Development of Incident Management Systems: The Seattle Case Study

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With an increased awareness of the congestion-related impacts resulting from the occurrence of incidents, urban areas across the nation are looking to improve the management of these incidents. Seattle officials were quick to recognize the importance of efficient incident management programs and sought to improve their existing system. This document examines the incident management techniques initially considered for implementation in the Seattle area, the incident management techniques that were actually implemented, the thought processes behind the development of these programs and the overall success of the systems approach as it was applied to the development of the incident management system in the Seattle metropolitan area.

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DEVELOPMENT OF INCIDENT MANAGEMENT SYSTEMS: THE SEATTLE CASE STUDY

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CHAPTER 1

INTRODUCTION

Traffic congestion is an ever growing concern in urban areas across the United States. Historically, long term efforts have been focused on alleviating daily or recurring congestion resulting from extensive automobile usage.

Because of the shift of employment centers from central business districts to outlying areas and population growth in the suburbs, commuters are more dependent than ever on their automobiles for travel to and from the workplace. Researchers have estimated that over half of all work trips are from suburb to suburb rather than from a suburb into the downtown area. This dispersion makes travel demand very difficult to adequately serve with a public transit system.

This problem is compounded by the increased number of people in the workforce. The most apparent increase is in the number of women. This growth trend is expected to continue.

In addition to the growth in certain sectors of the workforce, the overall population in the United States is expected to increase. The present U.S. population is expected to grow by a staggering 30 million over the next 20 years. Nearly 80 percent of this growth is predicted to occur in metropolitan areas, of which the majority of growth will occur in suburban areas. (1) These statistics imply a continued dependence on the automobile, which, in turn, will result in further delay and frustration experienced by motorists travelling on already overcrowded roadways.

In addition to the delay and frustration commuters experience, congestion has very serious implications for the nation's economy. As congestion has spread to affect areas not only near central business districts, but also bypass routes and arterials, and as the peak hour problem has turned into a peak period problem lasting 4, 6, even 8 hours, the cost to the nation has also increased.

Increased driving time, increased fuel consumption, and increased wear and tear on transport vehicles affect the manufacturing and retailing sectors that are served by these transport vehicles. Data from the Federal Highway Administration's Highway Performance Monitoring System database showed that traffic congestion in the nation's 37 largest cities cost the nation 1.25 billion vehicle-hours of lost time in 1984. The value of this time, combined with the estimated cost of wasted fuel, was approximately $9 billion. These values were updated in 1987 to $2 billion lost vehicle-hours and $16 billion of lost time and wasted fuel. In the year 2005, these losses are expected to jump to $8 billion lost vehicle-hours and nearly $88 billion of lost time and wasted fuel. (2)

Given these staggering figures, as well as the population forecasts and current urban growth trends, few can argue that traffic congestion is a growing concern for the nation. Further considerations are economic implications such as diminished productivity, environmental impacts such as air pollution, and changes to our overall quality of life.

Now that the severity of the problem is realized, we need to examine the true causes behind the problem, not merely the symptoms it creates. Recently, the focus of research has moved away from recurring congestion that results from daily commuting patterns to look at a phenomenon estimated to account for 60 percent of urban congestion. This phenomenon is the occurrence of incidents.

An incident can be defined as an accident, vehicle breakdown, spill, or other event that impedes the normal flow of traffic. This impedance can be as major as blockage of all or part of the roadway or as minor as a momentary distraction for the motorist. As a parallel, construction for roadway maintenance or special events such as football games cause the same problems.

Unlike recurring congestion, whose time span and location are usually predictable, the time and location of congestion created by incidents are completely unpredictable. Construction work or special events create a unique situation in that their time and location are predictable for those trying to mitigate traffic flow disruption.

Because of this increased awareness of the impacts of incidents, a number of studies have tried to quantify the effects of congestion caused by incidents. The Federal Highway Administration estimated that in 1987, incident congestion cost the nation 1.3 vehicle-hours of delay at a loss of nearly $10 billion. For a large metropolitan city like New York, these estimates imply a cost of $1.2 billion per year or, $100 per person per year. (3)

Extensive studies have also been performed to define the percentages of incident types in order to determine the best mitigation measures. Figure 1 shows a breakdown of reported incidents. (It is estimated that only 70 percent of all incidents are recorded by police or transportation agencies; the rest remain unrecorded and thus provide no source of data. (3)) As seen in Figure 1, congestion caused by an incident is highly dependent on the duration of the incident, the number of lanes that are blocked, and the volume of traffic at the time of the incident.

Incident-induced congestion was first recognized as a serious problem in the Seattle area in the mid-1980s. To study the extent of this problem, a research project was undertaken with two general objectives:

(1) to collect data on the characteristics of traffic incidents (vehicle accidents and disablements) and

(2) to determine the traffic impacts resulting from these incidents.

Because of the limitations of available data, the study focused exclusively on 20 of the Seattle area's most congested freeway miles. These 20 miles were divided into six, roughly homogeneous freeway segments (See Figure 2), and vehicle accident and disablement data were collected over a 2-year period, from April 1987 to March 1989.

The data collection effort indicated an average of nearly eight reported accidents per day in the study area, along with nearly 12 reported vehicle disablements per day.

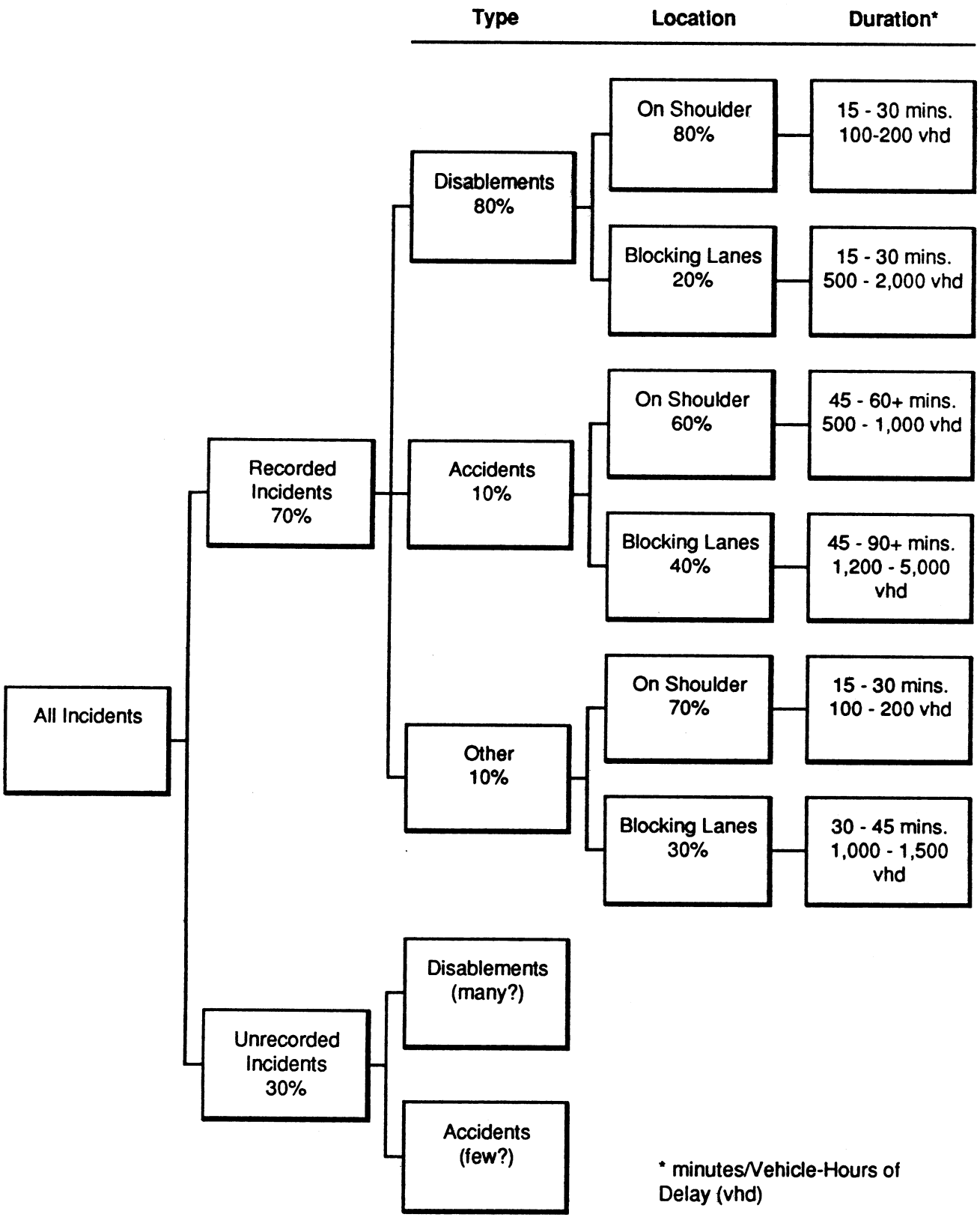

Figure 1. Breakdown of Incidents by Type for U.S. (3)

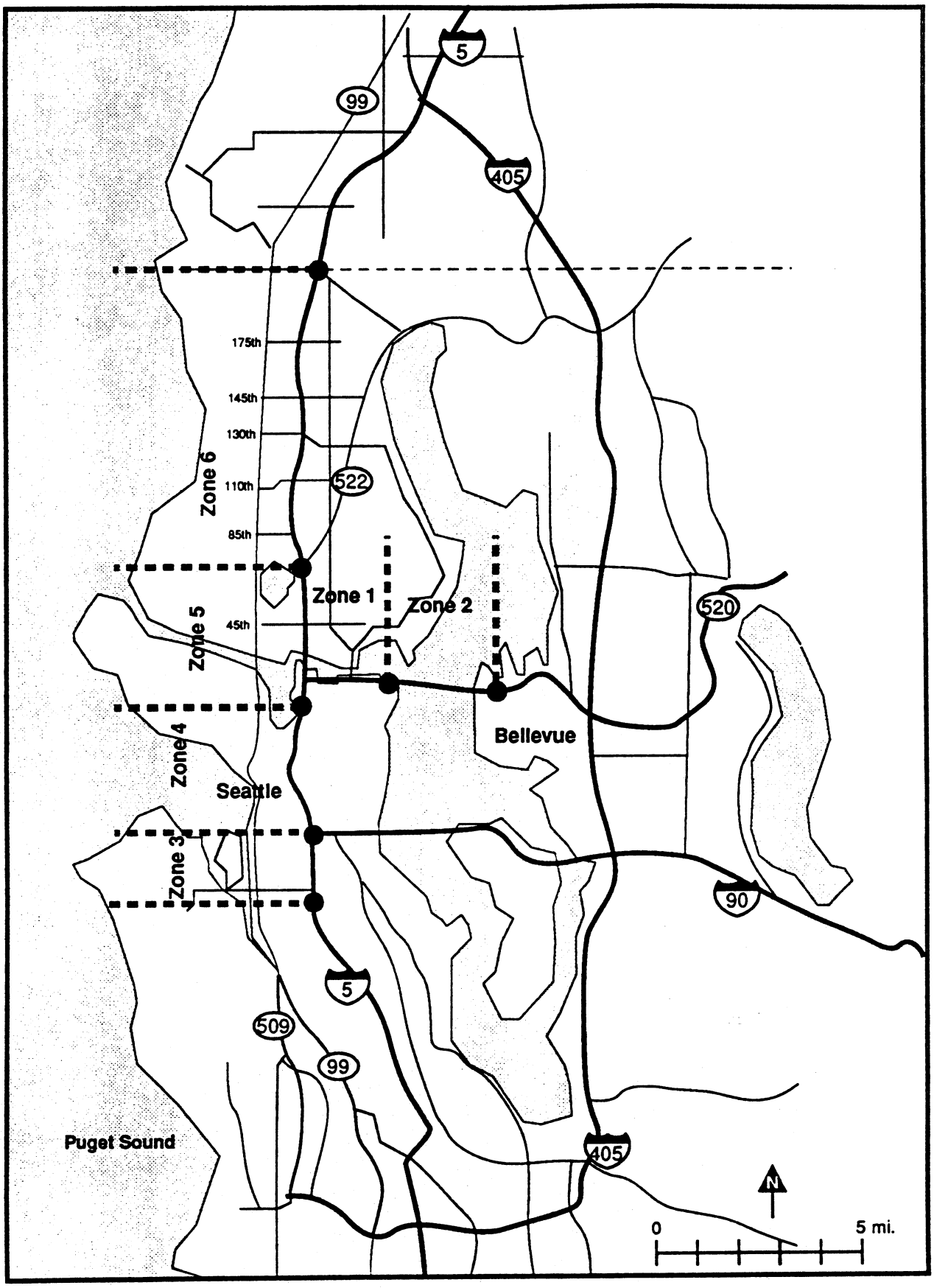

Figure 2. Zones of Study for Seattle Metropolitan Area

With accurate data from over 2,100 of the 5,637 reported accidents that occurred during that period, the researchers determined that Seattle area accident durations were similar to accident durations across the nation, as reported in Figure 1.

Finally, traffic simulations performed by the study team indicated that a 75 percent reduction in capacity, lasting 60 minutes during the afternoon peak period, on Seattle's congested Interstate 5 in Zone 5 (see Figure 2) would result in more than 15,000 hours of delay, and that incident-induced delay resulted in over $250 million in lost travel time per year on the 20 miles of interstate studied. (4, 5, 6)

As a result of the study and a growing public awareness, officials with the Washington State Department of Transportation became very concerned with the severe congestion problems resulting from incidents and sought to mitigate the impacts. The intent of this report is to present a case study that examines the systematic approach WSDOT officials undertook to develop the most successful and cost effective incident management plan for the area's specific management needs. If this approach is deemed successful in the Seattle area, its adaptability to other urban areas in Washington state, such as Tacoma, Vancouver, and Spokane, will be examined, as will its applicability throughout the nation.

The systematic approach mentioned above consisted of a logical series of steps to help agency staff responsible for program development identify

(1) the issues and problems to be resolved,

(2) alternative ways to solve these problems, and

(3) the relative advantages and disadvantages of each of the alternatives selected for analysis.

More specifically, the information contained in this case study consists of

- a list of incident management techniques initially considered for implementation,
- a list of incident management techniques that were actually implemented,

- a discussion of the thought processes behind the selection and development of these programs, and
- a discussion of the overall success of this systematic approach as it was applied to the development of the incident management system in the Seattle metropolitan area.

CHAPTER 2

APPLYING THE SYSTEMS APPROACH TO PROBLEM SOLVING

The approach suggested in the "Framework for Developing Incident Management Systems" (7) is patterned after the classic "systems" approach to program development. It is intended to create a logical series of steps that will help the agency staff responsible for program development identify

- the issues and problems to be resolved
- alternative ways to solve those problems, and
- the relative merits and disadvantages of the alternatives selected for analysis.

In presenting the Seattle area incident management case study, we will follow this eight-step systems approach to illustrate the process through which the Seattle area system was developed. This chapter gives a general overview of the systems approach. Later sections of this document will look specifically at how WSDOT officials applied this approach in developing the Seattle area incident management program.

The systems approach to program development breaks the decision making process into eight separate tasks. The tasks are as follows:

(1) define the problem,

(2) set goals and objectives,

(3) develop alternatives,

(4) evaluate alternatives,

(5) select alternatives,

(6) implement alternatives,

(7) re-evaluate alternatives, and

(8) refine the system

1. DEFINING THE PROBLEM

The task of defining the problem is the first step in developing an incident management plan. Understanding the types of traffic problems that exist in relation to incident occurrence, as well as the factors causing these problems to occur and the impacts that these traffic problems have on traffic flow, is vital in the systematic approach. Without fully understanding the scope of the problems that are occurring, agencies cannot expect to accurately identify the possible improvements that might alleviate these problems.

Special attention should be placed on identification of the factors that are causing the problems. Addressing the cause of the problem and not merely the symptoms helps to more narrowly define the scope of the incident management program being developed. Conversely, a narrowly defined task helps to ensure that the incident management program results in measurable, area wide improvements because it has addressed the real cause of the problem.

There are two important factors in defining the problems related to incident congestion. One of these factors is the incident type that predominates in the problem area. Incident type refers to the severity of the incident (i.e., fatality, hazardous material spill, etc.).

The second factor is the general impact of incidents on traffic flow. An incident blocking one lane of travel obviously has a different impact on a four-lane highway than on a two lane bridge.

These two factors, incident type and impact on traffic flow, can greatly alter the priorities for implementing the various incident management measures.

To determine the highest priority issues at hand, information can be collected regarding

(1) the frequency of incident occurrence in relation to a variety of criteria (i.e., occurrence by month, during rain or fair weather, during special events, etc.);

(2) incident duration, including the time required to detect, respond, and clear a variety of incident types; and

(3) traffic impacts.

Information regarding incident occurrence and duration can be obtained from accident and police dispatch reports. Information concerning the impacts on traffic flow is more difficult to gather and usually requires the use of video monitoring, electronic loop detection, or model simulation.

A traffic simulation model may be used in many instances to simulate or predict real-time effects and can be programmed to reflect the impacts of a specific incident's location, extent (i.e., number of lanes blocked), duration, and time of day.

As briefly outlined in the introduction, an extensive research effort was undertaken in the Seattle area early in the incident management planning process. This research examined three things: (1) incident type, (2) impacts on traffic flow, and (3) the operation of the existing system. (8)

Predominate Incident Type

Information was first collected regarding the types of incidents or incident characteristics that most frequently occur in the Seattle area. The aim was to more specifically define the problem. Both the frequency (number of occurrences) and the duration (the interval between the time an officer received notification and the time he/she left the incident scene) of incidents were examined.

Data were obtained from three local sources. Information describing vehicle disablements from April 1988 to March 1989 was obtained from Washington State Patrol dispatch logs and was coded to be later utilized in computer applications. Accident records dating from April 1987 to March 1989 were obtained in computer ready form from Washington State records and were matched to Washington State Patrol accident dispatch logs covering this same period. Lastly, information concerning special events was collected from various local agencies and was computer coded. A wide range of data was

obtained, including weather and roadway conditions at the time of the incident, driver characteristics, injuries, the types of vehicle involved, and property damage sustained (See Tables 1 and 2).

Once all of the necessary data has been collected and coded, computer modeling methods were used to simulate impacts on traffic flow, given various incident frequencies, durations, and locations. Poisson regression was used to represent incident frequency, and a Survival Model was used successfully to represent accident duration. (6)

The outcomes showed that the Seattle area's incident management problems did not result from lengthy detection or response times, nor did they result from the occurrence of special events or inclement weather. Instead, the problems stemmed from the management of severe incidents. These problems could be mitigated with improved on-site management, clearance efforts, or motorist information.

General Traffic Impacts

Secondly, the impacts on traffic flow resulting from the incidents were studied. This was accomplished through traffic modeling, and the results were described in lost vehicle-hours and lost person-hours.

A database was created to describe various aspects of the traffic flow system in Seattle. An afternoon peak-hour trip origin to destination table was obtained from the Puget Sound Council of Governments to describe traffic flow conditions. Information concerning the street and highway network, including number of lanes, capacity, section lengths, and speed limits, was obtained from numerous sources. Finally, network traffic volumes were obtained from the Washington State Department of Transportation to ensure that any predictions resulting from the traffic models were close to actual counts. (4)

Traffic models were then used to manipulate the database. More specifically, the user-equilibrium traffic assignment model, XXEXQ, was used to simulate various incident situations. In one case, an incident was simulated on the Interstate-5 Ship Canal Bridge (See Figure 3). A second simulation produced an incident on the State Route 520 Floating

Table 1. Variables Available from Accident Reports

Year	Year of accident
Month	Month of accident
Day	Day of Accident
Day of Week	Indicator for day of week Monday to Sunday
Hour	Hour accident report started
Minute	Minute accident report started
Sign Route	State route highway designation number
SR Milepost	State route mile post
Accident Sev	Accident severity index; property only, injury accident, or fatality
N. Injured	Number of persons injured in the accident
N. Fatal	Number of persons killed in the accident
Light	Indicator for illumination level at accident site: daylight, dawn, dusk, dark (with and without street lights, and other)
Collision Type	Code for various possible collision types including pedestrian/vehicle, vehicle/vehicle, parked vehicle and others kinds
Object Struck	Kind of object struck, if any (e.g. light standard)
M. Sev.Inj.	The most severe injury caused by the accident (no injury, fatal, disabling, non-disabling, possible, unknown)
N. Veh.	Number of vehicles involved in the accident
P.Dam.$	Property Damage measured in dollars
R. Char.	Roadway character - grades and curves
L. Char.	Location character - codes for various intersections, under and over passes and other facilities
R. Sur.	Road surface character: not stated, dry, wet, snow, ice, other
Weather	Weather at the accident site:clear/cloudy, rain, snow, fog, or other
Res. Prox.	Residence proximity of involved drivers: within 15 miles, elsewhere in state, or out of state
Sobriety	Sobriety of the drivers in the accident: 7 codes for had been drinking — ability impaired to had not been drinking
A. Sev.	Alcohol severity: drunkest driver involved in accident
Con.Circ	24 codes indicating different possible RCW violations or indicating no violation
D.V.Act	Driver Vehicle Action: codes indicating evasive or non evasive actions taken by the involved drivers
Veh. typ.	Vehicle type: vehicle type code
Age	Age for each of the involved drivers
Haz. Mat.	Kind of hazardous material involved, if any
Fuel	Fuel Spill (yes/no)
Fire	Fire Resulted (yes/no)

Table 2. Data Collected from Dispatch Logs

Year	Year of accident
Date	Month and day of the accident
DOW	Day of week: Monday to Sunday
TOD	Time of day: one of eight 3 hour time slots
Rcvd	Dispatcher received call for assistance
Enroute	Time Trooper was en route to accident scene
Atscene	Time Trooper arrived at the accident scene
Roadcl	Time road was cleared, if it had been blocked
Troopcl	Time Trooper cleared the scene of the accident
Tow	Number of tow trucks called to accident site
Amb	Number of ambulances called to the accident site
Other	Number of other emergency vehicles called to the accident site (e.g. Fire Department)
Exp	Indicates that accident occurred on the express lanes
Loc. C	Location Code: code for the cross streets on I-5 and SR 520 within our study area
Dir	Direction of travel
Lane	Lanes(s) involved
N.Veh	Number of vehicles involved
N.L.Block	Number of lanes blocked
Inj	Number of injuries
Ftl	Fatality accident (yes/no)
T/B	Truck or bus involved in the accident

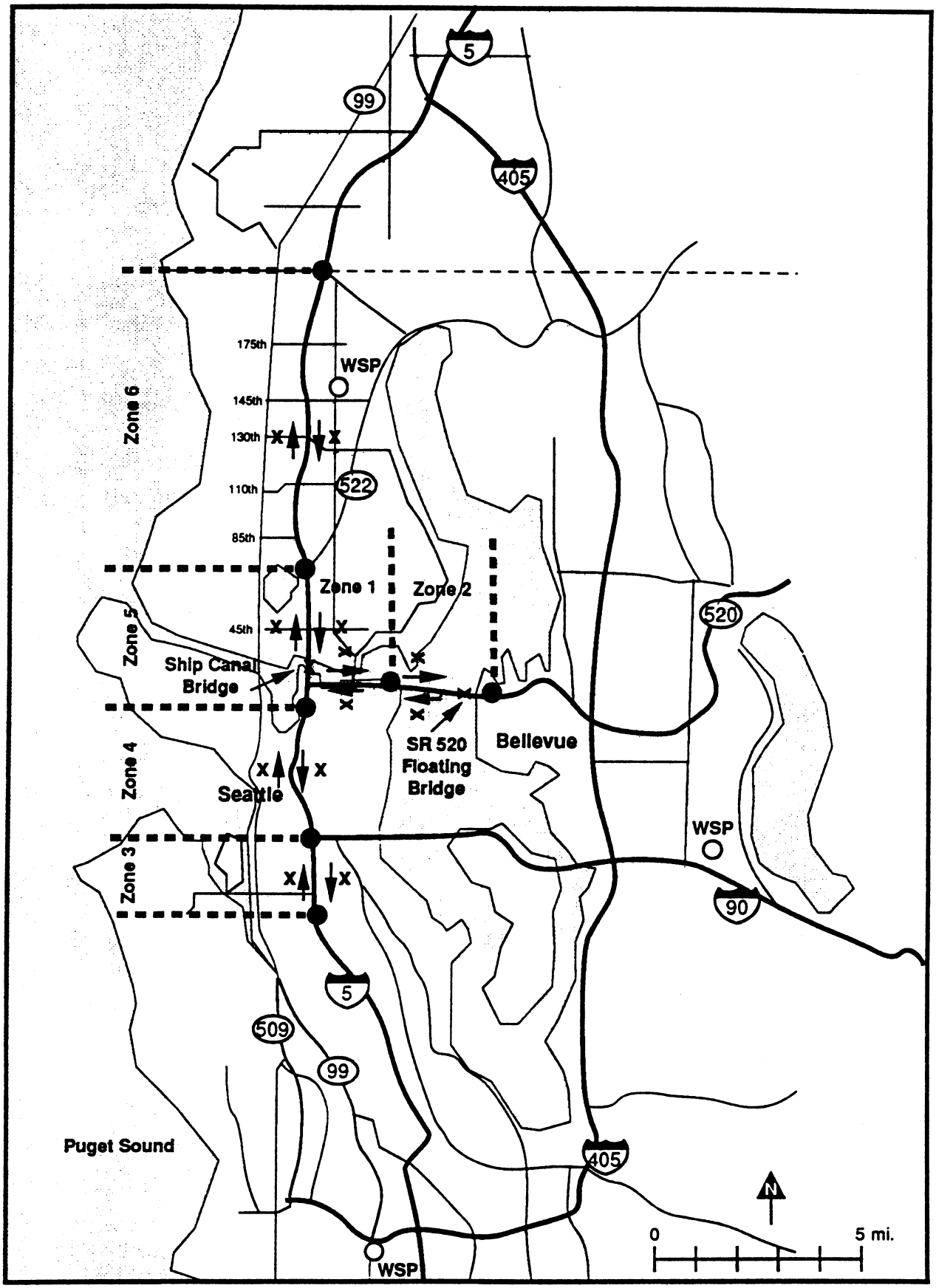

Figure 3. Location of Simulated Incidents

Bridge (See Figure 3). A third simulation looked at the effect of drivers slowing down to view an incident. In addition to these simulations, 12 other incidents were introduced (two in each of the six zones of study, one in each direction) to assess the relative incident related impacts by zone (See Figure 3).

The outcome was very surprising. Validated simulation procedures showed that a disproportionate amount of effort had been spent on mitigating the impacts of incidents occurring on the SR 520 floating bridge (Zone 2 in Figure 2). In actuality, the most severe impacts resulting from incidents had been occurring along Interstate 5 in the downtown Seattle corridor (zones 3 and 4 in Figure 2). The simulated increase in travel time resulting from a 60-minute incident and a subsequent 40 percent reduction in roadway capacity during the afternoon peak (for the six zones) is shown in Figure 4.

Existing System Operation

Lastly, the success of existing incident management efforts in the Seattle area were examined. This study was accomplished by interviewing field personnel. The results are summarized below.

The average time that elapsed before an incident was detected and reported was 5 minutes, and the average trooper response time was 4 minutes.(10) This second statistic was outstanding in comparison with other areas of the country. Those involved with incident response in the Seattle area attributed this success to the Closed Circuit Television system in operation and the good lines of communication between WSDOT's Traffic Systems Management Center and the Washington State Patrol.

However, these statistics did not seem nearly as impressive when the traffic models developed in the previous study were used to study the effects of a 75 percent reduction in capacity on the Ship Canal Bridge. These showed that within the first 10 minutes after an incident had occurred, 1,123 vehicle-hours would be lost. If the average vehicle occupancy rate were 1.2 (including high occupancy vehicles) and the average value of one vehicle-hour were $10, a reasonable person-hour rate would be $8.30. In other words,

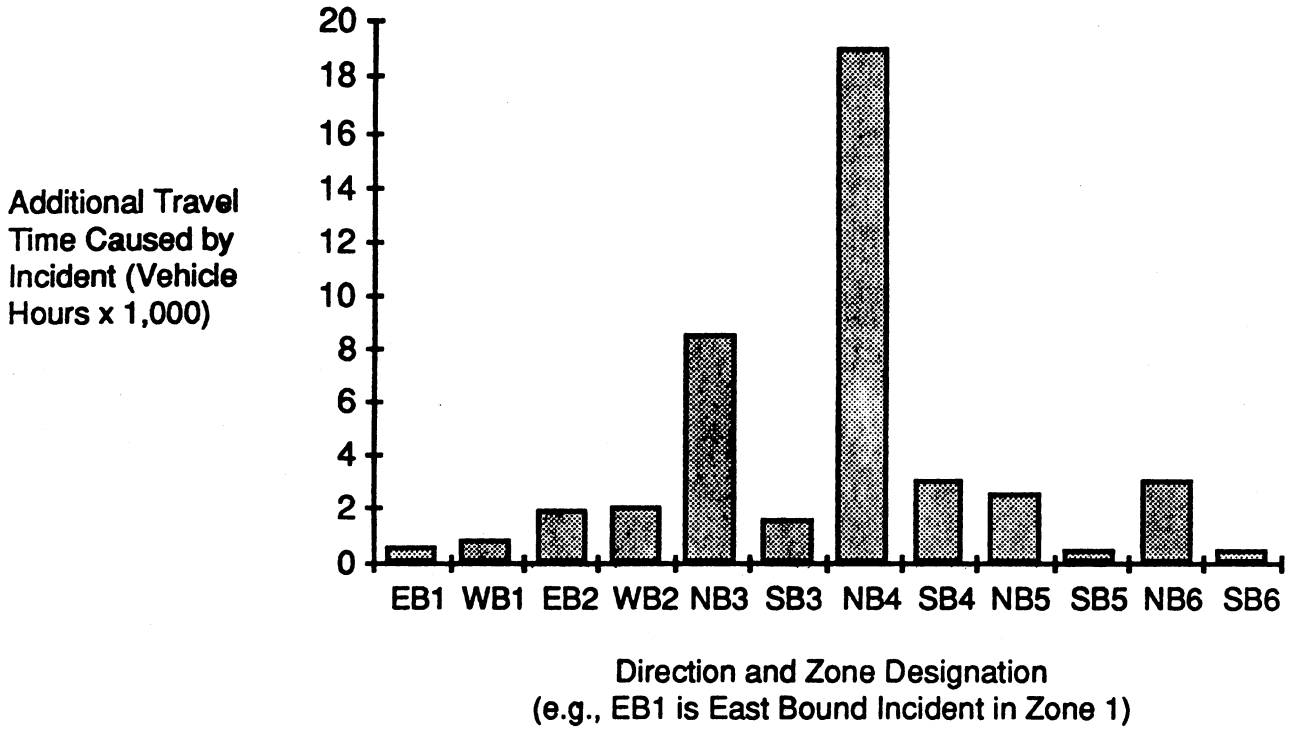

Figure 4. Impact of Incident Location on Total Travel Time

nearly $11,230 worth of commuting time would be lost before the trooper even arrived at the incident scene. (8, 9)

2. SETTING GOALS AND OBJECTIVES

Once a clear understanding of the problem has been gained, the ultimate goals and objectives in resolving these problems must be established and defined. These goals and objectives should relate to the specific problems that were previously identified, as well as to broader public needs and demands.

The goals and objectives should, if possible, be numerically quantifiable. This allows a realistic assessment of the success or failure of the program. Also, the public's perception of the program and the need to justify the initial program and its continued operation to local public officials and sometimes state legislatures must be considered.

A particularly important aspect of setting the specific goals and objectives is to prioritize these goals and objectives in the order in which they should be accomplished. By inference, this ranking also prioritizes the problems that need to be addressed first.

After examining the results from the pre-implementation study, WSDOT officials were able to define specific goals and objectives for the Seattle urban area. Four goals prevailed. The first was to better define the roles of agencies directly involved with incident management. Since the role of fire and rescue agencies was fairly unique and already well defined, the challenge was to define the roles of police and transportation agencies. Often the roles of these two agencies overlap during incident management tasks, and the incentive to form cooperative teams has not always existed.

However, in 1983 the first incident response coordination meetings began between the Washington State Department of Transportation and the Washington State Patrol. Cooperative efforts have been steadily improving, allowing issues over jurisdiction to be quickly resolved.

The second goal for the Seattle urban area was to improve an agency's flexibility in dealing with a wide range of incidents. Such improvements can be accomplished through a variety of means, including the acquisition of new or specialty incident response equipment such as heavy duty wreckers, or expansion of the scope of training for incident management respondents.

Thirdly, WSDOT officials realized the need to document their experience and standardize the practices and procedures that were being developed in both the administrative and field response arenas. Two documents were proposed for development through a cooperative effort among the Washington State Department of Transportation, the Washington State Patrol and the University of Washington.

The first document, "Incident Response Guide" (11), attempted to standardize field practices for transportation agency respondents and, consequently, to better define the roles of the Washington State Department of Transportation and the Washington State patrol.

The second document, "Framework for Developing Incident Management Systems" (7), attempted to standardize procedures at an administrative level throughout the development of an incident management system. Issues such as jurisdictional disputes and operational issues were discussed in this document in an effort to prevent unsuccessful incident management systems or misspent funds.

On a more quantifiable level, WSDOT officials desired to reduce response times to the incident scene and the time required to clear the incident from the roadway. New methods and programs were to be considered to aid in attaining this goal. After implementation, the success of these programs could be measured by comparing existing records with the previous police dispatch and accident report records. The methods and programs considered for implementation are discussed fully in later sections of this document.

3. DEVELOPING ALTERNATIVES

Once the goals and objectives have been defined and a concensus has been reached, the next task is to generate an extensive list of possible incident management alternatives from which to choose. The alternatives initially selected should respond directly to the problems identified earlier, should meet the stated goals and objectives, and, if incident management measures are already being taken, be able to be smoothly integrated into the existing program.

The relative costs, benefit levels, and implementational and operational issues of each of the alternatives should be well defined. A comprehensive summary of these issues was developed for inclusion in "Framework for Developing Incident Management Systems." (7)

For issues that are not addressed, it is beneficial to speak directly with officials in other cities across the United States that have previously implemented or are currently operating similar programs. This provides an excellent opportunity to learn of their experiences and avoid unnecessary pitfalls.

Learning of Incident Management in Areas Across the U.S.

Before WSDOT officials felt confident in selecting incident management alternatives for implementation, they chose to learn from the experiences of other urban areas across the country to avoid funding unsuccessful programs.

The questions posed to incident management experts across the country concerned basic implementational and operational concerns. These are summarized below.

- What types of traffic management problems spurred the development of their programs?
- What problems were initially encountered?
- At what level were their incident management efforts when they opted to implement additional programs?
- How well were these new programs integrated into the existing system?

- What types of pre-implementation studies, if any, provided sufficient justification for investment in the new program(s)?

Information was obtained from several large metropolitan areas across the nation, including Chicago, Cincinnati, Detroit, Fort Worth, Houston, Los Angeles, Minneapolis, New York, and Tampa. Each of these cities had relatively well developed incident management programs and, through conversation and literature provided by transportation officials in each of these geographic locations, WSDOT officials were able to learn much about their experiences when first developing and operating their programs.

In addition to the information gathered through conversation and literature, a site visit to the greater Chicago area provided first-hand experience in the day-to-day operation of Illinois Department of Transportation's extensive incident management program. Background information regarding this program is summarized below.

The Illinois Department of Transportation (IDOT) operates a highly developed freeway management program in the Chicago area. A growing demand along the Chicago area expressways, with traffic peaking above 300,000 vehicles per day in some sections, combined with the need for improved motorist safety , created a need for new emphasis on freeway, and specifically incident, management. Currently, the Chicago area freeway management program consists of three major components: (1) a Traffic Systems Center, (2) the Communications Center, and (3) the Emergency Traffic Patrol.

The Traffic Systems Center (TSC) centrally operates an extensive loop detection system (no video surveillance is used), ramp metering controls, and variable message signs. The Traffic Systems Center goes one step further by providing direct terminal hook-ups between its computer and area commercial radio and television stations. This allows real-time traffic information to be easily and effectively disseminated to the motoring public.

The Communications Center is responsible for receiving and dispatching incident reports, including those made by cellular telephone. A second task performed by the

Communication Center is to coordinate among the transportation agency, IDOT, and the other responding agencies, including police and fire agencies. Lastly, the Communications Center is responsible for operating the computer which performs the real-time, automatic update of traffic information based on link volumes for area highway advisory radio stations. The Communications Center also has the capability to remotely operate area variable message signs.

The Emergency Traffic Patrol provides mobile surveillance and assistance for all incidents and potentially hazardous situations. Currently, the patrol fleet consists of 35 trucks, several heavy-duty recovery vehicles, crash cranes, and other special units.

The three incident management components (Traffic Systems Center, Communications Center, and the Emergency Traffic Patrol), in combination, have been estimated to reduce congestion in the Chicago urban area by 60 percent and the number of accidents in the same area by 18 percent. (3)

As mentioned previously, Chicago was the location of a site visit by representatives from the Washington State Patrol, Washington State Department of Transportation, and the University of Washington in the early stages of this project. Much valuable information was gained from conversations with participants involved in incident management in the Chicago area, as well as through extensive literature. Seattle area representatives benefited from observing such a comprehensive and highly developed program; however, they also had difficultly envisioning such an extensive program (specifically the Emergency Traffic Patrol) in the Seattle area in the near future.

Examining the Existing Level of Incident Management in Seattle

Regardless of the specific programs selected for implementation, special attention must be paid to programs already in operation. Existing programs should be formally or informally examined to determine which of the existing programs warrant continued operation and which programs would be more cost effective to discontinue.

At the time this study began, the existing level of incident management in the Seattle urban area was well on its way to becoming a complete and successful system. However, it lacked a cohesiveness and consistency among the various existing programs, which severely hampered the efficiency of incident management efforts.

Perhaps the most highly developed component of the incident management system in Seattle, with respect to detection, response, on-site management, clearance, and motorist information, at the time of this study was incident detection. The detection/surveillance system consisted of over 900 electronic loops inbedded in roadways along major corridors (see Figure 5). Electronic loop detection not only helps in incident detection but also provides useful traffic flow data for other applications.

To help confirm incidents detected by the loop system, as well as to gain more information about the incident, video and closed circuit television were introduced. At the time of this study, 27 cameras were mounted strategically along Interstate 5, Interstate 90, State Route 405 and State Route 520 (see Figure 6). Even at that time, agencies realized the need to expand the number of video cameras to gain sufficient coverage of the highway system.

Non-technical programs for incident detection also existed, including motorist aid telephones on the SR 520 Evergreen Point floating bridge and CB and cellular telephone reports by private citizens.

Other programs in operation at the same time not only served to improve detection efforts but incident response and clearance efforts, as well. These programs included stationary tow truck patrols at each end of the Interstate 90 and State Route 520 floating bridges (see Figure 7), privately operated dedicated freeway/service patrols, and privately operated aircraft patrols. Police motorcycle and vehicle patrols were used as well; however, their main priority was law enforcement rather than incident management. In the case of the privately operated programs, the major sponsors were most often commercial radio or television stations or auto dealerships.

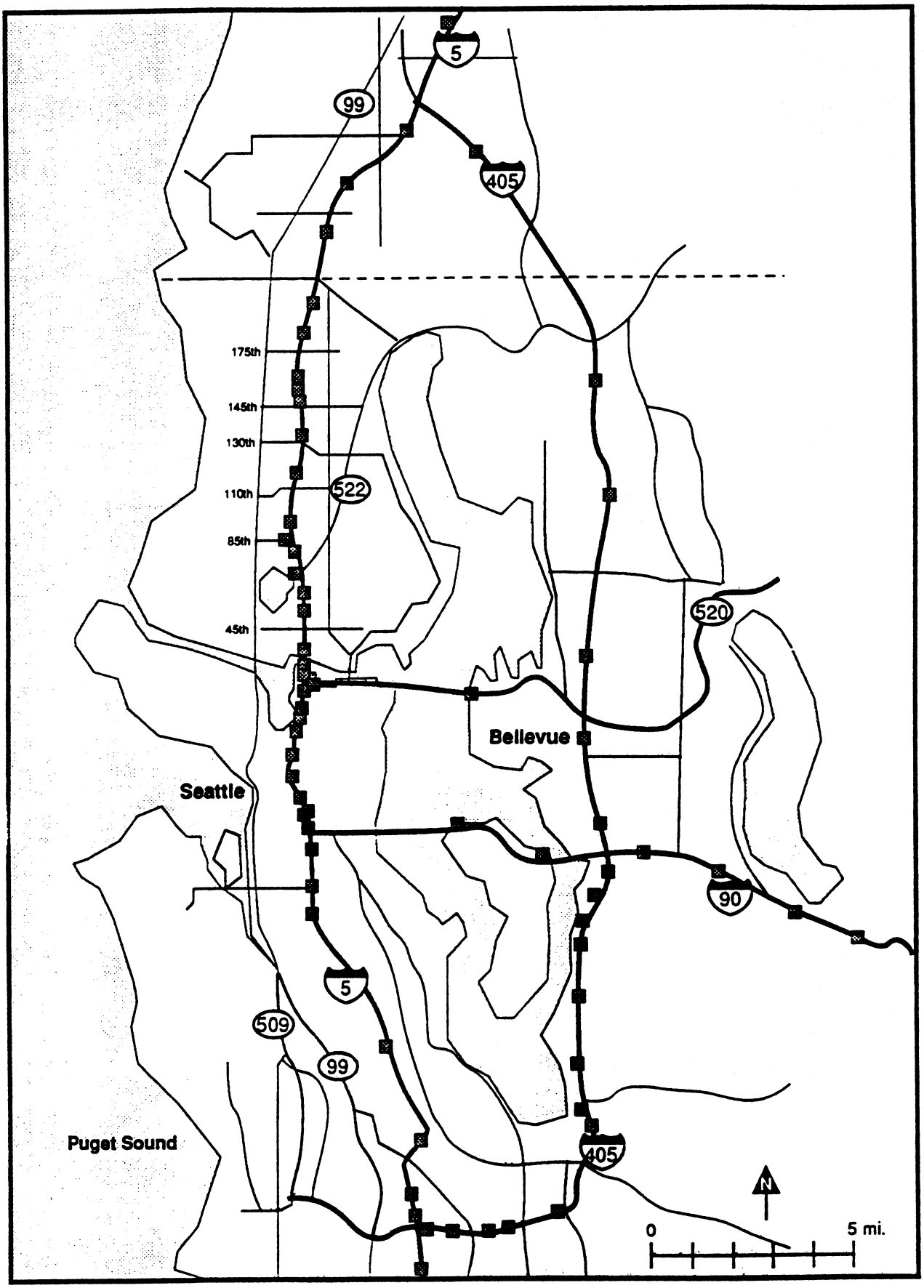

Figure 5. Seattle Area Electronic Loop Detection System

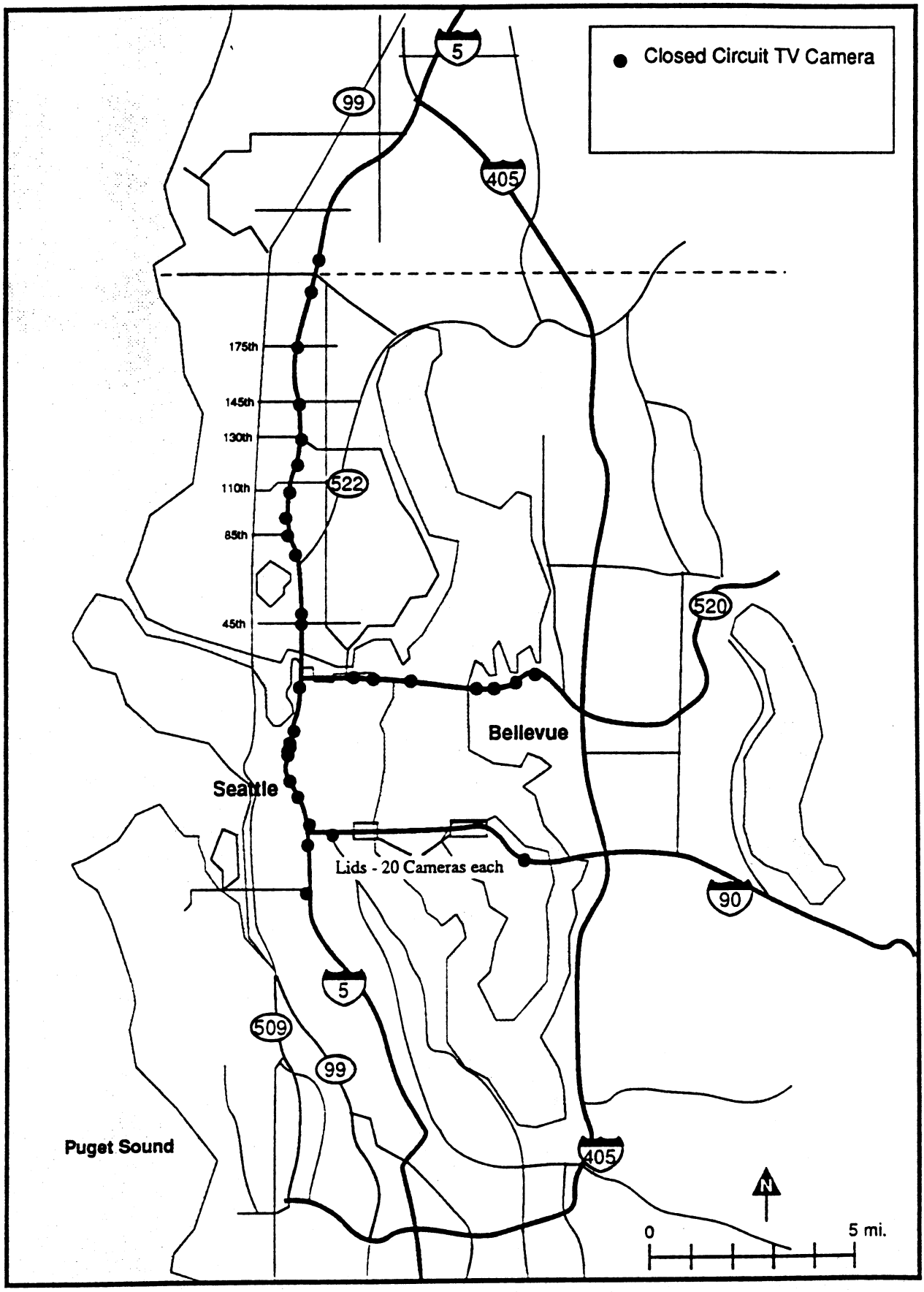

Figure 6. Seattle Area Video Surveillance System

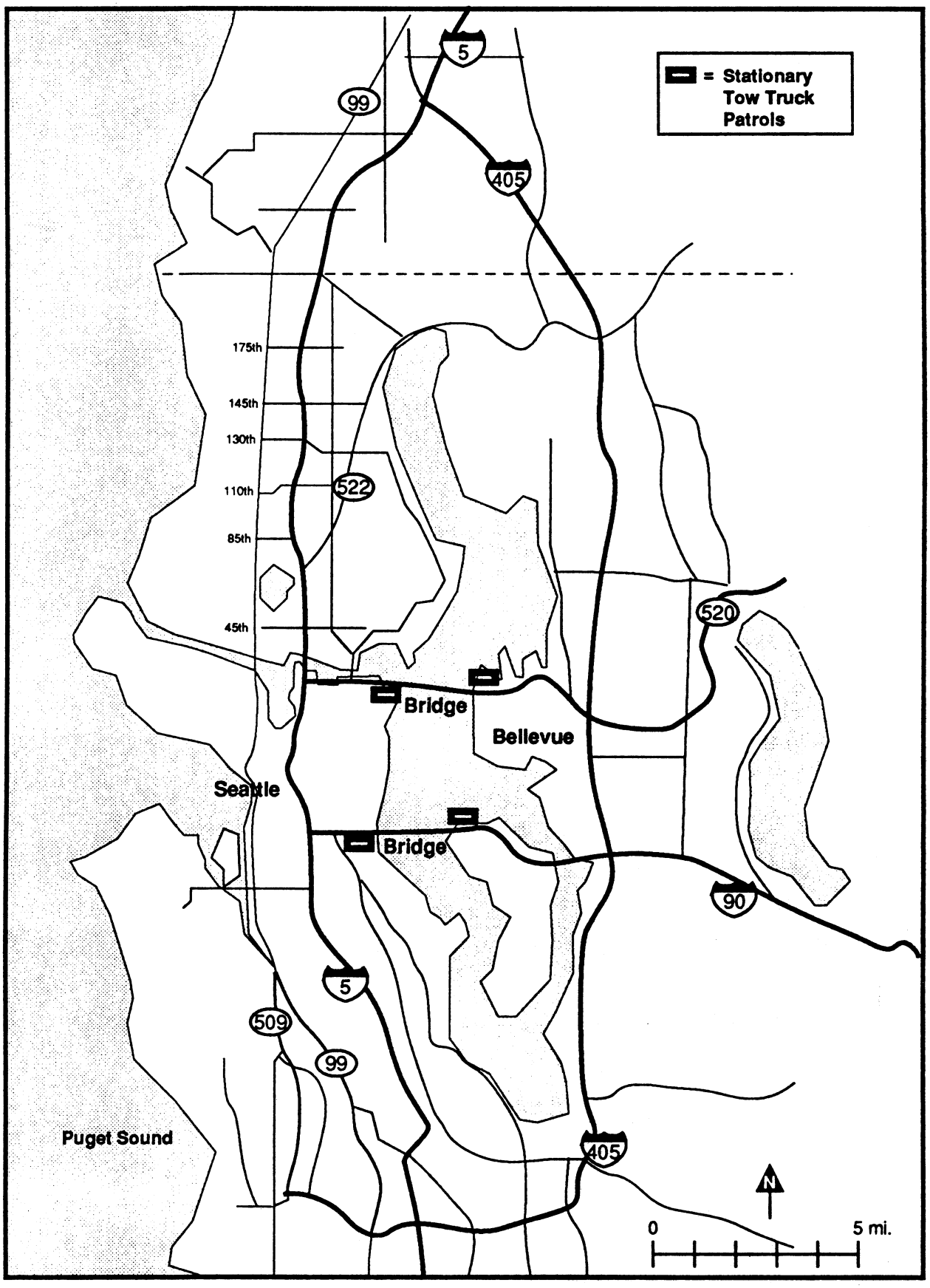

Figure 7. Location of Seattle Area Stationary Tow Truck Patrols

Alternate route plans existed but only for a large scale emergency. The routes were not intended to be used to alleviate frequent congestion caused by minor incidents.

Motorist information was identified early in the incident management process as a key element in improving the efficiency of the system. In the field, highway advisory radio, variable message signs, and ties with local media played and continue to play an important role in disseminating real-time traffic information to the motoring public.

In addition to the motorist information efforts already implemented, extensive research has begun at the University of Washington in cooperation with WSDOT's Traffic Systems Management Center to design and develop a real-time commuter information system, called Traffic Reporter. With its interactive screen, Traffic Reporter would be able to provide graphical, up to the minute data on volume and occupancy through links with the electronic loop detector system, indicate malfunctioning stations, and store commute (traffic volumes, speeds, etc.) data to create a record of freeway activity. Traffic Reporter will be used by engineers at the Traffic Systems Management Center, radio and television traffic reporters, and commuters.

While WSDOT officials were very open to new ideas to improve current incident management efforts, they emphasized selection of new programs that would integrate smoothly with the successful programs already in operation. Unsuccessful programs would be abandoned so that all available resources could be applied toward the creation of an efficient and cohesive incident management system.

4. EVALUATING ALTERNATIVES

Once a list of initial alternatives has been generated, these alternatives must be evaluated to determine which options would be most successful under the given conditions. These alternatives must not only be evaluated in relation to each other, but also in relation to available resources and agency and jurisdictional limitations. A more detailed description

of the Seattle area evaluation process as applied to specific incident management options is presented in a later section of this document.

This evaluation can be either formal or informal. A less formal evaluation procedure is appropriate for selection between incident management techniques that are reasonably similar or extremely dissimilar and where only one agency is impacted by management actions. Formal evaluation is needed when the differences between alternatives are less distinguishable and the scope of impact is larger.

Regardless of which evaluation technique is chosen, its selection should be based upon the costs and benefits accrued by the public, as well as the costs and benefits accrued by the operating agency.

In the Seattle area, WSDOT officials opted for an informal evaluation of the incident management alternatives available for implementation. Some of the issues considered in this informal evaluation included the following:

- existing jurisdictional issues at both the administrative and field response levels;
- the legal ramifications involved at each level;
- the geographic constraints of the area;
- the availability of resources, including equipment, staff, and funding;
- operational issues such as the level of inter-agency communications that currently existed, as well as the level required for each of the alternatives;
- the decision making responsibilities during the implementation and operation phases for various program types;
- the training required to successfully operate the program; and
- administrative issues such as the coordination of multiple agency programs.

This informal yet comprehensive analysis was deemed sufficient in place of a more formal traffic analysis, which would have been more difficult, time consuming, and expensive to conduct.

By considering the various areas that would be impacted by the implementation of an incident management program, WSDOT officials were able to substantially reduce the number of incident management alternatives considered for implementation. The programs that seemed best suited to meet the desired goals and objectives in the initial evaluation are described in the following section.

5. SELECTING ALTERNATIVES

Once the list of initial alternatives has been reduced to a manageable number of options, alternatives can be successfully selected. It should be noted that in many instances, a combination of alternatives may be better than a single alternative. For example, three lower cost options, when examined alone, may not provide a great benefit. However, when these options are combined, they may be more comprehensive, and thus more successful, than a higher cost alternative.

As mentioned previously, specific factors to consider when alternatives are chosen include jurisdictional issues, geographic constraints, available resources, operational procedures, training requirements, and administrative coordination. In any case, the system chosen should be flexible and capable of adjusting to meet changing circumstances.

Initial options considered for the Seattle area included programs attempted only in other areas of the United States, as well as expansion of some programs currently operating in the Seattle metropolitan area. The initial programs under consideration are listed in Table 3.

The first step in the selection process was to look at current programs and determine which of them were operating successfully, which could operate successfully with minor modifications, and which would be more cost effective to discontinue. The modifications that resulted are discussed below.

Seattle area agencies thought that the timeliness and accuracy of motorist information could be improved if closer ties were developed between local media agencies

Table 3. Initial Incident Response Options Considered in Seattle

EXPANSION TO EXISTING PROGRAMS					
	Incident Detection	Incident Response	On-Site Management	Incident Clearance	Motorist Information
Alternate Routes		X		X	
Improved Media Ties					X
Highway Advisory Radio					X
Variable Message Signs					X

NEWLY INTRODUCED PROGRAMS					
	Incident Detection	Incident Response	Off-Site Management	Incident Clearance	Motorist Information
Accident Investigation Sites				X	
Equipment Storage Sites		X			
Improved Interagency Communication		X	X	X	
Incident Management Teams		X	X	X	
Personnel Training Programs		X	X	X	
Total Station Surveying				X	
Traffic Management Teams		X	X	X	X

and the TSMC. Thus, a direct line of communication for both radio and television broadcasts was deemed necessary.

Improvement was also deemed necessary in the area of highway advisory radio. A new emphasis was to be placed on keeping the recorded message accurate and up to date.

Lastly, new variable message signs, both permanently mountable and portable, were to be purchased and utilized in high incident areas to better inform motorists of upcoming congestion.

In cooperation with the increased number of variable message signs, alternate routes were to be designated in hopes of diverting some traffic around the incident site and reducing the delay experienced by motorists in the backup.

Along with the proposed expansion of existing programs, a variety of new programs were initially considered. The development of accident investigation sites seemed ideal for improving clearance efforts. These strategically located sites would allow vehicles involved in the incident to be cleared, either by towing, pushing or driving a short distance, away from the roadway to prevent unnecessary congestion. At the accident investigation site the required accident reports could be filled out without the accident participants being endangered by flowing traffic or causing secondary accidents.

Equipment storage sites were also considered to be a way of reducing the time required to adequately respond to an incident. If equipped properly and fully utilized by all incident respondents, equipment storage sites could substantially reduce response times.

Integral to any program is an adequate level of communication between all respondents. Thus, a top priority program was to improve interagency radio communication, especially between Washington State Department of Transportation and Washington State Patrol employees.

The formation of incident management teams would require the highest concentration of resources, but the anticipated benefits deemed it necessary. Response,

on-site management, and clearance efforts would clearly benefit from a well-equipped, highly trained group of individuals.

Closely related to the development of incident response teams was the development of personnel training programs. With better trained respondents, incident management measures could be carried out in less time, reducing the overall impact of the incident. Decision makers also realized that cooperative training sessions with representatives from various responding agencies (e.g., Washington State Patrol and Washington State Department of Transportation) would be especially beneficial.

New technologies such as infra-red total station surveying instruments could be introduced to further improve incident management efforts. Washington State Patrol would benefit from the use of this equipment because of the dramatic reduction in time required for accident investigation. Washington State Department of Transportation would also benefit from the implementation of this equipment, because its use would greatly reduce both the time and the need for road and lane closures.

Lastly, to oversee the implementation and operation of both the existing and newly developed programs, administrative traffic management teams would be formed. These entities would help provide the necessary resources required for the operation of the incident management programs implemented and would ensure that agency goals were consistent with local, regional, and state incident management goals, as discussed in Chapter 2. Unlike incident management teams, administrative traffic management teams do not respond to incidents, but work behind the scene to provide the necessary resources for those that do go out in the field.

The specific alternatives selected for implementation are discussed in a later section of this document.

6. IMPLEMENTING ALTERNATIVES

After the selection process is complete, the alternatives can be implemented. However, the implementation process operates much more efficiently if some type of prioritization has already taken place. Since implementation is a step by step process, prioritizing allows the proper resources to be allocated to ensure that the steps that will be most cost effective are implemented first. The more risky alternatives can then be developed more slowly and carefully.

Perhaps the most frustrating aspects of the implementation process are securing funding, changing existing operational procedures, and developing strong interagency communication and cooperation. However, these aspects are also vital for ensuring the successful implementation and operation of any incident management program.

To ease the frustration of the implementation process, an agency may want to allocate a knowledgeable, dynamic, highly motivated individual full time to this effort. This individual is responsible for the development of the necessary interagency agreements, the funding of management measures, jurisdictional disputes, response boundaries, field crew response guidelines, field crew training, communication among agency personnel both before and after arrival at the incident site, and the command structure at the incident site.

Support from upper management must be strong in order for this individual to secure funding for project implementation; solve problems that require authority approval; adjust management measures; and create the incident management system, both within the agency and between the agency and cooperating agencies.

In the Seattle area, this person, the Incident Response Engineer (IRE), has been invaluable in initiating improved incident management efforts for WSDOT District 1 (the Seattle metropolitan area). This person had been involved in freeway operations for nearly 26 years and was well aware of the traffic impact's of incidents. The IRE is currently

stationed at the Traffic Systems Management Center, where the electronic loop detection and video/CCTV surveillance systems are located.

The IRE's dedication to the program has been immense. In addition to working 40 hours a week, he has been on call 24 hours a day, seven days a week as part of the incident management team program.

As was mentioned previously, one of the main tasks for an individual in charge of developing an incident management program is to resolve any disputes that arise, whether the disputes are between agencies, such as WSDOT and WSP (jurisdictional competition, etc.), or within an agency itself (budget competition, etc.). Usually these disputes can be resolved through frequent coordination meetings that are attended by upper management representatives from all responding agencies, field response personnel from the various agencies, and the person in charge of incident management development.

Issues regarding the availability of resources and funding alternatives are also discussed at the coordination meetings so that all responding agencies can offer input and have the opportunity to enter into resource sharing agreements.

In Seattle, the IRE is responsible for personnel training. He can easily monitor the progress of field response personnel because he is responsible for any on-site management that takes place at any major incident scene. He can not tolerate slow, improper, or unsafe response actions because he will most likely be held accountable.

A more detailed account of the implementation procedures for each of the alternatives is provided in a later section of this document.

7. RE-EVALUATING ALTERNATIVES

Once the programs have been fully implemented and are operational, the incident management system should be re-evaluated to judge the level of success of the newly introduced programs.

The success is most easily measured if data were collected before their implementation. Factors to observe include incident detection times, incident response times, incident clearance times, vehicular delay, and the actual cost of implementing and operating the program(s).

It is best to develop an ongoing monitoring system that reviews the success of programs in operation so that the incident management system can be continually refined with changing conditions. WSDOT officials are currently seeking funding to initiate such a system.

8. REFINING THE SYSTEM

Because of ever changing traffic conditions, urban growth patterns, technologies, and political viewpoints, any incident management system will need to be refined. These changes can be easily detected if an ongoing incident management monitoring system has been developed. Changes detected by field response personnel must be effectively communicated to upper management if they are to properly adjust to the system.

The end result should be a constantly evolving incident management system that continues to (1) improve management efforts, (2) adapt to the changing needs of the local area, and (3) meet the needs of the participating agencies, jurisdictions, and motoring public. Because many of the incident management programs in the Seattle area are still in the developmental stage, it is too soon to tell whether any major refinements will be necessary.

CHAPTER 3

OBSERVING THE DEVELOPMENT OF SPECIFIC PROGRAMS IN SEATTLE

The last chapter provided a general description of the application of the systems approach to development of an incident management system in the Seattle area. This chapter will look in detail at some of the steps involved in the process. Specifically, it provides a detailed description of the evaluation, implementation, and re-evaluation processes for each of the incident management programs identified for implementation early in Seattle's development process. These programs are listed in Table 4 and are addressed alphabetically below.

ACCIDENT INVESTIGATION SITES

Initial Consideration of the Option

An accident investigation site is a turnout from the freeway mainline. This turnout provides the motorist(s) and police personnel with a place to fill out accident reports and possibly place telephone calls.

Accident investigation sites require a minimum area of 1,000 square feet. This area must be designed to allow five typical vehicles to park easily. The surfacing of the area may consist of dirt/gravel, asphalt concrete, or concrete, depending upon the location and site conditions. Utilities for electricity must be accessible to provide security lighting. Signing is required to notify the motoring public of the existence and use of this facility.

Specific issues to consider when implementing an accident investigation site are as follows:

(1) administration issues including construction, maintenance, and operational responsibilities;

(2) location and design issues prioritized in terms of impacts and available funding;

Table 4. Incident Response Options Implemented in Seattle

EXPANSION TO EXISTING PROGRAMS					
	Incident Detection	Incident Response	On-Site Management	Incident Clearance	Motorist Information
Alternate Routes		X		X	
Improved Media Ties					X
Highway Advisory Radio					X
Variable Message Signs					X

NEWLY INTRODUCED PROGRAMS					
	Incident Detection	Incident Response	Off-Site Management	Incident Clearance	Motorist Information
Accident Investigation Sites				X	
Equipment Storage Sites		X			
Improved Interagency Communication		X	X	X	
Incident Management Teams		X	X	X	
Personnel Training Programs		X	X	X	
Total Station Surveying				X	
Traffic Management Teams		X	X	X	X

☐ = Programs which were implemented after fulfilling initial evaluation requirements.

☐ = Programs abandoned after initial evaluation.

(3) legal issues regarding the transference of vehicles and insurance; and

(4) public education to achieve maximum usability of the facility. (11)

Evaluation of the Option

The initial plan for the Seattle area called for five sites along the northern Interstate 5 corridor: Northgate (2), 45th Street (2), and Mercer Street (1) (see Figure 8). Because of budget constraints, the plan was reduced to only three: 45th Street (1) and Northgate (2). After further evaluation, accident investigation sites were deemed economically unfeasible because of space limitations. Most of the critically impacted areas initially considered were also characterized by limited space and poor geometrics, making implementation of a large facility difficult and not worth further pursuit.

ALTERNATE ROUTE PLANNING

Initial Consideration of the Option

In the case of a lane blocking incident, alternate routes can be used to help mitigate the impacts of the incident on the motoring public. Their use requires prior analysis of the freeway corridor. All responding agencies must then be made aware of the presence of these alternate routes. Such routes require adequate temporary or permanent signing at key locations to make them easily identifiable and accessible to the motoring public.

Evaluation of the Option

After further evaluation, WSDOT officials decided that alternate routes would provide some relief. However, congestion was already present on the alternate routes, severely reducing the benefit that would result from such a program. Also, the choice of alternate routes was limited because of numerous geographic constraints in the Seattle area (e.g., Lake Washington) (see Figure 9). Thus, original plans to develop large scale alternate routes were abandoned.

However, a renewed interest has been sparked in developing these diversionary routes, especially in high incident locations in South King County. It was realized that the

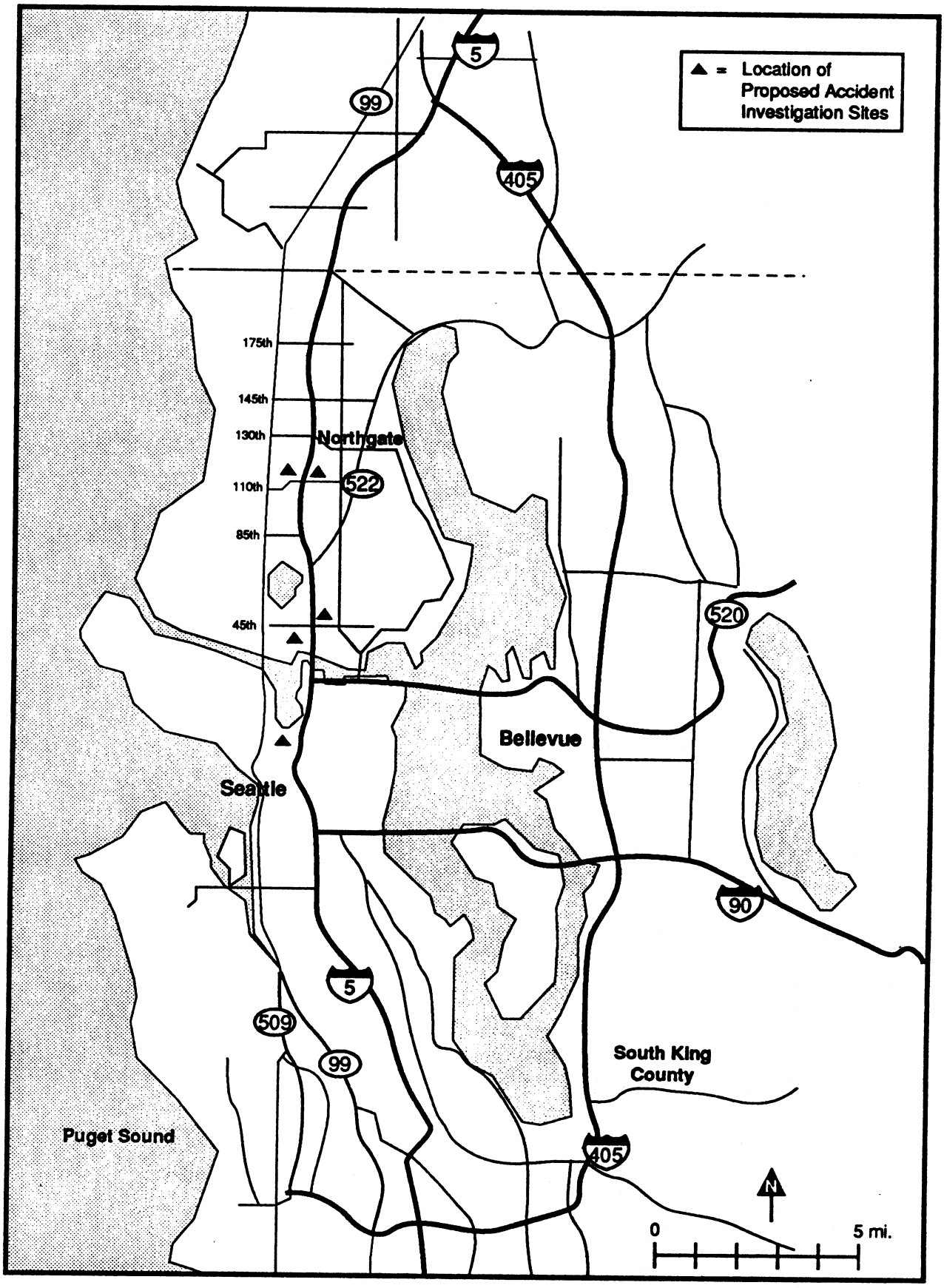

Figure 8. Proposed Accident Investigation Sites for the Seattle Area

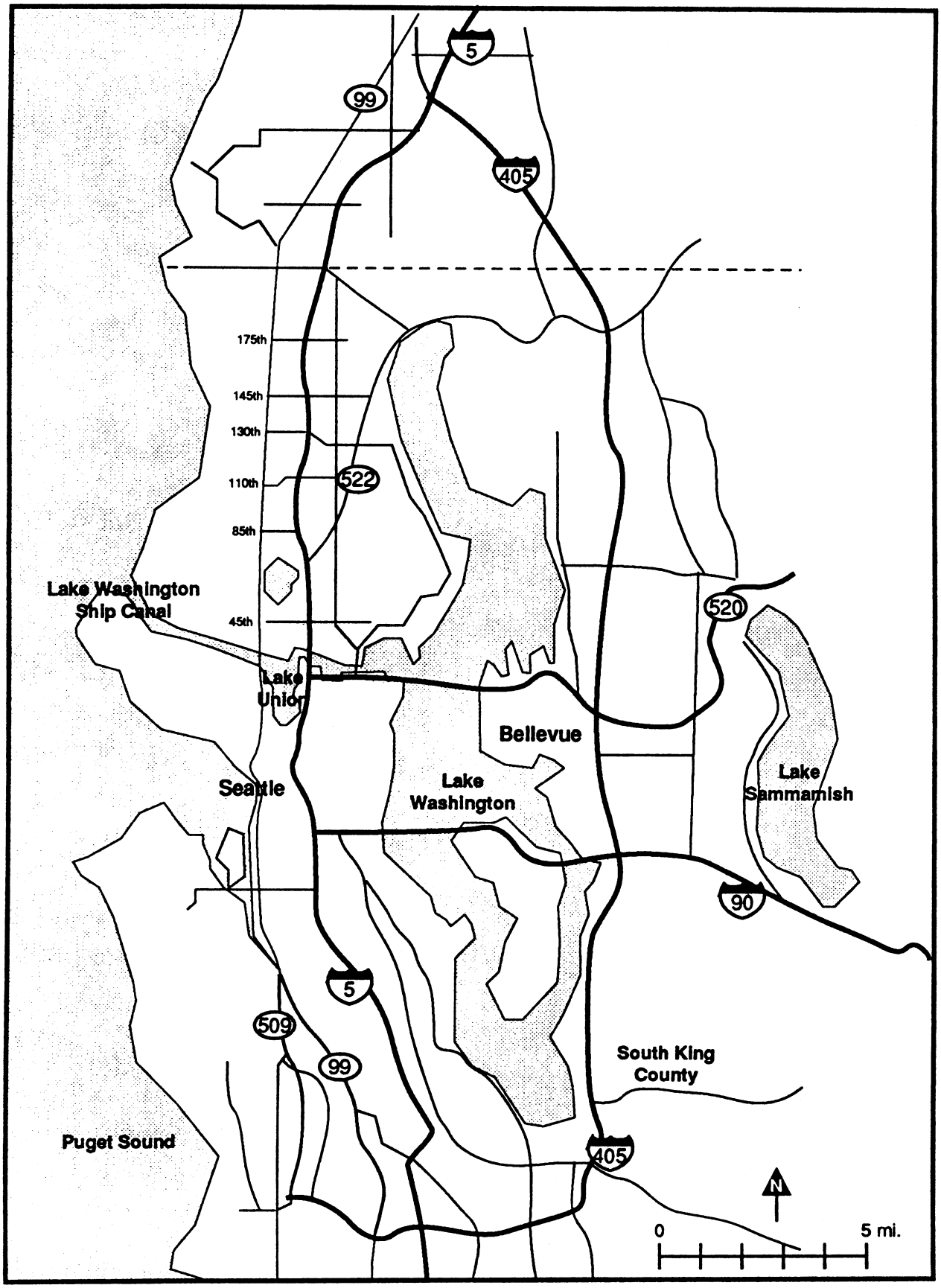

Figure 9. Geographic Constraints in Seattle Area

main reasons for abandoning this option were geographic constraints and capacity limitations on the possible alternative routes. In south King County, these factors do not pose as great a problem since fewer geographic constraints exist and there is less congestion on the arterial streets.

EQUIPMENT STORAGE SITES

Initial Consideration of the Option

Equipment and materials can be stored at key locations near areas that suffer from high incident rates. These facilities greatly reduce response time to an incident if they are easily accessible and used by all responding agencies. Cooperative agreements may be developed to provide the equipment available, the agency responsible for keeping the facility stocked, and the agency responsible for the initial costs associated with the facility.

Evaluation of the Option

A request for equipment storage sites originated with Washington State Patrol officers. In the event of a small spill or incident, a WSP officer on the scene would request maintenance personnel from WSDOT to come to the scene of the incident to deliver small equipment or supplies that WSP officers did not have in their vehicles. Typical requests included a broom for sweeping up broken glass, absorbent pads, and cones or signing paddles for simple traffic control.

Initial assessment indicated that the equipment storage site concept had potential but had to be expanded to better service the study area. However, this expansion was severely limited because of space constraints in the highly developed commercial areas. In addition to the physical construction and maintenance involved with these facilities, sufficient interagency promotional support is needed to accompany their introduction. This support may be accomplished through periodic flyers sent to Washington State Patrol to remind them of the location and availability of the equipment within these facilities. Another possibility is to have initial training sessions with WSP (assuming WSDOT has been

charged with implementing and operating the equipment storage facility) on the use of the stored equipment to further familiarize the officers with the facility.

Implementation of the Option

The pilot program began in October 1988 under the direction of the Urban Construction Engineer at the Washington State Traffic Systems Management Center. Located at the junction of Interstate 5 and State Route 520 (see Figure 10), the storage site seemed to be in an ideal location, and use of the facility seemed promising.

The facility consisted of an outdoor storage closet at the Traffic Systems Management Center. The lock was removed from the door for easy access (vandalism was not a concern). Shelves were constructed, and it was stocked with traffic control devices such as cones and signing paddles and clean up supplies such as absorbant material, shovels, brooms, and other supplies not usually carried in the transportation or police agency response vehicles.

Upon its opening in November, the facility was used frequently because of unexpected snow storms in the winter months. The supplies that were used included flares, sandbags and shovels. However, as soon as the inclement weather had receded, the use of the facility declined.

Another coincidental occurrence that may have added to the decline in usage was that the WSP eliminated its special assignment trooper position. The officer in this position would have been responsible for incident management operation and would have become familiar enough with the facility to use it often or recommend its use.

Re-Evaluation of the Program

One improvement deemed necessary after brief operation of the program was to make sure that the WSP officers were made aware of the existence and location of the facility and were periodically reminded. Another improvement was to make the sites more accessible. An initial thought was to locate them near the on ramps of high incident sections of the freeway.

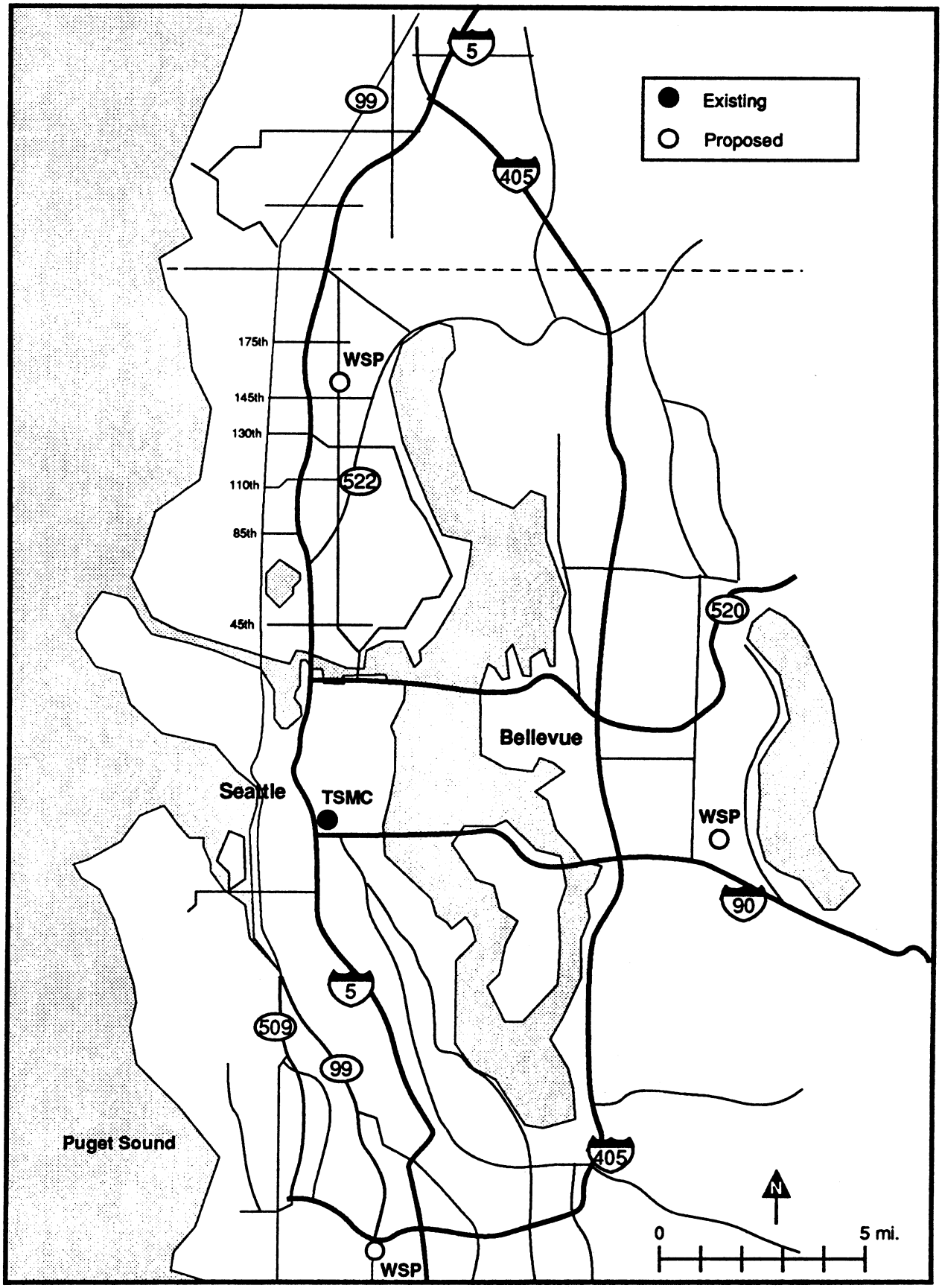

Figure 10. Proposed Equipment Storage Sites in Seattle Area

However, after continued operation with fully implemented incident response teams, a better plan of action appeared to be to locate the equipment storage sites at the Washington State Patrol offices. The equipment and supplies used by the incident response teams could be carried in their incident response vehicles, so it made sense to locate the storage sites where WSP could most easily access them.

Current plans consist of constructing three more equipment storage sites, one at each of the north, south and east State Patrol offices, as well as the continued operation of the facility at TSMC (see Figure 10).

The contents stored at these facilities will be changed to include only kitty litter, absorbent pads, fluorescent marking paint, plug and dike materials, and small booms. Other equipment should already be available in the incident response team vehicles.

Further evaluation showed that the most effective way to operate this program might be to develop a mobile equipment storage site. This would consist of one or more vehicles fully equipped with all necessary response supplies not normally carried by transportation or police respondents. This vehicle could easily be summoned to the incident site by radio. This would eliminate the delay associated with loading the necessary materials or equipment into the vehicles from a permanent, stationary facility. No action has been taken toward developing such a program.

HIGHWAY ADVISORY RADIO

Initial Consideration of the Option

Highway advisory radio (HAR) is a dedicated radio frequency that can provide traffic and alternate route information during congested periods. Several variations exist, including the HAR Portable System (HARPS), which is contained in its own trailer for ease of movement but is best suited for monthly projects, and the HAR Truck System (HARTS) which is mounted on a truck and can be moved easily.

Evaluation of the Option

Evaluation of additional investments in highway advisory radio revealed very little evidence to oppose it. This system is not a new technology and has been successfully used in both Seattle and across the United States, making it a low risk alternative. The HAR system is also relatively inexpensive in relation to other possible alternatives. The Federal Highway Administration saw merit in expanding the highway advisory radio system in the Seattle area and agreed to provide the funding to expand the current system as a demonstration project for the rest of the country.

Implementation of the Option

Seattle successfully developed a relatively extensive highway advisory radio system, which now addresses nearly all major interchanges, as well as the downtown corridor. Figure 11 depicts Seattle's advisory radio system, including the locations of the HAR transmitters and the informational signs with beacons that inform the public of special messages.

When an incident occurs, information is relayed to WSDOT highway radio by either WSDOT or WSP personnel. The radio operator updates the HAR message and this information is then relayed to the motoring public through the highway advisory radio broadcasts. When the incident has been cleared, WSDOT highway radio is again contacted so that the message may be deleted and normal traffic flow can resume. Often, follow up is conducted by sending a WSDOT vehicle out to the HAR vicinity and a WSDOT representative reports existing conditions via radio to the HAR base to ensure that the information is timely and accurate.

Re-Evaluation of the Program

Currently, the program is operating as anticipated, and no plans exist to upgrade or increase the highway advisory radio system.

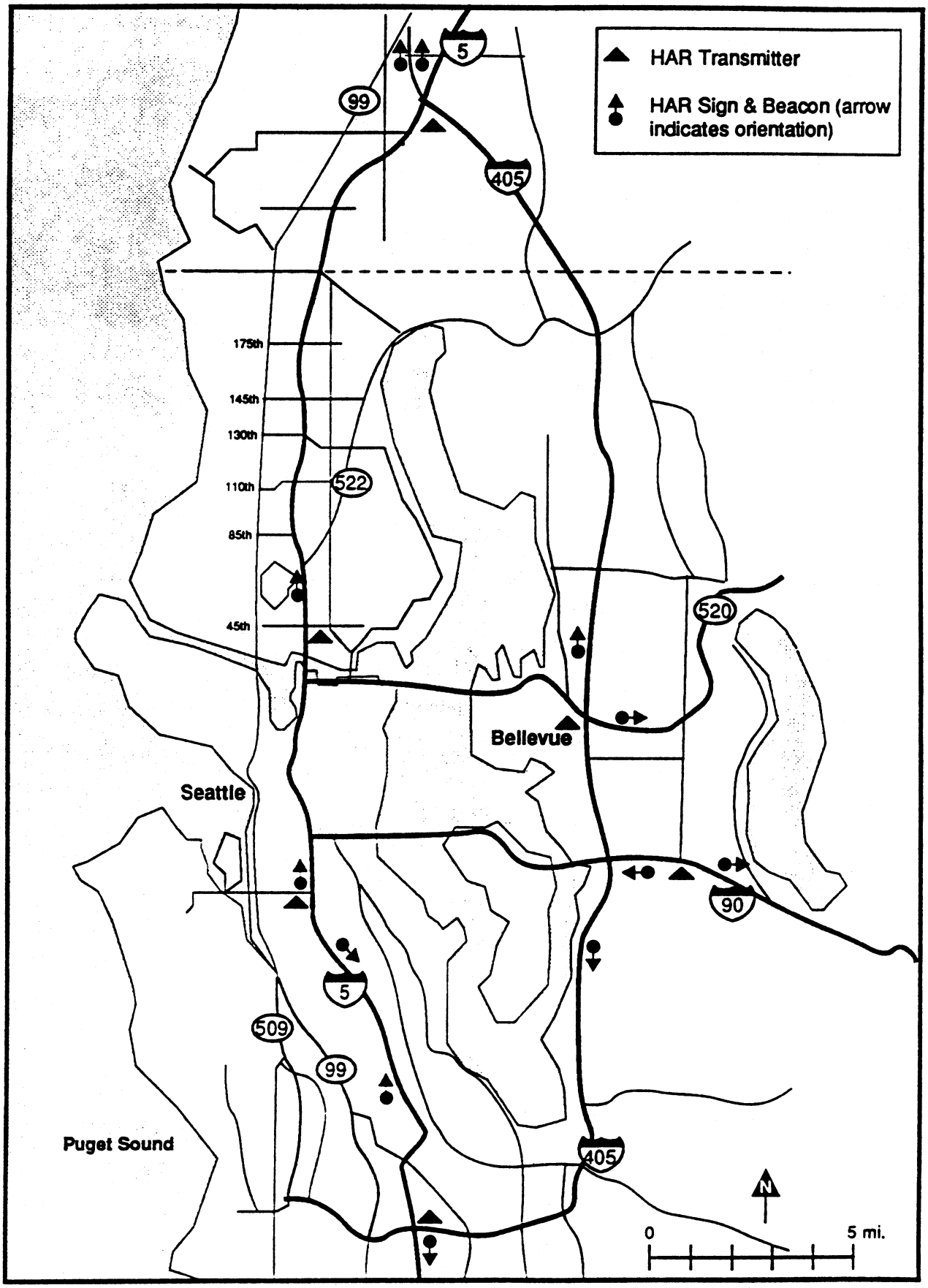

Figure 11. Seattle Area Highway Advisory Radio Sites

IMPROVED INTERAGENCY RADIO COMMUNICATION

Initial Consideration of the Option

Radio communications among various responding agencies can be improved. Such improvement may require the purchase of compatible radio systems that are two-way operational. Often radio systems allow one agency to listen to the communication taking place between another agency's respondents but the first agency is unable to give outgoing messages (e.g., respondents from WSP can communicate with each other and WSDOT respondents can hear this communication but cannot speak directly to WSP respondents via radio). It may also be accomplished with the installation of cellular phone systems. However, to be successful, each respondent must be able to communicate with any other respondent, and they must use a common radio language or lingo that all understand. Once this capability has been acquired, much time can be saved because repetitious commands and indirect communications are eliminated.

Evaluation of the Option

There are few disadvantages to investing in improvements to interagency radio communication. An enormous time savings, along with improved interagency relationships, result for a relatively minimal expense. Encouragement must be provided once the program has been implemented to break the practice of communicating only within one's own agency and to further initiate interagency communications.

Implementation of the Option

In an effort to improve interagency communications at the incident scene, an increased emphasis has been placed on the use of the On-Scene Command and Communication Radio Network (OSCCR) in the Seattle area.

OSCCR is a dedicated, on-site emergency radio frequency used by agencies at the scene of an incident. OSCCR provides all responding agencies an opportunity to quickly communicate the details of an incident; however, limitations have been placed on its use,

since it may interfere with other channels. No base stations are allowed, or even necessary, since the portable OSCCR units can transmit and receive over a range of 1 mile, and the mobile OSCCR units can transmit and receive over a range of 5 miles.

Permits are required for operation and, in the Seattle area, can be obtained from the Department of Emergency Management. A letter of authorization from WSDOT is also required. If for any reason the use of this dedicated radio frequency is abused, the permit can be revoked.

Currently, the agencies authorized to use OSCCR in the greater Seattle area include WSDOT, WSP, King County Emergency Medical Services, and nine fire districts. No formal training is required to use the system.

Cellular telephones also exist in several of the respondent's vehicles to aid in communication efforts outside of the range specified by the OSCCR system. The cellular telephone numbers are made readily available to all responding agencies to encourage interagency communication.

Re-Evaluation of the Program

At this time, no major investments in alternative systems or improved operations are planned. The system is deemed very successful in its ability to improve the level of communication among the responding agencies.

INCIDENT MANAGEMENT MANUAL

Initial Consideration of the Option

An incident response manual can be developed to improve efficiency at the incident site. This set of guidelines should be cooperatively developed by all responding agencies because agency input is required to compile accurate procedural steps. Once they have been completed, these guidelines should be distributed to all responding personnel and should be incorporated into regular training sessions.

Evaluation of the Option

When evaluating this option, WSDOT officials could foresee difficulty in gaining the cooperation of all agencies involved with incident response. However, this drawback was not large enough to prevent the development of an incident management manual.

Although the concept of an incident management manual is fairly new, the information to be contained within it has been around since incident management practices began. Therefore, the ultimate purpose of the manual is to compile and organize existing information into a usable format. Plans were set to begin development of this low cost, low risk option in early June 1990.

Implementation of the Option

After much discussion between the University of Washington researchers charged with developing the manual and representatives from the Washington State Department of Transportation and Washington State Patrol, a more specific purpose for this document was defined.

As a training guide, the incident management manual should include (1) a description of the types of decisions respondents would be forced to make (2) a summary of the available options, and (3) a description of the way in which the appropriate response to various situations should be chosen.

As a resource document, the incident response manual should include (1) a list of the equipment and resources available for use by incident respondents (2) the procedures for requesting and using those resources on short notice, and (3) procedural checklists for various incident types, including those involving hazardous materials.

More specifically, the information regarding equipment and resources should include the following:

- the ownership of the equipment or resources,
- normal location of the equipment or resources,
- geographic limitations to their deployment,

- types of incidents for which they should be used,
- procedures required to request them for response,
- existence of an agreement for their use, and
- cost of their use.

Also helpful was a list of equipment that was potentially useful but was currently not available and an outline of the steps required to make that equipment available for use. Agencies that were included in this survey were the Washington State Department of Transportation, Washington State Patrol, Washington State Department of Ecology, Washington State Department of Emergency Management, participating cities and counties, and the private sector.

Several difficulties arose when information was gathered for this manual. First, it was difficult to determine a format for the manual that would allow it to be comprehensive enough to include the required information and yet small and portable enough to be usable in the field. It was determined early on that the manual would only include WSDOT response procedures. Including non-WSDOT procedures would make the manual too cumbersome. To further maximize the utility and usefulness of this document, two different formats were planned. For easy office reference, the document was formatted as a standard 8-1/2" by 11" size. To make the document easy to page through and find information in the field, the format was reduced to glovebox size. The smaller size would also make the incident management manual distinguishable from other documents possibly stored in the field response vehicle.

A second difficulty was encountered in the data collection phase. Agencies that were not directly involved in the process of developing the incident response manual were initially very suspicious when questions were asked about their response practices. They were hesitant to reveal any information for fear of revealing improper response procedures.

Lastly, some difficulty was encountered in convincing the experienced incident response personnel to document their procedures. They had to understand that the

document was intended to introduce new personnel to field response practices and to ease the process of changing existing procedures. It was not intended to serve as a set of rules that the experienced respondents were required to follow under all conditions.

Re-Evaluation of the Program

At this time, little input on improvements to these documents are available because they are still in draft form and have not yet been fully implemented.

INCIDENT RESPONSE TEAMS

Initial Consideration of the Option

Incident response teams are interdisciplinary teams trained in handling unusually large or severe incidents. The teams may be staffed by volunteers from each of the responding agencies (i.e., transportation, police, fire and rescue), but someone must be available to coordinate all of the responding volunteer personnel.

Evaluation of the Option

When WSDOT officials evaluated the appropriateness of this option, information obtained in the pre-implementation study greatly influenced the outcome. The results of the pre-implementation study indicated that a majority of the incident related congestion occurred because of poorly managed operations at large incident sites. The implementation of incident management teams might serve to mitigate this problem by improving on-site management efforts and by reducing the clearance times required at large incidents.

Because an incident response team would be relatively labor and equipment intensive, WSDOT emphasized implementing a small initial program, sharing as many resources as possible with other agencies, and monitoring the success of the program throughout its operation. This would help to ensure that incident management monies were applied toward an effective program that resulted in measurable improvements in the flow of traffic.

The efficient use of funds was particularly important because a new budget was created to support the implementation and operation of this program. This budget competed with other budgets within the WSDOT for additional or continued funding.

Implementation of the Option

The Seattle area's incident response team program began operation in early 1990 with a single incident response engineer based at the Traffic Systems Management Center (TSMC) and a small group of maintenance technicians from each of the various maintenance offices in the greater Seattle area (see Figure 12).

After approximately 10 months of operation, a second incident response engineer was added. However, only one of the incident response engineers is dedicated to incident management operations. The second engineer acts as a backup in case of sickness or injury.

The responsibilities of the incident response engineer include establishing any required traffic control, establishing a command post at the incident site, and developing a staging area for the responding equipment if necessary.

Traffic control is an especially important responsibility for the incident management teams because, if properly performed, it serves to (1) prevent any secondary accidents that may result, (2) channel traffic around the incident to reduce traveller delay, and (3) ensure the safety of the people working at the incident scene.

This third responsibility, ensuring worker safety, cannot be implemented overnight. It requires time and successful repetition to gain the trust of the other agency respondents and to convince them that the presence of the incident response teams will free them to complete their own tasks more efficiently.

As mentioned previously, members of the incident response teams are not multidisciplinary. Instead, they consist of WSDOT maintenance technicians led by the Incident Response Engineer (IRE). Currently, 25 to 30 maintenance technicians work on a rotational basis to reduce the time commitment of any one individual. The response

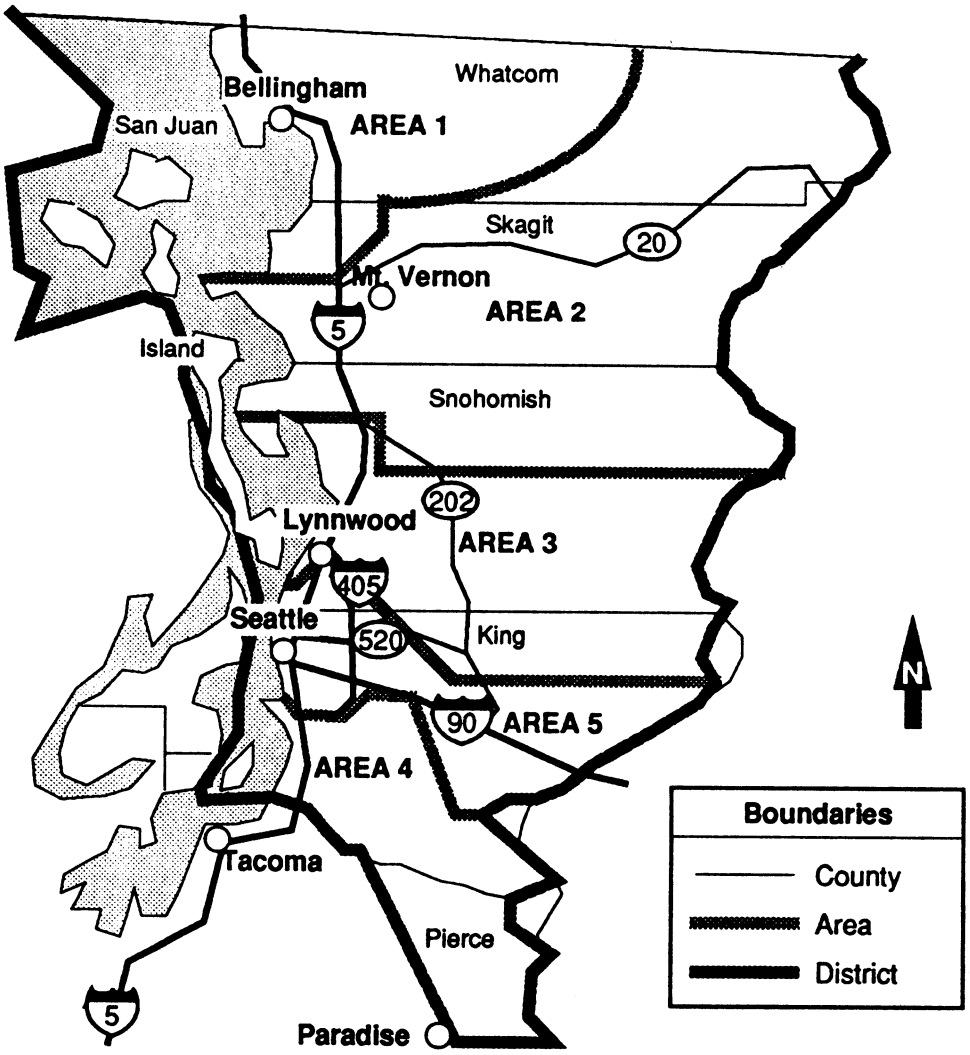

Figure 12. Maintenance Areas within WSDOT'S District 1

volunteers work as regular maintenance technicians but can be called away at any time during the day or can be contacted around the clock to respond to incidents.

Currently, the only training received by the maintenance technicians in addition to their regular WSDOT training is a general briefing regarding the use and care of equipment contained within the incident response vehicle. All other training is received essentially on-site under the guidance of the IRE.

The vehicles operated by the maintenance technicians were specially designed and include an arrow board mounted at the rear of the truck, a push bumper, spotlights, and an amber light bar. The vehicles carry containment materials, traffic control devices, communications equipment, and other materials. A list of the specific items is given in Table 5. Some delay was experienced in obtaining the vehicles because of the unusual requests for equipment. The cost of each vehicle was approximately $35,000.

The problems that were encountered during the implementation of the incident response team program stemmed not from anticipated interagency disagreements, but instead from disagreements within the WSDOT. After brief operation of the program, the IRE was able to easily recognize the procedures that were successful and those that were not, as well as other equipment and materials that would benefit the operation. However, he had difficulty convincing upper management of the need to invest further in the incident management program or to change the existing procedures. The IRE attempted and continues to attempt to mitigate these disagreements by accompanying representatives of upper management in the field so that they can see for themselves how the operation is working.

While upper management must be open to suggestions from those involved directly in the incident response process, the Incident Response Engineer must remember that the program needs to develop incrementally to remain successful.

A second problem within WSDOT concerned the use of maintenance technicians for incident response. Complaints were registered over discrepancies between the WSDOT

Table 5. Materials Contained in Incident Response Vehicles

Containment Materials

- trash can full of absorbent
- trash can full of sand
- trash can full of diapers (white foam pads used to absorb diesel or oil
- shovel
- broom
- coveralls
- spotting scopes (as opposed to binoculars)
- hard hats

Traffic Control Devices

- traffic cones
- pylons with hashboards (for ramp closures)
- arrowboard mounted above the truck
- traffic vests, 3 or 4 extras
- flashlight with fluorescent cones (for flagging)
- warning signs
- reader board for instructions regarding detours

Communication Devices

- cellular telephones
- radio (low and high band), 3 or 4 extras

Other Equipment

- marking paint
- fuses
- camera and film
- flares
- backpack air blower (to remove glass from scene)
- push bumper
- spotlights
- light bar
- electrical generator
- computer with personnel contact list and phone numbers
- *1987 Emergency Response Guide (for HAZMAT situations)*
- *MUTCD*
- *ATSA Guide for Work Area Traffic Control*
- Thomas Brothers Map
- WSP-style first aid kit
- two large fire extinguishers (20 BC or larger)
- spare fuel can (5 gallons)

districts in which the incident occurred and the maintenance district from which the technicians were called, and a lack of information to upper maintenance management in the event of an incident.

The first of these complaints was addressed through a general education of the maintenance supervisors. The importance of achieving the quickest response to the incident was emphasized time and again. During regular maintenance work hours, the IRE could fairly easily request technicians from the same maintenance district in which the incident occurred. However, after the regular work day, maintenance technicians departed from their homes, which might not necessarily have coincided with their assigned maintenance districts. Because of this, the IRE kept a list of both maintenance office locations and maintenance technician's residences to ensure the quickest response time to the incident in both daytime and nighttime conditions.

The second complaint, a lack of information to upper maintenance management, was remedied through the development of a standard procedure for calling maintenance supervisors at the time of the incident. Often, these calls must be made in the early hours of the morning. Many of the maintenance supervisors have accounted for this by installing answering machines in their homes. As long as they have received word of the incident before the next working day has begun they have been satisfied with the operation of the system.

Outside of WSDOT, other agencies involved in the incident management process clearly recognized the need for improved incident management practices and were very receptive to any cooperative efforts suggested. The only real challenge was to the make the task of contacting the incident response teams and relying on them for assistance an immediate, automatic reaction rather than an afterthought.

Small, usually site specific problems still exist in the operation of this program. In an attempt to quickly remedy these problems, post-incident meetings are held with members from all of the responding agencies to discuss the success of the process.

Specific issues addressed at these meetings include the positive and negative aspects of the operation, possible improvements, and changes required. An effort is made to always end the meetings on a positive note.

Agencies that are usually represented at these meetings include the WSDOT maintenance personnel, Washington State Patrol, fire department and others whose staff interact at the incident scene.

Re-Evaluation of the Program

One of the first noticeable drawbacks of the incident response team program was the immense time commitment required by all team personnel if the program was implemented with limited personnel. Therefore, one of the first improvements deemed necessary, was to assign a number of dedicated maintenance personnel who would perform non-critical maintenance duties but whose main purpose would be to respond to incidents.

The training for these dedicated personnel would be much more extensive than the training then given to the maintenance volunteers. The maintenance technicians made no decisions on their own at the incident scene but followed the guidance of the IRE. The intent for the dedicated personnel was for each person to be able to guide his or her own team through any incident situation. Maintenance technician volunteers could still be used in some capacity to relieve the dedicated personnel and reduce the time commitment involved for the various personnel.

Another improvement that is currently being facilitated is to acquire more specially equipped incident response vehicles and to station them at locations around the region, including the maintenance yards in Kent, in Monroe, at Northrup, at Spokane Street, and at the Traffic Systems Management Center at Roanoke Street (see Figure 13). Spreading the resources over a broader geographic area is anticipated to save response time.

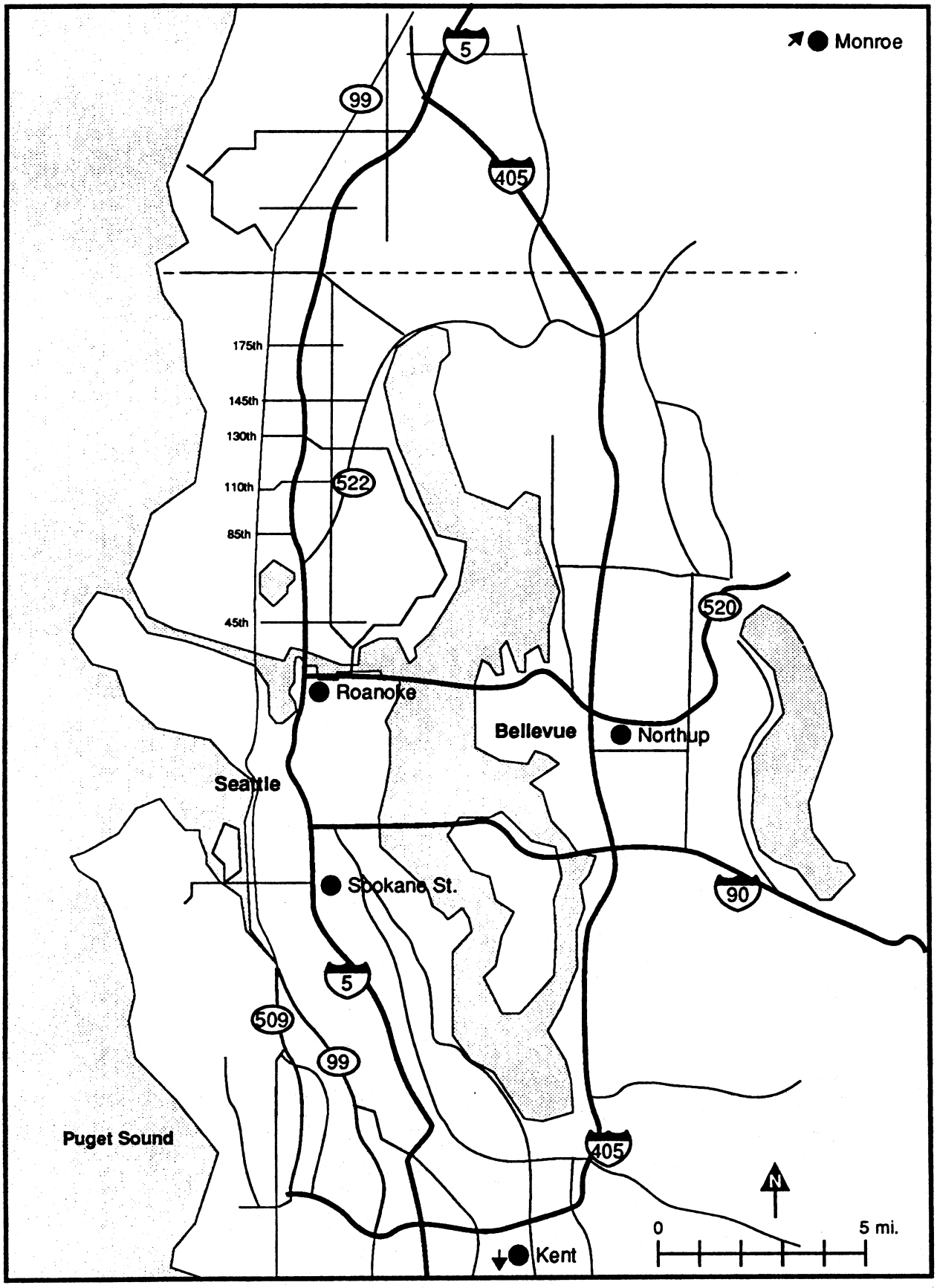

Figure 13. Proposed Response Vehicle Locations in Seattle Area

PERSONNEL TRAINING PROGRAMS

Initial Consideration of the Option

Personnel training programs should not only focus on the required policies and procedures of their own agencies, but also on the policies and procedures of other responding agencies. Because a safe and efficient incident response process is dependent on all responding personnel, these personnel must be aware of each agency's needs and requirements. Such cooperative training programs can serve to greatly improve interagency relationships.

Evaluation of the Option

An evaluation of efforts to improve the training of personnel involved in incident management revealed few disadvantages. Instead, WSDOT officials anticipated relatively high benefits from a minimal initial investment.

Implementation of the Option

Observation of the existing level of training within the WSDOT agency, as well as the training required at other agencies, showed that technical training for respondents was not lacking. Training consists of the following:

- CPR and basic first aid,
- radio communication procedures and terminology for the respective agencies,
- traffic control procedures currently through WSDOT,
- public relation procedures again provided through WSDOT,
- hazardous material identification through WSDOT and cooperating fire departments,
- incident command structure through on the job training,
- equipment use via on the job training,
- departmental procedures and policies via on the job training, and

- fatal or felony accident procedures through the WSP accident investigation team.

What was missing from this seemingly comprehensive list was an understanding of the reasons behind the actions. Thus, one of the first tasks in improving personnel training efforts was to provide a better understanding about the impacts of incidents and the importance of efficient incident management. WSDOT decided that the best medium for conveying this information was videotape.

Once the initial idea had been developed, other applications for this medium became apparent. WSDOT realized that, through video, applications of new incident management technologies or techniques could be demonstrated.

This idea coincidentally developed at the same time that WSDOT decided to acquire total station surveying equipment for the Washington State Patrol. Thus, the topic of a second video tape was determined. The program would describe both the use of the surveying equipment, and the benefits resulting from its use.

Re-Evaluation of the Program

So far, little feedback has been available on the success of these videotapes as informational training tools. Those involved with the development of these tapes anticipate their success and can foresee the use of the videotape medium in future incident management applications.

SURVEYING EQUIPMENT

Initial Consideration of the Option

New technologies such as electronic infra-red, total station surveying equipment can greatly reduce the amount of time police agencies need for accident investigation. Therefore, implementation of this option reduces the need for road and lane closures. Once data have been collected, the data can then be downloaded into a CADD system, which can draw maps of data points and model accident recreations.

Evaluation of the Option

Investment in this new technology was deemed worthwhile by both WSDOT and the Federal Highway Administration. Thus, WSDOT and WSP decided to acquire the equipment through funding provided at a federal level and operate the system as a demonstration program.

Implementation of the Option

Once the equipment had been acquired, introductory training on the use and benefits of the equipment followed. Since the Washington State Patrol personnel were responsible for operating and caring for this equipment, only WSP personnel were involved in the training procedures.

This new technology replaces the base tape method previously used for collecting accident data. In that method, ground measurements are taken with a measuring tape to locate skid marks, debris, sign locations, and other points of interest.

Re-Evaluation of the Program

Noticeable improvements have resulted from use of the total station surveying instruments. Accident investigation times have been reduced from 2 to 3 hours to only 45 minutes. In addition, many more data points are collected. No actions have been deemed necessary to improve the operational aspects of this new technology.

VARIABLE MESSAGE SIGNS

Considering Initial Option

Mounted on trucks or permanent fixtures, variable message signs can communicate special warnings and directional information such as lane closures, traffic diversions, and slow traffic ahead. Several varieties of variable message signs exist, including flap, matrix, and velcro. Regardless of the type of message sign used, a booklet should be compiled listing both standard and unusual messages that may be displayed. This documentation will save time and lend consistency to the program.

Evaluation of the Option

When WSDOT officials evaluated additional investments in variable message signing, they could find little evidence to oppose it. This system is not a new technology and has been successfully used in both the Seattle area and across the United States, making it a low risk alternative. Also, the VMS system is inexpensive in relation to other possible alternatives.

The Federal Highway Administration also saw merit in expanding the variable message sign system in the Seattle area and agreed to provide the funding to expand the system as a demonstration project for the rest of the country.

Implementation of the Option

WSDOT has successfully developed a relatively extensive variable message sign system that addresses nearly all major interchanges, as well as the downtown corridor. Figure 14 depicts Seattle's variable message signing system.

When an incident occurs, information is relayed to WSDOT highway radio by either WSDOT or WSP personnel. This information is then relayed to the motoring public through the variable message signs. When the incident has been cleared, WSDOT highway radio is again contacted so that the message may be deleted and normal traffic flow can resume. Often, a follow up is made to ensure that the information given out is timely and accurate. When the roadways are free of incidents, traffic related information such as traffic information telephone hotline is displayed.

Re-Evaluation of the Program

Currently, the program is operating as anticipated and no plans exist to upgrade or increase the variable message sign system.

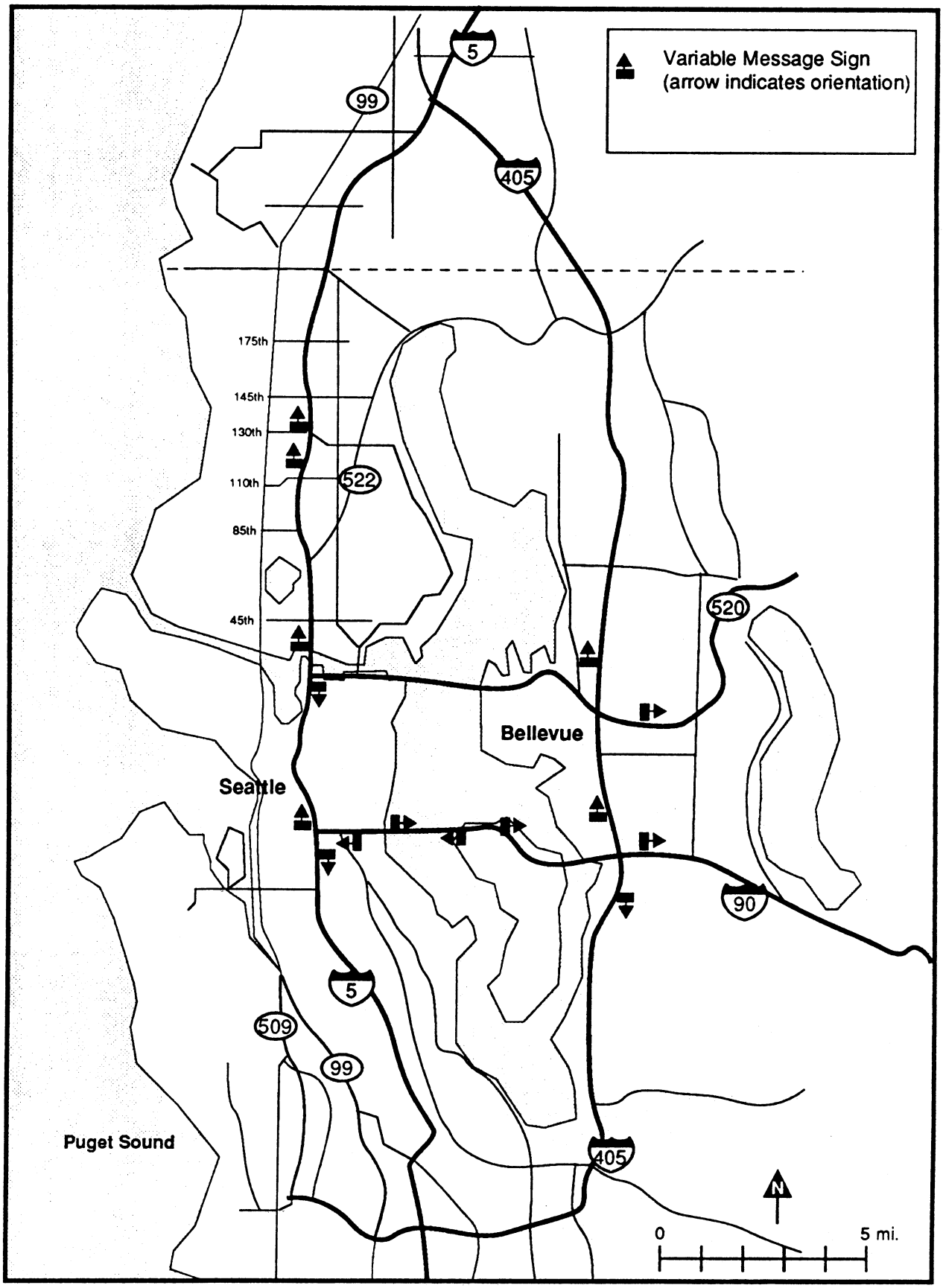

Figure 14. Seattle Area Variable Message Sign Sites

CHAPTER 4

MODIFYING TO ACCOUNT FOR SPECIAL EVENT CONDITIONS

From July 20 to August 5, 1990, WSDOT officials were faced not only with managing the usual delay on Seattle metropolitan streets, but also with managing traffic produced by the 1990 Goodwill Games, a gathering of international athletes competing in a variety of sporting events. These sporting events were to take place in both the Seattle and Tacoma metropolitan areas. Region officials expected the influx of spectators at isolated locations and at specific times of the day to result in gridlock. Incident management was viewed as a way to help prevent this gridlock.

DEFINING THE PROBLEM

The locations that were expected to suffer most from the increased traffic volumes included Husky Stadium at the University of Washington, Cheney Stadium in Tacoma, the Seattle Coliseum and the Seattle Center in downtown Seattle, and the Tacoma Dome in downtown Tacoma (see Figure 15).

Anticipated problem areas included portions of Interstate 5 that ran through the downtown areas of both Seattle and Tacoma and near the sites of the large events. Several of the I-5 structures near these locations had no shoulders. The result would be drastic reduction of capacity in the event of an incident or accident.

SETTING GOALS AND OBJECTIVES

The goal was to mitigate as much of the traffic problems as possible before serious congestion resulted. WSDOT officials looked to quick response and quick clearance measures to assist in the mitigation efforts.

DEVELOPING, EVALUATING, AND SELECTING OPTIONS

Because of the severe time constraints imposed by the upcoming Games, no formal development, evaluation, or selection processes were performed. Rather, the options

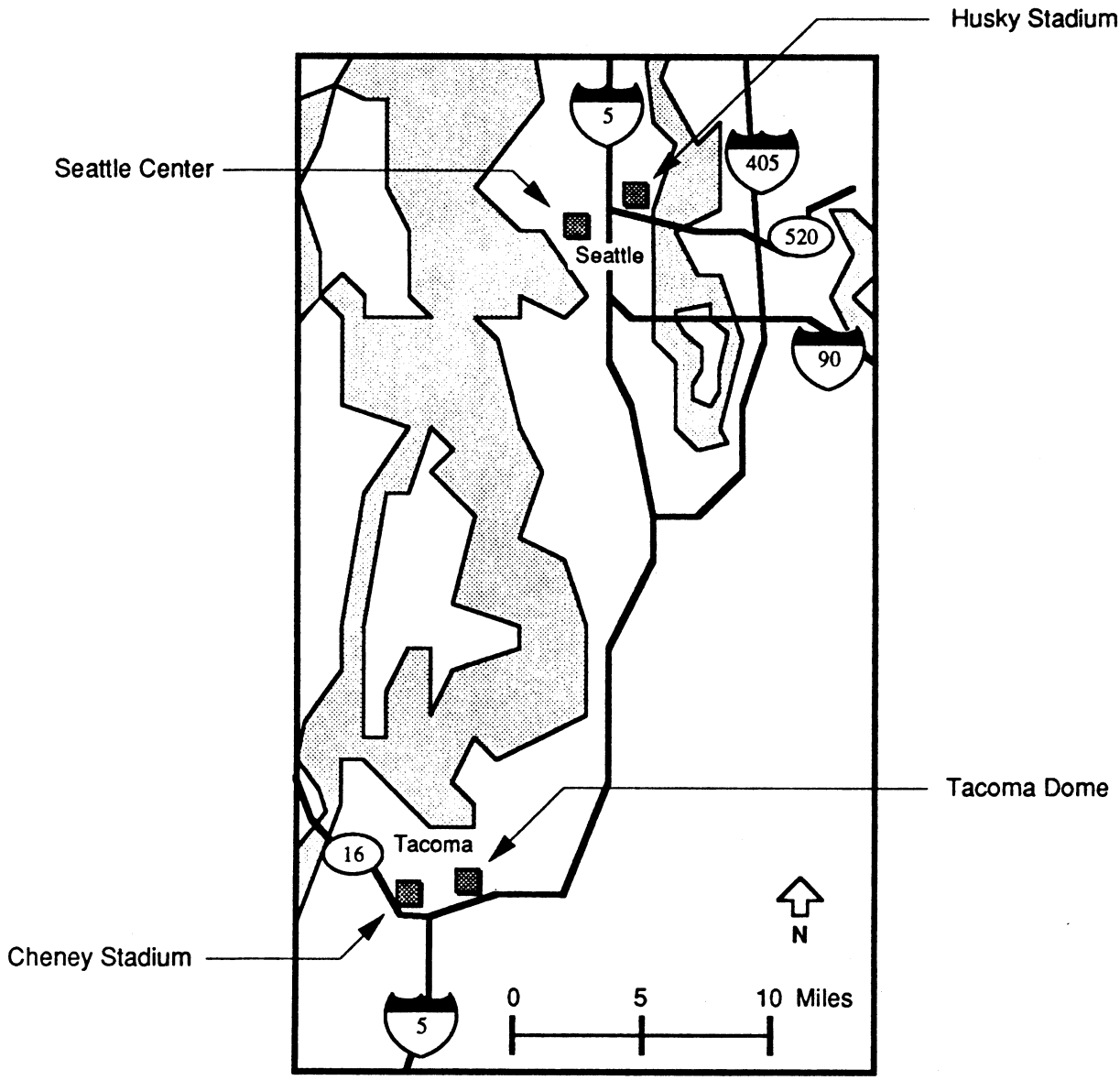

Figure 15. Goodwill Games Main Venues

chosen for implementation consisted of those options that were relatively inexpensive but that would result in large benefits and could be implemented very quickly.

The specific incident management measures that were considered for implementation during the Goodwill Games included the following:

- dedicated freeway/service patrols,
- telephone hotline for traffic information, and
- an extensive media campaign stressing alternate routes, travel times and modes.

WSDOT officials felt that these options were either very inexpensive and should be implemented because of their benefits or were relatively expensive but would result in an extremely high level of benefit. The Federal Highway Administration provided funding for the implementation and operation of the higher cost alternatives (i.e., dedicated freeway/service patrols) selected for implementation.

IMPLEMENTING THE OPTIONS

Three of the options chosen for implementation (additional bus routes, telephone hotline, media campaign) did not play a direct role in incident management but instead played an important role in congestion management. Therefore, the dedicated freeway service patrols carried a large responsibility for mitigating congestion resulting from incidents. WSDOT officials predicted that the establishment of a dedicated freeway/service patrol program would greatly improve the incident management effort.

To achieve the greatest benefit, freeway/service patrols should operate in congested areas during peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures.

With the implementation of this program, incident response times should improve because the patrol vehicles are usually closer to the incident site than vehicles that would

depart from a location removed from the corridor under surveillance. Also, with well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection times should decrease.

A third benefit that should result from dedicated freeway/service patrols is in the area of incident clearance. Many minor incidents or disablements can be cleared with a properly equipped responding patrol vehicle (i.e., with push bumpers), eliminating the delay of waiting for tow vehicles.

Implementation of the demonstration program began with six tow truck service patrols in Tacoma and six Washington State Patrol-operated service patrols in the Seattle area. The service patrols were to rove assigned patrol areas on the most severely impacted highways. The tow trucks were contracted by WSDOT only for the purpose of moving disabled vehicles from roadway to a previously identified staging area. The trucks were equipped with cellular telephones for dispatching and calling commercial tow operators if motorists desired.

The units operated by the Washington State Patrol were dispatched by radio and operated by off-duty troopers. The vehicles were four-wheel drive Jeep Cherokees acquired specifically for this program. Several advantages of the police patrols were that they provided greater authority on the scene, the troopers had superior training in controlling traffic, and they could be dispatched via WSP radio.

When implementing this program, WSDOT officials established an operational program that would allow them to accurately measure the success of this program. Data were collected for four weeks: one week before the implementation of the service patrol program and three weeks during its operation. The service patrols were implemented one week before the Goodwill Games and operated the two weeks during the Games.

The type of data collected included the time of the incident, the duration of the incident, various details of the incident (incident nature, number of lanes blocked, etc.),

who responded, and traffic volumes and congestion when available. (12, 13) Similar data was collected from comparable time periods in 1989.

RE-EVALUATING THE OPTION

The operation of the service patrols proved to decrease the response time required to reach the incident site, and to decrease the incident duration in those areas served by the dedicated patrols. These results are best depicted in Figure 16. Incident duration on those roadways (Interstate 90 and State Route 520) that were not assigned service patrols showed an increase in these factors during comparable time periods.

In addition to congestion relief, this program also served to improve public relations of the Washington State Patrol. In their usual line of duty, WSP troopers usually met with negative reactions from the motoring public. However, by operating a service patrol program, the troopers were met with very positive responses from the public. This made their job much more enjoyable and reflected positively on the agency as a whole.

REFINING THE PROGRAM

Given the notable success of the dedicated freeway/ service patrol program, current plans are to obtain funding to continue the operation of the dedicated freeway/service patrols.

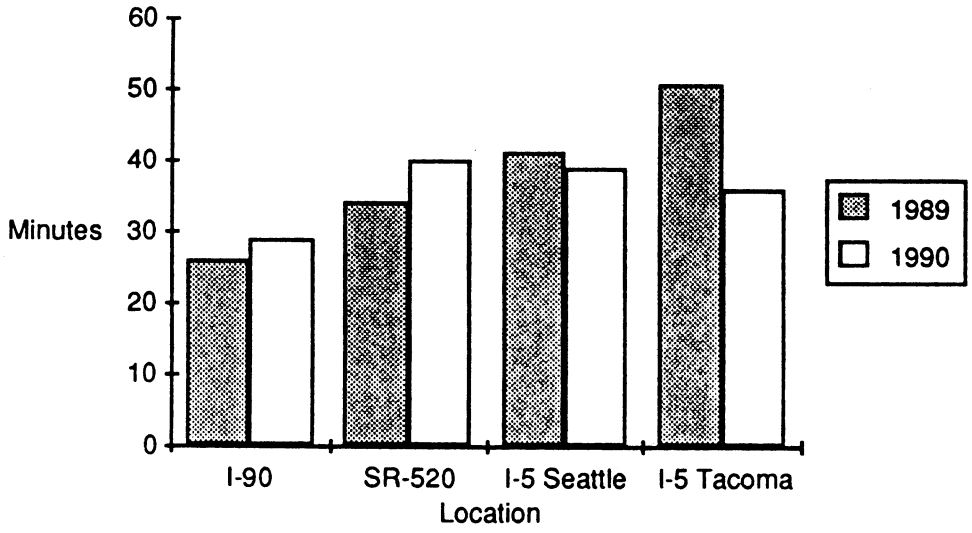

Figure 16. Duration of Incidents Involving Accidents (New service patrols operated on I-5, but not on I-90 or SR-520)

CHAPTER 5

RECOMMENDATIONS AND CONCLUSIONS

The development of an incident management program showed that several types of programs can be vital components of a comprehensive and efficient incident management system. These include the following:

- traffic management teams,
- a traffic operations center,
- dedicated freeway/service patrols,
- interagency communications,
- alternate routes, plans, and
- media ties

In developing these programs, several issues need to be considered:

- Resources need to be allocated or prioritized according to their impacts.
- Location of permanent facilities is key both for use of the facility and resulting impacts.
- A range of costs usually exists; it is better to implement on a small scale with the potential to grow than to do nothing.
- Interagency cooperation at both the field level and upper management level is vital.
- Adequate communication both within agencies at each level and within the various levels of a single agency is key.
- Incident management personnel need to be aware of the economics involved in the urgency of restoring the roadway capacity.

Each of these issues had to be addressed in the development of the Seattle area incident management program and need to be addressed in any developing program to ensure a successful and efficient incident management system.

In the Seattle area, the success of each of the component programs within the incident management system, as well as the success of the overall system resulted largely because of a careful study of the problems at hand, well defined goals and objectives, a comprehensive development and evaluation of alternatives, accurate selection and implementation of the appropriate alternatives, and a continued re-evaluation and refinement effort. In other words, in the greater Seattle metropolitan area, the use of the systems approach to develop a comprehensive incident management system has met with much success and is recommended for use in urban areas across the nation.

REFERENCES

1. United States Department of Transportation, Demographic Trends, National Transportation Strategic Planning Study, March 1990.

2. Lindley, J., Quantification of Urban Freeway Congestion and Analysis of Remedial Measures: Final Report, McClean, Virginia, Federal Highway Administration, Traffic Systems Division, FHWA/RD-87/052, October 1986.

3. Cambridge Systematics, Inc. in association with JHK & Associates, Transmode Consultants, Inc. and Sydec, Inc., Incident Management, 1990.

4. Garrison, D., and F. Mannering, Assessing the Traffic Impacts of Freeway Incidents and Driver Information, ITE Journal, Volume 60, Number 8, August 1990.

5. Garrison, D., F. Mannering and B. Sebranke, Department of Civil Engineering, University of Washington, Washington State Transportation Center, Washington State Department of Transportation, Generation and Assessment of Incident Management Strategies: Draft Technical Report, Volume 3, January 1990.

6. Jones, B., L. Janssen and F. Mannering, Analysis of the Frequency and Duration of Freeway Incidents in Seattle, Accident Analysis and Prevention, Volume 23, Number 2, 1991.

7. Koehne, J., M. Hallenbeck and F. Mannering, Framework for Developing Incident Management Systems: Draft Final Report, University of Washington, Department of Civil Engineering, Washington State Transportation Center, Washington State Department of Transportation, December 1990.

8. Janssen, L., B. Jones, F. Mannering and B. Sebranke, Department of Civil Engineering, University of Washington, Washington State Transportation Center, Washington State Department of Transportation, Generation and Assessment of Incident Management Strategies: Draft Technical Report, Volume 2, January 1990

9. Jones, B., and F. Mannering, Department of Civil Engineering, University of Washington, Washington State Transportation Center, Washington State Department of Transportation, Generation and Assessment of Incident Management Strategies: Draft Technical Report, Volume 1, August 1989.

10. Jones, B., F. Mannering and B. Sebranke, Department of Civil Engineering, University of Washington, Washington State Transportation Center, Washington State Department of Transportation, Generation and Assessment of Incident Management Strategies: Draft Technical Report, Volume 4, August 1989.

11. Tanemura, L. , F. Mannering, Incident Response Guide - Office Reference: Draft Final Report, University of Washington, Department of Civil Engineering, Washington State Department of Transportation, January 1991.

12. Dudek, C., W. McCasland, and E. Burns, Promotional Issues Related to Off-Site Accident Investigation: Final Report, Federal Highway Administration, Office of Safety and Traffic Operations Research and Development. FHWA/RD-87?038, 1987.

13. Hallenbeck, M., Traffic Impacts During the Goodwill Games: Draft Final Report, Washington State Transportation Center, Washington State Department of Transportation, January 1991.

14. Hallenbeck, M., and F. Mannering, Incident Management Systems Framework - Impacts of Service Patrols: Final Summary Report, University of Washington, Department of Civil Engineering, Washington State Transportation Center, Washington State Department of Transportation, March 1991.