EXECUTIVE SUMMARY

Introduction

In cooperation with the National Automated Highway System Consortium (NAHSC), case studies are being conducted on existing transportation corridors to determine the feasibility of AHS. Initial activities by the NAHSC have focused on urbanized areas. However, a need exists to investigate the applicability of advanced transportation technology and AHS in rural settings. AHS applications have primarily focused on problems associated with urban traffic congestion; secondary considerations have related to safety, air quality and energy conservation. These areas are also of concern to the rural transportation provider; however, the primary focus of the rural transportation provider is improved safety.

The Greater Yellowstone Rural Intelligent Transportation Systems (GYRITS) corridor comprises a loop roadway system traversing through Wyoming, Yellowstone National Park (YNP) and Grand Teton National Park, connecting Bozeman, Montana with Idaho Falls, Idaho. The combination of varied, often undesirable driving conditions with wildlife, unfamiliar drivers, a diverse traffic stream and a lack of communication infrastructure indicates an immediate and growing need for increased focus on safety. The problems experienced in the GYRITS corridor are common to many rural environments. Hence, it is an ideal location to showcase field operational demonstrations of advanced technologies.

The intent of this study was to recommend applications and consider implications of Automated Highway Systems (AHS) in a rural environment. This study focused on developing an applicable AHS for the GYRITS corridor that would ultimately increase safety and improve operation.

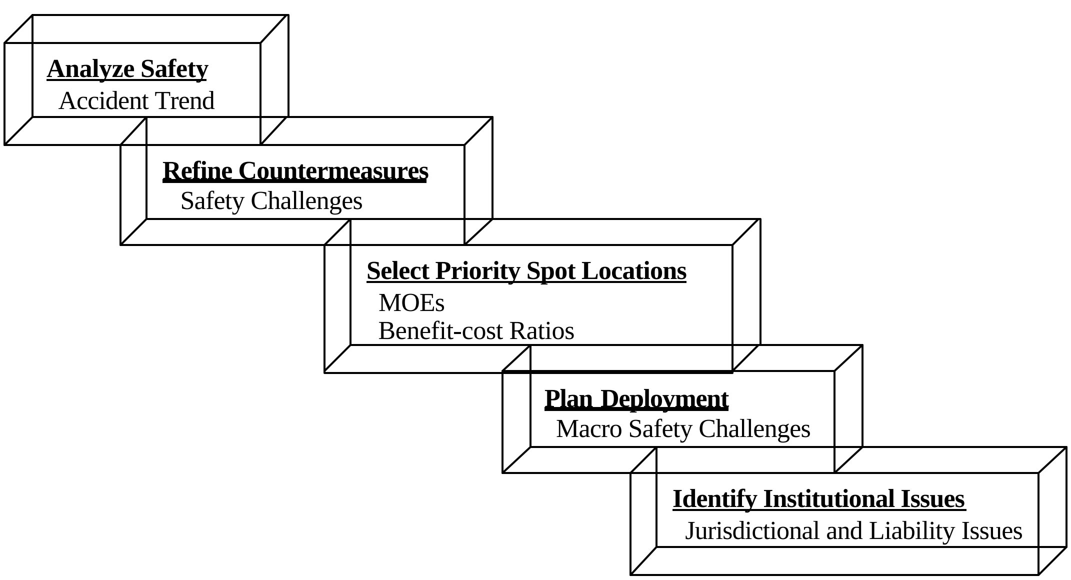

Figure i - Project Methodology

Rural AHS Vision

The system conceived for this project and used in the benefit-cost analysis assumes four incremental service levels: (1) Spot Application: locations where accidents are statistically over-represented will be implemented with technology to warning the driver of hazards via the infrastructure and dynamic messages; (2) Information Assistance: dangers warnings will be relayed to the driver via the vehicle; (3) Control Assistance: the vehicle warnings will be relayed to the driver and in the event the driver does not respond the vehicle will temporally assume control; and (4) Full Automation: in this instance the vehicle is fully autonomous.

Information Assistance, Control Assistance and Full Automation have three primary functions that assist with collision avoidance. These three functions are (1) longitudinal collision warning/guidance, (2) lateral collision warning/guidance and (3) intersection collision warning.

Institutional Issues

Challenges that may impede the deployment of AHS are institutional in nature. These include legal implications, public acceptance, procurement procedures, funding, operation and maintenance responsibility, privacy issues, environmental impacts, societal issues and jurisdictional coordination. Some public agencies are hesitant to get involved; the envisioned AHS system may be perceived as too futuristic. This is especially true in rural environments where agencies typically mitigate roadway problems using "low-tech, low-risk" solutions. Involving the rural transportation providers early in the planning, testing and evaluation phases will help promote the effectiveness of AHS, develop champions and achieve user buy-in. An incremental deployment strategy will help demonstrate early, visible, quantifiable safety benefits for potential users.

Accident Analysis

Accident rates were determined for each half-mile segment using a floating referencing system. Specifically, rates were determined on a half-mile basis, advancing along the route every tenth-mile. Additionally, severity rates were determined for each floating half-mile segment. Based on these rates, potential atypical accident locations were chosen for further study. These locations were analyzed to determine what, if any, accident trend(s) existed. Segments exhibiting trends were thought to have the best chance of maximizing benefits from AHS applications (see Table i).

Accident data, collected from Idaho, Montana, Wyoming and Yellowstone National Park, was standardized and assimilated to allow for spatial representation using Geographic Information Systems (GIS). Accident data was depicted both at spot locations and continuously along the roadway depending on the frequency and characteristics of the accidents. Before examining the accidents to determine geographic areas of focus, the corridor was separated into 18 major segments based on: changes in geometric alignment, city limits, mountainous areas, and state lines. Although state lines were assumed to be transparent, segments were broken along state lines for ease of analysis. The segment types included rural-flat, rural-mountainous, urban

Table i - Atypical Spot Locations

Milepost Range	Total Accidents	Total Trend	Milepost Range	Total Accidents	Total Trend
Montana U.S. Highway 191					
9.900-10.011	18	13	10.000-11.000	20	17
28.000-28.900	13	9	59.000-60.000	11	8
61.000-61.400	12	7			
Montana U.S. Highway 20					
1.000-2.000	10	6	8.619-8.946	11	7
Idaho U.S. Highway 20					
311.000-312.000	22	14	317.000-318.000	42	29
328.000-329.000	14	6	338.000-339.000	17	11
326.000	12	4	405.000-406.000	8	6
Idaho U.S. Highway 26					
335.000-336.000	23	12	336.000-337.000	34	24
338.000-339.000	16	11			
Wyoming U.S. Highway 89					
160.000-161.000	11	8	167.000-168.000	12	5
185.000-186.000	18	11	189.000-190.000	12	6
184.400-184.600	8	8	188.000-188.690	6	6
127.000-128.000	22	16			
Yellowstone National Park Highway 89					
21.034-21.834	18	9	21.334-21.834	5	5
43.122-43.672	9	5	66.180-67.780	20	9

(within city limits), suburban (directly outside city limits until change in cross section), and semi-mountainous (only in Yellowstone National Park). The number of accidents for each accident trend, identified previously for half-mile locations, was determined for each of the 18 major segments. A geographic area was identified for focus if the area possessed two of the three following criteria: (1) a high percentage of the accidents in the area had a common trend; (2) a high number of the accidents in the area had the same common trend; and/or (3) half-mile atypical locations existed with the same trend (see Table ii).

In addition to considering spot and regional locations for the entire accident sample, two smaller groups were separated out for further analysis: (1) commercial vehicles and (2) in-state/out-of-

Table ii – Atypical Regional Segments

Milepost Range	Road Type	Total Accidents
Yellowstone Park U.S. Highway 89		
0.000-93.446	Park	426
Wyoming U.S. Highway 26		
0.000-2.370	Mountainous	7
Montana and Yellowstone Park U.S. Highway 191		
0.000-10.835	Level	88
10.836-66.826	Mountainous	276
66.827-81.903	Level	98
Idaho U.S. Highway 20		
308.717-353.050	Level Suburban	271
353.051-401.300	Level	117
401.301-406.300	Mountainous	18
Montana U.S. Highway 20		
0.000-3.000	Level	27
3.001-9.397	Mountainous	39
Idaho U.S. Highway 26		
335.255-338.069	Level Suburban	64
338.070-375.538	Level	134
375.539-402.500	Mountainous	63
Montana U.S. Highway 89		
0.000-51.812	Level	112
51.813-53.068	Level Suburban	44
Wyoming U.S. Highway 89		
118.32-152.090	Mountainous	304
155.211-165.000	Level	86
165.001-211.620	Mountainous	245

Table iii - Heavy Vehicle Accident Rates

Accident Type	Total Accidents	Accident Rate (R/MVMT)	National Average	Difference
Property Damage Only	54	97.39	75.00	+22.39
Injury Accidents	69	40.73	47.00	-6.27
Fatal Accidents	8	4.72	2.50	+2.22

state drivers. Targeting smaller groups within this sample may actually help to accelerate NAHSC's near-term deployment goals.

Heavy vehicles were involved in approximately 10 percent of all accidents within the corridor, resulting in 28 percent of the fatality accidents and five percent of injury and property damage only accidents (see Table iii). Nationally, heavy vehicles accounted for 12 percent of all traffic fatalities and three percent of all accidents resulting in injury and property damage only. [10] The aforementioned statistics, which indicate that heavy vehicle accidents in the GYRITS corridor exceed the national averages, support the notion that a safety problem exists related to commercial vehicles in the corridor. However, the low frequency of accidents made it statistically difficult to sort heavy vehicle related accidents into trends. Instead, heavy vehicle accident rates appeared to be distributed randomly through mountainous and flat regions; indicating driver error may be the primary problem, while alignment and terrain are secondary contributors.

Traveler origin information was examined to determine if accidents within the corridor were a product of unfamiliar out-of-state travelers or local residents. It was hypothesized that this information would be helpful in determining target groups for early operational testing and evaluation. Tables iv and v describe the differences among in-state and out-of-state crash involvement rates for each geographic area of focus. The accident data from Idaho and Wyoming allowed for the determination of the causing party. Hence, each accident could be traced to a single in-state or out-of-state party; the proportion of in-state travelers and out-of-state travelers involved in an accident summed to one. Montana's accident data did not reflect causing party information but rather accident involvement. Hence, the proportion of in-state travelers and out-of-state travelers summed to greater than one.

Benefit-cost Analysis

Table vi presents realistic benefit-cost ratios based on predicted vehicle fleet market penetration as indicated in the deployment vision. Note the importance of vehicle fleet penetration and AHS service level on benefit-cost ratios for full-scale regional deployment. Many regions were deemed inappropriate for the installation of AHS infrastructure due to low benefit-cost ratios, likely resulting from the relatively low vehicle fleet market penetration. Lower accident

Table iv - Origin of Vehicle Causing Accident

State	Route	Segment	% In-state	% Out-of-state
Wyoming	89	total corridor section	51	49
	89	158.82 to 204.85	41	59
Idaho	20	total corridor section	68	32
	20	308.717 to 353.05	84	16
	20	353.06 to 406.30	37	63
	26	total corridor section	73	27

Table v - Origin of Vehicles Involved in Accident

State	Route	Segment	% In-state	% Out-of-state
Montana	20	total corridor section	65	94
	89	total corridor section	123	36
	191	total corridor section	71	48
	191	0 to 10.493	49	56
	191	10.494 to 81.903	60	36

reduction factors also resulted in lower benefit-cost ratios for the Information Assistance service level.

Next Steps

This section recommends several areas for possible early field operational testing (FOT)with low-level AHS technology. The intent of the recommended FOTs is to provide the driver with more information and more time to react. It is hypothesized that this additional information and time will help the driver avoid many collisions. Through the benefit-cost analysis, sites with the greatest potential were selected for AHS technology deployment in continuing efforts. The candidate sites include:

Friction/Ice Detection and Warning System

- Montana U.S. Highway 191, milepost 9.900 to 10.011 and 10.000 to 11.000;

Table vi - Benefit-cost Ratio Based on Deployment Vision

	Benefit-cost Ratios	
Location	**Information Assistance** 20% penetration after 10 years	**Control Assistance** 50% penetration after 20 years
Montana U.S. Highway 191		
MP 0.000 – 10.835	3:1	23:1
MP 10.836 – 66.826	2:1	17:1
MP 66.827 – 81.903	4:1	34:1
Montana U.S. Highway 89		
MP 0.000 – 51.812	0.007:1	0.07:1
MP 51.813 – 53.068	5:1	37:1
Montana U.S. Highway 20		
MP 0.000 – 3.000	2:1	14:1
MP 3.001 – 9.397	0.02:1	0.2:1
Idaho U.S. Highway 20		
MP 308.717 – 353.050	7:1	36:1
MP 353.051 – 401.300	3:1	32:1
MP 401.301 – 406.300	0.7:1	5:1
Idaho U.S. Highway 26		
MP 335.255 – 338.069	20:1	137:1
MP 338.070 – 375.538	2:1	17:1
MP 375.539 – 402.500	1:1	10:1
Wyoming U.S. Highway 26		
MP 0.000 – 2.370	0.2:1	2:1
Wyoming U.S. Highway 89		
MP 118.320 – 152.090	4:1	34:1
MP 155.211 – 165.000	4:1	36:1
MP 165.000 – 211.620	1:1	9:1
Yellowstone National Park U.S. Highway 89		
MP 0.000 – 93.446	1:1	9:1

<u>Intersection Crossing Detection</u>

- Idaho U.S. Highway 26, milepost 336.000 to 337.000;
- Idaho U.S. Highway 20, milepost 317.000 to 318.000 and 311.000 to 312.000;

<u>Animal-Vehicle Collision Avoidance</u>

- Wyoming U.S. Highway 89, milepost 160.000 to 161.000 and 189.000 to 190.000;

<u>Horizontal Curve Speed Advisory</u>

- Wyoming U.S. Highway 89, milepost 127.000 to 128.000.

These sites were estimated to have the greatest potential for improving safety in the GYRITS corridor through the deployment of AHS. However, before any of the above sites are designated as FOTs, further investigation of the police accident records, the site, and the transportation providers' perspectives needs to occur.