Application of Variable Speed Limits Along the Trans Canada Highway in Banff National Park

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ABSTRACT

The Trans Canada Highway (TCH) is to be twinned from the Castle Mountain Interchange to the Alberta/BC border within Banff National Park. In conjunction with the twinning of the Trans Canada Highway, Parks Canada is looking to initiate several Intelligent Transportation Systems within the park that will address an improved operation and safety performance of the highway. One such initiative focuses on the application of a variable speed limit to address speeding during poor weather conditions, congested periods or when wildlife is actively crossing the highway.

This paper attempts to address the following questions with respect to the application of a variable speed limit within the Banff National Park:

- What is the current legislation for variable speed limits on roadways?
- What is the safety performance of the Trans Canada Highway within Banff National Park?
- What effect will a variable speed limit have on reducing the collision rate?
- What criteria will determine a reduction or increase in the posted speed limit?
- What process will be employed to effectively reduce/increase the posted speed limit within the Park?
- Under who's authority (RCMP/Parks Canada) will the managing of a variable posted speed limit fall?

1.0 INTRODUCTION

The Federal Government is proceeding with the twinning of the Trans Canada Highway from the Castle Mountain Interchange to the Alberta/BC border within Banff National Park. This section of highway is approximately 35 kilometres in length and will tie in to the existing twinned section of the Trans Canada Highway at the Castle Mountain Interchange.

In conjunction with the twinning of the Trans Canada Highway, Parks Canada is considering deployment of Intelligent Transportation Systems (ITS) within the park in an effort to improve the operation and safety performance of the highway. One such initiative focuses on the application of a variable speed limit. This paper will report on a literature review that has been undertaken to understand issues associated with variable speed limit applications.

2.0 BACKGROUND

Twinning of the full section of highway is expected to take place over an unknown number of years. To address an improved operation and safety performance of the Trans Canada Highway within the Mountain National Parks, Parks Canada initiated a study into the short and long term benefits of installing variable message signs and the application of other advanced technologies along this section of highway. The literature review and the focus on variable speed limits is one aspect of the study. The implementation of a variable speed limit between the Castle Mountain Interchange and the Alberta/BC border seeks to address short-term benefits in the operation and safety of this section of highway prior to the completion of twinning.

Concerns have been raised by non-government organizations (NGO's), RCMP and Parks Canada staff with respect to the current safety performance and operation of the highway within the park boundaries. These concerns are related to collisions due to:

- Driving at high speeds, generally above the posted speed limit; and
- Driving at the posted speed limit during poor weather conditions.

A recent study conducted by Parks Canada along this 35 km section of the Trans Canada Highway [(1)] had two objectives:

- To review safety mitigation techniques on congested two-lane rural highways; and
- To examine the need to upgrade the highway from a two-lane undivided highway to a four-lane divided highway.

This study concluded, "The four-lane divided highway (twinning) option provides the greatest positive impacts towards achieving the goals of road safety, efficiency and service, and effectiveness…. In an exhaustive study by MTO of collision modification factors of 47 geometric design elements, creation of a divided highway facility ranked highest."

3.0 TRAFFIC CHARACTERISTICS AND SAFETY PERFORMANCE

3.1 Traffic Characteristics

Traffic data including the Annual Average Daily Traffic (AADT) for the Trans Canada Highway for 2003 at various locations within Banff National Park is available from Alberta Infrastructure and Transportation, and Parks Canada. Along the subject section of highway, the traffic volumes range from 5200 vehicles per day to 7400 vehicles per day. The overall proportion of truck traffic is likely greater than 10%.

Although the traffic characteristics for this section of the Trans Canada Highway are not discussed in detail in this paper, the information noted above provides some information for the reader to obtain an understanding of the nature of the operation of the highway in this mountainous region.

3.2 Safety Performance – Trans Canada Highway within Banff National Park

The study conducted by Parks Canada along the 35 km section of the Trans Canada Highway between the Castle Mountain Interchange and the Alberta/BC border [(1)] grouped the collision types in four categories. The first category included angle, head-on and sideswipe collisions with the other three being grouped as all run-off-road collisions, rear-end collisions, and miscellaneous collisions. Angle, head-on and sideswipe collisions were grouped together as these collision types represent "those collisions that would result in reduced severity by twinning." This first category contains the highest number of fatal collisions by type.

This study compares the safety performance along this section of the Trans Canada Highway in terms of fatal and injury collisions with local and international rates from Alberta and Ontario, and Australia and Europe. Collision rates in general were found to be larger along this study section than other local and international rates. No explanation for why this may be was presented.

The study provides comparison of collision rates on this highway to rates on similar highways in other jurisdictions. The comparison to similar highways in Alberta as provided in this report is as follows:

Highway Type & Year	Total Collision Rate per MVKM	% Fatal	% Injury	% PDO
TCH – Castle Junction to AB/BC Border, 2-Lane, 1992 - 2002	1.47	3.8	22.2	74.0
TCH – Castle Junction to AB/BC Border, 2 – Lane, 2000 - 2002	1.95	6.5	20.7	72.8
Alberta, 2-Lane, 1992	1.10	1.5	16.3	82.2
Alberta, 2-Lane, 2002	1.00	1.3	16.7	82.2
Alberta, 4-Lane, 1992	0.75	1.0	17.4	81.6
Alberta, 4-Lane, 2002	0.47	1.2	19.1	79.7

The study also found that "by comparison Alberta 2-lane and 4-lane (collision) rates were 1.34 and 0.58 per 100 MVKM (million vehicle kilometres) in 2002 respectively." These rates consider all levels of severity including property damage only. The fatality and injury rate for Alberta was identified as 18.17 collisions per 100 MVKM.

Based on this review of the safety performance along this 35 km section, the report concludes that providing a four-lane divided highway will provide the greatest level of improved safety on the Trans Canada Highway. Twinning of the existing highway is intended to be completed over an extended period of time. During that period, advanced technologies such as variable speed limits may be useful to provide some safety improvement.

4.0 LITERATURE REVIEW

An initial literature review was under taken at the same time as existing information was being compiled and reviewed. Sources, both hard copy and Internet based, that are known to be accurate and reliable have been searched. The focus of the literature review was in the following areas:

- Documented case studies of the application of variable speed limits in rural environments; and

- Legislation and enforcement requirements of existing variable speed limits.

The sources of information included published reports from academic, government and private sector sources, traveller information websites, government websites at the provincial/state and federal levels, conference proceedings.

The literature review resulted in very few directly applicable case studies that present coordinated initiatives for variable speed limits in remote locations. Information on appropriate technology is largely available but mostly defined for school or construction zones. Relevant findings from the literature review are presented in the subsections that follow.

4.1 Variable Speed Limit Applications

4.1.1 Washington State

The Washington State Department of Transportation is operating a variable speed limit system on I-90 across the Snoqualmie Pass. This system was installed due to high operating speeds and speed variance, which was found to contribute to winter collisions including primarily rear-end, sideswipe and run-off-the-road collisions [(2)].

The variable speed limit is displayed using variable message signs. All equipment is operated through a single operator interface based on the MIST system, which maintains coordination with the variable speed limit and variable message signs. Information for setting speed limits and for the message signs is gathered from a variety of sources. Wide aperture radar tracks speeds for feedback to the control system. All roadside data collection and control is processed through roadside cabinets. Field equipment communicates by packetized data radio on three mountaintop relay sites. Communications from the mountaintops to the control center are transmitted by microwave. All of this collected information goes to a central computer, which processes the data and determines the "safe speed" for the roadway. This system is monitored from a DOT maintenance office at the pass. Currently, a computer recommends the speed limit and an operator confirmation implements it. The system is designed so that speeds can vary along the corridor, and speed postings for one direction of travel may differ from those for the opposite direction. Inherent in the system's design is the capability for expansion, and there has been some planning to lengthen the variable speed limit to cover more of I-90 [(3)].

This system was implemented through a project called TravelAid [(4)], which had two objectives. The first was to study the effectiveness of variable speed limit and variable message signs in changing driver behaviour, and secondly to help reduce the number and severity of collisions along the Snoqualmie Pass. Findings from this study are documented in a report called TravelAid and include the following:

- Motorists drive as fast as the law allows and pay little attention to prevailing roadway conditions. Without enforcement by the Washington State Patrol, variable speed limits may lose their effectiveness.

- The reduction in mean speed and increase in speed deviation were significantly greater at the variable speed limit site than at the non-variable speed limit site, indicating that the effect of the variable speed limit was to reduce the mean speed and increase the deviation.

Speeds displayed on the variable message signs are enforced by the State Patrol [5].

4.1.2 New Jersey

A variable speed limit is in operation along the New Jersey Turnpike, an urban freeway, high-speed, limited controlled access roadway. The system is over 238 km in length and utilizes approximately 120 signs. Inductive loop detectors are used to collect speed and volume data with the addition of weather-sensing equipment planned for coordination of data collection in the near future. Posted speed limits in the variable speed limit zone are based on average travel speeds and are displayed automatically. The posted speed limit can be reduced from the normal posted speed limit in eight-km/h increments to a minimum posted speed of 48 km/h. The posted speed limit can be reduced for six conditions [3]:

- Vehicle collisions;
- Traffic congestion;
- Construction;
- Icy road conditions;
- Snowfall; and
- Fog.

The New Jersey Turnpike Authority Operations Department personnel monitor the system 24 hours per day, seven days per week. Incident information is transmitted electronically via loop detectors in the pavement to the Authority's Operation's Command Centre where the sign information is generated and displayed instantaneously to the variable message signs alerting drivers of the roadway conditions ahead [6].

Speeds displayed on the variable message signs are enforced by the State Patrol [5].

4.1.3 New Mexico

A variable speed limit was in operation along I-40 in Albuquerque from March 1989 until it was disbanded in 1998 due to grade widening of the freeway from three to five lanes and never reinstalled. It was designed to operate in all freeway environments. The system operated along six kilometres of a busy urban freeway using three roadside stations each consisting of a pair of loop detectors in each lane, with a variable message sign notifying drivers of the posted speed limit. Average traffic speed, light level and precipitation data were collected using the loop detectors. The system used a look-up table to generate the posted speed limit. The limit was based on the smoothed (90

percent old data plus 10 percent current) average speed plus a constant based on the environmental conditions. Negative constants were used to keep the posted speed below to maximum speed limit under normal operating conditions [3,6].

Speeds displayed on the variable message signs are enforced by the State Patrol [5].

4.1.4 Tennessee

A low visibility warning system was installed in Tennessee in 1990 following a chain-reaction collision involving 99 vehicles due to a reduction in visibility during adverse weather conditions [7]. This system is located on a 19-mile section of I-75 and includes 10 variable message signs. Data is collected using environmental sensors and vehicle detectors, which is transmitted to a central computer in the Highway Patrol office. This data is continually monitored by an on-site computer, which predicts and detects conditions conducive to adverse weather conditions, particularly fog. The system also detects significant reductions in traffic speed. Highway Patrol dispatchers are alerted when established threshold criteria is met and these dispatchers post a reduced speed on the variable message signs as well as notifying Highway Patrol troopers. Pre-programmed messages and appropriate speed limits are displayed based upon scenarios proposed by the central computer [2].

4.1.5 Finland

A trial variable speed limit system was developed on an 8.5 km section of road between Lohjanharju and the Turku Region [3]. Variable speed limits are displayed using variable message signs and are controlled automatically in response to speed recommendations derived from road weather system calculations.

A second system has been in operation from December 1997 along a 25 km section of road between Hammina and Kotka [5,6]. This system utilizes 67 fibre optic variable message signs with changes in speed limits displayed in response to road surface conditions and 13 variable message signs. The variable speed limit is determined from information collected from five unmanned road weather stations that collect local weather and road surface conditions. These inputs are analyzed by a central unit, which determines a recommended speed limit.

The speed limit posted by the system is enforced; however, the method of enforcement (i.e., photo radar or other) is not described in the available literature.

In a study produced by the Technical Research Institute of Finland [8], information was transmitted to drivers by several variable message sign types including slippery road condition signs, minimum headway signs, temperature displays and speed limits. Lowering the speed limit on a weather-controlled road had a greater effect upon driver

behaviour than displayed other warning or information variable message signs. A reduction in posted speed limit decreased both the mean speed and the variance of speed.

4.1.6 Netherlands

A variable speed limit system was installed along a 20 km rural section of the A2 motorway between Amsterdam and Utrecht in 1992. Variable message signs are spaced approximately every one kilometre. Data is collected using loop detectors spaced every half kilometre. A system control algorithm based on one-minute averages of speed and volume across all lanes determines the posted speed limit. If an incident is detected, a speed of 50 km/h is displayed. If the speeds are posted with a red circle, they are enforced by photo radar. If posted without the circle, they are advisory speeds only [3,6].

4.1.7 Australia

A variable aped limit has been in operation since 1993 on the F6 Tollway south of Sydney. This system was installed to reduce the number of rear-end collisions in fog conditions and covers an 11 km section of roadway. Twelve signs are located along this section and each sign is connected to road loops and a visibility detector. The posted advisory speed is based on the visibility distance and the speed of the preceding vehicle. Drivers are advised of the speed to travel at to avoid a rear-end collision with the preceding vehicle [5,9].

4.2 Legislation and Enforcement Requirements

4.2.1 United States

A report produced by the NCHRP (National Cooperative Highway Research Program) of the United States reviews the judicial enforcement of variable speed limits [10]. This report examines the impact of judicial decisions and enforcement on the likely success of enforcing variable speed limits. It reviews findings from a survey sent to the Attorneys General of the 50 states and to Puerto Rico. The purpose of the survey was to determine the existence of statutory or regulatory variable speed limits in each state and the enforcement of those limits. In some states where the authority to reduce speed limits is delegated to local officials, the minimum speed limit may already be specified in the statute. In general, state law allows state or local officials to decrease speed limits for sections of the highway or at intersections “if they determine, usually from a traffic and engineering investigation, that the absolute speed permitted under existing laws or regulations is greater than is reasonable or safe under the conditions found to exist. The Department of Transportation, Commissioner, town council or other designated official may determine that the decreased limit is to be effective at all times or at such times as are indicated upon signs, and differing limits may be established for different times of the day, …varying weather conditions, and other factors bearing on safe speeds.”

The report presents several suggested elements of a variable speed limit law that should be implemented in order to meet the requirements for enforcement and survive possible challenges to the constitutionality of the law.

- The statutory purpose should be stated allowing changes in speed limit to protect public safety. The legislature after declaring a policy and fixing a primary standard, may delegate to an agency power to prescribe the details.

- The law should require that alteration of a speed limit must be based upon engineering and traffic investigations that show the need for a variable speed limit due to certain conditions.

- The statute must require posting for the new limit to be effective.

- The statute should require posting of advance warning that the legal speed limit is changing ahead.

- The law would require that any information, summons, or other charging documents include both the existing speed limit and the speed at which it is alleged the charged driver's vehicle was traveling.

- The law might include a prohibition on set up of radar, photo-enforcement technology, or other electronic detection enforcement within a specific distance of the posting of a new limit.

- The law should provide broad discretion to the administrative agency for enactment of regulations and for sub delegation of decision-making power.

- Either the laws or regulations should provide for the admission of certain evidence by affidavit. Where the speed limit is decreased temporarily because of hazards such as weather, traffic, or other conditions, evidence of these reasons and of the specific limit on the section of highway where a traffic violation has allegedly occurred will need to be presented.

The report concludes that any legal issues arising from the creation and enforcement of a proposed variable speed limit should be no different from the legal issues that have been considered by courts where violations of prima facie speed limits and other fixed maximum speed limits have occurred. Although this information applies to the legal system in the United States, some points may be relevant to the study area.

4.2.2 Ontario

Bill 169 – the Transit and Road Safety Act [(11)] was introduced to the Legislature in February 2005. This Bill contains over 25 initiatives aiming to improve road safety. A

major focus of the Bill is on speed related matters with one of these initiatives addresses the use of variable speed limits. Contained in Bill 169 is the proposal to allow the Ministry of Transportation for Ontario to use variable speed limits on highways where the speed limit can be varied using electronic speed limit signs to respond to changes in highway conditions. This Bill however, does not address commitments to enforce these speed limits.

4.2.3 National Parks (Banff)

Under the Canada National Parks Act [12], the Governor in Council may make regulations respecting the control of traffic on roads, streets and highways and elsewhere in parks, including the regulation of the speed, operation and parking of vehicles. Regulations made under this section (Regulation Section) may authorize the superintendent of a park, in the circumstances and subject to the limits that may be specified in the regulations:

a) To vary any requirement of the regulations for purposes of public safety or the conservation of natural resources in the park;

b) To issue, amend, suspend and revoke permits, licences and other authorizations in relation to any matter that is the subject of regulations and to set their terms and conditions; and

c) To order the taking of any action to counter any threat to public health or to remedy the consequences of any breach of the regulations in the park.

A reduction in posted speed limit from 90 km/h to 70 km/h is put into operation each year along a section of the Trans Canada Highway between approximately 5 - 6 km west of Lake Louise and 1 km east of Lake Louise. This reduction is initiated by Parks Canada during the summer and fall months (approximately from the May long weekend through to Thanksgiving) to protect the grizzly bear population in the area [13].

4.2.4 Alberta

Part 5 of the Traffic Safety Act (Alberta) [14] governs the general operation of vehicles including speed limits and traffic control devices. Division 1, Section 108 states that a road authority may prescribe speed limits that are different from the speed limits established under Section 106 (Standard speed limits) or 107 (Standard speed limits re school and playground zone) should certain criteria be met. This part of the Act does not address the prescribing of variable speed limits; however, it is understood that a similar process to that outlined in Division 1 would be adopted for the governance and application of variable speed limits within the province.

5.0 CONSIDERATIONS

With respect to the implementation of a variable speed limit along any section of highway that may provide for improved operation and safety, the following issues should be considered:

- The information required for variable speed limit applications include improved road and weather information collection and dissemination. The type and volume of information collected needs to be considered as this rural environment subject to fluctuating conditions. During winter months, severe storms are not uncommon and during the summer months, this area is susceptible to forest fires and reduced visibility due to smoke. Locations and number of data collection stations, and how this technology might be integrated into the overall management system of the roadways in the Banff National Park should be examined.

- The number of signs and spacing should to be considered, as should the power supply for certain signage. Spacing and advance warning requirements for changes in speed limits may be subject to legislation that defines certain requirements for the posting of a speed limit and this should be confirmed through relevant jurisdiction officials. As well, the use of the appropriate technology for such signing, including confirmation of a power source, should be considered on a site-specific basis.

- A data management system should be designed to collect and analyse inputs from the collection stations. This system needs to include the specified criteria for when a reduction or increase in the posted speed limit is met. Consideration should be given to determine whether the system should be automatically or manually controlled. It should also record outputs produced from an analysis of the data. This would likely meet the legal requirements should any challenge to citations be made with respect to the decision matrix used to post a reduction in the speed limit.

- Variable speed limits can be used in conjunction with variable message signs. Consideration should be given to incorporate the two applications to increase the efficiency of the infrastructure available. This will provide benefits in the short and long terms and provides flexibility within the system to adapt to multiple safety and road network conditions, not just one application at a time.

- A system should be developed to determine the protocol of reducing speed limits due to serious collisions on the highway. This system should address the confirmation of a collision and its location prior to posting a reduction in the speed limit and how far in advance the reduction needs to be posted.

- Legislation addressing the use and application of variable speed technology will need to be further explored to determine the responsibility and governance of setting posted speed limits. Cooperation and coordination with local enforcement agencies

should be established and maintained to ensure that relevant stakeholders are notified of system changes and can act accordingly.

- Road users should be educated in the operation of variable speed limits so as to achieve success in the improvement in operation and safety of the highway. Advance warning signs should precede any reduction in posted speed limit and should educate the road user as the advisory or regulatory nature of the speed limit.

- Performance indicators should be established to determine a measure of the success of the system as a whole or as an individual component within the system.

- The deployment and maintenance of the infrastructure needs to be addressed.

6.0 CONCLUSIONS

From the analysis and discussion presented, the following conclusions can be made:

- Variable speed limits generally produce a reduction in the operating speed of vehicles; however, an increase in the speed variance may occur.

- Several of the applications mentioned above have shown an improvement in the safety performance of the highway where a variable speed limit has been installed.

- Generally, within the existing legislation, authority is delegated to local officials to manage the operation of variable speed limits.

- Consideration needs to be given to a number of factors to maintain the viability and effectiveness of a variable speed limit.

- The likely success of a variable speed limit is largely dependent upon the enforcement of the posted speed limit.

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