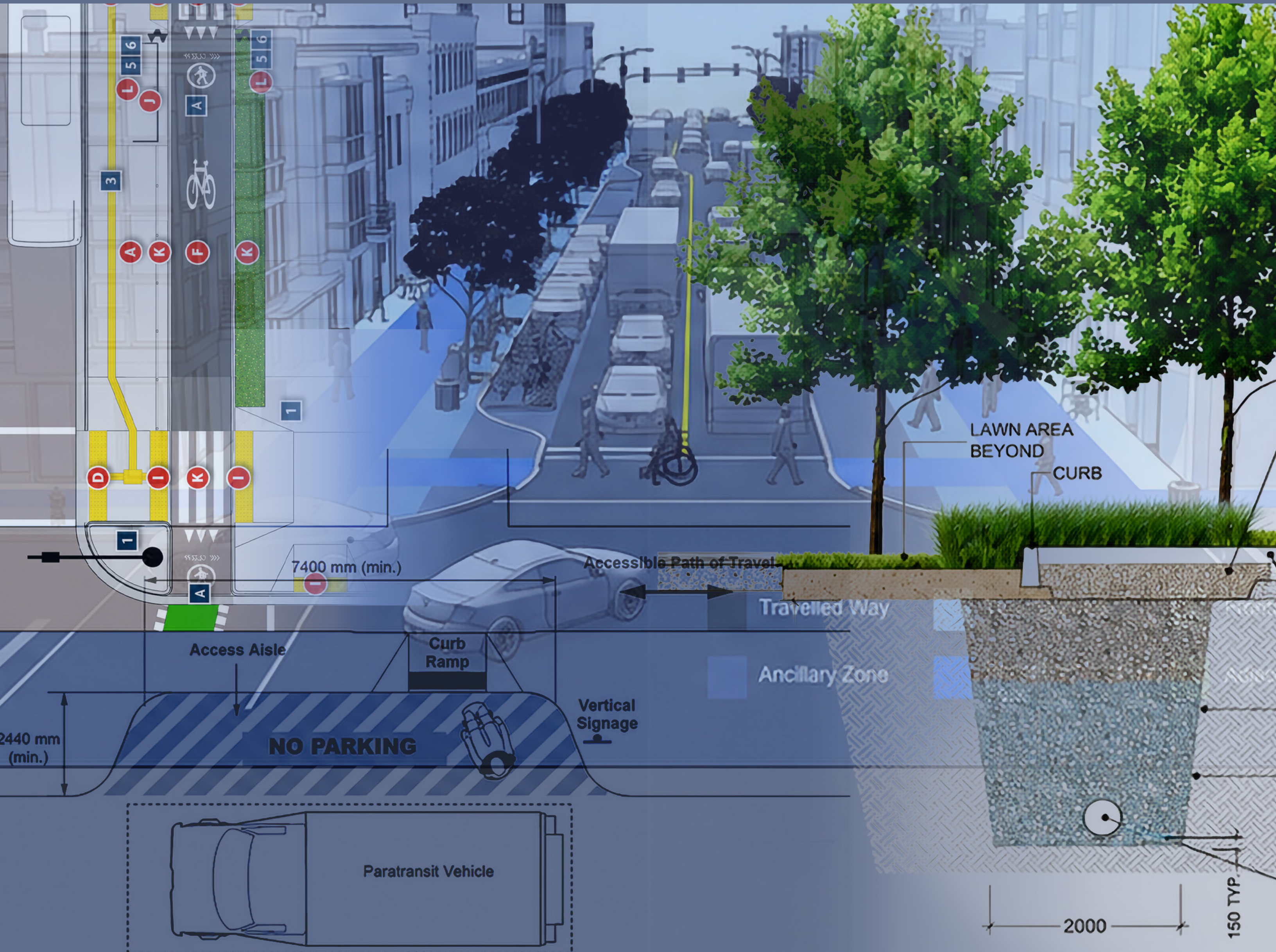
Transportation Association of Canada

Cross Section Elements: Research and Synthesis of Practice

July 2026



DISCLAIMER

This document is not intended to be used as a basis for establishing civil liability.

The material presented in this text was carefully researched and presented. However, no warranty expressed or implied is made on the accuracy of the contents or their extraction from reference to publications; nor shall the fact of distribution constitute responsibility by TAC or any researchers or contributors for omissions, errors or possible misrepresentations that may result from use or interpretation of the material contained herein.

Information within this report should be considered in the context of local legislation, regulation and policy.

401-1111 Prince of Wales Drive
Ottawa, ON | K2C 3T2
Tel.: (613) 736-1350
www.tac-atc.ca

ISBN# 978-1-55187-736-5
Publication Code: PTM-CSERSP-E

Cover photos courtesy of: City of Toronto, City of Edmonton, CSA Group, TransLink and the British Columbia Ministry of Transportation and Transit

TAC Report Documentation Form

Title and Subtitle Cross Section Elements: Research and Synthesis of Practice		
Report Date July 2026	**Coordinating Agency and Address** Transportation Association of Canada 401-1111 Prince of Wales Drive Ottawa, Ontario, Canada K2C 3T2	**ITRD No.**
Author(s) • Selby Thannikary, WSP Canada Inc. • Carolyn Sherstone, WSP Canada Inc. • Laura Cabral, WSP Canada Inc. • Beverly Ng, WSP Canada Inc.	**Performing Agency Name and Address** WSP Canada Inc. 1600 Buffalo Place Winnipeg, MB R3T 6B8	
Abstract The *Cross Section Elements: Research and Synthesis of Practice* presents findings from a literature review of technical and local resources across Canada and internationally, a survey of practitioners, a virtual workshop, and a series of interviews with practitioners from both the public and private sector. While the foundations of many locally used resources are rooted in the Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads* (GDG) Chapter 4 principles, multi-modal accommodation, accessibility, safety, and climate specific design considerations were identified as common areas requiring further guidance. Several gaps and emerging cross section design practices warranting further review were identified as beneficial practice that have evolved since the publication of the TAC GDG in 2017. The practices detailed in this Synthesis of Practice are recommended to be considered in the future update of Chapter 4 of the TAC GDG.	**Keywords** • Planning of Transport Infrastructure • Accessibility • Curb • Layout • Speed Control (struct elem) • State of the Art Report • Traffic Lane • Transverse Profile • Width • Winter Maintenance	

Formulaire de documentation de rapport de l'ATC

<table>
<tr><td colspan="3">Titre et sous-titre
Cross Section Elements: Research and Synthesis of Practice</td></tr>
<tr><td>Date du rapport
Juillet 2026</td><td>Organisme de coordination et adresse
Association des transports du Canada
1111, promenade Prince of Wales, bureau 401
Ottawa, Ontario, Canada K2C 3T2</td><td>Nº ITRD</td></tr>
<tr><td colspan="2">Auteur(s)
• Selby Thannikary, WSP Canada Inc.
• Carolyn Sherstone, WSP Canada Inc.
• Laura Cabral, WSP Canada Inc.
• Beverly Ng, WSP Canada Inc.</td><td>Nom et adresse de l'organisme responsable de l'exécution du projet
WSP Canada Inc.
1600, place Buffalo
Winnipeg, Manitoba R3T 6B8</td></tr>
<tr><td colspan="2">Résumé
Le document Cross Section Elements: Research and Synthesis of Practice (Éléments des profils en travers : résultats de la recherche et synthèse des pratiques) présente les conclusions d'une analyse documentaire portant sur des ressources techniques disponibles localement au Canada et à l'international, d'une enquête auprès de professionnels, d'un atelier virtuel et d'une série d'entretiens avec des professionnels des secteurs public et privé. Si les fondements de nombreuses ressources utilisées localement s'appuient sur les principes du chapitre 4 du Guide canadien de conception géométrique des routes (GCG), publication phare de l'Association des transports du Canada (ATC), des aspects tels que l'adaptation multimodale, l'accessibilité, la sécurité et les considérations de conception spécifiques au climat ont été identifiés comme des domaines communs nécessitant des orientations supplémentaires. Plusieurs lacunes et pratiques émergentes en matière de conception des sections transversales, méritant un examen plus approfondi, ont été identifiées comme des pratiques bénéfiques qui ont évolué depuis la publication de la plus récente édition du GCG en 2017. Il est recommandé de prendre en compte les pratiques détaillées dans la présente synthèse des pratiques lors de la future mise à jour du chapitre 4 du GCG par l'ATC.</td><td>Mots clés
• Planification des infrastructures de transport
• Accessibilité
• Abords de route
• Configuration
• Contrôle de la vitesse (éléments structurels)
• Rapport sur les nouvelles avancées
• Voies de circulation
• Profil en travers
• Largeur
• Entretien hivernal</td></tr>
</table>

Acknowledgements

Project Funding Partners

- City of Calgary
- City of Moncton
- City of Toronto
- City of Vancouver
- Halifax Regional Municipality
- Insurance Corporation of British Columbia
- ITE Canada
- Ministère des Transports et de la Mobilité durable
- Nova Scotia Public Works
- Ontario Ministry of Transportation
- Saskatchewan Ministry of Highways

Project Steering Committee

- Marcia Eng, ITE Canada (Co-Chair)
- Anne Sherwood, Halifax Regional Municipality (Co-Chair)
- Karim Abbany, City of Calgary
- John Bolger, City of Calgary
- Justin Bak, City of Toronto
- Vicente Benitez, Ontario Ministry of Transportation
- Rob Bushman, Saskatchewan Ministry of Highways
- Christopher Darwent, City of Vancouver
- Paul Storer, City of Vancouver
- Adrian Yau, City of Vancouver
- Margaret Gibbs, Insurance Corporation of British Columbia
- Bruno Marquis, Ministère des Transports et de la Mobilité durable
- Elizabeth Pugh, Nova Scotia Public Works
- Radya Rifaat, City of Moncton

Project Consultants

- Selby Thannikary, WSP Canada Inc.
- Carolyn Sherstone, WSP Canada Inc.
- Laura Cabral, WSP Canada Inc.
- Beverley Ng, WSP Canada Inc.
- Mara Bullock, WSP Canada Inc.
- Olivier Plante, WSP Canada Inc.
- Leah Whyte, WSP Canada Inc.
- Asagi Funahashi, WSP Canada Inc.
- Veronica Wambura, WSP Canada Inc.
- Eva Kwok, WSP Canada Inc.

Executive Summary

Cross Section Elements: Research and Synthesis of Practice presents an in-depth literature review of technical and local resources from across Canada and international sources, examining beneficial practices and practitioner experience regarding content contained in and similar to the Transportation Association of Canada (TAC)'s *Geometric Design Guide for Canadian Roads* (GDG), "Chapter 4 - Cross Section Elements". In addition to the literature review, the project methodology included a survey of practitioners across Canada, a virtual workshop with interested practitioners, and a series of interviews with additional parties from the public and private sector. The project confirmed that, while the breadth of guidance in Chapter 4 was generally comprehensive, several emerging practices and areas of focus warrant further consideration in a future update to Chapter 4.

The emerging practices identified as priority areas by the Project Steering Committee (PSC) include the following topics, which are discussed in more detail in this report:

- Snow storage and winter design considerations
- Transit design integration
- Bicycle facility integration
- Storm water management (low impact development)
- Complete Streets design philosophy
- Universal design and accessibility
- Lane widths
- Speed management and safety considerations
- Intelligent transportation systems
- Curbside Management

In addition, the results of the survey, workshop, and interviews identified several additional areas of potential updates to Chapter 4, including the following overlapping areas:

- Urban design considerations
- Lower speed design considerations
- Crossfall design
- Snow and maintenance implications of design measures
- Improved navigation between chapters of the GDG

The review identified that Chapter 4 would benefit especially from guidance on applications outside of rural and high-speed contexts; including low impact development, lower speed urban roadways, parking and loading, and urban design considerations such as transit and bicycle integration. Gaps and areas for update in subsequent versions of Chapter 4 are outlined in detail in this document.

Résumé

Cross Section Elements: Research and Synthesis of Practice présente une analyse documentaire approfondie des ressources techniques et locales provenant de l'ensemble du Canada ainsi que de sources internationales. Le document examine les pratiques avantageuses et l'expérience des professionnels concernant le contenu du « Chapitre 4 - Éléments des profils en travers », du *Guide canadien de conception géométrique des routes* (GCG), publication phare de l'Association des transports du Canada (ATC), ainsi que des documents apparentés. En plus cette analyse documentaire, le mandat du projet comprenait une enquête auprès de professionnels à l'échelle du Canada, un atelier virtuel avec des professionnels intéressés et une série d'entretiens avec d'autres parties prenantes des secteurs public et privé. Le projet a confirmé que, bien que l'étendue des recommandations du chapitre 4 du GCG soit globalement exhaustive, plusieurs pratiques émergentes et enjeux devenus prioritaires méritent d'être approfondis lors d'une future mise à jour de ce chapitre.

Les pratiques émergentes identifiées à titre d'enjeux prioritaires par le comité de direction du projet (CDP) comprennent les thèmes suivants, qui sont abordés plus en détail dans le rapport :

- Stockage de la neige et autres considérations relatives à la conception hivernale
- Intégration de la conception des transports en commun
- Intégration des infrastructures cyclables
- Gestion des eaux pluviales (aménagements à faible incidence)
- Philosophie de conception axée sur les « rues complètes »
- Conception universelle et accessibilité
- Largeur des voies
- Gestion de la vitesse et autres considérations en matière de sécurité
- Systèmes de transport intelligents
- Gestion des abords de routesystems
- Curbside Management

De plus, les résultats de l'enquête, de l'atelier et des entretiens avec les spécialistes ont permis d'identifier plusieurs autres sujets et enjeux particuliers devant faire l'objet de mises à jour dans le chapitre 4, notamment les domaines suivants qui se recoupent :

- Considérations liées au design urbain
- Considérations relatives à la conception pour des vitesses réduites
- Conception des pentes transversales
- Conséquences des mesures de conception sur le déneigement et l'entretien
- Amélioration de la navigation entre les chapitres du GCG

Intégration des infraL'examen a permis de constater que le chapitre 4 gagnerait particulièrement à inclure des recommandations concernant des applications en dehors des contextes ruraux et à grande vitesse, notamment les aménagements à faible impact, les voies urbaines à vitesse réduite, les aires de stationnement et de chargement, ainsi que les considérations d'aménagement urbain telles que l'intégration des transports en commun et des pistes cyclables. Les lacunes et les points à actualiser dans les prochaines versions du chapitre 4 sont présentés en détail dans le document.

Table of Contents

List of Figures

List of Tables

1. Introduction

The Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads* (GDG), Chapter 4, provides Canadian transportation practitioners with guidelines to support the consistent design of roadway cross sections. The chapter presents the rationale and design heuristics for the selection and design of roadway and roadside elements, including through and auxiliary lanes, special purpose lanes, shoulders, medians, sidewalks, boulevards, curbs and gutters.

The practice of planning and designing transportation networks is increasingly influenced by emerging trends, including new forms of mobility such as micro mobility; heightened awareness of climate change and healthy lifestyles; increasing demand for active transportation infrastructure; the growth of ride-sharing applications, and food and grocery deliveries; and the adoption of Vision Zero and Complete Streets principles. In response, many local agencies have adopted their own cross section practices and policies to accommodate these changes and align cross section design within their respective local contexts, informed by emerging research and international practices.

As such, Chapter 4 of the TAC GDG will require future updates to adapt cross section design guidelines to evolving transportation contexts. In preparation for this, TAC has commissioned a review of cross section guidelines and practices to compile a synthesis of current practice and provide recommendations for future updates. This review consisted of a literature review of technical and local resources across Canada and internationally, a survey of practitioners, a virtual workshop, and a series of interviews with practitioners from both the public and private sector. A project steering committee organized by TAC provided ongoing project guidance and support throughout the process.

Outlined in this document is a compilation of this review and key findings and gaps for potential consideration in the future Chapter 4 update.

2. Guidance Review

2.1 Overview

To inform potential updates to Chapter 4 of the GDG, a guidance review was undertaken to examine existing cross section standards and guidelines. An in-depth literature review of 37 available resources across Canada, the United States, and Europe was completed to analyze and compare the current state of standards and guidelines on cross section elements within Chapter 4 of the TAC GDG. The reviewed sources provide advice for rural, suburban, and urban contexts on topics including geometric design, safety, utility, drainage, and street furniture impacts.

Table 2-1 provides a summary of the documents cited in the guidance review. These documents were identified for detailed review following a literature scan. In addition, some primary research papers were also consulted and are cited throughout the text, with complete references at the end of the document.

Since the completion of the literature review and before the publication of this report, new and updated guidance documents have been published Notably, the NACTO *Urban Bikeway Design Guide* and the AASHTO *Guide for the Development of Bicycle Facilities*, Fifth Edition. These documents should be considered as additional inputs in a future update to Chapter 4.

The guidance review identified several emerging practices that warrant consideration in a future update to Chapter 4. The Project Steering Committee further prioritized the focus areas below, which are discussed in more detail in the following sections:

- **Section 2.2:** Snow storage and winter design considerations
- **Section 2.3:** Transit design integration
- **Section 2.4:** Bicycle facility integration
- **Section 2.5:** Storm water management and low impact development (LID)
- **Section 2.6:** Complete Streets design philosophy
- **Section 2.7:** Universal design and accessibility
- **Section 2.8:** Lane widths
- **Section 2.9:** Speed management and safety considerations
- **Section 2.10:** Intelligent transportation systems (ITS)
- **Section 2.11:** Curbside management

Table 2-1: List of Sources Reviewed

			Topics (source explicitly cited)									
Title	**Year**	**Author/Publisher**	Snow/Winter	Transit Design	Bike Facility	LID	Complete Streets	Universal Design	Lane Widths	Speed/Safety	ITS	Curbside Management
International Guidance												
Design Manual, Chapter 202	2025	Florida Department of Transportation								x		
NCHRP Research Report 1120: Active Traffic Management Strategies: A Planning and Evaluation Guide	2024	The National Academies of Sciences, Engineering, and Medicine (NASEM)									x	
NCHRP Research Report 1036: Roadway Cross-Section Reallocation: A Guide	2023	NASEM					x					
NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide	2021	NASEM								x		
City Limits	2020	NACTO*								x		
Blueprint for Autonomous Urbanism	2019	NACTO*									x	
NCHRP Research Report 880: Design Guide for Low Speed Multimodal Roadways	2018	NASEM							x			
Curbside Management Practitioners Guide	2018	Institute of Transportation Engineers (ITE)		x								x
ASVV Guide – Recommendations for Traffic Provisions in Built-Up Areas	2016	CROW			x				x			
Urban Street Design Guide	2013	NACTO*		x		x			x	x		
Designing Walkable Urban Thoroughfares: A Context Sensitive Approach	2010	ITE							x			

*Advocacy organization

Table 2-1: List of Sources Reviewed (Continued)

			Topics (source explicitly cited)									
Title	Year	Author/Publisher	Snow/Winter	Transit Design	Bike Facility	LID	Complete Streets	Universal Design	Lane Widths	Speed/Safety	ITS	Curbside Management
Canada-Wide Guidance												
Cycling Infrastructure and People with Sight Loss Design Challenges and Opportunities at Transit Stops Across Canada	2023	Canadian Institute for the Blind (CNIB)*		x								
Standard B651:23 Accessible Design for the Built Environment	2023	CSA						x				
Clearing Our Path	2022	CNIB*						x				
Design and Operation of Lower-Speed Collector and Arterial Roads: Synthesis of Practice - Draft	TBD	TAC								x		
British Columbia Guidance												
Design Guide for Bus Stops Adjacent to Cycling Infrastructure	2024	TransLink and Ministry of Transportation and Infrastructure		x								
British Columbia Active Transportation Design Guide	2019	Ministry of Transportation and Infrastructure			x		x	x				
Engineering Design Manual	2019	City of Vancouver							x			
Alberta Guidance												
Complete Streets Design and Construction Standards	2023	City of Edmonton		x			x	x	x			x
Beaumont Winter City Strategy	2022	City of Beaumont	x									
Stormwater Management and Design Manual – Volume 3 Drainage	2022	EPCOR Drainage				x						
Design Guidelines for Subdivision Servicing	2020	City of Calgary	x									
Edmonton Winter Design Guidelines	2016	City of Edmonton	x									

*Advocacy organization

Table 2-1: List of Sources Reviewed (Continued)

			Topics (source explicitly cited)									
Title	**Year**	**Author/Publisher**	Snow/Winter	Transit Design	Bike Facility	LID	Complete Streets	Universal Design	Lane Widths	Speed/Safety	ITS	Curbside Management
Saskatchewan and Manitoba Guidance												
Design and Development Standards Manual: Transportation System	2024	City of Saskatoon					x					
Low Impact Development: Design Guide for Saskatoon	2016	City of Saskatoon				x						
Ontario Guidance												
On-Street Bikeway Design Guidelines Chapter 1-3 Adoption	2023	City of Toronto			x							x
Roadway Cross-Section Reallocation Guide	2023	City of Toronto			x							
Complete Streets Design Guidelines	2022	City of Hamilton		x			x	x	x			x
Advanced Traffic Management System Design Guidelines	2021	Ontario Ministry of Transportation									x	
OTM Book 18: Cycling Facilities	2021	Ontario Traffic Council*	x	x	x			x				x
Road Engineering Design Guidelines	2018	City of Toronto							x			
Green Streets Technical Guidelines	2017	City of Toronto				x						
Accessibility Design Standards	2015	City of Ottawa						x				
Bikeways Design Manual	2014	Ontario Ministry of Transportation			x							
Quebec Guidance												
Politique des rues conviviales de la Ville de Gatineau	2021	City of Gatineau					x					
Aménagement pour les piétons et les cyclistes	2019	Vélo Québec*	x		x							
Atlantic Provinces Guidance												
Halifax Municipal Design Guidelines	2021	City of Halifax					x					

*Advocacy organization

2.2 Snow Storage and Winter Design Considerations

The literature review identified several strategies for snow storage and design considerations for winter conditions.

Edmonton's *Winter Design Guidelines* (2016) provide extensive guidance on these subject areas. For snow clearing on roadways, this guide suggests considering seasonal parking bans where on-street parking would be limited to one side of residential streets during the winter. While some of the guidance is not explicitly directed towards snow storage within the public right of way, practices identified could be applied to a street cross section. The guidelines recommend snow storage practices where snow storage areas are designed to consider solar access and maximize snowmelt and consider drainage patterns. Landscaped and permeable surface areas should be located on or near roadways to provide a natural filter for snowmelt and heavy rainfall to reduce pressure on the drainage network.

The literature review also identified strategies for integration of snow storage and winter design considerations with active infrastructure. Beaumont's *Winter City Strategy* (2022), for example, states that physically separated bike lanes and trails should be designed with at least 0.5m of space for snow storage. The strategy also recommends that boulevards should provide multiple pedestrian access points from roads that are clear from snow and snow storage or windrows that block crosswalks or sidewalk access points should be prohibited. It also states that all residential roadways should be designed with boulevards to provide a buffer region between windrows and sidewalks and as a space to provide street trees.

The City of Calgary's *Design Guidelines for Subdivision Servicing* (2020) recommends separated sidewalks on most roads, but where monolithic sidewalks are recommended, they should be a minimum 2.0 m (not including curb and gutter) in width for improved pedestrian safety and to provide adequate width for snow storage. Within the City of Calgary Guidelines, a sidewalk width of 1.5 m, exclusive of curb and gutter, is still considered acceptable on residential and industrial streets.

Mounting evidence, both academic and non-academic[1], indicates people are willing to ride bicycles during winter seasons if snow clearance is provided on bike lanes, paths and streets. The *Ontario Traffic Manual* (OTM) *Book 18: Cycling Facilities* (2021) suggests that snow clearing operations should include all designated cycling facilities on or adjacent to the roadway that are part of the winter cycling network—a network of priority routes that have high demand and provide access to major destinations. To aid in preventing the formation of ice, facilities should be designed such that snow melt drains away

[1] See, for example, the following:

Fossum, M. and Ryeng, E.O., 2022, *Pedestrians' and bicyclists' route choice during winter conditions*, Urban, Planning and Transport Research, 10(1), pp. 38-57. DOI: https://doi.org/10.1080/21650020.2022.2034524

Chapman, D. and Larsson, A., 2021, *Practical urban planning for winter cycling; lessons from a Swedish pilot study*, Journal of Transport & Health, 21. DOI: https://doi.org/10.1016/j.jth.2021.101060

Eco Counter, 2021, *Quantifying and communicating the growth of winter cycling in Montreal*, Blog post published February 10, 2021: https://www.eco-counter.com/blog/quantifying-and-communicating-the-growth-of-winter-cycling-in-montreal from bicycle and pedestrian facilities to catch basins or impervious surfaces. These guidelines note that narrow facilities (like unidirectional bike lanes) may require specialized equipment and snow clearance considerations should be factored into the design and selection of facilities.

A NACTO case study summary cited in OTM Book 18[2] notes that jurisdictions use snow clearing equipment with widths ranging from 1.0 m to 2.5 m for constrained spaces like bike lanes, pedestrian areas, and bridges. OTM Book 18 (2021) also references the Ontario's *Minimum Maintenance Standards* (MMS) for Municipal Highways, which were amended in 2018 to include active transportation facilities. Broadly, depending on snow depth, bicycle lanes should be cleared within 8 to 24 hours, with consideration given to peak commuting periods.

Vélo Québec's *Aménagement pour les piétons et les cyclistes* (2019) outlines considerations for winter maintenance based on facility width. For facilities that are directly against the curb (monolithic) and where any vertical equipment or utilities are located on the outer (property-line) side of the right-of-way, the lateral blade of conventional snow clearing machinery can be used. A truck outfitted with a blade can be used on sidewalks and cycling infrastructure that are at least 2.5 m wide. This represents a lower cost solution to maintenance, however, it cannot be used on narrower facilities. Sidewalks and cycling infrastructure between 1.5 m and 2.5 m in width require specialized equipment, while sidewalks narrower than 1.5 m need to be shoveled manually.

2.3 Transit Design Integration

Transit integration is an important design consideration, especially in urban environments. The guidance review highlighted several transit design elements, including pavement design treatments at bus stops, island bus stop treatment integration with protected bike lanes, and measures to improve accessibility and universal design at bus stops.

Hamilton's *Complete Streets Design Guidelines* (2022) offers details on design parameters for transit stops including stop widths and clear zone lengths for varying stop configurations as shown in **Figure 2-1**. The guidelines emphasize the importance of safety, comfort, accessibility, and integration with the transit design vehicle as critical elements of road design.

[2] NACTO and U.S. DOT Volpe Center, 2019, *Downsized Street Maintenance Vehicles – Case Studies*, 9 p.

Figure 2-1: Design Parameters for Transit Stops

Design Parameters for Transit Stops

ELEMENT	TARGET VALUE	MINIMUM VALUE
PLATFORM LENGTH	9.0 to 15.0 m	9.0 m
CENTRE MEDIAN STOP WIDTH	3.2 to 3.5 m	1.5 m (plus ramp) 2.0 m (where level boarding is provided)
ISLAND BOARDING STOP WIDTH	3.0 to 3.5 m	2.5 m
TRANSIT SHELTER AND STREET FURNITURE CLEARANCE FROM BIKEWAY	0.5 m	0.3 m
CLEARANCE WIDTH ALONG TRAFFIC CURB EDGE	1.8 m	0.5 m
CURBSIDE TRANSIT STOP WIDTH	3.0 m	2.5 m

Source: Hamilton Complete Streets Design Guidelines (2022) – Page 86

The City of Edmonton's *Complete Streets Design and Construction Standards* (2023) outline recommended dimensions required for a retrofitted concrete pad within the existing road structure at bus stops to prevent deterioration. It should be noted that this practice is becoming more common as municipalities transition to electric transit fleets that are often heavier than traditional vehicles.

The Institute of Transportation Engineers' *Curbside Management Practitioner's Guide* (2018) provides strategies to prioritize transit on key corridors including transit lanes, bus queue jumps, bus bulbs and bus boarding islands, commuter shuttle and private transit management and automated enforcement of transit spaces. Bus bulbs are described as unique curb extensions that allow buses to stop without leaving the travel lanes and can reduce crosswalk lengths. Additionally, bus boarding islands are identified to alleviate conflicts between transit vehicles and cyclists.

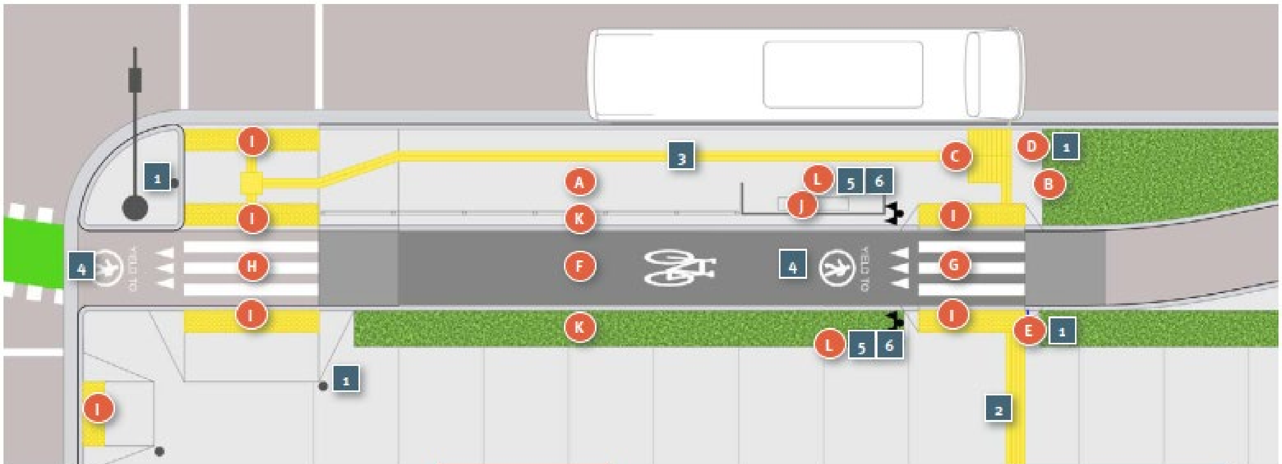
NACTO's *Urban Street Design Guide* (2013) recommends that bus bulbs be applied where offset bus lanes are provided, where merging into traffic is difficult, or where passengers need a dedicated waiting area. Where bus bulbs are applied, NACTO recommends that they should be 40 feet (12 m) long and at least 6 feet (1.8 m) wide with no step to the sidewalk (assuming a 40-foot (12-m) bus). If there is a step to the sidewalk, the bus bulb should be at least 3 m in width or be designed to accommodate the length of the wheelchair ramp used on most standard 12 m buses.

Accessibility considerations for how people with mobility aids and sight loss can more safely access transit emerge through many of the design guidelines. The CNIB report *Cycling Infrastructure and People with Sight Loss- Design Challenges and Opportunities at Transit Stops Across Canada* (2023) highlights design considerations for accessibility in transit stop design. Buffer widths between bikeways and bus shelters, major challenges for people with sight loss while accessing bus stops, and criteria for tactile surface elements on persons with disabilities are all outlined in the report. The *Design Guide for Bus Stops Adjacent to Cycling Infrastructure* (2024) by TransLink and British Columbia Ministry of Transportation and Transit offers island platform key elements and dimensions to include with considerations for accessibility.

As shown in **Figure 2-2**, desired widths of island platforms are 3.0 m, with a minimum acceptable width of 2.3 m. To minimize conflicts between cyclists and pedestrians – particularly those with sight loss – bike lanes may be curved, raised to sidewalk level, or narrowed to recommended minimum widths depending on the facility type (e.g., 1.5 m for uni-directional protected bicycle lanes) to reduce bicycle speeds through transit platform areas.

OTM Book 18 (2021) outlines the design approach for four stop types: island boarding transit stops, shared cycle track transit stops, lay-by transit stops, and curbside transit stops. That document also provides an assessment tool for transit stop design options, which is included in **Figure 2-3** While recent guidance has identified several improvements to accessibility at bus stops adjacent to cycling infrastructure, it is generally recognized that more research is required to develop mechanisms to help people with vision loss determine if a cyclist is approaching and has stopped or yielded.

Figure 2-2: Conventional Island Platform with Crosswalk Integration (Uni-Directional Protected Bicycle Lane)



Legend

- Shelter and Bench
- Bus stop ID pole
- Actuated flashing beacon
- Sign
- Pushbutton
- Landscaping
- Tactile Attention Indicator
- Tactile Directional Indicator
- Tactile Directional Indicator Mat
- Fence or other continuous amenities

Core Treatments

- A Island platform with desired width of 3.0 metres (minimum 2.3 metres)
- B Detectable 'bookend' at end of island platform
- C Tactile Directional Indicator Mat and Passenger Landing Pad clear of obstructions at front door of bus
- D Primary bus stop ID pole with enhanced braille and raised tactile letter signage at front of island platform
- E Secondary bus stop ID pole with enhanced braille and raised tactile letter signage on sidewalk
- F Bicycle lane raised to sidewalk level or intermediate level and/or narrowed through bus stop zone
- G Marked pedestrian crossing at front of island platform
- H Marked pedestrian crossing at rear of island platform integrated with signalized intersection with Accessible Pedestrian Signal
- I Tactile Attention Indicators at all marked pedestrian crossings
- J Bus shelter with no side panels or clear panels
- K Fence, landscaping, and/or other continuous amenities to provide detectable edge treatments and to channelize pedestrians to marked crossings
- L "Pedestrian Crosswalk" and/or "Bicycles Yield to Pedestrians" signage

Optional Treatments

1. Enhanced sign with tactile map of bus stop layout
2. Tactile Directional Indicators across sidewalk
3. Tactile Directional Indicators to direct pedestrians to signalized intersection
4. "Bicycles Yield to Pedestrians" and/or "Advance Yield to Pedestrians" pavement markings
5. Enhanced and/or dynamic "Bicycles Yield to Pedestrians" signage
6. Actuated flashing beacons

Source: Design Guide for Bus Stops Adjacent to Cycling Infrastructure (2024) – Figure 44

Figure 2-3: Assessment of Design Options for Transit Stops on Cycling Routes

	Physically Separated		Mixed Traffic	
	Island Boarding Transit Stop	Shared Cycle Track Transit Stop	Lay-by Transit Stop	Curbside Transit Stop
Cyclist-motor vehicle conflicts	None	None	High	Medium
Cyclist-pedestrian conflicts	Medium	High	None	None
Delay for transit vehicles	None	None	High	Low/High[1]
Delay for people riding bikes	Low	Medium/High[2]	Low	High
Infrastructure required	High	Medium	High	Low
Right-of-way requirements	High	Medium	High	Low
Compatible with two-way cycling facility	Yes	Yes	No	No
Disruption to other curb-side uses such as parking and driveways	Low	Low	High	Medium
Elevation of cycling facility	Sidewalk-level preferred	Sidewalk-level	Road-level	Road-level
Length of curb affected[3]	≤ 30 m	Bus Length	> 30 m [4]	> 30 m

[1] Depends whether bus exits motor vehicle lane to access stop

[2] Depends on transit service frequency and stop activity

[3] Length of curb affected is also related to the design transit vehicle length

[4] Lay-by transit stops affect a longer length of curb than curbside stops due to the longer taper requirements for buses to enter and exit traffic lanes.

Source: OTM Book 18 (2021) – Table 7.1

2.4 Bike Facility Integration

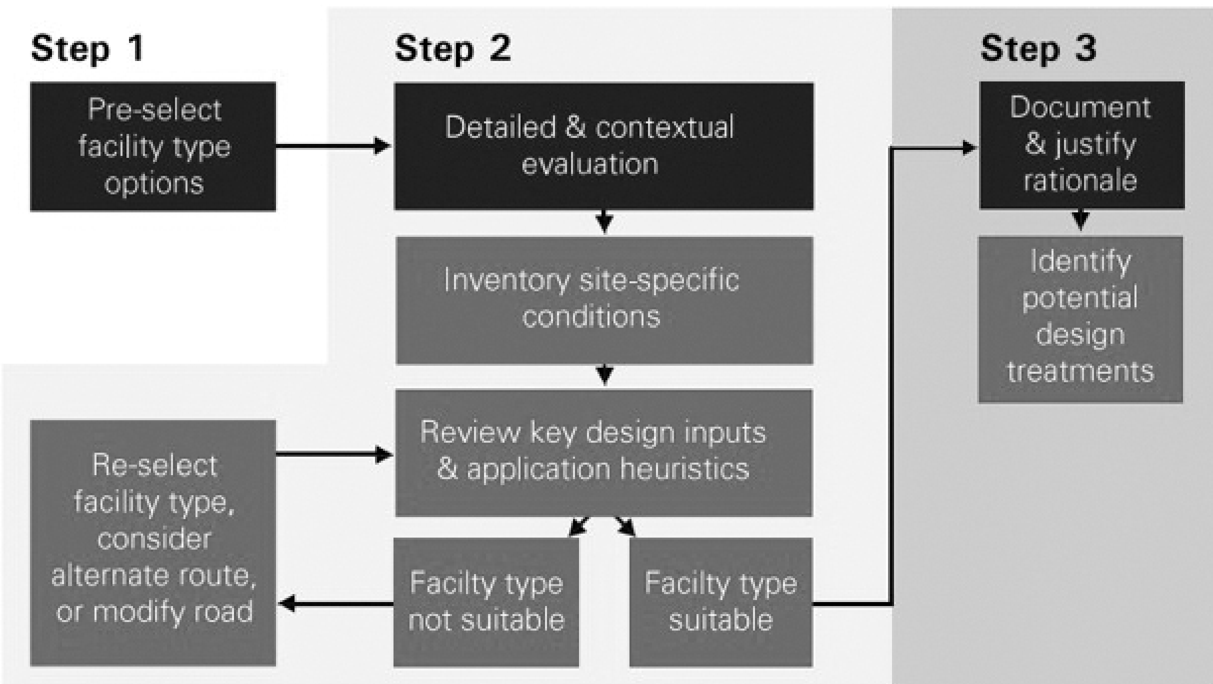
Bike facility integration within the roadway cross section recommendations typically vary based on roadway classifications, and encourages a higher degree of separation with higher vehicle speeds and volumes on the roadway. CROW's *ASVV Guide* (2016) includes recommendations for built-up areas, but separate guidance is provided for locations outside of built-up areas. In a North American context, this generally aligns with recommendations for urban and rural guidance. Urban roadway bike infrastructure may include shared lane, neighbourhood bikeways, advisory bike lanes, painted bike lane, painted buffered bike lanes, protected bike lanes and multi-use pathways. Rural roadways may include shared roadways, bicycle accessible shoulders and bicycle accessible shoulders with buffer. Many guidelines have been developed to support agencies in decision making on cycling infrastructure.

OTM *Book 18* (2021) describes buffer treatments and widths for different types of separated facilities while acknowledging that retrofit projects may entail reallocation of space such as reduction in parking, lane width, or number of vehicle lanes. The cross-slope for drainage plays an important role for physically separated bikeways and should not exceed 4% for an asphalt surface and 2% for a concrete surface. The cross-slope direction recommended varies depending on the height of the facility (sidewalk, intermediate or street level).

The guidelines also provide effective separation techniques which can improve safety for people of all ages and abilities. Minimum buffer widths range from 0.3 m to 1.0 m, however the preferred buffer width is 1.0 m between cyclists and motor vehicles. Examples of separation between pedestrians and cyclists include cane-detectable curbs and continuous detectable tactile buffer strips. Recommended widths are provided for rural paved shoulders with marked buffers and buffers with rumble strips, with buffers ranging from 0.0 m to 1.0 m.

OTM Book 18 also recommends a three-step process for selecting the cycling facility in urban areas as shown in **Figure 2-4**. The City of Toronto's *On-Street Bikeway Design Guidelines* (2023) and British Columbia Ministry of Transportation and Transit's *Active Transportation Guide* (2019) both suggest a similar approach for selecting the appropriate bicycle facility.

Figure 2-4: Three Step Facility Selection Flow Chart



Source: OTM Book 18 (2021) – Figure 5.1

The *Active Transportation Design Guide* (2019) includes a detailed discussion of separation types for street buffer zones for protected bike lanes including flexible delineator posts, wheel stop, planter box, concrete barrier, raised or landscaped median and parking lane. The guide also includes direction on the elevation of protected bicycle lanes including sidewalk level, intermediate level and street level, and the type of curb (vertical, beveled or mountable).

Similarly, the *On-Street Bikeway Design Guidelines* (2023) from Toronto and *Roadway Cross-Section Reallocation Guide* (2023) both provide guidance on separation and buffer treatments and widths; the former is shown in **Figure 2-5**. The selection of particular buffer materials is often based on motor vehicle speed, among other criteria, and can be more detailed with finer-grained speed thresholds as in **Figure 2-5** or more general, as in **Figure 2-6**.

Produced by Vélo Québec, *Aménagement pour les piétons et les cyclistes* (2019) also outlines another type of separation that may be needed between pedestrian and cycling dedicated spaces, particularly if they are both at the same height. They suggest using Tactile Warning Surface Indicators (TWSIs) or other textured surfaces to clearly delineate the two spaces. A width of 20-40 cm is recommended. This type of separation is particularly useful in constrained conditions, where a wider separation (for example, a planted boulevard) is not feasible.

Figure 2-5: Bicycle/Motor Vehicle Separation Types and Minimum Buffer Widths

Separator Type			Flexible Bollards	Modular Curbs	Planter Boxes	Poured Concrete Curb/ Median	Planted Median	Semi-Rigid Guard Rail	Concrete Barrier
Minimum Buffer Width[1]	**Low Speed**	**Operating: < 50 km/h Posted: 30 or 40 km/h**	0.3 m, max spacing of 6m	0.3 m, max spacing of 6m	0.9 m	0.3 m	1.0 m	1.2 m with curbside placement[2] 3.0 m if installed 1.8 m from curb face[3]	0.7 m, 450 mm low height barrier[4]
	Medium Speed	**Operating: >50 km/h through <60km/h Posted: 50 km/h (1 lane/direction)**	0.5 m, max spacing of 6m	0.3 m, continuous	0.9 m	0.3 m	1.0 m	1.2 m with curbside placement[2] 3.0 m if installed 1.8 m from curb face[3]	0.7 m, 450 mm low height barrier[4]
	High Speed	**Operating: > 60 -80 km/h Posted: 50 km/h (2+ lanes/direction), >60 km/h**	Not acceptable	Not preferred, but permitted in a standalone retrofit project	Not acceptable	Combination with semi-rigid guard rail preferred (buffer width based on guard rail); not preferred but permitted without a guard rail at minimum width of 0.4 m	1.0 m combined with curbside semi-rigid guard rail (1.5 m with op. speed >70 km/h)[2] 1.5 m combined with raised concrete planter 3.0 m combined with setback semi-rigid guard rail (op. speed ≤70 km/h)[3] 5.0-6.5 m without guard rail[5]	1.2 m with curbside placement (1.5 m with op. speed >70 km/h)[2] 3.0 m if installed 1.8 m from curb face (op. speed ≤70 km/h)[3]	1.0 m, 825 mm low height barrier[4]
Compatibility with Bikeway Elevation		**Street Level**	Yes	Yes	Yes	Yes	Rural cross section only	Yes	Yes
		Intermediate Level	Yes	No	Yes	Yes (may be asphalt if flush with cycle track and cycle track width is unable to accommodate side-by-side cycling)	Yes	Yes	Yes for standard height barrier only if it serves as the roadway curb No for low height barrier
		Sidewalk Level	Yes	No	Yes	Yes (may be asphalt if flush with cycle track and cycle track width is unable to accommodate side-by-side cycling)	Yes	Yes	Yes for standard height barrier only if it serves as the roadway curb No for low height barrier
Suitable Next to Parking Lanes			Yes (min. buffer width 0.6m, default buffer width 1.0m)	Yes (min. buffer width 0.6m, default buffer width 1.0m)	No	Yes (min. buffer width 0.6m, default buffer width 1.0m)	Yes	No	No
Suitable Along Bidirectional Facility			No, unless adjacent to parking lane	Yes, if generally continuous	Yes, if combined with other suitable separators	Yes	Yes	Yes	Yes
Durability			Low	Medium	Medium	High	High	High	High

NOTES

[1] When existing operating speed data is available and operating speeds are not anticipated to significantly change with bikeway implementation, this should be used to determine buffer width and separator type. Operating speed should be based on 95th-percentile speed. Otherwise, the posted speed can be used.

[2] Buffer width assumes approx. 0.1 m setback of guard rail face from face of curb (maximum 125 mm), 0.1 m rail thickness, 0.3 m offset block, approx. 0.2 m post width, 0.1 m rail thickness (no offset block), and an additional 0.4 m working width (zone of deflection in case of collision). This provides 1.0 m working width in case of 70 km/h collision (TL-2 crash test). An additional 0.3 m width should be provided where 95th-percentile speeds exceed 70 km/h to meet 1.3 m working width for a 100 km/h collision (TL-3 crash test). A lesser buffer width is not preferred since the guard rail may deflect into the bikeway and cause injury to the person cycling, but is acceptable in constrained conditions as some protection is still provided. In this situation, a minimum 0.2 m clear from the face of guard rail to edge of cycle track must be maintained.

[3] When not installed immediately behind the curb, Type M30 guard rail can be installed a minimum of 1.8 m from curb face. This placement is tested to 70 km/h (TL-2 crash test). If the guard rail is installed more than 1.8 m from curb face, an additional 1.2 m of buffer width should be provided to accommodate the guard rail.

[4] Buffer width assumes width of separator plus clear zone on bicycle side: 0.2 m for low height barrier, 0.5 m (at handlebar height) for standard height barrier. The buffer for a low height barrier may be narrowed to 0.6 m when the adjacent bikeway is above minimum width. Barrier wall is assumed to be placed on edge of adjacent vehicle lane. Additional buffer width is required if snow storage space or clear zone is desired on the vehicle side of the barrier.

[5] Based on MTO clear zone values in flat conditions, which is 5.0 m for roads with design speed ≤60 km/h and 6.5 m for roads with design speed of 70-80 km/h. Vegetated buffers of a narrower width may be used without a guard rail, but the bikeway would be within the clear zone of the road, with users at an increased risk of being struck by a vehicle that leaves the roadway.

Source: Toronto On-Street Bikeway Design Guide (2023) – Table 3.3 (Note: Modified from original version to fit page)

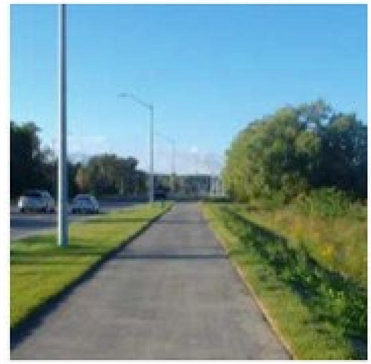
Figure 2-6: Preferred Separation Element based on Motor Vehicle Speed

POSTED SPEED LIMIT	PREFERRED SPACING TYPE
50 km/h or greater	Continuous barriers offering physical protection such as a raised median
50 km/h	Intermittent vertical elements, such as flexible posts and planters are acceptable. Continuous barriers may also be considered.
Less than 50 km/h	Ability to include less physical protection due to lower adjacent motor vehicle speeds.

Source: British Columbia Active Transportation Design Guide (2019) – Table D-12

In rural roadways, the selection criteria for the type of bicycle facility varies from an urban context due to changes in environmental and land use characteristics. OTM *Book* 18 (2021) provides detailed guidance on the distinction between the urban and rural bikeway facility selection. **Figure 2-7** shows the levels of separation and type based on the traffic volumes and speed.

Figure 2-7: Rural Levels of Separation

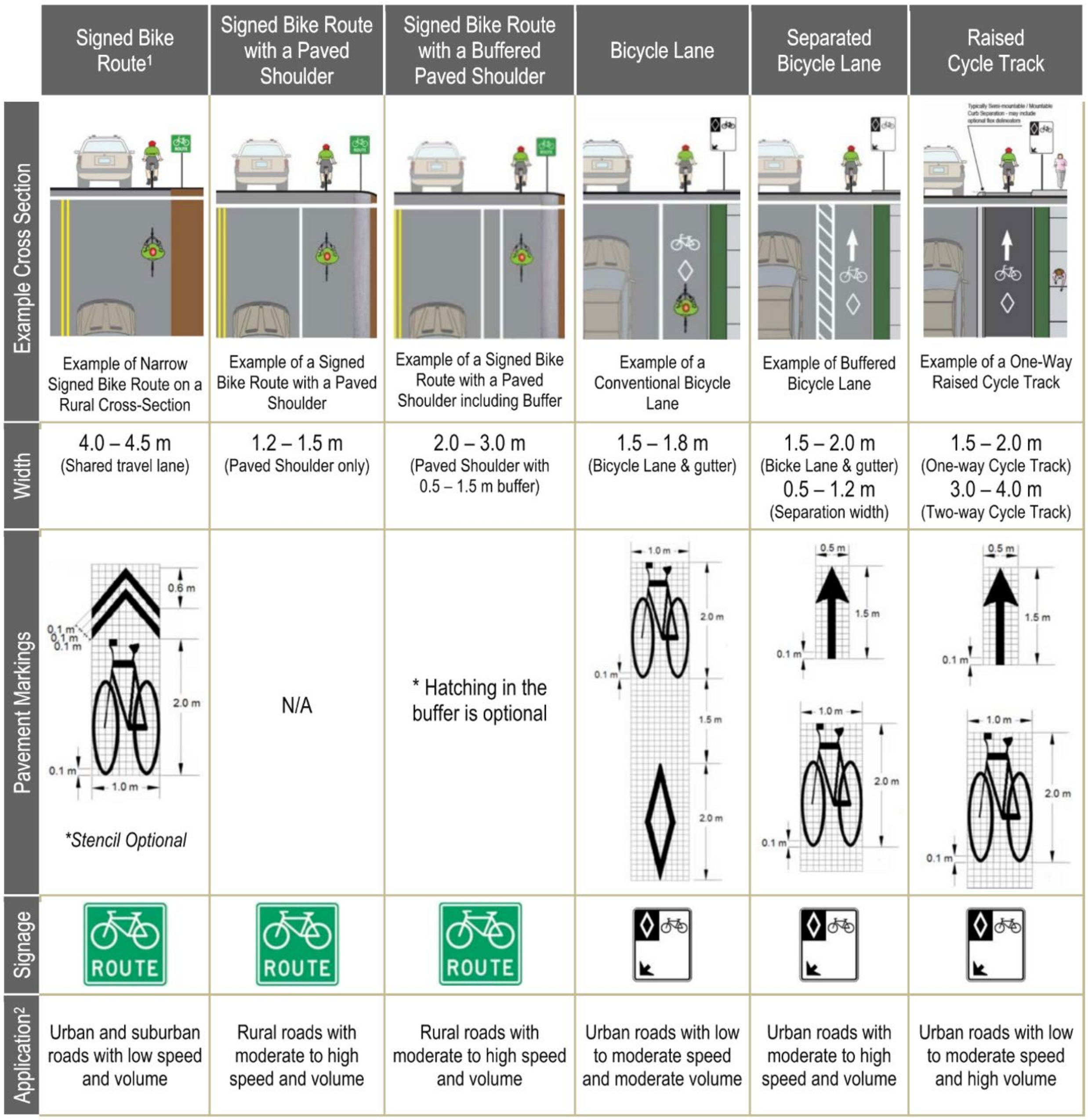
	Shared Operating Space	Paved Shoulder (may include buffer)	In-Boulevard Multi-use Path or Off-road Trail
			
Description	Roadways with low motor vehicle volumes and speeds where people cycling share the operating space with motor vehicles. On very low-volume rural roads (< 1000 ADT), there will be few vehicle/cyclist passing events, and a shared lane may provide a comfortable condition.	People on bikes ride on a paved surface adjacent to the traveled portion of the roadway in the same direction as traffic. In a rural context, a paved shoulder may also be used for pedestrian activity. Motorists may be allowed to stop or park on the shoulder, but do not typically operate within the paved shoulder. A buffer may be added for additional separation from motor vehicle traffic and to minimize the aerodynamic effects from large trucks.	A multi-use path beyond the clear zone of the roadway or an off-road trail provide the highest degree of separation between people cycling and motorists. These facilities should be considered where motor vehicle speeds and volumes are high and where there are high volumes of trucks. Consideration should be given to potential sightline issues and conflicts at intersections and driveways, which should be mitigated through design treatments found in **Section 6**.

Source: OTM Book 18 (2021) – Table 5.2

The Ontario Ministry of Transportation's *Bikeways Design Manual* (2014) provides a detailed summary of potential cycling facility cross sections including associated widths, pavement markings, and signage as shown in **Figure 2-8.** The guidance provided is partially based on a superseded version of the AASHTO *Guide for the Development of Bicycle Facilities* (2024) and may not represent current beneficial practice. Newer guidelines, such as the OTM *Book* 18 and the BC *Active Transportation Design Guidelines* (2019), contain similar (updated) content, but do not present it in a concise summary format as provided in the MTO *Bikeways Design Manual* (2014) figure shown in **Figure 2-8.**

Overall, the guidance reviewed indicates dedicated cycling infrastructure requires a minimum of 3 m of right-of-way that needs to be accommodated in the cross section (either as two 1.5 m unidirectional bike lanes, or a 3 m bidirectional facility), without including buffers between different road uses.

Figure 2-8: A Comparison of On-Road Cycling Facilities



	Signed Bike Route[1]	Signed Bike Route with a Paved Shoulder	Signed Bike Route with a Buffered Paved Shoulder	Bicycle Lane	Separated Bicycle Lane	Raised Cycle Track
Example Cross Section	Example of Narrow Signed Bike Route on a Rural Cross-Section	Example of a Signed Bike Route with a Paved Shoulder	Example of a Signed Bike Route with a Paved Shoulder including Buffer	Example of a Conventional Bicycle Lane	Example of Buffered Bicycle Lane	Example of a One-Way Raised Cycle Track
Width	4.0 – 4.5 m (Shared travel lane)	1.2 – 1.5 m (Paved Shoulder only)	2.0 – 3.0 m (Paved Shoulder with 0.5 – 1.5 m buffer)	1.5 – 1.8 m (Bicycle Lane & gutter)	1.5 – 2.0 m (Bicke Lane & gutter) 0.5 – 1.2 m (Separation width)	1.5 – 2.0 m (One-way Cycle Track) 3.0 – 4.0 m (Two-way Cycle Track)
Pavement Markings	*Stencil Optional	N/A	* Hatching in the buffer is optional			
Signage	ROUTE	ROUTE	ROUTE			
Application[2]	Urban and suburban roads with low speed and volume	Rural roads with moderate to high speed and volume	Rural roads with moderate to high speed and volume	Urban roads with low to moderate speed and moderate volume	Urban roads with moderate to high speed and volume	Urban roads with low to moderate speed and high volume

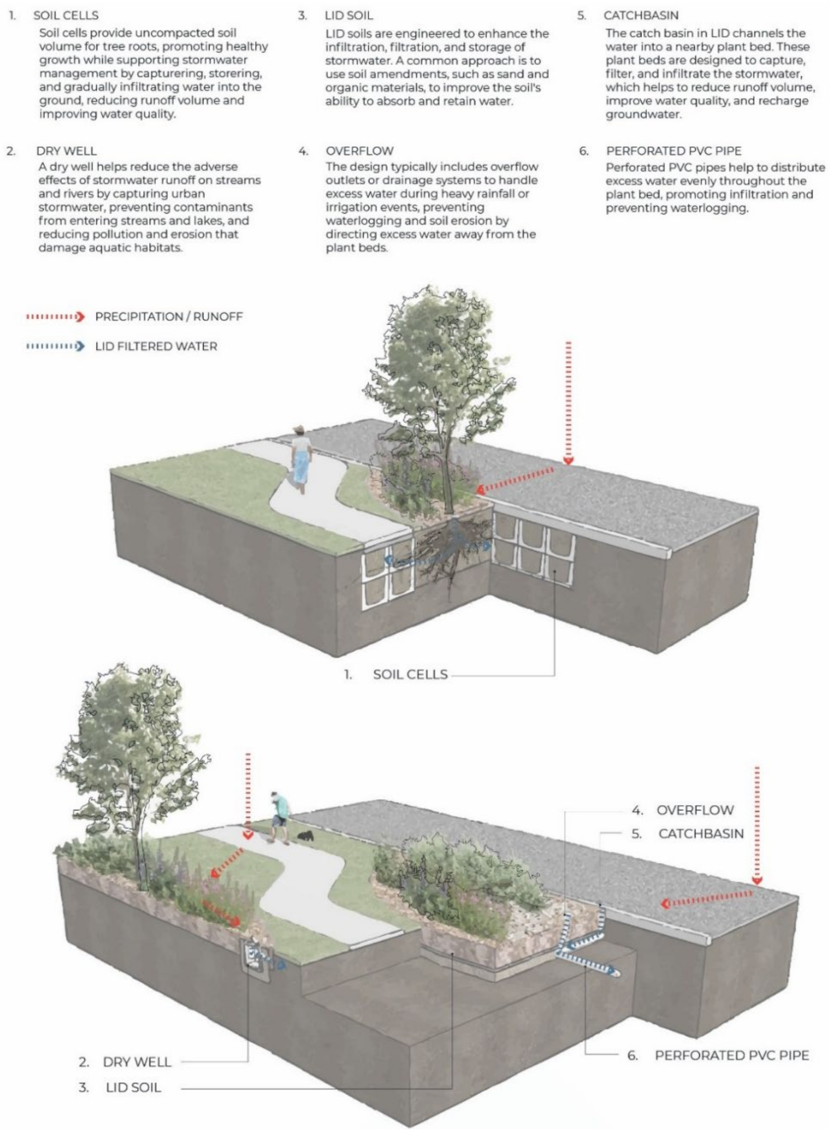
[1]Share the Road signs and Sharrow lane markings are optional
[2]For guidance on speed and volume thresholds, refer to Figure 3.2 - Cycling Facility Pre-selection Nomograph
Source: TAC Bikeway Traffic Control Guidelines, 2012 and AASHTO Guide for the Planning Design and Operation of Bicycle Facilities, 2012

Source: Bikeways Design Manual, MTO (2014) – Table 4-1

2.5 Storm Water Management (Low Impact Development)

Stormwater management using low impact development (LID) strategies is an emerging area of interest as transportation agencies seek to mitigate climate change impacts from extreme weather events. Examples of some LID features are shown in **Figure 2-9**.

Figure 2-9: Selected LID Features



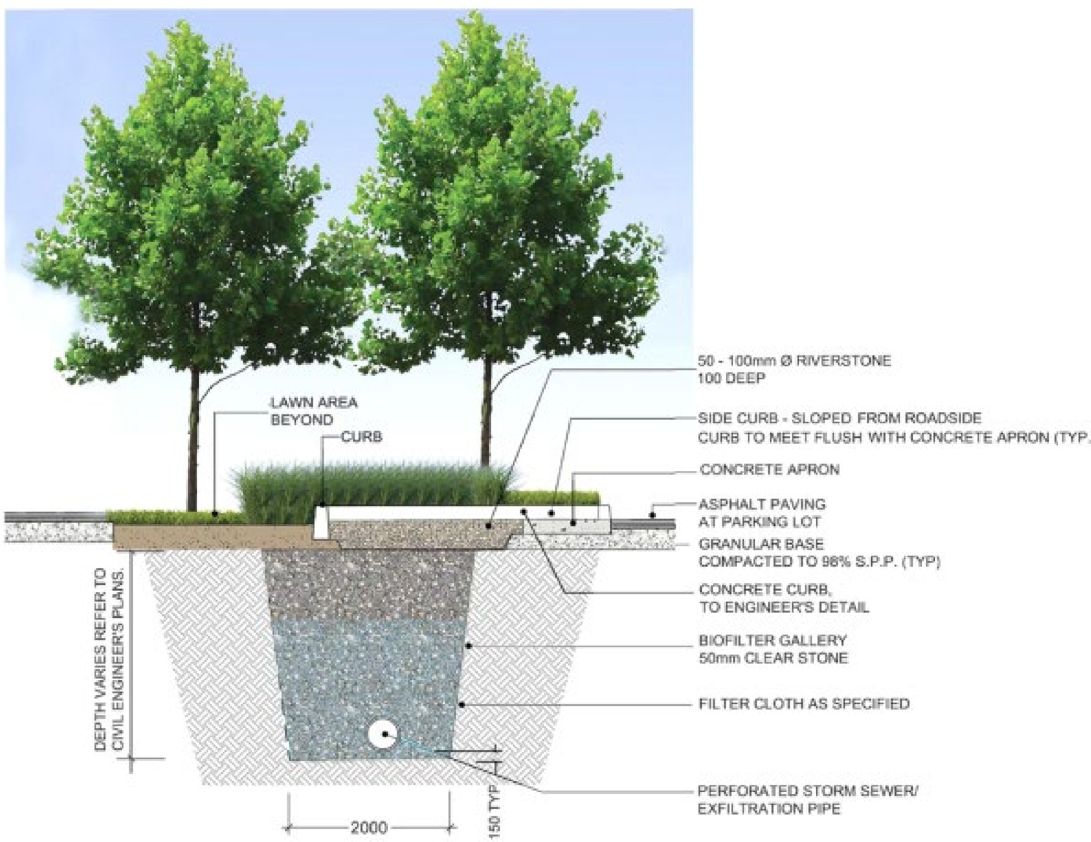
Source: WSP Canada (non-published)

The City of Toronto's *Green Street Technical Guidelines* (2017) presents tools for incorporating storm water management elements on urban streets, including stormwater tree pits, soil cells, stormwater tree trenches, swales, green gutters, filter strips, underground infiltration systems, rainwater cisterns and permeable pavements, amongst others. Low impact development measures may convey, treat and attenuate stormwater run off. The guidelines do not provide specific dimensions for different LID measures but do identify which LID measures can be appropriate for different street typologies (as defined in Toronto's *Complete Streets Guidelines* (2019), as well as between new builds and retrofit situations.

Stormwater tree pits and tree trenches are best suited for urban streets and are implemented within the furnishing zone. Bioswales (**Error! Reference source not found.**) and green gutters (**Figure 2-11**) are implemented in medians while filter strips are gently-sloping, heavily-vegetated areas that treat runoff from adjacent impervious surfaces including roadways, sidewalks and driveways. Swales and filter strips provide a suitable location for snow storage during the winter months, although plant materials must be chosen with care to sustain de-icing salt and potential physical damage.

The *Low Impact Development: Design Guide for Saskatoon* (2016) identifies a facility width between 0.6 m and 2.4 m for bioswales with side slope ratios of 4:1 preferred, up to a maximum of 3:1. The guide considers bioswales are particularly applicable to roadway environments given their linear nature and adaptability to cold climates.

Figure 2-10: Bioswale with Stone Wells



Source: Green Streets Technical Guidelines Version 1.0 (2017) – Chapter 3.2.18.3, City of Toronto

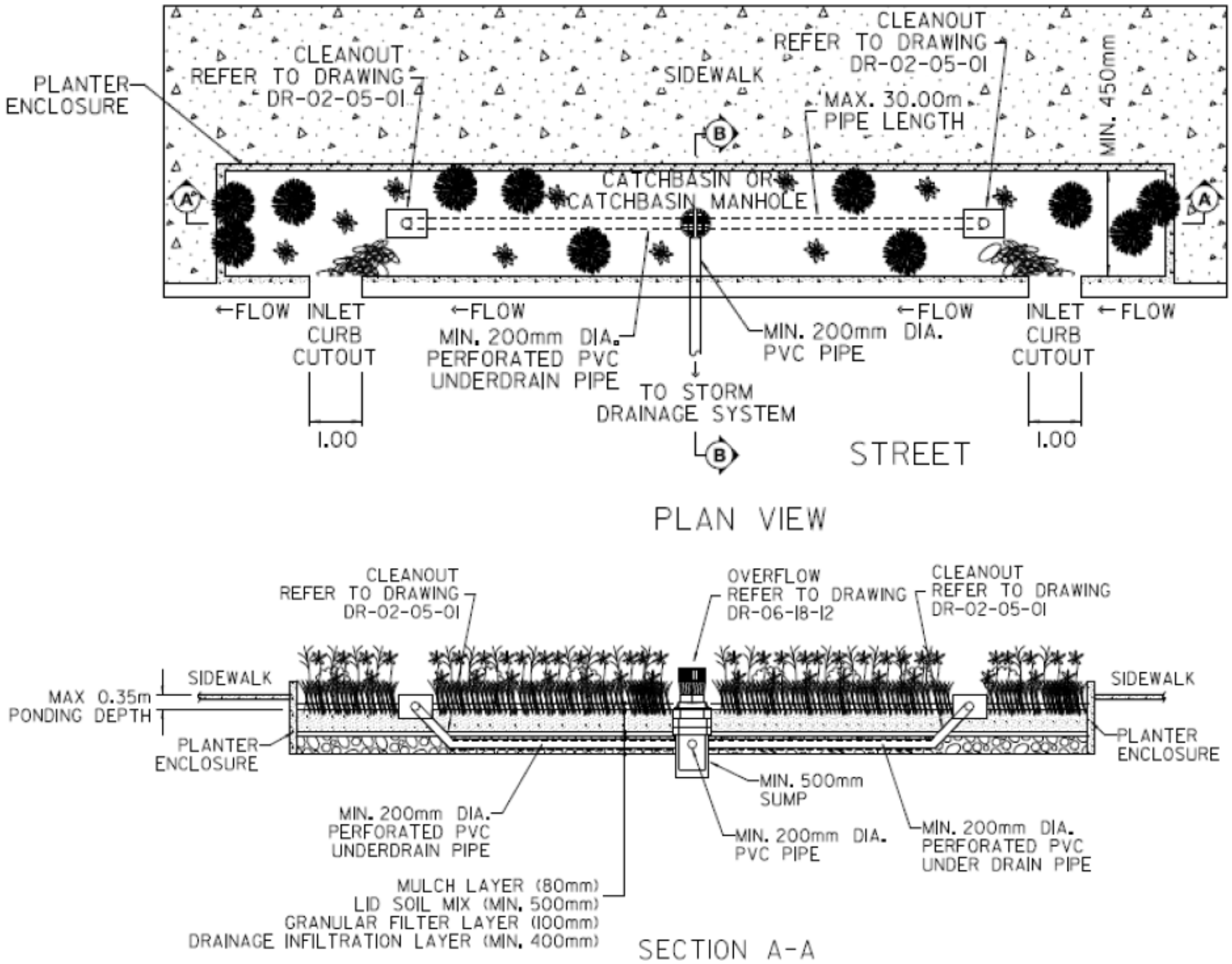
Figure 2-11: Green Gutters

Source: Green Streets Technical Guidelines Version 1.0 (2017) Chapter 3.2.19, City of Toronto

Edmonton's *EPCOR Stormwater Management and Design Manual – Volume 3 Drainage* (2022) includes design guidance on bioretention garden design, bioretention basin design, box planter design, soil cell design and piping and infrastructure considerations. The manual includes design parameters that relate to the roadway cross section design. For example, some LID facilities suitable for use along roadways must be separated from the sidewalk with a buffer of at least 0.5 m (such as bioretention basins) while others do not require similar separation. Similarly, most LID facilities must maintain a distance of 3.0 m from building foundations, unless engineering controls approved by a geotechnical engineer are provided.

Figure 2-13 provides a design detail for a box planter, which does not require separation from sidewalks, but has a minimum width of 450 mm for the facility itself. EPCOR does not provide typical widths for other LID facilities as the most important consideration is the volume of water the LID facility can capture, independent of any one given dimension. The type of plant material used in the facility is adapted to fit the available space (in conjunction with multiple other considerations).

Figure 2-12: Box Planter View and Cross Sections



Source: EPCOR Stormwater Management and Design Manual – Volume 3 Drainage (2022)

The NACTO *Urban Street Design Guide* (2013) recommends that bioswales be composed of diverse, native vegetation with minimum irrigation requirements, and the potential for wildlife habitat creation. The guide discourages the use of bioswales in locations with low infiltration rates since standing water and localized flooding could potentially cause problems within streets and sidewalks in an urban setting. The guide does not indicate width requirements and only qualitatively indicates a slight longitudinal slope should be maintained to move water along the surface. It does specify a minimum side slope (3:1) and ideal side slope (4:1); the spacing of curb cuts where they are used (3 - 15 ft or 0.9 - 4.6 m); as well as the length of curb cuts (18 in or 0.46 m).

NACTO further recommends the use of pervious pavement, which can have multiple applications including sidewalks, street furniture zones, and parking lanes. In cold climates, the guide recommends the use of biodegradable, non-corrosive de-icing agents (e.g., BX36, GEN3, and BetaFrost) on pervious pavements.

2.6 Complete Streets

Complete Streets principles seek to balance safety, access, and comfort for all road users, as defined in the TAC GDG Section 6.6.1. Complete Streets refers to a design approach that is integrated into an organization's policies, design guidelines and standards and implementation of capital infrastructure.

Complete Streets design practice typically includes segmenting an urban street into distinct zones that may include the travelled way, ancillary zone, furnishing zone, pedestrian through zone and frontage zone (see Error! Reference source not found.). Rural road zones may include the traffic zone, shoulder zone, clear zone and pedestrian or multi-use through zone as described in British Columbia's *Active Transportation Design Guide* (2019). Complete Streets design guidelines further articulate how each mode is accommodated within those zones. The design basis for design parameters included in guidelines include the TAC *Geometric Design Guide for Canadian Road*s (2017), provincial guidance and beneficial practices. The design objectives for each cross section varies based on the street's function.

Figure 2-13: Example of Complete Streets Zones

Source: Complete Streets Design and Construction Standards (2023) – Figure 2.1B, City of Edmonton

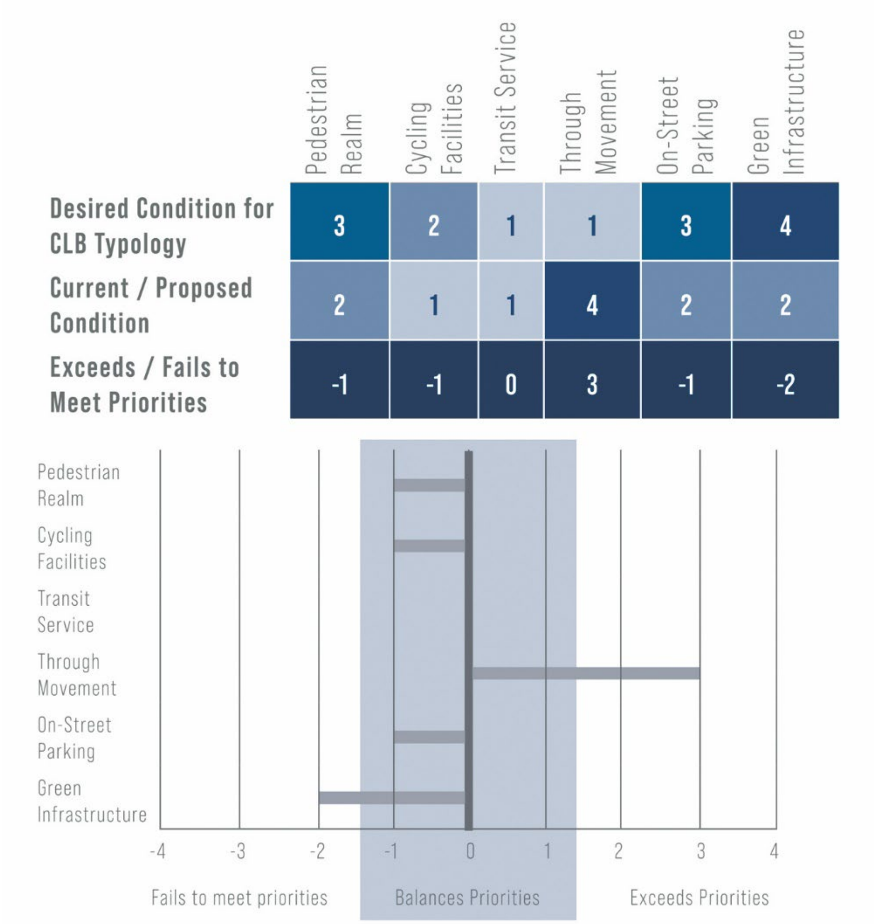
The Halifax Regional Municipalities' *Municipal Design Guideline*s (2021) was reviewed through a lens of Complete Streets philosophy and implementation in design guidelines. That document seeks to promote design of streets that are multifunctional and multimodal, consider the needs of people of all ages and abilities, contribute to sustainability, and form connected networks. Like most Complete Streets guides, Halifax's *Municipal Design Guidelines* (2021) recognize as a key principle that streets completement the adjacent land use and should be "sensitive to the character, scale and needs of surrounding neighbourhoods."

Similarly, the City of Hamilton's *Complete Streets Design Guidelines* (2022) outline a shift from the traditional "centreline out" approach to an "outside in" approach. Both the Hamilton *Complete Streets Design Guidelines* (2022) and the Saskatoon *Design and Development Standards Manual: Transportation System* (2024) use a street design checklist to keep track of key steps and considerations while adjusting the conceptual design for the streets. Hamilton also developed a scoring system for different cross sectional elements and provides a desired scoring matrix for each element dependent on the road classification as shown in **Figure 2-14**.

A similar scoring system is used in the *Politique des rues conviviales* (2021) from Ville de Gatineau. As illustrated in **Figure 2-15**, for retrofit situations, the target level of accommodation is provided for each street function (pedestrian space, cycling space, parking, rainwater management, etc.) and for the twelve potential street types, ranging from 1 (limited) to 5 (superior). Detailed descriptions define the features of each level. These types of scoring systems aim to help the designer establish which modes and public realm features to prioritize in constrained conditions, and are reflective of local context and priorities.

The City of Ottawa's *Multi-Modal Level of Service Guidelines* (2025) similarly support Complete Streets implementation by providing a framework to evaluate how well streets serve different modes, including walking, cycling, transit, and motor vehicles. The guidelines provide an approach for evaluating design trade-offs and allows practitioners to assess existing conditions and proposed designs against target levels of service for each mode, supporting decision-making in constrained rights-of-way.

Figure 2-14: Desired Street Conditions and Audit Tool



This diagram demonstrates the effectiveness of various street elements in meeting conditions for Complete Streets as set out by this manual.

Source: Complete Streets Design Guidelines (2022) – p. 25, City of Hamilton

Figure 2-15: Target Level of Accommodation by Street Type

1	Limité
2	Élémentaire
3	Normal
4	Élevé
5	Supérieur

Tableau 2 - Niveaux d'aménagement à atteindre selon chaque type de rue

No	Type de rue	Espace piétonnier	Aménagement cyclable	Transport en commun	Voies de circulation	Stationnement sur rue	Végétation	Gestion durable de l'eau pluviale
1	Rue piétonne	5	4	1	1	1	4	5
2	Rue partagée	5	3	1	1	2	4	5
3	Rue résidentielle	1	1	1	2	3	2	1
4	Rue de quartier	2	2	2	2	3	2	2
6	Rues d'emplois	2	2	2	3	2	1	4
7	Connecteur de quartier	3	4	2	2	4	3	3
8	Rue collectrice	4	4	3	3	4	4	3
9	Boulevard communautaire	4	5	4	4	5	5	3
10	Boulevard économique	4	4	4	4	2	2	4
11	Promenade	3	4	2	4	1	2	5
12	Axe de transport structurant	4	5	5	5	1	4	1

Source: Politique des rues conviviales (2021), Tableau 2, Ville de Gatineau

British Columbia's *Active Transportation Design Guide* (2019) suggests different retrofit strategies to improve active transportation facilities in constrained conditions. Retrofit strategies described in the guide includes reducing lane widths, reducing the number of lanes, removal of on-street parking or widening the roadway in reconstruction situations. The guide suggests motor vehicles can operate in lanes as narrow as 3.0 m while transit vehicles and trucks require 3.3 m; local transit agencies should be contacted to confirm design requirements. These widths are generally in line with lane widths found in other guides, regardless of a retrofit or greenfield implementation, but may be narrower than the width on older roadways built to a wider standard.

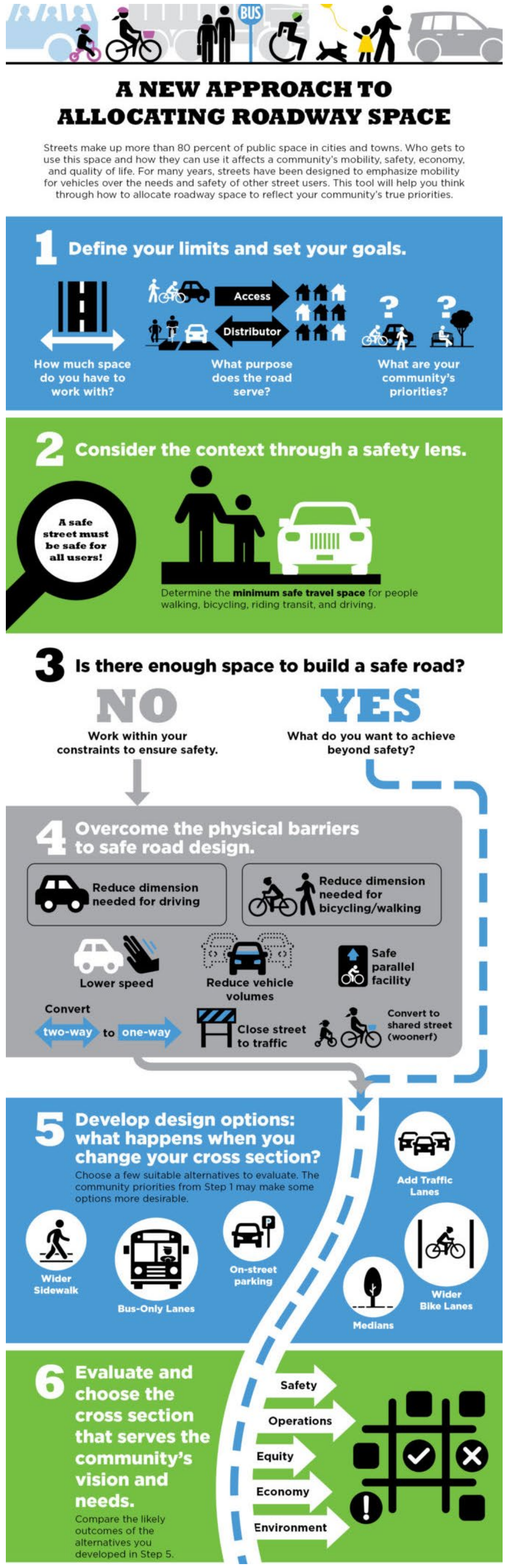
Complete Streets guidelines reviewed include many cross sections options for additional scenarios that vary from those included in TAC GDG, as they have been developed for specific communities. Cross sections tend to vary based on the adjacent land use context and road classification, and function as mobility or access. Some communities, such as City of London, Niagara Region and City of Calgary, map out their road network according to different classifications and the roadway hierarchy, and include corresponding cross sections for implementation. Other communities include example cross sections within Complete Streets Guidelines that serve as a starting point for design.

Several Complete Streets guidelines were found to acknowledge that retrofit situations entail design constraints and retrofit strategies are proposed to combat the associated constraints. For example, Edmonton's *Complete Streets Design and Construction Standard*s (2023) outline a process to evaluate trade-offs. A key element of the process is to identify the street type based on the relationship between the street and the land use (both existing and future, as documented in plans and policies), and identify the corresponding modal priority. Designers are encouraged to consider the full design domain of each cross section element to develop alternatives that accommodate prioritized modes. Where constraints exist, the highest priority mode takes precedence.

Ultimately, design of Complete Streets in retrofit conditions requires design professionals to evaluate trade-offs and to come up with a feasible solution that best accommodates all modes of transportation that are using the road. In some cases, a community-based approach to street cross sectional design which increases safety and promotes economic and environmental health has been adopted in recent years. A qualitative and quantitative approach is undertaken to make community-minded decisions while designing streets, emphasizing the impact on livability, equity, and environmental health, and providing practitioners with a practical framework for selecting inclusive street cross sections.

Different tools exist to assist in evaluating the trade-offs that often arise. Appendix B of NCHRP *Research Report 1036: Roadway Cross-Section Reallocation: A Guide* (2023) presents a comprehensive list of the common effects of adding, removing, widening, or narrowing different cross section elements on safety, mode shift, and economical, environmental, and social impacts. An accompanying decision-making workflow for reconstruction and repaving projects is shown in **Figure 2-16.**

Figure 2-16: Cross Section Decision - Making Framework Infographic



Source: NCHRP Research Report 1036: Roadway Cross Section Reallocation: A Guide (2023)

2.7 Universal Design and Accessibility

British Columbia's *Active Transportation Design Guide* (2019) describes universal design and accessibility within the cross section through the following principles:

1. Equitable Use – the design is useful and marketable to people with diverse abilities.
2. Flexibility in Use – the design accommodates a wide range of individual preferences and abilities.
3. Simple and Intuitive Use – use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
4. Perceptible Information – the design communicates necessary information effectively to the users, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for Error – the design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low Physical Effort – the design can be used efficiently and comfortably with minimal fatigue.
7. Size and Space for Approach and Use – appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

These principles are used to incorporate design elements that support people with mobility, vision or hearing disadvantages to navigate the street. These design elements include curb ramps, accessible slopes and grades, clear pedestrian through zones, smooth, firm slip-resistance surfaces, detectable warning surfaces (tactile walking surface indicators) and audible pedestrian signals.

Tactile walking surface indicators (TWSI) are used to provide information to people with vision loss and are typically used at conflict points. There are 2 types of TWSIs (i.e. Tactile Attention Indicator and Tactile Direction Indicator) which are commonly used across provinces. OTM *Book 18: Cycling Facilities* (2021) and Hamilton's *Complete Streets Guidelines* (2022) provide details on TWSI locations and design standards that consider the local context.

In addition to TWSI, Hamilton's *Complete Streets Guidelines* (2022) and Edmonton's *Complete Streets Design and Construction Standards* (2023) include details related to curb ramps and dropped curbs to support people with wheeled mobility aids, pushing strollers, walking bikes, etc., and also provides guidance on the type of curb that should be installed in different contexts to ensure safety and accessibility. Additionally, urban braille is a system of tactile information that uses color and texture contrast to provide warning signals and orientation cues. The City of Edmonton's curb ramp and adjoining sidewalk requirements for universal design accessibility are included in **Figure 2-17**.

Figure 2-17: Curb Ramp Design Requirements for Universal Accessibility

Design Criteria		*Design Requirement*
Approach/ Sidewalk	Cross Grade	≤ 2%
	Longitudinal Grade	≤ 5%
Curb ramp	Provision	At every corner and mid-block crossing
	Grade	≤ 6.0%
	Curb Ramp Flare	400 mm (separated sidewalk)/1700 mm (monowalk)
	Width (exclusive of fared sides)	1.8 m min.; should match sidewalk width
	Length	Based on grade
	Tactile Device	**Tool Grooved Concrete** Tool Grooved Concrete at minimum at each curb ramp along or crossings all freeway/expressway, arterial, and collector, and local streets and off-street shared pathways (e.g., paths along utility corridors) crossings with these street classifications. **Truncated Domes** Truncated domes shall be utilized at locations with high pedestrian volumes, including main streets, pedestrian priority areas, and street oriented developments, as well as at schools, transit centres, libraries, and recreation centres. If using truncated domes with midblock crossings, guidance should also be provided to direct users to the crossing, a physical element perpendicular should also be considered. Example details 5520, 5521, 5522, 5523, 5524, 5530 and 5531 provide guidance around the use of truncated domes for curb ramps. 5530 and 5531 provide pilot examples of directionality using truncated domes and detectable guidance surface indicators.
Landing	Width	Match curb ramp
	Length	1.8 m min. and up to 2.25 m to accommodate most wheelchair types

Source: Complete Streets Design Guidelines (2023) – Table 3.28, City of Edmonton

Accessible pedestrian signals (APS) provide a series of sounds to indicate when it is safe to cross an intersection. APS, as illustrated in **Figure 2-18** are suitable for people with limited vision.

Figure 2-18: Accessible Pedestrian Signals (APS)

Source: Complete Streets Design Guidelines (2022), City of Hamilton

British Columbia's *Active Transportation Design Guide* (2019) describe score lines, a series of parallel lines that are embedded into concrete pavement (as shown in **Figure 2-19**) that provide directional wayfinding for people with vision loss.

Figure 2-19: Score Lines on Curb Ramps

Source: Active Transportation Design Guide (2019), British Columbia Ministry of Transportation and Transit

Clearing Our Path (2022) guidelines include guidance for people with vision loss at locations such as stairs, ramps, platform edges, etc. The guide suggests that persons with sight loss may require texture and high contrast colour aids for improved navigation. The considerations for various surface materials are summarized in **Figure 2-20**.

Figure 2-20: Materials Used in Accessible Spaces

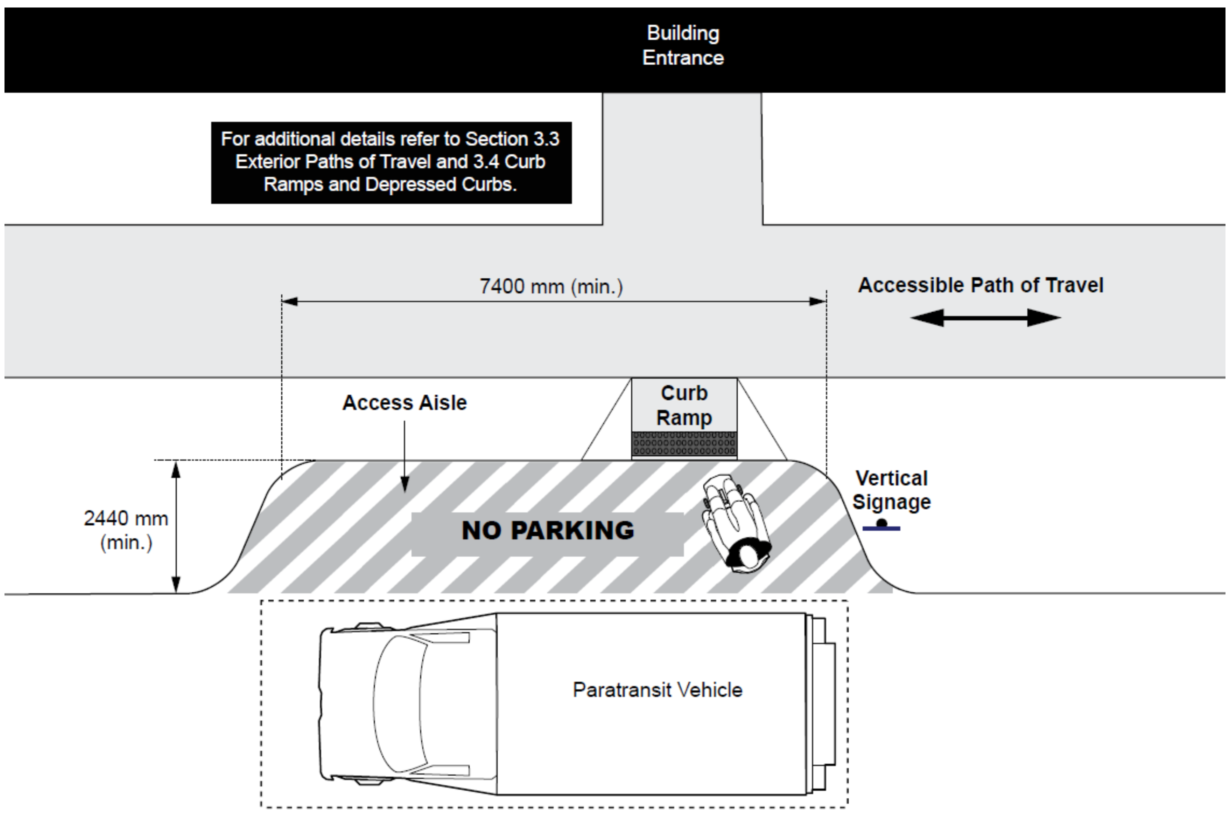
Materials	Pros	Cons
Asphalt	Slip resistant. Smooth and hard; good for mobility aids. Easy to maintain. Good for patios, walkways, pathways, gazebo floors	May become rough with time. Colour may fade reducing contrast to adjacent surfaces. May break over time, especially over roots of trees. Proper drainage required to prevent water from pooling. Sealants may be required over time
Interlocking Stones	Variety of textures. Variety of colours. Good for patios, walkways, pathways gazebo floors. Aesthetically appealing	May be slippery when wet. May provide firm, bumpy surfaces (depends if edges are bevelled). Stones need to be properly installed to ensure level surfaces. Periodic lifting of stones with freezing and thawing resulting in potential tripping hazard
Paving Stones	Smooth; ideal for mobility aids. Variety of colours. Suitable for patios, walkways, pathways and gazebo floors. Easy to maintain and clean	Slippery when wet. Tripping edges, due to movement over time
Poured Concrete	Not slippery when wet provided surfaces are brush finished or stamped with a texture. Very smooth; ideal for mobility aids. Suitable for patios, walkways, pathways, porches and gazebo floors	More expensive and difficult to maintain than individual paving slabs. Mainly white/grey although concrete may be coloured with chemical finishes. Subject to cracking
Rubberized Surfaces	Slip resistant when surfaces are textured. Available in smooth and textured material. Smooth and level. Excellent resilience. Easy to clean. Comes in a variety of colours. Easy to maintain	May be expensive. Staining may occur. Smooth textures may cause slipping. Grease spills may create slipping problems. May instigate environmental allergies

Source: Clearing our Path (2022) (partial reproduction)

Ottawa's *Accessibility Design Standards* (2015) provides guidance on passenger loading zones, and transit stops. It dictates passenger loading zones to be a minimum of 7.4 m long, 2.44 m wide (see **Figure 2-21**), and gives further information not specific to cross section design such as where loading zones should be located. The passenger loading zones are designed as a layby to provide a refuge/loading area for passengers, particularly those with mobility devices such as wheelchairs. Stopping in-lane allows for level boarding and minimizes the need for paratransit vehicles to maneuver in and out of traffic. The layby provides a safe buffer between the loading area and adjacent vehicle traffic, while providing flexibility for other uses, such as for delivery vehicles.

The standards also include details on minimum design widths for accessible transit shelters and stops, as well as boarding and alighting areas. It notes that the construction and redevelopment of accessible on-street parking design requires consultation with stakeholders, but does not provide specific guidance.

Figure 2-21: Passenger Loading Zone – Plan View

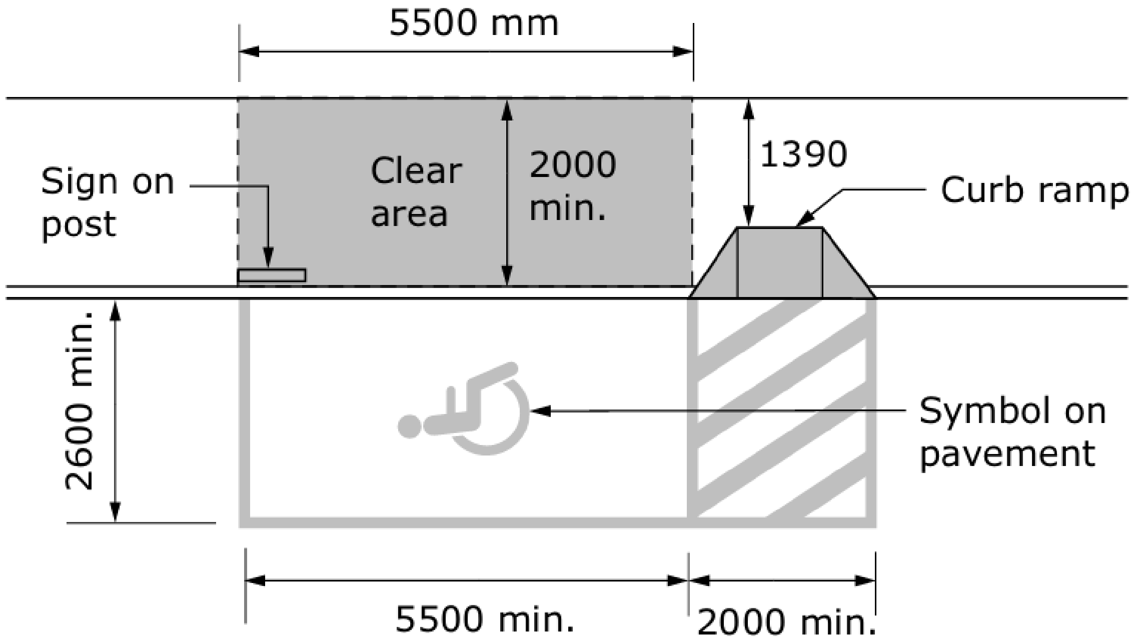


Source: Accessibility Design Standards (2015) – Figure 28, City of Ottawa

The *CSA Standard B651:23 Accessible Design for the Built Environment* (2023) provides detailed guidance for the design of accessible parking stalls. The minimum width for parallel parking stalls is higher than other guidelines reviewed at 2.6 m minimum width, as shown in **Figure 2-22**.

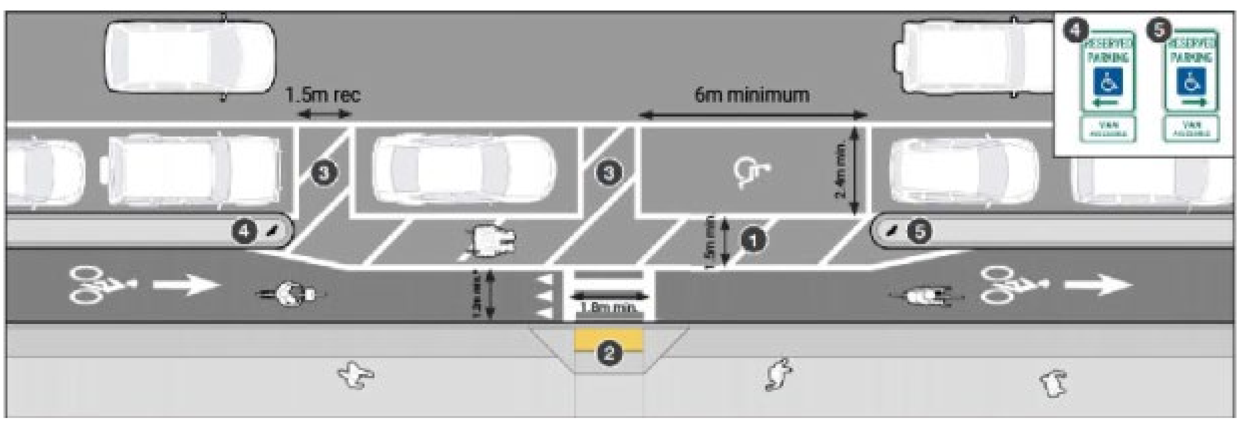
The design of accessible on-street parking adjacent to cycling infrastructure is discussed in Hamilton's *Complete Streets Design Guidelines* (2022), which references MassDOT standards in their own guidelines and calls for the bike lane to be narrowed, providing additional space for passengers to move around the parked vehicles, as shown in **Figure 2-23**.

Figure 2-22: Parallel Accessible Parking Space



Source: CSA Standard B651:23 Accessible Design for the Built Environment (2023) – Figure 68

Figure 2-23: Accessible On-Street Motor Vehicle Parking



Source: MassDOT in Hamilton's Complete Streets Design Guidelines (2022) – p.100

2.8 Lane Widths

The literature review found that most Canadian sources use lane widths based on TAC's GDG. Deviations from the GDG were based on reflecting local contexts and considering additional factors such as speed, parking turnover, curbside use, etc. Most guidance specifies that curb lane widths are measured from face of curb (e.g. Edmonton's *Complete Streets Design and Construction Standards* (2023), Vancouver's *Engineering Design Manual* (2019) and Tor*onto's Road Engineering Design Guidelines* (2018). The Hamilton *Complete Streets Design Guidelines* (2022) assigns lane widths based on parameters for urban streets and speed of the roadway.

The City of Edmonton *Complete Streets Design and Construction Standards* (2023) considers the public realm, and adjacent land uses and provides guidance for lane widths. The guidance provides a distinction for roadways with design speeds of 50 km/h or less (shown in **Figure 2-24**), and roadways with design speeds greater than 50 km/h. The CROW *ASVV Guide – Recommendations for Traffic Provisions in Built-Up Areas* (2016) provides significant guidance on shared roadways that are 30 km/h or less and recommends significantly lower lane widths than what TAC GDG currently recommends.

Figure 2-24: Lane Widths for Design Speeds Below 50 km/h

Parameter: Lane Widths [1,2]	*Design Domain Recommended Range*		*City of Edmonton Target Value*
	Recommended Lower Limit	*Recommended Upper Limit*	
Standard Travel Curbside Lane (non-transit, non-truck route) [3]	3.25	3.75	3.25
Standard Travel Lane (non-transit, non-truck route)	3.00	3.50	3.00
Transit Route Curbside Lane	3.55	3.75	3.55
Transit Route Lane	3.30	3.50	3.30
Truck Route Curbside Lane	3.55	3.95	3.65
Truck Route Lane	3.30	3.70	3.40
Parking Lane	2.35	2.65	2.45[4]

Notes:

1. Dimensions are for through and turning lanes. Turning lanes are typically at the lower end of the recommended ranges as these movements are completed at lower Operating Speeds.

2. Dimensions are measured to face of curb for curbside lanes.

3. For local streets, alleys, shared streets, and pedestrian only streets, a combined single drive lane with yield operation for both directions can be provided. This shared lane must be a minimum of 4.1 metres wide. For local streets, the minimum Travelled Way width shall be 8.0 m to accommodate required offsets for underground utilities and emergency response access, which may require parking restrictions. Service roads have a minimum Travelled Way width of 6.0 m due to the presence of an adjacent street. The designer must also consider the impacts of underground utilities, as well as winter design and operations when selecting Travelled Way widths.

4. Parking lanes for large trucks in industrial areas shall be 3.10 m to face of curb for collector and local roadways.

Source: Complete Streets Design and Construction Standards (2023) – Table 3.6A, City of Edmonton

Edmonton's standards require designers to consider the following elements when selecting lane widths: street classification, travel mode prioritization, parking utilization and turnover, collision history, and snow clearing and storage requirements. Hamilton's guide also offers guidelines relating to passenger loading zones in different configurations and discusses considerations surrounding curbside activities such as food trucks, flex zones, and EV charging areas. Hamilton's guide recommends locating the passenger loading zone at the beginning of a block and to increase the width of the buffer where a loading zone is located next to a cycling facility to allow pedestrians to wait within the buffer.

The City of Toronto's *Lane Width Guideline* within the *Road Engineering Design Guidelines* (2018) were developed based on a review of several other guidelines. The recommended lane width dimensions consider design controls such as dedicated cycling facilities, speed limit, TTC bus routes, TTC streetcar routes, high truck volume and horizontal alignment curves. The guideline recognizes that lane widths may be difficult to implement on all corridors due to limited road widths and includes a prioritized list of elements that should be allocated to a cross section in order of priority. **Figure 2-25**: below shows the recommended lane widths.

Figure 2-25: Lane Width Dimensions

Table 2.4.1.A Lane Width Dimensions

<table>
<tr><th colspan="3" rowspan="2"></th><th rowspan="2">Minimum (m)</th><th rowspan="2">Target (m)</th><th rowspan="2">Maximum (m)</th><th colspan="2">TTC</th><th rowspan="2">High Truck Volume</th><th rowspan="2">Horizontal Alignment Curves</th></tr>
<tr><th>TTC Bus Routes</th><th>TTC Streetcar Routes</th></tr>
<tr><td rowspan="3">Through Lane</td><td colspan="2">60km/h or more</td><td rowspan="3">3.0</td><td>3.0</td><td>3.5</td><td rowspan="3">x</td><td rowspan="3">+[1]</td><td rowspan="3">+</td><td rowspan="3">+</td></tr>
<tr><td colspan="2">50km/h</td><td>3.0</td><td>3.3</td></tr>
<tr><td colspan="2">40km/h or less</td><td>3.0</td><td>3.0</td></tr>
<tr><td rowspan="4">Curb Lane</td><td colspan="2">Shared Curb Lane without Urban Shoulder</td><td>3.3</td><td>4.3</td><td>4.3</td><td rowspan="4">+[2]</td><td rowspan="4">x</td><td rowspan="4">+</td><td rowspan="4">+</td></tr>
<tr><td rowspan="3">Shared Curb Lane with Urban Shoulder or Curb Lane with Dedicated Cycling Facility</td><td>60km/h or more</td><td rowspan="3">3.0</td><td>3.5</td><td>3.5</td></tr>
<tr><td>50km/h</td><td>3.3</td><td>3.5</td></tr>
<tr><td>40km/h or less</td><td>3.3</td><td>3.5</td></tr>
<tr><td colspan="3">Urban Shoulder</td><td>1.2</td><td>2.3</td><td>2.3</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Two-way Left Turn Lane</td><td>3.0</td><td>3.0</td><td>3.3</td><td>x</td><td>x</td><td>+</td><td>+</td></tr>
<tr><td colspan="3">Dedicated Left Turn Lane</td><td>3.0</td><td>3.0</td><td>3.3</td><td>x</td><td>x</td><td>+</td><td>+</td></tr>
<tr><td colspan="3">Dedicated Right Turn Lane</td><td>3.0</td><td>3.0</td><td>3.3</td><td>+</td><td>x</td><td>+</td><td>+</td></tr>
<tr><td colspan="3">Dedicated Parking Lane</td><td>2.0</td><td>2.4</td><td>2.8</td><td>x</td><td>x</td><td>x</td><td>+</td></tr>
<tr><td colspan="3">Dedicated Cycling Facility</td><td colspan="3">Note 1</td><td></td><td></td><td></td><td></td></tr>
</table>

Note 1 – Refer to Ontario Traffic Manual Book 18: Cycling Facilities
[1] Through lanes should be a minimum width of 3.1m on TTC streetcar routes.
[2] Curb lanes should be a minimum width of 3.3m on TTC bus service routes.
x Shows that the influencing design control has no impact on the lane widths.
+ Shows that the influencing design control gives reasoning to provide a lane width wider than the target, up to the maximum lane width.

Source: Road Engineering Design Guidelines – 2.0 Lane Widths Guideline (2018) - Table 2.4.1.A (table end notes added manually for legibility), City of Toronto

Research suggests that, when used in combination with other measures, narrowing lane widths can be an effective tool for speed management without compromising capacity. *NCHRP Research Report 880: Design Guide for Low Speed Multimodal Roadways* (2018) indicates that in low and moderate-speed contexts, lane widths should be measured to the face of curb unless legacy catch basin inlets or gutter design pose a safety risk to cycling or driving and cannot be addressed within the project scope. It is also recommended that under conditions with lower urban operating speeds (40 to 50 km/h), there is generally no need for an offset between the median curb face and the travel lane.

ITE's *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* (2010) indicates that lane width should be chosen based on four main factors: target speed, design vehicles, available right-of-way, and width of adjacent bicycle and parking lanes. Parking lane widths range from 2.0 m to 2.8 m depending on the road classification and context. Accessible on-street parking lane widths ranged from 2.4 to 2.6 m.

Comprehensive research published by Johns Hopkins Bloomberg School of Public Health, *A national Investigation on the Impacts of Lane Width on Traffic Safety: Narrowing Travel Lanes as an Opportunity to Promote Biking and Pedestrian Facilities Within the Existing Roadway Infrastructure* (2023), suggests wider lanes typically used in the United States (and replicated in Canada) are often unnecessary, can lead to increases in crashes, and could be repurposed to support better walking and cycling facilities. The core findings from that research are as follows:

- On streets with posted speed limits of 20-25 mph (~32-40 km/h), drivers do not perceive the difference in lane width and there is no difference in mid-block crashes between lanes of 9 ft-13 ft (~2.8-4.0 m).
- On streets with posted speed limits of 30-35 mph (~48-56 km/h), there are significantly higher numbers of crashes mid-block when the lane is 10 ft (~3.0 m) or wider compared to 9-ft (~2.8-m) lanes.
- On streets with a speed limit of >35 mph (~56 km/h), 11-ft lanes (~3.3 m) are still more appropriate if they serve as transit or freight corridors.

NACTO's *Urban Street Design Guid*e (2013) offers the following additional guidance on lane widths:

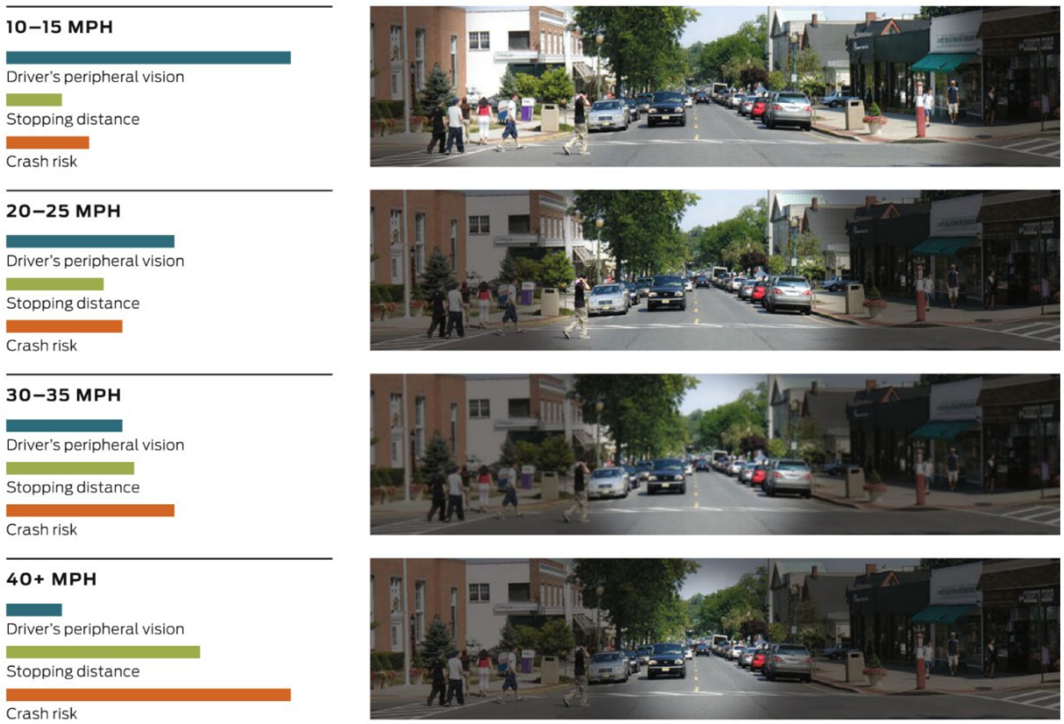
- Travel lane widths of 10 feet (3.0 m) generally provide adequate safety in urban settings while discouraging speeding. Cities may choose to use 11-foot (3.4 m) lanes on designated truck and bus routes (one 11-foot (3.4 m) lane per direction) or adjacent to lanes in the opposing direction.
- Parking lane widths of 7–9 feet (2.1 m to 2.7 m) are generally recommended. Cities are encouraged to demarcate the parking lane to indicate to drivers how close they are to parked cars. In certain cases, especially where loading and double parking are present, wide parking lanes (up to 15 feet (4.6 m)) may be used. Wide parking lanes can serve multiple functions, including as industrial loading zones or as an interim space for bicyclists.
- For multilane roadways where transit or freight vehicles are present and require a wider travel lane, the wider lane should be the outside lane (curbside or next to parking). Inside lanes should continue to be designed at the minimum possible width. Major truck or transit routes through urban areas may require the use of wider lane widths.

2.9 Speed Management and Safety Considerations

The interaction between cross section elements and speed management is also the object of the TAC *Design and Operation of Lower-Speed Collector and Arterial Roads Synthesis of Practice* (2025). Cross section elements that influence speed include the roadway width, lane width, presence of on-street parking, streetscape elements (including LID), clear zone, lateral clearance, and bicycle lanes. Relevant findings from this Synthesis of Practice should be integrated into any revision to Chapter 4.

NACTO's *Urban Street Design Guid*e (2013) summarises effectively the relationship between speed, stopping distance, and crash and fatality risk, as shown in **Figure 2-26**.

Figure 2-26: Relationship Between Speed and Crash Risk



As a driver's speed increases, his peripheral vision narrows severely.[2]

Higher speeds =
Higher crash risk =
Higher injury severity =
Lower safety

SPEED (MPH)	STOPPING DISTANCE (FT)*	CRASH RISK (%)†	FATALITY RISK (%)†
10–15	25	5	2
20–25	40	15	5
30–35	75	55	45
40+	118	90	85

* Stopping Distance includes perception, reaction, and braking times.

† Source: Traditional Neighborhood Development: Street Design Guidelines (1999), ITE Transportation Planning Council Committee 5P-8.

Conversions:

10 – 15 MPH	16 km/h – 24 km/h
20 MPH – 25 MPH	32 km/h to 40 km/h
30 MPH – 35 MPH	48 km/h – 56 km/h
40+ MPH	64+ km/h

Source: Urban Street Design Guide (2013) - p. 141, NACTO

NACTO offers the following guidelines for urban streets (and further contextual guidance is provided in *City Limits* (2020):

- The maximum target speed for urban arterial streets should be 35 mph (~60 km/h). Some urban arterials may fall outside of built-up areas. Where intersection spacing is higher and pedestrian and cycling interactions are uncommon, a higher target speed may be appropriate.
- The maximum target speed for urban collectors or local streets should be 30 mph (~50 km/h).
- In neighborhoods, designers should consider 20 mph (~30 km/h) zones to reduce speeds to those safe for interaction with children at play and other unpredictable behavior.

NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool (2021) by the National Academies of Sciences & Engineering and Medicine (NASEM) includes a detailed compilation of the roadway factors associated with both speeds and crash frequencies in the urban and rural contexts, as summarized in **Figure 2-27**.

The factors associated with an increase in urban operating speeds include an increase in average annual daily traffic (AADT), higher posted speed limits, presence and width of a centre dividing median, the number and width of lanes, shoulder width, and presence of bicycle lanes. Factors associated with a decrease in urban operating speeds include horizontal curves, vertical alignment (steeper grades), increased access density, presence of a school, presence of on-street parking, development presence adjacent to the roadway, and two-way operations. With regards to the posted speed limit, NASEM (2021) notes that the magnitude of the increase in operating speed is only a fraction of the amount of the actual speed limit increase.

Figure 2-27: Effect of Variables on Operating Speeds and Crash Frequencies

Category	Variables	Rural Operating Speed	Rural Crash Frequency	Urban Operating Speed	Urban Crash Frequency
Traffic	AADT	⇩⇧	⇧	⇧	⇧
	Operating speed	—	⇩⇧	—	⇧
	Congestion	—	—	—	⇧
	Percent truck	⇧	⇧	⇧	⇩
TCD	Posted speed limit	⇧	⇩⇧	⇧	⇩⇧
	Signalized intersection	—	—	—	⇧
	Passing lane/zones	—	⇩	—	—
Roadway Geometry	Horizontal alignment	⇩	⇧	⇩	⇩⇧
	Vertical alignment	⇩	⇧	⇩	⇧
	Presence of median	⇧	⇩⇧	⇧	⇩⇧
	Median width	⇧	⇩⇧	⇧	⇩⇧
	Number of lanes	⇧	⇧	⇧	⇧
	LW	⇧	⇩	⇧	⇩
	SW	⇧	⇩	⇧	⇩
	Bike lanes	—	—	⇧	⇩
	Intersection angle	—	—	—	⇧
	Intersection lighting	—	—	—	⇩
Surroundings	Access density (driveways and intersections)	⇩	⇧	⇩	⇧
	School	—	—	⇩	⇩
	Parking	—	—	⇩	⇧
	Liquor store	—	—	—	⇧
	Sidewalk presence	—	—	—	⇩
	Development (surrounding land and use)	⇩	⇧	⇩	—
Other variables	One-way or two-way	—	—	⇩	—

Note: ⇧ = increase with increase of the attribute, ⇩ = decrease with increase of the attribute, ⇩⇧ = mixed effect, — = relationship not identified or unknown.

Source: NASEM (2021) – Table 25

Speed choice is influenced by a wide range of factors including behavioural issues (e.g. influence of passengers, attitudes to safety), traffic factors (e.g., volumes of vehicles, presence of parked vehicles) and specific factors related to urban arterial roads (e.g., road layout, lane/shoulder width, roadside development, hazards and activity, presence of a median, number of access points, horizontal alignment, sight distance and road smoothness).

The *FDOT Design Manual*, Chapter 202 (2025) introduces three general speed management concepts that form the basis for successful strategies:

- Creating a sense of enclosure for motorists, using street trees, buildings close to the street, parked cars, and terminated vistas

- Creating environments that engage drivers, such as the potential hazard of a parked car's door opening, increasing the driver's cognitive load and lowering operating speeds
- Using horizontal or vertical deflection which creates a visceral physical sensation for the driver (compared to the previous two strategies which mainly rely on psychology)

Horizontal deflection refers to a lateral shift or lane/shoulder narrowing that may be introduced through curb extensions, chicanes, roundabouts, traffic circles, or medians. Vertical deflections manage speeds by creating raised areas in the path of motor vehicles and include speed humps, speed tables or platforms. Vertical deflections impact larger vehicles such as transit and emergency service providers, and that should be considered prior to implementation.

NACTO's *Urban Street Design Guide* (2013) also recommends the use of speed controls that alter the configuration of a roadway or change how people psychologically perceive and respond to a street. Of the traffic calming tools suggested, some impact intersection design and are out of the scope of cross section design. Of those that directly relate to cross section design, many overlap with tools suggested in other guidance documents: medians, pinch points, chicanes, lane shifts, 2-way streets, street trees, and on-street parking. NACTO does not provide detailed design guidance for these elements, but many, such as pinch points and chicanes, can fit within a cross section that includes on-street parking by removing the parking provision for a short distance.

NACTO recommends that vertical speed control elements (i.e., speed humps, speed tables, speed cushions) should be applied where the target speed of the roadway cannot be achieved through conventional traffic calming elements.

2.10 Intelligent Transportation Systems

Intelligent transportation systems (ITS) are information and communication technologies that aid in advancing safety and efficiency in traffic management and transportation systems. More specifically, Intelligent Transportation Systems Canada defines ITS as "the application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy, and the environment".

Under the umbrella of ITS, Advanced Traffic Management Systems (ATMS) have proven to be one of the most successful components in achieving improvements in mobility, safety, and overall productivity of the transportation system (OTM *Book 19: Advanced Traffic Management Systems*, 2007). An update to Chapter 4 should consider the addition of design guidelines for intelligent transportation systems as this field further develops and increases in implementation.

The *Advanced Traffic Management System (ATMS) Design Guidelines* (2021) of the Ontario Ministry of Transportation cover multiple topics within intelligent transportation systems. The placement and location of detector loops and constraints with standards are given, with specific additional considerations for double loop Vehicle Detector Stations (VDS) mainline and single loop VDS for ramps. Loops may be used to collect volume, occupancy, and speed data.

Non-intrusive traffic sensors (traffic radars) are also discussed in detail relating to the location, installation, and quantity. Traffic sensors may be mounted on the side of a roadway or overhead on poles or similar infrastructure. Bluetooth reader technology that measure travel time and speed of automobile users and are also discussed in the ATMS. Information on both queue and weather warning systems, and variable message signs are provided in the guide. Cable routing and maintenance of ITS infrastructure is also presented.

For jurisdictions considering ATMS, the OTM *Book 19: Advanced Traffic Management Systems* (2021) recommends several steps before deployment:

1. Identifying existing conditions
2. Predicting future traffic conditions
3. Identifying existing and future needs and problems
4. Establishing ATMS goals and objectives
5. Selection of appropriate strategies.

The *NCHRP Active Traffic Management Strategies: A Planning and Evaluation Guide* (2024) notes that while some strategies may include changes to the right of way (i.e., geometrics, pavement markings, striping, structures, gantries, static signage), many strategies can be built into existing right of way structures and existing signal equipment with updated software. Note, it is important to follow the recommended sight distances and placement standards for ITS elements, as dictated by your guiding jurisdictional reference document. **Table 2-2** presents a list of ATMS features that fall into either category.

Table 2-2: Examples of ATMS Features and their Level of Impact on Roadway Cross Section Elements[1]

ATMS Feature	Requires updates? (Y/N)	Explanation
Dynamic Message Signs	N	Dynamic Message Signs can be included in existing gantries. They should be located sufficiently upstream of known bottlenecks and high-crash locations
Lane Management Signs	N	Lane Management Signs can be included in existing gantries. Requires updated detection systems
Vehicle Detection Stations	N	An assessment will be conducted to determine if existing equipment can be utilized rather than adding new equipment. If within the limits of the equipment, use an existing cabinet rather than adding a new cabinet
Transit Signal Priority	N	Requires changes in existing signal timing plans and vehicle detection
Adaptive Ramp Metering	Y	May require ramp modifications to accommodate adaptive ramp metering stations
CCTV Technologies	N	CCTV Cameras can be located on existing poles (typically at a height range of 30-50 feet)
Dynamic Shoulder Use	Y	Potential need for drainage modifications, shoulder reinforcement, or removal of rumble strips
Queue Warning	N	Minimal changes required if existing field infrastructure like dynamic message signs and detection are located at the right locations along the bottleneck
Variable Speed Limits	N	Variable Speed Limit signs can be included in existing gantries. Requires updated detection systems
Dynamic Lane Reversal	Y	May require adjustable separation of lanes
Adaptive Traffic Signal Control	N	Existing signals may be used with updated software including bicycle and pedestrian detection

ATMS Feature	Requires updates? (Y/N)	Explanation
[1](NCHRP - ATMS Planning and Evaluation Guide (2024); Ontario Ministry of Transportation - ATMS Design Guidelines, (2021))		

Dynamic shoulder usage is an ATMS strategy that continuously monitors conditions to determine the need for using a shoulder lane based on congestion levels during peak periods, in response to incidents, or for use as a special purpose travel lane (e.g., transit only). Design requirements for this strategy include having the same shoulder lane width as a travel lane. Additionally, the shoulder lane should have no adverse superelevation. It is also possible to use pavement lighting to denote when the shoulder is open and closed (NCHRP, 2024).

While the dynamic use of shoulder lanes has been shown to reduce travel time and aid in incident management efforts, concerns include drivers using the shoulder during unauthorized times and speeding, which may make traffic conditions worse (NCHRP, 2024). Successful operations have been achieved when shoulder lanes were designed to be used for dynamic transit priority in locations such as Minneapolis-St. Paul, Minnesota, and Cincinnati, Ohio (Farzin et al., 2011).

In addition, as autonomous technology becomes increasingly prevalent, designing streets to accommodate Connected and Automated Vehicles (CAVs) becomes important. While there is still a degree of uncertainty regarding street design for CAVs, research by Riggs et al. (2020) posits that autonomous vehicles will travel closer together in platoons, with tighter vehicle tracking, and possibly via smaller vehicles. This suggests that there could be greater right-of-way recapture with a reduced number of lanes and narrower lane widths.

NACTO's *Blueprint for Autonomous Urbanism* (2019) states that street design and AV programming should restrict speeds to safe levels of 25 mph (40 km/h) citywide and even lower (15 to 20 mph (24 to 32 km/h)) in downtown cores, residential areas, and near schools. NACTO further recommends that frequent, formal midblock crossing points (every 50-100 feet (15-30 m)) coupled with sufficient gaps in AV traffic could relieve bottlenecks at intersections while accommodating pedestrian desire lines more seamlessly.

2.11 Curbside Management

Planning for the curbside activities is key to designing vibrant streetscapes. Effective usage of curbside space can also help to meet the street design objectives. ITE's *Curbside Management Practitioners Guide* (2018) provides a broad overview of the different potential uses of curbside space for parking/loading, transit, cycling, and pedestrian/activation purposes. Many of the recommended tools are programmatic and those that have cross section design implications typically do not provide design details.

Due to increases in active mode use and improvements to active transportation networks, the corresponding supporting infrastructure such as bike parking, scooter corrals, bike-share stations and other micro-mobility hubs are one of the major competitors for curbside space, alongside more traditional uses such as parking, waste collection (including, more recently, separated streams for waste, compost, and recycling), and emergency vehicle access. OTM *Book 18: Cycling Facilities* (2021) suggests strategies like designing bikeways with appropriate buffers and physical separation in areas with parking, pick-up/drop off bays, and shifting parking on streets with cycling facilities to nearby corridors/off-street locations. Similar strategies are included in Hamilton's *Complete Street Guidelines* (2022) and Toronto's *On-Street Bikeway Design Guidelines* (2023).

Unprotected bike lanes make it easier for various vehicles (waste collection, snow clearing, taxi/ride-hailing, and emergency vehicles) to access the curb face, but create facilities that are not typically adequate for people of all ages and abilities compared to cycle tracks (protected bike lanes). Toronto's *On-Street Bikeway Guidelines* (2023) and Hamilton's *Complete Street Guidelines* (2022) also consider curbside dining and food trucks as a mechanism to activate the streetscapes in contexts where implementation can concurrently manage the safety of cyclists, as shown in **Figure 2-28**.

Figure 2-28: A Cycle Track (Protected Bike Lane) Bends Around a Temporary Curb Lane Cafe

Source: On-Street Bikeway Design Guidelines (2023), City of Toronto

Hamilton's *Complete Streets Guidelines* (2022) and Edmonton's *Complete Street Design and Construction Standards* (2023) give design guidance on curbside activities like accessible parking, loading areas and flexible zones (i.e., multiple uses of the same space at different time-of-day).

Over the past several years, the installation of EV charging stations along the curbside were identified as potentially beneficial for the City of Hamilton to support the switch from motor vehicles to electric vehicles (see **Figure 2-29**). However, as chargers require additional space and adequate clearance for road users, the need for charging stations should be determined early in the planning process.

Figure 2-29: Curbside EV Charging Station

Source: Complete Streets Design Guidelines (2022), City of Hamilton

3. Practitioner Engagement

3.1 Overview

To identify key topics of focus and opportunities related to Chapter 4, the consultations were held with road authority employees, consultants and academics. The consultations were held through three different approaches as summarized below.

National Online Survey

An online survey was developed for circulation. The online survey was open for responses from August 19th to October 11th, 2024. A link was distributed to all TAC members and promoted at the 2024 TAC Conference and Exhibition. While 34 respondents started the survey, 25 substantially completed the core questions. These 25 response sets are summarized in this analysis.

Virtual Workshop

A cross-country virtual workshop was held on November 21st, 2024. The workshop participants were recruited from the online survey or their representatives, if those who participated in the survey could not attend. There were 13 practitioners who participated in the online event, and they shared their thoughts on Chapter 4 through discussions and by contributing to a Mural online whiteboard. Snapshots of the virtual workshop whiteboard can be found in **Appendix A**.

Individual Interviews

As a final outreach to practitioners, five individual interviews were held with professionals from Ontario and Quebec, as they had less representation in the virtual workshop. These discussions focused on similar themes as the workshop, and aimed to understand the current use of Chapter 4 and any gaps or modifications that should be addressed in an eventual revision. Two additional practitioners who were contacted provided brief email responses. This feedback is incorporated in the findings.

3.1.1 Key Findings

Taken together, the national online survey, virtual workshop, and follow-up interviews identified key findings that helped shape the approach to future updates to Chapter 4. Themes that emerged are summarized as follows:

- Chapter 4 is often a back-up reference. It is used when local standards are not sufficient, a deviation is required, or when updating local standards.
- Chapter 4 is most often used in rural or high-speed design. It is viewed as a reference for conventional design.
- Information about urban design and typical cross sections depicting urban environments are lacking.
- Additional, more granular, guidance is required at the lower end of the spectrum for both speeds and volumes.
- Better integration with other chapters is needed, including streamlined cross-referencing and integration of considerations from other chapters as they relate to cross sectional elements).

- An update to crossfall guidance is required.
- The section on snow should be expanded, particularly to include maintenance implications of cross section element choices.

3.2 Detailed Findings

3.2.1 Online Survey

3.2.1.1 Respondents Demographics

A summary of respondent demographics is provided below:

- Over half of the 25 respondents work as consultants in the private sector.
- Seven respondents indicated they work for a provincial or territorial agency.
- Four respondents work for a regional or municipal agency.
- One respondent identified as both a consultant and academic.

The role descriptions provided by respondents indicated they were generally experienced professionals (e.g., senior engineers, managers, etc.).

There was also relatively broad geographical representation across the country, although there were no respondents from Quebec, Newfoundland and Labrador, Prince Edward Island or the three territories.

3.2.1.2 Current Use of Chapter 4

A summary of responses related to use of Chapter 4 is provided below:

- Most respondents (14 of 25) indicated they use Chapter 4 on an average of 3 out of 10 projects.
- A fifth of respondents (5 of 25) reported never using the chapter.
- Six respondents use the chapter more frequently, split evenly between 6 and 9 times out of 10 projects.
- Under half of respondents consider Chapter 4 their first reference for cross section design, 11 use it as a first reference, while 14 do not.

Many respondents use provincial and local standards, or supplements to TAC, such as the BC supplement and the Saskatchewan supplement. A few respondents clarified that they use the local design guides first and reference TAC when the standards are lacking some details, or when the local standards point to Chapter 4.

Figure 3-1 illustrates how the current sections in Chapter 4 are used. Lane Widths and Shoulders are the most frequently used sections, and are used by over 50% of respondents. Other sections that are often used include:

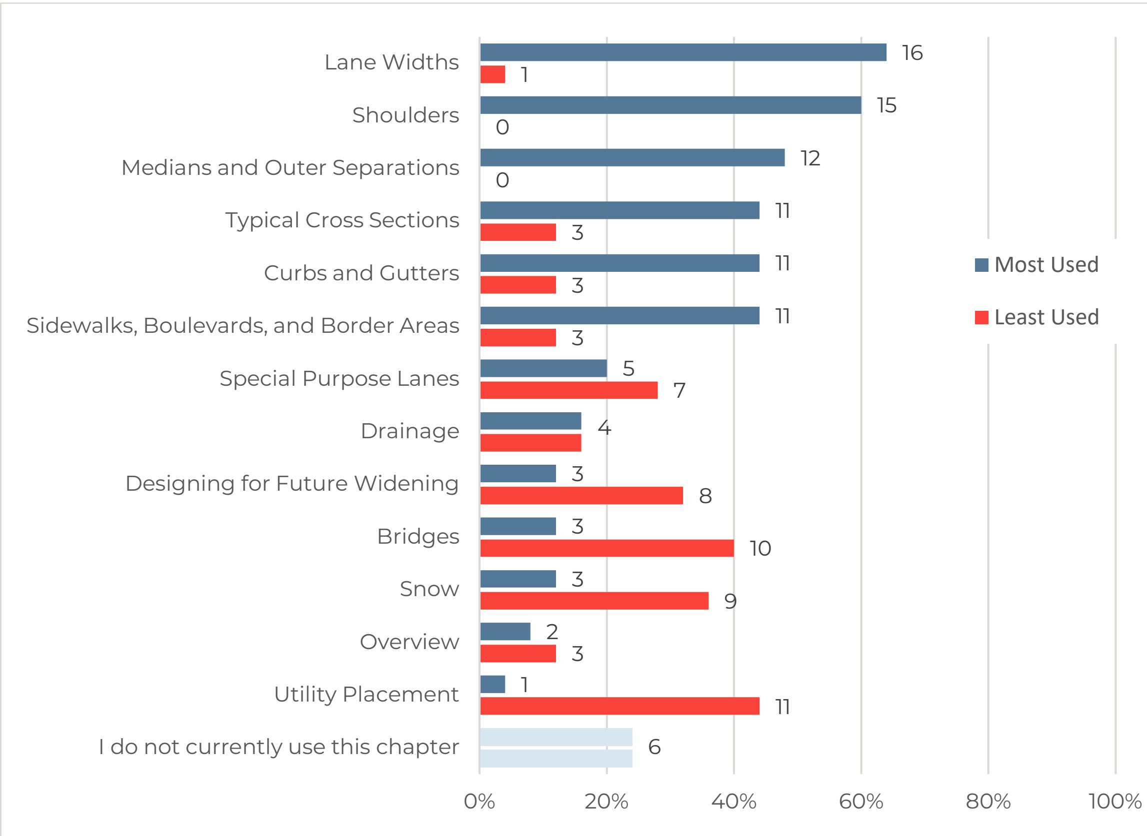
- Medians and Outer Separations
- Typical Cross Sections
- Curbs and Gutters
- Sidewalks, Boulevards, and Border Areas

The least used sections include:

- Utility Placement
- Bridges
- Snow
- Designing for Future Widening

Special Purpose Lanes has a mixed response, with five respondents indicating the section is among the most used, and seven selecting it as among the least used. The drainage section shows a similar pattern, with four selecting it as the least used and four as the most used.

Figure 3-1: Responses to the questions "Which sections do you use the most from the existing Chapter 4? (Select up to 5)" and "Which sections do you use the least from the existing Chapter 4? (Select up to 5)"



3.2.1.3 Ease of Use and Usefulness of Chapter 4

Respondents were asked how useful Chapter 4 is, how easy it is to find information, and how often they deviate from the recommended practice. For these three questions, responses were typically in the middle of the range. On the whole, respondents find Chapter 4 relatively useful (**Figure 3-2**), the information is relatively easy to find (**Figure 3-3),** and they rarely or sometimes deviate from the recommended practice (**Figure 3-4**).

The most common reason given for deviating from TAC guidance is using local jurisdictional guides. More recent guidance, particularly related to urban environments, is also used instead of Chapter 4 by some respondents (however, the specific guidance is not named).

Figure 3-2: Responses to the question "How useful would you rate the existing Chapter 4?"

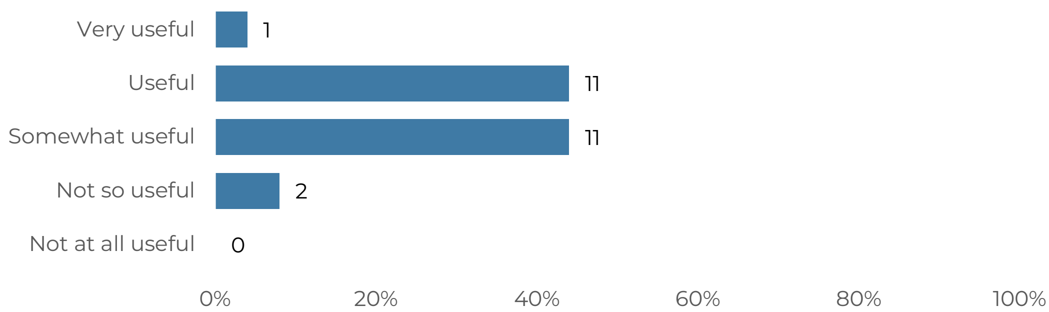


Figure 3-3: Responses to the question "How easy is it to find information in the existing Chapter4?"

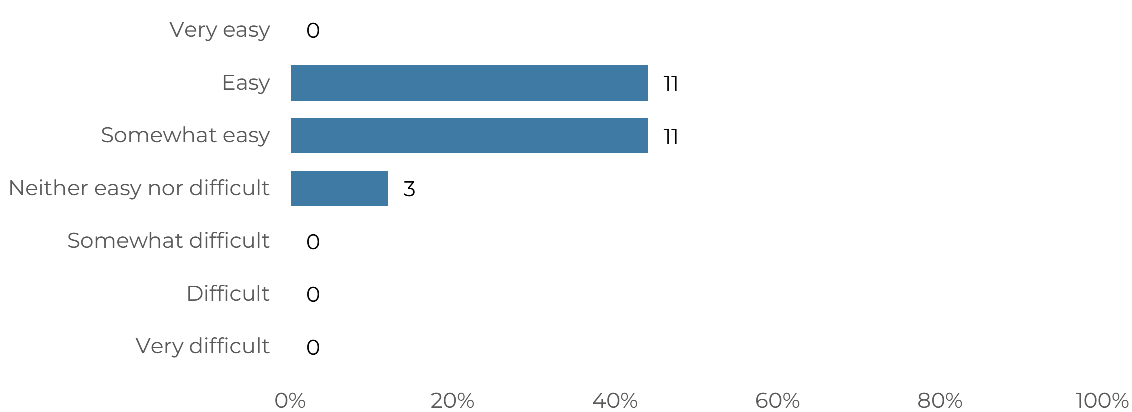
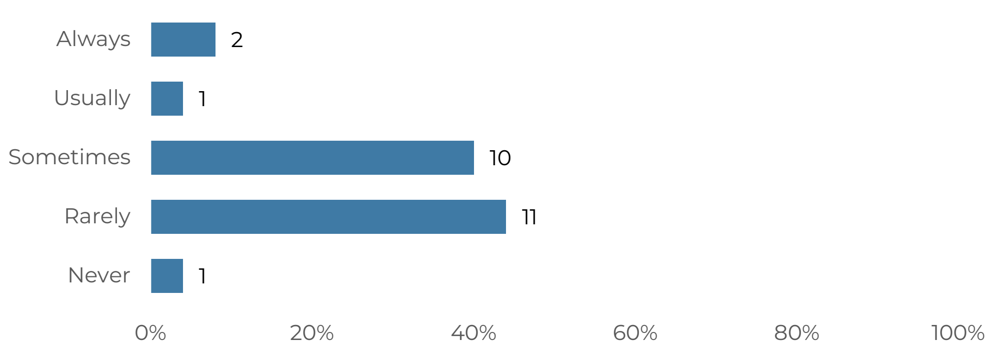


Figure 3-4: Responses to the question "How often do you deviate from the recommended practice in Chapter 4?"



3.2.1.4 Missing Elements and Impreovements to Existing Sections

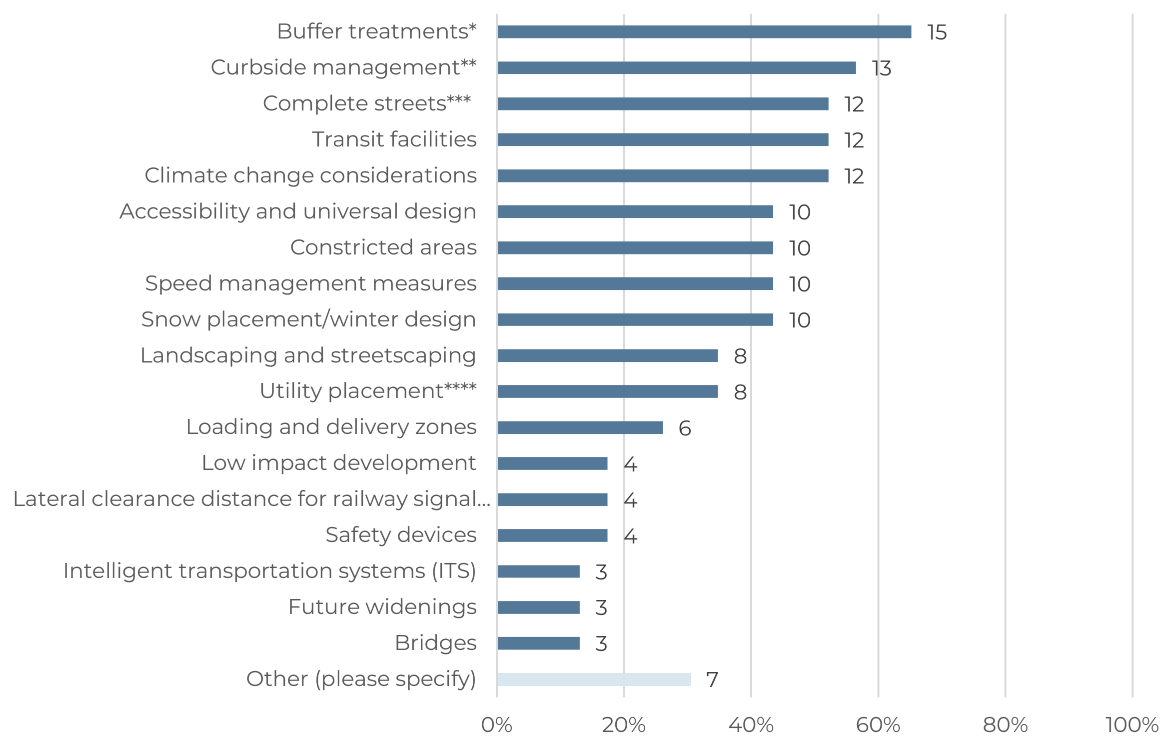
Respondents were asked to select elements from a pre-identified list of information potentially missing from Chapter 4. Two respondents did not answer. Of those who answered, over 50% identified the following elements as missing (see **Figure 3-5**):

- Buffer treatments (between different modes and uses)
- Curbside management
- Complete streets
- Transit facilities
- Climate change considerations

Respondents also had the opportunity to suggest other missing elements, and listed the following:

- Bike design and the interface between cyclists and pedestrians with a focus on accessibility.
- In an urban setting, what is an appropriate offset for fixed objects? (bus shelter, streetlights, etc.). When is it appropriate to use poles on break-away bases?
- Fringe area between rural and urban
- Rural treatments for cross sectional features

Figure 3-5: Responses to the question "What information is missing from the existing Chapter 4? (Select all that apply, there may be cross-over between areas)"



* Between different modes and uses
** e.g. Street furnishings, parking for shared bicycles/scooters, streetlighting
*** Notably related to retrofits and bridges
**** Above and below ground* Between different modes and uses

The survey also included specific questions on ways to improve each of the current sections. Suggestions from respondents for each section are listed below.

Overview: Suggested Improvements

- Include crossfall
- Complete Streets treatment guidance
- Climate change adaptations
- Additional heuristics on cross section design to influence lower speeds, particularly in urban environments
- Integrating active transportation design considerations

Lane Widths: Suggested Improvements

- Include references to Chapter 3 on lane widening
- Indicate effective lane width during winter months. Quantify, if possible, particularly for urban, lower classification roads
- Relate anticipated operating speeds to lane widths and discuss impact on safety and traffic flow
- Verify if CMFs are the most up-to-date
- Include all users, modes of travel and potential conflicts
- Include guidance on boulevard fixtures with narrow lane widths
    - Respondent example: “We have implemented lanes as narrow as 3.2 m in instances where we have an adjacent protected bike lane. The installation of the signage in the separation has regularly led to complaints about mirrors striking the signage.”
- Review guidance for lane widths on roads with AADT <450, coordinate with guidance in Chapter 11 Special Roads
- Confirm technical foundation in Section 4.2.1.1 is still relevant, considering more recent research and practice
- Enhance Section 4.2.2.2 on centreline rumble strips
- Provide guidance on locations where rumble strips should be installed: entire length, curves only, on marked no-passing sections, etc.
- Add or cross-reference information from Section 4.4.3.4 (shoulder rumble strips) that is also applicable to centreline rumble strips
- Include long-term maintenance concerns as a consideration

Special Purpose Lanes: Suggested Improvements

- Include shoulder widths for auxiliary lanes
- Add guidance for rural service or frontage road lanes
- Additional guidance on transit/HOV lanes
- Clarify what types of special lanes are included (e.g., bike lanes, bus lanes) and discuss their benefits. Consider including beneficial practices for their design and placement
- Discuss the safety effects of different types of parking
- Include transition zones/merging for transit, bike lanes, and HOV lanes as a consideration

Shoulders: Suggested Improvements

- Verify if CMFs are the most up-to-date
- Add guidance on shoulder widths for the following elements:

- Roads with AADT < 450 (coordinate with guidance in Chapter 11). May also warrant a further breakdown for smaller categories of AADT
- Higher design speed collector or local roads
- Shoulders used by e-scooters, e-bikes, etc.
- Width considerations when adding a barrier, and guiderail placement
- Expand on note about agencies using shoulder widths less than displayed in Table 4.4.1.
- Provide additional guidance and considerations for use of shoulders as travel lanes, particularly HOV/bus on shoulders
- Add explanation of the importance of shoulders for safety, emergency stops and drainage
- Discuss the use of shoulders for accessibility in rural areas

Medians and Outer Separations: Suggested Improvements

- Add information on clear zones, utilities, and vegetation cutback for fire protection
- Discuss the functional purposes of medians and separations
- Include cable medians
- Add considerations for auxiliary lanes
- Planning for future auxiliary lanes and beneficial practice to design for future improvements while maintaining desirable median separation
- When auxiliary lanes are present, clarify if median width should be based on the through lanes or edge of auxiliary lanes (Section 4.5.2, list item 9.)
- Introduce guidance on 2+1 roads

Sidewalks, Boulevards, and Border Areas: Suggested Improvements

- Accessibility topics:
    - Sidewalk grades
    - Minimum, desirable, and maximum longitudinal grades, for long sections (not just at ramps)
    - Increasing sidewalk width to 1.8 m minimum
- Continuous sidewalks and bike paths
- Urban interface, loading/unloading, parking
- Bio swales
- Active transportation considerations
- Micro mobility
- Bike infrastructure and interactions
- Protected bike lanes, multi-use paths

Curbs and Gutters: Suggested Improvements

- Clarify if gutter pan is included or not in the minimum shoulder width
- Considerations for the development of gutterless curb/gutter
- Include discussion of barrier curb, semi-mountable curb, truck aprons, half height curbs for bike lanes
- Include accessibility and snow clearing considerations
- Discuss maximum heights

Drainage: Suggested Improvements

- Update crossfall guidance
- Expand on effective drainage solutions and their importance for road longevity and safety. Include examples of beneficial practices and common pitfalls.

Snow: Suggested Improvements

- Discuss snow management strategies and their impact on design. Include considerations for areas with heavy snowfall and the importance of clear routes for emergency services.
- Discuss the impact of cross section design with minimum widths applied to all elements: increase in cost, longer service, or impossibility to clear
- Add guidance for divided rural highways: snow drifting benefits of staggering the vertical alignments as per Saskatchewan practice
- Add guidance on rounding of backslopes and offset distance in cut as per Saskatchewan practice

Bridges: Suggested Improvements

- Add information on railings for all users, separation between users.
- Clarify if guidance is different if the cross section is on the bridge or under.
- Add guidance on snow storage, snow spray through railings etc.
- Add discussion of expansion joint material consideration on sidewalks and bikeways

Utility Placement: Suggested Improvements

- Discuss clear zones and placement of poles, particularly in sidewalks and boulevards
- Include access needs for above and below ground utilities
- Provide guidelines for coordinating utility placement with roadway design. Discuss challenges and solutions related to maintenance and accessibility.
    - Include in particular the impact of installing conduit through major intersections on future operations
- Discuss implications of alignment selection in the right-of-way and protecting or blocking future alignments
- Discuss the value of installing multiple conduits or shared trenches

Designing for Future Widening: Suggested Improvements

- Include strategies for planning and executing future widening projects. Discuss potential impacts on existing infrastructure and community planning.
- Introduce guidance on 2+1 roads and staging of a passing lane corridor to a 2+1 road.

Typical Cross Sections: Suggested Improvements

- Introduce guidance on 2+1 roads
- Include crossfall
- Adapt design for the changing uses of e-mobility, such as bike lane width
- Include visuals or diagrams to illustrate typical sections more effectively
- Include cross sections that are representative of various road types and contexts
- Show urban sections that involve all modes and that include BRT
- Include cross section that includes BRT
- Include beneficial practice for bike infrastructure

3.2.1.5 Priorities

The last section of the survey included three questions that aim to identify priorities by asking respondents to name one element of importance in each of the following categories:

- One thing to change in the existing Chapter 4
- One thing to add that would make Chapter 4 more comprehensive
- An emerging trend to add to Chapter 4

Priority Elements to Change

- Improve integration with Chapter 11
- Integrate on-street active transportation design
- Provide examples of successful implementation
- Add the known safety effects of the cross sectional elements
- Modify the base crossfall to 3%
- Outline a mechanism to reduce lane width for buses, including if buses have cameras instead of mirrors
- Enhance visuals
- Provide guidance in a binder rather than glued bindings

Priority Elements to Add

- Include guidance on 2+1 roads
- Include guidance on designing for slow speeds for collectors and in dense urban environments, and guidance to design for the desired speed rather than the existing speed
- Enhance guidance on median and shoulder widths
- Include shoulder maintenance considerations
- Include guidance on the use of wick drains in urban cross sections
- Include climate change considerations
- Include guidance on superelevation
- Include guidance on allocating cross sectional width in constrained urban areas
- Update guiderail maintenance to follow change to standards (NCHRP to MASH)
- Provide a greater focus on urban issues

Priority Emerging Trends to Add

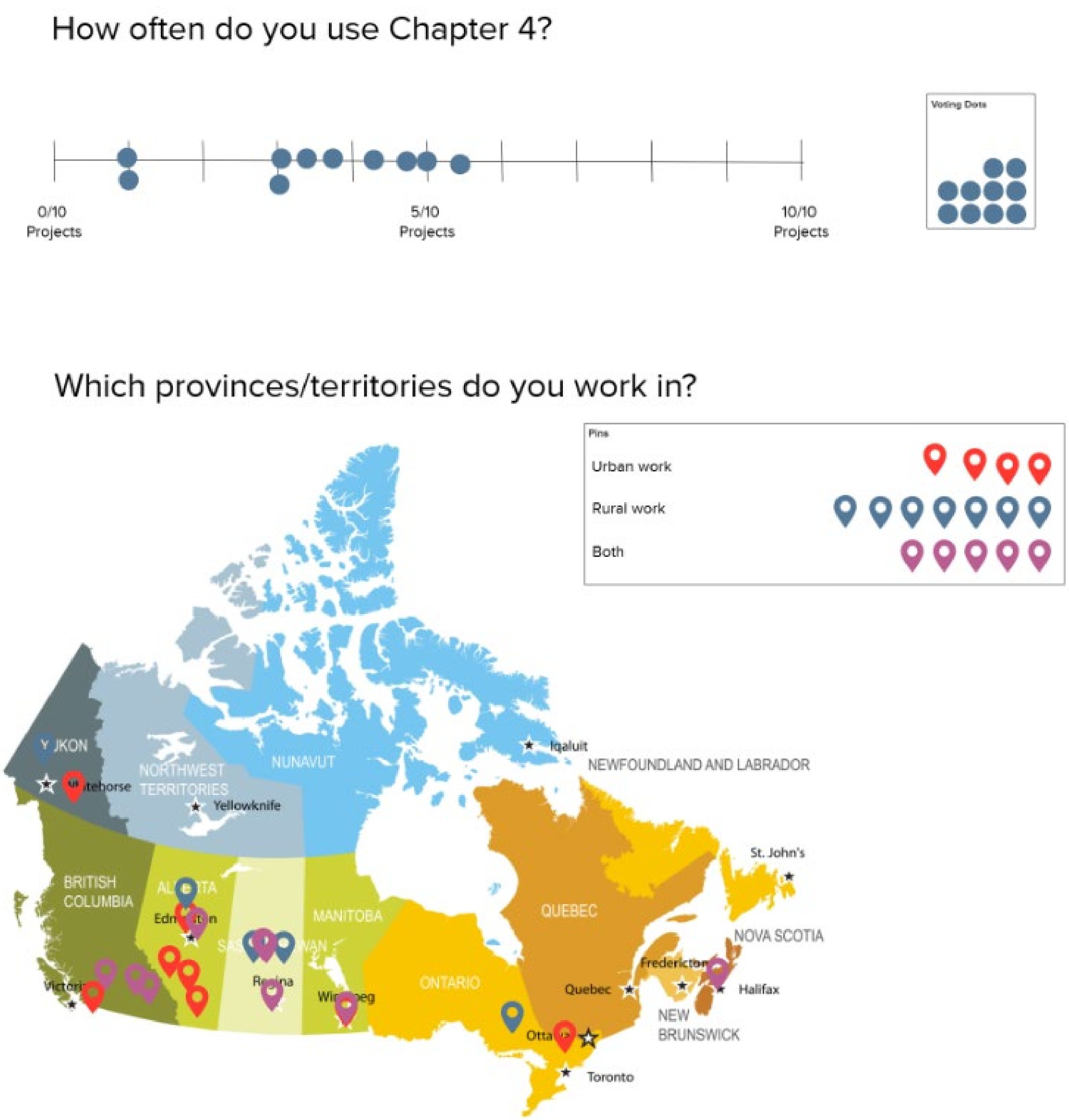
- 2+1 roads
- Accessibility
- Active transportation, e-mobility, including considerations for constrained rights-of-way
- Use of rolled curbs for bike lanes
- Transition buffer designs between sidewalks and bike lanes
- HOV and transit lanes
- 3% crossfall
- Curbside management and allocation
- Complete Streets
- Climate change
- Flexible roadway design: adaptable geometric features such as adjustable lane widths, movable barriers or dynamic lane allocations. Include guidelines on how to implement flexible designs.

3.2.2 Virtual Workshop

3.2.2.1 Participants

Participants were both from the public and private sectors and mostly work in Western Canada (see **Figure 3-6**). They typically use Chapter 4 for half of their projects or less. Some participants are also already part of the Project Steering Committee for this project.

Figure 3-6: Participant Introduction Activity on Mural



3.2.2.2 Most and Least Used Sections of Chapter 4

Participants were shown the results of the online survey regarding most and least used sections of Chapter 4 (shown in **Figure 3-1**) and asked if the results align with their own use. While participants generally agreed with the most used chapters, results were more mixed with the least used sections.

One participant noted that some of the least used sections listed simply don't have a lot of information, so it is not surprising they would not be well used.

The discussion pointed to Chapter 4 being used to inform local guidelines, or as a final check after other guidelines are applied. Local guidelines often use a more specific standard that falls within the ranges provided by Chapter 4. Providing a design domain and updating the guidance (particularly for the urban context) can help with keeping these local guides updated, while supporting variability between local jurisdictions.

3.2.2.3 Existing Chapter 4 Sections: What is Used Instead

Participants were asked what alternatives to Chapter 4 they use and why. As noted above, the practitioners often use a local jurisdiction's guidelines before referring to TAC, including local supplements to Chapter 4. The guidelines used by participants include Edmonton's, Toronto's, Ottawa's, Vancouver's, and Halifax's. Provincial guidelines were also mentioned.

Participants from Saskatchewan noted that the lane widths and shoulder widths in TAC do not cover a common scenario in this province: low volume highways and arterials as well as higher speed collectors. They refer to a provincial supplement to TAC for these dimensions.

Some additional resources were named:

- NACTO for lane widths, medians and other separations, special purpose lanes, sidewalks, boulevards and border areas, designing for future widening, and typical cross sections.
- CNIB for general context on accessibility
- CSA B651 – Accessible design for the built environment for sidewalks, boulevards and border areas, and for curbs and gutters
- Canadian Highway Bridge Design Code (CHBDC) for bridges

One participant indicated they will sometimes refer to CROW if there is cycling infrastructure included in the design. While cycling infrastructure is covered in a different chapter of the Geometric Design Guide, participants noted that a discussion of the interactions and trade-offs with other cross section elements would be warranted in this chapter. For example, they would want to know how active transportation impacts the placement of utilities, the width of buffers, and the needs for snow and ice management.

Additional text would also be warranted to discuss the impacts of maintenance practices. Participants discussed scenarios where a proposed design stacks multiple minimum dimensions. If proper snow clearing cannot be achieved, there may be impacts to the function of the cross section elements for part of the year. A clear discussion of the trade-offs and impacts would allow to design with an understanding of the consequences of different maintenance standards. Updating the section to also discuss maintenance budget implications and best design practices for maintenance would help improve planning.

Finally, another suggestion was to add emergency access and egress roads to typical cross sections. As climate change induces a higher number of emergency evacuations, the need for alternate escape routes is becoming higher, particularly in small communities.

3.2.2.4 Elements Missing from Chapter 4

Building on the discussion on typical cross sections for emergency access and egress roads, participants suggested expanding Chapter 4 to include this topic. This could include minimum widths, vegetation maintenance (cutbacks), specification for single lane roads, etc.

Participants otherwise provided comments on sections that had been proposed through previous research or engagement. The following sections had comments added:

- Complete Streets:
    - Discuss cross section design elements for slow speeds
- Speed Management Measures
    - Suggestion to bring some elements of the TAC *Traffic Calming Guide* into this proposed section
- Crossfall
    - Include a discussion of parabolic cross sections. Edmonton and Calgary use these for lower volume roads. A discussion of the advantages and limitations would be welcome.
- Curbside management
    - Include considerations for shared micromobility storage
- Low Impact Development
    - Suggestion to consolidate with utilities. For example, in Calgary, subdrains are seen as a stormwater utility/asset.

In addition, participants identified that they do not have good resources to turn to regarding the topics of landscaping and streetscaping in the context of cross sections, and regarding road diets.

3.2.2.5 Priorities

To finish the workshop, participants were asked what the priorities should be between the different existing and proposed sections. As the group was small, the voting results are to be taken as one input of many into setting priorities for changes to Chapter 4.

Under existing sections, revising the lane widths and sidewalks, boulevards, and border areas both received four votes. Snow was next, with two votes.

Speed management measures were selected as the priority new section by three people, while climate change and safety devices both received two votes.

3.2.3 Individual Interviews

3.2.3.1 Participants

Five individual interviews were held with professionals from Ontario and Quebec, with four representing public agencies and one private sector practitioner.

3.2.3.2 Current Use and Valuable Elements

All practitioners interviewed use Chapter 4 occasionally, typically when their provincial or municipal standards lack information, or they need to support a deviation from their local standards. This occurs most frequently in rural or higher speed/freeway roadway designs. Chapter 4 was mentioned as a source of information during the development or update of local guidelines and standard cross sections. One practitioner characterized the guidance provided by TAC as “tried and true” and others indicated that their local standards were more current.

In line with information gathered from the survey and workshop, the section on lane widths is often referred to. Medians and utility/clear zone details are also checked against Chapter 4 guidance.

3.2.3.3 Gaps and Suggested Additions

Several themes and needs emerged from the interviews, some of which confirmed elements already discussed in other engagement activities while others are new gaps or suggested additions.

Low Speed or Low Volume Roads

- Provide more granular information on the low end of the spectrum for speeds and volume
- Articulate the effect of lane widths on operating speeds
- Provide information on designing for low speeds when larger vehicles (such as buses) need to be accommodated
- Clarify that positioning vertical elements in the boulevard can help manage speeds

Chapter Structure and Cross-Referencing

- Provide more guidance around cycling infrastructure and sample cross sections that include cycling infrastructure and highlight the role of shoulders as active transportation infrastructure in rural environments.
- While some participants preferred keeping bikeway design in a separate chapter, others thought cross-referencing can be challenging or noted inconsistencies. For example, shoulder design on bridges is covered in Chapter 4, but cycling on bridges is in a separate section.

Snow

- Document the effect of trees parallel to higher speed rural roadways on snow drift

One practitioner mentioned they have experimented with placing trees in rows perpendicular to roadways as an effective mitigation for snow drift accumulation, which is not typically achievable within the right-of-way and requires collaboration from adjoining landowners.

Median Barriers

- Add information on narrow median barriers

One practitioner mentioned a better discussion of median treatments for high-speed opposing traffic is required. There is a challenge in identification of an appropriate barrier between two-way traffic when a high-speed roadway is built in phases. The participant recommended a discussion on the advantages and limitation of high-tension cables and anti-glare devices was proposed. They currently use guidance from Sweden (on high-tension cable design) and Quebec (on anti-glare devices).

Crossfall

- Provide guidance for retrofit situations. The standards included in Chapter 4 are typically hard to achieve

Low Impact Development (LID)

- Include LID as a factor to consider in boulevard design and increase the minimum recommended boulevard width in light of increasing LID use as part of storm management

Cost and Maintenance Implications

- Discuss the cost and maintenance (mostly winter maintenance) implications of various cross sectional elements

Urban Environments

- Add typical urban cross section
- Include a section on curbside lane treatments typical for urban environments such as drop-off zones, lay-by lanes, etc.

Active Transportation

- Note curb height implications for cycling facilities (potential striking hazard)
- Include allowance for cycling infrastructure on bridges and underpasses

4. Gap Identification and Recommendations

The information gathered from the guidance review, engagement with practitioners, and Project Steering Committee (PSC) discussions was reviewed and compared against the existing TAC GDG Chapter 4 to identify any existing gaps or discrepancies. In preparation for a future undertaking by TAC to update GDG Chapter 4, potential changes have been compiled into a list of recommendations for each section of the chapter. Several chapter-wide updates are also identified.

In some cases, specific beneficial practices are recommended. In other cases, more research is required to identify beneficial practices to be integrated in the chapter update, either because the topic was not one of the priorities identified for the guidance review, the changes are proposed for a different GDG chapter, or because the reviewed documents did not address the gap to a satisfactory level of detail. Specific dimensions and design details are typically not discussed in this section. Refer to Section 2.0 Guidance Review and to the listed sources of beneficial practices provided with each recommendation.

4.1 Overview (GDG Section 4.1)

Recommendation 4.1.1: Update design approach to align with Complete Streets philosophy

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and by practitioners engaged with through the online survey and the virtual workshop. Cross sections have been developed for different communities and contexts based on land use, road classification, and functional classification. The Complete Streets principles aiming to balance safety, access, and comfort for all road users should be incorporated into Chapter 4.

Specific Recommendations

- The principles of Complete Streets should be addressed in narrative form.
- Differences in Complete Streets implementation between new developments and retrofit situations should be discussed, as well as the application of the principle in urban and rural environments.
- The importance of developing a street typology and assigning priority to different goals should be emphasized. Resources to understand the trade-offs between different facilities and space allocations should be listed.
- The adverse effects of designing all cross section elements to minimum width should be discussed. As a practical example, practitioners who participated in engagement noted the following adverse effects:
    - Signage placed on narrow medians between the travel lane and cycling facilities can be struck if the placement of signage and buffer width are not carefully considered.
    - Snow clearing operations on narrow cycling facilities requires a higher level of effort and specialized equipment and can be impossible if adequate snow storage in buffer areas is not provided.

Recommended Sources for Beneficial Practices

- City of Saskatoon *Design and Development Standards Manual: Transportation System* (2024)

- NCHRP *Research Report 1036: Roadway Cross-Section Reallocation: A Guide* (2023)
- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- Halifax Regional Municipality *Municipal Design Guidelines* (2021)
- *Politique des rues conviviales* (2021) de la Ville de Gatineau

Recommendation 4.1.2: Consolidate and update GDG Figure 4.1.1 and GDG Figure 4.1.3 to show urban cross sections that reflect Complete Streets principles

Rationale

In line with PSC members and practitioners identifying Complete Streets as an emerging practice to be considered for an update to Chapter 4, example cross sections, presented to introduce nomenclature, should reflect a Complete Streets approach.

Specific Recommendations

- Include cycling facilities typical of urban environments.
- Include transit infrastructure.
- Introduce the zone nomenclature typical of Complete Streets approaches (e.g., amenity zone, frontage zone, etc.).

Recommended Sources for Beneficial Practices

- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- City of Vancouver *Engineering Design Manual* (2019)
- NACTO *Urban Street Design Guide* (2013)
- *Politique des rues conviviales* (2021) de la Ville de Gatineau

Recommendation 4.1.3: Discuss impact of design elements on vehicular speed and safety

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and a frequently requested topic by practitioners engaged with through the online survey and the virtual workshop.

Specific Recommendations

- Discuss elements of the cross section that impact vehicle speed and the direction of influence (e.g., wider lanes induce higher speeds, inclusion of street trees reduces speed, etc.).
- Link vehicle speed with safety outcomes.

Recommended Sources for Beneficial Practices

- TAC *Design and Operation of Lower-Speed Collector and Arterial Roads: Synthesis of Practice* (2025)
- NACTO *Urban Street Design Guide* (2013)
- NCHRP *Research Report 966: Posted Speed Limit Setting Procedure and Tool* (2021)

Recommendation 4.1.4: Include high-level climate change impacts of cross sectional design choices

Rationale

This is a topic identified as a gap by practitioners engaged with through the online survey and the virtual workshop.

Specific Recommendations

- Include discussion of mitigation and adaptation measures and the related impact of cross section design, such as impact to modal share, impervious surfaces and storm water management, heat island effect, and embodied carbon.
- Include discussion of the need for emergency evacuation routes and specific cross section design particularly in small, isolated communities.

Recommended Sources for Beneficial Practices

Additional research is required to identify adequate beneficial practices. Reliance on primary research rather than design guidelines may be necessary.

4.2 Lane Widths (GDG Section 4.2)

Recommendation 4.2.1: Increase granularity of design domain below 60 km/h for urban roads and below 450 AADT for rural roads

Rationale

This gap was identified by the practitioners engaged with through the online survey, virtual workshop and interviews. In line with Complete Streets approaches and the renewed emphasis on speed management, a higher granularity is required.

Specific Recommendations

- Add categories of design domain below 60 km/h, with at least one category of 40 km/h or less to GDG Table 4.2.3: Through Lane Widths – Urban Roadways. Factors such as adjacent land use, parking turn-over, transit, presence of bike facilities and horizontal curvature should be discussed as considerations in the choice of lane width.
- Add a table similar to GDG Table 4.2.1 for through lane width on rural roadway for an additional category of Design Hour Directional Volume below 450. The threshold to be used requires additional research to identify beneficial practices.

Recommended Sources for Beneficial Practices

- TAC *Design and Operation of Lower-Speed Collector and Arterial Roads: Synthesis of Practice* (2025)
- Johns Hopkins Bloomberg School of Public Health, *A national Investigation on the Impacts of Lane Width on Traffic Safety: Narrowing Travel Lanes as an Opportunity to Promote Biking and Pedestrian Facilities Within the Existing Roadway Infrastructure* (2023)
- NCHRP *Research Report 880: Design Guide for Low Speed Multimodal Roadways* (2018)
- CROW *ASVV Guide – Recommendations for Traffic Provisions in Built-Up Areas* (2016)

Additional research may be required to identify adequate beneficial practices. Reliance on primary research rather than design guidelines may be necessary.

Recommendation 4.2.2: Align lower and upper lane width limits with evidence-based beneficial practices and update content of GDG Section 4.2.2 Explicit Evaluation of Safety

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 as well as practitioners involved in the engagement activities. Factors such as safety effects, adjacent land use, parking turn-over, transit, presence of bike facilities and horizontal curvature may need to be included for consideration.

Specific Recommendations

- Adjust technical foundation statements regarding crash frequency on narrower lanes in urban areas in line with recent research findings, outlining that wider lanes increase crash frequency.
- Adjust design domain values, particularly recommended range, in GDG Tables 4.2.1 to 4.2.3 in light of recent research findings regarding the safety effects of different lane widths.
- Update the narrative in GDG Section 4.2.2 to align with known adverse safety effects of wider lane widths on speed and severe crashes.

Recommended Sources for Beneficial Practices

- Johns Hopkins Bloomberg School of Public Health, *A national Investigation on the Impacts of Lane Width on Traffic Safety: Narrowing Travel Lanes as an Opportunity to Promote Biking and Pedestrian Facilities Within the Existing Roadway Infrastructure* (2023)
- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- City of Vancouver *Engineering Design Manual* (2019)
- City of Toronto *Road Engineering Design Guidelines* (2018)
- ITE *Design Walkable Urban Thoroughfares: A Context Sensitive Approach* (2010)

4.3 Special Purpose Lanes (GDG Section 4.3)

Recommendation 4.3.1: Create new section for 'Curbside Management' or integrate into existing GDG Sections 4.3.2.4 Parking Lanes and 4.3.3.7 Bike Facilities

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and by practitioners engaged with through the virtual workshop. The emerging use of micromobility devices is increasing the demand for corresponding micromobility infrastructure and is an important driver of this recommended update.

Specific Recommendations

- Identify the list of curbside uses not discussed in GDG Section 4.3, such as loading zones, micromobility hubs, parklets and patios, bus bulbs, EV charging stations, etc. Discuss benefits, trade-offs, impacts to cross section dimensions and organization, and resources for additional guidance.

Recommended Sources for Beneficial Practices

- City of Toronto *On-Street Bikeway Design Guidelines Chapter 1-3 Adoption* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- ITE *Curbside Management Practitioners Guide* (2018)

Recommendation 4.3.2: Update GDG Section 4.3.2.4 Parking Lanes to address accessible parking requirements

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4.

Specific Recommendations

- Provide dimension specifications for on-street parallel accessible parking, and related accessibility elements, such as curb ramps.

Recommended Sources for Beneficial Practices

- CSA Standard *B651:23 Accessible Design for the Built Environment, Section 9.4 Designated accessible parking* (2023)
- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Ottawa *Accessibility Design Standards* (2015)

Recommendation 4.3.3: Update GDG Section 4.3.3.7 Bike Facilities to include context beyond a single line referring to Chapter 5.

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and was identified by practitioners engaged throughout the project.

Specific Recommendations

- Some contextual and high-level width guidance should be included in Chapter 4, with reference to Chapter 5 for details. Information on cross section impacts and trade-offs with other elements can also be integrated in this section and referenced in the Complete Streets principles introduced in GDG Section 4.1.
- Highlight advantages and disadvantages of unprotected bicycle lanes in relation to curbside management; considerations include emergency services, waste collection, snow clearing, ride-hailing, etc. Cyclist safety and comfort should be considered alongside curbside management considerations. Reference Chapter 5 for additional details on facility selection.
- Include bus platform design considerations in Chapter 4 with reference to Chapter 5 – Bicycle Integrated Design and Chapter 6 – Pedestrian Integrated Design. The exact location of bus platform design guidance within the GDG may be modified.

Recommended Sources for Beneficial Practices

- City of Toronto *On-Street Bikeway Design Guidelines Chapter 1-3 Adoption* (2023)
- OTM *Book 18: Cycling Facilities* (2021)
- British Columbia MoTT *Active Transportation Design Guide* (2019)
- BC Translink and MoTT *Design Guide for Bus Stops Adjacent to Cycling Infrastructure* (2024)
- AASHTO *Guide for the Development of Bicycle Facilities* (2024)

Recommendation 4.3.4: Update GDG Section 4.3.3.5 Transit Lanes to account for new designs and technologies

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and by practitioners engaged with through the online survey. Accessibility and the universal design approach should be prioritized in alignment with the increase in available guidance for accessible transit design.

Specific Recommendations

- Address new transit vehicle designs such as transit vehicles that use cameras instead of mirrors; this may affect lane width guidance.
- Add guidance on bus boarding islands / island platform bus stops adjacent to cycling infrastructure; this includes transit stop widths and clearance widths for various facilities (see Recommendation 4.3.3).
- Include transit accessibility considerations for people with vision loss or reference the appropriate publications as design guidance is still new and evolving.

Recommended Sources for Beneficial Practices

- BC Translink & MoTT *Design Guide for Bus Stops Adjacent to Cycling Infrastructure* (2024)
- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- CNIB *Cycling Infrastructure and People with Sight Loss Design Challenges and Opportunities at Transit Stops Across Canada* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- ITE *Curbside Management Practitioners Guide* (2018)

4.4 Shoulders (GDG Section 4.4)

Recommendation 4.4.1: Include considerations for use of shoulder as travel lanes for HOV, buses, and accessible shoulder considerations for active transportation users

Rationale

This topic was identified as a gap by the practitioners involved in the review process.

Specific Recommendations

- For active transportation:

  - Rumble strips should follow a skip pattern of 3.6 m gaps between 18.3 m long rumble strips. The BC Supplement to TAC suggests a skip pattern of 15 m rumble strips interrupted by 3.5 m gaps. Rumble strips should be 0.3-0.4 m wide, 0.15 m long, and start 0.2 m from the edge of the vehicle lane's painted line. The painted line furthest from the vehicle travel lanes should follow the same skip pattern used on the rumble strip and must allow a minimum paved shoulder width of 1.5 m.
  - Table 4.2 in OTM Book 18 (2021) provides minimum shoulder width of 1.2 m for rural cross sections, a desired shoulder width of 1.5 m for 701-4,500 AADT, and a desired width of 2.0 m for AADT exceeding 4,500. Note that where a width of 2.0 m of more is available, 1.5 m should be provided with the remaining width allocated to a buffer.
- For transit and dynamic use:
  - Add guidance on shoulder width, notably that the shoulder should be as wide as the typical travel lane width for the facility it is located on.
  - Add guidance on approaches to reduce the illegal use of shoulders as travel lanes.

Recommended Sources for Beneficial Practices

- OTM *Book 18: Cycling Facilities* (2021)
- NASEM NCHRP *Active Traffic Management Strategies: A Planning and Evaluation Guide* (2024)
- Farzin et al. I-55 *Bus on Shoulder Demonstration In the Spirit of the Time* (2011)

Recommendation 4.4.2: Add explicit guidance for upper limit of shoulder width

Rationale

This topic was identified as a gap by the practitioners involved in the review process.

Specific Recommendations

- Additional research is required to identify adequate maximum shoulder widths for different roadway contexts to minimize the risk of severe and fatal injuries:
  - AASHTO's *A Policy on Geometric Design of Highways and Streets*, 7th Edition (2018) suggests a minimum width of 3.0 m and preferred maximum of 3.6 m on high-speed and high truck traffic roads while simultaneously noting that widths greater than 3.0 m may encourage unauthorized use of the shoulder as a travel lane.
  - Practice noted from Canadian jurisdictions generally recommends much narrower shoulders for low volume roads, such as 1.2 m.
  - Primary academic research is inconclusive on the effects of shoulder width. For example, some research regarding rural roads shows decreased crash risk for very narrow (<1.0 m) or very wide shoulders (>3.0 m) but an increased risk for shoulders 1.8 m to 2.4 m wide[3]. Conversely, other research found that increasing shoulder widths generally reduces crash frequency, with the most significant improvements observed for shoulder widths of 5-6 feet (1.5m to 1.8m). However, shoulders widths equal to or exceeding 7 feet (2.1m) showed diminishing safety benefits, suggesting that excessive

[3] Gitelman, V., Doveh, E., Carmel, R. and Hakkert, S., 2019, *The influence of shoulder characteristics on the safety level of two-lane roads: A case-study*, Accident Analysis and Prevention, Vol. 122, pp. 108-118.

shoulder widths may encourage unintended driver behavior, such as higher speeds or improper lane positioning[4].

Recommended Sources for Beneficial Practices

- Federal Highway Administration, CMF Clearinghouse. Webpage: https://cmfclearinghouse.fhwa.dot.gov/

Additional research may be required to formulate a specific upper limit recommendation for different contexts and traffic volumes.

4.5 Medians and Outer Separations (GDG Section 4.5)

Recommendation 4.5.1: Update to include relationship between target speed and median island geometry

Rationale

This topic was identified as a gap from emerging guidance.

Specific Recommendations

- New research is available that has established a quantitative relationship between target speed and median island geometry that may necessitate a chapter update.
- Other elements related to medians including the use of a median as pedestrian refuge and storm water management treatments that apply to the median may also be considered.

Recommended Sources for Beneficial Practices

- TAC GDG Chapter 6 – Pedestrian Integrated Design (for guidance on medians as refuge islands)
- TAC *Design and Operation of Lower-Speed Collector and Arterial Roads: Synthesis of Practice* (2025)

Recommendation 4.5.2: Include cross-references to Chapter 5, indicating that medians can be used as separation between vehicle lanes and cycling facilities

Rationale

This topic was identified as a gap by practitioners engaged in the review process.

Specific Recommendations

- Refer to 5.15.3 Chapter 5 Updates for specific recommendations.

Recommendation 4.5.3: Discuss urban highway constrained conditions: narrow median options and anti-glare devices

Rationale

---

[4] Beyer, M.A.B., 2025, *Safety Effectiveness of Shoulder Width on Indiana Rural Roads*, Purdue University Graduate School. Thesis.

This topic was identified as a gap by a practitioner involved in the review process.

Specific Recommendations

- Discuss advances in cable barrier options and other narrow medians, including benefits and limitations.
- Discuss use and placement of anti-glare devices on narrow medians.

Recommended Sources for Beneficial Practices

- USDOT, NHTSA Report *DOT HS 809 672 An Investigation of Headlamp Glare: Intensity, Spectrum and Size* (2003)

Additional research is required to identify adequate beneficial practices. Reliance on primary research rather than design guidelines may be necessary.

4.6 Sidewalks, Boulevards, and Border Areas (GDG Section 4.6)

Recommendation 4.6.1: As needed, adjust minimum and recommended widths for sidewalks and boulevards to align with new guidance related to LID facilities and snow storage; include references to GDG Sections 4.8 and 4.9

Rationale

To ensure consistency with gaps identified by the PSC and practitioners involved in the review process related to LID and urban snow storage, an update to this section is warranted.

Specific Recommendations

- Refer to Recommendation 4.8.1 and Recommendation 4.9.1. Ensure recommended widths in GDG Section 4.6 are consistent with requirements for snow storage and LID facilities and include cross-references to GDG Sections 4.8 and 4.9.

4.7 Curbs and Gutters (GDG Section 4.7)

Recommendation 4.7.1: Include cross-references to Chapter 5, indicating that curbs can be used as buffers between cyclists and vehicles, and referencing the different curb types and heights that can be used

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and by practitioners engaged with through the online survey and virtual workshop. As the topic is best addressed in Chapter 5, the recommendation targets cross-referencing.

Specific Recommendations

- Refer to 5.15.3 Chapter 5 Updates for specific recommendations.

Recommendation 4.7.2: Include cross-references to GDG Section 4.8, discussing differences in curb and gutter design at LID facilities

Rationale

LID was identified by the PSC as an emerging practice to be considered for the update to Chapter 4 and practitioners engaged with throughout the project agreed this topic is a gap. To ensure the topic is covered in a comprehensive manner, cross-referencing design details in related sections is recommended.

Specific Recommendations

- Refer to Recommendation 4.8.1 for specific recommendations.

4.8 Drainage (GDG Section 4.8)

Recommendation 4.8.1: Create new subsection for 'Low Impact Development'

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4. Practitioners engaged with throughout the project agreed this topic is a gap. Storm water management through low impact development strategies has evolved significantly since the TAC GDG was published. These strategies warrant inclusion within an updated Chapter 4.

Specific Recommendations

- Include bioswales, green gutters, and filter strips as options in median design, and reference this new guidance in GDG Section 4.5.
- Include cross section guidance integrating stormwater tree pits, soil cells, stormwater tree trenches, swales, green gutters, filter strips, underground infiltration systems, rainwater cisterns and permeable pavements. In particular, highlight the use of boulevards as potential LID facilities and reference this new guidance in GDG Section 4.6.
- Include curb and gutter design considerations for LID facilities, and reference the new guidance in GDG Section 4.7.
- Include cross-references between the new LID guidance and its use as snow storage and filtration mechanism in GDG Section 4.9.

Recommended Sources for Beneficial Practices

- City of Toronto *Green Streets Technical Guidelines Version 1.0* (2017)
- *Low Impact Development: Design Guide for Saskatoon* (2016)
- EPCOR *Stormwater Management and Design Manual – Volume 3 Drainage* (2022)

Recommendation 4.8.2: Update cross slope and parabolic crown guidance in accordance with recommended updates to Chapter 3

Rationale

This gap was identified by practitioners engaged with throughout the project.

Specific Recommendations

- Refer to Recommendation 5.15.2 for specific recommendations.

4.9 Snow (GDG Section 4.9)

Recommendation 4.9.1: Add urban considerations for snow storage and snowmelt drainage

Rationale

TAC Geometric Design Committee discussions have identified a heavy rural focus on snow removal within Chapter 4 and a lack of guidance regarding snow removal in urban areas. The PSC, in addition to the practitioners engaged with through both the online survey and virtual workshop, identified snow storage and winter design considerations as a priority.

Specific Recommendations

- Separated sidewalks are recommended on most roads (i.e., sidewalks with buffer from vehicular lanes); where sidewalks are not paired with a boulevard, a minimum 2.0 m sidewalk should be provided to account for snow storage.
- Boulevards should be provided for snow storage where possible with street trees or other water filtration features, while providing multiple pedestrian access points clear of snow storage.
- Snow storage should be prohibited from blocking sidewalk access points.
- Consider seasonal parking bans where on-street parking is limited to one side of the roadway during winter conditions.
- Identify bioswales as potential snow storage and snowmelt drainage facilities during winter months.
- Provide references to this new content in GDG Section 4.7 Sidewalk, Boulevards, and Border Areas as well as GDG Section 4.8 Drainage. Ensure consistency with guidance in Chapter 6, which should be updated as needed.

Recommended Sources for Beneficial Practices

- Beaumont *Winter City Strategy* (2022)
- City of Toronto *Green Streets Technical Guidelines Version 1.0* (2017)
- Edmonton *Winter Design Guidelines* (2016)
- City of Calgary *Design Guidelines for Subdivision Servicing* (2020)

4.10 Bridges (GDG Section 4.10)

Recommendation 4.10.1: Add integration of active transportation: widths, clearances, separations/ railings, and abutment joint design for cyclists and motorcyclists

Rationale

This topic was identified as a gap by the practitioners involved in the review process as active transportation considerations have evolved since the TAC GDG was published.

Specific Recommendations

- The active transportation facility width on an overpass is recommended to have a constrained width of 3.5 m and desired width of 5.0 m.
- Bicycle facilities are recommended to be situated between pedestrian and motor vehicle travel lanes and facilities should be provided on both sides of the bridge when possible.
- Limit large movement finger joints to 100 mm for safe passage of motorcyclists, cyclists, and pedestrians.
- The cross section should account for the width of protective railings when active transportation facilities are located on the outside of the bridge.
- The cross section should account for the width of barriers where the vertical difference between the bicycle facility and the roadway is greater than 0.2 m or when motor vehicle speeds are greater than 60 km/h.
- Include cross-references to Chapter 5 where appropriate.

Recommended Sources for Beneficial Practices

- BC MoTT *Bridge Standards and Procedures Manual Volume 1 - Section 11* (2025)
- British Columbia MoTT *Active Transportation Design Guide* (2019)

4.11 Utility Placement (GDG Section 4.11)

Recommendation 4.11.1: Add considerations for utility placement in urban environments

Rationale

Utility placement in urban environments was a gap identified by practitioners, who were seeking more detailed guidance.

Specific Recommendations

Add a discussion of the following additional factors to consider for utility placement:

- Avoiding placing utility fixtures and appurtenances in the pedestrian through zone and in transit loading areas.
- Avoiding placing holes, valve boxes or other utility surface obstructions in the wheel path of vehicles or bicycles, where possible.
- Considering the safety effects of offset of utility poles separately for urban environments.
- Differences in placement considerations between deep and shallow utilities.
- Considering the inclusion of shared shallow-utility trenches (also called multi-party trenching).

Recommended Sources for Beneficial Practices

- Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Vancouver *Engineering Design Manual* (2019)

4.12 Designing for Future Widening (GDG Section 4.12)

Recommendation 4.12.1: Change 'Designing for Future Widening' to 'Increasing Roadway Capacity and Operational Efficiency'

Rationale

This topic was identified in discussion with the PSC during the review process. The title of the chapter should be modified to widen the scope of the section and provide guidance on multiple means of increasing the effective movement of people and goods from their origin to their destination, beyond roadway widening.

Recommendation 4.12.2: Add a subsection on techniques to reallocate the right-of-way, particularly in urban settings

Rationale

This gap was identified through discussion with the PSC committee and as a complement to the inclusion of beneficial practice on Complete Streets. In urban contexts, increasing people-moving capacity can be a more effective goal than increasing vehicle-carrying capacity. A subsection on this topic would be suitable within the revised scope of GDG Section 4.12.

Specific Recommendations

- Discuss the concept of people-carrying capacity.
- Discuss conditions where roadway reallocation may be appropriate.
- Highlight decision-making tools and additional resources.

Recommended Sources for Beneficial Practices

- NCHRP *Research Report 1036: Roadway Cross-Section Reallocation: A Guide* (2023)
- Toronto *Roadway Cross-Section Reallocation Guide* (2023)
- NACTO *Urban Street Design Guide* (2013)

Recommendation 4.12.3: Add a subsection on 2+1 roads, a category of three-lane roads consisting of two lanes in one direction and one lane in the other, with the centre lane alternating periodically

Rationale

This topic was identified as a gap by practitioners who participated in the online survey. This type of roadway can increase capacity while maintaining a relatively narrow cross section width and is therefore suitable for the revised scope of GDG Section 4.12.

Specific Recommendations

- Discuss appropriate context for use of 2+1 roadways and different types of applications.
- Specify appropriate dimensions for lanes, and differentiate considerations for urban and rural applications.

Recommended Sources for Beneficial Practices

Additional research is required to identify adequate beneficial practices. The Ontario Ministry of Transportation Ontario (MTO) has conducted research to implement 2+1 highways and evaluated design parameters and site selection criteria, with two pilot locations selected. Discussions with MTO may accelerate the identification of suitable beneficial practices.

Recommendation 4.12.4: Add a subsection on Intelligent Transportation Systems

Rationale

This gap was identified by the PSC as an emerging practice to be considered for the update to Chapter 4. As many ITS applications aim to improve operational efficiency, either directly or by improving safety and reducing collisions, a subsection on this topic would be suitable within the revised scope of GDG Section 4.12.

Specific Recommendations

- Describe the role of ITS as a mechanism to increase operational efficiency.
- Identify a list of ITS tools and whether they impact cross section design, similar to **Table 2-2** of this document.
- For ITS tools that require additional space in the cross section, identify relevant dimensions, or cross-reference to GDG sections that include information on space requirements (e.g. for gantries or other supporting infrastructure).
- Provide resources for additional information on ITS integration in roadway design.

Recommended Sources for Beneficial Practices

- NCHRP *Research Report 1120: Active Traffic Management Strategies: A Planning and Evaluation Guide* (2024)
- Ontario Ministry of Transportation *Advanced Traffic Management System Design Guidelines* (2021)
- NACTO *Blueprint for Autonomous Urbanism* (2019)

4.13 Typical Cross Sections (GDG Section 4.13)

Recommendation 4.13.1: Add typical cross sections that include active transportation, transit facilities, LID, 2+1 roadways, and evacuation routes

Rationale

This gap was identified in discussion with the PSC during the review process and by practitioners engaged with throughout the project. Consistent with other recommendations that aim to increase content for urban areas and embrace Complete Streets design principles, visual depictions that reflect a greater array of typical cross sections in different contexts are recommended.

Specific Recommendations

- Include sample urban cross sections with protected cycling infrastructure.
- Include sample urban cross sections with transit infrastructure (transit lane and amenity zone with bus shelter).

- Include sample urban cross section(s) with LID.
- The above cross sections may be combined together or with other existing cross sections already included in GDG Section 4.13.
- Include one cross section depicting a 2+1 roadway.
- Include one cross section depicting dimensions for an evacuation route.

Recommended Sources for Beneficial Practices

- City of Saskatoon *Design and Development Standards Manual: Transportation System* (2024)
- City of Edmonton *Complete Streets Design and Construction Standards* (2023)
- City of Hamilton *Complete Streets Design Guidelines* (2022)
- EPCOR *Stormwater Management and Design Manual – Volume 3 Drainage* (2022)
- Halifax Regional Municipality *Municipal Design Guidelines* (2021)
- British Columbia *Active Transportation Design Guide* (2019)
- City of Toronto *Green Streets Technical Guidelines Version 1.0* (2017)
- *Low Impact Development: Design Guide for Saskatoon* (2016)

Additional research is required to identify adequate beneficial practices for 2+1 roadways and evacuation routes. Reliance on primary research rather than design guidelines may be necessary.

Recommendation 4.13.2: Replace minimum sidewalk width in typical cross sections with recommended sidewalk width

Rationale

This recommendation is an outcome of ongoing discussions with the PSC regarding the adequacy of minimum sidewalk widths, balancing accessibility considerations with constructability and cost considerations. Showing the recommended width is a compromise that may entice designers to use the recommended width as a default, rather than the minimum.

Specific Recommendations

For all current and proposed cross sections as per Recommendation 4.13.1, show the recommended lower limit width as per GDG Table 6.3.1 (typically 1.8 m) rather than the practical lower width (typically 1.5 m).

Recommended Sources for Beneficial Practices

Does not apply: use recommended lower limit as per GDG Table 6.3.1 based on the expected flow rate of pedestrians for the cross section depicted.

Recommendation 4.13.3: Review travel lane widths in typical sections to align with changes to recommended lane width in GDG Section 4.2

Rationale

The recommendation aims to ensure consistency between the recommendations made in other sections of the chapter with the typical cross sections shown in GDG Section 4.13.

Specific Recommendations

- For all current and proposed cross sections as per Recommendation 4.13.1, show urban and rural lane widths that align with the recommended lower limit of the design domain, for a design speed that is appropriate for the context depicted (specify the speed on the cross section figure).

Recommended Sources for Beneficial Practices

Refer to recommended sources listed in Section 4.2 of this document.

4.14 Chapter-Wide Updates

Recommendation 4.14.1: Review all Crash Modification Factors (CMF)

Rationale

This area of update was identified by practitioners during the review process.

Specific Recommendations

- Ensure all CMFs currently cited are still the most up-to-date and applicable CMF available
- When discussing the safety effects of different treatments where no CMF is currently cited, verify if a CMF is now available.

Recommended Sources for Beneficial Practices

Federal Highway Administration, CMF Clearinghouse. Webpage: https://cmfclearinghouse.fhwa.dot.gov/

Recommendation 4.14.2: Integrate climate change and adaptation information throughout

Rationale

This is a topic identified as a gap by practitioners engaged with through the online survey and the virtual workshop.

Specific Recommendations

- Discuss climate change impacts on roadway design at a high level in GDG Section 4.1 Overview, as suggested in Recommendation 4.1.4.
- Discuss the use of street trees in boulevards as mechanisms to reduce heat island effect in GDG Section 4.6.
- Discuss LID as resilient infrastructure in the context of changing weather patterns that may increase total rainfall or the intensity of rainfall in GDG Section 4.8.
- Discuss the role of roadway reallocation as a mechanism to reduce the expansion of impervious surfaces and embodied carbon related to transportation infrastructure in GDG Section 4.12.
- Consider other opportunities to integrate climate change considerations throughout Chapter 4.

Recommended Sources for Beneficial Practices

Refer to recommended sources in each section as some contain climate change considerations. Additional research is required to identify adequate beneficial practices. Reliance on primary research rather than design guidelines may be necessary.

Recommendation 4.14.3: Improve cross-referencing between chapters or sections

Rationale

This area of update was identified by practitioners during the review process and is standard beneficial practice for ease of navigation.

Specific Recommendations

- Implement the cross-referencing outlined in other recommendations.
- Undertake a detailed review of the chapter to identify other potential cross-referencing opportunities. Ensure that the destination of cross-references provides substantive additional information and guidance.

Recommended Sources for Beneficial Practices

Does not apply.

Recommendation 4.14.4: Add considerations for cost and maintenance for each section

Rationale

This area of update was identified by practitioners during the review process.

Specific Recommendations

Updates to Chapter 4 should balance beneficial practices with consideration for inclusion of minimum standards that provide opportunities for jurisdictions to make design decisions that are sensitive to ongoing costs of maintenance in infrastructure.

Recommended Sources for Beneficial Practices

Additional research and resources may be needed to identify opportunities to incorporate this feedback into future updates.

4.15 Other Related Updates

Chapter 4 is closely related to other guidance contained in the GDG. While researching potential gaps in Chapter 4, some needs were identified in other chapters. It is out of the scope of this Synthesis of Practice to identify all updates required in other chapters, but the following potential updates are identified for consideration.

4.15.1 Chapter 1 Updates

Recommendation 4.15.1: Update GDG Section 1.1.4 The Concept of Safety to align with recent research findings

GDG Section 1.1.4 The Concept of Safety states “In many instances, the more generous a road’s design dimensions are, the safer the road will be”. Although a caveat is added to identify this may not be true in urban areas, the idea of more generous dimensions leading to better safety outcomes has also been shown not to be true in rural areas. In addition to this specific instance, the GDG chapters should be reviewed for other mentions of this design approach. Refer to Recommendation 4.1.2 for recommended sources.

4.15.2 Chapter 3 Updates

Recommendation 4.15.2: Update cross slope guidance

Practitioners identified gaps in cross slope recommendations. The typically recommended cross slope in Chapter 3 is 0.02 m/m (or 2%). Emerging beneficial practice suggests the typical cross slope should be adjusted to 0.03 m/m (or 3%), which allows for better drainage, while not adversely affecting large vehicle stability. An initial source of information to support the change can be found in Hildebran, E. and Morrall, J. *Cross Slope and Climate Change: Implications for Highway Design and Road Safety*, TAC Conference & Exhibition, 2021. Additional research may be required.

Recommendation 4.15.3: Include guidance on the use of parabolic crowns

Practitioners also identified parabolic cross sections as a gap in current TAC guidance. Parabolic crowns are used on narrower and lower volumes roads. For example, the Edmonton Complete Streets Design and Construction Standards (2023) use parabolic crowns 110 mm to 150 mm in height for local roads, and some collectors. Easier constructability and winter maintenance considerations are among the reasons parabolic crowns are preferred.

4.15.3 Chapter 5 Updates

Recommendation 4.15.4: Update Chapter 5 in tandem with Chapter 4 and integrate the guidance in both chapters with more extensive cross-referencing

Several Chapter 4 sections discuss topics related to the integration of cycling facilities. Engagement with practitioners also highlighted that the design and integration of cycling facilities with other cross section elements is top of mind. Generally, Chapter 5 should be reviewed in light of the recommended sources for beneficial practices listed in Recommendation 4.3.3.

Recommendation 4.15.5: Expand GDG Section 5.7.10 All-Season Bikeway Maintenance

- Include discussion of snow clearing equipment and effect of width on ease of snow clearing.
- Specify that separated bike lanes should include at least 0.5 m of width for snow storage.
- Specify that active transportation facilities should be designed such that snowmelt drains away from cycling infrastructure, to catch basins or impervious surfaces.
- Discuss the adverse effects of using narrow medians on available space for signage, and increased maintenance and replacement for struck signage.
- Include references and account for these design elements in the appropriate sections of Chapter 5, such as GDG Section 5.5 Bicycle Design: Alignment and Related Elements.

Recommendation 4.15.6: Expand the discussion on raised configuration for protected bike lanes

- Discuss curb types (vertical, beveled, mountable) and half or full height curb considerations. Add a discussion of the advantages and limitations of each, considering impacts on accessibility, cycling comfort, impact on facility width to accommodate shy distances, and appropriate design to avoid the risk of pedal strikes.

4.15.4 Chapter 6 Updates

Recommendation 4.15.7: Expand bus stop design guidance

In light of updated guidance on bus stop design, bus pad and bus stop amenity design require a more substantial discussion. The augmented discussion in Chapter 6 should be cross-referenced in Chapter 4 where transit amenities are discussed, notably in GDG Section 4.3, where transit lanes are discussed. Refer to Recommendation 4.3.4 for recommended resources for beneficial practices.

Recommendation 4.15.6: Ensure width and configuration guidance align with new recommendations for snow management

Specify that active transportation facilities should be designed such that snowmelt drains away from pedestrian infrastructure, to catch basins or impervious surfaces. Ensure recommended widths align with snow storage requirements (see Recommendation 4.9.1).

5. Recommendation Summary

The current structure of Chapter 4 can accommodate most updates within existing sections and sub-sections. Review of guidance documents did not suggest specific issues with the overall flow of the chapter, but recommendations that slightly alter the structure include:

- Creating a new subsection for 'Curbside Management' within 4.3 Special Purpose Lanes (or integrate into existing GDG Sections 4.3.2.4 Parking Lanes and 4.3.3.7 Bike Facilities)
- Creating a new subsection for 'Low Impact Development' within 4.8 Drainage
- Changing section 4.12 from 'Designing for Future Widening' to 'Increasing Roadway Capacity and Operational Efficiency', and adding three subsections to cover the following themes:
    - Right-of-way reallocation techniques
    - 2+1 roadways
    - Intelligent Transportation Systems

All Chapter 4 recommendations are summarized in Section 5.1 below. The recommendations requiring updates to other Chapters of the GDG are listed in Section 5.2.

5.1 Section Updates

Table 5-1 summarizes the areas identified as requiring update or review to reflect emerging practices and research for each section of the chapter. Refer to Section 4 for resources and additional details on beneficial practices.

Table 5-1: Potential Areas of Update – Chapter 4 Sections

Section and Sub-Sections	Magnitude of Update	Potential Areas of Update
4.1 Overview 4.1.1 Introduction 4.1.2 Focus of this Chapter 4.1.3 Design Focus 4.1.4 Chapter Outline 4.1.5 The Roadside 4.1.6 Cross Section: Design Domain Controls 4.1.7 Design Elements: Cross Section 4.1.8 Explicit Consideration of Safety: General Principle	Substantial	**Recommendation 4.1.1:** Update design approach to align with Complete Streets philosophy **Recommendation 4.1.2:** Consolidate and update GDG Figure 4.1.1 and GDG Figure 4.1.3 to show urban cross sections that reflect Complete Streets principles **Recommendation 4.1.3:** Discuss impact of design elements on vehicular speed and safety **Recommendation 4.1.4**: Include high-level climate change impacts of cross sectional design choices

Section and Sub-Sections	Magnitude of Update	Potential Areas of Update
4.2 Lane Widths 4.2.1 Through Lane Widths 4.2.1.1 Technical Foundation 4.2.1.2 Road Safety and Human Factors Considerations 4.2.1.3 Design Domain: Qualitative Aids 4.2.1.4 Design Domain: Application Heuristics 4.2.2 Explicit Evaluation of Safety 4.2.2.1 Lane Widths 4.2.2.2 Centerline Rumble Strips: Best Practices	Substantial	**Recommendation 4.2.1:** Increase granularity of design domain below 60 km/h for urban roads and below 450 AADT for rural roads **Recommendation 4.2.2:** Align lower and upper lane width limits with evidence-based beneficial practices and update content of GDG Section 4.2.2 Explicit Evaluation of Safety
4.3 Special Purpose Lanes 4.3.1 Technical Foundation 4.3.2 Design Domain and Application Heuristics 4.3.2.1 Passing and Climbing Lanes 4.3.2.2 Right-Turn Lanes 4.3.2.3 Left-Turn Lanes 4.3.2.4 Parking Lanes 4.3.3 Other Special Purpose Lanes 4.3.3.1 Left-Turn Slip-Around Lane 4.3.3.2 Continuous Right-Turn or Left-Turn Lane for Access 4.3.3.3 Acceleration and Deceleration Lanes 4.3.3.4 Weaving Lanes 4.3.3.5 Transit Lanes 4.3.3.6 Service or Frontage Road Lanes 4.3.3.7 Bike Facilities 4.3.3.8 Ramps 4.3.3.9 Turning Roadways	Substantial	**Recommendation 4.3.1:** Create new section for 'Curbside Management' or integrate into existing GDG Sections 4.3.2.4 Parking Lanes and 4.3.3.7 Bike Facilities **Recommendation 4.3.2:** Update GDG Section 4.3.2.4 Parking Lanes to address accessible parking requirements **Recommendation 4.3.3:** Update GDG Section 4.3.3.7 Bike Facilities to include context beyond a single line referring to Chapter 5 **Recommendation 4.3.4:** Update GDG Section 4.3.3.5 Transit Lanes to account for new designs and technologies
4.4 Shoulders 4.4.1 Technical Foundation 4.4.2 Shoulder Width 4.4.2.1 Design Domain: Quantitative Aids	Intermediate	**Recommendation 4.4.1:** Include considerations for use of shoulder as travel lanes for HOV, buses, and accessible shoulder considerations for active transportation users

Section and Sub-Sections	Magnitude of Update	Potential Areas of Update
4.4.2.2 Design Domain: Application Heuristics 4.4.3 Surface Treatment of Shoulders: Best Practices 4.4.3.1 Delineating the Shoulder and the Travelled Lane 4.4.3.2 Shoulder Material 4.4.3.3 Pavement Edge Drops 4.4.3.4 Shoulder Rumble Strips 4.4.4 Shoulder Cross Slopes: Best Practices 4.4.5 Shoulder Rounding: Best Practices 4.4.6 Explicit Evaluation of Safety		**Recommendation 4.4.2:** Add explicit guidance for upper limit of shoulder width
4.5 Medians and Outer Separations 4.5.1 Technical Foundation 4.5.2 Freeway and Expressway Medians: Application Heuristics 4.5.3 Arterial Road Medians: Application Heuristics 4.5.4 Outer Separations and Frontage Road Separations: Application Heuristics 4.5.5 Explicit Evaluation of Safety 4.5.5.1 Freeways and Expressways 4.5.5.2 Urban Median Application: Non-Freeway/Expressway	Intermediate	**Recommendation 4.5.1:** Update to include relationship between target speed and median island geometry **Recommendation 4.5.2:** Include cross-references to Chapter 5, indicating that medians can be used as separation between vehicle lanes and cycling facilities **Recommendation 4.5.3:** Discuss urban highway constrained conditions: narrow median options and anti-glare devices
4.6 Sidewalks, Boulevards, and Border Areas 4.6.1 Technical Foundation 4.6.2 Boulevards: Design Domain and Application Heuristics 4.6.3 Border Areas: Design Domain and Application Heuristics 4.6.4 Boulevard/Border Surfaces and Cross Slopes: Application Heuristics	Minor	**Recommendation 4.6.1:** As needed, adjust minimum and recommended widths for sidewalks and boulevards to align with new guidance related to LID facilities and snow storage; include references to GDG Sections 4.8 and 4.9

Section and Sub-Sections	Magnitude of Update	Potential Areas of Update
4.6.5 Sidewalks		
4.7 Curbs and Gutters 4.7.1 Technical Foundation 4.7.2 Curbs: Best Practices 4.7.2.1 Gutters: Best Practices	Minor	**Recommendation 4.7.1:** Include cross-references to Chapter 5, indicating that curbs can be used as buffers between cyclists and vehicles, and referencing the different curb types and heights that can be used **Recommendation 4.7.2:** Include cross-references to GDG Section 4.8, discussing differences in curb and gutter design at LID facilities
4.8 Drainage 4.8.1 Grades: Best Practices 4.8.2 Rural Drainage Channels (Ditchline): Best Practices 4.8.3 Urban Storm Drainage: Best Practices 4.8.4 Cross Slope: Best Practices	Substantial	**Recommendation 4.8.1:** Create new subsection for 'Low Impact Development' **Recommendation 4.8.2:** Update cross slope and parabolic crown guidance in accordance with recommended updates to Chapter 3
4.9 Snow 4.9.1 Technical Foundation: Snow Removal and Storage 4.9.2 Mitigative Measures: Best Practices	Substantial	**Recommendation 4.9.1:** Add urban considerations for snow storage and snowmelt drainage
4.10 Bridges 4.10.1 Technical Foundation 4.10.1.1 Roads under Bridges: Design Domain and Application Heuristics 4.10.1.2 Roads on Bridges: Design Domain and Application Heuristics 4.10.1.3 Multi-Modal Configurations 4.10.1.4 Vertical Clearances: Design Domain and Application Heuristics 4.10.1.5 Explicit Evaluation of Safety: Bridge Widths	Intermediate	**Recommendation 4.10.1:** Add integration of active transportation: widths, clearances, separations/railings, and abutment joint design for cyclists and motorcyclists
4.11 Utility Placement 4.11.1 Technical Foundation	Minor	**Recommendation 4.11.1:** Add considerations for utility placement in urban environments

Section and Sub-Sections	Magnitude of Update	Potential Areas of Update
4.11.2 Utility Placement: Best Practices 4.11.3 Explicit Evaluation of Safety: Utility Poles		
4.12 Designing for Future Widening 4.12.1 Introduction 4.12.2 Rural Roads: Best Practices 4.12.3 Six-Lane Divided Urban Arterials: Best Practices 4.12.4 Four-Lane Undivided Urban Arterials: Best Practices	Substantial	**Recommendation 4.12.1:** Change 'Designing for Future Widening' to 'Increasing Roadway Capacity and Operational Efficiency' **Recommendation 4.12.2:** Add a subsection on techniques to reallocate the right-of-way, particularly in urban settings **Recommendation 4.12.3:** Add a subsection on 2+1 roads, a category of three-lane roads consisting of two lanes in one direction and one lane in the other, with the centre lane alternating periodically **Recommendation 4.12.4:** Add a subsection on Intelligent Transportation Systems
4.13 Typical Cross Sections [Figures of typical cross sections]	Substantial	**Recommendation 4.13.1:** Add typical cross sections that include active transportation, transit facilities, LID, 2+1 roadways, and evacuation routes **Recommendation 4.13.2:** Replace minimum sidewalk width in typical cross sections with recommended sidewalk width **Recommendation 4.13.3:** Review travel lane widths in typical sections to align with changes to recommended lane width in GDG Section 4.2

5.2 Other Updates

Table 5-2 summarizes the chapter-wide updates as well as updates to other GDG chapters to reflect emerging practices and research. Refer to Section 4 for additional details.

Table 5-2: Potential Areas of Update – Chapter 4 and Other Chapters

Chapter	Magnitude of Update	Potential Areas of Update
Chapter 4 (Chapter-wide updates)	Substantial	**Recommendation 4.14.1:** Review all Collision Modification Factors (CMF) **Recommendation 4.14.2:** Integrate climate change and adaptation information throughout **Recommendation 4.14.3:** Improve cross-referencing between chapters or sections **Recommendation 4.14.4:** Add considerations for cost and maintenance for each section
Chapter 1	Minor	**Recommendation 4.15.1:** Update GDG Section 1.1.4 The Concept of Safety to align with recent research findings
Chapter 3	Substantial	**Recommendation 4.15.2:** Update cross slope guidance **Recommendation 4.15.3:** Include guidance on the use of parabolic crowns
Chapter 5	Substantial	**Recommendation 4.15.4:** Update Chapter 5 in tandem with Chapter 4 and integrate the guidance in both chapters with more extensive cross-referencing **Recommendation 4.15.5:** Expand GDG Section 5.7.10 All-Season Bikeway Maintenance **Recommendation 4.15.6:** Expand the discussion on raised configuration for protected bike lanes
Chapter 6	Intermediate	**Recommendation 4.15.7:** Expand bus stop design guidance **Recommendation 4.15.6:** Ensure width and configuration guidance align with new recommendations for snow management

6. References

American Association of State Highway and Transportation Officials (AASHTO). 2018. *A Policy on Geometric Design of Highways and Streets*, 7th Edition. Washington, DC: American Association of State Highway and Transportation Officials.

American Association of State Highway and Transportation Officials (AASHTO). 2024. *Guide for the Development of Bicycle Facilities*, 5th Edition. Washington, DC: American Association of State Highway and Transportation Officials.

BC Ministry of Transportation and Infrastructure. 2019. *British Columbia Active Transportation Design Guide*. Victoria, BC: Ministry of Transportation and Infrastructure.

BC Ministry of Transportation and Transit. 2025. "Section 11 – Joints and Bearings." In*Bridge Standards and Procedures Manual Volume 1*:, *Supplement to CHBDC S5:19.* Victoria, BC: Ministry of Transportation and Transit.

Beyer, Mario Alberto Barahona (2025). *Safety Effectiveness of Shoulder Width on Indiana Rural Roads* . Purdue University Graduate School. Thesis. https://doi.org/10.25394/PGS.28835708.v1.

WSP Canada. 2023. *Cycling Infrastructure and People with Sight Loss Design Challenges and Opportunities at Transit Stops Across Canada.* Toronto, ON: Canadian National Institute for the Blind (CNIB) Foundation.

Chapman, D. and Larsson, A. June 2021, "Practical urban planning for winter cycling; lessons from a Swedish pilot study." in *Journal of Transport & Health*, v21. DOI: https://doi.org/10.1016/j.jth.2021.101060

City of Beaumont, 2022, *Beaumont Winter City Strategy*, Beaumont, AB

City of Calgary, 2020, *Design Guidelines for Subdivision Servicing*, Calgary, AB

City of Edmonton, 2023, *Complete Streets Design and Construction Standards*, Edmonton, AB

City of Edmonton, 2016, *Edmonton Winter Design Guidelines*, Edmonton, AB

City of Gatineau, 2021, *Politique des rues conviviales de la Ville de Gatineau*, Gatineau, QC

City of Halifax, 2021, *Halifax Municipal Design Guidelines*, Halifax, NS

City of Hamilton, 2022, *Complete Streets Design Guidelines*, Hamilton, ON

City of Ottawa, 2015, *Accessibility Design Standards*, Ottawa, ON

City of Saskatoon, 2024, *Design and Development Standards Manual: Transportation System*, Saskatoon, SK

City of Saskatoon, 2016, *Low Impact Development: Design Guide for Saskatoon*, Saskatoon, SK

City of Toronto, 2023, *On-Street Bikeway Design Guidelines Chapter 1-3 Adoption*, Toronto, ON

City of Toronto, 2023, *Roadway Cross-Section Reallocation Guide*, Toronto, ON

City of Toronto, 2018, *Road Engineering Design Guidelines,* Toronto, ON

City of Toronto, 2017, *Green Streets Technical Guidelines*, Toronto, ON

City of Vancouver, 2019, *Engineering Design Manual*, Vancouver, BC

Canadian National Institute for the Blind (CNIB) Foundation. 2022. *Clearing Our Path ASC Project*, [online] [Viewed 6 November 2025] https://clearingourpath.ca/index.php/final-report-clearing-our-path-asc-project/

CROW, 2016, *ASVV Guide – Recommendations for Traffic Provisions in Built-Up Areas*

CSA Group. 2023. *Standard B651:23 Accessible Design for the Built Environment*. Ottawa, ON: Canadian Standards Association.

Eco Counter, 2021, *Quantifying and communicating the growth of winter cycling in Montreal*, Webpage: https://www.eco-counter.com/blog/quantifying-and-communicating-the-growth-of-winter-cycling-in-montreal

EPCOR, 2022, *Stormwater Management and Design Manual* – Volume 3 Drainage, Edmonton, AB

Farzin, J., Lensky, W., and Czarnecky, J. 2011, "I-55 Bus on Shoulder Demonstration In the Spirit of the Time." In *Transport Chicago 2011 Conference*, Chicago, IL.

Federal Highway Administration. *CMF Clearinghouse* [online]. https://cmfclearinghouse.fhwa.dot.gov/

FDOT Roadway Design Office. 2025. "Chapter 202 – Speed Management." In *2025 FDOT Design Manual*. Tallahasse, FL: Florida Department of Transportation.

Fossum, M. and Ryeng, E.O. 2022. "Pedestrians' and bicyclists' route choice during winter conditions." In *Urban, Planning and Transport Research*, 10(1), pp. 38-57.
DOI: https://doi.org/10.1080/21650020.2022.2034524

Gitelman, V., Doveh, E., Carmel, R. and Hakkert, S., 2019, "The influence of shoulder characteristics on the safety level of two-lane roads: A case-study." In *Accident Analysis and Prevention*, Vol. 122, pp. 108-118.
DOI: https://doi.org/10.1016/j.aap.2018.10.003

Hildebrand, E., Morrall, J. 2021. "Cross Slope and Climate Change: Implications for Highway Design and Road Safety." In *Transportation Association of Canada 2021 Conference **and** Exhibition - Recovery **and** Resilience: Transportation after COVID-19*

Mitman, M. F., Davis, S., Armet, I. B. and Knopf, E. 2018. *Curbside Management Practitioners Guide.* Washington, DC: Institute of Transportation Engineers (ITE).

Institute of Transportation Engineers (ITE). 2010. *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, Washington, DC: Institute of Transportation Engineers.

Hamidi, S. and Ewing, R. 2023. *A national Investigation on the Impacts of Lane Width on Traffic Safety: Narrowing Travel Lanes as an Opportunity to Promote Biking and Pedestrian Facilities Within the Existing Roadway Infrastructure*. Baltimore, MD: Johns Hopkins Bloomberg School of Public Health https://narrowlanes.americanhealth.jhu.edu/report/JHU-2023-Narrowing-Travel-Lanes-Report.pdf

National Association of City Transportation Officials. 2013. *Urban Street Design Guide.* Washington, DC: Island Press. https://nacto.org/publication/urban-street-design-guide/

National Association of City Transportation Officials. 2019. *Blueprint for Autonomous Urbanism.* https://nacto.org/publication/blueprint-for-autonomous-urbanism/

National Association of City Transportation Officials. 2020. *City Limits.* https://nacto.org/publication/city-limits/

National Association of City Transportation Officials and U.S. DOT Volpe Center, 2019, *Downsized Street Maintenance Vehicles – Case Studies*. https://nacto.org/wp-content/uploads/191017_Volpe_CaseStudies_updatedEOD-3.pdf

National Academies of Sciences, Engineering, and Medicine (NASEM), 2023, *NCHRP Research Report 1036: Roadway Cross-Section Reallocation: A Guide*, Washington, DC, https://doi.org/10.17226/26788

NASEM, 2018, *NCHRP Research Report 880: Design Guide for Low Speed Multimodal Roadways*, Washington, DC, https://doi.org/10.17226/25248

NASEM, 2021, *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*, Washington, DC. https://doi.org/10.17226/26216

NASEM, 2024, *NCHRP Research Report 1120: Active Traffic Management Strategies: A Planning and Evaluation Guide*, Washington, DC, https://doi.org/10.17226/27986

Ontario Ministry of Transportation, 2021, *ATMS Design Guidelines*, ON

Ontario Ministry of Transportation, 2014, *Bikeways Design Manual*, ON

Ontario Traffic Manual, 2021, *Book 18: Cycling Facilities*, ON

Ontario Traffic Manual, 2007, *Book 19: Advanced Traffic Management Systems*, ON

Riggs et al., 2020, *A design framework for livable streets in the era of autonomous vehicles, Urban, Planning and Transport Research*, 8(1), pp. 125–137, https://doi.org/10.1080/21650020.2020.1749123

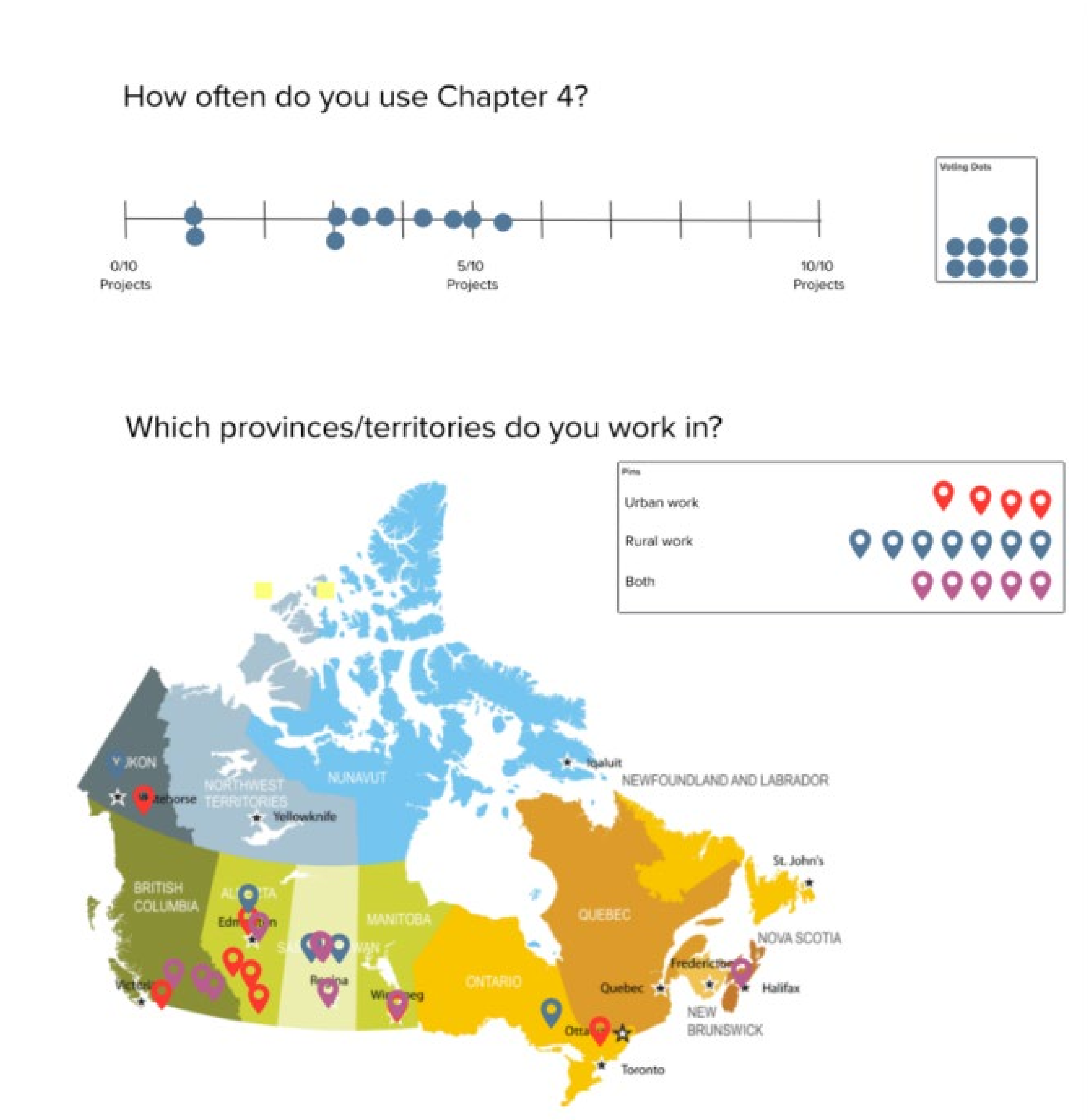
TAC, In Progress, *Design and Operation of Lower-Speed Collector and Arterial Roads: Synthesis of Practice - Draft*

TransLink and Ministry of Transportation and Infrastructure, 2024, *Design Guide for Bus Stops Adjacent to Cycling Infrastructure*, BC

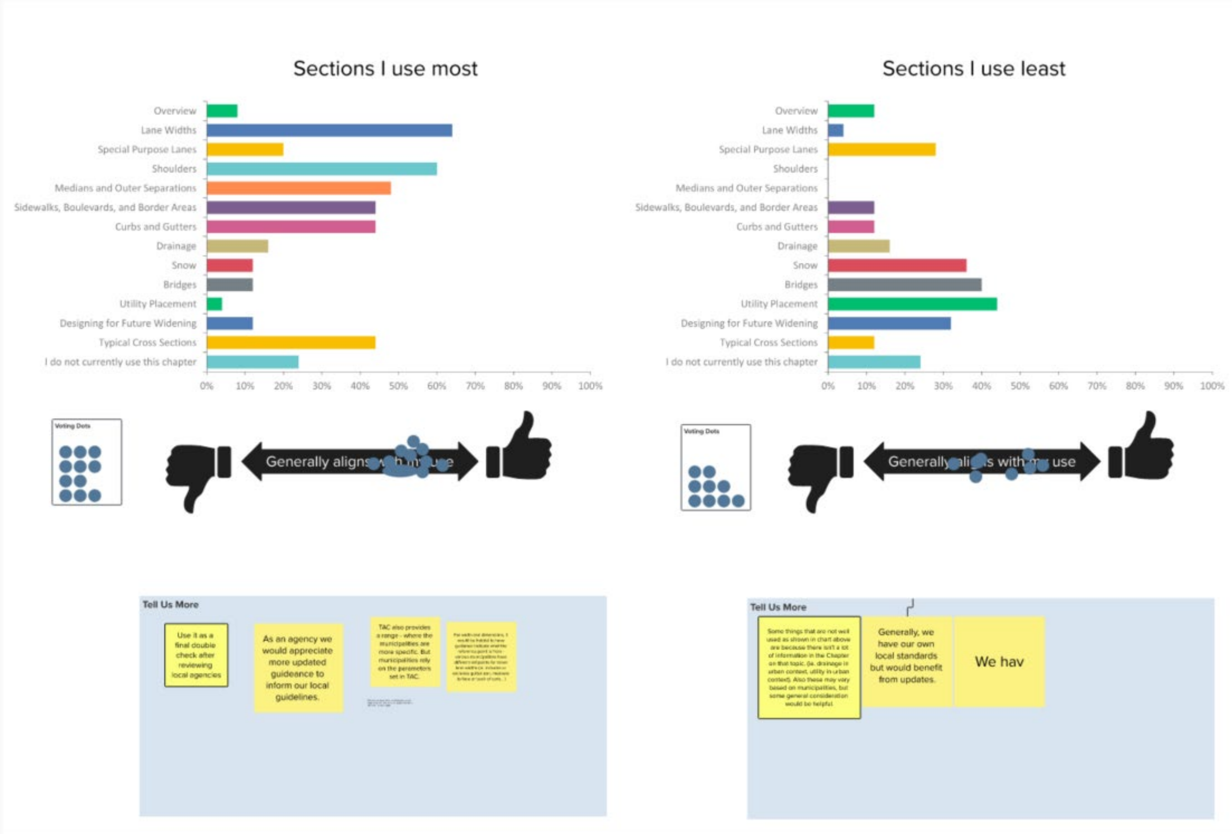
Bullough, John D., Van Derlofske, John, Dee, Peping, Chen, Jie, and Akashi, Yukio. 2003. *Report DOT HS 809 672 An Investigation of Headlamp Glare: Intensity, Spectrum and Size.* Washington, DC: National Highway Traffic Safety Administration.

Vélo Québec, 2019, *Aménagement pour les piétons et les cyclistes*, QC

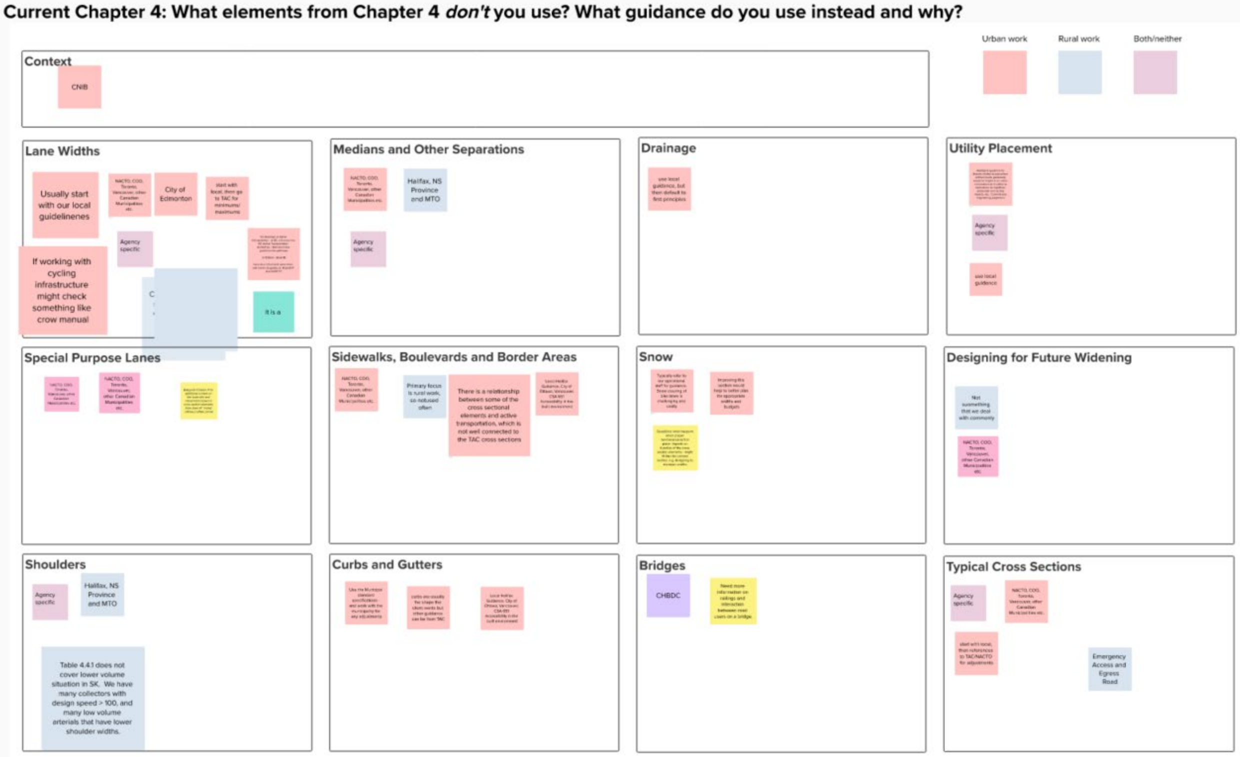
7. Appendix A - Virtual Workshop Snapshot



Survey Validation



Current Chapter 4: What elements from Chapter 4 *don't* you use? What guidance do you use instead and why?




Are any other elements missing? What are your go-to resources and what to you like about them?
Think technical content (e.g. dimensions), examples or case studies, layout, graphics, etc.
Urban work
Rural work
Both
Accessibility and Universal Design
Active transportation and micro-mobility design considerations, including e-mobility
Bridges
Buffer treatments
Climate Change
Complete Streets
Cross section design/ elements for slow speeds
Constrained areas
Crossfall
Parabolic cross sections
What about roundabouts?
Curbside management, including loading and delivery zones
Include consideration for shared micromobility storage
Flexible roadway design (e.g. movable barriers, dynamic lane allocations)
Intelligent transportation systems...
Landscaping and streetscaping
This is a major challenge related to winter maintenance. Do not have a good resource
Lateral clearance distance for railway signal assemblies
Is any of this covered in the railway safety guide?
Low Impact Development
Consolidation with utilities? Setbacks?
Road Diets (2+1 roads)
Guidance missing - need to turn to Europe, etc.
Safety and maintenance impacts of cross section elements
Safety devices
Safety devices require a lot of cross sectional space. How to incorporate into the cross section could be beneficial. Otherwise there is mostly manufacturer's specs
Snow placement/winter design
Speed management measures
Specifically related to traffic calming. Should we take some elements from the TAC traffic calming guide and bring them in here?
Transit facilities
Utility placement
Emergency Access and Egress Ro...
What widths? How far to cut back?
Unnamed area
Gutter drainage to align with Chapter 3
Unnamed area
Unnamed area


Priorities
Voting: Which of the existing Chapter 4 sections needs most attention in a future update?
Voting: Which of the missing elements should be prioritized for addition into Chapter 4?
If you could change one thing in the existing Chapter 4-Cross Section Elements, what would it be?
Improved integration with Chapter 11
Integration of on-street AT design.
Binder rather than glued bindings.
Examples of successful implementation
Add the known safety effects of the cross sectional element.
Enhanced visuals
Have a way to reduce the lane width for buses, including if buses have cameras instead of mirrors.
Crossfall should be 3%
Align crossfall slopes to new crossfall slopes in chapter 3
What's one thing we can add that would make Chapter 4 more comprehensive?
Include guidance on 2+1 roads
Guidance on slow speed design of Collectors and in dense urban environments.
Superelevation
Climate Change
Higher focus on urban issues
Include better guidance on median and shoulder widths.
Include: how to design for the speed you want, not the speed you have.
Cross sectional width allocation in constrained urban areas
Shoulder maintenance considerations
Wick drains in urban cross sections
Upkeep for guide rail keeping up with changes to standards NCHRP to MASH.

Transportation Association of Canada

401–1111 Prince of Wales Drive, Ottawa, ON K2C 3T2
(613) 736-1350 secretariat@tac-atc.ca

For more information about the Transportation Association of Canada and its activities, products and services, visit www.tac-atc.ca.