AN EVALUATION OF THE ALABAMA SERVICE AND ASSISTANCE PATROL WITH RESPECT TO MOBILITY-RELATED BENEFITS

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AN EVALUATION OF THE ALABAMA SERVICE AND ASSISTANCE PATROL WITH RESPECT TO MOBILITY-RELATED BENEFITS

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THESIS ABSTRACT

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WITH RESPECT TO MOBILITY-RELATED BENEFITS

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Freeway Service Patrols are one of the more commonly used incident management tools employed to reduce non-recurring congestion through quick response to accidents and other incidents along congested freeway segments. Patrol vehicles are often used to push stalled cars, or accident vehicles not involving injuries onto the shoulder to quickly restore capacity to the roadway. They are also capable of helping stranded motorists with services such as: changing a flat tire, giving a weak battery a jump, adding engine fluids, providing gasoline, and assisting with minor repairs. These actions benefit not only the stranded motorist, but all travelers by reducing their overall travel time as a result of the patrol reducing the duration of the incident. This thesis presents and applies a methodology to examine and evaluate the mobility-related benefits of the Alabama Service and Assistance Patrol (ASAP) against its operating costs in Birmingham, Alabama. This methodology addresses the process of estimating the reduced incident delay due to the ASAP program using the simulation model CORSIM. Sixteen separate simulation models were constructed and simulated to estimate the amount of delay saved due to ASAP for varying locations and types of incidents. The mobility benefit-cost ratio of the ASAP program is estimated to be approximately 23.5:1.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Urban freeway congestion has been an increasing problem in many large cities across the United States. Although urban interstates, freeways and principal arterials only make up 2.1% of the overall roadway network, they handle 37.6% of the nation's total vehicle mileage (Roadway, 2004). Drivers often experience long delays on these roadways due to both recurrent and nonrecurrent congestion. The average delay per peak traveler in the 85 urban areas covered in the Texas Transportation Institute's 2005 Urban Mobility Report is 47 hours per year (Schrank and Lomax, 2005). Congestion in these same areas cost U.S. drivers $63.1 billion dollars based on wasted time and fuel in 2003 (Schrank and Lomax, 2005). Recurrent congestion is due to increased traffic flow at typical peak periods such as morning or evening rush hour. Nonrecurrent congestion is caused by incidents such as vehicle accidents, road construction, special events, and severe weather occurrences. These non-reoccurring incidents increase motorists travel time, waste fuel, increase emissions, and raise the potential for secondary accidents. Incidents of this nature account for roughly 50% of the total congestion on U.S. Highways (FHWA Operations, 2006). To help combat the effects of minor traffic incidents in large urban areas, many states are forming Freeway Service Patrols (FSP). Considering the small cost required for the benefits received, FSPs can be very effective for reducing incident detection time and incident duration. These programs utilize roaming patrol vehicles to patrol high incident and congested locations of an urban freeway. The first known service patrol was Chicago's Emergency Traffic Patrol called Minutemen which started in April 1960 (Morris and Lee, 1994). Service patrols have increased dramatically in number since the early 1990s in an effort to offset rising congestion in the nation's busiest cities. Their primary goals are to quickly detect incidents, minimize incident duration, restore full capacity to the roadway network, and reduce the risk of secondary accidents to motorists. FSPs are usually only capable of reducing incident duration for minor incidents. They are not able to significantly reduce incident duration for major incidents involving tractor trailers, serious injury or death (Hawkins, 1993). During major incidents, the FSP operator helps by assessing the equipment and manpower needed on the scene to clear the incident, coordinating agencies on the scene, directing traffic, and providing a buffer between workers and traffic. For every minute the FSP is able to reduce the clearance time of an incident, a vast savings in the fuel consumption, emissions, and wasted man hours can be achieved. In 2003, 2.3 billion gallons of fuel were wasted due to congestion in the 85 urban areas covered in the Texas Transportation Institute's 2005 Urban Mobility Report (Schrank and Lomax, 2005). That amount of fuel could fill 230,000 gasoline tanker trucks or 46 super tankers (Schrank and Lomax, 2005). In the same study area, congestion resulted in 3.7 billion delay hours for motorists (Schrank and Lomax, 2005). This delay and wasted fuel translates into an average annual cost of $794 for each driver (Schrank and Lomax, 2005). Service patrols can reduce these costs by clearing minor incidents, greatly reducing incident duration and incident induced delay. One example is a service patrol vehicle pushing a stalled vehicle blocking a traveled lane onto the shoulder. This helps the driver of the disabled vehicle by reducing the danger of a rear-end collision as well as reducing delay for drivers upstream of the incident. Service patrols also help motorists with problems on the shoulder such as changing a tire, removing debris from the roadway, and making sure the right emergency personnel are on the scene for large accidents. Freeway service patrols do provide many benefits to motorists, but like everything else these services come at a cost.

The various costs associated with operating a freeway service patrol are fairly easy to quantify. These include annualized initial and capital costs for patrol vehicles with equipment and service buildings, annual costs of operations and maintenance, and annual administrative costs such as salaries, supplies, and equipment. It is much harder to quantify the actual benefits gained from service patrols. The true benefits received are a function of many things that must be assumed such as capacity reduction factors, incident duration without patrols, and the value of cost savings to assisted motorists. Two different companies performing an economic analysis on the same patrol would likely determine different benefit cost ratios simply because of different assumptions. Benefit cost (B/C) ratios are a standard measure of computing the effectiveness of a service patrol, and are computed by simply dividing the total perceived annualized benefit by the total annualized cost. These ratios must not be compared directly because program administrators calculate the overall program costs differently and researchers almost always value time at different rates (Morris and Lee, 1994). Some common benefits that freeway service patrols provide are travel time savings, fuel savings, emissions reductions, secondary crash avoidance, increased security to motorists, as well as the value of the service provided to the disabled motorist (Short, 2004). Since many of these benefits are difficult to quantify and monetize, B/C studies usually only consider one or two types of benefits for analysis (Short, 2004).

1.2 Scope

As previously mentioned, nonrecurrent congestion is caused by incidents such as vehicle accidents, road construction, special events, and severe weather occurrences. This study will focus only on vehicle incidents and how they are a part of nonrecurrent congestion. Freeway service patrols provide numerous benefits to highway users by assisting in the clearing of vehicle incidents. These benefits include but are not limited to customer service, safety, environmental impacts, and mobility. Customer service is the value of services provided directly to the motorist in need of assistance by the freeway service patrol. The safety benefit is the value of the avoided or reduced secondary crashes upstream of the incident. Environmental impacts include the value of reduced emissions and energy consumption. Mobility is the value of reduced travel time delay. Analyzing this last benefit will be the main objective of this study.

1.3 Objectives

The focus of this thesis project will be on documenting the approaches used to evaluate and quantify the cost-effectiveness of freeway service patrols. Specifically, the benefit of mobility or the value of reduced travel time delay for the Alabama Service and Assistance Patrol (ASAP) in Birmingham, Alabama will be modeled.

The ASAP program was started in June of 1997 to help the Birmingham metropolitan area deal with nonrecurrent congestion. The patrol operates from 6 a.m. to 10 p.m.

Monday-Friday and during special events covering approximately 112 miles of interstate. The program was originally funded by the Congestion Mitigation and Air Quality (CMAQ) funding category in the Intermodal Surface Transportation Efficiency Act (ISTEA), but funding through this bill is no longer possible. The outcome of this study is very important because ASAP needs an objective analysis to determine whether the program should continue or be terminated. A thorough economic evaluation has never been performed on the program. This leaves operators little to work with when trying to convey the importance of the program's operation. This study can be very beneficial to program directors by providing them with estimates in dollar amounts of the benefits to motorists the program provides. Hopefully this evaluation will determine whether the nonrecurrent congestion delay savings provided by ASAP outweigh its operational costs.

The value of these savings ($) can be estimated by using advanced computer simulation models and assuming justifiable values for factors such as incident duration and capacity reduction. This study will utilize the computer program CORSIM to estimate the travel time reduction due to the ASAP program. Incidents blocking the shoulder and a single lane will be simulated along high volume areas of the patrol route to estimate this time reduction. Using this program along with other observations, the intended outcomes will be:

- Develop a Benefit Cost ratio for the ASAP Program based on reduced travel time delay
- Compare the effectiveness of the ASAP programs to other patrols
- Provide a "stepping stone" for future ASAP studies involving other benefits

1.4 Outline of this Report

Chapter 2 of this report will consist of a literature review. It will cover some of the assumptions and decisions needed to perform an evaluation for a service patrol program. This will include a look at other service patrol programs and what models were used to evaluate them and the assumptions made to do so, such as incident duration, value of travel time and capacity reduction factors. Chapter 3 will cover the methodology of the evaluation of the ASAP program. This will include a detailed explanation of how the benefits gained from the program were determined. To do this, a model must first be configured in CORSIM to best portray the actual roadway network of the Birmingham metropolitan area. Many variations of this original model will then be developed and calibrated with each separate version representing a different type of incident on a particular road. Each variation of the original model will then be simulated multiple times. Finally, the findings and observations drawn from results achieved with the CORSIM model will be presented and reflected upon in Chapter 4. Chapter 5 will present conclusions, recommendations for the ASAP program, and recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW

The purpose of this chapter is to give the reader a brief overview of the information and assumptions needed to evaluate a Freeway Service Patrol. This will include: the types of services provided, funding sources, evaluation methods, traffic simulation models, and many other assumptions that must be made such as capacity reduction and incident duration. This chapter will list and compare methods and observations from previous studies of other freeway patrol programs. Based on these findings, assumptions will be made in each one of these areas so that the ASAP program can be evaluated.

2.1 Service Patrols

Service patrols are usually deployed for the same purpose, i.e. to alleviate incident induced congestion. However the inner workings of each can vary greatly including: how they are funded, their service hours, coverage area, and the type of services provided.

2.1.1 Service Patrol Funding

FSPs can be funded solely by public or private agencies or by a combination of both. About 74 percent of service patrols surveyed in 1998 are sponsored entirely by public agencies (Fenno and Ogden, 1998). Most often, the public agency sponsors are local and state police, departments of transportation (DOTs), and metropolitan transportation authorities. Around 15 percent of surveyed service patrols were sponsored exclusively by private agencies (Fenno and Ogden, 1998). These patrols are operated by private companies which are funded through commercial corporations, such as pharmacies, banks and radio stations. The remaining 11 percent of surveyed service patrols are funded by a combination of both public and private agencies (Fenno and Ogden, 1998). A majority of the publicly sponsored service patrols receive state funding through fuel taxes, Department of Motor Vehicle (DMV) fees, and a percentage of local or state sales tax (Fenno and Ogden, 1998). Some of these patrols receive federal funding through programs such as congestion mitigation and air quality funds, interstate construction funds, and highway safety funds (Fenno and Ogden, 1998).

2.1.2 Service Hours

Service patrols operate during various hours of operation based on need and available funding. Ideally, service patrols would operate 24 hours a day, 7 days a week. This is simply not feasible nor practical for smaller patrol programs with limited resources. Weekday coverages range from peak period only, the portion of the day that includes a.m. peak period through p.m. peak period, and 24 hours. Some patrols do not operate on weekends, or only operate a few hours a day, while some operate continually throughout the week. Hours of operation are often increased according to need, when construction is underway on the covered route. The hours of operation for the ASAP program are 6 a.m. to 10 p.m. Monday through Friday.

2.1.3 Coverage Area

The time between successive passes of the patrol or the frequency of coverage is an important consideration to take into effect when evaluating service patrols. The desired frequency of coverage ranged from 10 minutes to 1 hour for surveyed service patrols (Fenno and Ogden, 1998). The frequency of coverage a patrol provides is controlled by the maximum time spent assisting disabled vehicles, the length of the route, the number of units operating, and the prevailing traffic conditions. The frequency of coverage area can be increased by only allowing patrol operators to help disabled vehicles for a certain period of time; after this time has passed they must move on. Also, there is a trade off between a patrol with a small coverage area and high frequency of coverage and a patrol with a large coverage area and a lower frequency of coverage. Patrol administrators must choose a frequency of coverage and a coverage area that will result in the most benefits to users.

Freeway service patrol programs use many types of vehicles including pick up trucks, vans, cars, utility vehicles, and tow trucks. California FSP operates by using tow trucks owned by private towing companies working under contract for the organization (Davies et al., 2004). The most common arrangement is when patrols, like the Motorist Assistance Program (MAP) in Houston Texas, choose to purchase and operate vans themselves (Hawkins, 1993). Some vehicles are driven by off-duty officers while others are driven by specially trained civilians. The size of the coverage area and the assistance required will help the program operator choose the most efficient vehicle to use and who and how it should be operated.

2.1.4 Services Provided by Service Patrol

Typical freeway service patrol vehicles can provide a vast array of services to a stranded motorist. Vehicles are typically stocked with the following general equipment: push bumper, cellular phone, radio (DOT & Public Safety Communications), video camera, air tools and hand tools, directional arrow board, halogen area lights, emergency lights, air compressor for tools and tire service, safety cones, gas, oil, transmission fluid and coolant, generator for area lights and external power, and first aid kit. (ALDOT, 2006). Patrol vehicles are often used to push stalled cars, or accident vehicles not involving injuries onto the shoulder to restore capacity to the roadway. They are also capable of helping stranded motorists with services such as: changing a flat tire, giving a weak battery a jump, adding engine fluids, providing gasoline, and assisting with minor repairs. Initial responses towards free patrols from towing companies is often negative because they think they will lose business to the service patrol. When they realize patrols do not compete with them since they only push vehicles out of the traveled way, their attitude changes (Fenno and Ogden, 1998).

Whenever a service patrol vehicle stops to help a disabled motorist or remove debris from the roadway, it is common practice that they record many things about the event. Some service patrols record details about incidents in greater depth than others. In general, this includes the duration and time of the incident, type of incident, method detected, location of the incident, type of service provided, and vehicle make and license plate number (Fenno and Ogden, 1998). This information is very helpful for contacting motorists who have been helped for future surveys, and to run traffic simulation models.

2.2 Traffic Simulation Models

Traffic simulation models are used to help determine the cost worthiness of a service patrol by estimating the value of reduced travel time delay it provides. There are many different types of computer simulation models available such as FREQ10PC, FREWAY3, CORSIM, XXEXQ, and FSPE Version 12.1 to model travel time delays (Hagen et al., 2005). All of these models are designed for the same purpose but may require slightly different inputs and return varying results. None of the models can produce useable data without first calibrating them to suit the traffic and roadway conditions of the study area (Hagen et al., 2005). The Freeway Service Patrol Evaluation (FSPE) Version 12.1 developed by the University of California at Berkeley was used to evaluate the Road Ranger Patrol in Florida. It requires input information such as geometric characteristics, traffic volumes, total number of assists during the evaluation period, type of incident, and mean duration (in minutes) of an incident (Hagen et al., 2005). The FSPE model divided incidents into nine categories depending upon the location of the accident. Three types of incidents were considered: accident, breakdown, and debris (Hagen et al., 2005). Each of these categories has a subcategory for the location of the incident, either right shoulder, left shoulder or blocked lane. Logs maintained by Road Ranger Patrol operators did not have sufficient information about the lateral distribution of incidents, so the percentages of each type were estimated empirically (Hagen et al., 2005).

2.3 Value of Travel Time

The Road Ranger Patrol used a total time travel value of $22.71 in 2004, which is based on $13.45 for each person hour of travel and, $71.05 for each truck hour (Hagen et al., 2005). This value was determined assuming an average vehicle occupancy of 1.5 persons/vehicle and 5% for the number of trucks out of the total traffic (Hagen et al., 2005). The travel time values were determined from the Texas Transportation Institute (TTI) Urban Mobility Report for 2005 (Hagen et al., 2005). This study uses population and traffic data from federal, state, and local agencies to develop estimates of congestion and mobility within 85 urban areas around the U.S. This report is released annually, so the methodology of this study is continually improved yielding a quantitative estimate of urbanized mobility levels, utilizing generally available data, while minimizing the need for extensive data collection (Schrank and Lomax, 2005). TTI primarily uses the Federal Highway Administration's Highway Performance Monitoring System (HPMS) database, along with supporting information from various state and local agencies (Schrank and Lomax, 2005). To account for variations in data collection methods between states, researchers review and adjust the data to make it comparable.

There are many other ways to determine travel time values like the current Consumer Price Index. The Hoosier Helper Program operating in Northwest Indiana used the Consumer Price Index (1995 dollars) to represent the travel time value of vehicles: $8.03 per hour for automobiles, $27.26 per hour for single unit trucks and $30.38 per hour for combination trucks (Latoski et al.,1999). Based on the traffic distribution, a total 1996 unit travel time was found to be $15.02 per hour for weekdays and $12.14 per hour for weekends (Latoski et al., 1999). Whatever method a FSP chooses to determine the value of time will have a direct impact on the benefit cost ratio. This can cause B/C ratios to vary between programs simply because studies assume different real values for the same measures of effectiveness (Short, 2004).

2.4 Capacity Reduction

When an incident occurs, a drop in capacity occurs with varying degrees of intensity based on the location and how many traveled lanes it is impeding. It has been found that the actual reduction in capacity is much more than simply the proportion of original capacity that is physically blocked. Even a problem on the shoulder causes a reduction in capacity due to driver distraction and a reduction in speeds. A study performed by the Motorist Assistance Program (MAP) in Houston found that a closure of one-lane of a three lane highway can cause more than 52% reduction in capacity instead of 33% (Hawkins, 1993). A 29% reduction in capacity due to a stalled vehicle located on the shoulder was observed on the same three-lane segment and a 77% reduction was seen when two lanes were blocked (Hawkins, 1993). When analyzing a four-lane segment, experimenters saw a capacity reduction of 43% when one lane was blocked and an 82% reduction in capacity was observed when three lanes were blocked (Hawkins, 1993). Certain assumptions must be made about roadway capacity reduction for the evaluation of service patrols. The Road Ranger patrol adopted factors for percent capacity remaining due to an incident listed in the Highway Capacity Manual (HCM). The HCM gives different values of capacity reduction for various types of incidents based on their lateral location.

2.5 Incident Duration

The average incident response time without a service patrol is another pivotal factor that must be assumed when evaluating a patrol. The overall impact of incident duration has been found to be a function of regional incident management practices (Short, 2004). With all other variables constant, FSPs will probably have a lesser impact on incident durations in areas that already have a traffic operations center, a rotational tow truck program, quick-clearance legislation, accident investigation sites and other factors such as a toll-free number to report incidents (Short, 2004). Regions with relatively few or underdeveloped incident management procedures will probably benefit more from a freeway patrol then regions that already have these policies in place (Short, 2004). In either circumstance, the assumption used for incident duration will play a key role in determining the overall benefit cost ratio of an evaluation.

Overall, there is little uniformity when comparing the values used for incident durations between studies. Some assume a single value that covers all incidents, others use different values for each type of incident, while others choose values based on the number of lanes the incident blocks. A study of the Houston Motorist Assistance Program (MAP), conducted by Texas Transportation Institute (TTI), assumed an increase in incident durations without MAP from 5 to 20 minutes in 5 minute increments (Siegfried and McCasland, 1991). This provided a range of benefit-cost ratios from 7 to 36 depending upon the assumption used to estimate the impact of the MAP on incident durations (Siegfried and McCasland, 1991). An evaluation of the Massachusetts Motorist Assistance Program assumed 15 minutes of extra response and detection time without the service patrol for all types of incidents (Stamatiadis, et. al., 1998). They then used separate assumptions for the increase in clearance time for each incident without the service patrol. The response and detection assumption was then added to the clearance assumption to get the overall increase in incident duration. The evaluation assumed the average incident duration increase without service patrol for minor incident, vehicle disablement, accident on lane moved to shoulder, roadway debris, and accident on lane to be 15, 25, 25, 30, and 20 minutes, respectively (Stamatiadis, et. al., 1998). These numbers were determined by analyzing the length of the state police patrol route, average travel speed through the congestion area and actual incident reports (Stamatiadis, et. al., 1998). A study of the Hoosier Helper Freeway Service Patrol assumed only two different values to cover all reductions in incident durations due to freeway service patrols. They assumed 10 minutes for crashes and in-lane assists and 15 minutes for all other assists (Latoski and Sinha, 1999).

A case study of Virginia's Safety Service Patrol Programs, performed by the Virginia Transportation Research Council, used a two step process to estimate before and after incident durations (Dougald and Demetsky, 2006). They first performed an analysis of the Safety Service Patrol's database to determine the average clearance times for each distribution of incident types. They chose to divide the incidents into accidents, breakdowns, and debris and then distribute them into lateral locations of left shoulder, in-lane, and right shoulder (Dougald and Demetsky, 2006). The second step involved using the Virginia State Police's CAD Database to analyze the same incidents covered in the first step. Each accident was analyzed and a determination was made as to the type of responder as either VSP only or VSP and SSP jointly. The mean clearance times were then determined for each location according to responder type. The difference in clearance times without SSP support (VSP only) was then applied as a percentage to each accident distribution to determine the average clearance time without SSP (Dougald and Demetsky, 2006). The incidents where both VSP and SSP were joint responders were used to determine the average clearance time with SSP support (Dougald and Demetsky, 2006). This process, although fairly accurate since it was based on actual data, was very time consuming and labor intensive. A sample size of 504 incidents was analyzed with 398 being responded to only by the VSP and the remaining 106 were responded to by both the VSP and SSP. Researchers found an average accident clearance reduction of 11.25 minutes for shoulder incidents and an average reduction of 9.51 minutes for in-lane incidents (Dougald and Demetsky, 2006). They assumed a blanket 5 minute clearance time for all debris incidents without a service patrol to account for additional removal time had SSPs not been present for this service (Dougald and Demetsky, 2006). They also added 30 minutes of additional clearance time for all incidents where SSP either pushed or repaired vehicles that would have been towed by a wrecker, since they assumed an average wrecker response time of 30 minutes (Dougald and Demetsky, 2006). In total the evaluation found the average percent reduction in clearance times with SSP support for debris, shoulder breakdowns, in-lane breakdowns, shoulder incidents, and in-lane accidents to be 25.0, 15.0, 33.3, 20.3, and 12.9 percent, respectively (Dougald and Demetsky, 2006). If all incidents are combined, the average clearance time reduction with the SSP is 17.3 percent (Dougald and Demetsky, 2006). Evaluators in this study concluded that the assumption for tow-truck arrival time has the biggest potential to cause variations in clearance time reductions. To address this issue, a sensitivity analysis was performed with times ranging from 10 to 50 minutes in 10 minute increments to see how tow-truck arrival time would affect the percent reduction in clearance time (Dougald and Demetsky, 2006). They found a linear relationship between tow-truck arrival times and percent reduction in clearance time with SSP. An arrival time of 10 minutes had the effect of reducing the clearance time by 9.9 percent while an arrival time of 50 minutes provided a reduction of 23.6 percent (Dougald and Demetsky, 2006).

In a study of the Los Angeles Freeway service patrol, the Institute of Transportation Studies found a 16.5 minute reduction in duration between assisted breakdowns and non-assisted breakdowns (Petty et al., 1997). This number was determined by comparing records of incidents without a FSP and incidents where a FSP was present and finding the difference between the incident durations. Many studies take this reduction and use it in a queuing model to calculate delay savings which can lead to inaccurate results (Petty et al., 1997). This method can lead to conservative time savings because it assumes that the FSP trucks only helped the breakdowns that actually needed help. In reality patrol drivers often stopped to help motorists that otherwise wouldn't have needed help. This included things like stopping to read a map, changing drivers, or to change their own tire. These short breakdowns, included in the FSP records, would not have normally been assisted, and therefore pull down the average duration of the assists with service patrol (Petty et al., 1997). These events can be seen as an oversampling of the short duration breakdowns by the FSP trucks. Researchers then separated the reduction in assisted breakdowns into two parts: the reduction due to the FSP trucks arriving at the scene earlier and the reduction due to oversampling of short duration breakdowns (Petty et al., 1997). This study found that the reduction due to oversampling short duration breakdowns to be 9.8 minutes and 6.7 minutes can be attributed to reduction due to quick FSP truck response (Petty et al., 1997). Based on this study and others performed by the Institute of Transportation Studies at the University of California, Berkeley, researchers recommend a value of 30 minutes mean response time for conditions without a freeway service patrol. This is also the default value in its simulation model FSPE Version 12.1 (Davies et al., 2004). Researchers for the Los Angeles Freeway study also noted that assuming this single value for incident duration should represent the upper bound of values that can be assumed for incident duration. It may be realistic to assume durations can be increased by 15 minutes for the longer duration incidents, but not probable that all of the short duration incidents were increased by that amount (Petty et al., 1997). They also recommended that beat characteristics, patrol vehicle speeds, and time of day (peak, off-peak and mid-day) be taken into consideration when calculating response time (Hagen et al., 2005).

With results in mind, evaluators would like to assume a duration as large as they can possibly justify for incidents unaided by a service patrol. The difference in durations has a major impact on the overall results of a study. Keeping all other variable constant while using a larger duration will increase the Benefit-Cost ratio many times over when comparing the same study with a shorter duration. Careful engineering judgment should be used to pick a range of values for incident duration to produce a range of benefit cost ratios. Performing a sensitivity analysis instead of picking a single value provides a broader range a feedback allowing the operators to make more informed decisions. A summary of the varying incident durations assumed by service patrols and their basis can be seen in Table 2-1.

Table 2-1 Summary Incident Assumptions by Service Patrol

Service Patrol	Assumed Increase in Incident Duration	Assumptions based on:
Houston Motorist Assistance Program (MAP)	5 to 20 min in 5 min increments for all incidents	MAP Quarterly Reports
Massachusetts Motorist Assistance Program	15 min extra response and detection time for all incidents Assumed incident durations of 15,20,25,30 based on incident type	Actual data from incident reports and state police log
Hoosier Helper Freeway Service	10 min for crashes and in-lane assists 15 min for all other assists	Borrowed from another study
Virginia's Safety Service Patrol (SSP)	11.25 min clearance for shoulder incidents 9.51 min clearance for in-lane incidents 5 min clearance for all debris without SSP 10 to 50 min tow truck arrival time	SSP and Virginia State Police (VSP) databases
Los Angeles Freeway Service Patrol	16.5 min for all durations (actual) 9.8 attributed to oversampling of short duration incidents 6.7 min attributed to quick FSP truck response Recommended 30 min mean response for conditions without patrol (upper limit)	Incident records with and without service patrol

2.6 Type of Incidents

The number of incidents, location and the type of each is another important determination that must be made before simulation can begin. Very few studies if any publish how they determined the number of incidents to simulate and where they placed them in the coverage area. The most common method is to place incidents in areas with the highest vehicle miles traveled or sites where incidents are known to frequently occur. The number of incidents that are simulated must be a compromise between providing a sample size large enough to have statistical significance and a number low enough that the evaluators do not spend an exorbitant amount of time running simulations. The breakdown of incidents by lateral location can be determined by screening patrol operator logs or state patrol crash records. If these sources are not available, the Highway Capacity Manual can be used to estimate the percentage of incidents that occur by lateral location. When evaluating the Road Ranger Patrol in Florida, researchers looked at operator logs and determined that 81 percent of all incidents are break down type incidents (Hagen et al., 2005). Flat tires accounted for 23 percent of all breakdown incidents while accidents and debris only accounted for a very small portion of the total incidents (Hagen et al., 2005). The patrol log included 59,622 incidents in 2004, but only 53,623 were used for analysis in estimating the benefit since all the stops that did not provide any assistance were excluded (Hagen et al., 2005). It has been determined empirically in the Highway Capacity Manual that about 35 percent of accidents occur in one lane, 90 percent of breakdowns occur on the right shoulder, and 82% of debris is in one lane (Hagen et al., 2005). An evaluation of the Massachusetts Motorist Assistance Program's logs revealed that 42.5 percent of incidents could be labeled as minor incidents and 43 percent as vehicle disablements on shoulder (Stamatiadis et. al., 1998). The "minor incident" category included vehicles that are pulled over on the side of the road because they are using a cellular phone, lost, checking a map, sleeping, or any other reason for which no patrol service was required (Stamatiadis et. al., 1998). The remaining percentage of incidents, accident on lane then moved to shoulder, roadway debris, and accident on lane are 2.5, 9.5 and 2.5 percent respectively (Stamatiadis et. al., 1998).

CHAPTER THREE

METHODOLOGY

Evaluating a freeway service patrol can be very beneficial to both patrol administrators and to the motorists that travel through the coverage area. These evaluations can be very useful by allowing program directors to assess the benefits gained from money spent on the program to identify the particular areas that need improvement, and to apply the results to support future funding of the program. These evaluations benefit motorists by providing them with a service patrol that is hopefully better equipped to serve their needs. In the past, there have been many studies on the evaluation of freeway service patrols around the country. Methodologies of these studies are usually focused on how to estimate the benefits of delay and fuel savings that can be attributed to a freeway service patrol. One such study, the Road Ranger program in Florida, was evaluated using the Freeway Service Patrol Evaluation (FSPE) model and was found to have a benefit-cost ratio in excess of 25:1 (Hagen et al., 2005). Many other patrols have been evaluated and have received similar benefit-cost ratios such as Virginia's Safety Service Patrol, Indiana's Hoosier Helper Freeway Service Patrol, and Minnesota's Freeway Incident Response Team (FIRST).

The main focus of this chapter will be to present a procedure by which the evaluation of the ASAP program will be accomplished. This will include the traffic simulation which involves designing the network, calibrating the network using traffic data from

ALDOT, determining where and which incidents to model, and observing and quantifying the outputs. The main output will include the average change in incident duration between response scenarios with and without ASAP. Next, an economic evaluation will be executed to list the costs and mobility related benefits that can be attributed to the patrol. The costs will include labor for personnel and capital expenses including trucks, equipment, maintenance, and all other infrastructure needed to run the program. These figures will be determined through analyzing the records in ASAP's assist log. Costs that are not provided will be estimated using engineering judgment and data from other recent patrol evaluations. The benefit that will be quantified in this study is the value of reduced travel time delay. A benefit cost ratio will then be computed and compared with similar freeway patrols so that the overall program effectiveness can be estimated. It should be noted that this benefit-cost ratio may underestimate the total benefit provided by the program since it does not include benefits related to customer service, safety, fuel savings, and emission reductions.

3.1 Traffic Simulation

For the evaluation of the ASAP program in Birmingham, Alabama, a computer program called CORSIM will be used to simulate traffic incidents and the amount of delay that can be attributed to them with and without the services provided by ASAP. The Federal Highway Administration (FHWA) has supported a series of projects to design and develop the software for CORSIM since the mid-1970's (Traffic, 2003). CORSIM represents traffic and traffic control systems using widely accepted vehicle and driver behavior models. It has been applied by many researchers and practitioners worldwide over the past 30 years and incorporates a wealth of experience and maturity. CORSIM, which is short for Corridor Simulation, consists of an integrated set of two microscopic simulation models (NETSIM and FRESIM) that represent the entire traffic environment as a function of time (Traffic, 2003). NETSIM represents traffic on urban streets and FRESIM represents traffic on freeways. The model in this study will only deal with FRESIM, since ASAP's patrol routes consist of freeway segments.

CORSIM applies time step simulation to describe traffic operations, with each time step lasting one second. Each vehicle is a distinct object that is moved every second. All other variables and events are also updated every second. CORSIM is a stochastic model, which means that random numbers are assigned to each driver and vehicle characteristic and to decision making processes (Traffic, 2003). The results or Measures of Effectiveness (MOEs) for the model are obtained from a simulation using a specific set of random number seeds. To get an accurate representation of data for network performance, the network should be simulated many times using different sets of random number seeds. Before simulation and collection of MOEs can begin, a model must be built and calibrated to resemble the patrol coverage area.

3.1.1 Traffic Network

An existing CORSIM network model of the Birmingham metropolitan area was provided from another study performed by the University of Alabama at Birmingham. This model included major urban streets such as U.S. Hwy 280, U.S. Hwy 11 and U.S. Hwy 31 as well as Interstates 20, 59, 65, and 459. None of the interstates were extended beyond the loop formed by I-459 and I-59. To make the model suitable for the ASAP evaluation, all of the urban streets were removed from the model since these areas were not part of the ASAP coverage area. The model was then modified to emulate the existing ASAP coverage area. To do this, Interstate 65 had to be extended in both the north and south directions to meet the boundaries of the patrolled routes. Also Interstates 59 and 20 had to be extended east to the end of the coverage area. See Table 3-1 and Figure 3-1 below for an explanation of the ASAP coverage area.

Table 3-1 ASAP Coverage Boundaries

Interstate	Begin Coverage	End Coverage
I-20	1st Avenue So. (Exit 130)	US 411 Leeds/Moody (Exit 144)
I-59	Rock Mountain Lakes Road (Exit 104)	Deerfoot Pkwy. (Exit 143)
I-65	US 31 in Alabaster (Exit 238)	US 31 in Morris (Exit 275)
I-459	SR 150 (Exit 10)	US 11 in Trussville (Exit 32)

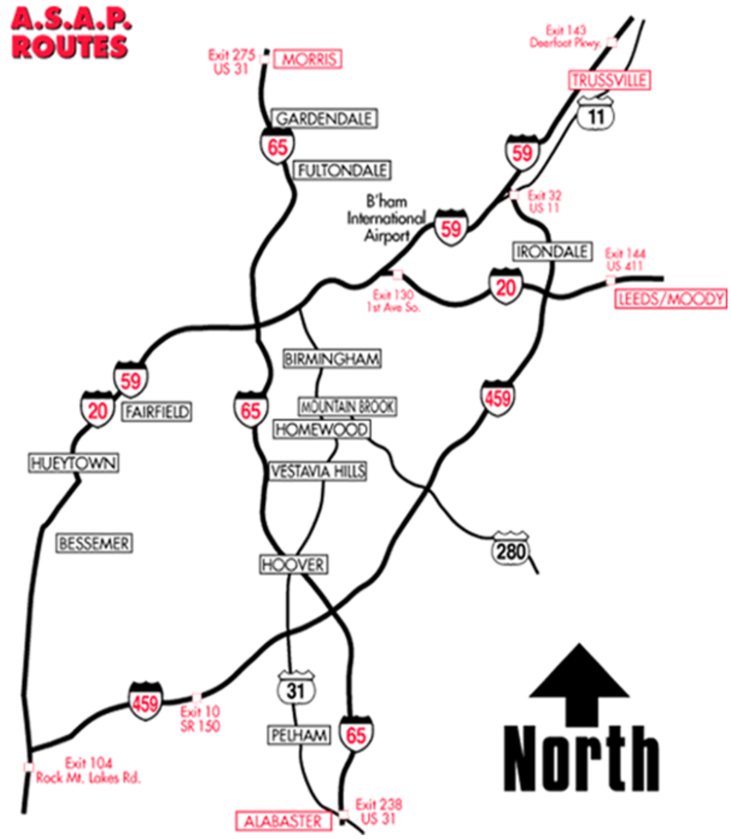

Figure 3-1 Map of ASAP Coverage Area (ALDOT, 2006)

The extensions were added by tracing over the roadway on an aerial photograph provided as the background to the model. Aerial photographs of each portion of the roadway that needed to be lengthened were obtained from the program Google Earth Pro (Google, 2006). This method was used for several reasons: ease of use, no extra cost, and it supplied files in a size CORSIM would accept. Since CORSIM is a very basic and simple program, it is only able to accept windows bitmap files to be supplied as background images to its models. The images used provided enough detail to allow for a fuzzy outline of the road to be viewable for tracing purposes. To allow for tracing, a scaling factor was determined and then the image was aligned with the existing network by trial and error. Next the geometric characteristics of the roadway were configured.

Google Earth was used to view approximately 500 foot sections of the roadway at a time. Zooming in to an area this size provided enough detail so that the number of lanes, length of ramps, and lane drops/additions could easily be seen and measured.

3.1.2 Traffic Data Collection and Management

The model was loaded with traffic data after it was configured to match the existing geometric layout of the ASAP coverage area. Cars can only enter the CORSIM network through on-ramps or at the beginning of the network. Traffic leaves the network by either exit ramp or exiting where the model terminates. The model begins and discontinues at the ASAP coverage boundary. ALDOT provided hourly traffic counts for approximately 75% of the segments between interchanges in the coverage area. These data consisted of 24 one-hour counts for one week at stations along the roadway located by milepost. A brief inspection was performed on the data for Tuesday, Wednesday, and Thursday to determine the day with the highest AM and PM peak hour. After looking at the data, it was determined that Thursday most often had the highest counts with a morning peak from 7:00-8:00 am and an evening peak from 5:00-6:00 pm. A majority of the data were collected in 2005, but some were collected from 2002-2004. Data from the earlier years were converted to 2005 values using linear growth factors determined from the Annual Average Daily Traffic (AADT) at that particular location. AADT data for the last 10 years was available for almost all of the segments in the coverage area on ALDOT's website (Alabama, 2006).

Two different methods were used to estimate the approximate 25% missing hourly counts. The hourly counts that were provided were recorded from upstream and downstream of the location in question. The difference between AADT from the upstream station, station in question, and the downstream station were then computed, along with the difference between the known counts. A ratio of the difference between inner stations and the beginning and ending station was then multiplied by the difference in traffic counts and either added or subtracted from the beginning traffic count. See Table 3-2 below for an example of this calculation.

Table 3-2 Method 1 Missing Data Estimation Example

A	B	C	D	E	F
I-65 (NB) Milepost Location	2005 AADT	Given Hourly Data (veh/hr) (missing value*)	Difference in AADT between Stations	Proportion of the Difference in AADT Stations	Hourly Data used for analysis (Interpolated Value*)
272.8	55300	1988	3010		1988
271.3	58310	-*	4900	0.38053	**2902***
268.9	63210	4391		0.61947	4391
		Difference=2403	7910		

Columns A, B, and C represent given data, while column D shows the difference in AADT between individual stations and the beginning and ending station. Column E displays the ratio of the individual AADT difference to the beginning and ending station difference in column D. Column F shows the values used for analysis including the given and interpolated values. The interpolated value is determined using Equation 3-1.

$$IV = [GV + (R)(GHD)] \quad \textbf{(3-1)}$$

Where,

IV= Interpolated Value

GV= Given Start Value

R= Ratio of Difference in AADT

GHD= Given Hourly Difference

$$IV = \left[1988 + \left(\frac{58310 - 55300}{63210 - 55300}\right)(4391 - 1988)\right] = 2902$$

If counts were only available for one station, ratios of the change in AADT between stations were computed. This ratio was then multiplied by the hourly count at the nearest segment. In this second method, the hourly counts increase or decrease in proportion to the AADT along the segment. See Table 3-3 for an example of this calculation.

Table 3-3 Method 2 Missing Data Estimation Example

A	B	C	D
I-59 (NB) Mile-Post Location	AADT	Ratio of change in AADT	Hourly Data used for analysis (Interpolated Value*)
130.8	80750		1453
131.8	73350	0.9084	1390
132.7	66240	0.9031	1255*
133.5	56730	0.8564	1075*
135.4	41080	0.7241	778*

Columns A and B represent given data, while column C displays the ratio between individual stations. Column D shows the values used for analysis including the given and interpolated values. The interpolated values are determined using the Equation 3-2.

$$IV = (GV)(R) \tag{3-2}$$

Where,

IV= Interpolated Value

GV= Given Start Value

R= Ratio of Difference in AADT

$$IV = (1390)\left(\frac{66240}{73350}\right) = 1255$$

After using one of the two methods above, engineering judgment was used to check for outliers. In this case, outliers are volumes that are not physically attainable nor probable with the geometric configuration of the road. One example is 1800 vehicles per hour traveling down a one lane entry ramp. This was roughly the required number of cars for an entry ramp on I-20 eastbound near Exit 132 because of a huge increase in one counting station. When this situation was observed, the count was removed and interpolation from the two bordering stations was used to provide more realistic values at this location. Another condition that was observed was an almost 3:1 directional split during the peak hour on sections of I-59 north of the I-20 junction. The data were checked and it was found that directional split remained fairly constant and reversed during the evening peak hour, so no action was taken. A third situation that was encountered was interpolated values that seemed to be too low. Data were not provided for I-59 from Exit 132 to Exit 143, which is also the northern boundary of the ASAP coverage area. The second method of interpolation was used to determine values for these exits. However they did not match up well with the data from the I-459 junction. To rectify this problem, data from the I-459 station nearest to the junction of I-459 and I-59 was used to interpolate the counts on I-59 on either side of the junction. This was done since there was higher confidence in the provided counts for I-459 than the first interpolated counts on I-59. The new counts were then used to interpolate the remaining stations on I-59.

Once all of the segment volumes were determined, the model was loaded by specifying the number of vehicles that enter the network on each entry ramp. This was done by first subtracting the number of vehicles that exit the network on the adjacent exit ramp so that the difference between the two segments joining the interchange can be found. For each exit ramp in CORSIM, the user must specify the amount of exiting traffic and through traffic. An assumption was made that 90% of the vehicles would be traveling in the through movement and 10% would be exiting. This assumption was used unless there was more than a 10% drop in traffic between segments joining an interchange. In this case, a larger exiting percentage was used so that enough of the upstream traffic could exit at the interchange allowing for a correct volume of vehicles downstream of the interchange. These percentages will also be different for the morning and evening peak since the predominant flow of traffic reverses. It was fairly simple to determine the number of vehicles entering at a particular interchange, but it was much harder to assign vehicles at junctions where the Interstates meet. To do this, the counts nearest to the junction from all directions were recorded, then the exiting percentages were manipulated until the entering volumes in each direction were as close as possible to the actual volumes observed in the field.

After the model was loaded with traffic volumes it was simulated without incidents to determine how well the model was calibrated to actual conditions. The model was scrutinized one section at a time to observe for any irregularities such as improper weaving, incorrect traffic volumes (either too high or low for the section observed), and any other abnormalities. It was determined that the model was calibrated to the field conditions to a reasonable or visually acceptable level, so no major changes were made to the model.

3.1.3 Model Assumptions

Once the network was loaded with traffic volumes and calibrated, many assumptions such as incident duration and location had to be made before the simulation process could begin. Many of the assumptions were based on assist data recorded by ASAP while on patrol. Each ASAP operator is required to keep a detailed record of the incidents they assist. These records include items such as: dispatch, arrival and departure time, incident location, type of incident, tag of vehicle, lanes available, lanes blocked, and service provided. Records from each of the drivers are then complied to create a database. The most recent database available for analysis contained records of 21,115 incidents from July 1. 2004 through July 1, 2005. The database was sorted by Interstate and service provided so that outliers could be removed. Obvious erroneous entries included entries like a mile marker that is far from the coverage area, incorrect direction or route number and negative clearance times. Assists where no assistance was provided, which accounted for 4065 stops or 19.3% of the total assists, were also removed. If these assists are recorded as incidents, they would have a tendency to reduce the average duration of ASAP assisted incidents. Once the outliers and "no assistance" assists were removed from the data set, 16,890 remained for analysis. The data was then sorted to determine the percent distribution of incidents on each interstate and the percentages of shoulder and one lane blocking incidents. See Table 3-4 for these values below.

Table 3-4 Distribution of ASAP Assists by Route

Interstate	Distribution of Incidents
I-20	3.63 %
I-59	43.20 %
I-65	38.92 %
I-459	14.25 %

It is often difficult to compare freeway patrol assumptions from different studies because evaluators use the same name to describe different variables with one example being incident duration. In this study, the total incident duration will include the clearance time and response time. The clearance time is the difference between the ASAP truck arrival time and departure time. The response time is the difference between truck arrival time and the time when the truck was dispatched to the scene. With the proliferation of cell phone usage today, the assumption was made that the difference between when an incident occurred and when it was reported (detection time) was negligible. See Figure 3-1 below for an explanation of these variables.

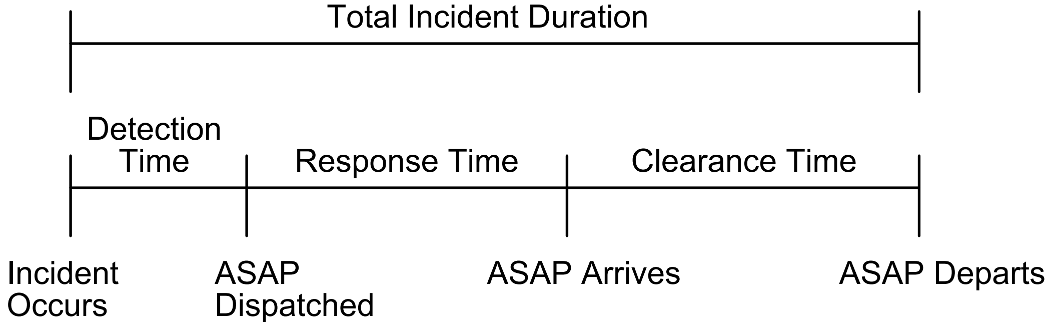

Figure 3-2 Incident Duration Breakdown

Out of the 16,890 incidents, only 909 contained ASAP dispatched times. This sample was used to find the average incident duration. The lateral distribution of incidents was determined using all 16,890 incidents. The values for incident duration with and without a service patrol can be seen in Table 3-5. The average increase in incident duration without service patrol was assumed to be 25 minutes with 15 minutes attributed to response and 10 minutes to clearance.

Table 3-5 Incident Duration Assumptions for Simulation

Incident Type	W ASAP (min)	W/O ASAP (min)
Shoulder	28	53
1 lane blocked	34	59

In this study, incidents blocking more than one lane were not considered for simulation because they are fairly rare and likely represent extreme cases of duration. It is difficult to link any significant reduction in incident duration to the service patrol for incidents of this magnitude because of all the other agencies usually involved. The decisions of these agencies also override the authority of the patrol. One example is the fire department blocking off as many lanes as they see necessary for their crew to safely extinguish a fire. The freeway patrol has little control of when or how many lanes are re-opened and therefore has little or no impact on the overall incident duration. Additionally, the sample size of incidents blocking more than one lane was also not large enough to make statistically sound choices, so these incidents were not analyzed for this study. The distribution of all incidents, incidents including ASAP dispatch times and sample size by incident type can be seen in Table 3-6 below.

Table 3-6 Incident Distribution and Sample Size

Incident Type	Distribution (%)	All incidents (with outliers and no assists removed)	Incidents with Dispatch Times
Shoulder	87.92	14850	805
1 lane blocked	8.02	1355	67
2 lanes blocked	2.80	472	29
≥ 3 lanes blocked	1.26	213	8

For this study, only a limited number of incidents were simulated to keep the scope manageable for the researcher performing the analysis. A shoulder incident and a one-lane blocking incident were placed at the locations with the most frequent ASAP assists on each interstate. The incidents were placed as far away as possible from interchanges to avoid potential conflicts. The shoulder incident consisted of a 500-foot segment with a capacity reduction percentage applied to all lanes that was determined from Exhibit 22-6 of the Highway Capacity Manual. This chart can be seen in Table 3-7.

Table 3-7 Proportion of Freeway Segment Capacity Available Under Incident Conditions (HCM Exhibit 22-6)

Number of Freeway Lanes by Direction	Shoulder Disablement	Shoulder Accident	One Lane Blocked	Two Lanes Blocked	Three Lanes Blocked
2	0.95	0.81	0.35	0.00	N/A
3	0.99	0.83	0.49	0.17	0.00
4	0.99	0.85	0.58	0.25	0.13
5	0.99	0.87	0.65	0.40	0.20
6	0.99	0.89	0.71	0.50	0.26
7	0.99	0.91	0.75	0.57	0.36
8	0.99	0.93	0.78	0.63	0.41

The one lane incident consisted of a 500-foot rubbernecking section, a 300-foot section with one lane blocked and a rubbernecking factor applied to the remaining lanes, and finally a 200-foot section with a rubbernecking factor applied to all lanes. The shoulder and one-lane models had total durations of 5000 and 6200 seconds, respectively. The incidents did not begin until 15 minutes into the simulation period to allow the network to reach a steady state. The simulation was then run at least 30 minutes after the end of the incident to allow traffic to return to pre-incident congestion levels. To avoid concerns about two incidents conflicting with one another, only one incident was simulated in the network per simulation run. To allow for this, four separate models of the network were created for each interstate. The sixteen total models were then simulated ten times each to obtain average statistics for each model. See Table 3-8 for a detailed explanation of the models.

Table 3-8 Sixteen Models Used for Analysis

Model Number	Route	ASAP on Site?	Incident Type	Total Duration (Seconds)	# of Runs
1	459	Yes	1 lane block	6200	10
2	459	No	1 lane block	6200	10
3	459	Yes	Shoulder	5000	10
4	459	No	Shoulder	5000	10
5	59	Yes	1 lane block	6200	10
6	59	No	1 lane block	6200	10
7	59	Yes	Shoulder	5000	10
8	59	No	Shoulder	5000	10
9	65	Yes	1 lane block	6200	10
10	65	No	1 lane block	6200	10
11	65	Yes	Shoulder	5000	10
12	65	No	Shoulder	5000	10
13	20	Yes	1 lane block	6200	10
14	20	No	1 lane block	6200	10
15	20	Yes	Shoulder	5000	10
16	20	No	Shoulder	5000	10
				Total Simulations:	160

Ten simulations were concluded to be of sufficient statistical size after a few models were randomly selected and simulated fifty times each. The changes observed when comparing the averages from ten and fifty simulation runs were minimal. For example, when analyzing the Interstate 65 one-lane with ASAP model, the average total vehicle time changed from 21,020.30 vehicle hours to 21,094.38 vehicle hours for 10 and 50 runs, respectively.

CORSIM provides output for both the local level (link where the incident occurred) and global or regional level. Since the overall regional benefit of ASAP is being considered, only the global output data was collected. The delay savings due to ASAP was determined by collecting the total travel time in vehicle hours from each simulation and finding the difference between the averages of the ten runs with ASAP assistance and those without. This operation produced delay factors in vehicle hours that could be used in computation of benefits.

3.2 Economic Evaluation

The economic evaluation will first involve determining the mobility related benefits provided by ASAP, and then computing an annualized cost for the program. The benefit and cost information will then be used to calculate a benefit-cost ratio.

3.2.1 Benefit Estimation

After the data was collected from the simulation runs, it was used to determine the benefits of the ASAP patrol. To do this, a spreadsheet was created based mostly on data from ASAP's operator log from July 1, 2004 to July 1, 2005. The log was used to determine the distribution of incidents by lane and by interstate. The total number of assists, not including the stops where no assistance was received, was then multiplied by distribution factors to estimate the type and number of incidents on each interstate. This operation can be seen in Equation 3-3 and a summary of projected incidents based on ASAP's 2004-2005 log can be seen in Table 3-9.

$$ITI = TI \times DF_1 \times DF_2 \qquad \textbf{(3-3)}$$

Where,

ITI= Incident Type by Interstate

TI= Total Incidents

DF_1= Interstate Distribution Factor, decimal (refer to **Table 3-4**)

DF_2= Lane Distribution Factor, decimal (refer to **Table 3-6**)

I-20 Shoulder Example: $ITI = 17090 \times 3.63\% \times 87.98\% = 546$

Table 3-9 Projected Incidents based on 2004-2005 ASAP Log

Interstate	Total Per Interstate	Shoulder	1 Lane
I-20	620	546	50
I-59	7383	6496	593
I-65	6652	5852	534
I-459	2435	2143	196

These values were then multiplied by delay time factors determined from the CORSIM simulations to compute the total hours saved for each interstate. The total number of hours from all interstates was then multiplied by the Travel Time Value to get the total estimated benefit of the program from July 1, 2004 to July 1, 2005. The Travel Time Value was determined from Equation 3-4.

$$TTV = [(X * O * (1 - T)) + (Y * T)] \quad \textbf{(3-4)}$$

Where,

TTV= Travel Time Value

X= travel time value for each person hour of travel

Y= travel time value for each truck hour of travel

O= average vehicle occupancy

T=proportion of trucks in total traffic

$$\$24.25 = [(\$13.45 * 1.5 * (1 - .08)) + (\$71.05 * .08)]$$

Please refer to Chapter 2 section **2.3 Value of Travel Time**, for more information on travel time values.

3.2.2 Annual Costs

Operational costs from the ASAP program for the year 1997 were used for this study because it was the most recent data available. An unpublished study was performed at Auburn University with this data set to project the annual costs of the ASAP program for the twenty years following 1997. This data included values for ASAP trucks, supplies, salary and benefits for five operators and one supervisor, fuel, and initial office and communication equipment. A four percent interest rate was used to annualize the initial office, communication equipment, supplies, and truck costs. The office was assumed to last the duration of the 20 year period, the trucks were replaced after 10 years, and the salaries were adjusted by a 3 percent increase for cost of living each year. Based on the findings of the unpublished study, the ASAP's total projected operating costs for

2004-2005 year were **$380,377.62**. This value severely underestimates the total program cost because the unpublished study estimated costs based on 5 patrol trucks and 5 operators. The program currently employs 18 operators using 10 patrol vehicles, so the actual costs for 2004-2005 year will be much higher. When this cost data becomes available the benefit-cost ratio should be recomputed.

3.2.3 Benefit Cost Ratio

The benefit-cost ratio provides a snapshot view of the effectiveness of a program that can easily be understood by most individuals regardless of their technical background. This ratio is computed by simply dividing the total perceived annualized benefit by the total annualized cost.

CHAPTER FOUR

RESULTS

In order to quantify the mobility related benefits reaped from a freeway service patrol, dollar values for the value of reduced travel time delay it provides must be estimated. The main focus of this chapter will be to thoroughly explain the mobility benefit provided by ASAP and how it was determined. This will include reporting the outputs from CORSIM, computing the actual dollar value for the benefits provided based on ASAP's patrol log and travel time values as documented in the literature review, describing the available cost data, and delivering a benefit-cost ratio. This ratio will reflect only the mobility related benefits provided by the program. It does not include customer service, safety, and environmental related benefits.

4.1 Traffic Simulation Outputs

When a CORSIM model is simulated, the program creates both global and localized or link specific output files. Link output files reveal only the events that happened on that certain link and nowhere else in the network. Global output files provide network wide average statistics for variables such as total vehicle miles traveled, average speed, vehicle move time, delay time, and total time.

In this study, to determine the mobility benefit provided by ASAP the average difference in global total time was analyzed for the models. The average total time for the ten simulation runs for each of the sixteen models can be seen in Table 4-1.

Table 4-1 Average Total Time by Model (Vehicle-Hours)

Route	Shoulder		1 Lane	
	W ASAP	W/O ASAP	W ASAP	W/O ASAP
I-20	16231.8	16234.7	20793.6	20825.0
I-59	16298.1	16300.2	20889.8	20895.0
I-65	16277.0	16305.7	21019.8	21335.9
I-459	16291.1	16295.6	20812.7	20821.5

The average delay savings due to ASAP for each incident type and location can be seen below in Table 4-2. At first glance these differences seem relatively small, but when these values are multiplied by the number of actual ASAP assisted incidents the overall benefit is actually quite large which will be demonstrated in later portions of this chapter.

Table 4-2 Time Saved Due to ASAP by Incident Type (Vehicle-Hours)

Route	Shoulder	1 Lane
I-20	2.9	31.4
I-59	2.1	5.2
I-65	28.7	316.1
I-459	4.5	8.8

As one would expect, the savings provided during one-lane incidents are much larger than the savings provided during shoulder incidents. Considering the four locations analyzed, the one-lane savings were two to eleven times greater than the shoulder savings. Figures 4-1 and 4-2 display the average difference in incident delay savings for shoulder and one-lane incidents, respectively. It is very apparent that the location of the incident on Interstate 65 represents a location of higher benefit than the Interstate 59 location. The possibility that the location representing the maximum benefit is not selected is relatively high since only one location was simulated per interstate. Every attempt was made to select this "maximum benefit location" by locating the incident on the segment where they most frequently occurred. The incident location with the most assists for Interstate 59 is not the location of maximum benefit because it does not have the largest traffic volume. During the morning peak hour, the location with the second most occurring assists, which is east of the I-65 and I-59 interchange, would provide a much higher benefit savings because this segment had approximately 2,000 more vehicles per hour traversing it. This anomaly is something that should be investigated in future studies, but is beyond the scope of this study.

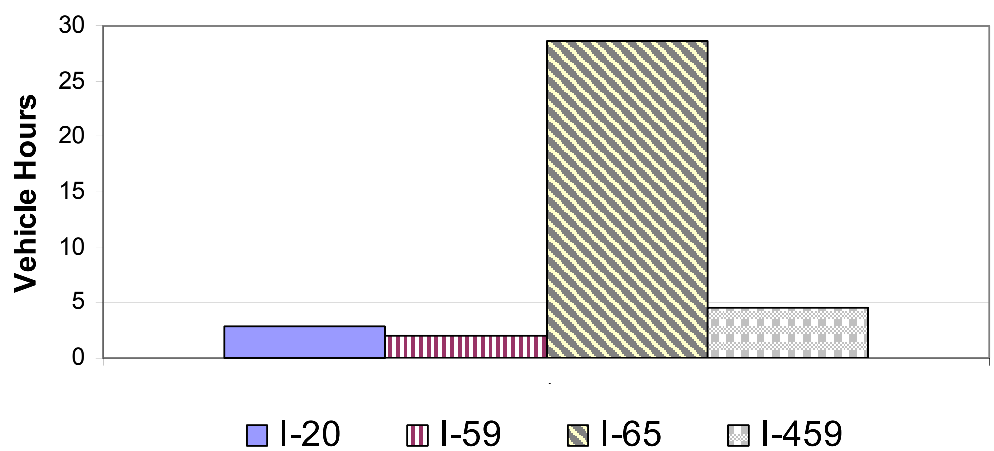

Figure 4-1 Shoulder Incident Average Delay Savings

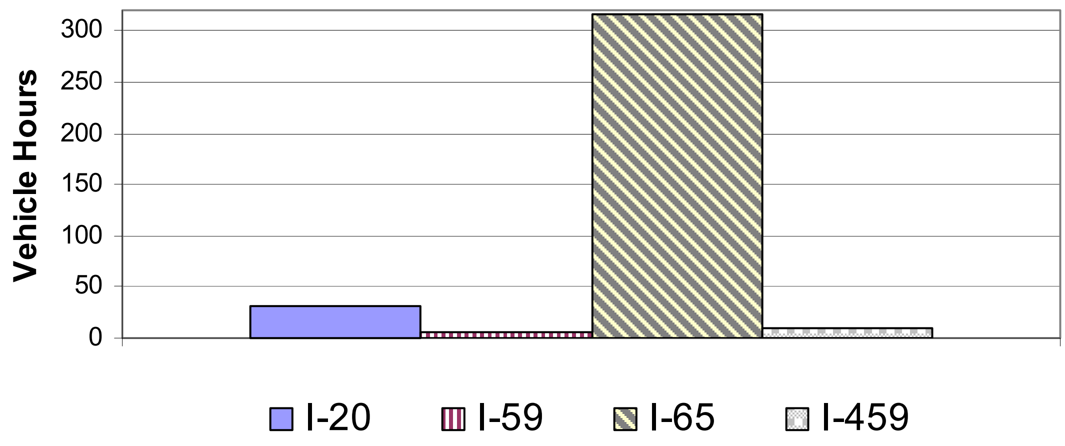

Figure 4-2 One-Lane Incident Average Delay Savings

4.2 ASAP Assist Log

ASAP provided assistance to 17,090 incidents from July 1, 2004 to July 1, 2005 based on their 2004-2005 assist log. This number was then extrapolated to estimate the number of incidents per Interstate and by lane distribution. These values can be seen in Table 4-3. The incidents blocking more than one lane were included so that the reader could understand the whole picture. These incidents were not used for simulation because of reasons mentioned in the previous chapter. Please refer to Section **3.2.1 Benefit Estimation,** including Equation 3-3 for more information on how these numbers were computed.

Table 4-3 Actual Incidents based on 2004-2005 ASAP Log

Interstate	Total Per Interstate	Shoulder	1 Lane	2 Lane	3+ Lane
I-20	620	546	50	17	7
I-59	7383	6496	593	206	88
I-65	6652	5852	534	186	79
I-459	2435	2143	196	68	29

Next the values in Table 4-2 and Table 4-3 were multiplied to estimate the total hours of delay saved by ASAP during the study year. These values can be seen in Table 4-4.

Table 4-4 Total Estimated Hours Saved Due to ASAP

Interstate	Shoulder	1 Lane
I-20	1583.16	1564.12
I-59	13640.69	3082.00
I-65	167964.44	168800.14
I-459	9641.80	1720.45
Summary	192830.10	175166.71
	Total Hours:	**367,996.81**

The travel time value was determined to be **$24.25** using Equation 3-4 in Section **3.2.1 Benefit Estimation.** The total hours were then multiplied by this travel time value to compute a mobility benefit worth **$8,992,082.55**. The estimated 2004-2005 program operating costs were determined to be **$380,377.62**. Please refer to Section **3.2.2 Annual Costs** to see how this value was computed and what it includes. Dividing the total mobility-related benefit by the program operating costs produces a benefit-cost ratio of **23.5:1**. Since this ratio is based on incident locations with the most assists, it represents a worst-case scenario and may therefore overestimate the systemwide mobility benefits provided by ASAP.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This chapter will convey the conclusions gleaned from the evaluation of the ASAP program and suggest improvements for ASAP and for future areas of study.

5.1 Conclusions

The results of this study indicate that the ASAP program is a successful, cost effective program. For the time period spanning July 1, 2004 to July 1, 2005, ASAP assisted **17,090** incidents. An analysis of the mobility-related benefits revealed a benefit-cost ratio of **23.5:1** for the program. This ratio is based on total perceived mobility benefits of **$8,992,000** and total program operating costs of **$380,400.** The perceived benefit is computed from the estimated **368,000** hours of delay saved by the program multiplied by a travel time value equal to **$24.25**.

This is the first thorough economic evaluation that has been performed on the program since it was started in June of 1997 to help the Birmingham metropolitan area deal with nonrecurrent congestion. The program was originally funded through the Congestion Mitigation and Air Quality (CMAQ) funding category established in ISTEA, but sponsorship through this bill is no longer possible. The outcome of this study is very important because ALDOT needs justification for funding to continue supporting the program. This study will be very beneficial to program directors by providing them with estimates in dollar amounts of the benefits to motorists the program provides. This evaluation has shown that the nonrecurrent congestion delay savings provided by ASAP greatly outweigh its operational costs by **23.5:1**. All assumptions used to determine the benefit-cost ratio noted previously in this thesis, are summarized in Table 5-1.

Table 5-1 Assumptions Used to Perform Analysis

Travel Time Values	$13.45 Each person hour of travel	$71.05 Each Truck hour of travel
Vehicle Occupancy	1.5	
Capacity Reduction (Shoulder Incident)	17% (3 Lane)	15% (4 Lane)
Capacity Reduction (One-Lane Incident)	51% (3 Lane)	42% (4 Lane)
Proportion of Trucks in Peak Hour	8%	
Assumed Increase in Incident Duration (25 minutes total)	15 minutes attributed to Response Time reduction	10 minutes attributed to Clearance Time reduction

5.2 Recommendations

Further studies should be performed to substantiate the findings in the preceding section and to explore other benefits not considered in this evaluation.

5.2.1 Recommendations for ASAP

Currently the ASAP logs do not include detailed information on lateral location of incidents, only the number of lanes blocked and open to traffic. It would be beneficial for future evaluations if the log could be modified to record this data. Also, only 5 percent of the incidents in ASAP's log have dispatch times available. If would be helpful if an effort could be made to record incident detection and more dispatch times. This data would help evaluators tremendously when they are trying to make assumptions on overall incident duration and the amount the incident duration is reduced due to ASAP.

5.2.2 Recommendations for Further Research

As mentioned before, one of the goals of this evaluation was to provide a "stepping stone" for future ASAP studies involving other benefits. A broader range of incidents should be located throughout the network to generate an average delay savings instead of the "worst case scenario" provided by the location with the most assists. Incidents should be located where ASAP assists frequently occur while considering traffic volumes as well. Also the models developed for this study are based on the morning peak hour from 7-8 a.m. Models for the evening peak hour of 5-6 p.m. should be developed and simulated to confirm the findings in this study.

The results of this study include only the mobility related benefits provided by ASAP. Future studies should consider looking at other program-provided benefits such as customer service, safety, and environmental impacts. Customer service is the value of services provided directly to the motorist by the freeway service patrol. The safety benefit is the value of the avoided or reduced secondary crashes upstream of the incident. Environmental impacts include the value of reduced emissions and energy consumption. Considering all of these benefits would allow for an all encompassing benefit cost ratio that could be used to further support future funding issues.

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