

**Vancouver 2010 Olympic and Paralympic Winter Games
BC MoT Traffic Management**

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ABSTRACT

The BC Ministry of Transportation and Infrastructure (BCMoT) was a major partner to VANOC in the delivery of the 2010 Olympic and Paralympic Winter Games. Under its mandate, BCMoT was the lead agency responsible for traffic management, highway maintenance and incident management at the two major bridge crossings over Burrard inlet and the Sea-to-Sky Highway (Highway 99) from West Vancouver to Whistler, contingency planning for highway routes critical to the Games, and Taxi policies and legislation.

Traffic volumes during Games-time were modelled conservatively to exceed normal patterns by approximately 10% at the two Burrard crossings and 100% on the Sea-to-Sky Highway.

A key principle of games-time operations was to make use of BCMoT's existing infrastructure and operational practices and thereby avoid significant expenditure on Games-specific works, while at the same time meet the projected traffic demand and the capacity commitments made by BC MoT in the Games bid book. As a result, Games-time interventions deployed on Highway 99 and the bridge approaches were mostly limited to operational measures for providing temporary additional traffic capacity and reliability. These included:

- lane reconfiguration, counter-flows and Olympic queue jump lanes;
- temporary road lane on active rail tracks;
- Traffic control persons to manage congestion at strategic locations;
- Site specific traffic management, e.g. temporary intersection reconfiguration to increase capacity;
- Implementation of a Vehicle Checkpoint on the Sea-to-Sky Highway approaching Whistler;
- Traffic Information Systems (traffic monitoring cameras and variable messaging signage); and
- Enhanced incident management and highway maintenance to maintain highway capacity.

The traffic management strategies developed by BCMoT for the Games were innovative not in technology, but conversely in the simplicity of the measures undertaken in order to provide short-term capacity improvements while minimizing cost. These games-time transportation measures were concluded successfully with safe and reliable travel maintained throughout the games period. As a testament to this success, the MoT Olympic Transportation team was selected as a finalist for the 2011 BC Premier's Awards in the Partnership Category.

This paper presents an overview of the measures undertaken, the challenges faced in organizing and implementing these measures, and the outcome and lessons learned.

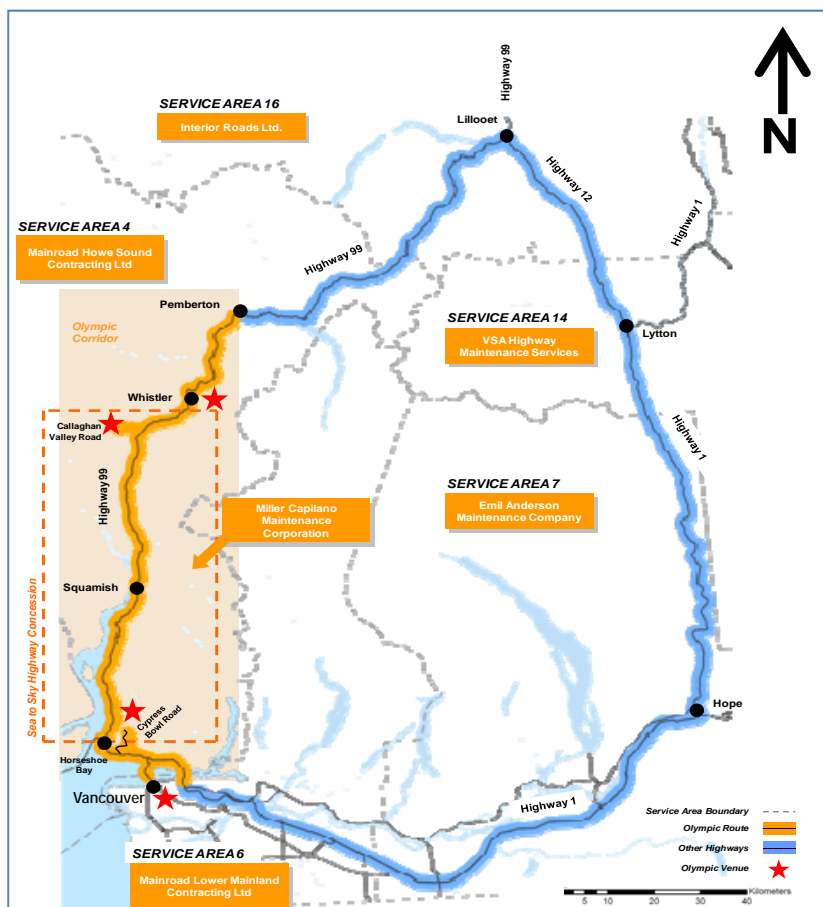
1.0 TRANSPORTATION NETWORK

The BCMoT highway and road network that was considered strategic to the Games is shown in *Figure 1* below. The network was generally divided into two categories:

- Primary Olympic Network – roads that were critical and would definitely be utilized for Games operations. These included Highway 1 west of the 1st Avenue Interchange; Highway 99 north of the Vancouver downtown core to Pemberton; Cypress Bowl Road to the Cypress venues; and Callaghan Valley Road to the Whistler Olympic Park.
- Secondary Olympic Network – Alternate Routes (Contingency Roads). These included Highway 1 and Highway 12 east of 1st Avenue and Highway 99 north of Pemberton, collectively forming an alternative route to Whistler from the north and east.

The key challenge for BCMoT was to ensure travel-time reliability for the Games, particularly since the Highway 99 corridor from Vancouver to Whistler was the only realistic road option for the transport of Olympic athletes, officials and spectators. It was imperative therefore that this corridor would remain open at all times and provide sufficient capacity to meet projected Games-related transport demands.

Figure 1: Strategic Road Network



2.0 MANAGEMENT AND COMMUNICATIONS

The BCMoT management structure implemented for the Games comprised two key components:

Olympic Transportation Planning Phase

This phase entailed pre-games strategic planning and development of the BCMoT operational plans over a period of approximately 2 years

During this period, BCMoT and its consulting team (*see Section 7.0 Acknowledgements*) performed extensive travel demand forecasting and developed simulation models for the Burrard Bridges, Sea-to-Sky Highway and Whistler (See [Figure 2](#)) in order to come up with strategies for improving capacity and travel-time reliability.

Figure 2: Travel Model Simulations



Games-Time Operations

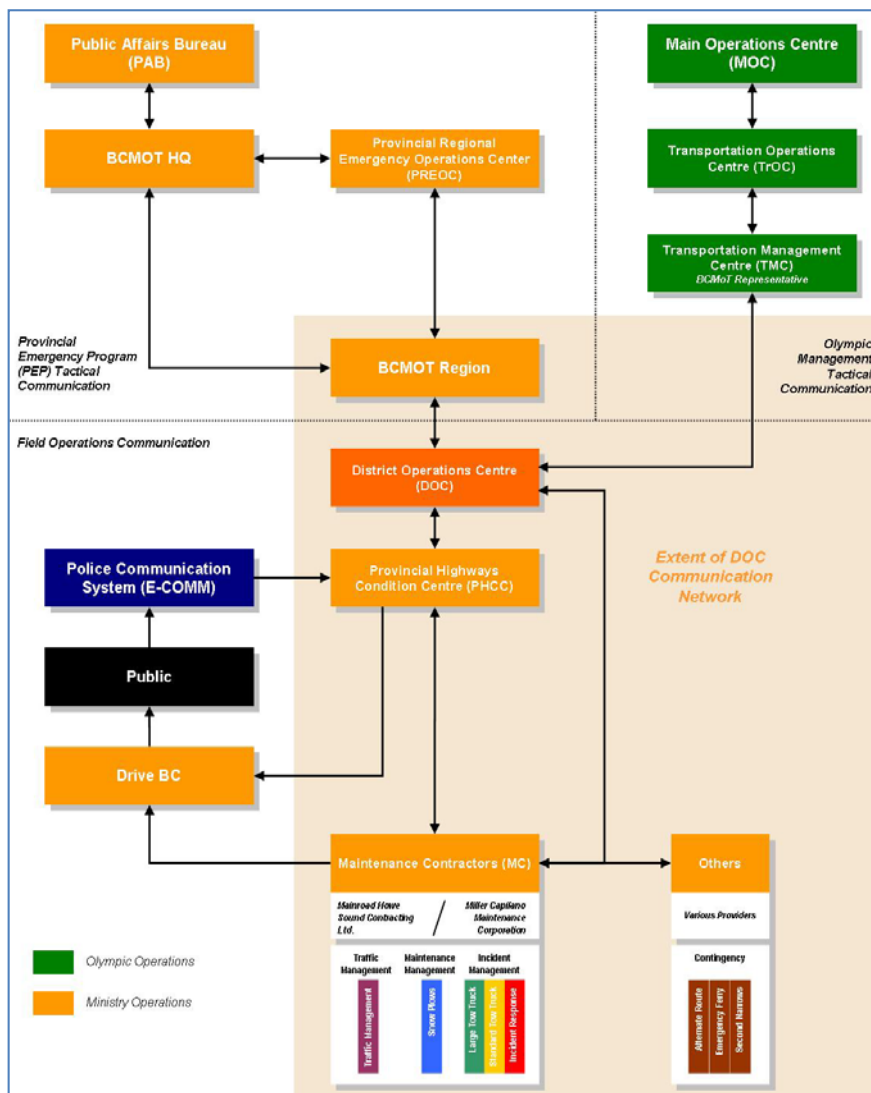
The management and reporting structure implemented for the Games period is shown in [Figure 3](#) below. Of note, the key principle was to maintain to the extent possible the existing infrastructure and practices that BCMoT used in normal non-Games highway operations. Games-time operations was managed and monitored by the District Operations Centre (DOC), which is an existing BCMoT department that deals with day-to-day highway field operations. DOC provided the central Games-time highway operations liaison to two Games-specific organizational groups:

- The Transportation Management Centre (TMC) established at the VANOC facility, in which BCMoT provided 24/7 representation together with the other agencies, and which provided tactical communication between DOC and the VANOC Transportation Operations Centre (TrOC) and Main Operations Centre (MOC) on highway operations-related matters.
- The Ministry Regional Operations Centre (MROC) established at BCMoT Region to provide liaison between DOC and the other BCMoT operational, regional and executive departments.

The transition from transportation planning to Games-time operation was seamless, largely because the key BCMoT individuals as well as operations contractors responsible for the Games-time operations actively participated during the planning phase, and were not presented with any surprises at the conclusion of planning and commencement of operations. As well, including the operations contractors early on enabled development of practical and achievable operations plans.

From the BCMoT perspective the TMC was a very effective communication and information resource for both internal BCMoT operations - maintenance, incident management, conditions monitoring - as well as interaction with other ground transportation agencies. Co-location with TrOC worked very well as the TrOC membership included ground transportation operations as well as a security component allowing for coordination of incident response. Access to other agencies operations information proved invaluable, particularly as it related to the overwhelming response to the TDM initiative and the use of public transit.

Figure 3: BCMOT Games-Time Operations Management Structure



3.0 TRAFFIC MANAGEMENT

3.1 Overview

BCMoT was the responsible agency for providing Games-specific traffic management on the provincial highways directly associated with the Games theatre. Traffic management services included lane operations at the Burrard Crossings, Sea-to-Sky Highway and in Whistler (see *Figure 4*), a vehicle checkpoint at Alice Lake north of Squamish and traffic information systems throughout the corridor.

A key objective in providing these services was to minimize new Games-specific construction by leveraging off and enhancing existing BCMoT assets to meet the projected traffic capacity needs and the commitments made by BCMoT in the Games bid book.

3.2 Lane Operations at the Burrard Crossings

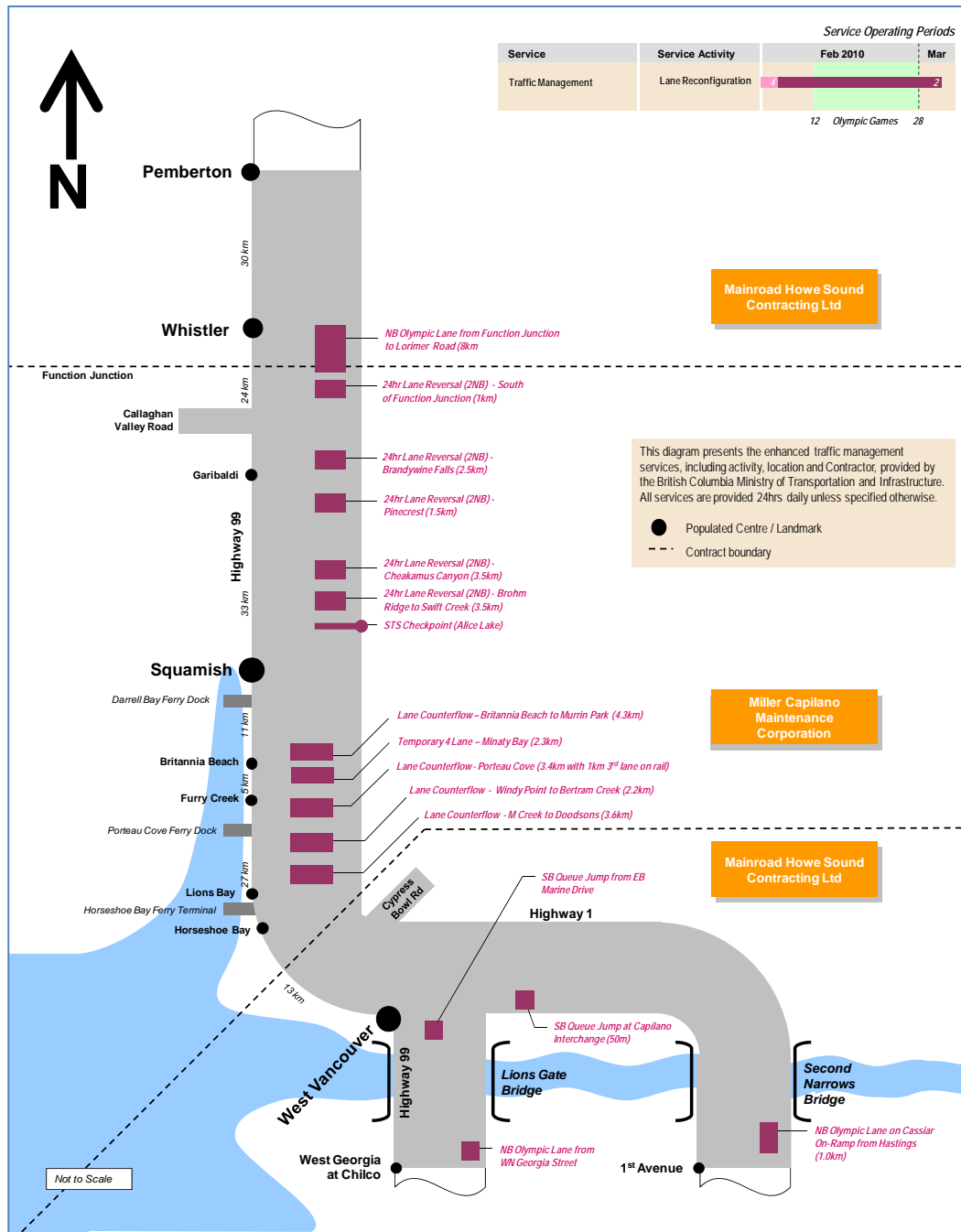
Iron Workers Memorial Second Narrows Bridge and Approaches

- Reconfiguration of existing roadway width to provide a temporary Olympic queue jump lane for buses and Olympic vehicles.
- Installation of emergency median barrier gates at each end of the bridge to allow dual directional travel on one side of the bridge in the event that partial bridge closure (one directional side) occurred.
- Planned emergency ramp metering of general traffic at the McGill onramp to provide another queue jump opportunity for Olympic vehicles should there be major traffic congestion.
- Traffic control personnel stationed at McGill onramp to facilitate the above, and to provide emergency back-up to implement plan for the emergency median barrier gates if required.

Lions Gate Bridge and Approaches

- Reconfiguration of existing roadway width and intersection to provide an Olympic queue jump lane at the Hwy 1 EB off-ramp onto Capilano Rd. - the route used by media and specific Olympic clients to access Lions Gate Bridge into downtown Vancouver.
- Conversion of an existing HOV 6+ lane into an Olympic Lane to access the Lions Gate Bridge going southbound into downtown Vancouver.
- Conversion of an existing HOV lane northbound on W. Georgia to access the Lions Gate Bridge to go to the Mountain venues.
- Reconfiguration of a critical intersection at Marine Dr and Taylor Way to provide westbound free-right movement for vehicles (key Olympic clients' route) originating from downtown and heading north through the Taylor Way corridor.
- Traffic control personnel stationed at the Hwy 1/Taylor Way interchange to facilitate traffic congestion through 2 tightly spaced traffic signals.

Figure 4: Traffic Management



During the Games period, these temporary interventions functioned as planned, with no incidents or Games-related congestion reported. The temporary emergency gates on the Ironworkers Memorial Bridge were never actuated and the stand-by traffic control personnel did not need to be mobilized for traffic control. Having traffic control personnel at key busy locations such as Taylor Way helped in efficiency of traffic flows during peak periods.

In general, bridge and bridge approach operations performed better than planned for as the TDM messaging worked in encouraging less vehicular traffic on the bridges, per below.

Traffic Volumes

Traffic volumes at this time of year on the Lions Gate Bridge and Ironworkers Memorial Bridge are on average approx. 31,000 and 62,000 vehicles/day in each direction respectively (2009 figures).

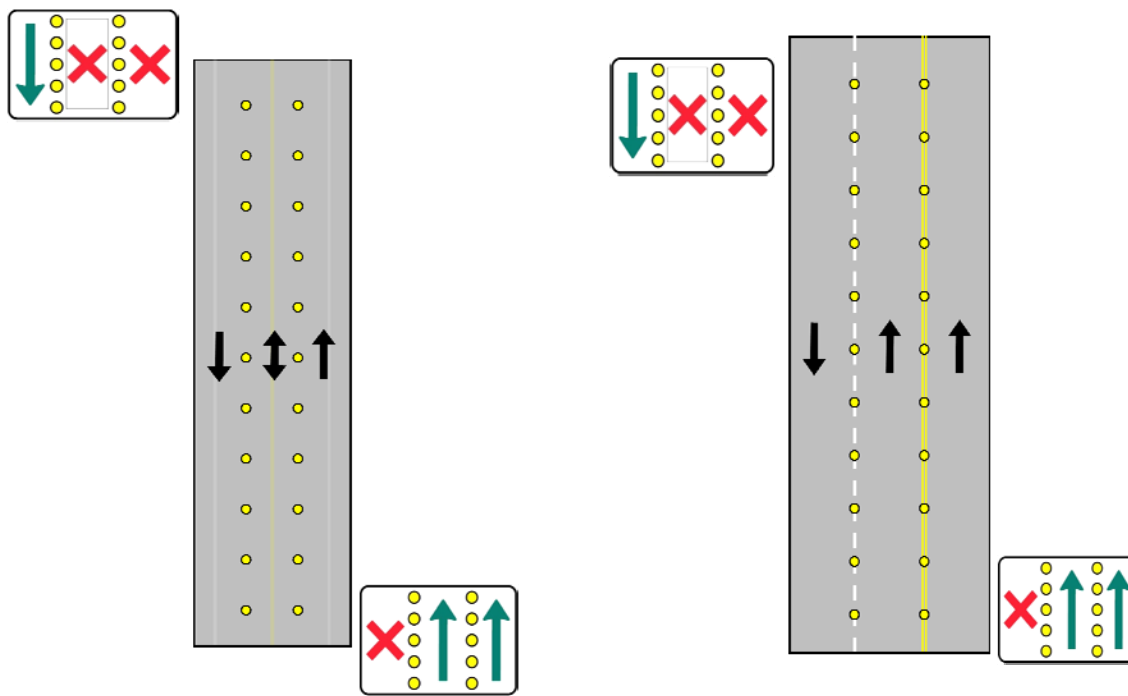
In preparation for the Games, BCMoT in collaboration with VANOC undertook a traffic modelling analysis to predict conservative traffic volumes with which to develop the traffic management plans. Based on this analysis, BCMoT allowed for an average of 35,000 and 65,000 vehicles per day in each direction respectively, with peak hour volumes generally consistent with existing traffic patterns.

The actual volume encountered on the bridges were in actuality approx. 27,000 and 55,000 vehicles per day in each direction respectively, which is approx 12% lower than a comparable period in a non-Olympic year at both bridges, 23% lower than the Lions Gate planning estimate and 15% lower than the planning estimate for Ironworkers. These reductions can be directly attributed to the successful Games-time TDM initiative.

3.3 Lane Operations On the Sea-to-Sky Highway

Lane operations on the Sea-to-Sky Highway comprised of a series of 3-lane counterflow sections south of Squamish and 24-Hr centre lane reversals north of Squamish (See *Figure 5*). Various strategies were considered in the months leading up to the Games to provide the additional NB and SB peak flow capacities using the existing pavement widths, including re-stripping of lane lines, moveable median barriers, free-standing delineator marker posts and fixed delineator marker posts (bolted to the pavement).

Figure 5: Using Existing 2-Lane Road for 3-lane Counterflow and 3-Lane Road for Lane Reversal



Lane Counterflows

After a thorough examination of the options, including two test programs to assess the efficacy of delineator posts under anticipated Games conditions (winter weather, higher ratio of large vehicles, delineator response to vehicle impact, etc.) and also considering that a majority of the highway has recently completed new pavement, it was determined that the most optimal solution for providing lane separation for the lane counterflows/reversals was the use of the fixed delineator marker posts. It was believed that this would provide the required high visibility lane separation required and would withstand snow clearing operations while avoiding the need for applying temporary paint which would then require eradication on the new pavement. Over 5,000 marker posts were installed along the corridor at various locations (see *Figure 6*). These marker posts were supplemented by roadside signage that provided drivers with information regarding the direction of each travel lane and drivers were guided into the appropriate lanes with standard traffic control barrels.



Figure 6: Fixed delineator marker posts and directional signage for lane counterflows

Installation of the marker posts and signage commenced approximately 3 weeks prior to Games opening day and were removed within 3 days of the closing day of the Olympic Games. The Sea-to-Sky Highway operated as normal for the Paralympic Games.

Overall, the counterflows and lane reversals operated as intended and provided the additional capacity as committed in the bid book. Switching direction of the centre lane south of Squamish twice a day took approximately 30 minutes on average, during which the centre lane was unavailable to traffic. These switches were timed for early morning and early afternoon when traffic volumes were lowest. At no time during the Games did the lane switching cause traffic delay. More importantly the delineators proved to be highly effective in separating traffic, to the extent that not a single vehicle incident occurred during the Games period which resulted in a lane closure.

3rd Lane on Rail

Within an 800 m stretch at Porteau Cove, geographic constraints prevented the addition of a temporary third road lane for counterflow and the third lane was accommodated on the adjacent rail track as a dual-use road/rail facility during the Olympic Games (see *Figure 7*). The 3rd lane was used only for southbound traffic and was temporarily shut down to traffic to allow passage of the daily Whistler Mountaineer passenger train and a CN freight train (see *Figure 8*). Average shut down duration was 15-20 minutes and due to the availability of a second SB lane in the afternoon periods, there was not one instance of a traffic delay to Games-related traffic resulting from this operation.



Figure 7: 3rd lane on CN rail bed at Porteau to provide additional southbound capacity



Figure 8: 3rd lane on rail bed at Porteau closed temporarily to allow passage of train

Traffic Volumes

Traffic volumes at this time of year along the Sea-to-Sky Highway north of Squamish average approx. 4,500 vehicles/day in each direction (2008 figures). In preparation for the Games, BCMoT in

collaboration with VANOC undertook a traffic modelling analysis to predict conservative traffic volumes with which to develop the traffic management plans. Based on this analysis, BCMoT allowed for an average of 9,300 vehicles per day in each direction, with peak hour volumes correlated to games event schedules for load-in and load-out of spectator busses.

3.4 Lane Operations on Highway 99 in Whistler

Highway 99 (Sea-to-Sky) through Whistler is predominantly two lanes with narrow shoulders and virtually no parallel road network or neighbourhood connectivity adjacent to the highway. Most neighbourhoods are fully reliant on the highway and the area has multiple intersection points to the main village area, which was expected to contribute significantly to volumes during the Olympics.

Widening of the highway to 3-lanes strictly for the Games was not justifiable from a long-term traffic planning perspective, and instead a planned widening of an 8-km section of the highway to provide an improved 2-lane facility with adequate shoulders was undertaken to coincide with the Games schedule. The improved cross-section was then temporarily modified to provide temporary 3-lanes, including a NB Olympic Lane (see *Figure 9*). The temporary 3-lanes was implemented with the use of fixed delineation, pavement markings, CMS boards, various signage and manual traffic control at key intersections during peak periods. Owing to the winter conditions, the modifications were accomplished in a staged progression so that line painting could be done late fall, prior to the first arrival of snow

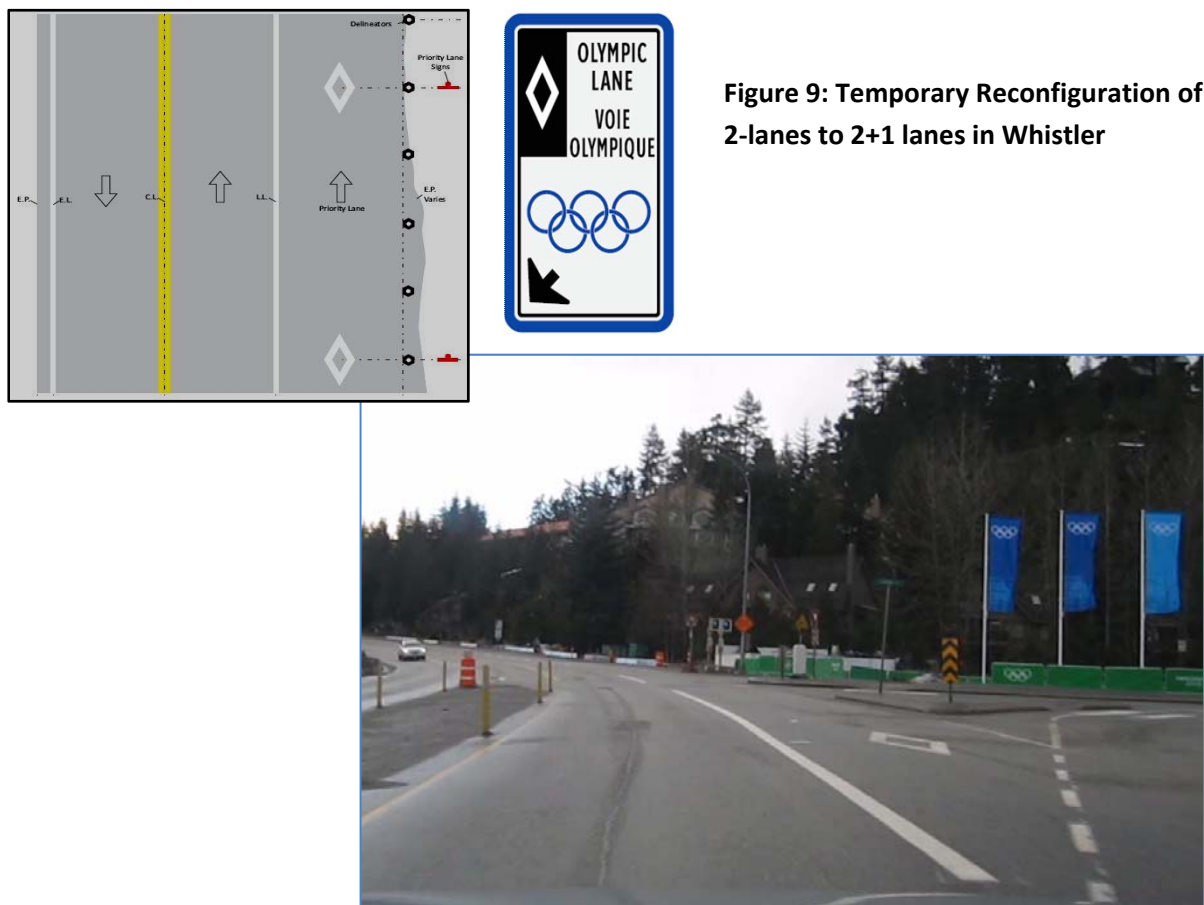


Figure 9: Temporary Reconfiguration of 2-lanes to 2+1 lanes in Whistler

While the Whistler Olympic lane provided the travel time reliability needed for authorized Olympic vehicles, including trucks and buses, there were some inherent constraints. One of which being the decreased shoulder width available for emergency refuge, especially southbound, which was addressed by an Incident Response Plan and deployment of Incident response Units (IRU's) if and when required. Ideally, more available width would have been beneficial but that was not possible with the physical constraints (rock outcroppings and significant urban build up) on site.

In one instance, additional widening of the highway was necessary adjacent to the downhill ski venue to accommodate spectator bus bays (see [Figure 10](#)).



Figure 10: Widening of Highway 99 NB to accommodate bus zones for Olympic spectators

3.5 Sea-to-Sky Permit Checkpoint

As a measure to limit the number of vehicles without secured parking in Whistler during the Games, a northbound “Checkpoint” was implemented on the Sea-to-Sky Highway at Alice Lake, north of Squamish. Motorists were required to display a valid permit in order to proceed north of the Checkpoint between 6:00 am and 6:00 pm. The site was selected for the following reasons:

- Availability of 2 northbound lanes
- Good sightlines for traffic approaching from both directions
- Availability of a turnaround area (reject route)
- Undivided highway with adequate shoulders, convenient for temporary lane modification
- No by-pass route available for northbound travelers.

The Checkpoint was established and operational on February 11, 2010, one day before the Olympic Games opening ceremony and shut down on the last day, February 28, 2010. It did not operate for the Paralympic Games.

The operations concept was established based on a traffic modelling analysis that predicted the daily and hourly vehicle volumes arriving at the Checkpoint, by classification (permitted/non-permitted).

Traffic approaching the Checkpoint from the south used two available 2 NB lanes, with no prior separation of permit-holders (see [Figure 11](#)). Traffic control personnel were stationed on the roadway to check that vehicles meet either one of 3 conditions:

- Valid Permit displayed in windscreen
- No visible permit, but easily identifiable as permit exempt
- No visible permit and not easily identifiable as permit exempt.

The first two groups were waved through at slow speed; the third group were moved into the NB shoulder lane and directed off the highway into a turnaround loop (the “reject route”).

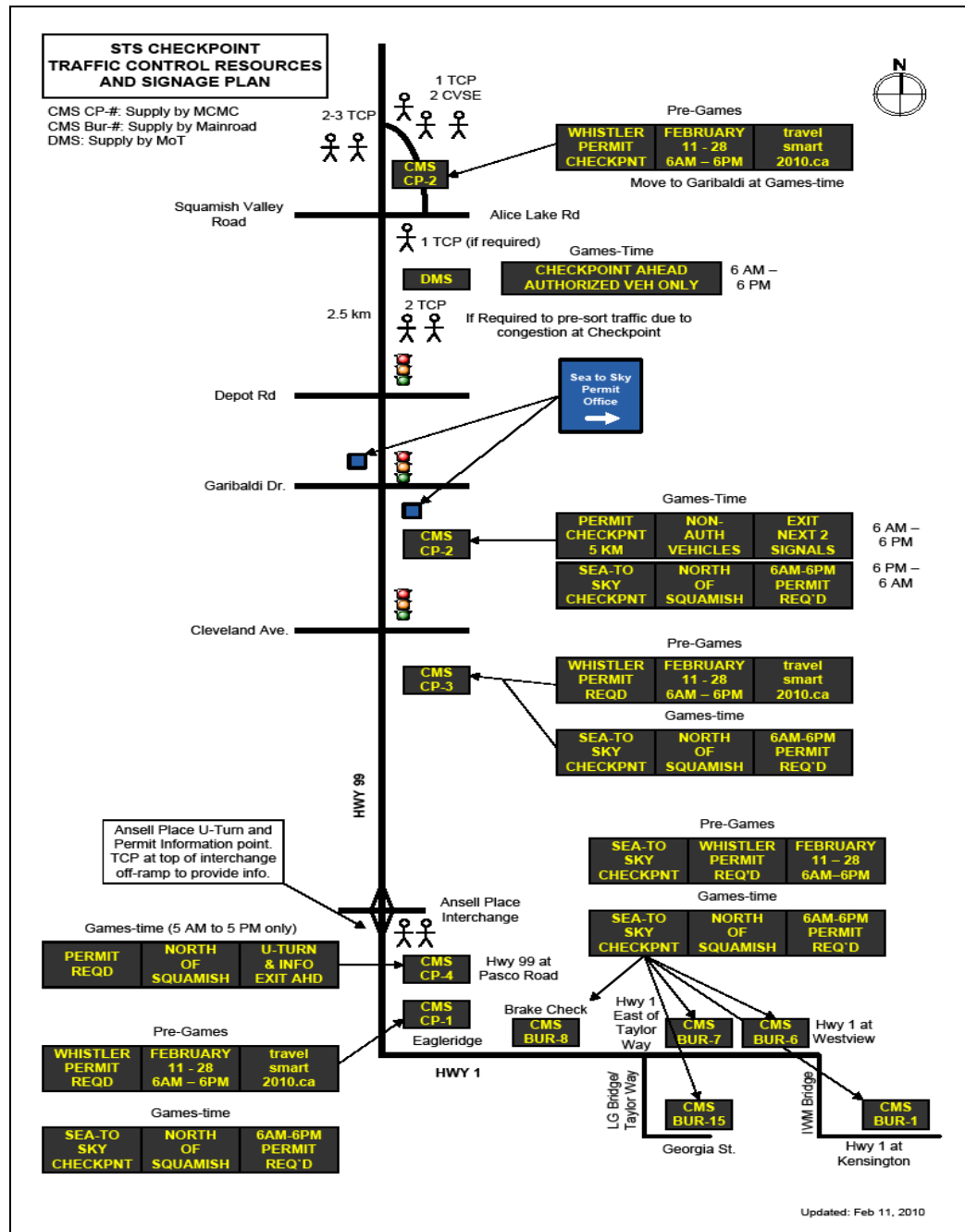
Commercial Vehicle and Safety Enforcement (CVSE) officers stationed in the turnaround loop processed vehicles to enforce either a return southbound on Hwy 99, or in rare instances allowed them to re-enter the NB lanes at the Alice Lake intersection and proceed through the checkpoint unimpeded. The CVSE officers issued small ‘tear-off’ maps showing the location of a permit centre office in Squamish for those drivers wishing and qualified to obtain a permit.



Figure 11: Sea-to-Sky Permit Checkpoint

Advance signage was placed through the STS corridor alerting drivers of the checkpoint. Travelers were advised that if they did not have a valid permit they should exit off the highway prior to Alice Lake (see [Figure 12](#)).

Figure 12: Checkpoint Traffic Control and Signage



The infrastructure and resources placed at the Checkpoint were established to handle the following:

- 6:00 AM to 6 PM Vehicle volume: 5,000 – 6,000 vehicles (based on 70% TDM uptake)
- Peak Hour (est. 8:00 am): 800 vehicles
- Projected Daily Reject Volume: 400-500 vehicles
- Peak Hour Reject Volume: 50 – 100 vehicles

Actual data from the Checkpoint during the Games period was as follows:

- 6:00 AM to 6 PM NB Volume: 3,500 vehicles (average over From Feb 11 to Feb 28)
- Average Peak Hour NB Volume: 450 vehicles (average from Feb 11 to Feb 28)
- Highest Peak Hour NB Volume: 555 vehicles (Friday Feb 19th, 8:00 am to 9:00 am)
- Average Daily Reject Volume: 60 vehicles (average over From Feb 11 to Feb 27)
- Highest Reject Volume: 130 vehicles (Saturday, Feb 20th).

It is clear that the Checkpoint experienced significantly less volumes than what BCMoT was prepared to handle. The Checkpoint acted as a significant suppressor of passenger vehicle traffic volumes, to the extent that the counterflow lanes on the Sea-to-Sky operated well below capacity.

3.6 Traffic Information Systems

Traffic information systems deployed by BCMoT for the Games are shown in *Figure 13*. The systems comprised of:

Drive BC Cameras

Existing permanent, publically accessible, low-resolution fixed cameras on the two bridges, bridge approaches and on the Sea-to-Sky Highway.

Lions Gate Bridge Advanced Traveller Information System (ATIS)

An automated system on Highway 1 for eastbound traffic approaching the Taylor Way off-ramp to Lions Gate Bridge system that incorporates overhead changeable message signs and a live-updated website showing webcam images and lane and congestion information to assist drivers plan effective routes or times for travel.

Dynamic Messaging

5 existing overhead changeable message signs primarily used to communicate road and weather conditions (one of these message signs forms part of the Lions Gate ATIS).

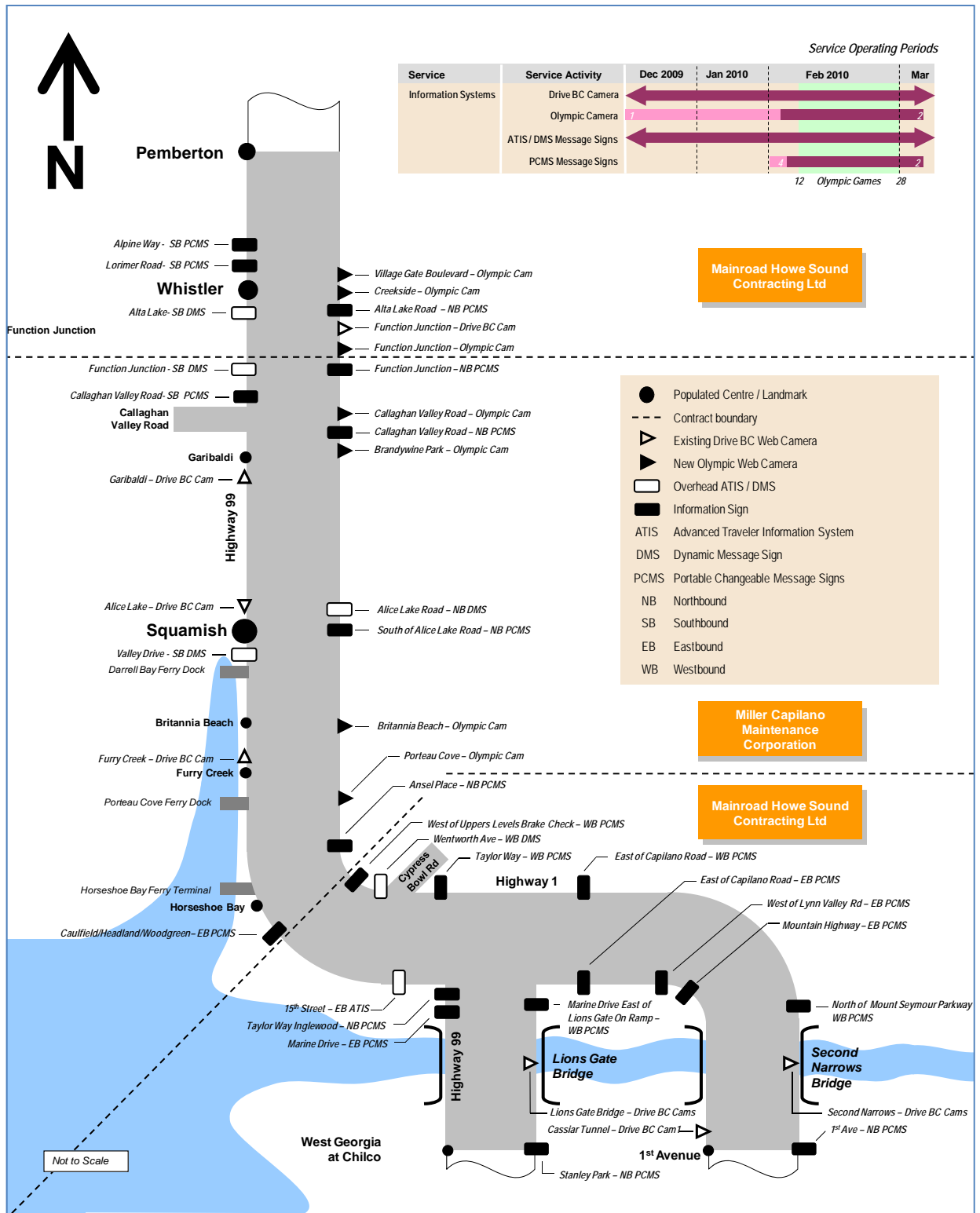
Olympic and Paralympic Games Cameras

High-resolution cameras, some with streaming video capability. Four cameras were located on the Sea-to-Sky Highway south of Whistler and 3 cameras in Whistler at Function Junction, Creekside and Village Gate. The cameras were removed after conclusion of the Paralympic Games.

Portable Changeable Message Signs

BCMoT installed 38 portable CMS signs specifically for the Games at the bridge approaches, Highway 1 and Highway 99 from Vancouver to Whistler. These portable message boards were used to communicate traffic pattern changes, public messaging regarding the TravelSmart program and Checkpoint location and timing. Emergency messaging for potential road congestion and incidents were also pre-programmed on some of the boards at key locations.

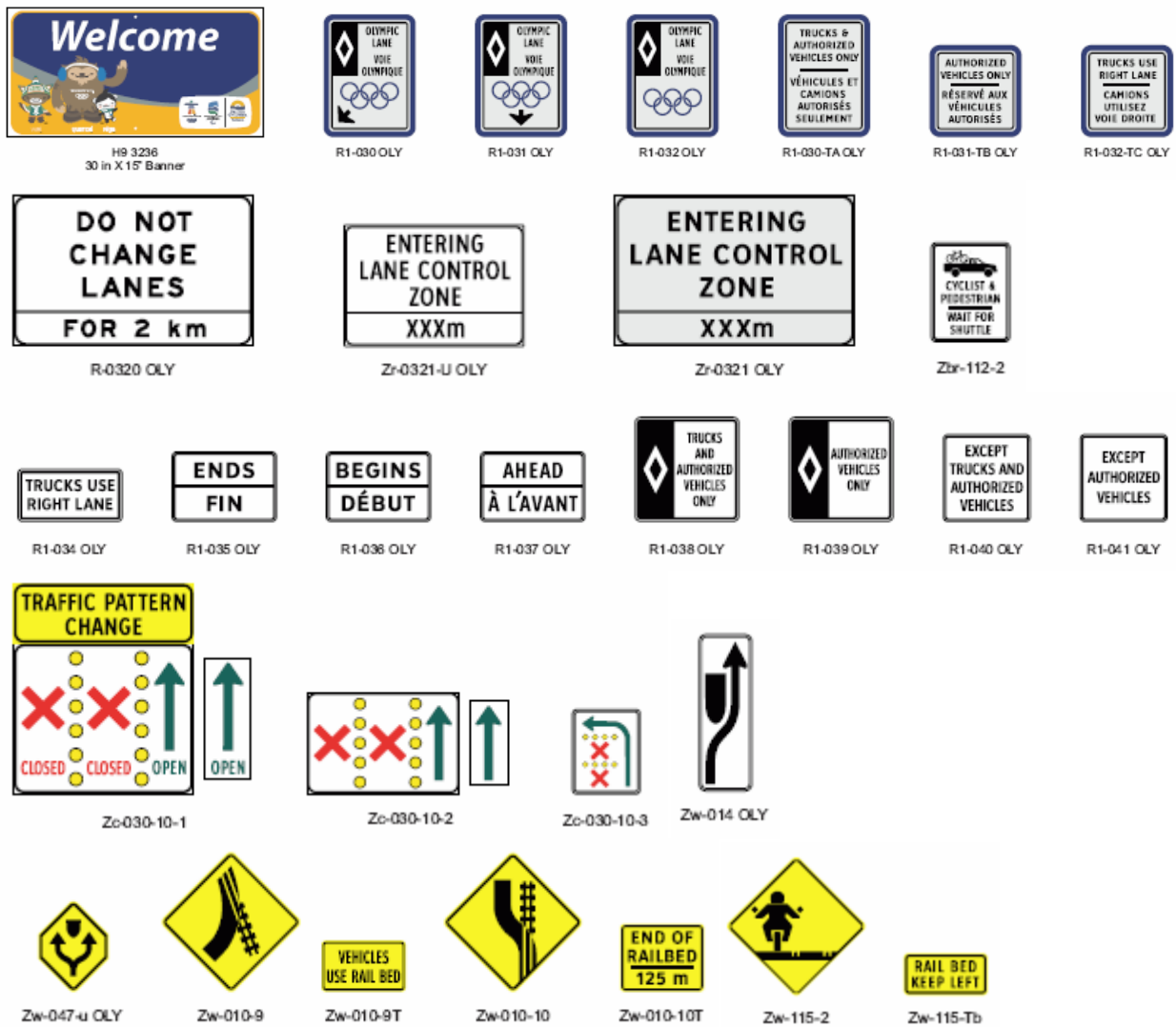
Figure 13: Traffic Information Systems



3.7 Traffic Control Signage

BC MoT developed a number of special roadside signage to accommodate the unusual nature of traffic interventions required for the Olympic Games. This included signage for the Olympic lane in Whistler and at the Burrard Bridges, lane counterflows on the Sea-to-Sky Highway, and operation of the 3rd lane on rail at Porteau. *Figure 14* below provides a sampling of the special signage.

Figure 14: BC MoT Special Signage



4.0 HIGHWAY MAINTENANCE MANAGEMENT

For the Games period, BC MoT amended existing contracts with its highway maintenance contractors to provide the following enhanced road maintenance services:

- Additional snow removal equipment (snow plows) to meet Games-specific specifications for snow clearance and snow accumulation
- Staging and extended hours of snow removal equipment for rapid response
- Provision of additional stockpile of winter materials, i.e. salt and sand.

Unusually warm and dry weather conditions during the games period did not overly tax maintenance operations for the most part. Materials usage - both sand and salt - did not exceed normal February/March quantities due to the milder than average temperatures and precipitation levels.

5.0 HIGHWAY INCIDENT MANAGEMENT

For the Games period, BC MoT developed detailed incident response procedures for a range of incidents and placed enhanced resources (Incident Response Units (IRU) and tow trucks) at key locations based upon reasonable response times. These resources were acquired through existing contracts with its highway maintenance contractors.

5.1 Incident Response Units

These rapid deployment units were very effective in terms of reacting to motor vehicle incidents and establishing traffic control measures in an expeditious manner. Road capacity and dependability were maintained throughout the games period and police personnel were able to focus their resources on incident investigation rather than traffic control of minor clean up.

The IRUs were used frequently in the patrolling and any small issues that needed to be addressed on the road immediately. Their presence was a huge part of the smooth operations along the BC MoT highways and delineated areas during the Games.

5.2 Tow Trucks

Similar to deployment of the IRUs, the pre-positioning of both light vehicle and heavy commercial vehicle tow truck units provided rapid response to vehicle removal. The role of these units was to clear the road as soon as practical due either to stalls or motor vehicle incidents (as opposed to recovery and relocation to a distant location) and their goal of ensuring road capacity and dependability was achieved. Trucks were located at the Burrard Crossings and along the STS corridor, with the ability to also respond to Callaghan Valley Road and Cypress Mountain Road.

6.0 CONTINGENCY PLANNING

BCMoT developed a number of existing contingency plans for Highway 99 in the event the highway became unavailable due to an incident or emergency situations. These plans included:

- Alternate Route to Whistler via the Duffey Lake Road;
- Emergency Ferry Operations; and
- Emergency Gates at the Ironworkers Memorial Second Narrows Bridge.

BCMoT transportation operations during the Olympic and Paralympic Games were accomplished without major incident and the three above noted emergency plans were not activated.

7.0 CONCLUDING REMARKS

The 2010 Olympic and Paralympic Transportation Team (OPTT) was established In February 2008 as a platform for cooperation and engagement between VANOC and the regional transportation partners faced with a challenge to design, create and manage transportation systems for the 2010 Games.

The OPTT's Olympic Transportation Plan focussed on the following goals:

- Ensure safe, reliable, accessible travel during the 2010 Winter Games
- Make the best use of the existing transportation networks
- Reduce vehicle traffic during the Games
- Create legacies of sustainable transportation choices

BCMoT was an integral part of the OPTT and worked closely with the partner agencies to develop these goals and use these as guiding principles in the delivery of its transportation plans as outlined in this paper.

Recalling that the theme of this paper is to demonstrate innovative methods to improve traffic flow in congested areas, the traffic management strategies developed by BCMoT for the Games were innovative not in technology, but conversely in the simplicity of the measures undertaken in order to provide short-term capacity improvements while minimizing cost. In particular the BCMoT team:

- Avoided expensive capacity improvements at the Burrard bridges by utilizing existing HOV and bus facilities to provide Olympic queue jumps, while maintaining accessible travel for Olympic and non-Olympic travellers;
- Reconfigured the new Sea-to-Sky highway using operational interventions to meet the temporary demand, while maintaining safe and reliable travel;
- Capitalized the legacy improvements of shoulder widening of Highway 99 for bicycles and pedestrians through Whistler by transforming it into a temporary third Olympic lane in February 2010; and
- Designed a checkpoint on the Sea-to-Sky Highway to filter out traffic that has no parking in Whistler, to reduce vehicle traffic during the Games.

We hope that other transportation professionals can benefit from the knowledge gained and lessons learned from this Olympic experience.

Acknowledgements

The planning, design and implementation of the BCMoT Olympic transportation network and traffic management strategies involved many people from BC MoT, its consulting firms and construction and maintenance contractors. The key firms who provided services and from which the content for this paper was sourced include the following:

- **Bunt and Associates** – Preparation of strategic area plans and Olympic travel demand forecasts and modelling (Highway 99).
- **SNC-Lavalin Inc.** – Strategic planning and preliminary design for Sea-to-Sky Highway Olympic traffic management, lane operations and Permit Checkpoint.
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- **Peter Kiewit Sons** – Sea-to-Sky Highway Improvement Project design-build, including the 3rd lane on rail at Porteau.
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