# Application of ITS to Manage Traffic at a Calgary Rail Crossing


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**ABSTRACT**

Intelligent Transportation Systems (ITS) have the potential to improve the safety and efficiency of traffic management when normal flow is interrupted by at-grade rail crossings. The City of Calgary has turned to an ITS solution to manage traffic problems caused by an at-grade rail crossing.

Barlow Trail is a significant arterial connecting the Deerfoot Trail freeway with an important industrial area. Rail cars can block Barlow Trail for periods of up to 30 minutes resulting in long delays for motorists and the development of long queues extending back to the freeway exit ramp, causing concerns for the safety and mobility of motorists.

To address the concerns of safety and mobility at this site, the City of Calgary has invested in an innovative traffic management system. The purpose of the system is to detect congested conditions due to a road blockage, provide advance warning to motorists to allow them to avoid the congested area, alter traffic control to reduce additional congestion, and implement appropriate queue clearing strategies to restore normal traffic flow as quickly as possible.

The solution required the integration of several available technologies to detect current conditions, determine appropriate actions, and enact the management strategy. The technologies included video traffic detection, wireless communication, traffic signal control, and portable changeable message signs. This paper will provide information on the existing site conditions and traffic problems and a description of the solution that was implemented including the technology and management strategy.

## Introduction – The Challenges of Growth

Traffic volumes on roadways continue to increase at a rate far faster than our ability to add new capacity. Between 1982 and 2002 in the United States, vehicle miles traveled increased by 79 percent while highway lane miles only increased by three percent (1). The result has been an increase in highway congestion. Between 1982 and 2000 the number of roadways considered congested in the United States increased from 34 percent to 58 percent (2).

Population and traffic growth is not a phenomenon that is only occurring in the United States. The City of Calgary has experienced a long period of economic and population growth resulting in increased traffic congestion. Between 1991 and 2001 the population of Calgary grew by 24 percent from 709,000 to more than 875,000 people. Along with the growth in population has been a 29 percent increase in per capita distance traveled from 10,500 kilometres per year in 1991 to 13,500 kilometres per year in 2001. The combination of increasing population and increasing mobility has resulted in an increase in total vehicle kilometres traveled from 7.4 billion in 1991 to 11.8 billion in 2001, an increase of 59 percent.

To sustain future economic growth and provide a safe and efficient transportation infrastructure will require a continued investment from responsible agencies. However, in some cases the best investment may not necessarily be in concrete and asphalt, but rather in the development and implementation of technology that maximizes the potential of the existing physical infrastructure. Intelligent Transportation Systems (ITS) provide applications that can be used to complement and maximize the gains from infrastructure expansion or be used as an alternative to infrastructure expansion. A recent ITS project by the City of Calgary demonstrates how ITS can be used to address traffic concerns by improving existing operations without making large investments in new infrastructure.

## Traffic Concerns at Barlow Trail and 50$^{th}$ Avenue SE

The intersection of Barlow Trail and 50$^{th}$ Avenue SE is located in the south east area of Calgary, just off Deerfoot Trail, as illustrated in Figure 1. Deerfoot Trail is a major urban freeway carrying high traffic volumes and Barlow Trail provides access to a large industrial area. Barlow Trail is crossed by railway tracks approximately 200 metres south of the 50$^{th}$ Avenue intersection. Barlow trail is frequently blocked by railcars for periods ranging from several minutes up to 30 minutes in duration. The southbound through movement has a peak hourly volume of approximately 1500 vehicles per hour, including approximately 12 percent trucks. Therefore, when Barlow Trail is blocked for long periods of time large queues are quickly formed that can reach as far north as Deerfoot Trail.

Large queues are both a safety and a mobility concern. A backup that causes traffic flow to be disrupted on Deerfoot Trail creates the potential for serious crashes and for triggering further congestion on Deerfoot Trail. Mobility along Barlow Trail is also decreased resulting in user delay and inconvenience.

The estimated cost to provide a grade separated crossing at this location to eliminate rail conflicts was approximately $20 million. To address the safety and mobility concerns at this site, a more economical solution using ITS technology was developed by the City of Calgary and the consulting firm of DELCAN Corporation (3).

**Overview of an ITS Solution**

The system had two primary objectives to address safety and mobility at this location. The first objective was to provide a means of alerting motorists approaching the area about the blocked crossing so they could seek an alternate route. The second objective was to implement queue clearance strategies to more quickly dissipate an accumulated queue once the rail blockage was removed. Both objectives have as an end goal an increase in mobility and safety. Assisting motorists to seek an alternate route when appropriate helps reduce delay time for the individual that selects the alternate route. At the same time, the queue is reduced for all remaining traffic reducing delay time for other motorists. Reduced queue lengths also impacts safety as the possibility of a crash will be reduced if the queue is prevented from reaching Deerfoot Trail.

To inform motorists of current conditions on Barlow Trail five portable changeable message signs (PCMS) were deployed on important approach routes to the area. These signs are operated automatically by the system to provide drivers with advance warning when congestion is present on Barlow Trail. In order to restore traffic to normal operating conditions after the occurrence of the blockage, two modifications were made to the signal timing at the intersection of Barlow Trail and 50$^{th}$ Avenue. The first modification reduces or prevents traffic movements that could add to the queue problem while there is a blockage and the second optimizes signal timing to quickly dissipate the queue while providing an acceptable level of service to other traffic movements.

**Implementation of the Solution**

International Road Dynamics was selected using a competitive RFP process and was contracted to implement the traffic management system. Installation of the system occurred in April 2005. Key components of the system included vehicle detection, signal control, sign control, and communications.

Detection and Activation: To react appropriately to current conditions the systems requires information on both train and traffic conditions. Signals from the rail crossing circuit were brought back to the intersection controller to provide status of the rail crossing.

Video based vehicle detection sensors were placed at two locations on Barlow Trail as illustrated in Figure 1. The first detection sensor (Sensor 1) was placed just south of the 50$^{th}$ Avenue. The purpose of this sensor is to determine when the available space between the rail crossing and the intersection has been filled with vehicles. The second detection sensor was placed on Barlow Trail approximately 350 metres north of the intersection. The purpose of this second detection sensor is to monitor the length of the queue that has developed on Barlow Trail and determine when the clearance mode of the signal timing plan should be in effect.

Programming and Signal Timing: The traffic controller electronics located at the intersection of Barlow Trail and 50th Avenue SE also act as the controller for the special traffic management and advisory functions of this system. The operating logic was reprogrammed to provide the desired control of signs and signals, as illustrated in Figure 2. Inputs are provided into the controller from the rail crossing, the two detection locations, as well as existing inductive loops used for actuated signal control under normal operations.

When a train is blocking Barlow Trail and the space between the intersection and the rail crossing is full, as detected by Sensor 1, then the signal timing is modified. Under queued conditions there is no space for southbound traffic to move through this intersection, so the through green phase could be eliminated. However, pedestrian crossings must still be serviced so the minimum time required for pedestrian crossing is provided. The left turn movement from westbound 50th Avenue to southbound Barlow Trail is not serviced under queued conditions. As well, the PCMS are activated under these conditions to alert motorists that a blockage of Barlow Trail is occurring allowing them to choose alternate routes. This state of operation will continue until there is no longer a train blocking Barlow Trail.

Depending on the length of time that a train is present, significant queues may have developed on Barlow Trail. As long queues may pose a safety risk, it is desirable to dissipate the queue as quickly as possible and return to normal operations. If a queue is detected by Sensor 2 and there is no train crossing Barlow Trail, the controller will go to a clearance mode. In clearance mode, extended green time is given to southbound Barlow Trail traffic, while providing minimum times to other movements, until the length of queue is less than 350 m. Under normal operation during the morning peak period the southbound through movement is given a maximum of 70 seconds of green per cycle. The initial implementation of the clearance mode will extend the southbound green cycle by up to 20 additional seconds. The additional green cycle time may be adjusted based on field observations to maximize effectiveness.

Signing: To alert motorists in the vicinity of the rail crossing of potential delays, five PCMS were deployed on surrounding roadways, as illustrated in Figure 1. The signs can display 3 lines of 8 characters with a character height of 18”. The signs have two basic modes of operation for purposes of the system. In default mode, the signs can provide either a generic message, such as “Drive Safely” or be left blank. When a back-up is detected due to the presence of a train, the signs go to active mode and will display an advisory message to drivers. The display message is fully programmable on-site or remotely (modem required) and was initially set as a two phase message with the message “Barlow Tr Rail Crossing / Blocked Use Alt Route.” To promote awareness of the active messages, during the initial deployment the default message will be a blank sign. Using a cellular modem for remote access, the default message on the sign can be updated at any time or an override message posted for special conditions.

Communications: A combination of communication methods was used on the project to reduce cost and maintain flexibility of the system. Signals from the rail crossing and Sensor 1 were hardwired back to the controller. Sensor 2 would have required more than 350 metres of trenching, conduit and cabling, so wireless communication was used instead. The PCMS are located up to three kilometres from the controller location. Wireless communication is used to switch each PCMS between default and active mode, as triggered by the traffic signal controller. The signs are positioned in a developed industrial area, so to ensure reliable wireless communication to the signs each antenna is mounted at the top of a retractable mast with a maximum height of approximately 10 metres. The RF communication antenna can be raised to the full height of the mast thereby clearing most possible obstructions to the communication path. At the intersection, the antenna is located on a 13 metre high camera pole. The PCMS can also be accessed via a cellular modem to remotely update sign messages if necessary.

**Deployment and Operation**

Prior to deployment of the advisory system, a large amount of data with respect to rail crossing blockages, length of vehicle queues that develop as a result and times that it takes queues to dissipate once the crossing has been cleared was collected. Similar data collection will occur after the system is operating effectively to determine what impact the system is having upon queue dissipation. The actual measures of effectiveness are yet to be determined, but may include the change in traffic volume that enters the upstream link when the sign are activated which that could indicate that motorists are choosing to use alternate routes.

**Summary and Conclusion**

As traffic volumes continue to increase, in many locations the existing transportation infrastructure has reached its limits to deal with the traffic demands. The result of excess demand is increased user delay and increased crash risk as slowed and stopped traffic conditions occur on high speed roadways. Building new infrastructure to accommodate the excess demand is not always feasible due to technical or economical restrictions. ITS solutions offer an alternative to manage traffic flows and increase safety without the need for a large infrastructure investment.

The City of Calgary has experienced a long period of sustained economic and population growth resulting in increased traffic demand. Increased traffic coupled with road blockages at an at-grade rail crossing on Barlow Trail near 50$^{th}$ Avenue SE created long traffic queues resulting in user delay and stopped traffic occurring on the Deerfoot Trail freeway. The use of ITS at this site has provided motorists with advanced warning of delay conditions and better traffic management by diverting traffic around the congested area and more efficiently servicing traffic queues formed as a result of train crossings.

**References**


1. U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2001*, Publication No. FHWA-PL-02-020 Washington D.C., 2001.
2. Shrank, D.L., Lomax, T.J., *The 2001 Urban Mobility Report,* Texas Transportation Institute, May 2001.
3. DELCAN Corporation, Consultant's Report for a Queue Detection and Driver Advisory System at Barlow Trail and 50th Avenue SE, unpublished, February 2004.

## Figures

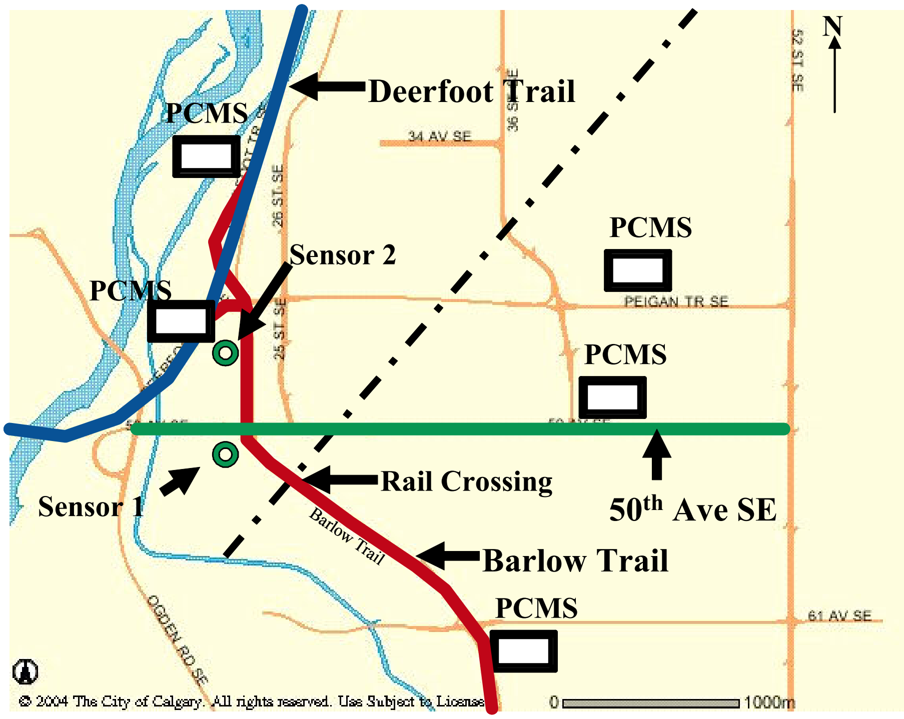


**Figure 1: Site layout of rail crossing traffic system at Barlow Trail and 50th Ave. SE**

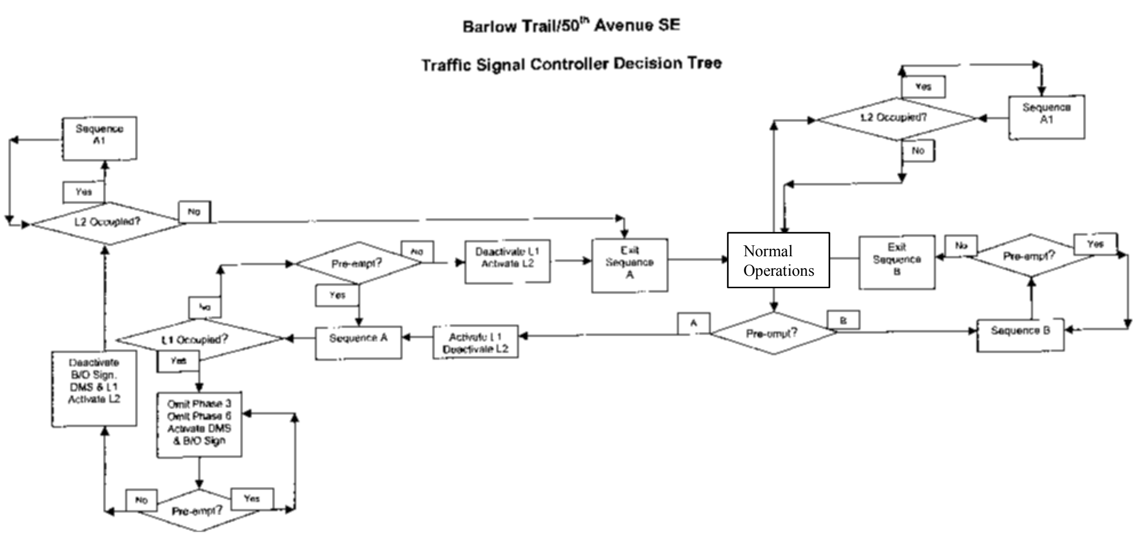


**Figure 2: Logic diagram for operation of Barlow Trail and 50th Ave. SE traffic system**