A Comparison of Traffic Accommodation Guidelines in Alberta from a Practical Perspective

Jeffrey Lo, Designer EIT, MMM Group Limited
Bosco W. Tong, Senior Project Manager, MMM Group Limited

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Abstract

With a natural resource rich economy, Calgary's rapid growth has necessitated the construction of southeast quadrant of Stoney Trail, which will serve as the city's ring road once all four quadrants are completed. The portion of Stoney Trail being constructed will include 14 km of new freeway, 13 km of upgrades and expansions and the construction or upgrade of 9 interchanges.

Traffic Accommodation Strategies (TAS) temporarily divert traffic to accommodate construction activities, while ensuring worker and traveller safety. The need is most prevalent where the existing roadways cannot be closed for construction. While TAS's are essential for safety, the attention paid towards their development and execution is sometimes less than what is warraneted.

In an effort to streamline the process, various jurisdictions and organizations have published standards and recommendations for TAS design and implementation. While these publications are sometimes similar they can differ greatly from each other in certain critical areas. On the Southeast Stoney Trail (SEST) project, the differences have become an issue at times, such as where the standard in-force impractical to implement, or when the TAS covers two different jurisdictions that employ significantly different standards.

This paper examines various standards and recommendations applicable to Alberta in order to analyse the similarities and discrepancies between them. A commentary on the SEST project is included to highlight any deficiencies in the published material. Finally, attempts are made to rationalize and streamline an approach in situations where conflicting standards are in-place. Potential legal issues with utilizing different standards are discussed.

1.0 Project Background

The City of Calgary (City) has been experiencing unprecedented growth over the past number of years. Already the largest city in Alberta, the population is expected to continue growing which will place additional strain on an already congested transportation network.

The issue is highly prevalent in the south east portion of Calgary which, in recent years, has been the site of many new residential, commercial and industrial developments. The area is primarily served by three major roadways. Deerfoot Trail is the city's main north-south freeway; Glenmore Trail provides an east-west link to the industrial areas of Ogden and Foothills; and Highway 22X serves as the main east-west link at the southern edge of the City. Due to geographical reasons, these three highly congested routes provide the only major river crossings that connect the area to the rest of the city.

To alleviate congestion, Alberta Transportation (AT), has begun the construction of Stoney Trail (aka Highway 201), which will serve as Calgary's first ring road. The roadway, once completed, will also provide a free flow bypass route for through traffic not destined for Calgary.

Stoney Trail is divided into four segments (northwest, northeast, southeast and southwest) of which the southwest portion is under negotiations and the northeast and northwest portions have already been completed. The section currently under construction is the southeast segment known as the Southeast Stoney Trail (SEST) project. This segment will extend the existing northeast portion of Stoney Trail, which terminates at 17 Avenue SE, south to Highway 22X. The roadway will then turn west and replace the existing Highway 22X from 88 Street SE through to the MacLeod Trail interchange (refer to Appendix A). The project includes 14 km of new freeway and 13 km of upgrades and expansions in addition to ongoing maintenance of a portion on Deerfoot Trail from Highway 22X through to the Highway 2A junction. Associated with the project, a total of 9 interchanges will be constructed or upgraded.

The construction of this roadway has been planned for a number of years by AT. As such, AT has reserved land as part of the Transportation and Utility Corridor (TUC) within which the SEST project will be built. While the TUC is contained within the city limits, the infrastructure within it falls under the jurisdiction of the respective departments of the Province of Alberta.

2.0 Project Genesis

A construction partnership of SNC-Lavalin Inc. and Acciona S.A., known as the Chinook Roads Partnership, was awarded the contract to design, build, maintain and partially finance the project. MMM Group Limited (MMM) was retained to assist in the development of the Traffic Accommodation Strategies (TAS) that would be required to accommodate traffic through the work areas while ensuring safety for both the workers and the travelling public.

The need for well-designed TAS's are essential to the success of this project. The east-west portion of Stoney Trail, which replaces Highway 22X, must be constructed with Highway 22X in service. Furthermore, works involves portions of Deerfoot Trail, which also must remain in

service. The TAS's are necessary to ensure that the work can be carried out safely while minimizing the disruption to traffic on these busy roadways.

During the TAS design process, MMM's designers have noted that the various established TAS standards and recommendations of different agencies are significantly different on a variety of issues. As a result, engineering judgement has been used to ensure that the designed TAS's comply with all applicable standards and are as safe and consistent throughout the site as practical.

This paper researches and examines the various published standards and recommendations applicable to Alberta, in order to identify and analyse the similarities and discrepancies between them, such as sign usage, spacing, taper lengths, delineation, lighting requirements, work area protection, etc. The standards are then compared with the practical experience gained on the SEST project to determine any deficiencies in the published material. As some TAS's used on the project cover multiple jurisdictions, a discussion of a practical approach to resolve differences between standards in-force is included in the paper.

3.0 Established TAS Standards and Applicability

In order to streamline the process of designing TAS's, general guidelines and standard drawings have been developed and published by various organizations. In addition different government departments often modify these guidelines and/or issue their own versions of the said documentation. In the United States, these standards are developed on a national level, under the *Manual of Uniform Control Devices*. In Canada, the Transportation Association of Canada (TAC) publishes recommendations as part of the Canadian version of the *Manual of Uniform Traffic Control Devices* (MUTCD) [1]. These recommendations usually form the design basis of the TAS.

On the SEST project, three different standards and recommendations are applicable and used. As AT is the project owner, their published *Manual of Traffic Accommodation in Work Zones* [2] is applicable to the project area. However, there are work activities which require traffic accommodation that stretches beyond the project area, in which case the City's *Temporary Traffic Control Manual 2011* [3] will apply. In addition the recommendations issued by TAC in the MUTCD were also considered; however these do not have a jurisdictional requirement.

4.0 Comparison of Standards

The above three standards applicable to the SEST project have been compared on a series of significant attributes. A table outlining the noted differences is given in Appendix B. While minor differences are common and expected between the standards, several major attributes that greatly affect the design of a TAS, are compared and discussed in further detail in section 5.0. These attributes include:

- Design Vehicle – The largest vehicle to be accommodated in the TAS design.

- Urban versus Rural Applications – The differences in standard designs for urban versus rural environments.

- Construction Area Advance Signage – Method by which drivers are warned of an upcoming construction area.

- Buffer Zones – Longitudinal area provided between the work area and end of travelled lane in the event of an errant vehicle.

- Clear Zones and Crash Barriers – Lateral buffer distance from the work area and the edge of nearest travel lane including the requirements for crash barriers.

- Delineation Spacing – Spacing of devices to delineate the permitted travel paths.

- Barricades Usage – Requirements for the usage of barricades.

- Signage Spacing – Spacing of signage though the TAS plan.

- Speed Limit Reductions – Methods by which the regular speed limit is reduced.

- Taper Lengths and Angles – Distances or angles over which a lane is closed or shifted.

- Illumination – Requirements for illumination within the TAS area.

- Pedestrian Accommodation – Requirements and standards for the accommodation of pedestrians.

5.0 Discussion of Significant Differences and Project Experience

While the TAS standards examined in section 4.0 are similar in purpose and concept, there were significant differences between each specification. While many of the differences are minor, such as the exact wording and symbols used on signage, the more major differences, such as taper lengths, are further discussed in detail including commentary based on the practical experience gained on the SEST project within the following subsections.

5.1 Design Vehicle

The design vehicle to be used is integral to the geometry of any roadway and its intersections. However, none of the three TAS standards researched provided guidance towards the selection of a design vehicle. Such an issue has been encountered on the SEST project on several occasions. The two primary roadways through the project area are major trucking routes where a WB-36 (Turnpike Double) design vehicle would be expected. Therefore turning movements were checked to ensure that the provided space is adequate. However, the cross streets serve primarily residential communities where such vehicles are rare, thus making the facilities to

accommodate these vehicles potentially wasteful for short-term traffic accommodation. This has therefore raised the question as to whether the design vehicle can be reduced for these streets and their associated turning movements from the main highway, in an effort to simplify the TAS and reduce cost where temporary pavement was necessary.

In addition to considering these vehicles in intersections, SEST experience has shown that thought must be given throughout the entire project area, as the sweep paths of larger trucks were often incompatible with the tapers provided by City and MUTCD specifications. Therefore, it has been necessary on multiple occasions to widen crossovers, lane shifts and intersections. However, caution must be exercised to ensure that lanes were not widened to an extent where there was the appearance of additional non-existent travel lane. To avoid confusion in such cases, the delineation was kept at a normal lane width, but with provisions made for the devices to be moved should such a vehicle arrive. Another method to prevent confusion is to move the flagger location farther from the intersection, where the sweep paths do not require significantly widened lanes.

5.2 Urban Versus Rural Applications

The MUTCD and City standards do not differentiate between urban and rural applications, which is a stark contrast to AT that provides different standards for rural, urban high speed high volume, and urban low speed low volume applications. Such a differentiation can be considered to be beneficial in a theoretical perspective. As urban and rural driving environments are vastly different, it is logical that the TAS standard be modified.

Notwithstanding, the differentiation between these standards is not without issues. Experience gained on the SEST project has found this to be problematic as large portions of Highway 22X fall within the city limits, and therefore would be classified as an urban roadway under the AT definition, even though the facility is more akin to a rural highway. This has complicated the TAS design process as careful engineering judgement was required to ensure that the design was safe and effective given the environment, while maintaining compliance with the relevant standards.

In addition to difficulty in differentiation, it is also notable that AT standards do not provide instruction towards urban roadways that are low volume and high speed or vice versa. On the SEST project, this was overcome by choosing the more conservative high speed high volume design standards, or by requesting an exemption to make use of MUTCD or City specifications instead.

5.3 Construction Area Advance Signage

The three standards analysed use significantly different project advance signage. While it is not uncommon for the sign design to vary, the warrants and signage required does vary significantly. In City standards, only one advance warning sign is required for short or long duration projects, MUTCD required one and recommends a second for long duration projects, while AT requires up to three sets of signage.

While it may seem excessive to include three sets of warning signage, it has proven to be beneficial on the SEST project. As the SEST construction site is approximately 13 km in length on Highway 22X, it would be unreasonable to expect drivers to maintain an increased level of alertness for the entire duration. To help improve safety, the first two warning signs required by AT specifications were placed at the entry points to the project area. The roadwork sign was then placed at the beginning of each area where construction activity was present. The signing method served to warn drivers that they are approaching the project area and provide a reminder wherever workers are present, while balancing costs and complexity of TAS design.

5.4 Buffer Zones

Both the City and MUTCD specifications provide for a buffer zone, which is measured longitudinally from the end of the final taper to the work area. The length of buffer is a function of the speed to ensure that from the beginning of the taper, there is adequate stopping sight distance before entering said work area.

However, AT specifications do not require a buffer area. While the standard AT taper is relatively long, it alone does not provide full stopping sight distance at higher speeds. Furthermore there is a provision to reduce the taper length for lower speeds, which can result in similar risks at low speeds.

5.5 Clear Zones and Crash Barriers

AT specifications do require the implementation of the clear zone concept to require lateral protection of the work area whenever warranted. As drivers pass though construction areas, it is expected that they will be more attentive, therefore AT allows for reduced clear zone requirements to simplify design and maximize the work area. Should the clear zone requirements not be met, then crash barriers are warranted. AT provides crash barriers specifications as part of their standards, which are similar to permanent barrier design guidelines. This is in contrast to MUCTD and City specifications which do not provide guidance for lateral buffers or crash barriers.

5.6 Delineator Spacing

AT specifications use a 15 m delineator spacing across all standard TAS plans. This is in stark contrast to the City and MUTCD specification which vary the spacing depending on the posted speed. City standards also specify the type delineators to be used depending on the speed limit, whereas AT requires barrels for certain types applications. MUTCD does not specify the type that is required.

On the SEST project, experience has identified that delineator spacing must vary with traffic speeds and the complexity of the movement. In order to prevent driver confusion, the TAS’s designed for SEST occasionally have reduced the delineator spacing from the AT requirements to those recommended by the City and MUTCD. In more complex movements, such as those within temporary intersections, the spacing has been reduced further, to as little as 5 m spacing, to ensure maximum visibility and reduce confusion.

5.7 Barricade Usage

While it is not unusual for the style and appearance of barricades to be different between the standards, it is important to note differences in their usage. Notably, the MUTCD standards do not require the use of barricades to close off roadways in many circumstances. This contrasts to City and AT specifications which require the use of barricades, a vehicle, variable message board or a sequential arrow board to provide a physical barrier in closed lanes as well as to separate the work areas from the travelled surface.

5.8 Signage Spacing

The spacing of signage is a critical part of TAS design. AT standards require 25 – 150 m with most standard drawings requiring 100-150 m. MUTCD and City standards both vary their sign spacing by the posted speed limit. While the sign spacing on MUTCD and City standards is shorter than AT at lower speeds (100 m spacing or less for speeds of up to 90 km/h), the standards occasionally employ an additional set of warning signs to provide more time for drivers to take action such as change lanes.

On the SEST project, the spacing of signs has often become an issue. Due to the proximity of intersections, interchanges and ramps, the available space for signage is often limited. As a result, there have been many circumstances where signage has been duplicated on incoming ramps as well as the mainline in an effort to ensure that all the required signs are displayed. In some cases, it has been necessary to use City or MUTCD design standards instead.

5.9 Speed Limit Reductions

It is often necessary to reduce the speed limit in construction areas. As a result, nearly all AT standard drawings do include speed limit reductions. AT further specifies that speed limit reductions of more than 30 km/h must be done progressively with an intermediate speed zone. However, AT specifications do not provide guidance towards the distances required in order to reduce speeds safely. City standards do provide suggested minimum distances which are employed on the SEST project wherever possible. MUTCD standards do not consider speed limit reductions.

5.10 No Passing Zones

As construction areas have a higher risk for collisions, passing is arguably unadvisable. AT standards include the concept by specifically prohibiting passing using signage on many standard applications. However, neither City nor MUTCD include No Passing signage in any of their standard drawings.

5.11 Taper Lengths and Angles

The design of tapers need to provide a balance between a compact size and the ability for traffic to safely merge or change direction. AT uses a standard lane closure taper angle of 40:1 for lane closures, whereas MUTCD and the City vary taper lengths with speed limits. For lane shift

tapers, AT requires a 40 m 20:1 taper followed by a designed detour, whereas MUTCD and City employ a fraction of the lane closure taper length.

Issues with tapers are also regularly encountered on the SEST project. As AT is the prevailing standard, tapers are designed as 40:1. However, the length of taper required for a lane closure is approximately 148 m for a 3.7 m lane width, which is often unavailable in urban design. To overcome this issue, the SEST project has employed City and MUTCD specifications as necessary and with regulatory approval.

With tighter tapers, it is important that adequate delineation be provided in order visually show that the travelled way has been shifted. Delineation spacing was reduced on multiple occasions to prevent driver confusion where necessary on SEST.

5.12 Illumination

As TAS's are often deployed at night, or will remain in place during night time hours, it is essential that roadway illumination be considered. However, illumination is not covered by any of the three standards analysed.

5.13 Pedestrian Accommodation

Pedestrian accommodation is often necessary in urban environments. MUTCD provides standard drawings for some pedestrian accommodation cases, while City standards provide only general guidelines. AT specifications do not provide any guidelines.

6.0 Work Covering Multiple Jurisdictions

The SEST project falls under the jurisdiction of AT and therefore their standards apply throughout the project area. However, the TAS plans often extend beyond the project area into City lands where the City specifications apply. While it would be ideal to meet both sets of standards, it is often impractical or impossible to do so.

In situations where a TAS covered multiple jurisdictions, dialogue with both authorities was essential to determine an acceptable level of compromise. In the case of SEST, the compromise often took the form of a hybrid design which consisted of:

- AT signage in their respective order plus any additional signs required by City standards using City sign spacing throughout,
- Designation of the area as a no passing zone,
- Speed limits reduced to AT recommended levels or lower with City minimum spacing,
- Tapers to City specifications,
- AT heavy duty barricades with City standard arrows, and
- City delineator spacing using traffic barrels where required by AT.

The aforementioned hybrid design was usually used on the lower speed cross streets that extended on to City lands. The mainline of Highway 22X was designed to AT standards. This

method of changing TAS standards only at intersections can help to reduce driver confusion as it is logical to expect the conditions to change when turning onto a different roadway.

The hybrid design deployed on cross streets allowed the TAS to meet both standards to a level acceptable to both authorities. Furthermore, the provision for City sign spacing and tapers reduced the size and complexity of the TAS as the signage no longer stretched beyond the first intersection on the cross streets.

7.0 Legal Implications and Considerations

As the aforementioned comparison shows, the TAS standards and manuals have similarities but are also dissimilar in various aspects. While the standards have specific jurisdictions where they are applicable, there are times when it is desirable or necessary to follow a less stringent standard where constraints exist. However there can be situations where the urge to economize and save on TAS devices will result in a similar push towards adopting a more relaxed standard, particularly those that are short term temporary. It is important that safety be the prime consideration, and of ultimate concern in the final analysis.

The subject is complicated by legal issues. The legality of a design approach by simply following one set of standards, but neglecting other parallel standards in existence, without engineering judgment, has been challenged by the courts as insufficient, and lacking of due diligence. Today engineers can no longer limit their liability by hiding behind guidelines promulgated in manuals as these publications are often protected by disclaimers and clauses to the effect that they are issued only as recommendations.

On the SEST project the client has elected to conduct an independent safety audit is conducted by a safety specialist/expert to review the design's accuracy and adequacy for complex or long duration TAS's. The requirement or need for such reviews is not discussed in the current manuals.

8.0 Conclusion and Recommendations

The SEST project has provided a rare opportunity to research and discuss the established TAS standards from both academic and practical points of view. From the research comparing the TAS's it is apparent that there are significant differences between the standards that create a challenge to designers. These differences span nearly all the broad categories of TAS's that were discussed in section 5.0. While the differences are substantial, there is not one standard that covers all aspects comprehensively or effectively. Furthermore practical experience has identified multiple areas where the standards are insufficient or absent.

The significantly different specifications have also caused issues on the SEST project where the TAS crossed the boundary between different jurisdictions. While a practical compromise was able to be reached in this circumstance, it is not certain that this will always be the case.

In order to improve the TAS design process, it is recommended that an effort be made by the engineering, academic and regulatory communities to undertake additional research in an effort

to unify and improve upon the standards and recommendations, while making use of the strengths of each standard with recommendations developed for neglected areas.

While it may be unreasonable to assume that one TAS design standard is sufficient nationwide, it is submitted that one TAS design standard should be developed and then modified slightly for each region/province/municipality's specific needs while sharing a common underling framework. Such an effort will streamline the TAS process and render it more efficient for designers, authorities and contractors. Furthermore, better TAS designs benefit the travelling public with standards that are not only improved, but also more consistency from region to region.

Finally, the SEST project has found the use of independent road safety audits to be a useful endeavour. Such reviews are not a requirement at present. However, given their potential benefit towards safety, it is recommended that studies be made to determine if such reviews should be part of the TAS process and provide guidelines as to when it is necessary or recommended.

References

[1] Transportation Association of Canada, *Manual of Uniform Traffic Control Devices for Canada*, 4th Ed, Ottawa, Canada , updated 2008.

[2] Alberta Transportation, "Traffic Accomodation in Work Zones,", 1st Ed, 2008. [Online]. Available: http://www.transportation.alberta.ca/Content/docType233/Production/tawz2008_1.pdf. [Accessed 27 March 2013].

[3] The City of Calgary, "Temporary Traffic Control Manual," 2011. [Online]. Available: https://www.calgary.ca/Transportation/Roads/Documents/Contractors-and-Consultants/temporary-traffic-control-manual.pdf?noredirect=1. [Accessed 21 March 2013].

[4] Chinook Roads Partnership, "Project Overview and Scope," 2010. [Online]. Abailable: http://www.sestproject.ca/wp-content/uploads/2010/06/SEST_Presentation_BoardFinal.pdf. [Accessed 09 July 2013].

Appendix A – Project Area Map

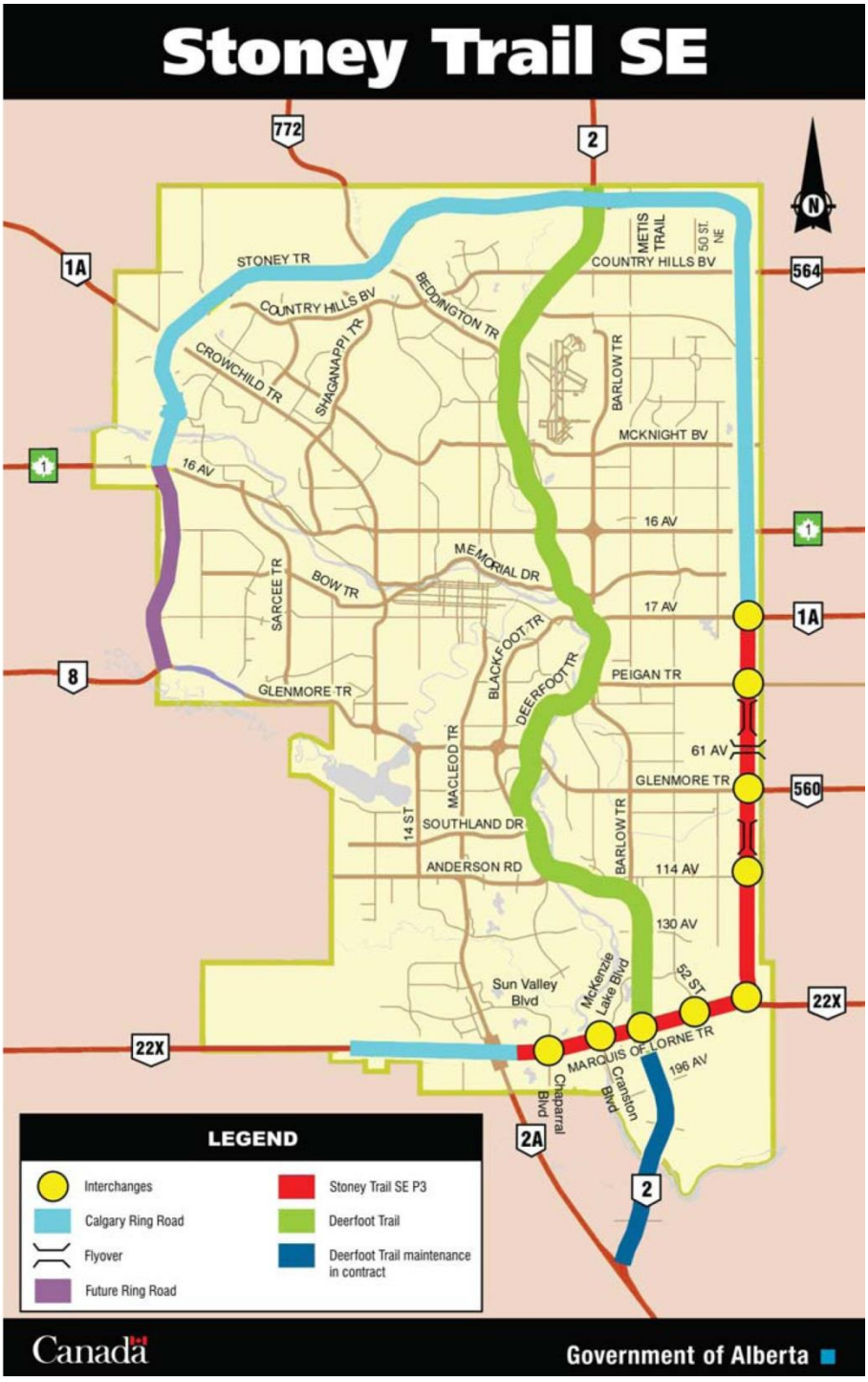

Image Credit: Chinook Roads Partnership / Government of Alberta [4]

Appendix B – Comparison of TAS Standards

Property	Alberta Transportation [2]	Manual of Uniform Traffic Control Devices [1]	City of Calgary [3]
Design Vehicle	Not included.	Not included.	Not included.
Urban vs. Rural Applications	Different applications. Rural defined as outside of city/town limits. Different applications for urban high speed high volumes and low speed low volume.	No categorical differentiation.	No categorical differentiation.
Project Advance and End Signage	Short duration: Roadwork sign Long duration low speed urban: Construction Ahead and Roadwork sign. Long duration rural or high speed urban: 2 km advance signage, Construction Ahead and Roadwork sign End Construction signage optional for short duration projects.	Long duration: Construction 1 km Ahead and Construction Ahead sign for selected works. Short duration: Construction Ahead sign. End Construction signage required for long duration projects.	All applications use Construction Ahead sign. End of project signage not required.
Work Area Buffer Zone	Not included.	Varies with speed from 35 m at 50 km/h to 75 m at 110 km/h.	Varies with speed from 35 m at 50 km/h to 75 m at 110 km/h.
Clear Zone	Use clear zone concept similar to permanent design with reduced requirements.	Not included.	Not included.
Crash Barriers	F-shaped barrier to be used within clear zone. Sand barrel cushion to be used for blunt ends. Specifications provided. Water filled barriers permissible in some cases.	Not included.	Not included.
Delineation	Use 15 m spacing. Traffic barrels for urban roads with gazetted speeds of 60 km/h or greater.	Spacing varies with speed from 8 m to 20 m. Markers, cones or barrels permitted.	Spacing varies with speed from 8 m to 20 m. Cones or barrels to be used depending on speed.

Property	Alberta Transportation [2]	Manual of Uniform Traffic Control Devices [1]	City of Calgary [3]
Barricades	Use heavy duty barricades. Use variations with arrows and “Road Closed” text where appropriate. Used for all roadway and lane closures.	Light or heavy duty variations available. Use directional variation as appropriate. Used for roadway and intersection closures only.	Light or heavy duty variations to be used depending on speed. Attach directional arrow to barricade as appropriate. Used for all roadway, intersection and lane closures.
Requirements for VMS	Where ASDT>10,000 or where sight is restricted in urban applications.	Not specified	Where volumes or high or where delays are likely.
Use of Sequential Arrow Boards	At end of lane closure tapers. Additional advance arrow board on rural applications when ASDT>10,000 or when sight distance is restricted. Size not specified.	At end of lane closure tapers where speed limit is 70 km/h or greater. Sizes based on speed. Hazard symbol specified for use on work outside of travel lane.	At end of lane closure tapers where speed limit is 70 km/h or greater. Sizes not specified. Hazard symbol specified for use on work outside of travel lane (different symbol from MUTCD). Bi-directional arrow symbol available.
Signage Size	Varies depending on sign and urban/rural applications. Table provided in manual.	Varies with roadway class (urban, rural and freeway). Signs after pre-warning area may be smaller for rural roadways.	Not specified.
Signage Spacing	Recommended 25 – 150 m. Many drawings specify 100 – 150 m in notes.	Varies with speed from 50 m to 125 m.	Varies with speed from 50 m to 125 m.
Signage - Speed Reduction	Shown as part of most standard drawings. No minimum deceleration lengths provided. Intermediate speed zone required for reductions of more than 30 km/h.	Not included.	One example provided. Minimum deceleration lengths provided.

Property	Alberta Transportation [2]	Manual of Uniform Traffic Control Devices [1]	City of Calgary [3]
Signage – Lane Closure	Urban high speed/volume: Standard advance warning signs, Reduced Speed Ahead, Lane Ends, No Passing and Maximum Speed. Sequential arrow board at end of taper. Rural: Additional sequential arrow board is required between Lane Ends and No Passing when the ASDT > 10,000 or when sight distance is restricted.	Speed limit ≤ 60 km/h: Construction Ahead, Lane Ends and an angled arrow. Speed limit > 60 km/h: Construction 1 km Ahead, Lane Ends, Construction Ahead, Lane Ends and an angled arrow.	All applications: Construction Ahead, Lane Ends, Lane Ends. Place arrowed barricade or a flashing arrow board at the end of taper depending on speed.
Signage – Flagger Operation	Rural applications: Standard advance warning signs, Reduced Speed Ahead, No Passing, Maximum Speed and Flagger signs.	All applications: Construction Ahead or Roadwork, and Flagger sign. Provide double the sign spacing between flagger and warning sign.	All applications: Construction Ahead, Be Prepared to Stop and Flagger signs.
Signage – Two Way Traffic	Rural applications: Standard advance warning and lane closure signage, Divided Highway Ends, Begin Detour 300m, Two Way Traffic Ahead, Reverse Curve and Two Way Traffic signs. Urban high speed applications: Standard advance warning and lane closure signage, Detour Ahead, Two Way Traffic Ahead, Reverse Curve and Two Way Traffic signs.	All applications: Standard advance warning and lane closure signage, Lane Shift, Two Way Traffic Ahead and Two Way Traffic signs.	Same as MUTCD. Barricades required blocking closed roadway. Use sequential arrow boards at speeds of 70km/h and above. Place Two Way Traffic signs along the two way section of roadway.
Signage – Construction at Intersections	Not included.	Various standard layouts provided including intersections with turning bays. For intersection closures with turning channelization, close right/left lane then provide exit to access channelization.	Various standard layouts provided. For intersection closures without channelization, designating a turn only lane is permitted.
Signage – Interchange Work	Standard provided for urban high speed applications for added lane or yield condition.	Various applications provided for on ramps and exit ramps closures and work.	Not included.
No Passing Zones	No Passing signs to be used on all long term applications.	Not included.	Not included.

Property	Alberta Transportation [2]	Manual of Uniform Traffic Control Devices [1]	City of Calgary [3]
Lane Closure Tapers	40:1 taper on multilane highways, may be reduced to 5:1 if space is restricted and posted speed is 60 km/h or less. 5:1 taper for two lane highways 350-500 m recommended between consecutive tapers	Varies with speed from 30 m at 50 km/h to 75 m at 110 km/h.	Varies with speed from 30 m at 50 km/h to 75 m at 110 km/h. Provide double the taper length between consecutive closure tapers.
Lane Shift Tapers	No taper specified. Major shifts to be designed as a detour.	Provide half of lane closure taper length.	Provide half of lane closure taper length. Minimum half of lane closure taper length between lane closure and lane shift.
Shoulder Tapers	Not specified. Provide minimum of 5 traffic barrels in urban applications.	Provide one third of the lane closure taper length.	Provide one third of the lane closure taper length.
Detour Design	Begin detour with a taper 20:1 taper. Diversion can be designed to reduced temporary standards.	No detour specific standards identified.	No detour specific standards identified.
Illumination	Provide if necessary. No warrants or specifications provided. Specification for barricade lights included.	Not included.	Provide for flaggers except where regular streetlights are serviceable.
Pedestrian Accommodation	No included.	Standard layout provided for intersection and sidewalk works.	General guidelines provided without drawings.