltered (raw, may include duplications, errors, etc.) incidents. These raw data were subsequently filtered to isolate 3,900 reported incidents in the study corridors. These raw corridor incidents were further filtered to remove duplicate incidents, and were reviewed for consistency, resulting in 2,500 incidents to be analyzed. Finally, each incident was analyzed carefully in terms of its severity, duration, timing and location to determine whether it actually caused delay to the motoring public. This resulted in the consideration of a total of 485 delay-causing incidents along the study corridors.

STUDY FINDINGS

The following information was determined from the analysis of the Region 2 IR program for the period 1995-2000. First, as shown in Figure 3, considering all 67,000 reported incidents in Region 2 during this period, it is clear that the majority of incidents are classified as HAZARDS (34%), followed by ACCIDENTS (15%) and MOTORIST ASSIST (10%). Nearly 60% of all incidents fall under these major categories.

As an example, Figure 4 shows a histogram of incidents by type on Highway 18 alone. This figure indicates that the incidents in the categories of HAZARD, ACCIDENT, MOTORIST ASSIST and ROADKILL account for nearly all of the incidents that occurred on Highway 18. Figure 5 displays the top four incident types (HAZARD, ACCIDENT, MOTORIST ASSIST and ROADKILL) by milepost location. As shown, it is possible to identify mileposts 1, 24 and 53 as the higher incident locations. This information can be useful when planning incident response staffing as well as when planning safety and other roadway improvements.

A series of analyses was also conducted with respect to incident duration. We know that an incident usually occurs some time before it is actually reported. Also, an incident may actually be cleared several minutes before this clearance is reported to dispatch. However, an incident’s impact can be felt for a long time after it is actually

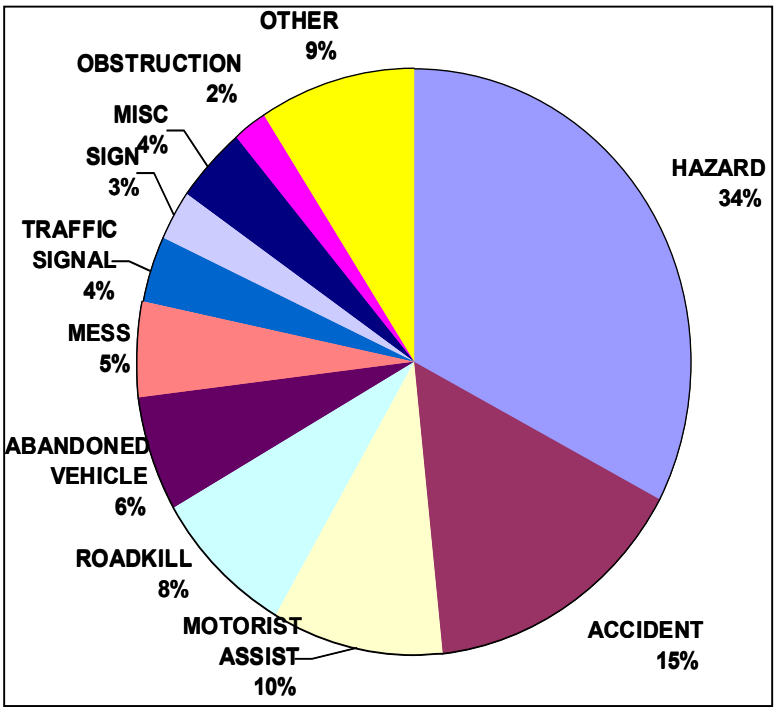

Figure 3 – Incident Characteristics

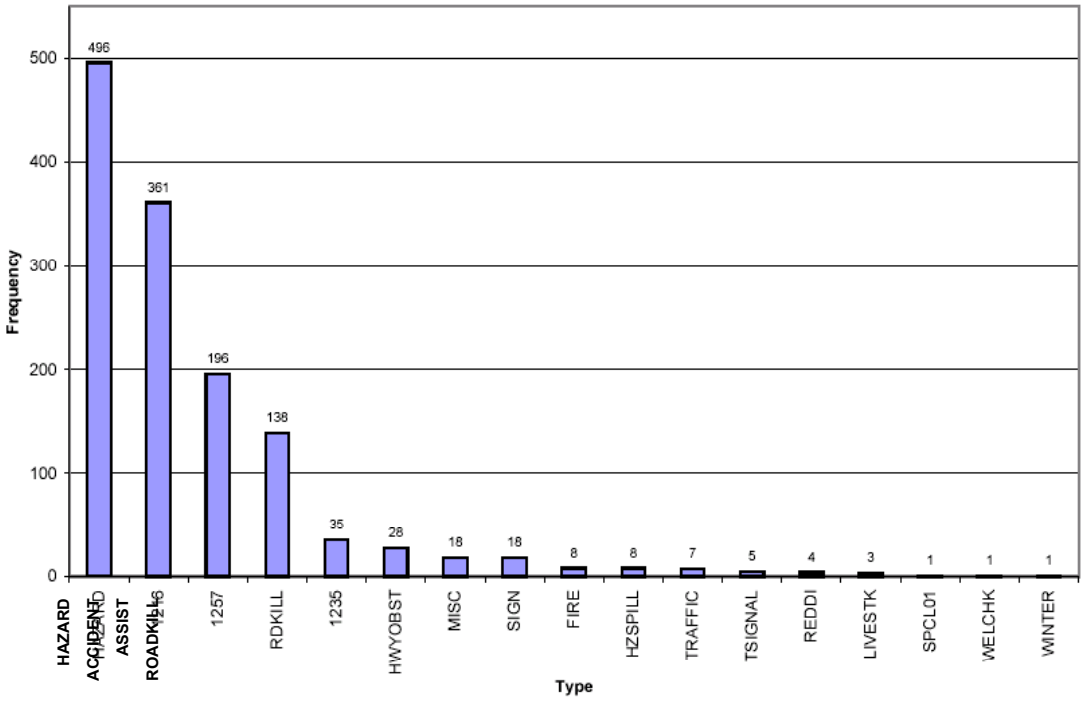

Figure 4 – Highway 18 Incidents

cleared from the roadway. It is the primary motivation of an incident response program to minimize the time between actual incident occurrence and clearance.

Once the incidents' actual durations are estimated, they can be plotted in the form of a histogram, as shown in Figure 6. This figure shows the distribution of incident durations on Highway 18 between 1995-2000. As shown, the majority of the incidents had durations between 45 minutes and one hour. The primary benefit of an IR program is to decrease the duration of incidents, thus reducing the impact of the incidents on driver delay.

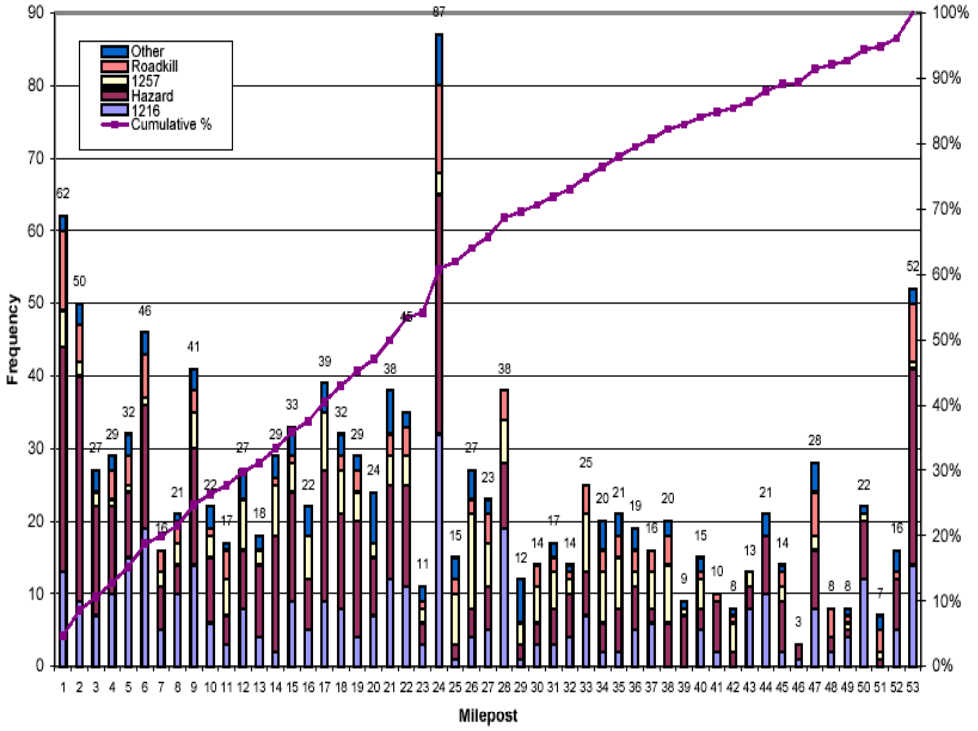

Figure 5 – Highway 18 Incident Locations

Some additional analysis was performed in order to assess the impact of IR on ODOT's maintenance productivity. If state property is damaged due to an incident, maintenance personnel must replace or repair items such as guardrail or signposts at substantial cost to the state. Prior to the implementation of IR, these costs were simply absorbed as "non-recoverable costs." As one indicator of the impact of IR, it was shown that that the non-recoverable costs in the Eugene metro area have been declining. This decline can be attributed to better incident reporting. Finally, ODOT has provided some additional data regarding their efforts to recover costs incurred during accidents that damage state property. It was shown that along Highway 18, this type of cost recovery has been increasing, likely due to the presence of the IR personnel who serve as additional witnesses to such damage.

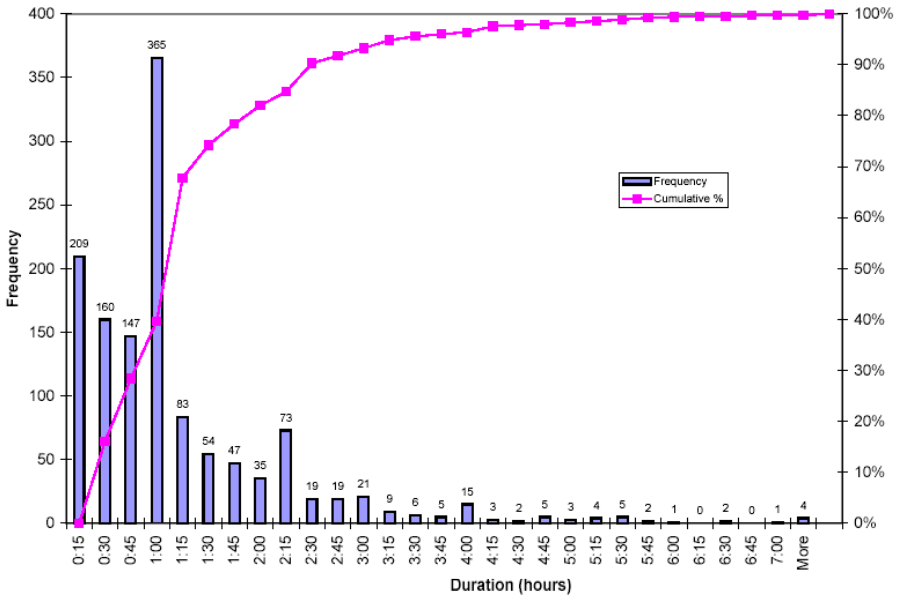

Figure 6 – Incident Durations

SUMMARY OF RESULTS

The results described below summarize the findings of this research.

	Highway 18	Interstate 5

Roadway Characteristics: The average daily traffic on both routes has increased substantially since 1995, with no increases in capacity. As on most highways throughout Oregon, this emphasizes the need to focus attention on development of new operational strategies.

Length (miles)	51	41
Average Daily Traffic – 1995	8,600	33,000
Average Daily Traffic – 2000	11,400	40,000
Average Daily Traffic Increase 1995 - 2000	+33%	+21%
Capacity Increases 1995 - 2000	0%	0%

IR Program Characteristics: The IR program handles more than 30 major assists per month. One major finding of this research was that 70-75% of the delay-causing incidents were accidents. This indicates that for future planning purposes accident statistics may help determine routes that would be candidates for new or expanded IR programs. It is important to recognize, however, that the number of accidents reported to the state by motorists is much smaller than the actual number of accidents that occur.

Total Number of Incidents Reported by IR	1,815	2,018
Average Assists per Month (Total)	36	35

Average Assists per Mile (total)	31	39
Percent Delay Causing that are Accidents	75%	70%

Accident Characteristics (ODOT statewide data): Based on statewide accident data, it is shown that the accident rate has decreased on Highway 18 over the period that the IR program has been in effect.

Accident rate expressed in number per million vehicle-miles traveled		
Accident Rate – 1995 (pre-IR)	0.72	0.12
Accident Rate – 1999 (post-IR)	0.63	0.19
Accident Rate Reduction	-13%	+58%

Average Duration of Incident (hours): Another major finding of this research is that the duration of delay-causing incidents has dropped substantially with the implementation of the IR program. This drop in duration was approximately 30% on Highway 18 and almost 15% on Interstate 5.

Delay-Causing Phase 1 (pre-IR)	2.07	1.10
Delay-Causing Phase 2 (post-IR)	1.42	0.95
Delay-Causing Incident Duration Reduction	-31%	-14%

Average Delay per Incident (vehicle-hours): Along with the reduction in mean incident duration has followed the reduction in delay imposed on other motorists. Delay per incident was estimated using a standard queueing model procedure based on the traffic volume, duration of the incident and estimated roadway capacity during the incident. *(1)* The average delay per incident has dropped 66% on Highway 18 and 36% on Interstate 5.

Delay-Causing Phase 1 (pre-IR)	3,572	1,907
Delay-Causing Phase 2 (post-IR)	1,227	1,224
Delay-Causing Incident Delay Reduction	-66%	-36%

Average Cost of Fuel and Person's Time Loss per Incident: When delay is reduced, so are fuel consumption and the value of drivers' time.

Delay-Causing Phase 1 (pre-IR)	$63,800	$34,100
Delay-Causing Phase 2 (post-IR)	$21,900	$21,900
Cost Reduction	-66%	-36%

Total Return on Program Investment: Based on reductions in delay and fuel consumption, the IR program in Region 2 has provided a total return on investment of $885,000 on Highway 18 and $1,010,000 on Interstate 5.

a. Total Program Cost (1995 – 2000)	$240,000	$400,000
b. Total Delay & Fuel Costs (1995 – 2000)	$3,700,000	$9,400,000

c. Total Delay & Fuel Savings (1997-2000)	$1,125,000	$1,410,000
d. Total Return (1995 – 2000) [c-a]	$885,000	$1,010,000

Year 2000 Maintenance Staffing Estimates: A more detailed analysis for the year 2000 was conducted considering the reduction in agency costs. As shown below, non-recoverable crew costs declined while charge against others revenue increased. It was estimated that maintenance staff costs plus overtime resulted in additional labor and equipment savings. Finally, the value of the extra maintenance that was performed while personnel were not diverted to incident response was also included. As shown, without considering delay or fuel, the IR program on Highway 18 is justified based on agency costs alone.

Decline in Non-Recoverable Crew Costs	--	$3,000
CAO Revenue (2000)	$10,000	
Maintenance Staff Costs Saved (2000)	$62,000	$50,000
Value of Extra Maintenance Done (2000)	$19,000	$19,000
Subtotal	**$91,000**	**$72,000**
Cost of IR Program (2000)	($71,000)	($126,000)
Delay and Fuel Savings (2000)	$230,000	$333,090
Annual Return (2000)	**$250,000**	**$279,090**

The majority of the delay causing incidents (approximately 75%) along Highway 18 and (approximately 70%) along I-5 are 1216 – Motor Vehicle Crashes. This suggests that a review of the reported accident (1216) data from the CAD system alone may suffice when considering the potential use of or the expansion of an existing IR program. Since the effectiveness of an IR program is a function of the roadway length, average daily traffic (ADT), and the accident rate, the results of the Highway 18 analysis were used to derive a simple procedure in order to consider the viability of future IR programs. By modeling the roadway length, ADT, and the accident rate, this study attempted to estimate the delay on similar facilities under different scenarios. The results of this will not necessarily provide a definitive answer as to whether an IR program will provide immediate returns, but whether the roadway under consideration should be given additional review when considering future IR programs.

RECOMMENDATIONS

The results of this study indicate ODOT's Region 2 IR program is beneficial and exceptionally cost effective. Recommendations are made not on the general operation of the IR program but on the reporting/record keeping portion. These recommendations are made to facilitate faster, more precise review of this and other IR programs. These recommendations include: 1) additional fields for more incident and roadway

characteristics, 2) using standard terminology when reporting incidents, 3) implementing AVL to measure time on specific routes, and 4) more detailed designations in the HAZARD category, since nearly one third of the incidents were reported as HAZARD.

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