RURAL IVHS SCOPING STUDY

An Assessment of Rural Minnesota Travelers' Needs

Final Report

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DISCLAIMER

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EXECUTIVE SUMMARY

The role of Intelligent Vehicle Highway Systems (IVHS) Applications in rural environments has yet to be precisely defined. The Minnesota Rural IVHS Scoping Study is an attempt to clearly define the needs of travelers throughout rural Minnesota in order to assess the potential for rural IVHS applications within the state.

This project was performed in a series of five tasks. The remainder of this executive summary will focus on brief descriptions of each of the following tasks:

- description of rural Minnesota highway users;
- identification of rural traveler needs and potential strategies to meet these needs;
- review of available technologies;
- identification of key issues concerning each technology; and
- development of conceptual ideas for future projects.

The initial stage of this project involved an assessment and description of rural Minnesota transportation users. This review served to draw a complete picture of the rural Minnesota highway environment including the identification of rural highway users, their numbers, and their reasons for travel. In order to facilitate the subsequent task of identifying the needs of rural highway users, descriptions of rural Minnesota roadways, rural travel problems and rural Minnesota highway users were developed. Additionally, a review of all current IVHS projects which potentially relate to rural applications, was conducted to assist the remaining stages of this project.

Once the Minnesota highway users were clearly described, the next task was to meet with rural Minnesota travlers to identify their needs. To accomplish this, two types of assemblies, regional meetings and focus groups, were conducted throughout the state. Nine regional meetings involving members of the transportation industry and six focus groups targeting general travelers in rural areas were held in fifteen separate Minnesota locations. To supplement these assemblies, a 505 person telephone survey focussed on both Minnesota residents and out of state tourists who had travelled on rural Minnesota highways within the last two years. These meetings provided various approaches for identifying the user needs. The following unprioritized list summarizes the results of this task and represents the needs of travelers throughout rural Minnesota:

- Weather and road condition information;
- Assistance for stranded vehicles;
- Information targeted towards tourists within each region;
- Increased safety using crash avoidance technologies;
- Information relating locations of construction zones or other detours;
- Impaired or inattentive driver alert systems;
- Congestion relief during special events or peak tourist periods;

- Congestion relief during special events or peak tourist periods;
- Transit services to assist non-drivers;
- Improved visibility concerning obstructions on or near the roadway;
- Improved management and coordination of emergency services;
- Congestion relief during special events;
- Transit services to improve service into metropolitan areas;
- Increased utilization of existing roadway network;
- Information concerning locations of emergency services;
- Updated transit information concerning service, costs and route information;
- Improved visibility concerning weather inflicted sight restrictions;
- Increased commercial vehicle efficiency while crossing state and country borders; and
- Improved commercial vehicle management.

The remainder of this project focused on determining the most effective strategies for satisfying these needs.

Once the needs of rural travelers had been clearly defined, the focus returned to the review of current projects which was conducted in the initial task. Emphasis was placed on identifying all technological options potentially capable of addressing the identified needs. The results of the technology review suggest that various solutions are available which offer both low and high technology levels of solutions to the identified needs. This review did not prioritize or place emphasis on any option, its purpose was merely to identify all technologies capable of addressing the needs.

To assist in the prioritization process of the available technologies, the fourth task assessed key issues for each application under consideration. The success of rural IVHS projects will depend greatly on the communication capabilities of each system. Therefore, an assessment of the communication requirements of each technology option coupled with a definition of numerous communication strategies and their characteristics resulted in a table which summarizes each IVHS technology option and potential communication strategies to accompany these options. An additional key issue considered was the compatibility of urban and rural system development. Two primary concerns of compatibility include operational compatibility of the systems and compatibility in the information provided to users. Each of these concerns was considered for the set of potential technologies in order to provide additional means for prioritizing the potential technologies. Issues of operational compatibility include:

- standard equipment;
- standardized data format;
- consistency in updates and expansions between urban and rural systems; and
- compatibility among the communication medias.

To promote both acceptance and understanding, services provided to the user should consider the following compatibility issues:

- interagency coordination;
- accurate updated information; and
- consistency of presentation.

The final issue which was addressed was staffing requirements of each technology option. Due to varying levels of available staffing at rural locations, a description of each task involved in the operation of the technology options was also included in the analysis.

It was the objective of the final task to consider the results of the previous analyses and develop conceptual ideas for future rural IVHS projects. Ten conceptual ideas, using the most promising technology options, have been developed to address the needs identified at the various meetings in rural Minnesota. These projects range from inexpensive, short-term projects to high cost long term projects. As a next step, detailed explanations of each project will be submitted to the Minnesota Guidestar Planning and Program Management Committee for review and potential inclusion in future Minnesota Guidestar activities. Additionally, results of this study will be considered in the revision of the Minnesota Guidestar Strategic plan due to be adopted in June, 1994. The following are brief descriptions of each potential project concept:

Inclement Weather Trip Avoidance

This project will determine the effects of providing travelers with real-time pre-trip and en-route weather information in an attempt to avoid trips during adverse weather conditions. A corridor between two cities will be monitored and travelers will be informed of hazardous conditions upon exiting each city. Information may be provided by telephone, changeable message signs and kiosks.

Assistance During Trips Under Adverse Weather Conditions

The objective of this project is to evaluate the effectiveness of providing services to motorists driving during inclement weather conditions. A pilot region will be chosen to monitor weather conditions and provide en-route assistance to travelers during inclement conditions.

Notification of Spot Hazardous Conditions

The objective of this project is to provide real-time warnings of icy conditions at locations prone to early icing. This low cost project will focus on locations that tend to freeze prior to other road surfaces.

Assistance for Road Maintenance and Construction

The objective of this project is to research weather related maintenance and construction activities to determine the most effective strategy for performing pro-active road maintenance. Once a maintenance strategy is developed, real-time collection and analysis of existing weather condition information will be used for determining the dispatch schedules of snowplows, sand trucks and other weather dependent maintenance and construction vehicles.

In-vehicle Mayday Devices

The objective of this project is to demonstrate the functionality of a wide area emergency notification system. Additionally, this project will be a first attempt at determining the most user accepted method for promoting in-vehicle mayday devices. This will allow stranded motorists to summons help from within the vehicle.

En-route Tourist Information

This project will evaluate the possibility of providing travelers with tourist information to encourage more en-route stops. These stops will both enhance the traveler's trip and support the economy throughout the local area.

Collision Avoidance at Unsignalized Intersections

The objective of this project is to evaluate the feasibility of providing a low cost system to assist in collision avoidance at an unsignalized intersection in a remote area. Warning signs would flash when conditions suggest a high risk for collisions.

Construction Zone Assistance

This project will advise travelers of both existing and impending delays due to construction. Routing advice will be both in anticipation of upcoming construction and in the form of real-time en-route advice about existing conditions.

Transit Application of IVHS

The objective of this project is to determine the potential for deploying an IVHS application to assist non-drivers. This will be an assessment of various regions to determine needs and existing services. The growing elderly population combined with the number of young adults in need of transportation has increased interest in rural transit applications.

Tourist Traffic Control

The objectives of this project are to demonstrate the feasibility of reducing or preventing congestion in a small rural area and to evaluate the effectiveness of using various urban traffic control techniques in a rural setting. These techniques might include signal optimization, changeable message signs and real-time congestion detection. Additionally, portable traffic management systems may be utilized in areas where special events occur less often. Improvements to traffic control will both enhance the tourists trips and improve the quality of life for residents of these rural sites during special events or peak tourist times.

The application of advanced technologies in a rural environment continues to gain an increasingly significant degree of exposure within the Intelligent Vehicle Highway System (IVHS) community. In parallel with the formation of IVHS America's ARTS Committee, Minnesota Guidestar's rural IVHS Scoping Study is the first initiative to establish needs of the rural highway traveler and identify technologies to address these needs. The aforementioned rural initiatives were not only developed in accordance with FHWA's 27 User Services, but will also represent a significant contribution to rural IVHS on a national level.

1. INTRODUCTION

1.1 Overview

This report represents the final results of the Rural IVHS Scoping Study conducted throughout rural Minnesota. The intent of this project is to assess the needs of travelers in rural Minnesota. Once the needs were identified, an exhaustive review of potential technological solutions identified numerous potential approaches for satisfying these needs. The results include conceptual ideas for projects which specifically address those needs identified by the users.

1.2 Structure of report

Chapter 2 of this final report presents a description of rural Minnesota traveler characteristics. Further, a review of current projects relevant to rural IVHS is presented.

A description of rural highway user needs is presented in Chapter 3. This chapter presents detailed explanations of the nine regional meetings, six focus groups, and 505 telephone interviews. Results of this chapter include a list of user needs identified at the various meetings.

Building upon the needs identified in Chapter 3, Chapter 4 contains a technology review of all possible strategies (both low and high technology levels) capable of satisfying the needs presented in Chapter 3.

The intent of Chapter 5 is to provide a detailed assessment of key issues for each application under consideration. The three key issues under consideration include the communication requirements of each technology, the staffing needs of candidate technologies, and the issue of urban and rural compatibility. These assessments will be used as a prioritization tool for the candidate technologies.

Chapter 6 presents conceptual ideas for numerous IVHS projects throughout rural Minnesota. These projects are the result of the rural needs assessment, the technology review for potential solutions and the assessment of key issues used as a prioritization tool.

2. DESCRIPTION OF RURAL MINNESOTA HIGHWAY USERS

2.1 Introduction

Chapter 2 will present the principal characteristics of rural highways and highway users so as to draw a complete picture of the rural Minnesota highway environment. The descriptions presented in this report will serve to facilitate the upcoming task of identifying the needs of rural highway users. Following this brief introduction, Section 2.1 will introduce a general description of rural Minnesota and rural area demographics. Section 2.3 will characterize rural area traffic situations and include a climatic description, an overview of traffic volumes and vehicle type distributions as well as a summary of rural highway accidents. Section 2.4 will describe the various rural highway uses and provide a list of rural vehicle fleets.

Serving as both a summary of the description of rural highway uses and as a precursor to the development of rural highway needs, Section 2.5 presents a literature review of current rural IVHS related projects.

2.2 General descriptions of rural Minnesota

The State of Minnesota is composed of eight districts, seven of which are characterized as rural in nature. For purposes of this project, rural Minnesota is defined as any area outside the seven county Metropolitan Area. In 1991, approximately 119,000 miles of the 132,000 total miles of Minnesota roadway consisted of rural highways. Of the total number of vehicle miles traveled (VMT) along all Minnesota roadway types in the year 1991, 53 percent of these VMT's were along rural highways.

Forty-eight percent of the population of Minnesota lives in a rural area. An important facet of consideration in describing rural Minnesota is the varying demographics found across the state. Table 2.2.1 depicts the population by age range for each county meeting rural criteria. An analysis of this table reveals that the median population age is highest throughout western and north central Minnesota. Accompanying the different ranges in population found in rural Minnesota are various factors creating problems unique to each area. Table 2.2.2 presents a summary of the population of cities and the number of crashes specific to each population.

County	Total	Under 17	18-44	44+
Aitkin	12,425	2,959	3,586	5,880
Becker	27,881	8,108	9,767	10,006
Beltrami	34,384	10,228	14,734	9,422
Benton	30,185	9,044	13,250	7,890
Big Stone	6,285	1,641	1,829	2,815
Blue Earth	54,044	12,391	27,158	14,495
Brown	26,984	7,397	9,860	9,727
Carlton	29,259	8,211	10,787	10,261
Cass	21,791	5,929	6,832	9,030
Chippewa	13,228	3,581	4,347	5,300
Chisago	30,521	9,404	12,053	9,064
Clay	50,422	12,625	23,677	14,120
Clearwater	8,309	2,419	2,650	3,240
Cook	3,868	936	1,440	1,492
Cottonwood	12,694	3,305	3,956	5,433
Crow Wing	44,249	11,928	15,804	16,517
Dodge	15,731	4,949	6,069	4,713
Douglas	28,674	7,780	10,315	10,579
Faribault	16,937	4,494	5,252	7,191
Fillmore	20,777	5,781	6,851	8,145
Freeborn	33,060	8,530	11,539	12,991
Goodhue	40,690	11,450	15,361	13,879
Grant	6,246	1,617	1,824	2,610
Houston	18,497	5,312	6,894	6,281
Hubbard	14,939	4,089	4,886	5,964
Isanti	25,921	8,112	10,304	7,505
Itasca	40,863	11,558	14,555	14,750
Jackson	11,677	3,136	3,926	4,615
Kanabec	12,802	3,885	4,588	4,329
Kandiyohi	38,761	11,037	15,089	12,635
Kittson	5,767	1,506	1,855	2,406
Koochiching	16,299	4,149	6,297	5,853
Lac Qui Parle	8,924	2,359	2,669	3,896
Lake	10,415	2,535	3,471	4,409
Lake of the Woods	4,076	1,128	1,445	1,503
LeSueur	23,239	6,865	8,550	7,824
Lincoln	6,890	1,801	1,891	3,198
Lyon	24,789	6,739	10,130	7,920
McLeod	32,030	9,282	12,373	10,375
Mahnomen	5,044	1,574	1,538	1,932

Table 2.2.1 - County Population by Age 1990

County	Total	Under 17	18-44	44+
Marshall	10,993	3,169	3,559	4,265
Martin	22,914	6,143	7,803	8,968
Meeker	20,846	6,127	7,181	7,538
Mille Lacs	18,670	5,437	6,483	6,750
Morrison	29,604	9,258	10,447	9,899
Mower	37,385	9,555	12,718	15,112
Murray	9,660	2,620	3,026	4,014
Nicollet	28,076	7,347	13,084	7,645
Nobles	20,098	5,331	7,063	7,704
Norman	7,975	2,153	2,409	3,413
Olmsted	106,470	29,528	47,589	29,353
Otter Tail	50,714	13,443	16,989	20,282
Pennington	13,306	3,562	5,082	4,662
Pine	21,264	6,043	7,623	7,598
Pipestone	10,491	2,949	3,425	4,117
Polk	32,498	9,143	11,595	11,760
Pope	10,745	2,960	3,285	4,500
Red Lake	4,525	1,354	1,471	1,700
Redwood	17,254	4,864	5,558	6,850
Renville	17,673	4,922	5,712	7,039
Rice	49,183	12,908	22,292	13,983
Rock	9,806	2,786	3,184	3,836
Roseau	15,026	4,683	5,875	4,468
St. Louis	198,213	48,321	78,657	71,235
Sherburne	41,945	13,318	19,337	9,290
Sibley	14,366	4,082	4,859	5,425
Stearns	118,791	33,009	55,265	30,517
Steele	30,729	8,792	12,167	9,770
Stevens	10,634	2,500	4,682	3,452
Swift	10,724	2,882	3,372	4,470
Todd	23,363	7,131	7,753	8,479
Traverse	4,463	1,171	1,228	2,064
Wabasha	19,744	5,712	7,216	6,816
Wadena	13,154	3,712	4,298	5,144
Waseca	18,079	5,184	7,017	5,878
Watonwan	11,682	3,281	3,909	4,492
Wilkin	7,516	2,126	2,667	2,723
Winona	47,828	11,730	21,883	14,215
Wright	68,710	22,385	28,570	17.755
Yellow Medicine	11,684	3,155	3,671	4,858

Table 2.2.1 - County Population by Age 1990 (continued)

Population of city or township	Numberof. cities	Total number of crashes	Total number of fatalities
100,000 +	2	21,913	34
50,000 - 100,000	7	6,246	9
25,000 - 50,000	17	16,687	29
2,000 - 25,000	192	24,394	84
Under 2,000	636	27,568	338
Total	854	96,808	494

Table 22.2 - Summary of crashes by population area

2.3 Description of rural travel problems

To present an exhaustive description of rural travel, both physical and environmental factors must be considered. The infrastructure of rural Minnesota highways consists of four-lane divided freeways, four-lane undivided highways, two-lane highways, and unpaved roadways.

In developing the needs of rural travelers, problems unique to each roadway type will be considered. Via discussions with engineers throughout the state, a list of potential problems has been identified. Problems associated with four-lane freeways include, but are not limited to:

- merging traffic at entrance and exit ramps;
- excessive heavy vehicle travel;
- excessive speeds;
- limited opportunities for route changes; and
- limited availability of information.

Numerous issues have also been identified with regards to travel along rural transit trunk highways such as:

- limited sight distances (due to obstructions or winding roads);
- traffic entering and exiting roadway at low speeds;
- passing vehicles in lanes of opposing traffic and
- traffic interchanges (both controlled and uncontrolled).

The number of accidents occurring along each various roadway type is an important consideration in determining user needs. For this reason, Table 3 presents accident statistics for the different roadway types.

In addition to difficulties associated with roadway layouts, Minnesota is exposed to severe weather conditions which can make driving hazardous. Conditions such as snow, ice, fog, high winds, and heavy rams may occur statewide. A 1992 statewide summary of accident statistics indicates that 8 percent of all accidents occurred during rain, 7 percent occurred during snow, 3 percent occurred during sleet or hail, and 46 percent occurred during clear conditions (1). These statistics are shown in Table 2.3.1.

Combinations of the two aforementioned factors create numerous locations of differing problems throughout the state. An additional factor essential in describing the rural travel characteristics is the traffic volumes and vehicle type distributions unique to each area. Traffic counts performed along major interstates and trunk highways have been conducted to determine the average number of vehicles traveling each roadway in one day. These Average Daily Traffic (AADT) flows (veh/day) have been averaged on a county basis. Tables 2.3.2-2.3.8 summarize activity in each county by presenting averaged traffic flows and average accident rates throughout the seven rural districts;

Factors affecting conditions	Total number of crashes	Number of fatal crashes
Road design		
Freeway	8,779	35
Other divided highway	10,785	55
4-6 lanes undivided	14,798	32
2 lane highway	39,864	360
Environmental factors		
Clear	44,799	250
Cloudy	30,534	156
Rain	7,564	29
Snow	6,410	23
Sleet/hail	2,507	13
Lighting conditions		
Daylight	58,110	243
Dawn/dusk	7,207	31
Dark/street lights on	16,243	53
Dark//no street lights	11,805	157

Table 2.3.1 - Summary of Minnesota crashes by roadway conditions

County	Avg. number of accidents 1987 – 1991	Ave. number of deaths 1987 – 1991	Major highways with county		
			Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy Vehicles (veh/day)
Aitkin	253	9	Hwy 65 Hwy 210 Hwy 169	1,969 3,100 2,600	79 336 224
Carlton	526	7	I-35 Hwy 210 Hwy 73 Hwy 27	14,500 2,270 1,467 1,585	1,265 192 72 98
Cook	168	3	Hwy 61	2,380	138
Itasca	670	7	Hwy 2 Hwy 65 Hwy169	4,055 1,403 5,670	500 77 293
Koochiching	276	3	Hwy 53 Hwy 71 Hwy 11 Hwy 217	3/040 1,274 3.588 650	260 164 60 40
Lake	229	2	Hwy 61	4.358	290
Pine	437	7	I-35 Hwy 48	11,112 1,670	1,405 170
St. Louis	3,617	24	Hwy 53 (near Duluth) Hwy 53 (outside Duluth) Hwy 2 Hwy 169	12,700 4,940 4,458 5,915	688 465 600 317

Table 2.3.2 – Traffic summary of District 1

County	Avg. number of accidents 1987 - 1991	Avg. number of deaths 1987 - 1991	Major highways within county		
			Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy vehicles (veh/day)
Beltrami	666	4	Hwy 89 Hwy 71 Hwy 72	1,312 2,567 1,325	52 188 91
Clearwater	117	1	Hwy 92 Hwy 2	1,760 4,025	160 563
Hubbard	268	4	Hwy 71 Hwy 34	3,500 3,710	223 199
Kitttson	85	1	Hwy 59 Hwy 75	735 800	98 75
Lake of the Woods	64	1	Hwy 11	1,625	145
Marshall	136	2	Hwy 59 Hwy 75	1,125 920	125 92
Norman	90	1	Hwy 200 Hwy 75	1,290 1,663	138 145
Pennington	257	1	Hwy 59	3,950	230
Polk	541	8	Hwy 2 Hwy 75 Hwy 220	4,022 1,224 2,267	407 129 167
Red Lake	63	1	Hwy 59 Hwy 32	1,550 1,050	168 182
Roseau	230	4	Hwy 11	2,800	175

Table 2.3.3 - Traffic summary of District 2

County	Avg. number of accidents 1987 – 1991	Ave. number of deaths 1987 – 1991	Major highways within county Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy Vehicles (veh/day)
Benton	700	7	Hwy 95 Hwy 23	2,667 6,450	217 453
Cass	382	9	Hwy 371 Hwy200	4,275 2,000	190 130
Crow Wing	1,069	10	Hwy 18 Hwy 210 Hwy371	3,775 4,875 9,167	155 463 297
Isanti	515	5	Hwy 65 Hwy 95	9,140 5,830	539 250
Mille Lacs	348	5	Hwy 169 Hwy 23	7,278 4,400	342 315
Morrison	493	8	Hwy 10 Hwy 371	7,025 6,133	726 547
Sherburne	750	7	Hwy 169 Hwy 10	18,250 12,433	663 2,947
Stearns	2,895	15	I-94 Hwy 23 Hwy 15 Hwy 71	15,200 6,600 4,725 2,788	2,254 298 345 310
Todd	386	7	Hwy 71	3,635	400
Wadena	265	1	Hwy 71 Hwy 10	3,080 4,800	275 480

Table 2.3.4 – Traffic summary of District 3

County	Avg. number of accidents 1987 - 1991	Avg. number of deaths 1987 - 1991	Major highways within county		
			Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy vehicles (veh/day)
Becker	444	6	Hwy 10 Hwy 59 Hwy 34	8,025 3,933 2,988	711 284 154
Big Stone	99	2	Hwy 75	1,388	119
Clay	1,078	8	I-94 Hwy 75 Hwy 34	12,190 2,900 1,750	2,250 135 135
Douglas	794	8	I-94 Hwy 27 Hwy 29	8,363 2,817 6,175	1,460 146 275
Grant	91	1	I-94	7,600	1,425
Mahnomen	57	2	Hwy 59	2,016	280
Otter Tail	847	10	I-94 Hwy 59 Hwy 210 Hwy 10	8,260 2,811 2,250 3,914	1,532 253 179 452
Pope	137	1	Hwy 28 Hwy 55	2,838 1,337	244 780
Stevens	150	2	Hwy 28 Hwy 59	2,417 2,000	635 330
Swift	121	1	Hwy 9	2,533	208
Traverse	45	0	Hwy 75	1,100	125
Wilkin	160	2	Hwy 75 Hwy 210	1,710 2,500	131 250

Table 2.3.5 - Traffic summary of District 4

County	Avg. number of accidents 1987 – 1991	Ave. number of deaths 1987 – 1991	Major highways within county		
			Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy Vehicles (veh/day)
Dodge	256	4	Hwy 14 Hwy 56	8,200 1,767	888 158
Fillmore	351	6	Hwy 52 Hwy 63	2,686 3,750	274 570
Freeborn	700	6	I-90 I-35 Hwy 65 Hwy 13	7,300 10,930 9,200 2,588	1,200 2,330 490 196
Goodhue	985	11	Hwy 52 Hwy 58 Hwy 19	11,767 3,075 2,383	1,683 210 208
Houston	307	4	Hwy 44 Hwy 16	2,840 1,638	296 108
Mower	695	4	I-90 Hwy 218 Hwy 63	8,733 3,350 5,650	1,075 278 650
Olmstead	2,457	10	I-90 Hwy 63 Hwy 52 Hwy 14	6,975 12,080 11,450 8,110	1,362 669 6,180 570
Steele	712	6	I-35 Hwy 14	15,350 6,567	2,800 314
Rice	1,061	9	I-35 Hwy 19 Hwy 3 Hey 60	17,975 3,370 6,267 4,333	3,138 314 562 285
Wabasha	382	6	Hwy 63 Hwy 61 Hwy 42	2,167 4,812 2,850	145 735 260
Winona	1,162	7	I-90 Hwy 43 Hwy 14	7,640 6,000 4,450	1,940 338 570

Table 2.3.6 – Traffic summary of District 6

County	Avg. number of accidents 1987 – 1991	Ave. number of deaths 1987 – 1991	Major highways within county		
			Hwy name	Avg. traffic volume (veh/day)	Avg. volume heavy Vehicles (veh/day)
Blue Earth	1,461	7	Hwy 60 Hwy 22 Hwy 169	8,507 3,245 1,825	1,140 280 305
Brown	476	3	Hwy 14 Hwy 15	3,220 2,833	251 323
Cottonwood	183	2	Hwy 60 Hwy 71	4,600 1,800	540 280
Faribault	221	2	I-90 Hwy 169	6,070 2,550	1,010 239
Jackson	204	2	I-90 Hwy 71 Hwy 60	6,200 2,175 3,015	956 246 515
LeSueur	507	4	Hwy 99 Hwy 13	2,900 2,950	219 331
Martin	389	2	Hwy I-90 Hwy 15	7,150 3,200	1,063 337
Nicollet	508	5	Hwy 14 Hwy 169	5,550 12,500	722 1,800
Nobles	364	2	I-90 Hwy 60 Hwy 59	6,350 3,150 2,034	956 539 228
Rock	208	1	I-90 Hwy 75	6,500 1,450	965 1,180
Sibley	235	3	Hwy 19 Hwy 15	3,080 2,250	416 255
Waseca	338	3	Hwy 14 Hwy 13	6,050 2,800	688 264
Watonwan	176	1	Hwy 60 Hwy 15	4,730 4,660	800 871

Table 2.3.7 – Traffic summary of District 7

County	Avg. number of accidents 1987 - 1991	Avg. number .of. deaths 1987 - 1991	Major highways within county		
			Hwy name	Aug. traffic volume (veh/day)	Avg. volume heavy vehicles (veh/day)
Chippewa	189	4	Hwy 7 Hwy 23 Hwy 59	2,663 2,333 1,750	298 323 184
Kandiyohi	785	8	Hwy 12 Hwy 71 Hwy 23	5,600 4,550 5,115	335 423 407
Lac Qui Parle	90	3	Hwy 212	1,829	374
Lincoln	101	2	Hwy 75	755	90
Lyon	354	3	Hwy 23 Hwy 68 Hwy 59	3,667 3,100 1,725	382 170 235
McLoud	693	7	Hwy 212 Hwy 22	4,880 4,900	850 441
Meeker	374	5	Hwy 12 Hwy 15	4,500 2,475	480 208
Murray	108	2	Hwy 59	2,010	222
Pipestone	170	3	Hwy 23 Hwy 75	2,250 1,463	206 180
Redwood	213	2	Hwy 71	2,136	272
Renville	231	8	Hwy 71 Hwy 212	2,683 3,783	338 590
Yellow Medicine	128	2	Hwy 23 Hwy 59 Hwy 68	2,550 1,500 897	430 142 75

Table 2.3.8 - Traffic summary of District 8

2.4 Description of rural highway uses

The total annual vehicle miles traveled along rural Minnesota highways exceeded 20 billion VMTs in 1991. A combination of interstates, rural trunk highways, and private roadways enable travelers to reach nearly every location in rural Minnesota and are used for a variety of purposes:

- Commerce. Various sizes of fleets carry goods to and from locations both within and outside Minnesota. Additionally, widespread locations create the need for business related travel.
- Commuters. The desire to live in areas away from ones work creates many commuters driving the identical route each day.
- **Leiire.** Minnesota's wide assortment of lakes and nature parks creates great demand for rural highways. Additionally, the differing levels of city development often inspire long trips to reach entertainment locations.

Of particular importance is the commerce related travel. Often, large fleets or trucking industries create point sources of excessive traffic at unexpected locations statewide. To describe such areas, Table 2.4.1 details some Minnesota fleets, their location and size.

2.5 Current IVHS projects

In July 1993, the IVHS America National Program Plan introduced a list of IVHS User Services and Sub-services. This list depicts IVHS as 27 related services targeted towards the user or customer. Roth IVHS America and the Federal Highway Administration have determined which of these services they feel are applicable to rural IVHS Table 2.5.1 lists each user service and highlights those considered applicable to rural areas (4).

Extensive activity is currently underway throughout the world targeting the application of IVHS technologies to satisfy rural travelers needs. Two national conferences have focused specifically on rural IVHS applications throughout the United States. The conference in Redding, California, "Improving Rural Transportation Through Advanced Transportation Technology", in September 1992 identified the objectives and the primary issues involved in each of the following areas (2):

- development of a research and demonstration agenda for rural transportation technology;
- establishment of a national coalition and program to advance rural transportation technology; and
- identification of rural transportation technology.

The "National Conference for Rural IVHS in Keystone, Colorado consisted of presentations summarizing current rural IVHS projects throughout the United States. Associated with the description of each project were discussions concerning each of the unique considerations applicable to rural areas (3). Presentations of both existing and planned rural projects is of increasing interest at several international transportation conferences. The July 1993 Pacific Rim TransTech Conference devoted a session to rural applications of OVJS Additionally, rural IVHS presentations consistently appear at the IVHS America annual meeting. To properly establish a list of all rural IVHS activities, both existing and planned, an extensive literature review was undertaken and has identified projects throughout the United States and Europe applicable to this study. This review will be essential in the future identification of available technologies and in the recommendations for potential Minnesota projects. As a prelude to the upcoming examination of rural Minnesota users needs, the user services each project addresses is presented in Table 2.5.2. Brief project summaries are found in the Appendix of this report.

The appendix of this report contains one page descriptions of each project listed in Table 2.5.2. The intent of this initial literature review was to identify current projects to determine their applicability to rural Minnesota. Those projects found to be applicable will be examined more closely in future tasks.

Name	District	City	County	Number of vehicles (Trucks + Tractor-trailers)	Type of carrier
Monson Trucking	1	Duluth	Lake	204	Commercial
Halvor Lines Inc.	1	Duluth	Lake	102	Commercial
Hibbing Taconite Co.	1	Hibbing	St. Louis	102	Private
U.S. Steel Corp.	1	Mountain Iron	St. Louis	264	Private
Shafer Contracting	1	Shafer	Chisago	125	Private
Minnesota Power Co.	1	Duluth	Lake	191	Private
Mueller Pipelines	2	Bermidji	Beltrami	306	Private
North Star Transport Inc.	2	Roseau	Roseau	243	Commercial
Charles A. Bernick Pepsi-Cola	3	Waite Park	Stearns	300	Private
Pueriner/Multifoods	3	Rice	Benton	122	Commercial
Anderson Trucking Service Inc.	3	St. Cloud	Stearns	1,078	Commercial
Spee Dee Delivery Service	3	St. Cloud	Stearns	208	Commercial
Otter Tail Power Company	4	Fergus Falls	Otter Tail	200	Private
Daggett Truck Lines Inc.	4	Frazee	Becker	100	Commercial
Transport Inc.	4	Moorhead	Clay	108	Commercial
United Building Centers	6	Winona	Winona	355	Private
Hunting Elevator Company	6	Austin	Mower	250	Private
McNeilus Manufacturing	6	Didge Center	Dodge	200	Private
Bud Meyer Truck Lines Inc.	6	Lake City	Wabasha	251	Commercial
Roadrunner Repair	7	LeCenter	LeSueur	150	Private
Sather Cookie Company	7	Round Lake	Jackson	102	Private
Blue Earth Tier	7	Blue Earth	Faribault	250	Private
Sather Trucking Company	7	Round Lake	Jackson	164	Commercial
J&R Schugel Trucking Inc.	7	New Ulm	Nicollet	239	Commercial
D&J Transfer Company	7	Sherburn	Martin	112	Commercial
Schwans Sales Enterprises	8	Marshall	Lyon	2,020	Private
Quast Transfer Inc.	8	Winsted	McLeod	134	Commercial

Table 2.4.1. – Summary of large trucking fleets in rural Minnesota

IVHS user services	Services considered applicable to rural travel	
	FHWA	IVHS America
Traveler services information		$
Pre-trip travel information	$	$
Route guidance		$
En-route driver advisory		$
Emergency notification and personal security	$	$
Incident management		$
Travel demand management		
Traffic control	$	
Electronic payment services	$	$
Emergency vehicle management		$
Longitudinal collision avoidance		$
Fully automated vehicle operation		
Pre-crash restrain deployment		$
Lateral collision avoidance		$
Impairment alert		
Vision enhancement for crash avoidance		$
Intersection crash warning and control		
Commercial vehicle preclearance		$
Automated roadside safety inspections		$
Commercial vehicle administrative processes		
On-board safety monitoring		
Commercial fleet management	$	
Personalized public transit	$	$
Public transportation management	$	
Public travel security		
Ride matching and reservation	$	$
En-route transit advisory	$	$

Table 2.5.1 – IVHS user services and those related to rural travel

Project Name	FHWA User Services														
	En-route driver advisory	Traffic advisory	Route guidance	Traffic control	Longitudinal collision avoidance	Incident mgmt.	Commercial vehicle preclearance	Electronic payment services	Commercial vehicle admin. processes	Commercial fleet mgmt.	Public transport. mgmt.	Emergency vehicle mgmt.	Pretrip travel info.	Ride matching + reservation	Traveler services info.
Rural applications of advanced traveler information systems	●														
Travel-aid	●			●											
Remote sensing of rural mad and travel conditions	●														
Safer					●										
Arizona weather monitoring	●		●												
REACH-75	●		●			●									
I-76 Fog warning system	●	●													
Idaho storm warning operational test	●		●												
Automatic mileage tracking							●	●	●	●					
I-70 Rural IVHS corridor planning & feasibility study	●	●	●												
Intelligent runaway truck ramps	●				●										
Chart	●	●	●	●		●									
Odyssey	●		●												
Smart signal system				●											
Avion							●		●						
Ontario small properties AVL/C initiative											●				

Table 2.5.2 - Matrix summarizing current projects and related user services

Project Name	FHWA User Services														
	En-route driver advisory	Traffic advisory	Route guidance	Traffic control	Longitudinal collision avoidance	Incident mgmt.	Commercial vehicle preclearance	Electronic payment services	Commercial vehicle admin. processes	Commercial fleet mgmt.	Public transport. mgmt.	Emergency vehicle mgmt.	Pretrip travel info.	Ride matching + reservation	Traveler services info.
Travel guide	●	●	●												
WAVM system										●					
PASS							●	●	●						
Op test for Gary-Chicago Milwaukee IVHS priority corridor	●	●					●		●						
Smart bus											●				
Seattle to Portland early deployment corridor	●	●	●				●		●						
IVSAWS		●		●											
Promethus/Promise	●		●												
Socrates	●	●													
Road weather info system project (RWIS)	●														
Intelligent workzone traffic management system			●	●											
ARTIC												●	●	●	
Op tests of systems to enhance emergency medical service response												●			
YARTIS	●	●	●										●		●

Table 2.5.2 - Matrix summarizing current projects and related user services (continued)

3. DESCRIPTION OF RURAL HIGHWAY USER NEEDS

3.1 Introduction

The purpose of this chapter is to present an analysis of the needs identified for rural highways in Minnesota. To identify the needs of rural highways, nine regional meetings, involving professionals related to the transportation industry, were conducted throughout the state. Additionally, a qualitative analysis of user needs was conducted using six focus group meetings involving general residents of rural Minnesota. To supplement this qualitative study, a telephone survey of 500 travelers in rural Minnesota provided a quantitative assessment of rural needs. Figure 3.1 shows the locations of the nine regional meetings and the six focus groups. The results presented in this report will serve to facilitate the upcoming task of identifying preferred technologies and projects. Following this brief introduction, Section 2 will present an analysis by location describing primary transportation concerns identified at each regional meeting. Section 3 will present the results of the focus groups and telephone surveys. Appendix B of this report presents a description of the regional meetings format and a list of attendees at each meeting.

3.2 Analysis of regional meetings by location

Nine regional meetings were conducted between October 26, 1993 and November 18, 1993. The objective of these meetings was to assemble professionals within the transportation industry in order to identify rural highway users needs throughout Minnesota. Participants at each meeting were asked to describe local transportation concerns that could be addressed using advanced or existing technologies. This section provides an analysis of the discussions at each meeting by location. Following a brief demographic description of each location, the primary needs identified for each area will be presented. A brief analysis will then relate these needs to potential contributing conditions.

Figure 3.1.1 - Map showing the locations of regional meetings and focus groups

Regional meeting #l

Location: Brainerd, Minnesota

Demographics

Population of Brainerd: 12,353
Population of Crow Wing County: 44,249
Population by age for Crow Wing County:

Under age 18	11,928
Age 18-24	3,477
Age 25-44	12,327
Age 45-64	8,874
Over age 65	7,643

Description of needs identified within region:

The following general issues were repeatedly mentioned as problems within this region:

- **Information.** Travelers need real-time weather information both pre-trip and en-route.
- **Congestion.** The influx of tourists or weekend travelers visiting the area regularly or during special events creates periods of congestion within this region.
- **Safety.** The issue of crash avoidance is a concern. The safety of the older driver population is a concern as their reaction time decreases.

In addition to the above primary concerns, the following issues were raised:

- **Emergency medical services.** The need exists to increase the efficiency of managing emergency medical service fleets.
- **Paratransit.** A need exists for a flexible transit system to assist those residents not capable of driving. Also, transit service is needed to the Minneapolis metropolitan area.
- **Education.** The need to properly educate the public about the available IVHS systems and proper use of such systems was identified.

Summary of findings

The region surrounding Brainerd is a major tourist attractor. This unusually high number of tourists is responsible for the area-wide congestion. Additionally, travel between this region and the Minneapolis metropolitan area is on a four-lane highway. Travel reduces to a two-lane highway near Brainerd, resulting in a number of concerns.

In summary, the following conditions describe Brainerd:

- majority of travel along two-lane highways;
- large number of tourists; and
- numerous trips to Minneapolis area.

Regional meeting #2

Location: Moorhead, Minnesota

Demographics:

Population of Moorhead: 32,295
Population of Clay County: 50,422
Population by age for Clay County:

Under age 18	12,625
Age 18-24	9,973
Age 25-44	13,704
Age 45-64	8,138
Over age 65	5,982

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** Participants within this region feel they would benefit if tourists travelling either past or through Moorhead were informed of the attractions within this region. Therefore, a need exists for tourist information in an attempt to boost the economy of this region. Additionally, accurate, real-time weather information is needed throughout this region both informing travelers of current weather and road conditions, and informing maintenance personnel of the road conditions.

- **Safety. Several** concerns regarding crash avoidance both along highways and at intersections were identified.

- **Commercial vehicle operations issues**. The concern regarding commercial vehicles and border crossing issues was identified.

In addition to these primary issues, the following issue was mentioned with less emphasis:

- **Congestion within the Moorhead-Fargo city limits.** The congestion created by the attractions within the cities was identified as a concern. This concern is typical for a city with a population of over 32,000 residents.

Summary of findings

Moorhead is located near two major interstate freeways (I-94 and I-29), and as a result, large numbers of tourists pass by this region. This contributes to the need for tourist information. Additionally, the Moorhead-Fargo area is a large urban area with, for example, the Fargodome a major attractor for travel into the area for special events. The population of Moorhead is also comprised of many college students and only a small percentage of the total population is considered elderly. This explains the absence of concern regarding transit.

In summary, the following conditions describe the Moorhead region:

- located near major freeways;
- contains a relatively large centralized urban area;
- contains a number of colleges leading to a younger mean population with relatively large amounts of cross border traffic; and
- state border city.

Regional meeting #3

Location: Paynesville, Minnesota

Demographics:

Population of Paynesville: 2,275
Population of Stearns County: 118,791
Population by age for Stearns County:

Under age 18	33,009
Age 18-24	20,665
Age 25-44	34,600
Age 45-64	18,041
Over age 65	12,476

Description of needs identified within region:

The following primary issues were identified within this region:

- **Economic development.** A concern surfaced regarding the need to better utilize the existing roadways to improve the economy of this region.

- **Safety.** The physical highway design includes many intersections occurring at various angles of intersect other than 90 degrees. Additionally, the safety concerns associated with crash avoidance were identified.

- **Information.** Tourist information provided to attract travelers to this region is needed. Additionally, real-time, area specific weather and road condition information is needed.

In addition to the above primary issues, the following issue was mentioned with less emphasis:

- **Education.** The need to properly educate the public about safe and efficient driving practices.

Summary of findings

Paynesville is a small community located away from any major freeway or tourist attraction. The majority of travel is on two-lane highways. The infrastructure in this region does not encourage economic development. The city lacks major industry and the majority of residents commute to nearby St. Cloud or Minneapolis. In summary, the following conditions describe Paynesville:

- tourism is less than desired;
- majority of travel on two-lane highways;
- no access to freeways;
- lack of major industry; and
- residents commute to other areas to work.

Regional meeting #4

Location: Thief River Falls, Minnesota

Demographics:

Population of Thief River Falls: 8,010
Population of Pennington County: 13,306
Population by age for Pennington County:

Under age 18	3,562
Age 18-24	1,376
Age 25-44	3,706
Age 45-64	2,413
Over age 65	2,249

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** The primary information need is real-time weather and road conditions. Parallel to this is the need for information regarding construction locations and detours specific to the area. Information assisting tourists to the area is an additional concern, as is the need for commercial vehicle routing around towns and road construction sites.

- **Safety.** Crash avoidance is a concern with the numerous two-lane highways and head-on/rear-end collisions.

- **Emergency Medical Services.** Concern was raised regarding the risk of vehicles becoming stranded in **remote** areas, unable to contact services for assistance.

In addition to the above primary issues, the following issues were mentioned with less emphasis:

- **Transit.** The area consists of several independent paratransit providers. The need exists for better coordination of these systems and improved passenger information relating to the available services.

- **Commercial Vehicle Operations (CVO).** Several commercial vehicle issues were suggested relating to the need for improved efficiency and safety of transport.

Summary of findings

The region surrounding Thief River Falls has no major tourism. The majority of travel occurs along two-lane rural highways. This region supports a large sugar beet industry with extremely intense harvests requiring fast transport of products. Often commercial vehicles are forced to travel repeatedly through the city limits, resulting in delays to commercial vehicles as well as other travelers. In summary, the following conditions describe the Thief River Falls region:

- very little tourism;
- primarily two-lane highways;
- extensive commercial vehicle traffic during harvests;
- small town; and
- located away from major freeways.

Regional meeting #5

Location: Two Harbors, Minnesota

Demographics:

Population of Two Harbors: **3,651**
Population of Lake County: **10,415**
Population by age for Lake County:

Under age 18	**2,535**
Age 18-24	**583**
Age 25-44	**2,888**
Age 45-64	**2,589**
Over age 65	**1,820**

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** Travel information is needed by tourists within this region. Specifically, travelers need real-time weather information both pre-trip and en-route.

- **Commercial vehicle issues.** Delays encountered by commercial vehicles is a concern.

In addition to the above primary issues, the following issues were mentioned with less emphasis:

- **Safety.** Safety concerns associated with vehicles running off the roadway and with unprotected at-grade rail crossings were mentioned.

- **Emergency Medical Services.** Concern was emphasized for stranded vehicles in remote areas requiring assistance.

- **Transit.** The need exists to coordinate the existing transit systems to increase overall efficiency.

- **Condition of roadways.** Numerous problems with roadway conditions were voiced.

Summary of findings

The region surrounding Two Harbors attracts a large amount of tourist traffic. Additionally, the mining industry in this portion of the state creates large amounts of truck traffic traveling to the harbor in nearby Duluth. A four-lane highway connects Two Harbors with Duluth, thus limiting the congestion within this region. In summary, the following conditions describe the Two Harbors region:

- small population, near large community;
- large amounts of commercial vehicle traffic;
- major tourist attractions; and
- four-lane highway accessibility.

Regional meeting #6

Location: Marshall, Minnesota

Demographics:

Population of Marshall: 12,023
Population of Lyon County: 24,789

Population by age for Lyon County:	Under age 18	6,739
	Age 18-24	3,298
	Age 25-44	6,832
	Age 45-64	4,066
	Over age 65	3,854

of needs identified within region:

The following primary issues were identified within this region:

- **Information.** Real-time updated weather information is needed. Additionally, information concerning the location of construction sites and detours, and possible rerouting was identified as a need.

- **Safety.** The issue of crash avoidance is a major concern. Driver impairment and inattentive driving was also noted as a regional concern.

In addition to the above primary issues, the following issues were mentioned with less emphasis:

- **Transit. Since** several independent transit services exist, the need is for coordination of and communication between these providers.

- **Education.** Concern was identified about properly educating drivers about the rules and proper driving procedures.

- **Law enforcement.** A need for increases to existing law enforcement services was identified.

Summary of findings

Marshall is considered to be a developing city. It houses a University with 3,000 students (25 % of city population). A four-lane highway bypasses the town with two-lane connectors within the city limits. The younger population, attracted by the college, contrasts with the older population within the town. In summary, the following conditions describe the Marshall region:

- developing city;
- four-lane highway around the city with two-lane highways within the city; and
- large percentage of college aged residents.

Regional meeting #7

Location: Slayton, Minnesota

Demographics

Population of Slayton: 2,147
Population of Murray County: 9,660
Population by age for Murray County:

Under age 18	**2,620**
Age 18-24	**593**
Age 25-44	**2,433**
Age 45-64	**2,023**
Over age 65	**1,991**

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** Real-time, accurate weather and road condition information is needed. Additionally, construction work locations and accompanying routing information is an issue.

- **Emergency Medical Services.** Concern was emphasized for stranded vehicles in remote areas requiring assistance.

- **Safety.** The need for some form of crash avoidance device was emphasized. The inattentiveness of older drivers and resulting hazards were mentioned. Additionally, safety surrounding construction zones and at-grate railroad crossings was identified as a concern. The infrastructure layout was identified as a safety concern as it contributes to many accidents due to poor visibility.

Summary of findings

Slayton is a small rural town. The majority of local industry is farming and an older population is found throughout the region. In summary, the following conditions describe the Slayton region:

- small, rural town;
- no large industry;
- older population; and
- located away from any large freeway.

Regional meeting #8

Location: Rochester, Minnesota

Demopraphics:

Population of Rochester: 70,997
Population of Olmsted County: 106,470

Population by age for Olmsted County:	Under age 18	29,528
	Age 18-24	9,796
	Age 25-44	37,793
	Age 45-64	18,749
	Over age 65	10,604

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** Real-time accurate weather and road condition information is necessary. The location of road construction sites and associated route advisories is also needed.

- **Safety.** The issue of crash avoidance is a concern. Driver impairment and inattentiveness were both focused upon. Additionally, hazards created by snowplows limiting the visibility of the roadway and concerns relating to at-grade railroad crossings were identified.

- **Emergency Medical Services.** Concern was expressed regarding the risk of vehicles becoming stranded in remote areas, unable to contact services for assistance. Additionally, emergency services need increased coordination and efficiency.

In addition to the above primary issues, the following issues were mentioned with less emphasis:

- **Education.** Concern was voiced regarding the education of drivers as to safe and effective driving habits.

- **Transit.** Effective transit between rural and urban areas was identified as a need within this region.

Summary of findings

Rochester is a large city and a major employment center for surrounding communities. The Mayo Clinic within the city is a major employer. Many people live in nearby small towns and commute into Rochester. Therefore, the travel needs, as identified within this region, reflect those of small communities surrounding a larger urban center. Rochester is also located near a major east-west freeway (T-90). In summary, the following conditions describe the Rochester region:

- large employment center;
- extensive development in outlying rural communities; and
- access to large freeways.

Regional meeting #9

Location: LeCenter, Minnesota

Demographics:

Population of LeCenter: 2,006
Population of LeSueur County: 23,239
Population by age for LeSueur County:

Under age 18	6,865
Age 18-24	1,786
Age 25-44	6,764
Age 45-64	4,327
Over age 65	3,497

Description of needs identified within region:

The following primary issues were identified within this region:

- **Information.** En-route advisories capable of providing real-time accurate weather information are a need within this region.

- **Safety.** Crash avoidance was identified as a key concern for travelers within this region. Additionally, the limited visibility due to inclement weather is also a concern.

- **Emergency Medical Services.** Vehicles which become stranded in remote areas are in need of a means for communicating with EMS providers. Additionally, coordination among EMS providers needs to be improved upon.

- **Transit.** The availability of some form of transit system to assist the elderly within this region is a concern.

Summary of findings

LeCenter is a small rural town with no large industry, very little tourism, and limited access to large freeways. In summary, the following conditions describe L&enter:

- small town;
- older population;
- very little tourism;
- lack of industry; and
- majority of travel on two-lane highways.

Summary of the analysis of regional meetings:

This analysis by location has identified primary needs for each region. These needs are summarized below:

Information needs

- weather and road condition information
- information relating locations of construction zones or other events and associated detours
- information targeted towards tourists within the area

Congestion needs

- congestion relief during weekends or peak tourist seasons
- congestion relief during special events (ie. sporting events)

Safety needs

- increased safety using crash avoidance
- impaired or inattentive driver alert for increased safety
- improved visibility concerning obstructions on or near the roadway
- improved visibility concerning weather inflicted sight restrictions

Emergency Medical Service needs

- increased management and coordination of emergency services
- assistance for stranded vehicles

Paratransit needs

- transit services to assist non-drivers
- transit services to improve service into metropolitan areas

Commercial Vehicle needs

- increased efficiency while crossing state and country borders
- improved efficiency of commercial vehicles management

Economic developmental needs

- increased utilization of existing roadway network

An analysis of these needs and respective conditions at each location has led to a set of heuristics (rules-of-thumb) capable of determining potential needs based on contributing factors. In addition to the primary needs, numerous needs which were emphasized to a lesser extent have also been identified. Although important, these needs are not presented with related conditions.

Analysis of needs identified at regional meetings

The analysis in this section has presented conditions describing each location accompanied by respective needs. A heuristic approach is used in an attempt to match conditions with potential resulting needs. The following decision trees (Figures 3.2.1 - 3.2.7) present sets of similar needs and accompanying contributing factors. Figure 3.2.8 is a summary of the 15 needs identified and respective contributing factors.

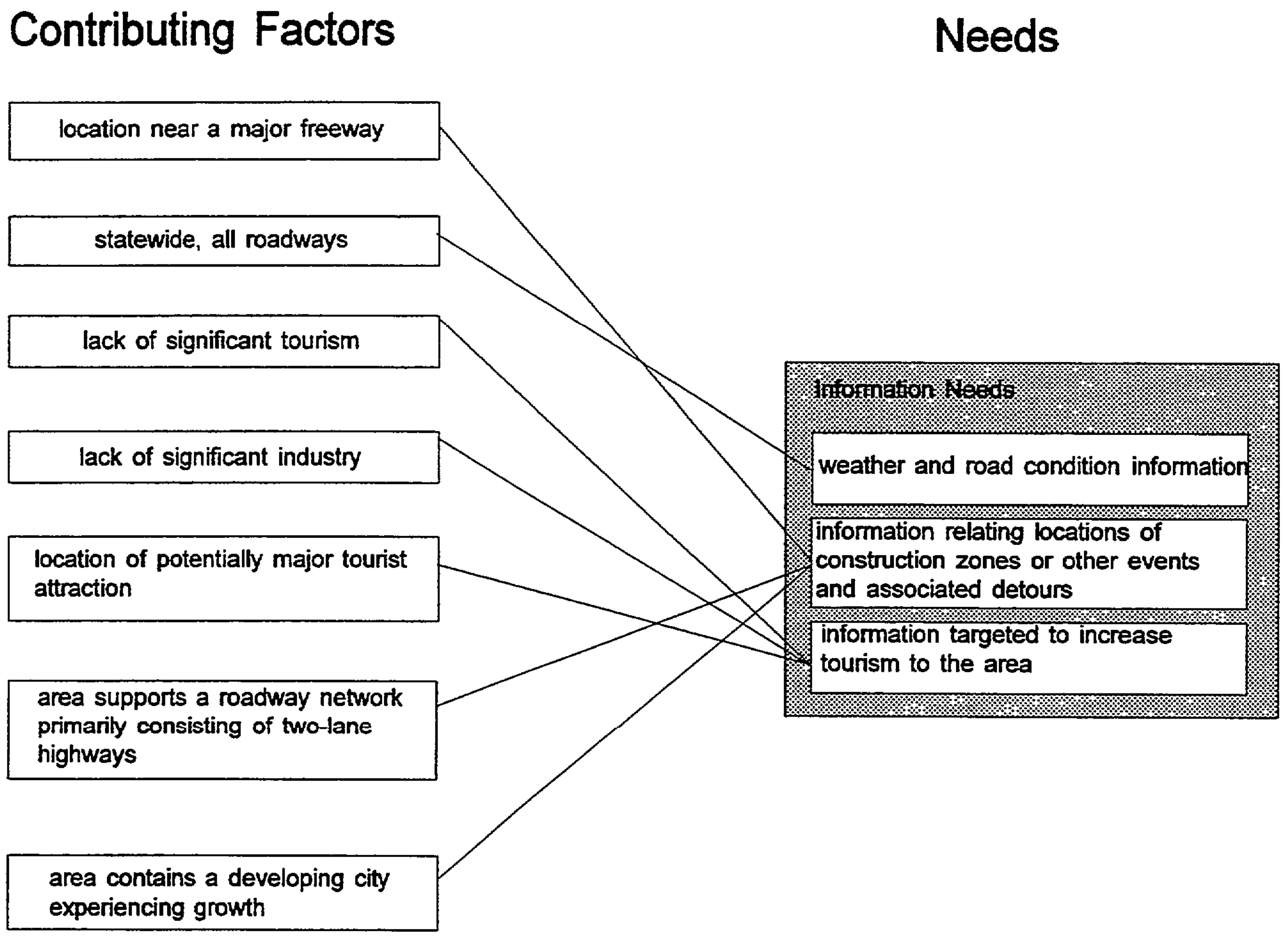

Figure 3.2.1. Factors describing locations and potentially related information needs

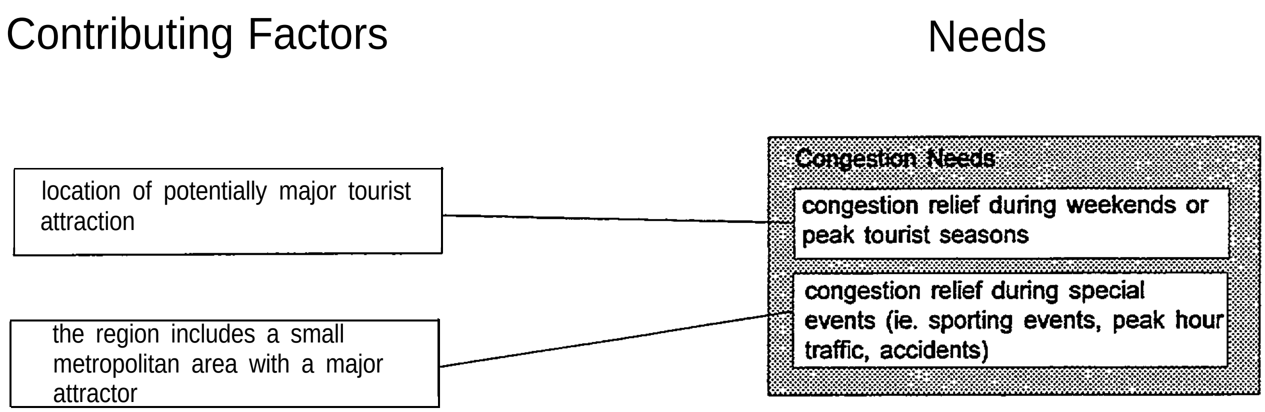

Figure 3.22. Factors describing locations and potentially related congestion needs

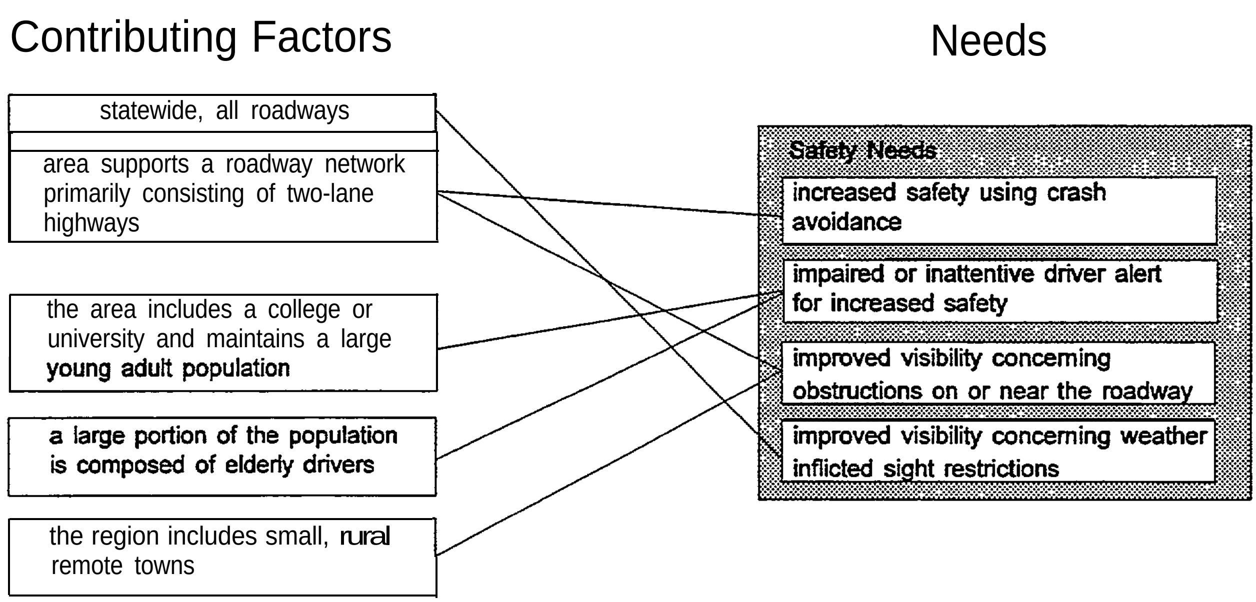

Figure 3.2.3. Factors describing locations and potentially related safety needs

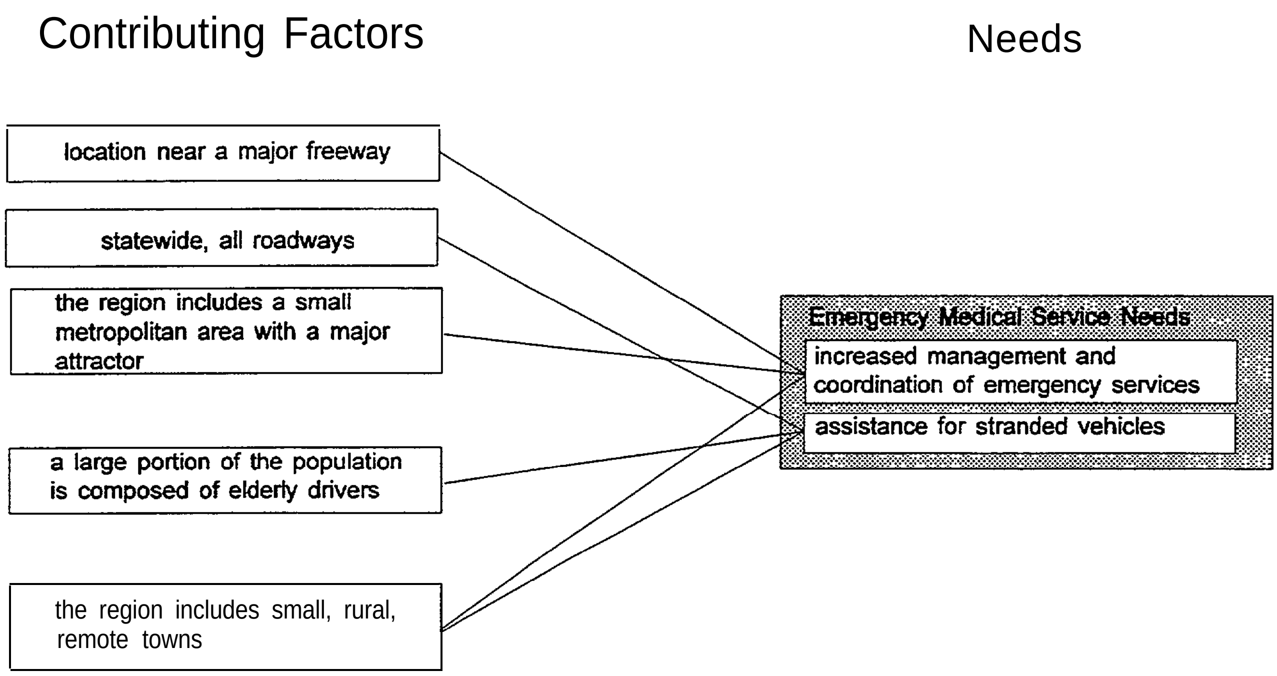

Figure 3.2.4 Factors describing locations and potentially related EMS needs

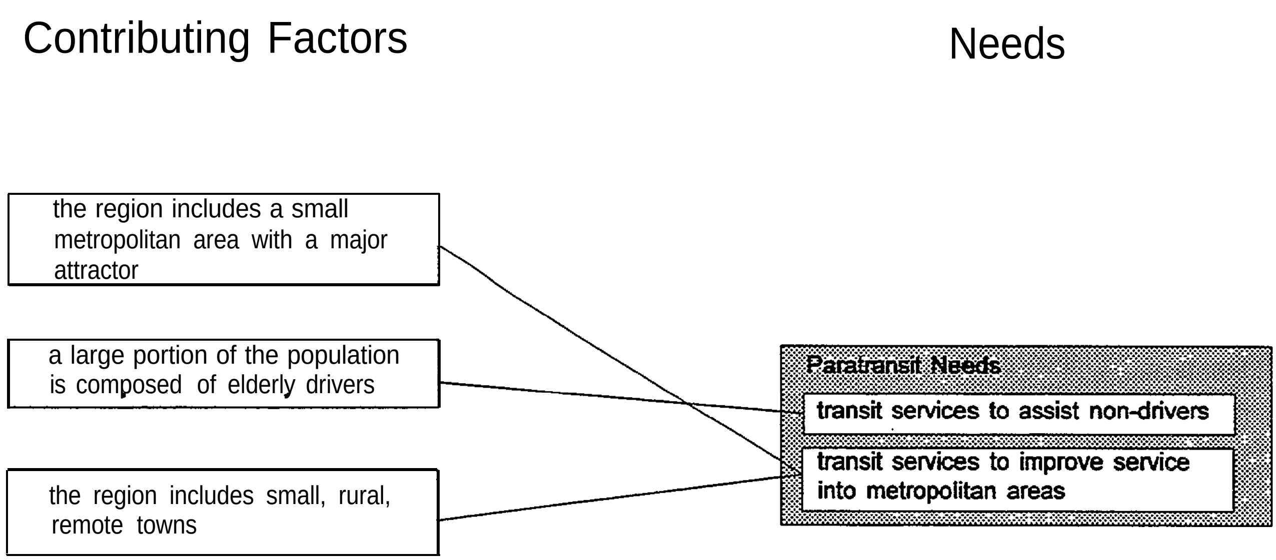

Figure 3.2.5. Factors describing locations and potentially related transit needs

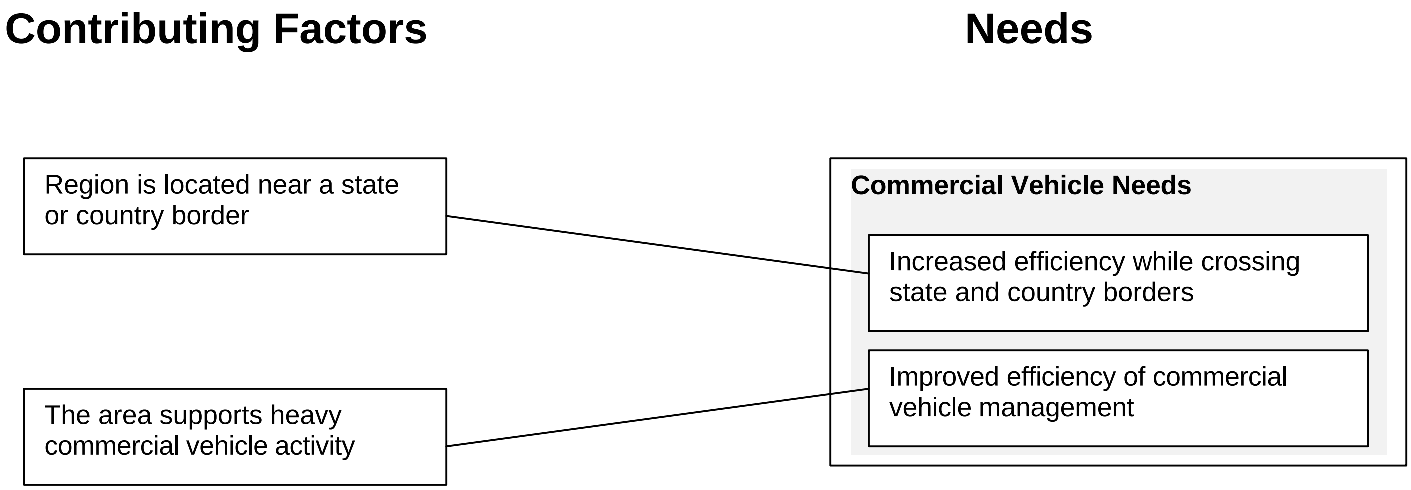

Figure 3.2.6 Factors describing locations and potentially related CVO needs

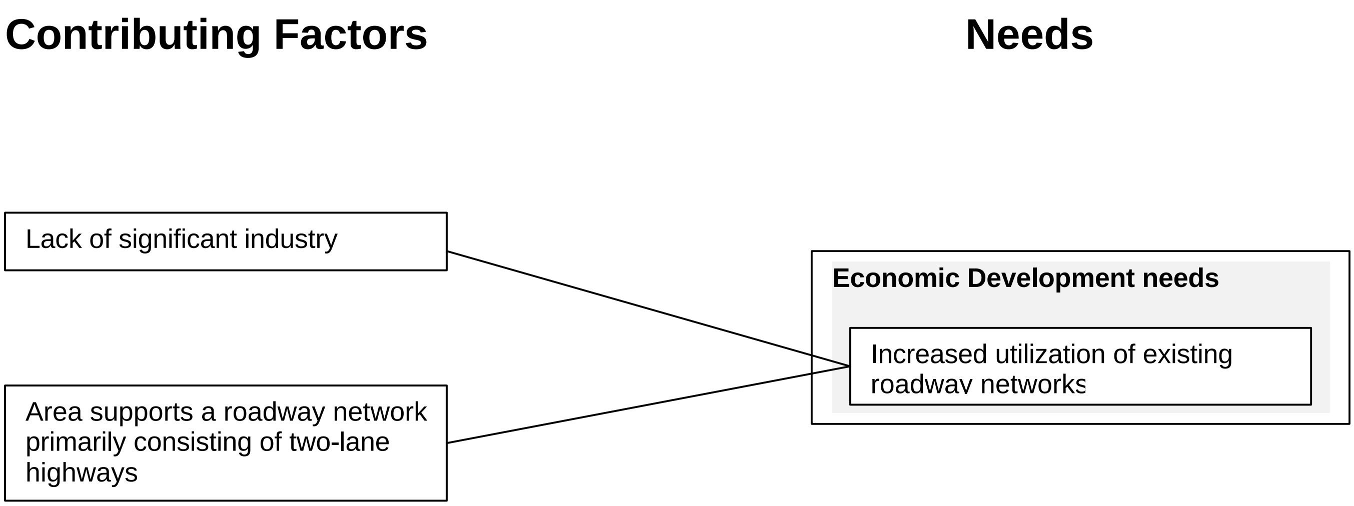

Figure 3.2.7. Factors describing locations and potentially related economic needs

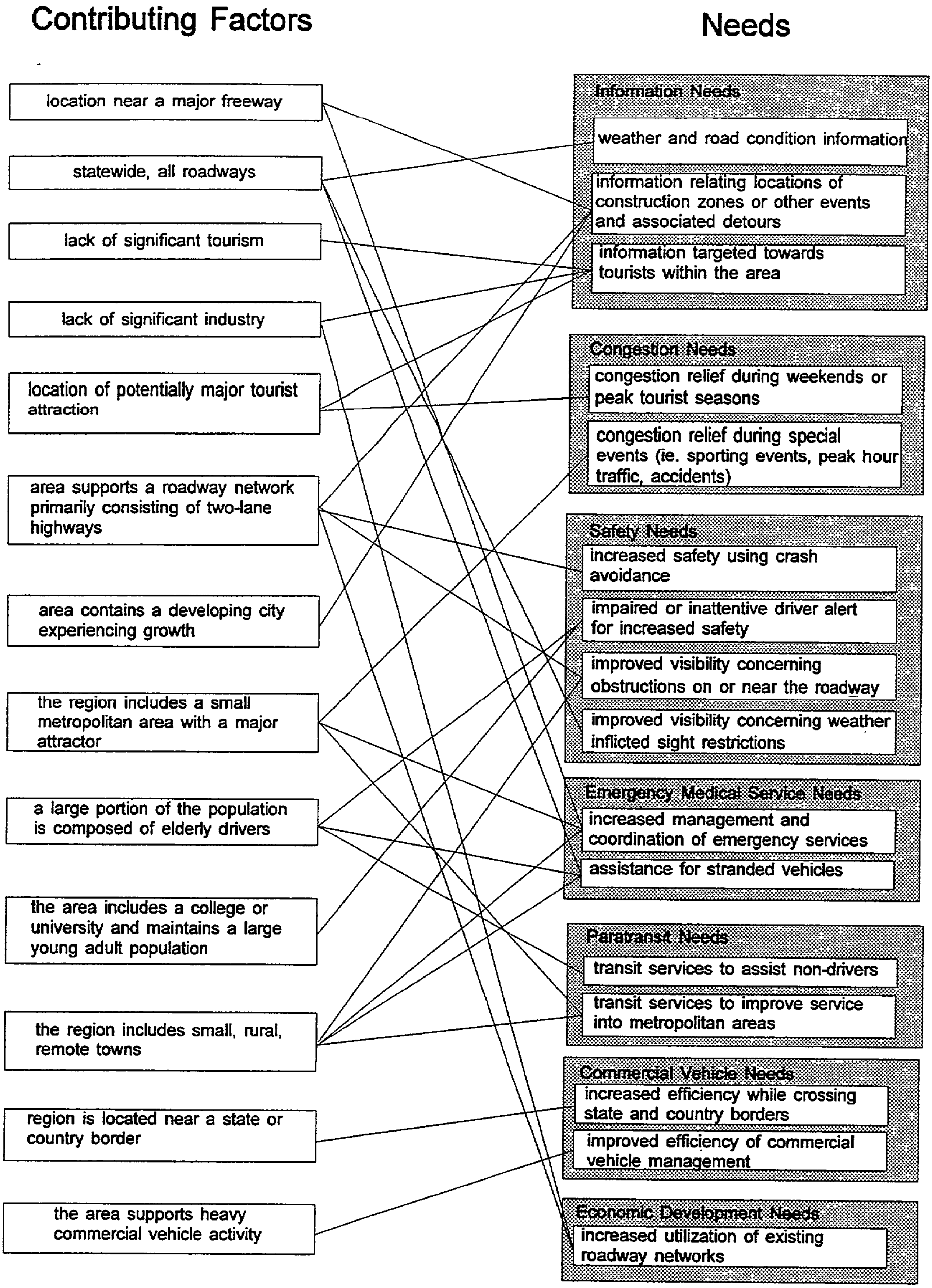

Figure 3.2.8. Factors describing locations and potentially associated needs

3.3 Analysis of focus groups and telephone surveys

In addition to the previously mentioned regional meetings, both a qualitative and a quantitative study involving the general public were conducted. A telephone survey targeted both residents and non-residents who have travelled in rural Minnesota, within the past two years, in order to provide a quantitative assessment of rural user needs. Additionally, six focus groups involving residents of rural Minnesota were conducted as part of a qualitative assessment of rural user needs.

Description of focus groups

The primary objective of the six focus groups was to conduct a qualitative assessment of transportation needs throughout rural Minnesota. These meetings involved Minnesota residents from various age ranges, with two meetings being held for each range: 18-40 year olds, 35-54 year olds, and 55 years and older. It was decided to separate the ages in this manner in order to promote more interactive, uninhibited conversations. Each discussion was professionally moderated by C.J. Olson Market Research, Inc.

Similar to the phone surveys, the conversations at these meetings served multiple purposes. The focus was the identification of traveler needs. Additionally, other questions will be analyzed in future sections of this report. This assessment of rural traveler needs has led to the following list of needs applicable to rural Minnesota:

Information needs

- weather and road condition information
- information relating locations of construction zones or other events and associated detours
- locations of emergency service providers

Transit needs

- transit services to assist nondrivers
- updated service, costs and route information

Safety needs

- increased safety using crash avoidance
- impaired or inattentive driver alert for increased safety
- improved visibility concerning obstructions on or near the roadway
- improved visibility concerning weather inflicted sight restrictions

Emergency Medical Services

- assistance for stranded vehicles

Description of telephone surveys

Five hundred and five phone interviews were completed from December 2, 1993 through December 15, 1993 by C.J. Olson Market Research, Inc. in Minneapolis, Minnesota. A random digit sample was used in addition to a KISH respondent selection method for choosing one person at each household to participate in the survey. The survey consisted of 27 questions related to travel concerns of rural Minnesota residents as well as tourists who have travelled rural Minnesota highways and roads within the last 24 months. A copy of the telephone survey appears in Appendix C of this report. The survey gathered the following information from each participant:

- demographic information;
- number of miles driven per day;
- types of roadways driven on;
- reasons for driving;
- importance of information before leaving on a trip;
- importance of information while planning a trip;
- safety concerns while travelling;
- preference for method of receiving pre-trip information;
- preference for method of receiving en-route information;
- likelihood of using new technologies, if available;
- likelihood of paying for special services;
- preference for obtaining in-car devices;
- interest/preferences toward automatic emergency devices;
- likelihood of using available public transit; and
- effectiveness of driver education for improved safety.

Summary of needs identified in phone survey

In the interview, numerous approaches were used in attempting to identify user needs. Of the questions asked, the following were considered most pertinent in the identification of user needs:

- importance of information before leaving on a trip;
- importance of information while planning a trip; and
- safety concerns while travelling.

Importance of pre-trip information

Participants of the telephone survey were asked to indicate the importance of various types of information before a trip begins. On a scale of l-10, one being not at all important and ten being very important, participants were asked to rate each option of pre-travel information. Of the options, the following four types of information were weighted an average of 8.0 or higher:

- road conditions (mean value of 8.91);

- weather conditions (mean value of 8.86);
- visibility conditions (mean value of 8.85); and
- road safety problems (mean value of 8.43).

Importance of information while planning a trip

Once again, using a ten point scale with zero being not important and ten being very important, the participants ranked the importance of various types of information while planning a vacation or trip. The interest appeared to be high in two types of information:

- locations of lodging (mean value of 7.18); and
- locations of scenic routes (mean value of 7.03).

Safety concerns

The telephone survey also focused on safety issues. The participants were asked to rank the issues, on a ten point scale, in terms of how much they worried about each safety issue. The following issues received the highest scores (most worried about):

- road conditions (mean value of 8.44);
- winter road maintenance (mean value of 7.86);
- drunk drivers (mean value of 7.83);
- reckless speeding drivers (mean value of 7.50); and
- medical or breakdown assistance (mean value of 7.26).

Consideration of the previously mentioned survey questions reveals the following list of needs for rural travelers in Minnesota as identified by the telephone survey:

Information needs

- weather and road condition information
- route choice assistance
- locations of special events
- information targeted towards tourists in the area

Safety

- impaired or inattentive driver assistance
- crash avoidance

Emergency medical service needs

- assistance for stranded vehicles

The remainder of the survey questions will be used in further tasks to assist in the process of prioritizing options for addressing user needs. In addition to soliciting information of users needs, the telephone survey also focussed on several issues relevant to the intended application of IVHS to the rural environment; the following information was considered for this task:

- preference for method of receiving pre-trip information;
- preference for method of receiving en-route information;
- likelihood of using new technologies, if available;
- likelihood of paying for special services;
- preference for method of obtaining in-vehicle devices;
- interest/preferences toward emergency notification devices; and
- likelihood of using available public transit.

To determine user preference for receiving regional pre-trip information, each interviewee was asked to indicate at which location(s) they would like to be able to receive information. The most popular location is rest stops. Three other options were chosen by more than half the participants: gas stations, truck stops, and cafes/restaurants. The following list indicates the percentage of participants who indicated interest in each location:

- rest stops (70% of interviewees)
- gas stations (61% of interviewees)
- truck stops (58% of interviewees)
- cafes/restaurants (54% of interviewees)

Public acceptance of IVHS applications is one of the primary goals when developing conceptual projects. To assist in achieving this acceptance, each survey participant was asked to rank the likelihood that they would use each of a selected group of technologies for providing information related to weather, construction zones, detours and road conditions. Using a ranking scale of l-10, with one meaning not at all likely and ten meaning very likely, the specified services received the following overall mean values:

- special radio channel (7.89);
- changeable message signs (7.83);
- phone number (7.54);
- cellular phone (6.67);
- computerized information centers (6.07); and
- in-vehicle TV monitor (5.99).

Each participant who ranked the likelihood of using an in-vehicle TV monitor lower than six, was then asked why such a low rating was chosen. Sixty-three percent of those questioned stated that the monitor would be distracting, unsafe and hazardous to watch while driving. When participants were further questioned regarding a special radio channel and whether they prefer AM or FM, forty-one percent of the total sample chose FM while 46 percent chose either one. Regarding the option of calling a phone number to obtain information, 61 percent of the participants stated a preference for a live voice offering the information, while thirty-one percent prefer a voice mail system and seven percent prefer a recorded message. For the previously mentioned in-vehicle devices, the participants were asked how they would prefer to obtain the in-vehicle device. Fifty-four percent indicated they would prefer the equipment be installed before purchasing the vehicle, while twenty-two percent would prefer to lease the equipment and 13 percent showed interest in purchasing the equipment.

The danger of becoming stranded along the roadside was mentioned quite often in the focus groups. As a follow-up to this issue, each participant of the telephone survey was asked if they were interested in an in-vehicle mayday device. Eighty-two percent of the participants expressed interest in such a device, and of those interested, 78 percent wish to be notified that help is on the way.

Perhaps the most important issue facing the execution of IVHS applications is the funding sources. Within the telephone survey, each participant was asked who should pay for these new services or products. Thirty-nine percent of the participants stated that the user should pay for the services, while three percent felt the government should pay and two percent felt that private industry should fund the projects. However, 54 percent agreed that the costs for these new services should be supported by a combination of the government, the user, and private industries. As a follow-up to this, a question of how user fees should be assessed was asked. Seventy-six percent of the total population stated that a user fee would be appropriate while 14 percent favored support through taxes and eight percent favored a combination of the two. To further address this issue, the results of this question were cross-tabulated with the results of the question asked for participants to indicate which service they would be likely to use. The results of this analysis are summarized in Table 3.3.1.

Technologies participants would be likely to use	Appropriate funding sources (%)					Method of payment (%)			
	Government	Private Industry	User	All 3	Industry & User	Taxes	User Fee	Both	Other
Special phone number	2.1	1.6	37.4	56.5	1.6	15.5	73.8	9.1	.6
Special radio channel	2.4	2.0	38.3	54.9	2.0	14.6	74.4	9.5	.5
In-vehicle TV monitor	3.0	1.1	35.6	57.8	1.9	14.7	74.8	8.5	.4
Cellular phone	2.8	.6	37.3	56.6	1.6	13.5	75.3	9.9	.7
Changeable message signs	2.5	1.5	36.7	56.3	1.7	15.4	73.4	8.9	.8
Computerized information centers/kiosks	2.2	1.4	32.9	61.0	1.4	15.1	74.0	9.1	.4
In-vehicle paging services	4.9	N/A	30.6	61.1	1.4	17.8	68.9	11.1	1.5
Emergency notification	1.7	1.2	37.3	57.2	2.2	14.6	74.9	8.7	.7
In-vehicle intoxicated driver barrier	2.8	1.7	37.9	54.5	1.9	14.4	76.0	8.0	.5

Table 3.3.1 – Results of cross-tabular analysis of IVHS application usage versus appropriate funding

3.4 Summary of needs identified in the various meetings

Section 2 presented the needs identified at the regional meetings while Section 3 addressed those needs identified at the focus group meetings and via the telephone surveys. It is the intent of this section to summarize these lists into one set of needs relevant to travelers in rural Minnesota. Table 3.4.1 presents each identified need and the respective meeting type in which the need was identified. It is important to note that the lack of consistency between needs surfacing at the different meetings does not place lesser emphasis on any need. In fact, it was the intent to use three separate procedures in order to identify as wide a variety of needs as possible.

Category of needs	Needs identified	Regional meetings	Focus groups	Phone survey
Information needs	Weather and road condition information	●	●	●
	Information relating locations of construction zones or other events and associated detours	●	●	
	information targeted towards tourists within the area	●	●	●
	Locations of emergency services		●	
Congestion needs	Congestion relief during weekends or peak tourist seasons	●		N/A
	Congestion relief during special events	●		N/A
Safety needs	Increased safety using crash avoidance	●	●	●
	Impaired or inattentive driver alert for increased safety	●	●	●
	Improved visibility concerning obstructions on or near the roadway	●	●	●
	Improved visibility concerning weather inflicted sight restrictions	●	●	●
EMS needs	Increased management and coordination of emergency services	●		N/A
	Assistance for stranded vehicles	●	●	●
Transit needs	Transit services to assist non-drivers	●	●	
	Transit services to improve service into metropolitan areas	●		
	Updated service, costs, and route information		●	
Commercial vehicle needs	Increased efficiency while crossing state and country borders	●	N/A	N/A
	Improved efficiency of commercial vehicles management	●	N/A	N/A
Economic development needs	Increased utilization of existing roadway network	●		N/A

*N/A: Issue not addressed

Table 3.4.1 - Summary of rural transportation needs identified at various meetings

In an attempt to define rural Minnesota transportation needs in regards to the 27 User Services defined by the Federal Highway Administration, Table 3.4.2 summarizes the previously identified needs along with parallel user services.

Needs identified for discussions at nine Minnesota via open. 'meetings	Related Services
Weather and road condition information	Pre-trip travel information En-route driver advisory
Information relating locations of construction zones or other events and associated detours	Route guidance
Information targeted towards tourists within the area	Traveler services information
Locations of emergency services	En-route driver advisory
Congestion relief during weekends or peak tourist seasons	Traffic control
Congestion relief during special events (ie. sporting events)	Incident management
Increased safety using crash avoidance	Longitudinal collision avoidance Lateral collision avoidance Pre-crash restraint deployment
Impaired or inattentive driver alert for increased safety	Impairment alert
Improved visibility concerning obstructions on or near the roadway	Vision enhancement for crash avoidance
Improved visibility concerning weather inflicted sight restrictions	Vision enhancement for crash avoidance
Increased management and coordination of emergency services	Emergency vehicle management
Assistance for stranded vehicles	Emergency notification and personal security
Transit services to assist nondrivers	Ride matching and reservation
Transit services to improve service into metropolitan areas	Personalized public transit
Real-time service, costs and route information	En-route transit advisory
Increased efficiency while crossing state and country borders	Commercial vehicle preclearance
Improved efficiency of commercial vehicle management	Commercial fleet management
Increased utilization of existing roadway networks	Route guidance En-route driver advisory

Table 3.4.2 Rural Minnesota transportation needs and parallel User Services

In a further attempt to define traveler needs in terms of the IVHS User Services, a survey was conducted at each regional meeting. For this survey, each of the 27 User Services was defined in detail and participants were asked to identify those services they felt had potential as a means for satisfying transportation needs within each region. A total of 103 transportation related professionals participated in this survey. Table 3.4.3 identifies the percentage of participants who chose each user service and similarly indicates which user services were identified in either the regional meetings, focus groups, or phone surveys. This information is ranked in descending order according to the percentage of participants who have selected each user service.

IVHS User Services	Percentage of participants who selected the user service as applicable to greater Minnesota (%)	User services identified in open discussion at regional meetings
Pre-trip travel information	92	$
Emergency notification and personal security	88	$
Traveler service information	85	$
Route guidance	83	$
En-route driver advisory	82	$
Longitudinal collision avoidance	81	$
Emergency vehicle management	78	$
Automated roadside safety inspections	73	
Lateral collision avoidance	72	$
Impairment alert	71	$
On-board safety monitoring	70	
Precrash restraint deployment	68	$
Vision enhancement for crash avoidance	67	$
Incident management	66	$
Commercial vehicle preclearance	63	$
Commercial fleet management	57	$
Intersection crash warning and control	53	
Traffic control	53	$
Public travel security	52	
Commercial vehicle administrative processes	52	
Personalized public transit	51	$
Ride matching reservation	41	$
Public transportation management	40	
Fully automated vehicle operation	35	
En-route transit advisory	29	
Electronic payment services	25	
Travel demand management	23	

Table 3.3.3 – Sorted results of user service survey and open discussions

4. REVIEW OF EXISTING TECHNOLOGY

4.1 Introduction

It is the intent of this chapter to build upon the previous two chapters and present a review of existing technologies possibly capable of satisfying the needs identified in Chapter 3. This review will serve as a precursor to future tasks which will evaluate each technology option so as to identify those options most appropriate for rural Minnesota.

4.2 Approach to technology review

The focus of this technology review is to investigate potential approaches for satisfying the user needs identified in the previous chapters. Table 2.5.2 of this report presented a list of current projects and the IVHS User Services addressed by each project.

Using Table 3.4.3 as a guide of which user services are applicable to rural Minnesota, consideration is then given to every project identified within Table 2.5.2 of this report.

4.3 Description of technologies

This review was conducted to identify all possible options for satisfying user needs. For this reason, the options ranged from non-technical to high technical. At this point in the report, the technologies are only listed and not described or prioritized, so as not to instill any preference to any option. Later in the report, several aspects of each option will be considered to assist in the prioritization. Tables 4.3.1 - 4.3.7 present these technology options.

TRAVELER INFORMATION					
Function	Technology option	Applicable need			
		Weather/road conditions	Tourist	Workzones	EMS locations
Data Collection	Weather spotters	$	$		
	Police/EMS reports	$	$	$	$
	Traveler reports	$	$		
	Inductive loops		$	$	
	Cameras	$	$	$	
	Weather sensors	$			
	Radar	$			
Data Processing	Manual	$	$	$	$
	Semi-automated	$	$	$	$
	Fully automated	$	$	$	$
Information Dissemination	Newspapers/publications	$	$	$	$
	Word of mouth	$	$	$	$
	Manned phone systems	$	$	$	$
	Automated phone systems	$	$	$	$
	Television	$	$	$	$
	Commercial radio	$	$	$	$
	Radio stations dedicated to traffic	$	$	$	$
	Radio stations with subcarriers (e.g., RBDS)	$	$	$	$
	Pagers	$	$	$	$
	Changeable message signs	$	$	$	$
	Static signs	$	$	$	$
	Personal computers	$	$	$	$

Table 4.3.1 – Summary of technologies applicable in satisfying the Need for traveler information

CONGESTION RELIEF			
Function	Technology option	Applicable need	
		Weekends/ tourist seasons	Special events
Data Collection	Traffic spotters	●	●
	Police/EMS reports	●	●
	Inductive loops	●	●
	Cameras	●	●
	Vehicles as probes	●	●
	Radar	●	●
Data Processing	Manual	●	●
	Semi-automated	●	●
	Fully automated	●	●
Congestion Response	Information dissemination (see Traveler Information table)	●	●
	Traffic signals	●	●
	Traffic bans	●	●
	Traffic rerouting	●	●

Table 4.3.2 - Summary of technologies applicable in satisfying the need for congestion relief

SAFETY					
Function	Technology option	Applicable need			
		Crash avoidance	Driver alert	Obstruction limiting vIslbtl&y	Weather limiting visibility
Weather Monitoring Systems	Wheel slip measurement	●			
	Cross wind detection		●		
	Uneven surface detection	●			
	Wetness, ice detection	●			
Warning Systems	Vehicle rollover warning	●	●		
	Vehicle headway warning	●	●	●	●
	Blind spot/vehicle overtaking warning systems	●			
	Pedestrian detection system		●	●	
Assistance Systems	Lane following system	●		●	
	Reversing assistance system	●			
	Driver status recognition		●		
	Ultraviolet or infrared headlight illumination				●
	Thermal imaging				●
	Image processing			●	●
	Intelligent cruise control systems	●			

Table 4.3.3 - Summary of technologies applicable in satisfying the need for increased safety

EMERGENCY MEDICAL **SERVICES**			
Function	**Technology option**	**Applicable need**	
		Management/ coordination	**Stranded vehicle assistance**
Emergency Alert Systems	Roadside call boxes		●
	Two-way communication	●	●
	In-vehicle **crash detector/mayday** communication device		●
	Electronic locator transmitter	●	●
Fleet Operations	Automatic vehicle location	●	●
	Computer aided dispatching systems	●	
	On-board route guidance	●	
	Signal preemption	●	

Table 4.3.4 - Summary of technologies applicable in satisfying the Emergency Medical Services needs

TRANSIT SYSTEMS				
Function	**Technology option**	**Applicable need**		
		Nondriver **assistance**	**Metropolitan access**	En-route service info
Passenger Services	Multimodal trip reservations	●	●	
	En-route schedule information	●	●	●
	Electronic ticketing and automatic trip payment	●	●	●
Fleet Operations	Computer aided ride matching/ scheduling and dispatching	●	●	●
	Automatic vehicle location	●	●	●
	Demand monitoring	●	●	
	Signal preemption	●	●	
	High-occupancy vehicle lanes	●	●	

Table 4.3.5 - Summary of technologies applicable in satisfying the transit needs

COMMERCIAL VEHICLE OPERATIONS			
Function	Technology option	Applicable need	
		Border crossing	Efficient management
Fleet Operations	Weigh-in-motion	●	
	Automatic vehicle identification	●	●
	Vehicle to station communication devices	●	●
	Vehicle monitoring		●

Table 4.3.6 - Summary of technologies applicable in satisfying commercial vehicle operations needs

ECONOMIC DEVELOPMENT NEEDS		
Function	Technology option	Applicable need
		Increased roadway utilization
Traffic Control	Traffic signals	●
	Traffic bans	●
	Traffic rerouting	●
	Traveler information dissemination (see Traveler Information table)	

Table 4.3.7 - Summary of technologies applicable in satisfying economic development needs

4.4 Preliminary prioritization criteria of technologies

The results of nine regional meetings have been analyzed to determine a set of primary rural transportation user needs for Minnesota. Further, contributing factors have been identified for each need. A review of existing projects has determined a set of technological methods for solving the needs. To properly prioritize potential projects, the first step is to determine a set of preliminary prioritization criteria which will ultimately be evaluated in ranking the preference of each project. The following criteria will be considered in prioritizing a project:

- cost of implementing the system;
- costs incurred by travelers;
- number of motorists served by each project;
- potential for public unacceptance of technology;
- nature of the need addressed (ie. safety vs. time-saving); and
- proof of technological applications.

Consideration of the nine regional meetings, the six focus groups, and the 500 phone surveys will prioritize all projects and technologies based upon the above criteria.

5. ASSESSMENT OF KEY ISSUES

5.1 Introduction

The results of Chapters 2, 3, and 4 include a description of travelers needs identified for rural Minnesota, and an accompanying matrix of potential IVHS applications capable of addressing these needs. The intent of this chapter is to provide a detailed assessment of key issues for each application under consideration so as to identify any potential constraints or problems of the proposed strategies. This assessment will identify potential constraints or problems, and thus assist in ultimately selecting projects with the greatest potential for success. Following this introduction, Section 5.2 will address the unique communication needs for rural IVHS applications. Section 5.3 will describe rural IVHS staffing and operations needs, and Section 5.4 will describe the need for compatibility between urban and rural IVHS systems.

5.2 Assessment of communications requirements

Rural applications of IVHS involve different communications needs than do those in urban areas. This section is an attempt to provide an additional assessment of the previously identified technologies to promote a more rigorous prioritization of potential technologies. Therefore, the ultimate goal of this task is to determine a set of candidate communication systems applicable to each potential technology. Further, an assessment of each technology will reveal both advantages and disadvantages for each option.

<u>Definition of communication categories for rural IVHS</u>

The initial step in defining communication needs involves a categorization of the various methods of communication used in IVHS applications. The following three categories have been defined:

1. Communication between a central control area and permanent stations, includes service to the following technologies:

   - Kiosk
   - Changeable message signs
   - Variable speed limit signs
   - In-field weather stations
   - Roadside call-boxes

2. Communication servicing mobile personal equipment, includes service to the following technologies:

   - Commercial radio systems
   - Special in-vehicle radio receivers

- Hand held pagers
- Telephone systems
- Personal computers
- Vehicles as probes
- On-board route guidance devices
- Mayday beacon
- Automatic vehicle locator
- Automatic vehicle identification

3. Communication between permanent stations and in-field equipment, includes service to the following technologies:

   - Weather sensors
   - Loop detectors
   - Video cameras
   - Ramp metering
   - Traffic signals

Identification of the communications requirements for each of the above mentioned candidate technologies is the next step. To perform this assessment, the following characteristics must be considered:

Range (wide area or local). For this purpose, local is defined as those distances approximately ten miles or less and includes technologies addressing needs within a limited area. Wide area refers to any distance greater than ten miles.

Data throughput. The bit rate at which data must be passed through the communication system varies upon the amount and type of information being passed.

Transmission definitions (point-to-point or point-to-many). Different applications require different types of transmission. These are classified as communicating between one point to either another single point receiver or to many receivers.

Transmission direction. The need for data to travel either one way or two-way (interactive) is an important consideration.

Connection time. This requirement determines whether the communication connection needs to be a full time connection or a temporary connection.

Each of the above mentioned issues has been considered for each of the potential technologies. Tables 5.2.1- 5.2.3 present an analysis of the communication needs for each technology. Table 5.2.4 presents 17 communications options for consideration in this task. Each option is presented with issues as defined previously in this section.

The characteristics of each communication option are then considered in conjunction with the needs of potential technologies. The previously mentioned issues serve as guidelines for this task. It is important to note that for those technologies requiring local range communication, an option providing wide area range is also a possible solution. Similarly, those technologies requiring low data rate may also be served by a high data rate option. Technologies requiring one way transmission may also be served by two way communication options, and finally, those technologies requiring part time connections may use a full time connection. Table 5.2.5 summarizes potential communication options for each identified IVHS technology.

Technology	Communication Requirements									
	Range Wide area/local		Data throughput		Point-point point-many		One-way/ Two-way		Full/part-time connection	
	W.A.	L	Hi	Lo	P-P	P-M	1	2	F	P
Kiosks	$			$	$	$	$	$		$
Changeable message signs	$	$		$	$	$	$		$	$
Variable speed limit signs	$			$	$	$	$		$	$
Weather and/or traffic monitoring stations	$		$		$		$		$	
Roadside call-boxes	$			$	$			$		$

Table 5.2.1 – Requirements for communication between a central
Control area and permanent stations

Technology	Communication Requirements									
	Range Wide area/local		Data throughput		Point-point point-many		One-way/ Two-way		Full/part-time connection	
	W.A.	L	Hi	Lo	P-P	P-M	1	2	F	P
Existing radio station	$			$		$	$		$	
Special in-vehicle radio receivers	$			$		$	$	$		$
Hand held pagers	$			$	$	$	$			$
Audiotext telephone systems	$			$	$		$	$		$
Personal computers	$		$	$	$			$		$
Vehicles as probes*		$		$	$		$			$
On-board route guidance	$			$		$	$		$	
Mayday beacon	$			$	$		$	$		$
Automatic vehicle locator	$			$		$		$		$
Automatic vehicle identification		$	$	$	$			$		$

* Communication is from a mobile unit to a permanent location

Table 5.2.2 – Requirement for communication servicing mobile
Personal equipment

Technology	Communication Requirements									
	Range Wide area/local		Data throughput		Point-point point-many		One-way/ Two-way		Full/part-time connection	
	W.A.	L	Hi	Lo	P-P	P-M	1	2	F	P
Weather sensors		$		$	$		$		$	
Loop detectors		$		$	$		$		$	
Video cameras		$	$		$		$		$	
Ramp metering		$		$	$		$		$	
Traffic signals		$		$	$		$		$	

Table 5.2.3 – Requirements for communication between permanent stations and in-field equipment

Technology	Communication Requirements									
	Range Wide area/local		Data throughput		Point-point point-many		One-way/ Two-way		Full/part-time connection	
	W.A.	L	Hi	Lo	P-P	P-M	1	2	F	P
Copper wire		$		$	$			$	$	
Coaxial cable		$	$		$			$	$	
Serial connection		$	$		$			$	$	
Fiber optics	$		$		$			$	$	
Telephone lines	$			$	$			$		$
Radio (800 MHz – SMR)	$			$		$		$		$
Microwave		$	$		$	$		$		$
Cellular	$			$	$	$		$		$
AM broadcast	$			$		$	$		$	
FM broadcast	$			$		$	$		$	
AM subcarriers	$			$		$	$		$	$
FM subcarriers	$			$		$	$		$	$
Television	$		$		$	$	$		$	
Television subcarriers	$		$		$	$	$		$	
Roadside beacons		$	$		$			$		$
Meteor burst	$			$	$			$		$
Satellite	$		$		$	$		$	$	$

Table 5.2.4 – Characteristics of communication technologies

Technology /communication	Copper Wire	Coexial cable	Serial connection	Fiber Optics	Tele-phone lines	Radio	Microwave	Cellular	AM Broad-cast	AM Sub-carriers	FM Broad-cast	FM Sub-carriers	Roadside Beacons	Beteor Burst	Satellite
Kiosks				X	X										X
CMS				X	X										X
Variable speed limit signs					X										X
Weather and traffic monitoring station				X											X
Roadside call boxes					X			X							X
Commercial radio systems						X			X		X				
Special in-vehicle radios						X				X		X			
Hand held pagers								X		X		X			X
Telephone systems				X	X			X							X
Personal computers				X	X			X					X		X
Vehicles as probes													X		X
On-board route guidance						X		X		X		X	X		X
Mayday beacon							X								X
Weather sensors		X	X	X	X										
Loop detectors	X	X													
Video cameras			X	X	X										
Ramp metering	X	X	X	X											
Traffic signals		X	X	X	X										

Table 5.2.5 potential communication options for each identified IVHS technology

5.3 Assessment of staffing and operational needs

A difference in staffing and operational needs exists between urban and rural IVHS applications. In addition to this difference in needs, the available staffing resources will vary between the two regions. Perhaps the most vivid example of such differences is the fact that rural areas generally maintain smaller staff sixes. Therefore, many of the technologies identified would require these rural areas to hire additional staff and/or possibly educate existing staff. It is for these reasons that this section will assess the staffing and operational needs for each of the candidate technologies identified in previous tasks.

<u>Assessment of tasks required by each technology option</u>

A set of tasks has been compiled for each of the candidate technologies. To assist in determining staffing needs, each task has been defined in terms of the level of support required, which are separated into the following categories:

Full time. Attention is required at all operational times.

Part time. Attention is required for various amounts of time, depending upon current conditions.

On-call. Staffing must be available to respond to situations when necessary.

To further describe these tasks, each one is indicated as being performed either in-house or in the field. In-house tasks refer to those performed within the boundaries of an office, while in-field refers to those tasks requiring an on-site visit. Table 5.3.1 describes each technology option in which specific tasks are applicable. Those options not included in Table 5.3.1 include in-vehicle contained devices that require staffing for normal operations. Table 5.3.2 describes potential agencies involved in the operation and maintenance of each technology option.

Technology	Applicable tasks	Staffing			Location	
		Full time	Part time	On call	In house	In field
Weather spotters	Answer phones and record data		●		●	
Police/EMS reports	Monitor radio for information		●		●	
Traveler reports	Answer phones and record data		●		●	
Video cameras	Monitor cameras	●			●	
	Regular maintenance of cameras in-field		●			●
	Electrical repairs to cameras and monitors			●		●
	Maintenance of communication service			●		●
Radar	Monitoring of incoming data		●		●	
	Maintenance of receivers			●	●	
Vehicles as probes	Maintenance of in-field equipment			●		●
	Maintenance of computer systems			●	●	
Inductive loops	Maintenance of in-field hardware			●		●
Weather sensors	Maintenance of sensor equipment			●		●
	Monitoring of incoming data		●		●	
Newspapers/ publications	Determine message content		●		●	
	Submit reports		●		●	
Telephone systems	Determine message content		●		●	
	Answer and respond to phone calls (if manual)		●		●	
	Record or synthesize message (if automated)		●		●	
Television/radio broadcast	Determine message content		●			
	Broadcast message		●			
Changeable message signs	Determine messages for various signs		●		●	
	Enter message into controller		●		●	
	Update computer software			●	●	
	Maintain in-field equipment			●		●
Static signs	Determine locations for various signs		●		●	
	Manually place signs in-field			●		●
	Maintain in-field signs			●		●

Table 5.3.1 - Staffing needs for the technologies identified

Technology	Applicable tasks	Staffing			Location	
		Full time	Part time	On call	In house	In field
Traffic signals	Collect traffic flow data			●		●
	Calculate signal timings			●	●	
	Manually adjust in-field controllers			●		●
Traffic bans/ rerouting	Determine strategies		●		●	
	Manually place traffic barriers			●		●
Roadside call boxes	Telephone monitoring	●			●	
	Maintenance & repairs of phone systems			●		●
Mayday devices	Monitoring of distress signals	●			●	
Automatic vehicle locator	Maintenance of in-vehicle devices			●		●
	Updating computer software for additional devices			●	●	
Computer aided dispatching	Maintenance of in-vehicle devices			●		●
	Updating computer software for additional devices			●	●	
On-board route guidance	Maintenance of in-vehicle display units			●		●
	Updating of computer software		●		●	
Signal preemption	Maintenance of in-field receivers					
Multimodal trip reservations	Processing of requests		●		●	
	Coordination between agencies		●		●	
En-route schedule information	Processing of real-time information	●			●	
	Dissemination of information to receivers in transit vehicles		●		●	
	Maintenance of in-vehicle devices			●		●
Electronic ticketing and automatic trip payment	Maintenance of ticketing devices			●		●
Computer aided ride matching, scheduling, and dispatching	Answer requests		●		●	
	Processing of data		●		●	
	Computer operations		●		●	
	Dispatching of services		●		●	
Demand monitoring	Maintenance of data collection equipment			●		●
	Analysis of recorded data		●		●	

Table 5.3.1 - Staffing needs for the technologies identified (continued)

	Agencies potentially responsible for operations and maintenance					
	Police/ EMS	Weather Service	Mn/DOT	Vehicle Mfg.	Private Sector	Local Gov't
Weather spotters		$			$	
Police/EMS reports	$					
Traveler reports					$	
Video cameras			$			$
Radar		$				
Vehicles as probes			$			$
Inductive loops			$			$
Weather sensors		$				
Newspapers/publications					$	
Telephone systems	$		$		$	$
Television/radio broadcast	$	$			$	
Changeable message signs			$			$
Static signs			$			$
Traffic signals			$			$
Traffic bans/ rerouting	$		$			$
Roadside call boxes	$					
Mayday devices	$					
Automatic vehicle locator	$					
Computer aided dispatching	$		$		$	$
On-board route guidance			$			$
Signal pre-emption	$		$			$
Multimodal trip reservations			$			$
En-route transit schedule information			$			$
Electronic ticketing & automatic trip payment			$			$
Computer aided ride matching, scheduling & dispatching			$			$
Transit demand monitoring			$			$
In-vehicle safety systems				$		
HOV lanes	$		$			
Weigh-in-motion			$			
Variable speed limit signs	$					

Table 5.3.2. – Potential contributors to the operations and maintenance of each technology option

5.4 Assessment of urban and rural compatibility

In the quest for a truly statewide IVHS program, it is important in the development of new projects to consider the compatibility between those systems in rural and urban environments. The first step towards ensuring broad compatibility between IVHS systems identified for rural and urban areas is to identify those approaches in which compatibility is essential. For the technologies identified throughout greater Minnesota, two general compatibility considerations include:

- compatibility in services provided to users;
- system operation compatibility

To promote compatibility in services provided to users, the following important steps have been identified:

Interagency coordination. Agencies including government services, transit providers, and news and weather reporters must coordinate their actions in order to provide efficient and consistent service to the user.

Accurate, updated information. It is vital that information provided to the user, either in-vehicle or roadside, be consistent and accurate throughout each trip. Although situations will vary according to vehicle location, travelers should not be given inconsistent data through various sources.

Consistency of presentation. The delivery of information to the travelers must be consistent between urban and rural areas. It is important for travelers to receive similar types of data to avoid confusion and misunderstanding.

In addition to the above steps towards achieving service compatibility, the following steps address the issue of operational compatibility:

Standardized equipment. For the agencies responsible for the operations and maintenance of each project, it is desirable to have standard equipment so that parts are interchangeable and maintenance is simplified. The fact that urban and rural projects are generally developed at different times requires emphasis on this step.

Standardized data format. Various methods exist for recording and processing data. The format of data recorded in rural areas must match that in urban areas to ensure compatibility of the various equipment.

Consistency in updating and expanding equipment. As technology progresses, one area may experience more rapid updates or expansions to equipment than another. For this reason, it is important that all updates consider expandability with regards to existing equipment.

Compatible communication medias. Communication of data is crucial to the success of an IVHS system. The communication links connecting urban and rural areas must be adequate to support all necessary data transfer.

Consideration of these guidelines for urban/rural compatibility will assist the prioritization procedures for the identified technologies. Table 5.4.1 represents each technology option and presents those steps which are relevant towards achieving compatibility.

Technology	Compatibility to users			Operational compatibility				No compatibility required
	Interagency coordination	Accurate updated information	Consistency of presentation	Standard equipment	Standard data format	Consistent updates/ expansions	Compatible communication medias	
Weather spotters	$				$			
Police/EMS reports	$				$			
Traveler reports	$							
Video cameras					$			
Radar				$	$	$		
Vehicles as probes				$		$	$	
Inductive loops				$		$		
Weather sensors				$	$			
Newspapers/ publications								$
Telephone systems	$							
Television/ radio broadcast		$						
Changeable message signs	$	$	$	$				
Static signs	$		$	$				
Traffic signals				$				
Traffic bans/ rerouting	$							
Roadside call boxes	$			$			$	
Mayday devices	$				$		$	
Automatic vehicle locator	$			$	$	$		

Table 5.4.1 – Steps towards achieving compatibility for the technologies identified

Technology	Compatibility to users			Operational compatibility				No compatibility required
	Interagency coordination	Accurate updated information	Consistency of presentation	Standard equipment	Standard data format	Consistent updates/ expansions	Compatible communication medias	
Computer aided dispatching	$					$		
On-board route guidance	$	$		$	$	$	$	
Signal pre-emption	$					$		
Multimodal trip reservatins	$					$		
En-route schedule information	$	$	$	$	$	$	$	
Electronic ticketing & automatic trip payment	$							
Computer aided ride matching scheduling, & dispatching	$	$		$		$		
Demand monitoring								

Table 5.4.1 – Steps towards achieving compatibility for the technologies identified (continued)

6. FUTURE PROJECT IDEAS

6.1 Introduction

The preceding five chapters have defined the needs of rural travelers, identified numerous potential IVHS technologies capable of satisfying these needs, and researched several key issurs so as to prioritize these options. Chapter six will now build upon this and recommended a set of conceptual project ideas for future implementation in rural Minnesota.

6.2 Description of projects

Repeatedly, the subject of financial concerns surfaced at the meetings. This makes is apparent that for any IVHS project to be successful in rural Minnesota, it must be cost effective. For this reason, the projects range in price from low to high cost. The following table (Table 6.2.1.) presents the names for the ten projects recommended as the result of this study categorized into estimated costs and anticipated durations.

Cost	Short Term (1-12 months)	Long Term (1-5 years)
Low (0 - $500,000)	• Notification of spot hazardous conditions • Collision avoidance at unsignalized intersections	• Construction zone assistance • Transit application of IVHS
Medium ($500,000 - $1,000,000)		• Indlement weather trip avoidance • Tourist traffic control • En-route tourist information
High (>$1,000,000)		• Assistance for road maintenance and construction • In-vehicle mayday devices • Assistance during tips under adverse weather conditions

Table 6.2.1 – Categorization of recommended projects

Table 3.4.3 indicated the user services most applicable to rural Minnesota. Table 6.6.2 presents which user service is addressed by each of the ten recommended projects.

Project Name	FHWA User Services												
	En-route driver advisory	En-route travel info.	Route guidance	Traffic control	Incident mgmt.	Personalized public transit	Intersection crash warning & control	Emergency notification & personal security	Public transport mgmt.	Emergency vehicle mgmt.	Pretrip travel info.	Ride matching & reservation	Traveler services info.
Inclement weather trip avoidance		•									•		
Assistance during trips under adverse weather conditions	•		•	•				•		•	•		
Notification of spot hazardous conditions	•												
IVHS assistance for road maintenance										•			
In-vehicle mayday devices								•					
En-route tourist information													•
Collision avoidance at unsignalized intersections							•						
Construction zone assistance	•										•		
Tourist traffic control	•		•	•	•								•
Transit application of IVHS						•			•			•	

Table 6.2.2 - User Services addressed by each project

4.3 Recommended projects

The following project descriptions will be submitted to both the Planning and Program Management Committee and the Rural Working Committee for their review and possible inclusion into future Minnesota Guidestar activities.

RURAL IVHS SCOPING STUDY

WEATHER AND ROAD CONDITION INFORMATION

INCLEMENT WEATHER TRIP AVOIDANCE

Project objectives: To determine the effects of providing travelers with real-time pre-trip and en-route weather information in an attempt to avoid or alter trips during adverse weather conditions.

Project description: This project will monitor weather situations along a corridor linking two cities and distribute real-time control information to motorists. Initially, changeable message signs will be located so as to be visible to motorists leaving each city. An additional message sign may optionally be located approximately halfway along the route, directed in each direction. Kiosks will also be located at strategic locations so as to allow travellers access to weather information along the route before leaving each city. In addition to the en-route information, telephone service will provide travelers with pre-trip information.

User services addressed:

- pre-trip travel information
- en-route travel information

Technologies involved:

- weather stations (approximately one every 5-10 miles)??
- radar
- pavement monitoring devices (all bridges, locations of early freezing, accompanying weather sensors)
- telephone systems
  - manned (61% of phone survey preferred live voice)
  - voice mail (31% of phone survey preferred voice mail)
  - recorded message (7% of phone survey preferred recorded message)
- changeable message signs
- kiosks with touch screen displays

Operations: The system will need to be staffed during periods of inclement weather (at least initially). Human decisions will interpret the weather information to determine CMS context, telephone reponses, and kiosk displays. Changeable message signs, weather stations, pavement sensors, and kiosks will require maintenance and repairs.

Duration: Long term (1-5 years)

cost: Medium cost ($500,000 - 1 million)

RURAL IVHS SCOPING STUDY

WEATHER AND ROAD CONDITION INFORMATION

ASSISTANCE DURING TRIPS UNDER ADVERSE WEATHER CONDITIONS

Project objective: The objective of this project is to evaluate the effectiveness of providing services to assist motorists driving during inclement weather conditions. Services will help travelers avoid dangerous situations, and assist them when encountering trouble.

Project description: It is the intent of this project to address those travelers driving during adverse weather conditions. Real-time weather information will be collected using various sources throughout the test site; these methods with include: weather stations, weather spotters, police or EMS reports, video cameras and radar. The response to these conditions will be in the form of traffic control and traveler information. Variable speed limit signs will both inform motorists of safe speeds and attempt to maintain a constant speed throughout the freeway in order to avoid longitudinal collisions.

Travelers will be informed of current road and weather conditions in an attempt to identify hazardous locations, road closures and preferred routes. This information will be disseminated using various approaches including: changeable message signs, radio broadcasts, kiosk locations, personal computers and telephone systems. For those motorists encountering difficulties, several roadside call boxes, located throughtout the test area, will enable travelers to telephone for help, mayday devices located in a sample set of vehicles will transmit distress signals when stranded, and automatic vehicle locators will assist emergency response teams in responding to troubled motorists.

User services addressed:

- pre-trip travel information
- emergency notification and personal security
- route guidance
- en-route driver advisory
- emergency vehicle management
- traffic control

Technologies involved:

- weather stations
- video cameras

RURAL IVHS SCOPING STUDY

WEATHER AND ROAD CONDITION INFORMATION

ASSISTANCE DURING TRIPS UNDER ADVERSE WEATHER CONDITIONS

Project objective:

The objective of this project is to evaluate the effectiveness of providing services to assist motorists driving during inclement weather conditions. Services will help travelers avoid dangerous situations, and assist them when encountering trouble.

Project description:

It is the intent of this project to address those travelers driving during adverse weather conditions. Real-time weather information will be collected using various sources throughout the test site; these methods with include: weather stations, weather spotters, police or EMS reports, video cameras and radar. The response to these conditions will be in the form of traffic control and traveler information. Variable speed limit signs will both inform motorists of safe speeds and attempt to maintain a constant speed throughout the freeway in order to avoid longitudinal collisions.

Travelers will be informed of current road and weather conditions in an attempt to identify hazardous locations, road closures and preferred routes. This information will be disseminated using various approaches including: changeable message signs, radio broadcasts, kiosk locations, personal computers and telephone systems. For those motorists encountering difficulties, several roadside call boxes, located throughtout the test area, will enable travelers to telephone for help, mayday devices located in a sample set of vehicles will transmit distress signals when stranded, and automatic vehicle locators will assist emergency response teams in responding to troubled motorists.

User services addressed:

- pre-trip travel information
- emergency notification and personal security
- route guidance
- en-route driver advisory
- emergency vehicle management
- traffic control

Technologies involved:

- weather stations
- video cameras

- radar
- variable speed limit signs
- changeable message signs
- radio broadcasts
- kiosks
- personal computers
- telephone systems
- roadside call boxes
- mayday devices
- automatic vehicle locators

Operations: This project may serve as a weather information test bed in which initially the weather sensors are installed. Later the various technologies may be installed and tested in phases. Other options may see this entire project developed in one step or any part of the project submitted on its own.

Duration: Long term (> 10 years)

cost: High cost (> $1 million dollars)

WEATHER AND ROAD CONDITION INFORMATION

NOTIFICATION OF SPOT HAZARDOUS CONDITIONS

Objective: The objective of this project is to provide real-time warnings of icy conditions at dangerous locations.

Project description: It is the intent of this project to inform motorists of icy conditions at locations inclined to freeze earlier than other locations. Pilot test sites will be selected to support a pavement monitor and/or thermometer to detect icing immediately upon freezing. An example may include bridges in rural areas. Upstream of these locations, a sign with an accompanying flashing yellow light will inform motorists that the pavement is icy when the light is flashing.

User services addressed:

- en-route driver advisory

Technologies involved:

- weather stations
- static signs

Operations: Initially, research will determine the most effective method for monitoring pavement conditions and detecting hazardous situations. Once initial setup is complete, this sytem will operate automatically. Periodical on-site investigations and maintenance will be required. Expansions to the system may include automatic communication with various agencies (local radio stations, state patrol, Mn/DOT) alerting them of these dangerous locations.

Duration: Short term (< one year)

cost: Low cost (< $500,000)

WEATHER AND ROAD CONDITION INFORMATION

ASSISTANCE FOR ROAD MAINTENANCE AND CONSTRUCTION

Project objective: The objective of this project is to collect and analyze ambient weather condition information in order to inform road maintenance crews of ideal times for maintenance and construction activities.

Project description: Minnesota Department of Transportation Maintenance Office estimates that approximately 25 million dollars are spent annually on snow removal along Mn/DOT roads. This project will assist road maintenance crews in their task of plowing, salting and sanding roads. Weather stations will report locations experiencing inclement conditions. These stations may monitor such items as humidity, temperature and wind. consideration will be given to all incoming data to determine the ideal time to remove snow or to apply chemicals to the road. Such determination may eliminate clearing a road too soon and having to repeat the process. Similarly, it may avoid waiting too long and having the surface become very difficult to clear. Although a similar process is currently used by maintenance crews, this project will enhance this system and also involve some research into new techniques for determining optimal maintenance schedules. Similar decisions will also assist construction crews.

User services addressed:

- emergency vehicle management

Technologies involved:

- weather stations
- computer-aided dispatching
- automatic vehicle locator

Operations: Initially, during the setup phase, research will be conducted to determine an optimal time at which roadway maintenance should be performed. A large portion of time will be spent compiling information relating to roadway maintenance from various sources including maintenance crews across the state. This information combined with research of state-of-the-art snow removal will be used to develop new strategies for road maintenance using real-time information. During operations, operators, assisted by computers, will make decisions based on these strategies.

Duration: Long term (l-5 years)

cost: High (> $1 million)

RURAL IVHS SCOPING STUDY

ASSISTANCE FOR STRANDED VEHICLES

IN-VEHICLE MAYDAY DEVICES

Project objective: The objective of this project is to demonstrate the functionality of a wide area emergency notification system. Additionally, this project will be a first attempt at determining the most user accepted method for selling such devices.

Project description: This project will specifically target stranded vehicles throughout greater Minnesota. A test area will be equipped to identify, locate and respond to vehicles stranded and/or in danger. Once the infrastructure exists to provide these services, travelers will be informed of the opportunity to purchase such an in-vehicle device. As an operational test, select mayday devices may be located in test vehicles in order to demonstrate the functionality of the system. These vehicles may include state owned maintenance vehicles, car rental fleets, post-office truck fleets or other vehicles capable of demonstrating the feasibility of the system. Results of the telephone survey suggest that 82 percent of travelers are interested in such a system. Of those who showed interest in such a system, 57 percent felt a combination of the government, the user and private industry should bear the cost. Additionally, 54 percent of those surveyed would prefer to have in-vehicle devices installed when they purchase the vehicle. Based on these statistics, car dealers will be utilized as a potential for the distribution of mayday devices. Also, an attempt will be made to share the expense between the three parties previously mentioned.

User services addressed:

- emergency notification and personal security

Technologies involved:

- satellite communications
- radar
- mayday devices
- global positioning
- Automatic vehicle locator
- computer aided dispatching

Operations: This project will be performed in three general phases. The first phase will build upon other national projects currently researching mayday systems and use these results to decide which system is most appropriate for this area. Phase two will involve placement of these devices into state maintenance vehicles to demonstrate the functionality of the system. Once the system has been demonstrated, phase three will explore various marketing strategies for selling the product to the consumer. Operations will involve installation of the devices into test vehicles, and operation and staffing of a central control center.

Duration: Long term (1-5 years)

cost: High (> $1 million)

IN-FORMATION TARGETED TOWARDS TOURISTS WITHIN EACH REGION

EN-ROUTE TOURIST INFORMATION

Project objective: The objective of this project is to evaluate the possibility for providing travelers with tourist information to instigate more en-route stops. These stops will both improve the travelers trip and support additional economic activity throughout the area.

Project description: This project will target tourists traveling through a rural area which supports scenery, entertainment or other tourist attractions. Results of the telephone survey state that travelers on vacation are most interested in the following: where to find lodging, scenic routes, directions to parks, and historical sites. Collection of tourist information will be done using various methods including: meeting with local residents to discuss points of interest and communication with local businesses and organizations to compile lists of traveler services (ie. restaurants, hotels). The information will then be broadcast to travelers using various approaches. These may include, but are not limited to, the following: kiosks located at strategic locations (rest stops, convenience stores), changeable message signs dedicated to tourist information, static signs, and flyers and other printed material, in-vehicle devices, and pagers. Partnerships with local chamber of Commerce groups, the Office of Tourism, and the American Automobile Association will be explored to enhance this system.

User services addressed:
- traveler services information

Technologies involved
- word of mouth
- personal computers
- telephone systems
- changeable message signs
- static signs
- newspapers/publications

Operations: This project will require initial research into the available services at the test site. This information will then need to be entered into a presentable format and broadcast through the various methods mentioned previously.

Duration: Long term (1-5 years)

cost: Medium cost ($500,000 - $1 million)

INCREASED SAFETY USING CRASH AVOIDANCE

COLLISION AVOIDANCE AT UNSIGNALIZED INTERSECTIONS

Project objective: The objective of this project is to evaluate the feasibility of providing a low cost system to assist in collision avoidance in remote rural areas.

Project description: Numerous collisions occur at unsignalized intersections. One example of such a location is a four-way intersection in which only two directions must stop. The danger is further increased when such an intersection occurs along a horizontal curve in the roadway. The majority of these locations occur on highways supporting limited vehicle miles traveled (VMT). For this reason, any IVHS application within these areas needs to be inexpensive enough so as to be cost effective. The idea behind this project is to locate warning signs upstream of the dangerous intersection to alert motorists to slow during possibly risky times. Because such a system will be located in a remote, sparsely populated area, periods of large traffic flows can be correlated with the events occurring in nearby towns (ie. restaurants busy times, factories starting/stopping work, schools), Therefore, initially, a traffic count will be done for several successive days to determine periods when the intersection is most busy. A timer will then be developed to flash a yellow light on the warning sign alerting motorists that hazardous conditions may exist. One shortcoming of such a project is that at times when risks are not high, the lack of a flashing light may give a false sense of security while in actuality, a collision is possible.

User services address:

- intersection crash warning and control
- impairment alert

Technologies involved:

- static signs
- loop detector

Operations: This project will involve a set up phase to install the equipment and conduct the traffic counts. Following this phase, a careful record of all accidents occurring at or near the intersection will provide an evaluation of the system. Further, a survey may be conducted with frequent travelers.

Duration: Short term (< one year)

cost: Low cost (< $500,000)

INFORMATION RELATING TO LOCATIONS OF CONSTRUCTION ZONES OR OTHER DETOURS

CONSTRUCTION ZONE ASSISTANCE

Project objective: The objective of this project is to evaluate the effectiveness of advising travelers of both existing delays due to construction as well as impending delays.

Project description: Detours are created to divert traffic from either a construction/road maintenance site or from an area with a non-recurring planned incident or event. For construction and roadway maintenance locations, these detours can be predicted some time before they occur. This project will be an attempt to inform motorists of these locations of detours so as to allow motorists to avoid delays. In anticipation of upcoming detours, numerous methods will be used to spread the word in advance. Various signs will be stategically located near the impending construction site allowing drivers to explore alternate routes ahead of time. Additionally, literature will be circulated to businesses and residents in an attempt to inform them of the upcoming activity. Results of the survey indicate that Minnesota travelers rank4 information related to construction zones as 6.6 on a scale of l-10 as being important for pre-trip planning. For motorists en-route, portable signs will advise them of impending delays and expected durations of such delays.

User services addressed:
- pre-trip travel information
- en-route driver advisory

Technologies involved:
- word of mouth
- newspapers/publications
- direct mail
- changeable message signs
- static signs
- radio systems

Operations: The operations for this project will involve actions in anticipation of future detours to inform visitors to the area of possible delays accompanying these detours. Additionally, some real-time response will be involved in an attempt to reduce delays occurring at the detour locations. These responses will include the control of changeable message signs, and positioning and control of temporary variable speed limit signs.

Duration: Long term (1 - 5 years)

cost: Low cost (< $500,000)

CONGESTION RELIEF DURING EVENTS OR PEAK TOURIST PERIODS

TOURIST TRAFFIC CONTROL

Project objective: The objectives of this project are both to demonstrate the feasibility of reducing or preventing congestion in a small rural area, and to evaluate the effectiveness of various traffic control techniques, normally used in an urban setting, in a rural setting. These improvements will both improve the travelers trips and improve the quality of life for residents at these rural tourist sites.

Project description: The focus of this project will be on preventing or relieving congestion during weekends or peak tourist periods. With the influx of travelers visiting rural areas as tourists, two primary problems arise. First, a temporary unusually large demand is placed on the limited infrastructure of a small community. Numerous traffic control techniques, proven to be effective in urban settings, will be tested in this rural project. Among these techniques will be traffic signal control, changeable message signs, static signs, traffic rerouting, and incident detection using loop detectors and video processing. The second problem arising in these situations involves the lack of driver familiarity with the surrounding street network. In addressing this concern, the test area will be equipped with various signs as well as information distribution locations advising people of alternate. routes and of routes which allow vehicles to bypass communities en-route to their final destination.

User services addressed:

- traveler services information
- route guidance
- en-route driver advisory
- incident management
- traffic control

Technologies involved:

- traffic signals
- changeable message signs
- static signs
- traffic rerouting
- loop detectors

Operations: This project will require extensive interagency coordination. The chamber of commerce, tourist board, and local tourist attractions will need to inform other agencies (police, local governments, city engineers) of potentially high tourist activity. A control plan will then need to be developed to determine the most appropriate method of response. One method of response may be signal control. Due to the limited capabilities of traffic signals in these areas, several traffic counts will need to be done during a wide spectrum of traffic scenarios to determine appropriate phase splits. It may require in-field personnel to set the traffic signal to these alternate settings once events begin to occur.

Duration: Long term (l-5 years)

cost: Medium cost ($500,000 - $1 million)

TRANSIT SERVICES TO ASSIST NON_DRIVERS

TRANSIT APPLICATION OF IVHS

Project objective: The objective of this project is to determine the potential for deploying an IVHS application directed to assist non-drivers.

Project description: The rural needs assessment revealed that travelers feel IVHS may have applications towards assisting non-drivers. Although drivers are not likely to relinquish their vehicles, a market exists for those residents who do not drive. Participants at various meetings mentioned several types of systems in existence for assisting non-drivers. For example, church groups as well as local cities, counties, townships and other agencies provide voluntary carpools. Concern was voiced regarding the lack of coordination between the different providers and the lack of user awareness of existing services. A system which is both flexible and coordinated would greatly enchance these rural locations. The idea of this project is to conduct an extensive evaluation of all transit services provided within a test site. Upon describing both the nondriver needs and the available services, this project will assess each areas potential for an IVHS application. Results of the Advanced Rural Transportation Information and Coordination (ARTIC) project (see Appendix A) will then be considered in determining future projects.

User services addressed:

- personalized public transit
- ride matching and reservation
- public transportation management

Technologies involved:

- personal computers
- word of mouth
- newspapers/literature
- telephone systems
- television/radio broadcasts

Operations: The operations will primarily be two-fold. Initially, an exhaustive study will determine who needs transit service and how they are serviced. This will include the identification of volunteer services, paying services, and will even include identifying those who share rides with friends and relatives. This phase will be non-technical and will involve meetings with transit providers and town members as well as conducting surveys. Upon completion of this task, the applicability of various IVHS technologies will be assessed. These will build upon results of the ARTIC project under development in Minnesota.

Duration: Long term (1-5 years)

cost: Low cost (< $500400)

REFERENCES

1. Minnesota Department of Public Safety, Minnesota Motor Vehicle Crash Facts, 1992.

2. Pacific Rim TransTech Conference Proceedings, Volume 1: Advanced Technologies, July 25-28, 1993; Seattle, Washington.

3. Proceedings of the IVHS America 1993 Annual Meeting, Surface Transportation: Mobility and Society April 14-17, 1993; Washington, D.C.

4. Advanced Rural Transportation Systems Committee, Steering Committee Meeting Minutes; July 19, 1993.

APPENDIX A

DESCRIPTION OF RELATED PROJECTS

TRAVEL-AID

Location: Snoqualmie Pass, Washington State

Description: Snoqualmie Pass is a 40 mile stretch of rural highway subject to snow, ice and poor visibility. The objective of the Travel-Aid project is to improve safety during adverse conditions using changeable message signs (CMS), variable speed limits and in-vehicle communication.

Start date: November, 1992

End date: May, 1996

Estimated total project cost: $4,986,291

Status: Changeable message signs and highway advisory radio currently in place. Design of sensing equipment and variable speed limit signs is underway.

User services addressed: En-route Driver Advisory and Traffic Control.

Contact: Stephen Clinger, FHWA, (202) 366-2160

RURAL APPLICATIONS
OF ADVANCED TRAVELER INFORMATION SYSTEMS

Location: United States, nationwide

Description: The objective of this study is to develop an Advanced Traveler Information System for rural applications nationwide. The study will determine the needs of rural areas and review possible technologies for assisting these areas. Promising alternatives and related technologies will be assessed, and an engineering prototype of the more promising ATIS designs will be developed and tested in a limited environment.

Start date: January, 1992

End date: July, 1995

Estimated total project cost: $1,536,000

Status: Focus groups and telephone surveys are currently underway to identify the needs of rural travelers.

User services addressed: En-route Driver Advisory

Contact: Davey Warren, FHWA, (703) 285-2426

ARIZONA WEATHER MONITORING

Location: Flagstaff, Arizona

Description: On-line weather monitoring devices provide weather information to Arizona Department of Transportation. Weather information is used for maintenance and snow removal, with future plans for implementing changeable message signs and variable speed limit signs.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Project underway

User services addressed: En-route Driver Advisory and Route Guidance

Contact: Arizona Department of Transportation

RURAL EVALUATION OF ADVANCED CONCEPT HIGHWAYS FOR I-75 REACH-73

Location: I-75 in rural Florida

Description: The goal of REACH-75 is to improve the safety, quality and efficiency at construction locations along I-75 in rural Florida and Georgia. Information is collected by surveillance, motorists, cellular telephones, police and emergency services, workzones and CB radios. It is anticipated that trucks currently participating in the Advantage I-75 project could be used as probes in the near future. Future plans include processing this information within a permanent traffic management center (TMC) to determine road and weather conditions, detect incidents and distribute necessary information to motorists. Information is to be broadcast via changeable message signs (CMS), kiosks and highway advisory radio (HAR).

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Operational; future plans subject to funding.

User services addressed: En-route Driver Advisory, Route Guidance, and Incident Management.

Contact: Florida Department of Transportation

REMOTE SENSING OF RURAL ROAD AND TRAVEL CONDITIONS

Location: Wyoming

Description: This project explores the correlation between weather conditions as described by motorists and the actual weather as recorded by the remote weather information stations (RWIS). Travel diaries and interviews of local motorists, truck drivers, and snowplow operators were used to determine how drivers perceive the conditions.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Study completed. The results suggest little correlation between motorists and the RWIS. Conclusions suggest that a single RWIS is not sufficient for accurately describing the driving conditions.

User services addressed: En-route Driver Advisory

Contact: Wyoming T2 Center

SOUND/LIGHT ALARM FOR EXTRA REACTION TIME (SAFER)

Location: Florida

Description: The SAFER project involves in-road magnets capable of triggering in-vehicle timing devices. If a vehicle passes the magnets at a speed too fast for conditions, the in-vehicle alarm will sound. The preset safe time constraint within the vehicle may adjust to account for poor weather or human factors.

Start date: N/A

End date: N/A

Estiited total project cost: N/A

Status: Commercially available

User services addressed: Longitudinal Collision Avoidance

Contact: Gold Coast Commuter Services

I-70 RURAL IVHS CORRIDOR PLANNING AND FEASIBILITY STUDY

Location: I-70 in rural, mountainous Colorado

Description: The purpose of this study is to explore the potential benefits of numerous IVHS technologies when implemented in rural Colorado. Remote video surveillance, weather sensors and dynamic warning signs will each be evaluated as a means for data collection. Changeable message signs, highway advisory radio, and kiosk-based traveler information centers will provide communication to travelers.

Start date: N/A

End date: December 1993

Estimated total project cost: N/A

Status : Project underway, scheduled for completion in December 1993.

User services addressed: En-route Driver Advisory, Traffic Advisory, Route Guidance

Contact: Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, CO 80222

I-75 FOG WARNING SYSTEM

Location: Bradley and McMinn counties, Tennessee

Description: This project is an attempt to increase safety along I-75 during periods of dense fog. Speed detectors, fog detectors and weather stations will collect information on road and weather conditions. Changeable message signs may then be used to communicate relevant information to motorists. Additionally, remotely activated gates will be used for traffic control.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: N/A

User services addressed: En-route Driver Advisory, Traffic Advisory

Contact: Tennessee Department of Transportation

IDAHO STORM WARNING OPERATIONAL TEST

Location: Idaho

Description: An M-IS operational test has been approved for rural Idaho. This test will focus on areas subject to poor visibility due to snow and dust. Visibility sensing equipment will identify potential problem areas and changeable message signs will relay information to drivers.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Approved as an IVHS operational test. Negotiations underway.

User services addressed: En-route Driver Advisory, Route Guidance

Contact: Idaho Department of Transportation

AUTOMATIC MILEAGE TRACKING

Location: Iowa, Minnesota, and Wisconsin

Description: This project's aim is to automate the regulations associated with the operation of commercial vehicles. Global positioning satellites and on-board computers track on-board mileage, thus allowing automatic submission of commercial vehicle fuel tax registration records to IRP and IFTA base jurisdictions. Involvement will include Rockwell International Corporation, Rand McNally-TDM, the American Trucking Association, the Trucking Associations of Iowa, Minnesota and Wisconsin, and the Iowa Transportation Center.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: N/A

User services addressed: Commercial Vehicle Preclearance, Electronic Payment Services, Commercial Vehicle Administrative Processes, and Commercial Fleet Management

Contact: Iowa Department of Transportation
800 Lincoln Way
Ames, IA 50011

INTELLIGENT RUNAWAY TRUCK RAMPS

Location: Colorado

Description: The objective of this study is to increase safety for trucks traveling on steep grades. Using weigh-in-motion (WIM) technologies to weigh the vehicle, a safe speed will be calculated for each vehicle. Additional detectors will determine the vehicles speed and when necessary, roadside signs will alert drivers of excessive speeds and recommend runaway truck ramps.

Start date: N/A

End date: N//A

Estimated total project cost: N/A

Status: N/A

User services addressed: En-route driver advisory, longitudinal collision avoidance

Contact: Colorado Department of Transportation
Division of Transportation Development
4201 East Arkansas Avenue, Room A-100
Denver, CO 80222

CHESAPEAKE HIGHWAY ADVISOROES ROUTING TRAFFIC (CHART)

Location: Maryland

Description: The objective of the CHART project is to respond to non-recurring incidents throughout Maryland. Existing traffic data collection procedures such as the Maryland State Police, Emergency Traffic Patrol, CHART communications, vehicles and traffic monitoring stations coupled with proposed Video Image Detection (VID) will provide information describing incidents. Information describing traffic conditions and recommended alternate routes is then broadcast to drivers via changeable message signs and traveler advisory radio.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Operational. Completion of system for entire state scheduled for 1999.

User services addressed: En-route driver advisory, traffic advisory, route guidance, traffic control, incident management

Contact: Maryland State Highway Administration
7491 Connelly Drive
Hanover, MD 21076

ODYSSEY

Location: Minnesota

Description: The objective of ODYSSEY is to develop a statewide traveler information system for Minnesota. Road weather information system (RWIS) sensors will collect weather information at locations throughout the state. In the first phase of ODYSSEY, this information will be transmitted in real-time to traffic information centers and rest area kiosks throughout the state. Future phases will involve personal communication devices capable of transmitting and receiving data at individual vehicles.

Start date: Anticipated November 1993

End date: Anticipated November 1996

Estimated total project cost: $3,000,000

Status: Minnesota Guidestar Rural IVHS Task Force established to develop proposal for submission to USDOT requesting inclusion in their Operational Test Program. Task Force prepared Odyssey concept paper May 1993.

User services addressed: En-route driver advisory, route guidance

Contact: Minnesota Guidestar
Minnesota Department of Transportation
117 University Avenue
2nd Floor, Ford Building
St. Paul, MN 55155

SMART SIGNAL SYSTEM

Location: Route 18, Middlesex County, New Jersey

Description: The objective of this project is to reduce delay and increase average travel speeds along Route 18, a rural arterial highway, in Middlesex County, New Jersey. Approximately ten miles of Route 18 will be equipped with loop detectors for the purpose of detecting platoons of vehicles. Using this data, timing plans will be computed in real-time to control the signalized intersections along this corridor.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Under construction.

User services addressed: Traffic control

Contact: New Jersey Department of Transportation
Division of Research and Demonstration
CN 600, 1035 Parkway Avenue
Trenton, NJ 08625

AUTOMATIC VEHICLE IDENTIFICATION IN ONTARIO (AVION)

Location: Ontario

Description: The objective of AVION is to increase efficiency and reduce paperwork at truck inspection locations throughout Ontario. Prequalified AVI equipped vehicles will be capable of bypassing normal truck inspection station procedures.

Start date: N/A

End date: N/A

Estiited total project cost: N/A

Status: N/A

User services addressed: Commercial vehicle preclearance, commercial vehicle administrative processes

Contact: Ministry of Transportation of Ontario
Room 333, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M lJ8

ONTARIO SMALL PROPERTIES AVL/C INITIATIVE

Location: Ontario

Description: This projects aim is to assist small transit systems in communities of Ontario by providing low cost standardized radio control, automatic vehicle location, and predictive scheduling. This project will target both fixed route and demand responsive applications.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: N/A

User services addressed: Public transportation management

Contact: Ministry of Transportation of Ontario
Room 333, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M lJ8

TRAVEL GUIDE

Location: Ontario

Description: The objective of Travel Guide is to explore the potential of a portable personal traveler information device. It is anticipated that these personal communication devices will receive data anywhere within the range of FM transmission.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: N/A

User services addressed: En-route driver advisory, route guidance, traffic advisory

Contact: Ministry of Transportation of Ontario
Room 333, Central Building
1201 Wilson Avenue
Downsview, Ontario 3M3 lJ8

WIDE AREA VEHICLE MONITORING (WAVM) SYSTEM

Location: Ontario

Description: The objective of the WAVM project is to expedite the exchange of information between headquarters and drivers of fleet vehicles. Global positioning satellites (GPS) are used to provide information on vehicle location. This information is exchanged using a two-way communication system.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Commercially available as "Road Kit" from Telesat Mobile, Inc.

User services addressed: Commercial fleet management

Contact: Ministry of Transportation of Ontario
Room 333, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M lJ8

PORT-OF-ENTRY ADVANCED SORTING SYSTEM (PASS)

Location: I-5 in Ashland, Oregon

Description: The objective of PASS is to allow high speed sorting of heavy vehicles on I-5 in Ashland, Oregon. High speed weigh-in-motion and automatic vehicle identification equipment collect information on the vehicles. Two-way transponders then send the information to the port-of-entry truck weigh station.

Start date: N/A

End date: N/A

Estiited total project cost:

Status: Operational

User services addressed: Commercial vehicle preclearancc, electronic payment services, commercial vehicle administrative processes

Contact: Oregon Department of Transportation
Transportation Research
325 Thirteenth Street NE, Room 605
Salem, OR 97310

OPERATIONAL TEST FOR GARY-CHICAGO-MILWAUKEE IVHS PRIORITY CORRIDOR

Location: Corridor connecting Gary, Indiana; Chicago, Illinois; and Milwaukee, Wisconsin.

Description: The objective of this project is to improve traffic operations and safety along this corridor which consists of both urban and inter-city (rural) interstate highways. In the commercial vehicle operations, high speed weigh-in-motion devices will be used to automate the flow of information between carriers and regulatory agencies. Area specific advanced traveler information systems will also serve as a focus of this project.

Start date: N/A

End date: N/A

Estimated total project cost:

Status: N/A

User services addressed: En-route driver advisory, traffic advisory, commercial vehicle preclearance, commercial vehicle administrative processes

Contact: Wisconsin Department of Transportation
Division of Highways and Transportation Services
PO Box 7916
Madison, WI 53707-7916

SMART BUS

Location: Des Moines, Iowa and surrounding counties.

Description: The objective of Smart Bus is to explore the possible interactions between urban and rural transit providers to increase in both areas. The project will concentrate on global positioning satellites (GPS) for automatic monitoring of the locations of transit vehicles in both the rural and urban areas.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Study underway. Scheduled for completion in September, 1994.

User services addressed: Public transportation management

Contact: Midwest Transportation Center, Design Center
Iowa State University
Ames, IA 50011

SEATTLE TO PORTLAND EARLY DEPLOYMENT CORRIDOR

Location: I-5 corridor between Seattle and Portland.

Description: FHWA has approved funding to explore potential IVHS applications along I-5 from Seattle to Portland. This project will investigate traveler information systems, remote location call boxes, highway advisory radio, changeable speed limit signs, tourist traveler information, and commercial vehicle operations.

Start date:

End date:

Estimated total project cost:

Status: Study underway.

User services addressed: En-route driver advisory, traffic advisory, route guidance, commercial vehicle preclearance, commercial vehicle administrative processes

Contact: Washington Department of Transportation

ADVANCED RURAL TRANSPORTATION INFORMATION AND COORDINATION

Location: Minnesota

Description: The objective of ARTIC is to better coordinate rural transportation services using IVHS technologies. Potential applications include demand responsive rideshare matching to increase participation in rideshare programs. Automatic vehicle location will assist in real-time rideshare assignment and expedite deployment of Mn/DOT district maintenance vehicles. Additionally, a toll free regional telephone transit information system will provide easily accessible transit information.

Start date: October 1993

End date: October 1996

Estimated total project cost: $1,500,000

Status: Currently submitted as part of the 1994 Minnesota Guidestar Workplan.

User services addressed: Emergency vehicle management, pre-trip travel information, ride matching and reservation.

Contact: Robert Works
Minnesota Department of Transportation
815 Transportation Building
395 John Ireland Boulevard
St. Paul, MN 55155

IN-VEHICLE SAFETY ADVISORY AND WARNING SYSTEMS (IVSAWS)

Location: N/A

Description: The objective of IVSAWS is to investigate the potential for providing in-vehicle warnings for roadway hazards, to enable the driver to respond accordingly in a timely manner. Warning transmitters may be placed at hazardous locations either permanently or temporarily. In addition to technological research, human factors testing is expected to evaluate various Driver Alert Warning Systems.

Start date: September 1990

End date: 1993

Estimated total project cost: $924,111

Status: Project underway, candidate systems currently being reviewed.

User services addressed: Traffic control, traffic advisory

Contact: N/A

OPERATIONAL TESTS OF SYSTEMS TO ENHANCE EMERGENCY MEDICAL SERVICE RESPONSE

Location: N/A

Description: The objective of this study is to enhance Emergency Medical Service (EMS) response by providing more accurate information regarding accidents.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: In planning stages.

User services addressed: Emergency vehicle management

Contact: Art Carter, NHTSA Headquarters

YOSEMITE AREA REGIONAL TRANSPORTATION INFORMATION SYSTEM (YARTIS)

Location: Yosemite area, California

Description: YARTIS is a proposed FHWA operation field test. The objective of this project is to disseminate traveler information to act as both a visitors guide assisting tourists in visiting the Yosemite area, and a traffic advisory system. Information will be distributed via information kiosks, changeable message signs, highway advisory radio, and personal computers.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Proposed project

User services addressed: En-route driver advisory, traffic advisory, route guidance, pre-trip travel information, traveler services information

Contact: California Department of Transportation
1120 North Street
Mail Stop #83
Sacramento, CA 95814

PROMETHUS CED 10 MOBILE AND PORTABLE INFORMATION SYSTEMS IN EUROPE (PROMISE)

Location: Gothenburg, Sweden; Birmingham, United Kingdom, and future sites.

Description: The objective of PROMISE is to develop and test a traveler information system providing multi-modal information and services to the public. This information will include traffic information, hazard warnings, public transportation information, availability of parking, and tourism information.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Technical and commercial feasibility studies have been completed. Information services to be implemented in Gothenburg, Sweden and Birmingham, United Kingdom have been identified and system architecture issues are being explored.

User services addressed: En-route driver advisory, route guidance

Contact: N/A

SOCRATES

Location: Gothenburg, Sweden and London

Description: The objective of SOCRATES (System of Cellular Radio for Traffic Efficiency and Safety) is to implement a pan-European traffic information and communications system. Cellular radio serves as the communicating device to assist in the integration of rural and urban traffic management, freight and fleet transport, and public transit.

Start date: N/A

End date: N/A

Estiiated total project cost: N/A

Status: Socrates completed successfully with a small test in Gothenburg. Expansions currently underway as SOCRATES 2 Kernel Project.

User services addressed: En-route driver advisory, traffic advisory

Contact: N/A

ROAD WEATHER INFORMATION SYSTEM (RW.9 PROJECT

Location: Minnesota

Description: The objective of the RWIS project is to collect information on highway and environmental conditions from sensors throughout the state. This information will then be used by Mn/DOT to promote more efficient highway maintenance and will be broadcast in real-time, supporting traveler information.

Start date: N/A

End date: N/A

Estimated total project cost: $5.2 million

Status: Project underway.

User services addressed: En-route guidance

Contact: Minnesota Department of Transportation

INTELLIGENT WORKZONE TRAFFIC MANAGEMENT SYSTEM

Location: Minnesota

Description: The objective of this project is to reduce driver uncertainty and increase workzone traffic capacity and efficiency, thereby maximizing workzone safety and minimizing congestion. Both environmental and traffic sensors will collect real-time information throughout workzones. This information will then be broadcast to drivers via changeable message signs (CMS). A human factors study will determine the optimum CMS configurations.

Start date: N/A

End date: N/A

Estimated total project cost: N/A

Status: Under negotiation

User services addressed: Traffic control, route guidance

Contact: Minnesota Guidestar, Minnesota Department of Transportation

APPENDIX B

DESCRIPTION OF REGIONAL MEETINGS

DESCRIPTION OF REGIONAL MEETINGS

1. Format of meetings

Each of the nine regional meetings followed a similar format. This format consisted of the following:

I. A general introduction explained that the purpose of the meeting was to identify rural highway user needs.

II. A video tape then gave a brief introduction of IVHS, including descriptions of the five functional areas.

III. Conducted as a survey, each of the 27 IVHS User Services were then explained in detail to the participants. They were asked to indicate which user services they felt have potential as a means for satisfying transportation needs within the region.

Iv. The participants then wrote down three transportation concerns and in an open discussion, the most important concerns were expressed.

V. An open discussion followed and was guided by the following discussion questions:

1. Where should transportation related services/products be available?
2. How should transportation related information be available?
3. What is the best method for communicating and explaining the new technologies so people can understand them?
4. What are some potential problems that may accompany the new technologies?
5. What information may be useful when traveling on a vacation?
6. What information would be useful before starting a trip?
7. What information would be useful while en-route?
8. Could some form of mass transit be an option within this area?
9. How could advanced transportation technologies support economic growth?

VI. The purpose of the meeting was restated and concluding remarks closed the meeting.

2. List of attendees

For each meeting, a list of professionals related to the transportation industry was compiled specific to each region. The following is a participant list for each location:

REGIONAL MEETING #l - BRAINERD
Mn/DOT Office - Brainerd, MN
October 26, 1993
1:00pm - 3:30pm

List of attendees:

Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Bonnie Cumberland (City of Brainerd)
Don Klein (City of Brainerd)
Mary Gettsch (Brainerd Chamber of Commerce)
Amelia Hiesen (Crow Wing Township)
Bob Bollenbeck (East Central Regional Development Comm)
Mark Daly (Wadena County Engineer)
Duane Blanck (Crow Wing County Engineer)
Cpl. Dick Devine (Minn. State Patrol - Brainerd)
Lt. Kent O'Grady (Minn. State Patrol - Brainerd)
Don Raisanen (Mn/DOT)
Jerry Kreutzer (Mn/DOT)
Mike Denzer (Mn/DOT
Tony Kempenich (Mn/DOT)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #2 - MOOREHEAD
Moorhead City Hall - Moorhead, MN
October 28, 1993
10:00am - 12:00pm

List of attendees:
Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Jack Cousins (Clay County Engineer)
Jerry Christensen (American Crystal Sugar Company)
Al Fitch (Minnesota-Dakota Coaches Inc.)
Dave Smilonich (Mn/DOT)
Steve Grabill (Fargo-Moorhead Council of Government)
Herb Reimer (Moorhead City Engineer)
Tom Baumtrog (Moorhead T.I.C.)
Bruce Hentges (Minnesota State Patrol)
Tallack Johnson (Mn/DOT)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #3 - PAYNESVILLE
Paynesville City Hall - Paynesville, Minnesota
November 3, 1993
l:00pm to 3:30pm

List of attendees:
Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Kevan McCarney (City of Paynesville)
John Dolentz (City Engineer - St. Cloud)
Dave Schwarting (Sherbume County Engineer)
Douglas Weiszhaar (Stearns County Engineer)
Bill Fahmey (St. Cloud Area Economic Development)
Tom Dumont (Assistant Traffic Engineer)
Doran Cote (St. Cloud Area Planning Organization)
Sid Williamson (City of Paynesville)
John Atwood (Paynesville Township Supervisor)
Rick Amebeck (Mn/DOT)
David Solsrud (Mn/DOT)
Linda Stelling (Paynesville Press)
Steve Witcomb (City of Paynesville)
Steve Risendine (City of Paynesville - Community Ed)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #4 - TWO HARBORS
Two Harbors City Hall - Two Harbors, Minnesota
November 4, 1993
12:30pm to 3:00pm

<u>List of attendees:</u>

Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Dennis Jindra (Kirscher Transport)
Curt Pianalto (Arrowhead Regional Development Commission)
Alan Goodman (Lake County Highway)
Roger Christensen (Lake County Highway)
Bob Kind (Mayor - Silver Bay)
Dean Beeman (City of Duluth)
Wayne Sletten (Mayor - Two Harbors)
Robert Monson (Monson Trucking)
Robert Selmans (Two Harbors Fire Department)
Bruce Larson (Mn/DOT)
Dick Hansen (St. Louis County)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #5 - THIEF RIVER FALLS
Best Western - Thief River Falls, MN
November l0,1993
11:00am - 1:30pm

List of attendees:

Linda Dolan (Mn/DOT)
Delton Schulz (Pennington County Engineer)
Vince Olson (Emergency Medical Service-Thief River Falls)
Gary Bruggeman (Red Lake City Highway Engineer)
Skip Swanson (Chairman -Pennington County Board)
Greg Whiting (Polk County Ambulance Service)
Donald Jensen (Commissioner-Pennington County)
William Sylvester (Township Supervisor)
David Kildahl (Crookston City Engineer)
Sandy Warner-Colton (NW Regional Development Commission)
Mark Anderson (Mn/DOT)
Joe McKinnon (Mn/DOT)
Steve Baker (Mn/DOT)
Mike Rardin (Polk County Engineer)
Bud Cumstad (Pennington County)
Ken Murphy (Pennington County)
Tony Kozojed (Minnesota State Patrol)
Steve Voight (Marshall County Engineer)
Gerald Moe (Pennington County)
Ken Froschheiser (Chief of Police-Thief River Falls)
Leon Heath (NW Regional Development Commission)
Carolyn Olson (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #6 - MARSHALL
Mn/DOT Office - Marshall, Minnesota
November 16, 1993
1:00pm - 3:30pm

List of attendees:

Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Melanie Braun (Mn/DOT)
Bruce DeVos (Fairview Township)
Ronald McLaughlin (Fair-view Township)
Arlene Lesewski (State Senate - Marshall)
David Robley (Lyon County Highway Engineer)
Dan Schmidt (Lyon County Co-op)
Rich Victor (City of Marshall)
Keith Voss (Mn/DOT)
Steven Voss (U.M.V.R.D.C.)
Jim Archibald (Speedway Moving)
Vi Mayer (Marshall Chamber of Commerce)
Bob Bymes (City of Marshall)
Barry Anderson (Yellow Medicine County Engineer)
Floyd Wild (City of Marshall)
Carolyn Olson (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #7 - SLAYTON
Country Host Restaurant - Slayton, Minnesota
November 17, 1993
9:00am - 11:30am

List of attendees:

Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Melanie Braun (Mn/DOT)
Robert Knoff (Murray County)
George Welk (Mn/DOT)
Annette Bair (Southwest Regional Development Commission)
Dave Halbersma (Pipestone County Engineer)
Tom Kappis (Slayton Fire Department)
Jack Lewis (Slayton Police Department)
Keith Winter (City of Slayton)
Michelle Ulranowski (Murray County Transit)
Carolyn Olson (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #8 - ROCHESTER
Mn/DOT Office - Rochester, Minnesota
November 18, 1993
8:30am to 11:00am

<u>List of attendees:</u>
Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Melanie Braun (Mn/DOT)
Randy Huston (Rochester City Lines)
John Sheppard (City of Spring Valley)
Dave Reinhart (Elephant Express)
Darryl Peterson (Minnesota State Patrol)
Virgil Johnson (Minnesota State Representative)
Tony Knauer (City of Rochester)
Curt Bolles (Olmsted County)
David J. Brandt (ROCOG)
Gary Shannon (Mn/DOT)
Frank Schloegec (Mn/DOT)
Chuck Sorenson (Olmsted Sheriffs Department)
Steve Borchardt (Olmsted Sheriffs Department)
Kermit McRae (Mn/DOT)
Mark Peipho (Mn/DOT)
Davey Warren (FHWA)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

REGIONAL MEETING #9 - LECENTER
LeSueur County Courthouse - LeCenter, Minnesota
November 18, 1993
2:00pm to 4:30pm

List of attendees:

Linda Dolan (Mn/DOT)
Mike Sobolewski (Mn/DOT)
Don Hayden (Chamber of Commerce - LeCenter
Allen Cords (Economic Development Commission - L&enter)
Eric Weller (Region 9)
Myron Bertrang (Civil Defense - LeSueur)
Jim Felmke (LcSueur-Henderson School District)
Myron Hentges (Mn/DOT)
Clarence Mager (LcSueur County)
Greg Ilkka (LeSueur County)
Bill Zishler (LeSueur County)
Stephen Schnieder (Nobles County)
Marc Flygare (Mn/DOT)
Don Monson (Minnesota State Patrol)
Jim Swanson (Mn/DOT)
Davey Warren (FHWA)
Ron Palosaari (Moderator)
Nancy Fisher (Castle Rock Consultants)
Dean Deeter (Castle Rock Consultants)

APPENDIX C

TELEPHONE SURVEY

REP #: ______ LISTING #: ______ START: ______ END: ______

NAME: ______________________________

CITY: ______________________ POPULATION: ____________

COUNTY: ______________________ POPULATION: ____________

DISTRICT #: ____________________

PHONE: ______________________ STATE: ____________

RESIDENCE: GENDER:

MINNESOTA . . . . 1 MALE 1
TOURIST . . . . 2 FEMALE 2

INTERVIEWER: ______________________ DATE: ____________

Hello this is _________ calling from Olson Research, an independent market research company located in Minneapolis. We're talking with people about travel and other transportation issues in Minnesota and would like to include your opinions. We're not selling anything.

A. Do you live . . . . . (READ LIST - CIRCLE CODE)

- in the 7-County Twin Cities area . . . . 1 (END INTERVIEW RECORD AS Q-A)
- in Minnesota, but outside the Metro area .2 - (CONTINUE}
- in another state . . . . 3 - (CONTINUE)

B. Would you say you live in a... (READ LIST AND CIRCLE CODE)

- town 1

or

- in the country 2

C. Have you traveled in Minnesota outside of the Minneapolis/ St. Paul metro area within the past two years,... or not? (CIRCLE CODE)

YES . . . . 1 - (ASK Q.D)
NO . . . . 2 - (END INTERVIEW RECORD AS Q-C)

D. When you traveled in rural Minnesota, how did you travel? (READ LIST AND CIRCLE CODE)

Motor vehicle driver	1	(CONTINUE)
Motor vehicle passenger	2	
Airplane	3	(END INTERVIEW/ RECORD AS Q-D)
Bus with driver/greyhound/ tour bus	4	
Train	5	

1. On the average, about how many miles per day do you drive or ride with someone else? (WRITE IN NUMBER)

____

NONE 98

1a. On what type of roads do you usually drive? (CIRCLE ALL CODES THAT APPLY)

2 LANE HIGHWAYS 1
4 LANE HIGHWAYS 2
COUNTRY ROAD 3
TOWN/CITY STREETS 4
OTHER (WRITE IN) 5

____

DON'T KNOW 6

2. For which of the following reasons do you drive or need transportation on a regular basis? (READ LIST & CIRCLE CODE FOR EACH)

	YES	NO
Going to work	1	1
Going to school	2	2
Chauffeuring kids or others around	3	3
Shopping	4	4
Visiting	5	5
Medical/dental appointments	6	6
Entertainment/sports	7	7
General errands	8	8

OTHER (WRITE IN) ____________________ 97
DON'T KNOW 99

3. Using a ten point scale where one means not at all important and ten means very important, please tell me what number on the scale best describes how important each of the following kinds of information are for you to know about before you start a trip by motor vehicle on rural roads and highways in Minnesota. (STARTING WITH CHECKED ITEM, READ LIST, ROTATING ORDER AND CIRCLE CODE) (REPEAT SCALE AS NEEDED)

		NOT AT ALL IMPORTANT ... VERY IMPORTANT	DK
a.	Weather conditions . . .	1..2..3..4..5..6..7..8..9..10	99
b.	Visibility conditions .	1..2..3..4..5..6..7..8..9..10	99
c.	Road conditions due to weather	1..2..3..4..5..6..7..8..9..10	99
d.	Construction zones . . .	1..2..3..4..5..6..7..8..9..10	99
e.	The best way to your destination	1..2..3..4..5..6..7..8..9..10	99
f.	Where the detours are .	1..2..3..4..5..6..7..8..9..10	99
g.	Length of detour	1..2..3..4..5..6..7..8..9..10	99

(REPEAT SCALE)

h.	Length of time to get to destination . …	1..2..3..4..5..6..7..8..9..10	99
i.	Number of miles to destination	1..2..3..4..5..6..7..8..9..10	99
j.	Location of accidents/ incidents	1..2..3..4..5..6..7..8..9..10	99
k.	Traveler service locations like rest stops	1..2..3..4..5..6..7..8..9..10	99
l.	Distance between towns ..	1..2..3..4..5..6..7..8..9..10	99
m.	Safety problems due to icy bridges, flooding, storms, hazardous spills, etc. . . .. …	1..2..3..4..5..6..7..8..9..10	99
n.	Location of heavy traffic due to special events . .	1..2..3..4..5..6..7..8..9..10	99

4. Using a ten point scale where 1 means not at all important and 10 means very important, please tell me how important each of the following items are to you when you are planning a vacation by car in Minnesota. (STARTING WITH CHECKED ITEM, READ LIST, ROTATING ORDER AND CIRCLE CODE)

		NOT AT ALL IMPORTANT … VERY IMPORTANT	DK
a.	Directions to parks and campgrounds	1..2..3..4..5..6..7..8..9..10	99
b.	Locations of historical Sites	1..2..3..4..5..6..7..8..9..10	99
c.	Scenic routes.	1..2..3..4..5..6..7..8..9..10	99
d.	Ability to make meal reservations from rest stops or other places along the way	1..2..3..4..5..6..7..8..9..10	99
e.	Help with activity ideas	1..2..3..4..5..6..7..8..9..10	99
e.	Trip planning help from rest stops or other places along your route.	1..2..3..4..5..6..7..8..9..10	99
g.	Where to find lodging .	1..2..3..4..5..6..7..8..9..10	99

5. When you are traveling in Minnesota, how frequently do you worry about the following safety concerns and other issues as a driver or passenger? Please use the same ten point scale where 1 means you never worry about it and 10 means you always worry about it. (STARTING WITH CHECKED ITEM, READ LIST, ROTATING ORDER AND CIRCLE CODE)

		NOT AT ALL IMPORTANT … VERY IMPORTANT	DK
a.	Where to get assistance If your car would break Down or if you needed Help like medical assistance	1..2..3..4..5..6..7..8..9..10	99
b.	Drunk drivers.	1..2..3..4..5..6..7..8..9..10	99
c.	Animals such as deer Or farm animals.	1..2..3..4..5..6..7..8..9..10	99
d.	Reckless and/or Speeding drivers.	1..2..3..4..5..6..7..8..9..10	99
e.	Getting lost	1..2..3..4..5..6..7..8..9..10	99
(REPEAT SCALE)			
f.	Encountering slow moving vehicles like snow plows or farm equipment. . . .	1..2..3..4..5..6..7..8..9..10	99
g.	Headlight glare1. . . .	1..2..3..4..5..6..7..8..9..10	99
h.	Getting sleepy behind the wheel	1..2..3..4..5..6..7..8..9..10	99
i.	Not enough information From signs along the Roadway	1..2..3..4..5..6..7..8..9..10	99
j.	Not enough police cars Around	1..2..3..4..5..6..7..8..9..10	99

25. Which of the following categories best describes the highest level of education you have completed? (READ LIST AND CIRCLE CODE)

Less than high school	1
High school graduate	2
Some College	3
Two-year college degree	4
Vo-Tech or trade school	5
Four-year college degree.............	6
Graduate degree	7
REFUSED	8

26. What kind of work do you do ? (CIRCLE CODE OR WRITE IN)

RETIRED	1
HOMEMAKER	2
STUDENT	3
OTHER (WRITE IN)	
________________________________	4
REFUSED	5

27. Which of the following best describes your annual household income, before taxes? (READ LIST AND CIRCLE CODE)

Under $20,000	1
$20,000 - $34,999	3
$45,000 - $54,999	4
$55,000 - $64,999	5
$65,000 - $74,000	6
$75,000 or more	7
REFUSED................................	8

THANK RESPONDENT. FILL IN INFORMATION ON FRON PAGE AND END INTERVIEW.

22. Using a ten point scale where 1 means not at all effective and 10 means very effective, please tell me how effective each of the following changes in driver education classes would be in improving safety on the roads and highways? (READ LIST AND CIRCLE CODE -- REPEAT SCALE)

	NOT AT ALL EFFECTIVE ... VERY EFFECTIVE	DK
a. requiring longer than 6 hours behind the wheel training	1..2..3..4..5..6..7..8..9..10	99
b. using interactive videos or computers to educate drivers	1..2..3..4..5..6..7..8..9..10	99
c. requiring written and behind the wheel testing whenever a drivers license is renewed	1..2..3..4..5..6..7..8..9..10	99
d. using driver simulators to "place people in hazardous conditions: to train them in safer driving	1..2..3..4..5..6..7..8..9..10	99

Finally, a few questions *to* sort your answers.

23. What was your age on your last birthday? (WRITE IN)

_______ YEARS

24. Do you currently have a drivers license, or not? (CIRCLE CODE)

YES 1
NO 2