III. WINTER MAINTENANCE: THE EXTREME CHALLENGE

Winter travel in rural Arizona is a true challenge for a number of key reasons. The terrain in the northern and eastern areas of the state rises from just 500 feet above sea level at the Colorado River, to 7,300 feet on Interstate 40 near Flagstaff. Over 250 miles of I-40 are at elevations above 5,000 feet. Many other route corridors in the northern, eastern and central mountains rise above 8,000 feet and even as high as 9,500 feet above sea level.

Figure 3: Dawn Patrol on Interstate 17 in a Winter Storm

Across the state, the Arizona Department of Transportation maintains a fleet of more than 240 snowplows to patrol and maintain nearly 4,000 miles of designated plow routes in the 6,200 mile state highway system. Of these snowplow routes, ADOT maintenance forces around the state have identified more than 1,300 miles of highway with moderate to severe visibility impairment in winter storm conditions.

Keeping Arizona's highways open and operating smoothly for commercial and tourist traffic in winter is always a tremendous challenge. In the harsh reality of this new millennium, each state, regardless of size and population, must do more with less. For ADOT's highway maintenance crews, new technology offers the ability to cope with winter operational problems that include reduced budgets, high crew turnover, growing truck and passenger car volumes, motorists with varying driving skills, and increasing traffic speeds.

The Arizona Transportation Research Center began this project in 1997 as an in-house research effort for ADOT. The project's mission was to study the possible practical applications in Arizona for vehicle-based and infrastructure-based Intelligent Transportation Systems (ITS) technologies, to enhance both efficiency and safety.

This project report covers Phase Three (Year Five) of the Intelligent Vehicle research program, beginning in early 2002. It focuses on northern Arizona's 2002-03 winter season, and it also describes the new direction in testing and research that was mandated after Phase Two(b) ended.

THE PROJECT NEED – THE COSTS OF WINTER TRAVEL

Crash statistics from the ADOT Traffic Records Section reveal the magnitude of the safety issues involved in winter travel across rural Arizona. Complete 2003 figures are not yet available, but the records for calendar year 2002 in Arizona show that 14 lives were lost and 539 persons were injured in crashes on roadway surfaces with snowy, slushy or icy conditions.

Table 1: Arizona "Snowy-and-Icy" Roadway Crashes: Calendar Year 2002

Description	2002
Total Crashes - Snowy or Icy Road Surface Conditions	1,243
Fatal Crashes - Snowy or Icy Conditions	12
Fatalities – Snowy or Icy Conditions	14
Injuries – Snowy or Icy Conditions	539
Property Damage Only Crashes – Snowy or Icy Conditions	909
Snowfall Days / Total Snowfall for Calendar Year 2002: Flagstaff	8 days / 30 inches
Total Estimated Economic Loss – Snowy or Icy Conditions: *Per National Safety Council 2002 Estimating Criteria*[4]	**$29,944,532**

Source: "Arizona Motor Vehicle Crash Facts 2002," ADOT Traffic Records Section [4]

In all of 2002, with regional snowfall only 30 percent of average, snowy or icy road conditions still were relevant factors in more than 1,200 crashes that took 14 lives across Arizona. National Weather Service records show that Flagstaff, for example, received only 8 days of significant snowfall (one inch or more) in calendar year 2002, for a total of 30 inches. Since records have been kept, the long-term average annual snowfall at Flagstaff's Pulliam Airport is 84 inches. For just the past six years of this research project, four years were above that average for Flagstaff, and the annual snowfall totals ranged from 30 inches to 131 inches.

The *estimated economic loss* to the State of Arizona from the more than 1,200 reported winter crashes on storm-impacted roadways was nearly $30,000,000 in 2002. These economic figures include estimates of lost personal earnings, medical costs, and property losses from crashes, but they do not assess the fiscal impacts to a time-sensitive economy of accident-related travel delays for commercial carriers and for the public. These vehicle crash cost figures are separate from any estimates of regional storm-related travel delays, and they do not include any snowplow crash repairs or operational costs to ADOT. Note also that these crash and weather statistics in Tables 1 and 2 are tabulated on a calendar year basis, not by the winter season.

Winter Storm Impacts on Highway Safety

Table 2 below shows the breakdown of winter storm-related crashes by county in Arizona for calendar year 2002. This table presents two sets of figures showing weather-related crash-event factors from police reports, the first being the road surface condition and the second being the observed weather at the time of the crash.

In Table 2, "weather condition" includes several classes of impaired visibility in winter storms, which is the critical concern for this research project. Rain-caused crashes and those on "wet" roads, however, are not included. The two key criteria, road surface and weather, are obviously not directly related, since icy roads in clear weather are a very frequent hazardous condition.

Table 2: Wintry Conditions in Crashes: Calendar Year 2002

2002 - Statewide Motor Vehicle Crash Summary - by Counties									
Winter Storm Conditions - *Snow, Ice, & Impaired Visibility*									
	Road Surface Condition				**Weather Condition**				
Crash Data - By Counties	Snow	Slush	Ice	*Sum*	Sleet / Hail	Snowing	Blowing Snow, Dust	Fog, Smoke	*Sum*
Apache	51	15	145	*211*	8	138	10	2	*158*
Cochise	4	2	33	*39*	7	20	5	1	*33*
Coconino	137	41	216	*394*	43	220	9	13	*285*
Gila	24	5	25	*54*	3	29	1	2	*35*
Graham	0	0	1	*1*	0	0	0	0	*0*
Greenlee	2	0	4	*6*	0	2	0	0	*2*
La Paz	0	0	1	*1*	0	0	2	0	*2*
Maricopa	5	14	37	*56*	131	7	61	13	*212*
Mohave	10	1	30	*41*	10	31	8	0	*49*
Navajo	59	6	192	*257*	19	149	9	24	*201*
Pima	2	6	68	*76*	67	13	24	9	*113*
Pinal	0	2	12	*14*	18	2	49	7	*76*
Santa Cruz	1	1	1	*3*	1	3	0	0	*4*
Yavapai	22	13	71	*106*	10	53	2	1	*66*
Yuma	0	3	0	*3*	4	1	9	3	*17*
Total Crashes	**317**	**109**	**836**	***1,262***	**321**	**668**	**189**	**75**	***1,253***
ATRC Note: Regional Snow Totals were only 30% of average in 2002									

Source: "Arizona Motor Vehicle Crash Facts 2002," ADOT Traffic Records Section [4]

The road surface and weather factors tabulated above are observed conditions from crash reports, and may or may not be an actual causative factor in any of the crashes. There may also be local disparities in reporting of crash totals between counties, or from year to year. These figures are provided to indicate probable significant storm-related factors in winter crashes, and their distribution across the entire state.

The Project Need: Snowplow Accident Repair Costs

ADOT's snowplow fleet is subject to serious attrition during major storms, when all available trucks and manpower are deployed on the state's highways. Even for this relatively mild winter of Year Five, between November 2002 and March 2003, records show a total of 16 snowplow vehicle damage incidents were entered into the ADOT equipment repair cost-tracking system.

These 16 incidents resulted in plow equipment repair costs for 2002-03 of more than $112,000, which does not include any possible property damage to roadside features such as guardrail, road signs and delineators. It also does not include any third party damage claims from snowplowing.

This figure also does not include any operating costs or ADOT internal costs for repairs or maintenance work that the district shop would consider as ordinary snowplowing wear and tear.

The following Table 3 illustrates the fluctuations in the number, type and severity of snowplow accident reports for the three most recent winters. For this summary, the weather statistics are reported by winter season, for the October to May time window. The winter snowfall totals are generally quite different from the calendar year totals, which combine two partial seasons, and the winter summary gives a truer picture of fleet attrition over a snowplowing season.

Table 3: Arizona Snowplow Accident Repairs by Winter Season

Description	Phase Two 2000-01	Phase Two(b) 2001-02	Phase Three 2002-03
*Snowfall Total by Winter Season at Flagstaff**	*125"*	*39"*	*55"*
Total Repair Cost for Snowplows - Statewide	$66,714	$49,852	$112,159
Total Incidents of Snowplow Damage	19	22	16
Damaged During Snowplowing Activity	15	8	16
- Struck or Struck By Other Vehicle	9	9	4
- Struck Fixed Object	6	6	12
- Other Incidents – Loading, Rigging, Transit	4	7	0
Average Repair Cost of Reported Accidents	$3,511	$2,266	$7,010
Storm Records courtesy of National Weather Service – Flagstaff			

Source: ADOT Equipment Services Group Records

Depending on the severity of the winter season, many or most of these damage reports would be for on-the-road snowplowing activity, as opposed to loading materials, rigging plow equipment, training or other causes. For the winters tabulated above, on average seven of these incidents involved collisions with other vehicles, and eight involved plows striking fixed objects.

For the 2002-03 winter, the accidents included three rollovers, which as indicated by the average repair cost for the year, were clearly a major cost element. In most crashes during snowplowing operations, roadway visibility would logically be a key factor, and this is an area where this advanced vehicles research project has made its most significant efforts over five winter seasons.