Keeping Sidewalks Safe in Winter: 2023 Update

Prepared for *Walk Toronto*

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Executive summary

Intent

Walk Toronto's 2014 report, [*Keeping Sidewalks Safe in Winter*](#), is the foundation to this document's research into the continued evolution of winter sidewalk maintenance in the city of Toronto. The team started by researching the City's current standards and procedures for winter sidewalk maintenance, then compared them against Walk Toronto's 2014 recommendations. This allowed the team to understand how the City's operations have or have not advanced. Research into City policy contextualized the importance of safe winter sidewalks within the City's broader goals and initiatives. Despite numerous policies supporting a high standard of winter sidewalk maintenance and a large overhaul of City winter sidewalk maintenance strategy in 2021, some of the 2014 recommendations were left partially or fully unimplemented.

To provide an understanding of the state of Toronto in 2023, we profile the people, infrastructure and climate that make the city what it is today. Our findings demonstrate that Toronto's demographics are shifting, infrastructure is expanding, and the climate crisis is affecting the city: all pointing to the urgency for updated winter sidewalk strategies and providing a mandate for this report. The research question grounding this work is,

> How might snow clearing operations in the City of Toronto forefront accessibility, mobility, and equity in the reality of a changing climate?

Process

A scan of Toronto-specific policy, reports and data formed a clear picture of the state of winter sidewalk maintenance in 2023. The team also conducted a preliminary literature review to gain understanding of challenges and successes related to winter maintenance, both in Canada and internationally. In order to screen the research that would form this report, the team created an eight-value search framework and compiled direction from our client, Walk Toronto, at an early stage of the project.

From here, the team defined five main areas of focus to improve sidewalk winter maintenance in Toronto at this time: 1) Deep public engagement, 2) Clear and accountable winter maintenance operations and procedures, 3) Intentional built form design, 4) Accessible and interesting winter programming, and 5) Resilience. Guided by the search framework and main areas of focus, best practices helped us formulate recommendations that are specific, targeted, and applicable to the Toronto context.

Outcomes

The four-month research period of this project resulted in a set of recommendations that are rooted in Canadian and international precedent, centring the people who use Toronto sidewalks and furthering the valuable work of Walk Toronto. Recommendations target active engagement on winter mobility, enhanced service standards, long-term infrastructure alignment for winter mobility, and social resilience. Within these recommendations, we highlight 13 specific actions that engage actors from within City government and outside it, providing realistic context for how

change can be made going forward. A full table of recommendations, including the search framework values that inform them, and the problem areas they touch is available in the [Conclusion](#) of the report.

1. <u>Background</u>

1.1.　　　About the authors

The *Keeping Sidewalks Safe in Winter: 2023 Update* is co-authored and edited by a studio group from Toronto Metropolitan University's (TMU) Master of Planning (MPI) in Urban Development program. The client for this studio project is Walk Toronto. Mentors for the project are TMU MPI alumni Emory Davidge, Senior Associate at Urban Strategies Inc., and Keira Webster, Climate-Neutral Cities Advisor, EIT Climate-KIC. Dr. Pamela Robinson MCIP RPP is the project supervisor. Studio team members include Catherine Caetano-Macdonell, Sara Cullen, Alex Hanes, Kiera McMaster, Frani O'Toole, Ramya Ragavan, and Aneil Sihota.

1.2.　　　About Walk Toronto

Founded in 2013, [Walk Toronto](#) is a volunteer-led advocacy group working to represent the needs and interests of pedestrians in the city of Toronto ([Walk Toronto, n.d.](#)). Centring safety and the experience of pedestrians, the group has participated in the municipal planning process by responding to, and working with, various levels of municipal government. Additionally, Walk Toronto engages with neighbourhood-level initiatives that affect pedestrians and supports national initiatives that advance street conditions for pedestrians ([Walk Toronto, n.d.](#)). Members of the Walk Toronto Steering Committee who volunteered their time for this project include Michael Black, Adam Cahoon, Pamela Gough, Daniella Levy-Pinto, Dylan Reid, and Doug Vallery.

1.3.　　　Walk Toronto's 2014 report: *Keeping Sidewalks Safe in Winter*

In 2014, Walk Toronto published the [*Keeping Sidewalks Safe in Winter*](#) report, which called on the City of Toronto to expand its sidewalk clearing operations ([Black et al., 2014](#)). In the report, Walk Toronto outlined the inequitable snow clearing practices resulting from the City's varied sidewalk plowing service and its overreliance on shoveling by residents. At the time of the report, the City plowed the majority of its sidewalk network, but a very large portion within the pre-amalgamation borders of the city was not serviced (Figure 1). Within this area, comprising approximately 1,100 linear kilometres of unplowed sidewalks, extra responsibility was placed on residents and businesses for sidewalk snow clearance. Residents took varying levels of care in this task, with some clearing to a high standard, and others neglecting to do it at all. Theoretically, sidewalk snow clearance was to be enforced by the City through its S[now and Ice Clearing By-Law](#) ([City of Toronto, 2022b](#)), however, enforcement was unreliable and, according to Walk Toronto, overly dependent on 311 requests ([Black et al., 2014](#), p. 1). This all led to a winter sidewalk network that poorly served sidewalk-users, especially those with greater mobility needs (p. 1-2).
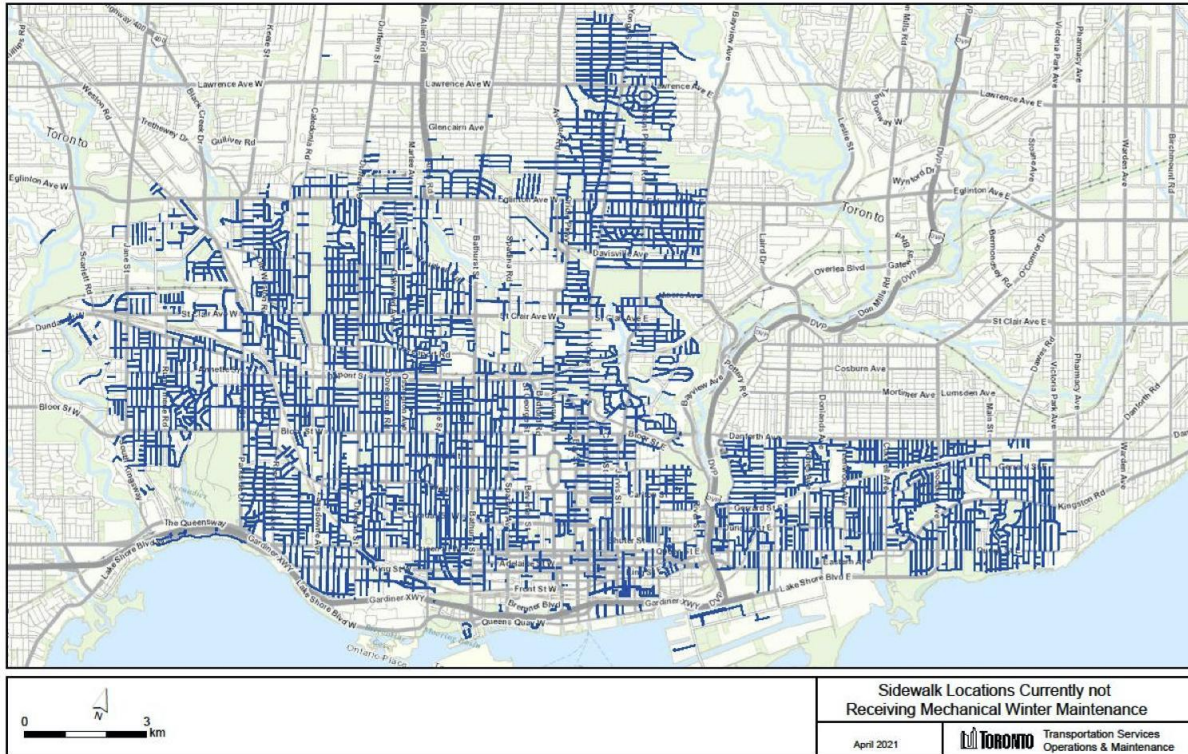
Figure 1: Sidewalks that did not receive mechanical snow clearing prior to expansion of the service in 2021 ([Transportation Services, 2021a](#)).

The problem, as Walk Toronto outlined, was a lack of equity in how the City cleared its sidewalks of snow: some residents enjoyed better, safer, and more accessible sidewalks in the winter than others ([Black et al., 2014](#), p. 5). Compounded onto this was the issue that the neglected sidewalks were in some of the busiest areas of the city, where pedestrian traffic was at its highest (p. 4). This meant that the sidewalks serving the most pedestrians were receiving some of the least attention. Users from across the region commute into the inner-city for work or pleasure, so interest in better servicing the inner-city sidewalks cut across geographic lines. According to Transportation Services, these sidewalks posed insurmountable challenges to mechanical plowing operations due to the particularities of their layout and streetscaping, thereby making their servicing infeasible (p. 3). Nevertheless, Walk Toronto argued that expanding sidewalk plowing to all sidewalks in the city was worth the investment.

In their report, Walk Toronto explored the rationale for expansion of the City's sidewalk clearing through a number of angles. Support for expanding the service was demonstrated through an analysis of previous Toronto initiatives and policies, such as [Toronto's Official Plan](#), [Pedestrian Charter](#), [Green Standard](#), and [Complete Streets](#). The report cited the need to consider vulnerable demographics such as youth, the elderly, and disabled community members (p. 8-11). Winter maintenance practices from nine other Canadian cities were assessed (Ottawa, Montréal, Burlington, Stratford, London, Halifax, Vancouver, Edmonton, Oakville, Toronto), each of which highlighted a weakness in Toronto's operations (p. 15-22). With the above rationale discussed, Walk Toronto made a number of recommendations to the City of Toronto (see

for a summary of these recommendations and our analysis of the City's relevant actions).

1.4. 2023 City strategy on sidewalk winter maintenance

Since Walk Toronto published their *Keeping Sidewalks Safe in Winter* report in 2014, the City has made significant changes to their winter sidewalk maintenance strategy. Below, current practices for winter sidewalk maintenance are summarized, with an assessment of whether or not Walk Toronto's 2014 recommendations were implemented and to what extent.

1.4.1. Current strategy and operations

Expansion of City sidewalk maintenance responsibilities
In 2021, the City of Toronto expanded sidewalk winter maintenance to include all previously un-plowed sidewalks. To support this expansion of winter maintenance, a pilot was run in the winter of 2020/21, demonstrating that narrow mechanical plows could be used on 95% of the city's sidewalk network (City of Toronto, n.d.-d.). In alignment with the results of this pilot, the 2021 decision also directed Transportation Services to purchase new mechanical plowing equipment (City of Toronto, 2021a, item 2). Even in areas where narrow mechanical plows would not be viable, the City made a commitment to manually remove snow from sidewalks, taking responsibility for all previously unplowed sidewalks (City of Toronto, n.d.-d.).
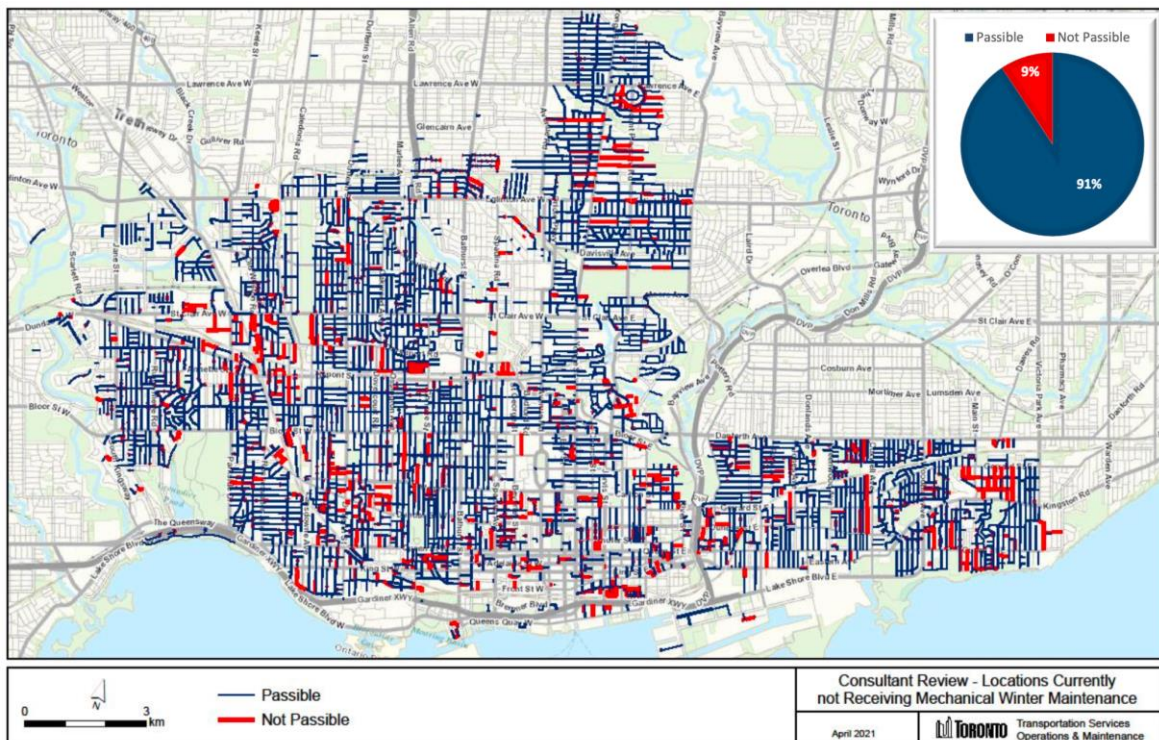
Figure 2: Sidewalks unplowed prior to 2021, with review results designating which sidewalks will require mechanical or manual plowing under expanded City sidewalk winter maintenance (City of Toronto, 2021a, Appendix F).

The City's decision to expand sidewalk winter maintenance did not completely void responsibility for residents and businesses. If an accumulation of snow is under two centimeters, residents and businesses are responsible for clearing snow from sidewalks adjacent to their properties (n.d.-c.). After the two-centimeter threshold is reached, the City becomes responsible for sidewalk snow clearing (n.d.-c.). This once again leads to different clearing time periods that sidewalk users can expect, as residents have 12 hours to clear snow under the two centimeter limit from adjacent sidewalks, yet the City may take up to 13 hours to complete one snow clearing cycle, a process that can continue up to 72 hours after snowfall ends due to multiple clearing cycles being needed (n.d.-c.). Furthering the patchwork of timeframes, private property owners have 24 hours to remove snow from walkways on their property, regardless of the amount of snowfall (n.d.-c.).

Delivery of winter sidewalk maintenance
Now that the City has assumed responsibility for winter sidewalk maintenance, sidewalks throughout the city should be maintained to the same standard in the case of a snowfall over two centimeters. The standard applied to sidewalks is "safe and passable," defined by the City as, "a road surface that is free from as much ice and snow as is practical and may be traveled safely at reasonable speed" (311 Toronto, n.d.-b.). Toronto's Auditor General has defined this standard more specifically, stating that "safe and passable" means that salt and a windrow may be present but that snow cover under eight centimeters may remain and loose snow, slush, and ice may be present (2023b, p. 22). The level of detail specified by the Auditor General is not available on the City of Toronto website.

In order to deliver on sidewalk winter maintenance, the City contracts private companies to clear snow (Toronto Auditor General, 2023a, p. 1). The City of Toronto is split into eleven contract areas (p. 20), with only two companies performing winter maintenance operations on roads, bikeways and sidewalks in eight of the eleven zones (p. 23). Previously, the city was split into 47 contract areas but consolidation of these areas was completed as part of the strategy to streamline service delivery under the 2021 procurement process (p. 17).

To let residents know where sidewalk plows are in the city and how recently streets have been serviced, the City hosts a live map called PlowTO. During winter months, plow GPS data from the last 12 hours is published on the map (City of Toronto, n.d.-b.). Unlike other municipally collected datasets, historical data and planned routes are not made available on Toronto's Open Data Portal. Information about when and where the City has measured over or under two centimeters of snow in an area, is also not made available.

Triaging issues with winter sidewalk maintenance: 311 service
14,408 snow-related service requests that could be applicable to pedestrians were made to Toronto's 311 service in the winter months of 2022 (City of Toronto Open Data, 2023). The City has not yet publicly stated if and how they utilize their service request database to inform updates to winter maintenance strategies. When considering the value of 311 service requests, it is important to note that this municipal system has been found to be an imperfect measure of resident need and issue frequency (Cullen, Gibson, & Hanes, 2023), pointing to the need for a more complete understanding of how well the City delivers winter maintenance.

Demonstrating 311's limitations, preliminary research has found no correlation between frequency of snow-related 311 service requests and proportion of residents age 65 and over in Toronto (Cullen, Gibson, & Hanes, 2023). In this case, we see that a group with a higher need for snow and ice clearing is not using 311 to express that need. While these results do not uncover the reason why residents in need may use 311 less, they demonstrate the potential for inequity in the use of 311 and a need for further insight. Until data is published on plowing routes and completion rates, analysis on the efficacy of winter maintenance based on need will be limited in Toronto.

A brief literature review backs up the claim that municipal 311 services are subject to bias. Research has found that sociodemographic characteristics can have an effect on how likely someone is to utilize 311 services (Kontokosta, Hong, & Korsberg, 2017), overriding objective and subjective needs (Kontokosta & Hong, 2021) and resulting in unequal overall use of the service. Studies note that minority populations, limited English speakers and low income groups are more likely to under-report issues to 311, whereas the elderly, high income groups, and white residents may be more likely to over-report (Kontokosta, Hong, & Korsberg, 2017; Kontokosta & Hong, 2021). While 311 service requests will remain a common tool for residents to flag complaints and concerns, this must be coupled with the knowledge that certain residents are likely to under- or over- report based on background circumstances.

City updates about winter sidewalk maintenance
Since the 2021 update to the City's sidewalk winter maintenance strategy, two winters have passed and a consolidated strategy has not been published by the City. The City has also not published an evaluation of their regular sidewalk winter maintenance strategy, nor reported back on whether they consistently met their intended level of service or time frames on city sidewalks in day-to-day operations. In March 2023, Walk Toronto supported Councillors Dianne Saxe and Shelley Carroll in calling for a review of winter maintenance contracts (City of Toronto, 2023a). While this recommendation was adopted and scheduled for the September 2023 Infrastructure and Environment Committee meeting (City of Toronto, 2023a), no such review has been included on the Committee's agenda to date. Following January 2022's major snow event, however, the City published a summary and evaluation of their performance from a harmonized maintenance perspective (General Manager, Transportation Services, 2022). While this assessment resulted in numerous recommendations, updates about implementation have not yet been published. It is also notable that regular winter maintenance has not been dissected in the same way as emergency snow scenarios, leading to a lack of clarity and centralization about quality of servicing during typical winter conditions.

In June 2023, the Toronto Auditor General published two reports related to winter snow operations. The first report reviews the procurement and contract award process followed by the City when awarding winter maintenance contracts. The second report followed up on recommendations made in 2020 about holding contractors accountable to contract terms, evaluating if the City had made sufficient changes to adhere to the recommendations. In November 2023, the Auditor General published a short additional report addressing a change in winter contract terms which imposes a lesser financial penalty on contractors not adhering to

one of the contract terms. While these reports demonstrate that there is need for continued improvement to Toronto's winter maintenance strategy, they also highlight the lack of holistic review of current maintenance practices. Although in-depth and area-specific assessment provides value and direction to the City, further review of harmonized winter maintenance policies and their impacts on residents is vital.

1.4.2. Now vs. then: How have the 2014 *Keeping Sidewalks Safe in Winter* recommendations been addressed?

Comparing the changes the City has made to its winter maintenance practices against the recommendations made by Walk Toronto in 2014, it is clear that the City has made some progress but still has work to do. Below is our evaluation of how well we think the City has addressed the recommendations made by Walk Toronto in the *Keeping Sidewalks Safe in Winter* report (Black et al., 2014, p. 31).

1) Expand the City of Toronto's responsibility for sidewalk clearing to the remaining 1,100 linear kilometres of unplowed sidewalk, preferably through mechanical means.

> **Full implementation with questions remaining**
> As of May 2021, this recommendation has been officially adopted by council (City of Toronto, 2021a), with mechanical clearing performed on 95% of the city's sidewalk network (City of Toronto, n.d.-d.). While this means that the City has taken on a larger share of snow clearing responsibility, residents are still responsible for clearing sidewalks adjacent to their dwelling in many cases (n.d.-c.). Responsibility for snow clearing only passes from residents to the City when snow accumulates to over two centimeters (n.d.-c.).
>
> A question remains about who is responsible after consecutive sub-two-centimeter snowfalls. We could not determine if the City has declared a stance on this issue based on a scan of the City's Snow Clearing Portal, Snow Clearing by-law, relevant Council/committee minutes (e.g., City of Toronto, 2021a; City of Toronto, 2022a), relevant staff reports (e.g., Transportation Services, 2021b; General Manager, Transportation Services, 2022) and the City's relevant policies (see Section 1.4.3).

2) City staff should review best practices in other winter cities to form an evidence-based determination of what is possible, feasible, and equitable.

> **Unsatisfactory implementation**
> A "Winter Maintenance Program Review" was conducted in 2019 by HDR Inc. through procurement by the City of Toronto (HDR, 2019). This review assessed the City's snow clearing service at the time and included comparisons to peer cities (Ottawa, Montréal, Chicago, Milwaukee, Minneapolis, and New York) and other GTHA municipalities (Brampton, Hamilton, Mississauga, London, and York Region). The report found that Toronto's sidewalk clearing either met or exceeded the standards set by peer cities and other GTHA municipalities (p. 38, p. 57).

In a letter addressed to council, Walk Toronto noted dissatisfaction with HDR's comparative review (Walk Toronto, 2019, p. 3). Walk Toronto highlighted that an overly favourable conclusion about Toronto's sidewalk clearing practices was due to the over-representation of American cities and near-exclusive sampling of municipalities in which the responsibility for sidewalk snow clearing is placed on residents.

Nevertheless, HDR made a number of recommendations that the City has since followed (HDR, 2019, p. 59). One such recommendation is that the City reduce the snowfall accumulation threshold for initiation of snow plowing from eight centimeters to two centimeters. This was recommended on the basis of improving "equity of service, safety, and pedestrian mobility" (p. 59). HDR also recommended the pursuit of a sidewalk snow clearing trial for the then-uncleared sidewalks in the city (p. 59).

3) In case the City did not expand their service (as described in sections 1 and 2), "bare minimum" steps should be taken to ensure that resident shoveling was adequate.

> **Conditions mostly met / action not required**
> The City did pursue the actions described in recommendations 1 and 2. Given the conditional framing here, this recommendation does not request City action. However, because questions persist about resident responsibility (see recommendation 1), and Walk Toronto noted their dissatisfaction with HDR's "Winter Maintenance Program Review" (see recommendation 2), we chose to still inquire into the City's actions on this recommendation. Two of the most substantial recommendations included:

a) Rigorous enforcement of the Snow and Ice Removal By-law;

> **No evidence of implementation**
> Based on our scan of City materials, including but not limited to, the City's Snow Clearing Portal, Snow and Ice Removal By-law, relevant Council/Committee minutes (e.g., City of Toronto, 2021a; City of Toronto, 2022a), relevant staff reports (e.g., Transportation Services, 2021b; General Manager, Transportation Services, 2022) and relevant policies (see Section 1.4.3), no evidence was found that enforcement has been enhanced for snow clearing by residents. A search through Toronto's Open Data Portal, Toronto Police Services' Open Data Portal, and various grey literature sources revealed no data on how many tickets are distributed for snow clearing violations. This meant we could not determine a way to assess whether or not the City had escalated enforcement. Given that no evidence has been found, it is assumed that compliance with the by-law remains unchanged from 2014 and thus continues to rely on 311 requests made by residents, as per Walk Toronto's assessment (Black et al, 2014, p. 1-2).

b) An amendment to the Snow and Ice clearing By-law that requires residents to clear a minimum width of 1.2m on sidewalks of 1.5m in width.

No evidence of implementation

No amendment has been made to the By-law specifying the minimum width for clearing snow from sidewalks (City of Toronto, 2022b). Instead, subsection 719-3.A of the Toronto Municipal Code requires that sidewalks be *completely* cleared of snow by residents (2022b), but in our experience as residents of the city, this is seldom achieved on streets that do not have designated snow storage space (City of Toronto, 2017b, p. 75). On such streets, windrows usually pile up on the edge of the sidewalk, resulting in a narrow cleared path. This disproportionately impacts residents with mobility devices, who require a wider pedestrian clearway (Figure 3).

| Person with Mobility Assistive Device 0.9m | Two People Walking Space 1.4m | Pedestrian + Bags 0.7m + 0.3m | Pedestrian Pushing Stroller 0.9m | Passive Walking 0.7m |

Figure 3: An illustration from Toronto's Complete Streets Guidelines showing the width requirements of different types of pedestrians (2017b, p. 79).

Current road clearing operations pile snow at the edge of the road, which spills over onto the sidewalk. This makes it effectively impossible for residents to achieve complete sidewalk clearance, because of snow that has been piled onto the sidewalk from the road. For many narrow sidewalks that do not have designated snow storage space, complete clearance would require the City to substantially expand its snow removal operations (311 Toronto, n.d.-c) to clear windrows. Barring such a change, complete clearance lacks specificity, which results in poorer and more inconsistent winter sidewalk conditions.

4) "Sidewalk winter maintenance should be coordinated with that of streets as a whole" (Black et al., 2014, p. 31).

Some implementation

The reason given for the negotiation of new winter maintenance service contracts was to "consolidate operations for all road classifications, sidewalks, and cycling facilities within the same vicinity achieving a more integrated method to delivering services" (General Manager, Transportation Services, 2022, p. 5). This not only consolidates facilities, but consolidates efforts for streets as a whole (General Manager, Transportation Services & Chief Procurement Officer, Purchasing and Materials Management, 2021, p. 8).

Transportation services has also implemented service level agreements with the TTC, and pursued similar arrangements with the Toronto District School Board, Toronto Catholic District School Board, and Toronto Parking Authority (General Manager, Transportation Services, 2022, p. 12). In places, snow removal is now occasionally undertaken when a major snow event is declared and the City prohibits parking along a street to enable snow removal, but this is purportedly "rare" (311 Toronto, n.d.-d).

While the above initiatives have led to greater coordination of winter maintenance operations for streets as a whole, it is not clear if they have addressed what we perceive to be the core of this particular recommendation; that streets as a whole be coordinated for efficiency and timeliness of service, ensuring that sidewalk and roadway maintenance are performed in tandem to provide an equal standard of maintenance for all, as opposed to just drivers.

5) New sidewalks should be built to ensure efficient snow removal.

Full implementation
Toronto has adopted provisions in its Official Plan and Complete Streets Guidelines that specify the allocation of street space for on-street snow storage (City of Toronto, 2017b, p. 77; City of Toronto, 2023c, sec 3.1.1-6.a.iii). The City has also adopted design standards for sidewalks that require a minimum pedestrian clearway width of 2.1 m (City of Toronto, n.d.-e.; Engineering and Construction Services, 2018), which is sufficient for operation of the City's older (wider) sidewalk plows (Black et al., 2014, p. 24-25).

6) The City should investigate the costs of slip and fall claims and compare their costs against the potential cost of expanding the City's Plowing service.

Implementation unknown
With our search framework (see Section 2.4), which was the result of our meetings with Walk Toronto and other research (See Appendix C), we thought that the analysis of this recommendation was outside the scope of this project. Application of this framework meant we applied an accessibility and equity lens to this research thereby centering user need over economic/operational feasibility. The goal of this recommendation (as far as we could tell) was to demonstrate the economic feasibility of an expanded snow clearing service. Accordingly, we did not inquire into whether or not the City had pursued such action, because it did not fit within the goals of this project, as defined by the search framework. This is not to say that a user-centric approach is infeasible, but that we did not define success of this project by what the City would deem feasible.

1.4.3. Toronto policy scan in support of safe winter sidewalks

The City of Toronto has a variety of plans, policies, and guidelines that identify the need to better accommodate pedestrians. Given that Toronto is a winter city, all plans that support walking in Toronto must address the ways that winter affects walking conditions. Supporting walkability in Toronto means ensuring that sidewalks are adequately cleared of snow in the winter, designed to be serviced efficiently, and meet the needs of all users, including those with disabilities. The following policies, plans, and guidelines provide broad support and outline opportunities for the goal of improving winter pedestrian mobility in Toronto and highlight the varying interests of safety, accessibility, and environmental protection.

Official Plan

The Toronto Official Plan is very clear in its endorsement of walking as the transportation mode to be most prioritized (City of Toronto, 2023c). For instance, section 2.2-4.a specifies how the City will develop its transportation system such that it "prioritizes walking, cycling and transit over other passenger transportation modes" (2023a); section 2.2.1-8 specifies that "priority will be given to improving walking, cycling and transit… within Downtown" (2023a); and section 2.4-3.b.i commits the City to pursue measures that "increase the proportion of trips made by walking, cycling, and transit" (2023a). The Plan also requires dedication to street space for snow management (2023a, sec 3.1.1-6.a.iii) but stops short at identifying the impact that snow has on walking and the pedestrian experience.

Salt Management Plan

The Salt Management Plan (Transportation Services, 2021c) outlines the ways in which the City will use and store salt to ensure safe road operations while minimizing environmental impact; however, the scope of the Plan covers other winter maintenance activities, including snow clearing and removal. The Plan outlines a number of ways to reduce salt usage, such as the use of liquid brine (sec. 3.2), many of which have been implemented since the Plan was first adopted (sec 4). It also outlines the City's vision for the future of snow removal, stating that "melting as opposed to snow disposal sites [is] the way of the future as regards Snow Removal" (sec. 3.4). Unfortunately, much of the information regarding sidewalk clearing is out of date, with the Plan still claiming that most sidewalks within "the Toronto and East York District… do not meet established guidelines [for snow clearance], and, as such, adjacent residents are required under existing by-laws to clear the snow from sidewalks" (sec. 3.5). This has not been true since sidewalk clearing services were expanded to cover these sidewalks in 2021 (City of Toronto, 2021a). Section 3.5 provides valuable insight into the City's application of the "safe and passable" standard for sidewalks. According to the document, the City cannot clear sidewalks to bare pavement due to "surface undulations"(Transportation Services, 2021c, sec 3.5). This strikes us as an odd argument because roadways also have surface undulations (ie. potholes) (City of Toronto, n.d.-c). Based on this rationale, it does not appear that consideration of user need was a factor in the application of this service standard.

Complete Streets Guidelines

The City first adopted Complete Streets as a street planning approach in 2014 in its Official Plan, and later adopted its Complete Streets Guidelines in 2017 (The Centre for Active Transportation, n.d.). The City states that the "complete streets approach reinforces that streets

should safely accommodate all users – pedestrians, cyclists, transit services and motor vehicles" (City of Toronto, 2017b, p. 2). The guidelines outline the City's vision for streets as being safe, accessible, beautiful, and prosperous for all (p. 7). In outlining its vision for sidewalks, the guidelines stress that accessibility is "a top priority" (p. 75), and that the City should design for comfortable sidewalk use all year long (p. 75). Part of designing for all-year use is allocating utility space at the edge of the sidewalk for maintenance activities such as snow clearing (p. 77). To effectively use this allocated space, a consistent and reliable snow maintenance service is required (p. 87).

Figure 4: An illustrated example of a Complete Street (City of Toronto, 2017b, p. 29).

Vision Zero

Vision Zero is a global road safety movement that aims to reduce all traffic related injuries and fatalities to zero (Vision Zero Network, n.d.). In 2019, the City adopted Vision Zero 2.0, which asserts that "human life should be prioritized over all other objectives within all aspects of the transportation system" (General Manager, Transportation Services, & General Manager, Solid Waste, 2019, p. 1). If the City truly does prioritize human life over all other transportation objectives, then it is reasonable to demand high quality, reliable, and safe sidewalk winter maintenance. After all, winter conditions pose clear safety risks to all users, including pedestrians and vulnerable road users (Abohassan, El-Basyouny, & Kwon, 2021).

Toronto's [Vision Zero 2.0](#) uses a safe systems approach to road safety that "recognizes that the human body is vulnerable to injury and that humans make mistakes" ([General Manager, Transportation Services, & General Manager, Solid Waste, 2019](#), p. 13). Consequently, the road network must be made inherently safe and account for errors in judgement and operation. Road safety is not merely the responsibility of an individual road user, but is instead the responsibility of many interest-holders, including road designers and maintenance crews (p. 13). While enforcement of the rules of the road is an important countermeasure in the Plan, it is only one piece of the puzzle, along with engineering, education, engagement and evaluation (see 5Es, p. 1-2). Where the strategy discusses snow-related issues, it identifies the lack of sidewalks (p. 30) and dangers associated with maintenance vehicle operation (p. 45), but curiously, not slips and falls. Winter sidewalk maintenance is also a contributing factor in the safety of the road network and should be prioritized as such. The Vision Zero strategy lists six emphasis areas, three of which are sidewalk users: pedestrians, school-aged children (4-19), and older adults (65+) (p. 12). If the City intends to protect these groups from injury during the winter, then it is imperative that the City ensures that sidewalks are usable by all sidewalk users, especially those who have greater mobility needs.

TransformTO

In 2017, Toronto adopted its climate action strategy, [TransformTO](#), with the chief objective to achieve carbon neutrality by 2050 ([City of Toronto, 2021b](#), p. 6). To meet this goal, the City intends to phase out fossil fuels by 2040 through building a cleaner energy grid (p. 58-63), ensuring the efficiency of buildings (p. 50-57), and promoting low carbon forms of transportation (p. 64-71). The strategy sets very ambitious modal shift targets, with the goal that "75 percent of school/work trips under 5 kilometers are walked, biked, or by transit, by 2030" (p. 10). According to the strategy, 38 percent of local greenhouse gas emissions are the result of transportation (p. 65). Even though modal shift is an important aspect of TransformTO, it does not identify the role that winter conditions might play in modal choice. Research has suggested that pedestrians feel uncomfortable using slippery walkways ([Muraleetharan et al., 2005](#)), while other research in Toronto has shown that weather can affect modal choice ([Saneinejad et al., 2012](#)). Research on how sidewalk conditions in the winter affect willingness to walk appears to be lacking, but it is reasonable to assume that if pedestrian comfort is affected by slippery walkways ([Muraleetharan et al., 2005](#)), then pedestrians may shift up to more comfortable and carbon intensive modes (such as driving or rideshare). In order to achieve the City's ambitious modal shift goals and offset the large proportion of greenhouse gas emissions resulting from transportation, winter sidewalk conditions must be cleared to a high standard. Pedestrians should have reliable and enjoyable year-round sidewalks, to encourage walking in all seasons.

Multi-Year Accessibility Plan 2020-2024

In compliance with the [Accessibility for Ontarians with Disabilities Act](#) (AODA) (Government of Ontario, 2016), the City of Toronto adopted its current [Multi-Year Accessibility Plan](#) (MYAP) in 2020 ([City of Toronto, 2020](#)). With this plan, the City aims to ensure compliance with AODA, but also advance "beyond legislative requirements" (p. 5). The Plan covers a range of areas in which accessibility is to be advanced, from employment to transportation (p. 5) and adopts six guiding principles, including "Accessibility by Design" (p. 7). The Plan identifies that the "City of Toronto is committed to increasing accessibility and usability of all City sidewalks and

roadways" (p. 32), which includes the Plan's transportation initiative seven: a review of snow clearing policies and procedures through an accessibility and equity lens (p. 34). We believe that adequately conducting such a review entails a fundamental shift in Transportation Services' current assessment practices for winter maintenance operations, which focus on feasibility, rather than user need (e.g. Transportation Services, 2021b). Taking an accessibility lens means recognizing the impact that these standards have on disabled residents, and putting that understanding into action, with potentially new standards that meet those needs.

The City's most recent Multi-Year Accessibility Plan Annual Status Report (People & Equity, 2022) identifies that the MYAP's transportation initiative seven had an impact on the decision to clear all sidewalks upon accumulation of two centimeters of snow (p. 39). However, in the staff report directing council to adopt this change, it appears to us that this decision was more the result of a feasibility assessment than an accessibility assessment (Transportation Services, 2021b). The report briefly recognizes the impacts that snow clearing has on disabled and elderly residents, (2021b, p. 10), but this appears to us to play a small role in the recommendations made in the report. As of 2022, it appears Transportation Services have begun collaboration with the Toronto Accessibility Advisory Committee, which will include a review of "the current levels of winter service for all public spaces" (General Manager, Transportation Services, 2022, p. 8-9). It is good that this work has begun, but we have yet to see the results of this collaboration.

Toronto Senior Strategy 2.0
Toronto adopted the original Senior Strategy in 2013 which contained 91 recommendations to promote an age-friendly city (City of Toronto, 2018b, p. 4). With 90 of those recommendations having been acted upon, the City then adopted a second iteration of the strategy in 2018 with 27 new high-impact recommendations through consultation with over 10,000 senior residents (p. 4). In continuing to improve the lives of seniors in the city, Version 2.0 of the Seniors Strategy seeks to centre its perspective on the diversity of seniors, paying particular attention to black, indigenous, low-income and LGBTQ2S seniors (p. 16). The recommendations range from expanding dental programs for low-income seniors (p. 22) to increasing digital literacy programs at the Toronto Public Library (p. 24). The strategy also makes recommendations to enhance the mobility of seniors, including expansion of Senior Safety Zones as part of the City's Vision Zero plan (p. 34), and the construction of sidewalks in places they were previously missing (p. 34). Notably, the strategy highlights snow removal as a main concern voiced by seniors during consultation (p. 17), but no specific recommendation in the strategy addresses this concern. In expanding the mobility options for seniors, it is crucial that Transportation Services consider the concerns of Senior sidewalk users. Slips and falls pose serious risks for seniors (Public Health Canada, 2022), so it is crucial that the City take extra care in the way that it maintains its sidewalks during the winter.

1.4.3.1.   Policy scan takeaway

This section highlights a variety of plans and initiatives the City has undertaken that contextualize the need for better winter sidewalks. Building a safer winter sidewalk network means considering issues of land use and urban design, but also the needs of equity-deserving

groups. In both the Multi-Year Accessibility Plan and the Senior Strategy 2.0, snow clearance was recognized as a critical consideration for residents with greater mobility needs. The City has worked to consult these segments of the population, but it is not clear the degree to which that message has been fully received by Transportation Services.

Both the Salt Management Plan and TransformTO provide an important environmental perspective for judging the impacts of winter maintenance operations. Encouraging walking in the winter is crucial for the City to reach its carbon goals, but this must be balanced with the potential local ecological impacts of salt usage. Looking from a macro and micro environmental perspective demonstrates the need for better urban design and land use that can mitigate the need for environmentally harmful practices. Bringing all these approaches together will be crucial to creating safer winter sidewalks.

1.5.   Toronto (2023): Our people, climate and infrastructure

In order to understand winter sidewalk maintenance in Toronto as a whole, the current composition of people, infrastructure, and climate must be used to provide context to City operations and policy. Below, research about Toronto's current state is summarized, with specific focus on characteristics that directly impact or are impacted by winter conditions.

1.5.1.   People in Toronto

Population

In 2021, the census recorded 2,794,356 individuals residing in the City of Toronto, representing a 2.3% population increase since 2016 (Statistics Canada, 2023b). Combined with the construction of high-rise dwelling units, the unaffordability rates have reached unprecedented levels (Statistics Canada, 2023a). The number of high-rise apartment buildings with five or more storeys grew by 14.7% from 2016 to 2021, more than double the 6.4% total growth of single private dwellings (Statistics Canada, 2022b). Currently, the condominium market represents 30.7% of all dwellings in the downtown core and urban centres within Toronto, the highest percentile recorded throughout Canada (Statistics Canada, 2022b). Changes related to population and housing type matter as this data represents that as population increases, so should Toronto's winter maintenance standards. Winter weather patterns and unsafe sidewalk maintenance will affect a higher percentage of individuals as the population increases.

Elderly

Seniors are predicted to grow and account for 19% of Toronto's population by 2030, demonstrating the increasing relevance of winter maintenance in the city (City of Toronto, 2019c, p. 7). Seniors (aged 65 and above) currently account for 17.1% of Toronto's population (Statistics Canada, 2023b). Research shows that 30-50% of elderly individuals' main use of transportation is walking (Wennberg, Ståhl, & Hydén, 2009). Therefore, older individuals who have mobility limitations consider accessibility and usability to be very important factors for their well-being, especially as they age (Wennberg, Ståhl, & Hydén, 2009). This data shows that a large portion of Toronto's population are seniors whose main mode of transportation is walking. During the winter season, particularly during winter weather conditions, a senior's level of

movement may be hindered due to unsafe sidewalk maintenance which affects their day-to-day well-being.

Children & youth

Accessibility during the winter months also affects children and youth, especially those who have a physical or mental disability. According to Census Profile 2021, children grouped between the ages of 0-14 account for 131,710 of Toronto's population, whereas youth grouped between the ages of 15-24 account for 220,460 of Toronto's population (Statistics Canada, 2023b; City of Toronto, 2022c). Children are more reliant on active transportation modes to get to and from school (Larouche et al., 2020). Children's physical activity and active transportation use varies depending on the size and built form of the community in which they live (Larouche et al., 2020). As physical activity levels decrease with age, promoting active transportation and physical activity is beneficial for developing children's and youth's well-being and mental health (Larouche et al., 2020). Accessibility limitations are proven to have heightened negative psychological impacts on youth by increasing loneliness, depression, and dependency (Lindsay et al., 2014). An analysis of young power-wheelchair-users explains that weather creates additional challenges when being outside: in addition to snow build-up along the edge of sidewalk paths that prevents access to public streets and public transportation, cold weather can numb hands and legs and bulky winter clothing restricts the ability to manoeuvre wheelchairs efficiently (Lindsay et al., 2014). Youth with disabilities vocalize that changing weather conditions prevent them from taking part in daily activities when only a little snow on the ground can prevent a wheelchair-user from going outside (Lindsay et al., 2014).

Vulnerable sidewalk users

Accessibility issues during winter months also affect caregivers and individuals who rely on assistive devices such as canes, walkers, scooters, guide dogs, etc**.** When snow conditions are severe, routines between caregivers and the recipients of care are disrupted (Skinner, Yantzi, & Rosenberg, 2009). When a caregiver is unavailable to assist, it places more stress on the individual requiring those services (Lindsay et al., 2014).

A case study from Sweden identifies that trip, fall, and skid injuries are notably higher for women, accounting for nearly 70% of pedestrians who were injured from icy weather conditions (The Clandestine, 2021). When looking at a gender-based lens in a winter climate, men are more likely to use a vehicle whereas women are more likely to walk, cycle, and use public transportation in addition to travelling with groceries, buggies, and children (The Clandestine, 2021).Winter cities should prioritize the clearing of sidewalks first to establish safe and clear spaces for their most vulnerable sidewalk users. As of recently, the City of Toronto has goals to create its first gender equity plan which will be aimed at reducing gender inequities for the 50% of Toronto's population who identify as a woman, girl, or gender diverse (Draaisma, 2023).

Renter vs. owner

Census 2021 recorded renters living in Toronto households have increased by 21.5% between 2011-2021, compared to owner households showing an increase of 8.4% between 2011-2021 (Gorski, 2023). Much of the increase in renters is due to rising housing costs and market inflation when purchasing a new home. Consumer price indexes have also increased by 10.9%,

making mortgage costs and homeownership unattainable for many Canadians, resulting in an increased demand for rental units (Gorski, 2023). Additionally, Toronto tenants indirectly pay municipal property taxes via annual rent increases made by landlords (Lobo, 2021). The same level of tax is applied to residential tenants with fixed incomes, or tenants living in affordable housing units (Seepe, 2019). As property taxes fund essential services such as education, garbage collection, and road maintenance, they tend to be typically higher or equal in condominium units compared to single family homes (Lobo, 2021). According to the Residential Tenancy Act, landlords are responsible for "maintaining a residential complex" whereas snow and ice clearing fall under the term "maintenance" which abides by Ontario's health and safety standards (Government of Ontario, 2023). Even if a landlord adds a term to a lease agreement which passes on their maintenance obligations to a tenant, the landlord will still be liable for any loss (Souch, 2018). This was upheld in the Montgomery vs. Van law case, which "ruled that it was possible to pass this responsibility on to the tenant but it must be done by way of a separate contract for services or as a clause in the lease that could be severed and would be able to stand as a separate contract" (Montgomery vs. Van, 2009; Souch, 2018). This text represents the responsibilities that renters and landlords have, particularly how landlords or condo corporations must comply with safe winter clearing practices for their properties. If snow is not properly cleared, then it can cause disruptions to renters.

1.5.2. Infrastructure in Toronto

Currently, Toronto hosts 7900 kilometres (311 Toronto, n.d.-b.) of sidewalks and operates mechanical plows on 95%, or approximately 7505 kilometres, of this network during winter months. The City continues to expand this network, filling gaps in the pedestrian network via the Missing Sidewalks Program. In 2023 alone, Transportation Services identified 19 road segments to add sidewalks to (Transportation Services, 2023, p. 2-3). This is the highest number of recommended additions to the network since Transportation Services was assigned this responsibility in 2019.

Sidewalk network expansion is not the only form of infrastructure growth in Toronto, as construction continues to boom. In 2022, a review of the development pipeline in Toronto identified 613,689 residential units that are under review or active, demonstrating the potential to increase the number of residential units in the city by over one-half if built (Toronto City Planning, 2022, p. 1). While the need for housing outpaces supply, current rates of residential development in Toronto are set to meet 90% of the 10-year housing supply increase targets set by the Province (Crawley, 2023).

With a large and consistently expanding network of sidewalks and homes, it is reasonable to predict the City's obligations for snow removal will only increase with time. As new infrastructure is built, the amount of winter servicing will increase in volume and complexity, making the case for a corresponding increase in adaptable and resilient City winter sidewalk strategy.

1.5.3. Climate in Toronto

Climate change creates unpredictable and erratic winter weather conditions, as fluctuations in temperature create patterns that are different from historical norms. For example, 30 days of

snow were recorded in 2012, whereas after a decade there were 48 snow days recorded in 2022 (Figure 6) (Environment and Climate Change Canada, 2022a).Toronto's average annual snowfall is around 130 centimeters but has varied year-to-year in the last 24 years (Figure 7). This data solely reflects the amount of snow days and does not account for the intensity of snow events.

Temperature is an important variable to consider when predicting the form that precipitation will take as the climate shifts. Mean annual temperatures are projected to rise in the next couple years, leading to storms and changes in snowmelt patterns. The Intergovernmental Panel on Climate Change (IPCC) projects a global increase of 3.3 to 5.7 degrees Celsius by the end of the century under a high greenhouse gas (GHG) emission scenario (Figure 5) (Toronto and Region Conservation Authority, n.d.). It is important to note that this is a global projection, which helps set the overall understanding that temperatures will continually increase over time across the globe. From a local perspective, average Toronto temperatures are projected to increase 9.8 to 15.8 degrees Celsius by the end of the century under a high GHG emissions scenario (Toronto and Region Conservation Authority, n.d.-a.). Increasing temperatures typically produce higher amounts of precipitation since warmer temperatures cause more water to evaporate (United States Environmental Protection Agency, 2023). In the Toronto context, we can infer an increase in precipitation, either rain or snow, to occur due to the increase in temperature caused by climate change.

Based on Toronto's projected temperature increases, more precipitation in the form of rain, hail, and sleet may arise. Hail occurs in warmer temperatures during severe thunderstorms with strong updrafts (NOAA National Severe Storms Laboratory, n.d.). Sleet occurs under conditions below the freezing point when the raindrop freezes before reaching the surface (NOAA National Severe Storms Laboratory, n.d.). A variety of studies demonstrate the link between global warming and precipitation using climate-model projections, indicating potential future weather outcomes (Liang, Gillett, & Monahan, 2020; Sohoulande Djebou & Singh, 2016 & O'Gorman, 2015). In 2018, a study on Canada's north coast analyzed the effect climate change had on the region, finding that climate change increases weather variability and decreases weather predictability (Ford et al., 2018). Recognizing the unpredictability of our current climate and developing recommendations that adapt to and mitigate poor climate outcomes are key to resilience.

Altering climate and weather patterns cause issues for both natural and built systems. Warming temperatures produce earlier and faster snowmelt, which strongly impacts water systems and ecosystems. For example, ecosystems that are dependent on regulated water supply would be disrupted by unpredictable snow melt patterns (Malhi et al, 2020), which impacts human activity with the potential for water and/or food shortages (Confalonieri & Aparicio Effen, 2011). This would be an added stressor to residents in Toronto who already face issues with accessibility during the snow season. Regarding our built systems, unpredictable melting can lead to excessive runoff that can interfere with the built form where construction has not been planned for such weather conditions (Kumar et al., 2022). Without proper drainage systems and other built features to reduce flooding, cities can experience trouble when the

unpredictable weather conditions occur. In Toronto, the built form is an important factor to consider when implementing strategies for resilience. Either major reconstruction or improvements need to occur for the built form to withstand any unexpected weather conditions.

Winter temperatures for Toronto in 2022-23 and 1840-41

A comparison of daily mean temperatures (C) for winter 2022-23 and winter 1840-41 in Toronto

— 2022-23 Temp (C) ···· 1840-41 Temp (C)
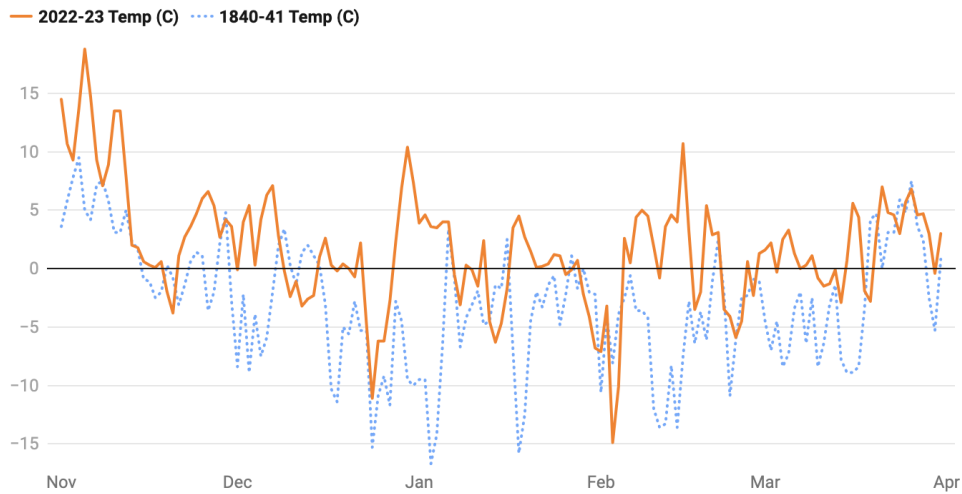
Chart: Huma Hamid • Source: Government of Canada • Created with Datawrapper

Figure 5: Winter temperatures for Toronto in 2022-23 and 1840-41 (Government of Canada, 2022).
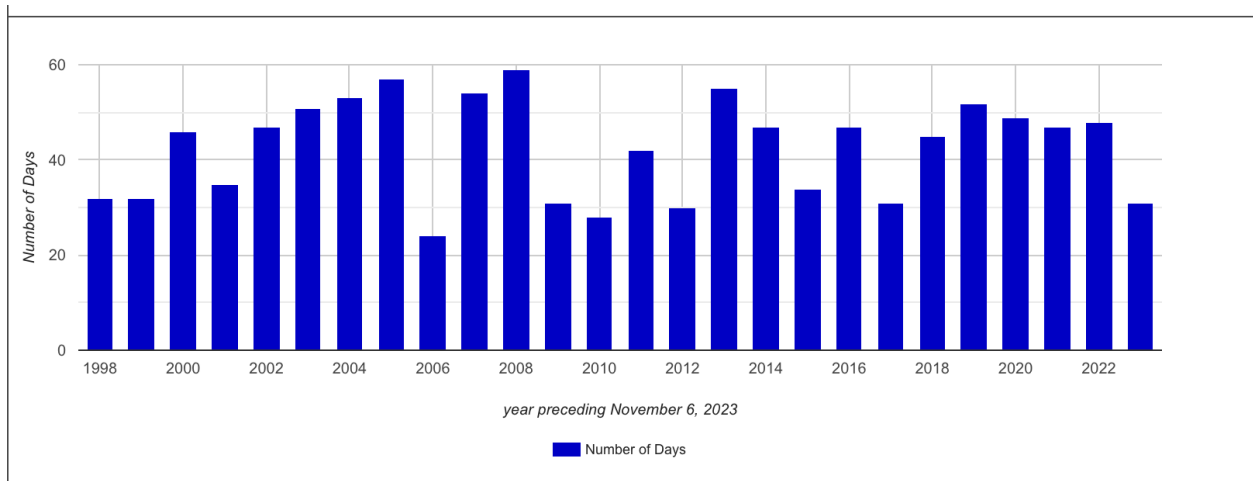
Figure 6: Bar graph displaying annual number of snow days in the city of Toronto from years 1998 to 2022. Number of snow days vary throughout the 24 year span, with no particular trend (Environment and Climate Change Canada, 2022a).
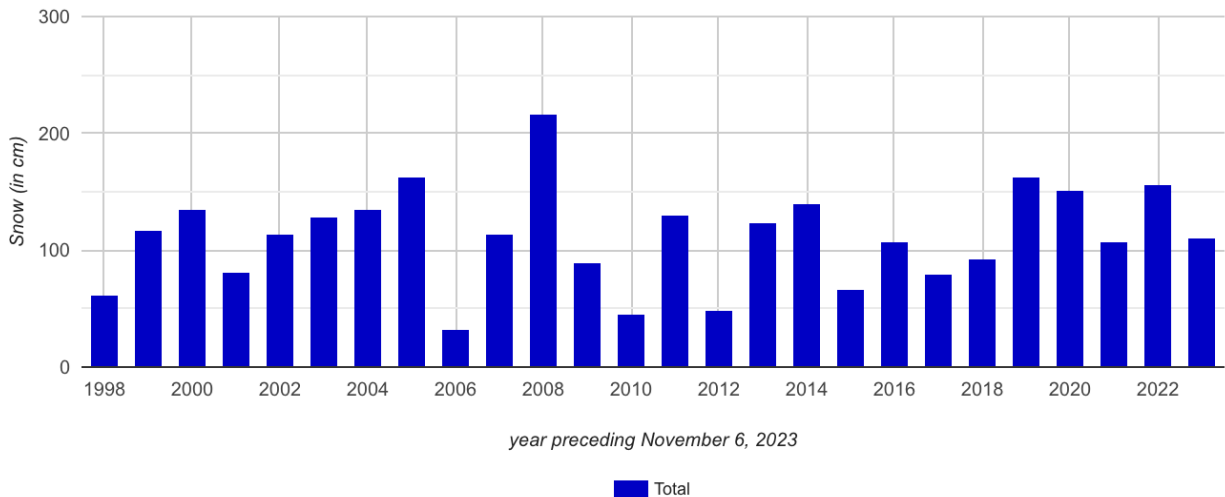
Figure 7: Bar graph displaying annual snowfall (centimeters) in the city of Toronto from years 1998 to 2022. Annual snowfall vary throughout the 24 year span, with no particular trend ([Environment and Climate Change Canada, 2022b](#)).

Weather impacts on mental health and physical health

The changing climate has serious implications on mental health and physical health for residents. Projected temperature increases mentioned above can create more precipitation and storm events ([Toronto and Region Conservation Authority, n.d.-a.](#)), which in turn is linked to changes in mental health ([Cianconi, Betrò, & Janiri, 2020](#)). The winter season consists of shorter days with limited sunlight which contributes to the feeling of depression ([Øverland et al., 2020](#)). The disappearance of animal and plant species in the winter has also been linked to feelings of hopelessness or depression ([Cianconi, Betrò, & Janiri, 2020](#)). There are a multitude of factors that add to negative mental health of residents during the winter season.

Further, presence of barriers to leaving your home, which can result from winter conditions, adds to negative mental health. Referring back to the people in Toronto, snow presents different barriers amongst the variety of groups we have identified. For example, sidewalk-users who use assisted devices to navigate their path run into more problems than a resident who does not need extra assistance. Residents who need to wait for the snow to be cleared due to their guide dog feeling uncomfortable walking outside or one's wheelchair unable to navigate through the snow puts stress onto their daily activities. This limits their capability to access food from grocery stores or go visit the doctor's office because they feel unsafe travelling in uncomfortable weather. This leaves them isolated in their homes until the City makes their way around to clear sidewalks. Looking into physical health, uncleared sidewalks can lead to physical injuries such as trips, slips, and falls which increases hospital visits ([Wilkins & Park, 2004](#)). For example, Toronto's vulnerable sidewalk-users may risk their safety to access important necessities. According to Walk Score, Toronto is the most walkable city in Ontario with a score of 61 compared to the average score in Ontario of 34 ([Walk Score, n.d.](#)). This makes it clear that there is value in winter sidewalk maintenance, in both preventing negative outcomes and supporting active transportation levels.

1.5.4. People, infrastructure and climate takeaways

In the almost 10 years that have passed since Walk Toronto completed the *Keeping Sidewalks Safe in Winter* report, Toronto's makeup of residents, infrastructure and climate has contributed to a new landscape for winter sidewalk maintenance. Considering the people who live in Toronto, senior populations – who are more likely to be impacted by winter sidewalk conditions – are increasing. The number of residents living in rental units has also increased, with a larger proportion of housing stock taking the form of high-rise buildings, meaning that the responsibility for sidewalk snow removal cannot easily be ascribed to those living in buildings bordering sidewalks needing winter maintenance. Findings about differing use of sidewalks in winter present opportunities for equity to be centred in future winter maintenance strategies.

Alongside a steadily increasing population, the city is seeing increasing numbers of housing developments and the addition of sidewalk infrastructure. Higher numbers of people utilizing Toronto's network of sidewalks makes the City's responsibility for winter maintenance more important than ever. This responsibility and the expenditures that accompany it will continue to gain complexity as further growth occurs, making it critical that the City create an agile strategy that considers all residents. Adding to the need for robust and adaptable sidewalk winter maintenance that serves Toronto's residents, climate change has created changing and less predictable weather conditions. A changing climate and its associated side effects complicate resident health and use of outdoor amenities, leaving the City with a chance to improve and maintain resident quality of life in winter in the face of climate uncertainty through high quality sidewalk maintenance.

The findings from this portion of our background research support the need for an updated assessment of Toronto's current winter sidewalk strategy. Not only has the need for winter sidewalk maintenance increased due to population, infrastructure, and climate shifts, but these areas of change also demonstrate that strategies must be adapted to Toronto's current and future state.

2. Research methods

2.1.　　　Research question

As we began to update the report, we started by defining our research question:

> How might snow clearing operations in the City of Toronto forefront accessibility, mobility, and equity in the reality of a changing climate?

Within our research question, we had additional considerations to support our framing. These include:

- The City of Toronto should be the main party responsible for clearing snow. A snow clearing approach that relies too heavily on dispersed responsibility results in inconsistent clearing conditions that make it difficult for residents to navigate the city. However, there is a wider network of actors who have obligations to contribute to the state of winter maintenance, including private business owners, residents, Business Improvement Areas (BIAs), and other community organizations. The City should consider how the wider network of actors can be involved in winter maintenance, without overly diluting their own responsibilities.

- Poor winter conditions create varying barriers for residents. This is why accessibility and equity are central to our work. We will expand on these ideas in our search framework.

- Solutions need to be responsive and factor in the need for adaptability in light of a changing climate. While it might be possible to forecast some of the ways weather may change, it is not possible to predict new temperature and precipitation patterns with full certainty. Snow may fall more or less frequently; the quantity of snow could vary widely; and the consistency of the snow that does fall could be significantly wetter and heavier (Harvey & E&E News, 2019).

2.2.　　　Intended outcomes

The primary intended outcome of this research is to create a resource that will support Walk Toronto with their pedestrian advocacy work. To support this outcome, we performed extensive research on City of Toronto policy and practices; conducted an environmental scan of national and international best practices for winter mobility and snow management; and synthesized the research findings into recommended actions. Through this work, we created a product that supports both Walk Toronto's immediate mandate for improved winter mobility, as well as their desire for a broader scope of actions and research that address the speculative aspects of what winter *could* be like. They have asked us to look at practical, as well as playful, interventions. Both are included in our final recommendations. Some key directions from Walk Toronto that informed our research are outlined below.

2.2.1. Direction from Walk Toronto

We received feedback from Walk Toronto at the interim and final presentations for our studio project (see Appendix B for a full feedback log from our clients, mentors, and supervisor). Through these two checkpoints, as well as meetings with individual Walk Toronto Steering Committee members, we received direction on specific considerations to address through our research.

Responsibility

Walk Toronto asked us to forefront recommendations to which the City would be accountable, rather than emphasizing recommendations that rely on shared responsibility. Walk Toronto primarily directs their advocacy efforts to the City: therefore, it makes sense that they would like us to focus on areas where the City can take ownership over snow clearing. However, they did not want us to forgo a discussion on responsibility entirely, and asked us to consider how different levels of responsibility can be defined and communicated to residents, business owners, and property managers (Doug Vallery, Pamela Gough). We took this direction, and applied it to the creation of our dialogue kit engagement activity.

Environmental impact

In an interview, Michael Black indicated that the environmental impact of current snow clearing practices was an important factor he would like us to research. Adam Cahoon also called attention to salt usage at our interim presentation meeting, sharing that excessive salt usage can damage his wheelchair. Daniela Levy-Pinto highlighted that excessive salt can also harm guide dogs' paws. Within our scope, we have incorporated recommendations that speak to more environmentally-friendly practices for snow management.

Attitudes towards winter

Michael Black pointed out that snow is a fact of life in Toronto, and that, collectively, our approach to snow management needs to change. Internally, our team discussed a thread of recommendations that boil down to the question: What if Toronto changed its attitude towards winter? How would that impact how the City prioritizes snow clearing and programming in winter?

Proactive advocacy

In conversation with Doug Vallery, we learned that Walk Toronto would like to take a more proactive approach to advocacy. Historically, their advocacy has been reactive in response to City policies. To address this piece, we provided an overview of current City of Toronto policies and practices, as well as case studies from other cities. Our hope is these "best practice" examples can help support targeted advocacy about tools and approaches that could be adopted by the City.

Gender and snow clearing

Michael Black and Pamela Gough both indicated in their one-on-one conversations that a gendered lens to snow clearing might be worth considering. We have used Sweden as an example in our international scan to point to the gender and snow clearing piece.

Communication

In both the interim and final presentation meetings, Walk Toronto highlighted the importance of clear, two-way communication between residents and the City. Adam Cahoon stressed the issue of snow hardening in the time between an accumulation being reported to 311 and it being cleared. For him, a top priority is better communication that does more than instructing callers to "just wait." Our research brought us to the same conclusion: respectful, affirming communication is crucial for effective snow management. Walk Toronto will find this thread reflected in many of our recommendations.

2.3.   Research methods and process

Initial scan

We started our research with a large team literature review. We gathered over 70 academic and popular sources that reflect different aspects of winter maintenance, snow removal, and winterizing cities. Following our initial review, we had our first team-client meeting, where we met with Walk Toronto to understand their goals for the project.

Following our initial meeting, each team member met with a different Walk Toronto steering committee member for a more in-depth discussion about their objectives for the project. Doug Vallery offered to lead us on a walking tour of the downtown to highlight how different sidewalk conditions can impact mobility, so we joined him on a startlingly warm October day.

In tandem with our client conversations, we began mapping out themes that we felt were central to the spirit of the work we wanted to do. We had extensive discussions about how we would define and apply the themes we identified: ultimately, they became our search framework outlined in the following section. Additionally, we sought out information from the City to understand how their winter maintenance policies have changed in the past 10 years. We performed policy analysis, read news articles, and reviewed census data to gain a rough understanding of Toronto's winter momentum.

Interim presentation

In our interim presentation, we presented all of our background research to our mentors, classmates, professors, and clients. We received extensive feedback, and used it to direct our research in the second half of the course.

Problem framing themes

Following the interim presentation, we met as a group to distill our research up until that point. We decided on five common themes that underpinned the multi-faceted problem of winter maintenance in Toronto: operations, engagement, built form, resilience, and programming. We felt that all of the research we had done so far pointed to shortcomings in at least one of those five areas. They first informed our best practices scan, and then our recommendations.

Best practices scan

Our best practices process began by revisiting prior research in our initial scan and comparing it with Toronto's current winter maintenance practices to identify any pressing issues. With those ideas in mind, we were able to pull from prior research and new research on different best

practices on overall winter maintenance, snow removal, and winterization of cities. We decided to examine both international and Canadian-based snow best practices. This allowed us to pull from international cities that have continued to perform excellent winter maintenance and servicing for the residents, and find connections to local Canadian cities where these practices can be replicated in the Toronto context. Through our extensive best practice research we were able to create a list of best practices which were coded into main groups by commonalities. This method led us to establish recommendations based on the problem framing areas that frequently appeared throughout our best practices research.

Recommendation forming
Following our best practices scan, we looked at our eight values and five problem-framing areas to come up with three cross-cutting recommendations. Within these recommendations, we identified strategic actions to support their execution. Each strategic action was linked to specific values, a specific problem area, an associated timeframe for implementation, the scale of the action (e.g. a local versus a city-wide intervention), and potential groups at the City that would be responsible for their implementation. In framing the recommendations this way, we hoped to provide Walk Toronto with specific, concrete actions that they can either advocate for themselves, or pass along to implementation partners.

Final presentation and incorporating feedback
At the end of November, we held a final presentation for Walk Toronto. We presented the research that we completed since the interim presentation and three of our recommendations. We received excellent feedback from our client, mentors, and supervisor, and used some of the notes from the post-presentation conversation to clarify our last two recommendations. Additionally, we incorporated feedback from our clients and supervisor into this report in order to clarify the purpose of our writing.

2.4. Search framework

Our search framework is a set of eight interrelated values that speak to the concerns of our client. We arrived at these through consideration of those who are most underserved by the current snow clearing practices in the city, such as seniors, children, caregivers, newcomers and especially those with mobility or visual impairments. These groups have the greatest need and are thus the primary focus of these eight values. These values evolved with input from Walk Toronto and our mentors, with an intention to communicate what we chose to prioritize as a team. The values that we have identified as the most important to evaluate current and ideal snow clearing and winter city practices include: accessible, equitable, integrated, predictable, accountable, adaptable, environmentally sustainable, and affirming.

The eight values were applied as a filtering and evaluation tool to review current and best practices from Canadian and international examples. This created a tool to objectively screen practices, highlight relative risks, strengths, and the degree of alignment with our values. Additionally, each value used a similar method of measurement or review, which will make prioritizing recommendations more systematic.

Each of these values was the result of a literature review and extended conversation. Excerpts from some of our research material can be found in Appendix C.

2.4.1. Eight core values

Accessible

A winter sidewalk network should go above and beyond 'access' to create a place where all sidewalk users – especially those with mobility needs – can interact with and enjoy the public realm during winter. We recognize that what has been established as 'feasible' within snow clearing policy tolerates conditions in the built and programmed elements of the urban environment that are themselves 'disabling.' Reviewing City policy like the overview of the Toronto Pedestrian Charter and the City of Toronto's *Multi-Year Accessibility Plan* (City of Toronto, 2020), we envision an **accessible** city that rights these wrongs through dignity and interdependence, distributing resources such that people with disabilities not only receive the benefit of snow clearing, but are also involved in helping to shape the definitions of its success (City of Toronto, 2002).

Equitable

Services should be **equitable** and reduce bias in the City's service delivery. The consequences of snow events can be severely uneven. We believe equitable decision-making and consistent service delivery centers community members and community areas that have experienced marginalization, lower service investment, and under winter conditions especially, experience the greatest need (Transportation Services, 2019).

Integrated

Integration is a team effort across departments, community groups, BIAs, and individuals. In addition to participatory management processes, an **integrated** approach can draw from systems approaches and systems thinking to permit flexible responses to complex issues and mixed adaptive models (Acaroglu, 2017). The approach, policies, and infrastructure should consider the relationships between City and non-City actors, and the interrelatedness of transportation, culture, infrastructure, social services, and the environment.

Predictable

Service delivery should be **predictable** for sidewalk users, which is earned through proven and consistent service delivery, real-time information, and fulfillment of requests. This value should be seen in how service providers demonstrate care (especially for those who have the greatest mobility need), and there should be a discernable and reliable pattern of snow clearing. When considering predictability as a value, it is important to analyze the recipients of the service and adapt it to their user-need (Accessibility Unit, n.d.).

Accountable

Maintenance service providers must be **accountable** to the lived experience of sidewalk users**.** Winter sidewalk maintenance crews in the city should respond in a timely and regular manner to service needs (including additional service requests). Requests from those with the greatest mobility constraints should be prioritized. The City uses the language of ensuring "consistency, comprehensiveness and clarity" (Toronto Auditor General, 2023c), which is itself not static:

rather, it is the outcome of committed communication and long-term investment.

Adaptable

Services should be **adaptable** and responsive**,** meaning proactive planning of winter maintenance schedules should produce greater ease in responding to changes in weather patterns. Services should respond to feedback from residents or staff to ensure quality service, providing extra care for those who rely on clear sidewalks the most ([Accessibility Unit, n.d.](#)).

Environmentally sustainable

Environmental sustainability is urgent in the context of a changing climate, which is reinforced in Toronto City Council's vision of "a clean, green and sustainable city" ([City of Toronto, 2019a](#), p. 5). Snow clearing practices (such as salt usage) can have a serious ecological footprint: sustainable snow clearing means minimizing detrimental environmental and ecological impacts while supporting environmentally-conscious lifestyles ([Dybas, 2023](#)). Successful implementation of this value to improve climate mitigation means infrastructure must become resilient to growing environmental issues and mitigate harm to the ecosystem ([Pratte, 2011](#)).

Affirming

In points of interface with the public, the City can **affirm** residents' sense of belonging and stewardship over the public realm. Affirmation is an opportunity for the City to be reparative in how it interacts with community members, some of whom have been systemically overlooked or disempowered in their interactions with the City. In dignifying the contribution of community members, the City can work to set the right norms for taking care of each other under all weather conditions ([Cole & Low, 2023](#)).

2.4.2.   Solutions across scales

Solutions and practices can vary in scale and have applicability at different levels. That is why the second part of our framework considers scale and asks questions such as:

- ○ Who is responsible?
- ○ Who has a say?
- ○ What is the consistency of the service geographically?
- ○ How can the City build operations processes that are visible to residents so they can make informed decisions about their mobility choices in the winter?

While our intended audience for much of this work are our clients Walk Toronto, the City of Toronto, and the City's Transportation Services, there are possible solutions at lower levels of organization too. Solutions for issues experienced by individuals, especially those with the greatest need, must have their needs addressed and responded to. Large groups like communities can create solutions that suit the needs of their community; broadly, the City can create practices that lead to more consistent service comprehensively.

2.5.　　　Research limitations

There are a few key research limitations that we would like to note:

- Our group was constrained in the amount of time we had to complete this research. We worked on this project for a four-month period (September to December, 2023). The strict timelines of the studio course meant that we were unable to pursue ethics approval to undertake community-engaged research. Ideally, we would have liked to work with community members in the creation of our recommendations and snow dialogue kit; however, we were unable to pursue that in the context of our studio project. We would suggest this as a potential area of future research.

- We did our best to present a holistic background of the state of winter maintenance in Toronto, but were only able to access City of Toronto documents that are publicly available. Some information was impossible for us to find, out of date, or contradictory to other documents or policies. Understanding the City's operations is difficult from an external vantage and we have spent significant energy to ensure accuracy. Due to the decentralized state of winter policy in Toronto, some level of inaccuracy is expected, which reinforces our recommendation that clear municipal communication is crucial.

- As urban planners, we are only able to fully engage with domains of our particular practice. In other words, we are strongest at presenting policy and built form interventions related to winter maintenance. Some of our recommendations require the expertise of engineers or landscape architects. We have done our best to ground them in precedent, to prove that they are theoretically feasible; however, their implementation would require the additional expertise of other professionals.

3. Research findings: Framing the problem with winter sidewalk maintenance in Toronto

Through our review of the state of winter maintenance in Toronto, we have identified five key areas where winter maintenance falls short. In this section, we will outline our research findings as they relate to our five key areas, commenting primarily on the gaps we have identified in the current state of winter maintenance.

These key areas in need of attention are:
- Deeper public engagement
- Clear and accountable winter maintenance operations and procedures
- Intentional built form design
- Accessible and interesting winter programming
- Resilience

In the following section, we will outline the research that points to our concerns with the current state of winter maintenance in Toronto. As demonstrated by the supporting research, these five areas span a significant range of issues across different scales.

3.1.   Deep public engagement

In our research it became clear that the vast majority of Toronto's snow policy currently glosses over the variety of needs people have during winter conditions (notable exceptions include the *Seniors Strategy* and the *Multi-Year Accessibility Plan*). In treating all residents the same, the service doesn't account for differences in how some populations experience snow over time. Places where the City does interface with the public, such as 311, can therefore be reactive and code real-time information as 'complaints.'

Engagement in this context can perhaps be understood as the opposite of a 'complaint' process: defining itself as proactive, sustained, and not treating constructive feedback as anomalous, but rather an essential and constitutive part of the system. Where a complaint frames participation – e.g. calling in through 311 – as a one-time externality of the system failing, proper engagement situates feedback as an integral part of responding to real-time conditions. As such, engagement will need to be longitudinal and change the narrative around how the City relates to the public, and the public to the City.

Currently, a clear public platform for understanding public sentiment around snow clearing is 311 service request data, available through Toronto's Open Data Portal. An introductory look at 311 service requests from 2022 demonstrates that snow service types affecting pedestrians make up 8% of requests during winter months (January, February, March, November, and December) in Toronto (City of Toronto Open Data, 2023). However, this is an incomplete log of overall snow-clearing concerns due to equity issues mentioned in Section 1.4.1 and City control: during a 2023 winter storm, the City decided to stop accepting new 311 service requests related to snow until days after the storm had passed (Elliott, 2023).

In 2019, the City of Toronto contracted HDR Inc. to complete a comprehensive review of the City's winter maintenance levels. 43% of the individuals surveyed said that they thought the City was doing a fair or poor job of winter maintenance (as compared to 37% of respondents in 2013) (HDR, 2019). 22% of respondents thought that service levels had worsened since 2013 (as compared to 33% of respondents who thought that service levels had improved, and 37% who thought they were about the same).

It is clear from these results that the City's snow clearing is under-performing in its delivery and customer service. Improved performance will need to orient around exactly how it is that residents define an 'excellent' job – and the lived experience that informs that standard – in order to establish protocol accordingly (HDR, 2019).

3.2. Clear and accountable winter maintenance operations and responsibilities

Our scan of Toronto's current winter maintenance operations revealed a confusing mixture of information across brochures (e.g., 311 Toronto, 2022; 311 Toronto, 2023), webpages (e.g., 311 Toronto, n.d.-a; 311 Toronto; n.d.-c), staff reports (e.g., Transportation Services, 2021b; General Manager, Transportation Services, 2022), by-laws (City of Toronto, 2022b) and policies (see Section 1.4.3). Despite this broad overview, we still have questions about the share of responsibility between residents and the City, the equity of enforcement, the application of service standards, the accountability of operations and the ecological impacts of salt usage.

Responsibility
The City has made a number of improvements to its operations in recent years (see Section 1.4.1), but a substantial portion of responsibility for clearing snow is still left on residents (See Section 1.4.2, recommendation 1). In many North American cities, the responsibility for clearing snow from sidewalks is shared by residents, while in some notable Canadian cities - such as Ottawa and Montreal - it is solely the responsibility of the municipality (HDR, 2019, p. 27-28). We believe that in a complex and resourceful city such as Toronto, winter maintenance responsibilities should not primarily fall on residents, for numerous reasons. Relying on individual residents to clear their snow results in a patchwork of different levels of snow clearance. This can make it difficult or impossible for disabled residents, children, elderly folks, and other sidewalk users to safely traverse the city (see Bergström and Magnusson, 2003 for a discussion on active transportation in winter).

The 2-centimeter accumulation threshold used to determine when responsibility shifts from residents to the city is much better than the 8-centimeter threshold of the past, but it does leave questions unresolved: what happens when there are consecutive sub-2-centimeter snowfalls? Does the snow continue to accumulate if not shoveled by residents? Should safe pedestrian mobility on city sidewalks depend on residents at all? The experiences expressed by our client speak to the fact that the over-reliance on individual actors (residents, business owners, property owners, public entities, property managers) to clear snow can mean that residents with the greatest need are subject to dangerous conditions due to a lack of care from their peers. The result of that lack of care is a winter sidewalk network whose quality and safety can

fluctuate greatly from sidewalk to sidewalk and from neighbourhood to neighbourhood. In the Transportation Service's own words: "humans make mistakes. The roadway system should be designed and operated so those mistakes are not deadly" (General Manager, Transportation Services & General Manager, Solid Waste, 2019, p. 13). The same logic applies to sidewalks: people mistep/slip, so sidewalks should be designed and operated such that those mistakes are not deadly.

Enforcement

Toronto's Municipal Code allows individuals who do not shovel their sidewalks to be fined (City of Toronto, 2022b). While no data was found on just how many tickets are issued for failure to clear snow from sidewalks (see Section 1.4.2), it is important to consider the broader context of enforcement as a tool that can disproportionately impact some demographics more than others (Canadian Civil Liberties Association, 2020; Brace, 2023). Additionally, it is nearly impossible to actually enforce: the City Council in London, Ontario voted down a snow clearing enforcement bylaw in 2020 because it would take too many resources to implement (Rodriguez, 2020). Given the temporal nature of snow (i.e., it melts), it is difficult to rely on a system of enforcement with such a significant time delay (residents are discouraged from calling 311 until 16 hours after the snow has finished falling: see figure 8 below.).

The City of Toronto used to offer a snow clearing service for seniors and people with disabilities; however, with the expansion of the mechanical sidewalk clearing program, the City has decided to discontinue the separate program, and roll it up under the mechanical sidewalk clearing program (Transportation Services, 2021b). However, the mechanical plows only deploy with 2 or more centimetres of snow accumulation. This means that, for snowfall under 2 centimeters, seniors and people with disabilities may have to rely on the support of others to clear their sidewalks, or else risk a fine. While private snow clearing companies exist, expecting individuals to pay for private companies due to inconsistent or inadequate public service is unfair.

Monitoring

The City claims that "crews monitor road conditions and actively patrol roads to identify problem areas that need additional service" (311 Toronto, n.d.-a.), but frequency of snow-related 311 service requests demonstrate that many residents feel the need to request service delivery directly. We could not find information on the City's website on how other public spaces (e.g., parks and squares) are monitored. The responsibility to request snow clearing in a neighbourhood places an extra burden on residents who cannot climb over unshoveled snow, as it takes their time to submit these requests. While this is an unfair toll on resident time, tabulation of 311 service request data is also insufficient, as sociodemographic characteristics impact propensity to use the service, resulting in a misrepresentation of relative need (See Section 1.4.1). This demonstrates that 311 is an unreliable method of measuring adequate service delivery.

There is also the question of timing: residents are asked to wait 16 hours after snow stops falling before they may call 311 to submit a snow removal request (311 Toronto, 2023). With the 12 hours allowed to residents to clear snow from the sidewalk in the case of a 2 centimeter or less accumulation (City of Toronto, n.d.-d.), there is a four hour interim period where the

responsibility has not been met, but residents cannot place a request. In the case that the City is responsible for clearing sidewalk snow, clearing may continue up to 72 hours after snowfall ends, further lengthening the amount of time someone may be stuck inside due to snowfall (City of Toronto, n.d.-c., see figure 8 below)! Is there a way the City can better monitor sidewalks and coordinate clearing routes to reduce snow-related limitations to mobility?
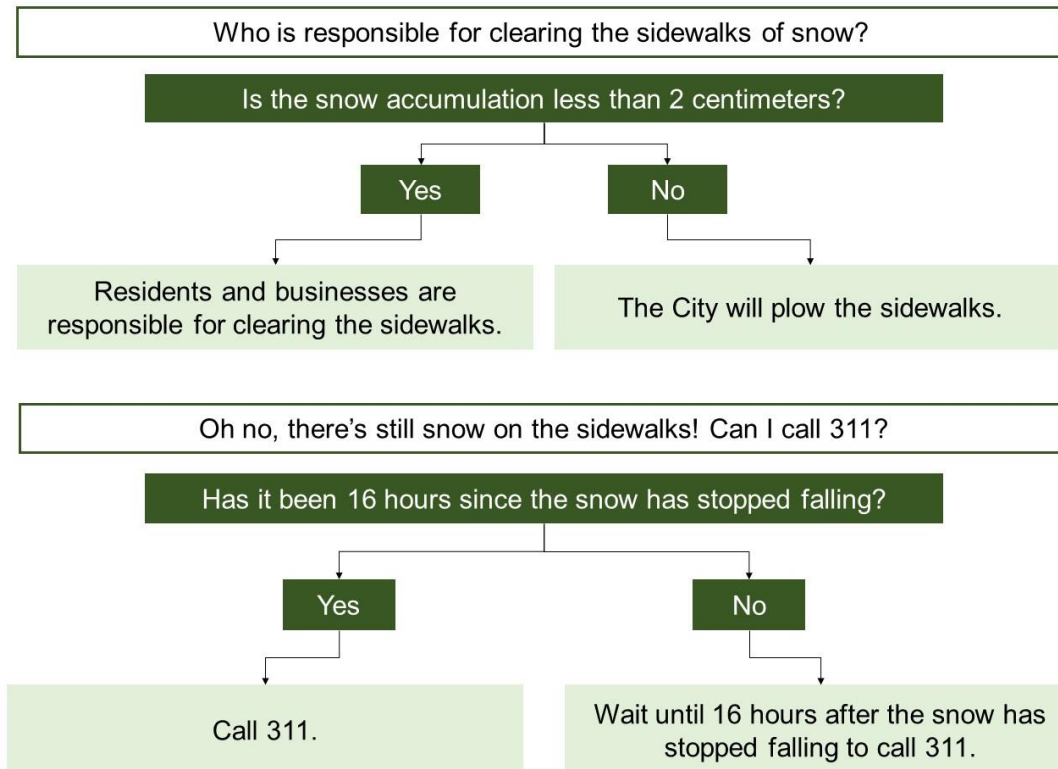
Figure 8: The flow chart speaks to two main questions of responsibility: who is responsible for clearing the sidewalks of snow, and when can residents call 311? The first question (who is responsible for clearing the sidewalks of snow?) has a sub-question: is the snow accumulation less than 2 centimeters? If yes, residents and businesses are responsible for clearing the sidewalks. If not, the City will plow the sidewalks. Next, the chart asks when residents can call 311 to report inadequate clearing. The sub-question is "Has it been 16 hours since the snow has stopped falling?". If yes, residents can call 311. If not, residents have to wait until it has been 16 hours since snow has stopped falling to call 311.

The current City processes create a complicated network of responsibility that leaves a lot of questions for residents. For example, how will residents know that it has been 16 hours since the snow has stopped falling? What happens if the snow starts and stops in multiple flurries?

Accountability
Clear winter maintenance operations and procedures can also reduce costs and increase transparency, according to analysis done by Toronto's Auditor General (Toronto Auditor General, 2023a; Rieti & Jeffords, 2023). While the Auditor General has significantly investigated

issues regarding maintenance contracting in the city, little municipal attention has been paid to assessing the recently improved service. The City is supposed to be clearing all sidewalks (including residential sidewalks), but it would seem that some clearance is slipping through the cracks (Elliott, 2023).

Service standards

The standards the City uses for roadways ranges from "safe and passable" (Figure 9) - defined as "a road surface that is free from as much ice and snow as is practical and may be traveled safely at reasonable speed" (311 Toronto, n.d.-b.) - to "bare pavement" - defined as "fully cleared snow from a driving surface" (n.d.-b.). The application of these standards on roadways depends on road classification (expressway vs. arterial vs. collector etc.), while all sidewalks use one standard: "safe and passable" (n.d.-b.). Except for one sentence in the Salt Management Plan about "surface undulations" (Transportation Services, 2021c, sec 3.5, also see Section 1.4.3.), it is not clear why high volume sidewalks cannot also receive a higher standard of snow removal. Afterall, roadways are also prone to "surface undulations", such as potholes, with the City having to fill 177,543 potholes in 2022 alone (City of Toronto, n.d.-c). It seems to us that there is an open question about the application of a "bare pavement" standard on some sidewalks. If some roadways can receive a higher standard than "safe and passable", then why can't the same be true for sidewalks?

Figure 9: This is the example photo provided on the Toronto's Salting & Plowing Roads webpage that shows "safe and passable" conditions on a residential street (311 Toronto, n.d.-b). Note the example is for roadway conditions, not for sidewalks: the City does not provide an example photo of "safe and passable" sidewalks. With the amount of loose slush left on the road, we are skeptical that this would allow for the safe passage of all pedestrians crossing the street. This also highlights the oddity of applying a singular standard to both roads and sidewalks. To us, this condition appears acceptable for slow vehicular traffic, but hazardous for pedestrians. We believe that applying this condition to sidewalks would not constitute particularly safe conditions for any pedestrian, let alone disabled or elderly pedestrians. Given that this is the only standard applied to sidewalks, why is the City only providing a photo of safe and passable roads, and not safe and passable sidewalks as well?

Ecological impact

Finally, the current state of winter maintenance operations relies on road salt to help reach the City's goal of "safe and passable" sidewalks. However, an over-reliance on road salt has catastrophic implications for the environment: all the salt that gets used to melt snow ends up in land and waterways around the city, damaging the local ecosystem (Logan, 2022). Investigating alternative, less-salt reliant strategies and tools for winter operations will help protect groundwater and can ultimately lead to safer and better-serviced cities (Dybas, 2023; Sparacino et al., 2022).

3.3. Intentional built form design

While Toronto's Complete Streets Guidelines advise street designers on the need for on-street snow storage, there are other ways that built form can contribute to vibrant and well-maintained winter cities. Design guidelines that optimize wind flows, minimize precipitation impact, and maximize sunlight can make public spaces more comfortable in the winter months (Paukaeva et al., 2021). Sidewalk grading can direct snowmelt into drainage systems or permeable surfaces, such as intentionally-placed bioswales (Cruickshank, 2022; Urban Systems, 2000). Bioswales are landscape features that can help filter out pollutants in the snow (such as road salt or oil from cars) before it enters the sewer system (Milwaukee Metropolitan Sewerage District, n.d.). Typically, they contain a variety of native plants, and can help manage large amounts of stormwater (or snowmelt) runoff, especially in areas with a significant amount of paved surfaces (Milwaukee Metropolitan Sewerage District, n.d.). Usually, they are a few feet wide, so can work well in areas with wider roads or existing medians. Decisions for the built form can make traversing the city in winter safer, more comfortable, and more beautiful, if approached with intentionality.

3.4. Accessible and interesting winter programming

Intentionally programming public spaces in the winter months can help increase physical activity in winter, which can support positive mental health outcomes (Paukaeva et al., 2021). Toronto has some annual events that activate spaces in the city (such as the Distillery District winter market and skating at Nathan Phillips Square): however, it is a mixed bag whether the programming is managed privately or by the City of Toronto. There is an opportunity to (re)think about how the City manages and programs public spaces in winter to be more inviting and interesting. This is especially important in the context of newcomers to Toronto: Toronto received just under 160,000 immigrants in 2022 (Jeudy, 2023), so programming that focuses on newcomers' needs could help make a "first winter" more tolerable (see Keung, 2022).

3.5. Resilience

The urban environment will be impacted by climate change in ways that, currently, we cannot fully predict. What models show and what will actually happen are difficult to reconcile. Therefore, any harmonized winter maintenance strategy for the City of Toronto needs to have protocol for unpredictability, so the City can adapt and respond as needed. Planning for

resilience involves, "contemporary planning, which uses smart tools on cities and urban settlements to administer and manage urban transformations to cope with climate change and the mitigation of environmental hazards" (Moraci et al., 2018, p. 5).

Community resilience assesses a community's ability to withstand, respond to, and recover from a disaster (Chandra et al., 2013; Maguire & Hagan, 2007). It became a top-of-mind concern in many places with the COVID-19 pandemic: however, community resilience will continue to be integral as climate change adds additional layers of unpredictability. There are different scales of community resilience initiatives (representing everything from grassroots community initiatives to networked, multi-organization responses) (Fransen et al., 2022), meaning there are multiple opportunities for the City to contribute to resilience interventions, especially for migrant populations (Hameed Qamar, 2023). Strong public networks that provide access to resources for new and long-term residents help to create networks of resilience throughout the city, and can help reduce the impact of sociocultural stressors (Hameed Qamar, 2023). In Toronto, with the population always on the rise, it is essential to create strategies to help build strong community resilience to tackle winter-specific issues.

4. Precedent and best practices

Utilizing the five key areas defined in the previous section, we completed best practice research based on precedent from Canadian and international case studies. These examples contribute human-centric winter management strategies that align with our eight core values. The following best practices have different elements that contribute to an integrated winter management strategy that prioritizes people and their needs.

The precedent and best practices summary table is as follows:

Section	Location	Title	Summary
Operations best practices			
4.1.1.	Holland, USA	Snowmelt systems and heated sidewalks	Heated waste water is used to clear sidewalks of ice and melt removed snow, eliminating the need for salt.
4.1.2.	Reykjavik, Iceland	Geothermal sidewalk heating	Geothermally heated water and spent water from heating systems is used to reduce the need for snow clearance.
4.1.3.	Ottawa, Canada	Winter Maintenance Quality Standards	Winter sidewalk maintenance timing and standards are prioritized based on pedestrian-centred criteria.
4.1.4.	Québec City, Canada	Snow weather technology mandates	Weather conditions are measured, used to coordinate winter maintenance, and can be accessed on-demands by residents.
Engagement best practices			
4.2.1.	Sydney, Australia	Sydney Center for Disability Research and Policy	Disability is centred in engagement practices, re-defining problem framing and dimensions of discrimination.
4.2.2.	St. John's, Canada	Snow public engagement	Diverse engagement mechanisms allow for resident mobilization and the collection of resident viewpoints.
4.2.3.	North America	Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)	Resident knowledge of weather conditions is harnessed to improve weather-responsive plans.

Section	Location	Title	Summary
Built form guidelines best practices			
4.3.1.	Umeå, Sweden	All-season urban design and planning	Outdoor space is planned with winter conditions in mind, encouraging year-round mobility.
4.3.2.	Kalskoga, Sweden	Gender prioritization for sidewalks	Sidewalk snow clearing plans are created to prioritize gender equitable outcomes.
4.3.3.	Edmonton, Canada	Winter design guidelines	Strategic vegetation and boulevard design reduce snow cover and storage.
4.3.4.	Vancouver, Canada	Water runoff and salt filtration	City design responds to the primary form of precipitation, mitigating its negative effects.
Resilience best practices			
4.4.1.	Copenhagen, Denmark	Street green infrastructure	Learnings from extreme weather events inform design that can accommodate winter conditions and a changing climate.
4.4.2.	Winnipeg, Canada	Winter guide for new residents	Newcomers are prepared for winter risks with a guide specific to one city.
Programming best practices			
4.5.1.	Tromsø, Norway	Positive winter mindset	Communication and space activation foster positive emotions during winter.
4.5.2.	Sapporo, Japan	Winter snow festivals	Winter festivals attract and accommodate visitors, supporting the local economy.
4.5.3.	Edmonton, Canada	Winter play and recreation experience	Cold conditions are leveraged to provide winter-specific tools and events to residents.
4.5.4.	Saskatoon, Canada	Winter city initiative	Proactive engagement events and snow clearing are planned to provide increased winter opportunities.
4.5.5.	Fort St. John	Winter placemaking	Placemaking is used to foster community during winter months.

4.1. Operations best practices

4.1.1. Holland, USA: Snowmelt systems and heated sidewalks

Core values: Accessible, Integrated, Predictable, Adaptable, Sustainable

Snowmelt systems are a highly effective snow clearing solution that can eliminate salt usage, reduce operational costs, and increase safety. Holland, Michigan operates the largest publicly-owned snowmelt system in North America (City of Holland, n.d.; Christensen, 2020). Installed in 1988, this system uses 190 miles of under-sidewalk tubing to distribute heated wastewater from its centrally-located power plant (Christensen, 2020). The heated water in the system distributes excess energy that would have otherwise not been captured through the operations of the powerplant. This means that the energy used to heat sidewalks is essentially free, and provides an environmentally- and ecologically-sensitive alternative to regular snow clearing operations. In the City's words, this means "no salting, no plowing, no slipping or sliding" (City of Holland, n.d.). The City also distributes heated water to private snowmelt systems, covering a total of approximately 190,000 square feet. This demonstrates the opportunities for partnerships between municipal and private interests in snowmelt initiatives (Christensen, 2020). Toronto has pre-existing district heating systems, such as those provided by York University, University of Toronto, and Enwave (District Energy Team, n.d.). The City could partner with these institutions for the piloting of heated sidewalk systems.

4.1.2. Reykjavik, Iceland: Geothermal sidewalk heating

Core values: Accessible, Integrated, Predictable, Adaptable, Sustainable

Snowmelt systems can use residual heat from spent water to heat sidewalks. Iceland is geographically located well to take advantage of geothermal resources for numerous uses, such as power generation and heating (Ragnarsson, Steingrímsson, & Thorhallsson, 2021). The abundance of this resource has led the country to innovate in usage of excess energy sources, including the use of snow melting applications (p. 4). Iceland uses heated water from geothermal sources to heat its sidewalks and thereby melt snow, ice, and slush. Its snow melting systems cover an area of 1,200,000 square metres, primarily in the capital (p. 4). Through loops of plastic pipes installed under sidewalks, heat from hot water is distributed to walking surfaces, thus reducing the need for manual or mechanical clearing. Reykjavik uses an efficient system that captures residual energy from spent heating water. Ragnarsson, Steingrímsson, and Thorhallsson note that "About two thirds of that energy comes from spent water from the space heating systems and one third directly from hot supply water" (2021, p. 4). While all the used water is originally heated by geothermal heat, theoretically any district heating network that uses heated water could implement similar techniques. After being used to heat building interiors, heated water delivered through central heating could then use residual heat to melt sidewalk snow, regardless of the origin of that energy. As mentioned in 4.1.1, Toronto has pre-existing district heating systems, such as those provided by York University, University of Toronto, and Enwave (District Energy Team, n.d.). The City could partner with these institutions to pilot heated sidewalk systems.

4.1.3.　Ottawa, Canada: Winter Maintenance Quality Standards

Core values: Accessible, Adaptable, Integrated, Accountable, Affirming

Ottawa's Winter Maintenance Quality Standards (WMQS) report, which was updated in 2021, is used to understand how people move about in winter months, viewing climate change, accessibility, and gender equality with an overall focus on improving current standards for winter maintenance ([City of Ottawa, 2021](#)). This report focuses on defining optimal levels of maintenance by safely removing hazards such as snow and ice along sidewalks through an overview of different engagement practices ([City of Ottawa, 2021](#)). Its top priorities are to address sidewalks, pathways, and residential roads which include transportation options such as the OC Transpo and Light Rail Transit (LRT) systems ([City of Ottawa, 2021](#)). WMQS are categorized by priority level, identifying accessibility and inclusivity as the first priority, followed by connectivity, environmental sustainability, communications, coordination, and innovative solutions ([City of Ottawa, 2021](#)). This report engages public participation with the residents of Ottawa, bridging residents with their goal to navigate different types of mobility requirements throughout the city, and connecting City maintenance standards to engagement participation ([City of Ottawa, 2021](#)).

The current WMQS standards are categorized based on a class system by monitoring roadways or sidewalks ([City of Ottawa, 2020](#)). The first level categorizes major roads, including highways and transit ways in which the City is to clear winter precipitation during the morning and afternoon commutes ([City of Ottawa, 2020](#)). The second level is cleared on high volume roads which include the downtown core, busy sidewalks, and cycling networks when a minimum of 2.5 centimeters of snow accumulates ([City of Ottawa, 2020](#)). The third level is determined once five centimeters of snow has fallen, where the City then responds to class 4 and 5 road systems which include major and minor collector roads, or regional roads that link to neighbourhoods ([City of Ottawa, 2020](#)). This process is to be completed within six hours for roads and within 16 hours for sidewalks after the last snow stops falling ([City of Ottawa, 2020](#)).The fourth level occurs when seven centimeters of snow has fallen: the City respondents and service workers help clear residential roads with a goal of finishing ten hours after the snow stops falling ([City of Ottawa, 2020](#)). WMQS is relevant to the Toronto context as it recognizes how snow clearing can be categorized based on individuals who utilize spaces the most.

4.1.4.　Québec City, Canada: Snow weather technology mandates

Core values: Accessible, Integrated, Predictable, Sustainable, Affirming, Accountable

Québec's use of data collection technology to understand roadway conditions in real-time enables accurate operational responses. The Province of Québec has adopted a network of 50+ weather information systems equipped with probe rods that measure the average hourly temperatures at various sections of the roadway ([Gouvernement du Québec, 2023](#); [Government of Canada, 2023](#)). In addition, vehicles and road users have over 240 mobile weather systems installed in their vehicles which are managed directly by the Ministry of Transport and Sustainable Mobility (MTMD) ([Gouvernement du Québec, 2023](#); [Government of Canada, 2023](#)).

These information systems provide information about air temperature, network traffic, roadway conditions (snow-covered, ice-covered), dew point temperature, and management (Gouvernement du Québec, 2023). Data collected by these instruments also calculates temperature at various levels on the roadway to ensure safe travel.

Québec City has a system in place for snow de-icing which is dependent on outside temperature. Since salt cannot melt ice below -15 degrees celsius, it is only used at temperatures above this threshold (Gouvernement du Québec, 2023). Below -15 degrees celsius, Québec City applies abrasives, which include sand and small stones, that do not melt snow but help with vehicle traction. Additionally, all snow plow operations must operate at a maximum of 50 kilometres per hour, including when they are on highways (Gouvernement du Québec, 2023). This slower speed allows snow to be sufficiently pushed off the road without reducing road user visibility or compacting snow and pushing it outside the traffic lane (Gouvernement du Québec, 2023).

SMS and text message alerts are also available in Québec City, allowing residents to receive on-demand alerts about snow removal (Ville de Québec, n.d.). In addition to text messages, individuals can subscribe to an emailing service or Real Simple Syndication (RSS) about news regarding snow removal operations (Ville de Québec, n.d.). Winter operation details are updated twice daily and can also be found on the City's X (formerly known as Twitter) page, allowing individuals to use a wide range of resources to access up-to-date snow or weather-related material (Ville de Québec, n.d.). Weather station systems, snow de-icing tools, and SMS text message alerts would be helpful if implemented in a Toronto context allowing road users to have up-to-date information similar to Quebec City, regarding weather patterns and conditions which could impact travel times and accessibility needs for pedestrians.

4.2.   Engagement best practices

4.2.1.   Sydney, Australia: Sydney Center for Disability Research and Policy

Core values: Accessible, Equitable, Integrated, Affirming, Accountable

Learning from the Sydney Centre for Disability Research and Policy, we see that centering disability in engagement is a first step in understanding the problem at hand. In order to use engagement to problem-set and -solve, the Sydney case study offers lessons in three primary ways, improving a) the framing of the problem b) guiding what inclusion looks like in all steps of the process and c) broadening the applications and timing of participation (Villeneuve, 2020).

Social vulnerability is language used by the Sydney Centre for Disability Research and Policy to express the understanding that environmental conditions impact populations unevenly, and to draw attention to the structural barriers that frequently get exaggerated during extreme conditions. Vulnerability is nonetheless a term the Centre cautions readers to use mindfully, respecting the relevance of a) what people are vulnerable to b) the variety in risk factors c) barriers to equitable outcomes and d) necessary steps to dismantle them. The Centre also

stresses that inclusion itself cannot be realised separate from the structural discrimination, marginalisation, and institutional dismissal experienced by people with disabilities (Villeneuve, 2020).

Different populations, of course, experience Toronto's "safe and passable" standards differently. Whether it is an increased risk for slips and falls, or challenging commutes forced by economic circumstances, what is "safe and passable" for some may seriously disrupt the lives of others (Wilkins & Park, 2004). Depending on the circumstances, snow service patterns can be a matter of life or death in the context of access to healthcare or in disruptions in homecare from support workers. Adverse consequences become exacerbated when there are information disconnects between the perception of risk and the reality of how it is experienced by more socially vulnerable groups, including people with disabilities (Villeneuve, 2020). In understanding the stakes of social vulnerability under more extreme scenarios, the Sydney Disability Centre found that people with disabilities:

- Are two to four times more likely to die in a disaster;
- Experience elevated risks for injury and property damage;
- Are more challenged in sheltering and evacuation;
- Require increased health and social services during and after disaster events;
- May be more likely to feel a burden – something that impacts decision-making and increases risk (Villeneuve, 2020) (See Section 4.2.1 for more on the Sydney Disability Centre).

Even as they may be non-emergency scenarios, experiences of snowfall can add new dimensions to discrimination. Since snowfall can be so longitudinal, impacts from extended sheltering-in-place can range from missing appointments, to the negative health impacts associated with isolation, to having to pay extra for groceries to be delivered. In an investigation on Instacart's hidden markups, the CBC reports on this as 'the disability tax,' emphasizing that many people with disabilities – who are statistically more likely to live in poverty, as well as to be at risk from other social disruption – may be unable to afford these extra costs in the first place (Grundig et al., 2022).

From an accessibility and equity perspective, Toronto's snow clearing should thus center engagement as part of its process of due diligence. Forecasting for an uncertain future, it will be important that the City likewise future-proof its winter maintenance strategy to center socially vulnerable populations.

4.2.2. St. John's, Canada: Snow public engagement

Core values: Accountable, Equitable, Integrated, Affirming, Accessible, Predictable

St. Johns' is a Canadian example of centering snow clearing in intentional community engagement. The City of St. John's engagement report states that the public engagement on sidewalk snow clearing was catalyzed by social mobilization in the form of Facebook groups, petitions, and a protest at city hall, following unprecedented snow events the preceding winter

(2020). While prior efforts from 2014 had included snow clearing as part of a larger municipal winter maintenance review, the snow clearing piloted from that study was then impacted by budget cuts in 2016.

In a gesture of accountability, the report states that "Council and staff recognize that there is a voice within the community advocating for improved service in sidewalk snow clearing. …. to make these [clearing] decisions, it will be imperative that the City understand what the issues are, and for whom, in the current level of service and where the improvements will have the greatest impact." They state that the goals are to "create space where residents and key stakeholders can learn more about the current sidewalk snow clearing program and provide their perspective on current, and potential future service levels using tools that are easy to use and accessible." They point to Public Works staff, who are tasked with taking the feedback to council (City of St John's, 2020).

St. Johns, in centering the imperative that "the City understand what the issues are, and for whom" realigns service delivery with user need. To do so, they acknowledge the role of voice, as well as education. Their example tells Toronto to also expect people to mobilize around this as a political item, and leaves a precedent as to how the public will exert pressure on the issue of snow clearing — especially in improving the experience of active transportation, and seeing that the improvements are guided by equity. In naming Public Works, they decide on accountable parties and integrate insider knowledge of policy-making – the benefit of having planners involved – to plan implementation realistically.

St. Johns had more than 3,000 touch points in their engagement, including through social media and online surveys, as well as through calls to 311. They published that the 311 calls — which they refer to as an engagement tool — showed "major concerns with winter access, safety, priority street without priority service, downtown and limited access off street to connector streets, increased use of the Go Bus in winter, less physical activity in winter, and mail service impacted." As explored in the recommendations, the precedent of thinking about 311 as a place of interface will be pertinent to Toronto's engagement plan moving forward (City of St John's, 2020).

The overall findings of the St. John's public engagement includes results from both public and business surveys, showing that the average rating for the "importance of winter walkability" was 8.49 for the public and 9.42 for businesses. Data like this is helpful in the Toronto context as well, as it provides a more complete profile of the interest in proper snow-clearing – even and especially from the private sector (City of St John's, 2020). 70% of citizens surveyed indicated that they would pay $25 or less per property per year to support improvements to sidewalk clearing. They indicated strong favourability to Council making winter walkability a priority (92%) and increasing investment overall (88%). Having exact figures helps assign a value, drawing on participatory budgeting methods, to exactly how much 'interest' translates to 'spending' (City of St John's, 2020).

St. John's also surveyed perspectives and education-levels with regard to current snow clearing. They found that 95% of citizens surveyed had at least some awareness of the City's priority sidewalk system. Participants were also asked specifically about timeliness, and 60% of residents responded that they expected sidewalks to be cleared within 24-72 hours after a snow event (City of St John's, 2020). In order for a city like Toronto to run an awareness campaign around City services, it will be important to understand general impressions among the public. As clear communication is a challenge in the City's snow clearing process, engagement that borrows from St. Johns's successes can help advance accountability as well as predictability.

Overall, St Johns and winter cities across the world are good examples of how to supplement the heavier, more disaster-focused narratives to the fun and playful imaginative exercises that can mobilize coalitional groups of people.

4.2.3.   North America: Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)

Core values: Affirming, Accountable, Predictable, Integrated

The Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) is an example of citizen science finding uptake in larger governing bodies. CoCoRaHs has been incorporated by the United State's National Weather Service (NWS) daily precipitation maps, in flood predictions by river forecasters, and in project planning by the Army Corps of Engineers. Research suggests that the success of this project comes from its easy integration into the technology's installed base, with volunteers measuring quantities already commonly used by weather forecasters (Ottinger, 2021). Details were also made available to forecasting offices in real time (CoCoRaHS, n.d.) and participants were "encouraged to become part of the forecasters' communities of practice" by conducting research and attending scientific conferences.

The idea is that resident – and visitor – knowledge is valuable and can indeed be harnessed where appropriate. It is only further powered by people who must pay close attention to the environment, e.g. people with disabilities. Global mapping of citizen science projects for disaster risk reduction cites examples of games, apps, and mapping software used to detect, document, and warn. Social media is another forum the writers recommended, using the example of Petabencana.id, which geo-located tweets about flooding to form a 'knowledge network' of flood events (Hicks et al., 2019).

Civic tech, as explored in the recommendations, will be an important way for Toronto to capture the value of the public's attention on snow. Torontonians, like people everywhere, watch the weather. Beyond that, weather is something people already often interface with via technology – for example, air quality monitoring. In learning from CoCoRaHS's integration methods, Toronto can move from individual observation to responsive service delivery practices. Capturing the value of 'user data' will only help the City adapt more to needs as they are experienced and expressed.

4.3. Built Form Guidelines best practices

4.3.1. Umeå, Sweden: All-season urban design and planning

Core values: Integrated, Adaptable, Sustainable

The use of urban design and all-season planning for parks and green spaces in Umeå encourages mobility and active transportation year-round. Umeå is the largest and fastest growing city in northern Sweden with a subarctic climate, with a population of 125,080. This city has used street and urban design, all-season vegetation selection, and technical solutions to create adapted environments and encourage mobility.

Since a large number of Umeå residents use active transportation, the municipality fosters better mobility through urban design, smart building facade design, and road planning to limit the negative impact of winter conditions on movement (Yang et al., 2020; Dialog, 2021; Wallace, 2017). The City's Plan stipulates, "a minimum width of two meters before it is acceptable to store snow on that street refuge or sidewalk" (Välimaa, 2021). The management of public spaces with snow and ice removal provides a high quality experience for local residents and tourists. One implemented solution is the design of park spaces that can transition into winter sports areas, including park stair banisters for snowboarding rail use in the winter (Dialog, 2021). Additionally, the City's Plan for all-season vegetation selects plants with spring flowers, autumn colours, and winter greenery to create a vibrant atmosphere. The use of urban design and all-year planning are becoming more prevalent in planning projects in Toronto and being introduced to City of Toronto documents.

Finally, the innovative use of climate-smart bus stops use smart energy, heating solutions, free Wi-Fi, and other technical data solutions to improve comfort and support public transportation use. The City also provides light therapy by temporarily replacing bus stop advertising with artificial daylight boxes in 26 bus shelters around the city (Dialog, 2021). Toronto has an extensive public transit system with many transit stations or bus shelters that could implement or test the impact of innovations that improve people's experience to gauge the wider impact of small interventions on neighbourhood ridership. In 2020, TTC increased the amount of heated bus shelters and in 2023 the TTC expanded the free Wi-Fi network with the goal of increasing safety and comfort. It is important to make active transportation more accessible and to promote low-carbon forms of transportation, by increasing the comfort residents feel in public and active transit (City of Toronto, 2021b, p. 64-71). Therefore, the technology use and urban design strategies in this case study could support the ambitious TransformTO modal shift targets for 2030 (City of Toronto, 2021b).

4.3.2. Kalskoga, Sweden: Gender prioritization for sidewalks

Core values: Equitable, Integrated, Adaptable

In Kalskoga, sidewalks are cleared before roads as a way to prioritize caregivers and other sidewalk users over vehicle users. The result of this clearance strategy is a large reduction of injuries and gain in productivity. Kalskoga, Sweden has a population of 27,562, with a northern

climate that goes down to an average of -5 degrees Celsius in the winter. Kalskoga recognized snow clearing as a gendered and equity issue, based on who is primarily impacted by winter sidewalk conditions (Perez, 2019). In 2013, a gender-equal snow clearing plan was implemented by prioritizing side roads and pedestrian paths during periods of heavy snowfall for better accessibility to daycares, schools, and for caregivers (The Clandestine, 2021; Perez, 2019). This decision was made in response to a 2011 gender mainstreaming review of gender-disaggregated slip and fall data, which found that women were most affected by icy and snowy road and pavement surfaces (European Institute for Gender Equality, 2022). Additionally, costs associated with the municipal maintenance process of clearing roads and sidewalks were not affected by the change in prioritization (Perez, 2019). The impact of clearing sidewalks and paths first reduced injuries, cost of healthcare, cost of liability, and loss of productivity.

In Toronto, snow is cleared in the order of highways, major roads, residential streets, bike lanes, and then sidewalks. If Toronto were to make a clearance strategy using gender equity as a priority like Karlskoga, that would involve running engagement sessions with community members and subject matter experts to determine what needs should be prioritized. Additionally, this prioritization would need to be used to create an integrated clearance and evaluation strategy.

4.3.3.   Edmonton, Canada: Winter design guidelines

Core values: Integrated, Adaptable, Sustainable

Edmonton's winter guidelines promote nature-based solutions that filter salt from melting snow through vegetation and natural ground filtration (City of Edmonton, 2016). Select vegetation near roadways can withstand exposure to sand and salt with little maintenance throughout the year (City of Edmonton, 2016). To improve tree health and biodiversity, the City chooses cold and salt-resistant species and practical trees are grouped instead of planted in rows (City of Edmonton, 2016). This type of landscape creates natural filtration and results in an annual median snow or ice cover three times less than that of regular pavement (City of Edmonton, 2016). Green rainwater infrastructure incorporates both nature and engineering to better manage water to slow its movement and filter out toxins before it reaches the local waterway (City of Edmonton, 2016). An effective interface between environmental benefits and safety can be planned for using boulevards between roadways and sidewalks. Boulevards are important areas for snow storage which can protect individuals acting as a buffer between pedestrians and road spray (City of Edmonton, 2016). Additionally boulevards act as a natural filter for winter precipitation near roadways to reduce snowmelt, as well as being a traffic calming measure at the street level which helps with crosswalk and sidewalk safety (City of Edmonton, 2016).

Edmonton's sidewalk and boulevard design includes clear, barrier-free pedestrian through-spaces adequate for street space, cleaning, and snow clearing equipment (City of Edmonton, 2016). In addition, the roads have a downward slope to funnel snowmelt toward a drain in the middle, moving drainage and slush away from the edge of sidewalks and subsequently away from pedestrians (City of Edmonton, 2016). Edmonton creates street plans identifying where

snow will be stored on streets and neighbourhoods. For example, lawns are used for snow storage, and snow mounds can create play areas (City of Edmonton, 2016). Additionally, snow storage should be located in areas that maximize sunlight and snowmelt, by conducting sun/shadow studies and planning for filtration (City of Edmonton, 2016). The strategic location of wind barriers and the provision of storage areas throughout the city reduces snow removal costs and increases safety (City of Edmonton, 2016). Furthermore, valuable street design features such as heated concrete can be powered by clean power sources. Heated pavement can increase pavement longevity, reduce salt requirements, and remove plowing requirements. Toronto's streetscape manual references street furniture, lighting, medians, street trees, and paving as elements that make up streetscape zones. However, it is different in a sense from Edmonton's Winter Design Guidelines, as this document does not talk about how streetscapes can be used in the winter climates (City of Toronto, 2019b).

4.3.4.   Vancouver, Canada: Water runoff and salt filtration

Core values: Equitable, Integrated, Adaptable, Sustainable

Rainwater resources can be used to filter out saline, sand, and other abrasive materials used to de-ice roads during winter months. Reports indicate that "rainwater treatment and resource utilization can reduce the contradiction between urban water supply and demand, and it is also of great significance in saving water, flood control, and reducing nonpoint source pollution" (Liu et al., 2019, p. 1). Vancouver has a unique way of addressing its water runoff from snowmelt and rain, taking ideas from its Rain City Strategy (Conger et al., 2019). Currently, Vancouver's precipitation consists primarily of rain, as it rains more than 160 days per year, and rain is expected to increase by the year 2050 (Cruickshank, 2022). As a protective solution, the City has adopted the "Rain City Strategy" which builds on its 2012 Climate Change Adaptation Strategy (Cruickshank, 2022). This strategy targets rain specifically and aims to capture, infiltrate, and clean 90% of Vancouver's rainfall that is captured by civic facilities, parks, and streets (Conger et al., 2019). This strategy embraces rainwater as a valuable resource for its ecosystems (Conger et al., 2019). Building onto this strategy, the City has implemented the design of new pavement along four residential blocks which will develop a "rainway" system through a series of gardens, streambeds, and small dams (Cruickshank, 2022). This design will capture and slow some of the rainfall that rushes downhill over impervious pavement. This concept will connect with the City of Vancouver's rain water design standards by adding green infrastructure along roads to provide positive ecosystem effects by slowing the movement, and filtering water before it reaches local waterways (Cruickshank, 2022). During Toronto's winters, the use of salt abrasives from snow plows and other maintenance services goes directly into drainage systems. Toronto can implement similar systems outlined in the 'Rain City Strategy' to remove toxic debris from its waterways. As Toronto uses salt for de-icing, salt water filtering can reduce stress on clean water systems and create a better ecological footprint when implemented properly.

4.4.   Resilience best practices

4.4.1.   Copenhagen, Denmark: Street green infrastructure

Core values: Accountable, Adaptable, Integrated, Affirming, Predictable

Copenhagen, Denmark uses green infrastructure on their streets to make the city more resilient to intense weather and improve cycling infrastructure to support residents. The city has cool winters with an average low temperature of -1 degree Celsius and a population of 799,033. It is well known for its robust cycling culture that is supported by the city's infrastructure and maintenance. Since 2011, a municipal Climate-Resilient Neighbourhood strategy has demonstrated a model for climate adaptation, with a focus on engaging and empowering citizens in their own neighbourhood. This initiative is part of "Copenhagen's overall strategy for district and urban renewal that was initiated in 2010 through the Copenhagen Climate Adaptation Plan" (Urban Sustainability Exchange, n.d.). These climate strategies were initiated in response to worsening climate events and an intense rain storm in 2011 that caused extensive city damage. Rather than invest in expanding the sewage and stormwater system capacities, the City took a more holistic approach with urban design and green infrastructure.

As part of the neighbourhood climate initiative, guidelines for road design that prioritize cycling infrastructure were combined with snow clearance width considerations, resulting in the ability to use bicycle paths as stormwater channels that manage rainwater flow at ground level. This use of green and blue infrastructure improves the City's capacity to respond and absorb these weather changes in the short- and long-term. Actions also included creating more green spaces, enhancing biodiversity, developing a stronger neighbourhood identity by bringing tangible solutions to residents, and presenting a scalable climate change strategy. Results of this Climate-Resilient Initiative include increased public awareness on climate change and mitigation, increased public participation in climate action initiatives, and improved neighbourhood image and attractiveness (Urban Sustainability Exchange, n.d.).

This case study can help Toronto shape their neighbourhood resilience strategy, as Copenhagen's "urban renewal program helps stakeholders set a common agenda for the development of their neighbourhood" in an empowering, participatory method (Urban Sustainability Exchange, n.d.). This could be used in Toronto for neighbourhood climate planning and green infrastructure projects to improve the City's resilience to extreme weather. There are parallels between Copenhagen's use of scaled adaptations with a holistic strategy and Toronto's resilience policies and green infrastructure projects that improve resident experience, winter maintenance, and mobility. Toronto's use of green streets, similar to Copenhagen's use of cycling infrastructure as water retention, could be expanded further (City of Toronto, 2017c) and explored with relevant applications for winter conditions.

4.4.2. Winnipeg, Canada: Winter guide for new residents

Core values: Accountable, Integrated, Accessible, Equitable, Affirming, Adaptable

As of 2023, Canada is set to experience one of the highest immigration rates per population in the world (Statista Research Department, 2023). By understanding resilience and the rates of newcomers into the country, Newsroom has created a guide for new residents moving into the city of Winnipeg called *Winter In Winnipeg: A Guide For New Residents* (Lies & Ash, 2023). This guide helps prepare newcomers by providing information about snowfall, winter programs, activities, dress, transportation, and more. This prepares residents for potential risks associated with moving to a new climate. With temperatures sometimes dropping below -20 degrees Celsius with windchill, winter preparedness in Winnipeg is essential (Lies & Ash, 2023). This guide provides a way for new residents to understand how the City provides winter maintenance while gaining tips about how to thrive in cold climates (Lies & Ash, 2023). By adapting a newcomers guide similar to Winnipeg, newcomers moving into Toronto will have tools that can help them settle into a new environment and make advantageous connections early on.

4.5. Programming best practices

4.5.1. Tromsø, Norway: Positive winter mindset

Core values: Integrated, Equitable, Accessible

Tromsø is located 350 kilometres north of the arctic circle, resulting in a two-month long 'polar night' when the sun does not come above the horizon from November 28th to January 14th. It has a population of 75,638 and is the largest urban area in northern Norway. The maximum average snowfall is 140 centimeters, with an average low winter temperature of -9 degrees Celsius, and 1.15 average winter daylight hours (Dialog, 2021). Despite the cold temperatures and limited sunlight, the population has not been affected by seasonal affective disorder typical in colder urban centers (Dialog, 2021). Researchers at the University of Tromsø studied how residents view wintertime and found that a positive winter mindset led to greater positive emotions, life satisfaction, and personal growth (Dialog, 2021; Leibowitz & Vittersø, 2020; Pressman, 1996).

A positive winter mindset was created intentionally through positive communication about winter culture, as well as the design and planning of public spaces. Examples of intentional design decisions include the use of lighting, activation of outdoor spaces for cultural events, and messaging about creating a cozy culture. The use of public infrastructure and space design that focuses on the connection to nature increases the public outdoor time. Additionally, at a local and individual level, entrances to public buildings have 'boot rooms', which encourage a more comfortable experience transitioning from outdoor to indoors. Community design choices also included the creation of a comfortable atmosphere via fireplaces, candles, blankets, and food and beverage services. These intentional choices were made with the intention of creating positive perceptions and associations with winter. This case study can help Toronto shape their winter strategy to include aspects in improving the negative outlook we have on winter. A positive mindset on winter will help residents explore what winter has to offer.

4.5.2. Sapporo, Japan: Winter snow festivals

Core values: Accessible, Adaptable, Integrated

Sapporo is home to 1,973,832 people and has been at the forefront of the winter cities movement (Dialog, 2021). The humid continental climate creates very snowy and cold winters. The city took advantage of this climate to become host of three major winter festivals: The Sapporo Icicle Festival, the Sapporo Yukiterrace (a festival of lights), and the Sapporo Snow Festival (Dialog, 2021). These events attract people from within the city and outside regions to participate in winter-centric activities and experience local business and restaurants. Due to the high tourist population during the winter season, the City's Winter Life Promotion Council has created a guide for tourists on safety hazards during the winter, accessible to the public online (Dialog, 2021). This case study is relevant for Toronto because there needs to be more winter appreciation activities taking place in the city to shift from winter being a burden to an asset. Currently, Toronto has a few winter focused events such as The Toronto Christmas Market in Distillery District, but lacks accessibility for all groups with the mandatory fees. Therefore there needs to be better consideration for inclusive winter celebrations for the whole public.

4.5.3. Edmonton, Canada: Winter play and recreation experience

Core values: Integrated, Adaptable, Sustainable

Snow can be used as a building material by children and families, as well as by professional carvers and artists. Cities much like Edmonton use snow to add to winter play and recreation experiences - providing snow rides, snow molds, and carving tools to contribute to the winter experience along pedestrian streets and alleyways (Fricson & Ranson, 2011). This outlook on snow can be recognized as an accessible and multigenerational approach in alignment with the City of Edmonton's core goals on winter life demonstrating viewpoints on design, economy, and story (City of Edmonton, n.d.). An example of this is how the City of Edmonton adapts certain memorable landmarks which can include sports facilities, art installations, or natural landforms, which act as a significant feature that values and enhances the winter experience (Fricson & Ranson, 2011). The main goals of Edmonton's Plan provide opportunities to "Go outside and Play" and design "Communities for Winter Safety and Comfort," enhancing the quality of life or livability in winter (Fricson & Ranson, 2011). By adopting similar winter play programs, Toronto can promote therapeutic and cost-efficient ways to enjoy the outdoors.

4.5.4. Saskatoon, Canada: Winter city initiative

Core values: Accountable, Adaptable, Integrated, Affirming, Predictable

Saskatoon sets an example of a proactive, asset-based winter city engagement plan related to a collaborative planning approach (City of Saskatoon, 2021). Its Winter Cities Toolkit offers best practices for celebrating the city of Saskatoon within the larger framework of fun and play. This strategy recognizes those who are vulnerable and provides a safer space for all residents during the winter focusing on an "economic diversity and prosperity" perspective (City of Saskatoon, 2021, p. 8). It should be noted that their plan specifically names snow clearing as part of its

implementation and strategic goals (City of Saskatoon, 2021). The City's report mentions that quality of life is achieved by providing opportunities in winter seasons. Additionally, the "Wintercity YXE Implementation Plan" is applied to provide sustainable growth to vibrant city centres in all seasons of the year (City of Saskatoon, 2021) They refer specifically to making sure accessibility and connectivity exist when snow and ice are present, allowing snow to be an enjoyable element of city life (City of Saskatoon, 2021). Understanding winter life and culture can help create positive changes to the quality of life during winter months in Toronto. Showcasing a positive outlook towards winter will provide opportunities for collaboration for winter guidelines that encourage different groups and organizations to work collectively.

4.5.5.   Fort St. John, Canada: Winter placemaking

Core values: Integrated, Adaptable, Sustainable

In Fort St. John, British Columbia, Winter festivals such as *High on Ice* and *Impulse* involve interactive art installations, family fun activities, light sound experiences, and playgrounds hosted by various artists (Fort St. John, 2023). Festivals are one of Fort St. John's unique winter placemaking activities that attract people across the region. Fort St. John winters are cold and dark with temperatures reaching below -20 degrees Celsius (Avery, Karlberg, & Reardon, 2023). In small cities like Fort St. John, winters can make it difficult to establish a sense of community or place, making placemaking essential in bringing people together and creating bonds to enhance social connections (Avery, Karlberg, & Reardon, 2023). Additionally, Fort St. John uses strategic community planning to promote the quality of life, reconciliation, and a strong economy by aiming to bring diverse communities together through programming (Avery, Karlberg, & Reardon, 2023). Toronto has outdoor activities such as the Nuit Blanche festival; however, there are not many other winter placemaking activities that embrace the cold temperatures. By adapting winter placemaking festivals and spaces throughout Toronto neighbourhoods, communities will be able to promote adaptive and integrated winter spaces to interact and collaborate within.

4.6.   Case study takeaways

This case study research shows how local governments across Canada and internationally have adopted many approaches to improve the winter experience, pedestrian safety, and the needs of residents who are most vulnerable to the inadequacies of poor winter maintenance. Through our understanding of the context of snow clearing in Toronto (Section 1) , the use of our search framework (Section 2.4), and our assessment of Toronto's current issues with winter sidewalks (Section 3), we found and explored the above relevant case studies. They highlight the ways that Toronto can innovate with technology to provide a better winter maintenance service (Section 4.1), engage and collaborate with residents on winter maintenance (Section 4.2), implement built form infrastructure through a winter lens (Section 4.3), increase social resilience (Section 4.4), and encourage healthier resident attitudes towards winter through fun programming (Section 4.5). We believe that for Toronto to forefront accessibility, mobility, and equity in the reality of a changing climate, the City will need to approach winter sidewalks with this combination of techniques.

5. <u>Recommendations</u>

In this section, we will outline numerous recommendations for Toronto based on the five precedent focus areas identified in the "Framing the Problem" and "Precedent and Best Practice" sections. We tried to ground these recommendations in our understanding of Walk Toronto's position and interests. Each recommendation is based on global and Canadian precedents (where they exist) and connect to our core values. These recommendations are contextualized by what they could look like in practice in Toronto.

Our four recommendation areas include:

1. **Enhance service standards:** We recommend that the City revise its "safe and passable" standard for sidewalks, consider the implementation of a sidewalk classification system, and adoption of a Vision Zero approach to safe winter sidewalks.

2. **Active engagement on winter mobility:** We call on the City to initiate greater engagement with its residents to develop an understanding of the levels and types of need and encourage enriching dialogue among interest-holders. To do so will require understanding and elevating points of interface between the City and the public.

3. **Long-term infrastructure alignment for winter mobility:** We are calling for more intentionality with winter-friendly public realm infrastructure that is responsive to the changing climate and support's people's accessibility needs. The current urban design guidelines and plans do not use an in-depth understanding of winter conditions, changing climate, or diverse accessibility needs when preparing for resilient environments.

4. **Social resilience**: We recommend the creation of accessible winter programming and updating Toronto's current newcomers' guide to include a stronger section on winter adaptation.

5.1. Active engagement on winter mobility
5.1.1. Target engagement to populations insufficiently serviced by the "safe and passable" standard

Key problem areas addressed: (Targeted) Engagement
Timescale: Short term
Scale: City-wide
Responsible groups: Toronto City Planning; People & Equity Division at the City of Toronto; the Toronto Accessibility Advisory Committee; Toronto Public Works; Community organizations (like the Center for Independent Living Toronto, Access Alliance, NCHPAD, the Rick Hansen Foundation)

It is important that the City engage residents around the efficacy of its snow clearing standards. First, the City needs to shift its service delivery model toward user-need. Toronto's current snow-clearing practice is dislocated from the conditions of lived experience. Feasibility is

reinforced in all language where "safe and passable" is situated as "a road surface that is free from as much ice and snow as is practical and may be traveled safely at reasonable speed" (311 Toronto, n.d.-b.). The kind of engagement described here could contribute to the previously made commitments by the City to review snow clearing policies with an accessibility and equity lens (City of Toronto, 2020, p. 34).

In light of the Sydney Centre for Disability's findings about risks associated with the perception of "being a burden," we recommend that City of Toronto-run engagement efforts be designed to correct for dynamics that, to-date, have discouraged or disempowered active participation, often from the groups whose voices need to be heard most. Best practices in consultation, the Centre advises, come directly from experience (e.g., understanding the problem leads us to a solution) and include the following:

- 'Nothing about us without us': center disabled voices out of a place of understanding their extreme capability, and 'do with, not for'.
- Attend to the multiplicity of disability (e.g., not just one aspect or type).
- Be proactive (which includes focusing on recovery after mistake).
- Timing is important. Even as being proactive is important, there are other ways to also talk about engagement along a continuum. As the Centre writes, "Communication and engagement with members of the disability community must be viewed differently, depending on the point at which it is initiated" (Villeneuve, 2020). These points include:
  - Very Early: integrated into engagement, preparedness, community-level risk assessments.
  - Early: included as warnings, notifications, and advice.
  - During: included in all messaging during an event.
  - After: including as recovery and for services and supports.

The Sydney Centre for Disability demonstrates how engagement with socially vulnerable groups should exist along a continuum, including very early (engagement and preparedness), early (prior to snow events), during (during snow events), and after (in terms of evaluation). Marking it according to time, the recommendation is therefore for the City to build the voice of socially vulnerable groups into its *whole* decision-making process, including the framing of engagement unto itself. To-date, the City has missed an opportunity to be user-centered in its process as well as its outcomes, resulting in service delivery that not only fails to meet residents' needs, but has yet to fully understand them. In starting with social vulnerability rather than responding to it, the City has a chance to multiply the benefits of engagement in a way that creates better conditions for winter equity, accessibility, and accountability.

5.1.2. Inform and enrich City practice through snow-specific dialogue kits

Key problem areas addressed: (Broad) Engagement
Timescale: Medium term
Scale: City-wide

Responsible groups: Toronto City Planning; People & Equity Division at the City of Toronto; the Toronto Accessibility Advisory Committee; Toronto Public Works; Community organizations (like the [Center for Independent Living Toronto](#), [Access Alliance](#), [NCHPAD](#), [the Rick Hansen Foundation](#)); Toronto Community Foundation; Public school boards; Community centers

Adding new points of interface with the public around snow clearing, the City can circulate a custom self-guided snow activity. We recommend the concept of dialogue kits to enfranchise members of the public – of all ages, backgrounds, abilities – to become agents of conversation and change within their own network and community ([Climate Fresk, n.d.](#)). Recognizing that there are disconnects in the City's ability to connect with the public around snow, dialogue kits are an intervention that allow for improved channels of communication and knowledge-exchange.

Peer cities like Vancouver have used kits to divide "category" areas into target and action. These gather information around a) what is needed for successful implementation, b) could there be groups negatively impacted, c) enthusiasms and concerns, d) ways the action can serve the purposes of equality ([City of Vancouver, 2020](#)). In the Toronto snow context, an early advisory panel with people with disabilities, as well as representatives from other 'socially vulnerable' groups, can help shape these questions. What, working backwards from solutions, can we identify as barriers to future implementation? What information is missing – and once identified, how can the City keep that real-time information flowing?

Snow dialogue kits in Toronto specifically might benefit from a mapping activity. Mind map exercises offer alternative forms for people to express their lived experience beyond just language ([City of San Antonio, 2023](#)). A question, for example, might be:

1. What do you see outside your window?
    a. Draw a map of the neighborhood. Where are some places you like to go? Where might snow be getting in the way?
    b. Think of someone in your life who might have trouble traveling to see you during snow (e.g. someone with a mobility device, an elderly relative, a caregiver with a stroller). Where might snow be a problem for them?

To ask about improved communication, another line of inquiry might be:

2. How does the City better communicate around current snow clearing policies? What would be a good way for us to reach you?
    a. Have you ever called 311?
        i.   If so, what was your experience?
        ii. If not, what might it take for you to feel comfortable doing so?
    b. What are other apps you use? For example, the TOWaste tool – would you like to see information about snow there?

Completed dialogue kits should be photographed and sent to the City Planning staff overseeing engagement, following models from cities like Vancouver ([City of Vancouver, 2020](#)). The kits can serve as broad engagement tools, complementing the engagement recommended in the

report that specifically solicits information to address known gaps in service provision. Maps can help put a story and an image to the user experience, perhaps becoming mobilization tools that can reach more political corners of action, like City Council.

Dialogue kits can start to change the narrative from snow-as-inconvenience to snow-as-condition, turning winter conditions into something we can expect and even normalize. The benefit of dialogue kits is, in empowering the public – of all ages – to themselves become agents for snow change, the City not only can gain a better understanding of real-time conditions, but it can help teach people the tools for interacting with government effectively and to mutual benefit.

Because snow clearing is an issue that requires cooperation and coordination across many realms, including private property-owners and small businesses, dialogue kits can help seed more dialogue among the grassroots. By activating stewardship, the dialogue kits can begin to set new, positive norms around community care during the winter season. The City has experience implementing similar kits, such as the [Leading and Learning with Pride Tool kit](#) (Seniors Services and Long-Term Care, n.d.), so this recommendation entails that the City has only to apply its engagement expertise on the issue of snow removal.

5.1.3. Improve two-way public-facing feedback technology

Key problem areas addressed: Engagement, Resilience
Timescale: Medium term
Scale: City-wide
Responsible groups: Toronto City Planning; 311 Toronto; People & Equity Division at the City of Toronto; the Toronto Accessibility Advisory Committee; Toronto Transportation Services; [UHN's OpenLab](#)

We recommend that Toronto's engagement draw from technology-based citizen science to ask itself, what are existing opportunities for connection between the City and the public? How can these opportunities be inventoried and analyzed for their potential to support more knowledge-sharing around snow events in particular? For this, the City will benefit from identifying points of existing interface in a way that is expansive and cross-cutting: for example, the TOWaste app is an operating technology that could be programmed to also alert and direct residents durationally during incidences of snow. Knowing, for example, that garbage day can create multiple overlapping mobility challenges where there are heavy and prolonged snowfalls, integrating models can offer new channels for information flow (see [Section 4.1.4](#) for information on municipal snow communications through civic tech). Currently, it can be confusing for residential property and business owners to know when they are responsible to shovel their snow: with the TOwaste app, the City already uses communication techniques to notify residents of responsibilities. As such, improving communications may only be a matter of retooling existing software and expertise.

Due to the equity-related flaws of municipal 311 systems found in our own research and literature review (see [Section 1.4.1](#)), responsibility falls to the City to understand how 311 is

used during winter months and what creates barriers and accelerators of use. To identify who is being left out by 311 – or those for whom 311 interactions have been disempowering and discouraging – the City should engage specifically around where it might improve 311, introduce new touch points and/or, as in the case with TOWaste, adapt others. Following the major snow event in January 2022, the Toronto Accessibility Advisory Committee recommended the prioritization of urgent 311 service requests made by seniors and disabled residents (2022). It's in this context that partnerships that unite around the common goals of seniors and disabled residents, such as OpenLab working with naturally occurring retirement communities (NORCs), might integrate new voices. While it is not clear if the City has taken up the Toronto Accessibility Advisory Committee's recommendation, it is an example of an action that centres need and recognizes differences in resident experiences with municipal touch-points. As a call to action in Toronto, it will be important to think about how, even as snow clearing technology evolves opportunities to improve snow clearing via quantitative methods and metric-driven results, civic tech can be enlisted to add texture and information to the City's attempt to reduce bias and amplify its outreach.

Despite its 24 hours a day, seven days a week availability, Toronto's 311 service has failed to meet resident needs during winter months (see Section 1.4.1): calls related to winter clearance have to deal with long wait times or insufficient answers. Residents should have the ability to take action on pressing issues without feeling disempowered. In particular, requests from disabled and senior residents should receive priority, even during 311 black-out periods, as recommended by the Toronto Accessibility Advisory Committee (2022, see recommendation 1.a)

In the context of this report, and for the City and publics' shared interest going forward, it is important to recognize that the public – especially people with disabilities, who interface with the City often around issues like snow clearing – already play a valued role. It is incumbent on the City to recognize, and benefit from, the public's role as such. App-based engagement is one way to transition one-off participation into a process, and a habit. It can capture the value inherent in real-time feedback. The Sydney Centre for Disability Research and Policy example draws attention to the language of valued roles, writing:

> "contributing to community resilience implies becoming involved, volunteering your time, knowing your neighbours, lending a hand, and looking out for others, particularly those who are at greater risk when disasters strike. These are valued roles that help communities to prepare, respond and recover. Building resilience for everyone in the community means making sure that people with disabilities have the same opportunity to participate in these valued roles" (Villeneuve, 2020) (see Section 4.2.1 for case study analysis).

Communication of course goes both ways. We think the City should share information about winter maintenance, such as the snowplow data, clearance timing, and sidewalk conditions, more transparently. Significant characteristics for winter maintenance data shared through PlowTO are hidden from the public when the year is over (see Section 1.4.1). If data collected over the years was shared, it could be used and studied for better prediction and analysis of

future risks. Further, a published evaluation of service delivery and City-reported degree of satisfaction would allow residents to discern between what is a problem of standards and what is a problem of execution. The City has assessed its operations post-major snow events (General Manager, Transportation Services, 2022), but not for its day to day winter operations. Reviewing the service would allow for transparency between the City and residents, fostering trust.

5.2. Enhance service standards

5.2.1. Revise safe and passable service standards

Key problem areas addressed: Operations
Timescale: Short term
Scale: City-wide
Responsible groups: Toronto Transportation Services

We recommend that the City use the engagement data collected through efforts described in section 5.1 (specifically 5.1.1) to revise its standards for sidewalks. We believe that the City must address the needs expressed by sidewalk users, and particularly the needs of vulnerable groups (see Section 4.2.1). It is clear that feasibility is the primary concern of Transportation Services in its understanding of snow clearing (Transportation Services, 2021b). While feasibility is a relevant perspective when assessing technical work such as snow removal, the City must also be sure that what it deems to be feasible is addressing the needs of residents. Once Transportation Services understands the scope of resident need in the City, it may very well reach different conclusions about what is reasonable in its snow clearing standards (See Section 4.3.2 for a case study on user-centric decision making). The Toronto Accessibility Advisory Committee has made similar recommendations recently (2022, see recommendation 1.b) Pursuing this recommendation means more than simply raising the standard: it also means providing greater clarity on the meaning of the City's standards.

We found two definitions of "safe and passable" in our scan: one that appears on the City's websites and brochures, and another in the Winter Maintenance Program Follow-Up (see Section 1.4.1 subsection *Delivery of winter sidewalk maintenance*). The definition of "safe and passable" found on the City's website and brochures (which we assume is the definition that the public is more likely to consult) is poorly defined: "a surface that can be traveled safely at a reasonable speed" (311 Toronto, n.d.-b.). Because this standard is used on roads and sidewalks, by different users with different needs, this definition is inherently variable in its application. A reasonable speed for a motor vehicle is very different from a reasonable speed for a pedestrian on the sidewalk. What is safe and passable for many residents is not necessarily safe and passable for all, such as those with mobility aids or strollers (Wilkins & Park, 2004). When the City is revising its sidewalk snow clearing standards, it should define them to be clear, precise and detailed. They should be tailored to the needs of the variety of sidewalk users in the city. This consideration would also support the City's modal-shift TransformTO goals, as safer conditions will support greater pedestrian use. Doing this may involve creating a classification system of sidewalks and sorting them according to pedestrian

traffic and level of need, similar to what is done in Ottawa (See Section 4.3.1 for Ottawa case study).

5.2.2. Research innovative technology for efficient strategizing of operations

Key problem areas addressed: Operations
Timescale: Medium term
Scale: City-wide
Responsible groups: Toronto Transportation Services, Toronto Environment and Climate Division

We recommend that the City research and implement technology that can detect sidewalk conditions in real-time to better strategize and triage winter maintenance operations. This means researching hard infrastructure solutions, such as Québec City's network of weather information systems (Section 4.1.4), but also approaches that source citizen science, such as CoCoRaHS (Section 4.2.3). If Transportation Services has a better understanding of the real-time conditions of the sidewalk, then it can allocate limited resources to problem areas efficiently. And if residents have a real time view of sidewalk conditions in the city, then they can adjust their daily activities accordingly. Incorporating such approaches will allow for a proactive approach to snow clearing, and mitigate the need for more reactive services such as 311 requests for snow removal (see Section 1.4.1 for issues with 311). This proactive approach would help ensure that snow removal in the city is predictable and accessible for all residents, but particularly for residents who are more vulnerable to poor sidewalk maintenance, such as residents with mobility devices, elderly residents and caregivers (Villeneuve, 2020). This applies a Vision Zero approach to winter sidewalk safety through proactively and systemically prioritizing needs (General Manager, Transportation Services, & General Manager, Solid Waste, 2019, p. 13).

5.2.3. Adopt a Vision Zero approach for winter sidewalk safety

Key problem areas addressed: Operations
Timescale: Short term
Scale: City-wide
Responsible groups: Toronto Transportation Services, Toronto City Council

We recommend that the City formally adopt a Vision Zero approach for its winter sidewalk maintenance (See Section 1.4.3 subsection *Vision Zero*). Transportation Services has already made the connection between snow clearing and Vision Zero (e.g. 311 Toronto, 2023), but the City's Vision Zero 2.0 does not currently recognize the safety risks posed to pedestrians (especially elderly and disabled pedestrians) due to poor winter maintenance. Part of this adoption means amending the Vision Zero Strategy to recognize that preventing slips and falls on city sidewalks is just as worthy of consideration as preventing traffic collisions. Just as Vision Zero seeks to build a culture of road safety amongst road users and operators (General Manager, Transportation Services, & General Manager, Solid Waste, 2019), the City should

seek to build a culture of winter sidewalk safety among residents and operators. This means recognizing the role of the various interests (including engineers, educators and residents) and building strategies and countermeasures to engage those interest-holders.

The City could introduce a host of countermeasures from the 5Es (see Section 1.4.3, subsection *Vision Zero*) to build this culture of winter sidewalk safety. Engineering countermeasures could include the implementation of design features that provide for inherently safer sidewalks during winter (e.g., Sections 4.1.1, 4.1.2, and 4.3.1). Engagement countermeasures could use programming (e.g., Section 4.5) as an opportunity to build empathy among residents for their peers. Education countermeasures could include the use of technologies/applications and informative materials (e.g., Sections 4.1.4, 4.4.2, and 5.1.3; also 311 Toronto, 2023) that will better inform residents about when they are responsible for snow clearing. And for the City's evaluation countermeasures, it should look at its current approach to enforcement to determine how effective it has been (if at all) at encouraging resident snow clearing. As mentioned in section 1.4.2, no information appears to be available on the frequency of ticket issuance for inadequate resident snow clearance: the City should publish this information through its Open Data Portal. It may be found that enforcement countermeasures are not effective at building a safe winter sidewalk culture (Rodriguez, 2020).

In addition, we would encourage the City to assess the mechanical clearing program in relation to the services provided by the discontinued snow clearing program for seniors and people with disabilities. The City believes that they are able to provide better service with the mechanical clearing program than the previous program (as the plows are triggered sooner than the former snow clearing program) (Transportation Services, 2021b). As previously mentioned, the City of Toronto plows do not begin operations until 2 centimeters of snow have accumulated, whereas the former snow clearing program only "kicked in" after the snow had stopped falling (Transportation Services, 2021b). This is why City staff believe that the new program will be better for seniors and people with disabilities: their sidewalks should be cleared sooner than under the previous program, and more of the sidewalk network will be cleared to support longer pedestrian trips (Transportation Services, 2021b). However, we believe it would be beneficial to verify this assumption, so that seniors and people with disabilities are receiving adequate service and avoiding potential fines. The new system does not have provisions in place for clearing sidewalks for seniors and people with disabilities under the 2 centimeter snow threshold.

5.3.   Long-term infrastructure alignment for winter mobility

5.3.1.   Create Urban Design guidelines for winter conditions with accessibility and resilience as key priorities

Key problem areas addressed: Built form
Timescale: Long term
Scale: City-wide

Responsible groups: Toronto City Planning; Toronto Parks, Forestry, and Recreation

We recommend that Winter Urban Design Guidelines are created for street design that is more resilient to changing weather and climate conditions. Doing so will allow people to live their lives and have equitable access to mobility. In Toronto there are urban design guidelines in some neighbourhoods that recommend the use of facade design to reduce wind and intentional street planning, however this practice is not widespread in all areas of the city (Bousfield, 2020; City of Toronto, 2018a). We recommend the City create new urban design guidelines that plan for winter conditions and cold climates, as winter considerations are somewhat limited in the planning and design documents from the City of Toronto (see Section 1.4.3 for Toronto policy scan).

Additionally, we recommend that the City update the Official Plan, secondary plans, and urban design guidelines with a lens for winter. Street planning is designed to encourage active transportation in Toronto; however, we feel the streetscape design recommendations should be more robust. The transition of spaces from summer uses to winter, such as Umeå's use of the park for winter recreation and bus shelters to increase light exposure to pedestrians, would improve pedestrian safety and outdoor enjoyment (see Section 4.3.1 for Umeå case study).

Built form should be designed to create a better microclimate and a more vibrant and inviting public realm through the use of environmentally-conscious designs that consider mental and public health needs. This can be accomplished with winter streetscape redesigns that incorporate the complete street approach and environmentally resilient nature-based solutions infrastructure to improve permeability, ecological connectivity and pedestrian comfort. This would support the TransformTO targets of shifting to less carbon intensive transportation modes (i.e. driving a car to walking). Research in winter climates found that low temperatures had little impact on people's willingness to walk, but snow and ice conditions were mitigating factors to modal shifts to active transport (Muraleetharan et al., 2005; Pratte, 2011). Similar to findings in Toronto which show that weather can affect modal choice, however streetscape designs for mobility and maintenance increase likelihood of pedestrian mobility and their safety (Saneinejad et al., 2012; Pratte, 2011).

Ultimately, this would involve Toronto City Council, Transportation Services Department, Planning Department, Parks and Recreation Department, the Complete Streets team, and potentially community interest groups.

Planning Document Title	Impact	Date
Toronto Official Plan	City-wide	Adopted as of June 19, 2023
TOcore: Planning Downtown (Secondary Plan)	Downtown core 25-year vision	Adopted as of June 5, 2019
Downtown Parks and Public Realm Plan (Chapter 7 of TOCore Secondary Plan)	25-year integrated plan	Adopted as of June 5, 2019

Accessibility Design Guidelines	City-wide	Updated as of 2021
Complete Streets: Urban Design Guidelines	City-wide	Released in 2017
King-Parliament Secondary Plan	Builds on TOcore	Adopted as of May 5, 2021

5.3.2. Implement efficient and environmentally sustainable infrastructure

Key problem areas addressed: Operations
Timescale: Medium term
Scale: City-wide
Responsible groups: Toronto City Council; Toronto City Planning; Toronto Transportation Services

We recommend that the City create a strategic sidewalk plan that manages tree roots, heated sidewalks in critical zones, uses porous sidewalk materials, and utilizes green infrastructure. These sidewalk design changes could be incorporated into ongoing and future infrastructure projects from the City or with developers. Better sidewalks would make winter maintenance easier, increase pedestrian safety, and improve the pedestrian experience.

Green infrastructure improvements
In Toronto there are similar green infrastructure initiatives for climate action and city resilience that support policies such as TransformTO, the Resilience Strategy, Green Streets initiatives, and provincial and TRCA flood resilience goals. Some of Toronto's infrastructure goals for the Resilience Strategy include advancing the City's efforts to develop a system of green and blue infrastructure, similar to the bioswales and street design infrastructure in Copenhagen (See section 4.4.1) (City of Toronto, 2017a). Green infrastructure can help build a Toronto that is resilient to climate change while improving overall quality of life. The Green Streets Technical Guidelines and the Complete Streets Guidelines are "compatible and complementary documents that have been developed through an iterative process to ensure that Green Street objectives can be achieved across the City's entire portfolio of street types" (City of Toronto, 2023c). We recommend that green streets with more extensive consideration to winter conditions are integrated into all future plans as they go through urban renewal processes or following street construction (see Sections 4.3.3 and 4.3.4 for relevant case studies).

Heated sidewalks
To implement this plan successfully we recommend the City planners responsible for street renewal create a community engagement strategy that emphasises the benefits of green street's environmental sustainability and resilience to those impacted. In the Copenhagen case (Section 4.4.1), community members and community groups that were engaged continued to support climate action and community support initiatives.

Currently there is limited use of heated sidewalks in the city. The expansion of such systems could be highly beneficial in the City's continuing efforts to reduce salt usage. The City of

Toronto could make use of preexisting district heating systems (District Energy Team, n.d.) to power these heated sidewalks, such as those operated by municipal partners like Enwave (2022) and educational institutions such as York University (n.d.) and University of Toronto. Retrofitting these systems to use excess waste heat is an opportunity that the City could explore in collaboration with these partners. A pilot project with one of the universities could be an effective way to test the feasibility of such systems (See Sections 4.1.1 and 4.1.2 for case studies on heated sidewalks).

5.3.3.   Increase planting of salt-tolerant, winter-hardy trees for wind breaking and pedestrian safety

Key problem areas addressed: Resilience
Timescale: Medium term
Scale: City-wide
Responsible groups: Toronto City Planning; Community organizations

We recommend the creation of a city-wide strategy for intentional salt tolerant street trees and vegetation, as this would improve wind breaks, snow protection, and pedestrian safety. We recommend the City of Toronto reviews their street tree planting program and urban forestry strategy to increase the green boulevard spaces and encourage more diverse vegetation usage. The City of Toronto states that during capital improvements on city streets, "Transportation Services plants native trees, shrubs and plants whenever possible, increasing potential habitat and adding to biodiversity" (City Planning et al., 2019, p. 19). This would be an optimal time to plant street trees and other plants more densely in order to improve the shelterbelt of the roads, improving pedestrian experience in the winter months. We also recommend that the street tree approach on urban streets incorporates more roadside shelterbelts using evergreens for windbreaks and snow protection (Sherwood's Forest Tree Farm, n.d.; Urban Systems, 2000; Agriculture and Agri-Food Canada, 2010).

As capital improvements are ongoing, updating the streetscape design to be more winter and pedestrian friendly would fit into current municipal plans and contribute to goals in TransformTO, Vision Zero, the Complete Streets approach, and the *Toronto Seniors Strategy 2.0* (see policy scan in Section 1.4.3). The implementation of some of these recommendations currently occurs in some locations in Toronto (such as Byng Avenue, Fairford Parkette, and Stanley Green Boulevard) (City of Toronto, 2023c), however we recommend that these infrastructure improvements be widespread in all neighbourhoods and street types of the city (See Section 4.3.3 for a relevant case study).

This recommendation is based on research and best practices, but would require expertise of experts (such as landscape architects) in order to move forward. As an exercise to visualize our research, conceptual application of these design suggestions to two downtown Toronto streets was created and can be seen in Appendix D.

5.3.4. Pilot a project to implement climate-resilient and winter-friendly streetscape design

Key problem areas addressed: Resilience, Built form
Timescale: Medium term
Scale: Targeted area (one pilot project location)
Responsible groups: Toronto City Planning; Institution or private partner

We recommend advocating the City or connecting with another group to run a pilot project to test winter-friendly designs. Based on best practice research and literature, we have compiled a collection of winter-friendly street design elements that could be incorporated into a pilot project (see Appendix D). As we are not experts in urban design or landscape architecture, we recommend consulting a professional before proceeding. We have included a conceptual application of these design suggestions to two downtown Toronto streets (see Appendix D, also Sections 4.4.1 and 4.4.4).

5.4. Social resilience

5.4.1. Design winter programming that is safe and accessible for everyone

Key problem areas addressed: Programming, Resilience
Timescale: Medium term
Scale: City-wide
Responsible groups: Parks and Recreation Department, Community organizations

We recommend that the City of Toronto create a winter cities program to allow for residents to have the opportunity to positively learn about and experience winter through cultural and educational events. Through the creation of a booklet accessible to the public, residents of this winter city will be able to form a stronger community as a whole. Some examples include diverting the relocation of snow to create art for snow festivals.

The Sapporo case study is significant for the Toronto context as it showcases the celebration of snow rather than an aspect to endure during the winter season (see Sections 4.5.2 and 4.5.3 for case studies on winter programming). Winter has been associated with seasonal affective disorder (SAD) (Leung & O'Connor, 2019), but the implementation of winter festivals can allow for positive connections towards winter. The Toronto Christmas Market in Distillery District is a popular tourist attraction that promotes concepts of winter through local vendors, activities, and overall aesthetics. However, this event is privately run and requires an entrance fee (The Distillery District, n.d.), which poses issues for some who may be unable to pay. Instead, having free City-hosted winter events can allow for greater participation. Currently, Toronto hosts winter recreation programs (Client Services & Information Unit, n.d.) but it is unclear based on program descriptions if this programming is focused on creating positive associations with winter. The use of the accessible guide for the winter festivals in Sapporo has promoted safety and awareness (see Section 4.5.2). Toronto can benefit from this concept by creating a winter safety

guide within their winter programming that details how to safely access and participate in cold-weather activities.

5.4.2.   Circulate an accessible guide to help newcomers understand winter risks and safety

Key problem areas addressed: Programming, Resilience
Timescale: Short term
Scale: City-wide
Responsible groups: Toronto City Council, Toronto Employment and Social Services; Community organizations like Social Planning Toronto and The Neighbourhood Group

We recommend that the City produce a winter risks and safety guide for newcomers, who make up a large share of Toronto's growing population. Currently Toronto has newcomers guides and brochures, but none about winter (Newcomer Services Kiosk, n.d.-a.). Canada has unique winter conditions, therefore a key element in this guide should address the risks, especially to populations that are more socially vulnerable, while framing its exciting possibilities.

Manitoba does a great job with their creation of their newcomers guide, *Winter in Winnipeg: A Guide for New Residents* (Lies & Ash, 2023; also see Section 4.4.3), where they educate newcomers on topics such as snowfall, winter programming, transportation, etc. This well-rounded guide shares information about mitigation of snow-related risks to residents (Lies & Ash, 2023; also see Section 4.4.3). Toronto should adopt a similar guide, using it to become more transparent with their residents about winter maintenance strategy and to promote overall safety strategies for individuals who may have not experienced winter before their arrival to Canada.

6. Conclusion

With current City snow clearing policy predicated on feasibility rather than user-need, it is important to recognize that the recommendations included in this report should be updated to consistently align with what engagement gleans about direct lived experience. Committing to resident need at each step will not only help the process remain equitable and accessible, but it will serve accountability and affirm the constructive possibilities of dialogue between the City and its residents.

As Master's in Planning students, it should also be acknowledged that our positionality and training leads us to take a planner's lens on the issue of snow clearing. Early on, our process included rigorous analysis of relevant policy and planning documents. The following recommendations thus situate themselves in particular ways of interacting with the City's policy and planning levers. With our planner's lens, it also became important to us to embed the issue of snow clearing within the City's larger agenda and forecasts: attaching snow clearing to Toronto's potential to express and own its status as a winter city, for example, we see as a potential tool for mobilizing a cross-coalitional group of interest-holders.

At the advice of our mentors, we take the City's language and mirror it back in ways that prime a pathway for integration. Naming accountable parties where we can, the following chart builds on the text in the prior sections to tag key problem areas, core values, timescale, scale, and responsibility. Even as the summary tables below offer what we hope is a user-friendly structure to our recommendations, we intend for the best practices and values to continue to serve as a reference for the narrative and logic that led us to each suggestion.

Finally, the planner's lens means that each of us will take these studio lessons back into our own planning practice. Some of these lessons include: a) City operations having tangible impact b) going above and beyond basic consultation c) incorporating iterative feedback d) the power of precise and intentional language and e) the skill and strategy advocacy groups apply in their interaction with the City.

Walk Toronto, after all, has already been instrumental in pushing the needle on snow clearing. It is our belief that, in our report's focus on disparate user needs, Walk Toronto will only continue to have more to offer: whether that is in demonstrating how grassroots organizations maneuver various levels of government, or in the snow stories and lived experience of every Walk Toronto member. Many community partners could benefit from a relationship with Walk Toronto, and vice versa – with this, snow is a natural common ground.

Disability advocate Dana McGarr has a quote that says, "Accessibility isn't more work …the work was incomplete" (McGarr, 2021). Likewise, these user-centered recommendations need not be seen as *adding* to the City's work – they can help fulfill it.

6.1. Recommendation summary tables

Recommendation 1: Active engagement on winter mobility

Action	Key problem areas	Core values	Timescale	Scale	Responsible groups
Target engagement to populations insufficiently serviced by the "Safe and Passable" standard	(Targeted) Engagement	Accessible, Equitable, Accountable, Affirming	Short term	City-wide	Toronto City Planning; Toronto People & Equity Division; Toronto Accessibility Advisory Committee; Toronto Public Works; Community organizations like the Center for Independent Living Toronto, Access Alliance, NCHPAD, the Rick Hansen Foundation)
Inform and enrich City practice through snow-specific dialogue kits	(Broad) Engagement	Accessible, Equitable, Integrated, Affirming	Medium term	City-wide	Toronto City Planning; Toronto People & Equity Division; Toronto Accessibility Advisory Committee; Toronto Public Works; Toronto Community Foundation; Public schools boards; Community centers; Community organizations like the Center for Independent Living Toronto, Access Alliance, NCHPAD, the Rick Hansen Foundation)

Action	Key problem areas	Core values	Timescale	Scale	Responsible groups
Improve two-way public facing feedback technology	Engagement, Resilience	Accessible, Integrated, Predictable, Accountable, Adaptable	Medium term	City-wide	Toronto City Planning; 311 Toronto; Toronto People & Equity Division; Toronto Accessibility Advisory Committee; Toronto Transportation Services

Recommendation 2: Enhanced service standards

Action	Key problem areas	Core values	Timescale	Scale	Responsible groups
Revise safe and passable service standards	Operations	Accessible, Equitable, Integrated, Predictable, Accountable, Environmentally sustainable	Short term	City-wide	Toronto Transportation Services
Research innovative technology for efficient strategizing of operations	Operations	Accessible, Integrated, Predictable, Accountable, Adaptable	Medium term	City-wide	Toronto Transportation Services, Toronto Environment and Climate Division
Adopt a Vision Zero approach for winter sidewalk safety	Operations	Accountable	Short term	City-wide	Toronto Transportation Services, Toronto City Council

Recommendation 3: Long-term infrastructure alignment for winter mobility

Action	Key problem areas	Core values	Timescale	Scale	Responsible groups
Create Urban Design guidelines for winter conditions with accessibility and resilience as key priorities	Built form	Accessible, Equitable, Integrated, Predictable, Environmentally sustainable	Long term	City-wide	Toronto City Planning; Toronto Parks, Forestry, and Recreation
Implement efficient and environmentally sustainable infrastructure	Operations	Integrated, Environmentally Sustainable, Accessible	Short to long term	City-wide	Toronto City Council; Toronto City Planning; Toronto Transportation Services
Increase planting of salt tolerant, winter-hardy trees for wind breaking and pedestrian safety	Resilience	Integrated, Predictable, Environmentally sustainable	Medium term	City-wide	Toronto City Planning; Community organizations
Pilot a project to implement climate-resilient and winter-friendly streetscape design	Resilience, Built form	Integrated, Predictable, Environmentally sustainable	Medium term	Targeted area (one pilot project location)	Toronto City Planning; Institution or private partner

Recommendation 4: Social resilience

Action	Key problem areas	Core values	Timescale	Scale	Responsible groups
Design winter programming that is safe and accessible for everyone	Programming, Resilience	Accessible, Integrated, Accountable	Medium term	City-wide	Toronto City Planning; Community organizations
Circulate an accessible guide to help newcomers understand winter risks and safety	Programming, Resilience	Accessible, Integrated, Accountable, Predictable	Short term	City-wide	Toronto Employment and Social Services; Community organizations like Social Planning Toronto and The Neighbourhood Group

6.2. Acknowledgments

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Appendix A: Initial project brief

Initial challenge statement

The variability and intensity of precipitation in Winter 2023 presented particular challenges for accessibility and mobility in Toronto. We know that the significant snow, slush and ice volumes presented challenges for people using sidewalks, bike lanes, and TTC stops making it harder for people to go about their daily lives.

With a changing climate comes more frequent and intense weather events, and changes to the freeze-thaw cycles all which have impacts on accessibility and mobility in our cities. Snow and ice volume, type and timing all present challenges to our city. Municipalities are having to revisit their snow and ice clearance approaches. Some snow and ice removal takes place under private contract from the municipality and by large property owners. In some municipalities, like ours, residents have an obligation to clear snow and ice too but this obligation can be harder for some residents due to physical constraints while other residents simply do not participate. Collectively, this system of responsibility means that Torontonians have widely varied experiences when it comes to navigating our city during the winter.

It is also important to note that decisions about how and when to deal with ice, snow and slush are values-based. Which parts of the public realm are cleared first: roadways, bike lanes or sidewalks? Which parts of the city get first attention (e.g. how do density, road hierarchy, types of land use factor in)? What is the sequence of clearance and what are the implications of what is done and in what order (e.g. do you plough a road and end up blocking sidewalk access? Are snow, ice and slush removed, cleared, melted, or salted? Do homeowners rise to their individual obligations to the public realm by doing their part to clear their sidewalks? Which communities of our people experience more disruption when these kinds of extreme winter weather events take place (e.g. people who use mobility devices; e-bikes users who deliver food and other on-demand packages; seniors; people who take buses to work)? How do these weather events change how people experience the public realm (e.g. are there more people walking on roads, what happens in parks)? These questions among many point to the need for us as planners to think carefully about the intersections of environmental issues, accessibility, and equity in municipal decision-making. In collaboration with the volunteer group WalkToronto, our studio seeks to explore new more equitable and accessible ways for Toronto to think about snow, ice and slush for winter mobility.

Project Overview

We'll spend the first week of studio grounding ourselves in existing research and knowledge about winter precipitation-related issues in Toronto including the work already completed by our client, WalkToronto (see links below). We'll begin to update Michael Black's 2014 report (see below). In week 2 we'll arrange an evening meeting with our client (virtual) to revisit this brief and confirm next steps. You'll get busy students gathering background research to first understand the challenges that our city faced in Winter 2023. You will work with 311 open data, learning from City staff and elected officials about what they heard, and also attend meetings of the Infrastructure Committee in the fall. You will explore community concerns as shared through

social media and other sources. This reconnaissance will help our studio group frame the scope of the challenges that winter precipitation presents to Toronto.

With a clear understanding of the problems at hand, we'll conduct an environmental scan internationally to see what we can learn from other jurisdictions about how they are tackling the snow, ice and slush challenges Toronto faces. We will pay particular interest to who does what and what are the values driving their decisions. We'll consider questions such as: What roles are municipal governments playing and which departments? Are there community-based efforts? What kinds of community-based organizations are leading this work (e.g. mobility, accessibility, climate action)? And what role are private sector firms playing? We'll learn about accessibility plans related to winter precipitation. We will look at municipal climate action plans to see if there are directions about how a changing climate is changing plans for winter precipitation. We will explore public realm strategies in winter cities. And we will also explore which cities are using an equity lens in their municipal decision-making to better understand whose needs are prioritized first when it comes to snow/ice clearing and removal.

This studio will conclude with students sharing their best-practice findings in time for consideration for Winter 2024. Students in this studio with interests in public realm access and accessibility, active transportation, climate change, urban governance, and more inclusive municipal service delivery will find this studio a good fit.

Deliverables
The deliverables for this project will focus on readable, public-facing material that meets accessibility standards. Our client is a volunteer organization that does mobility advocacy work so we'll work with them after the interim presentation to discuss the specific forms of deliverables.

Appendix B: Feedback log

Throughout the studio process, we were very fortunate to receive feedback from the Walk Toronto Steering Committee, our mentors, and our supervisor. There were two key feedback periods that correlated to milestones in the project: the interim presentation period (October 17 to 19), and the final presentation period (November 28). In the spirit of transparency and accountability, we have compiled this log of the key points of feedback from the interim and final presentations.

Interim presentation period (October 17-19, 2023)

Who gave the feedback?	Relationship to the project	Feedback
Pamela Gough	Walk Toronto Steering Committee member	Asked how we understand empowerment and suggested using power dynamics instead as that's what she thinks we are getting at. - She thinks that empowerment may be a difficult word for people to grasp Examples of power dynamics: ● Councillors have lots of power for how the system works ● Power in hands of civil servants ● Power in hands of motorists - to go fast, be heavier, and faster than pedestrians
Pamela Gough	Walk Toronto Steering Committee member	Consider tragedy of the commons, like the approach taken with Great Lakes responsibility levels, we can use this approach to hold different people responsible and operate. It may be difficult, but we should quantify what each level is responsible to commit to.
Pamela Gough	Walk Toronto Steering Committee member	Use a legal lens to determine levels of responsibility, reckon with who does have legal liability and use legal liability to measure responsibility. Using liability as a measure used to quantify the responsibility. Example: Cities have liability, drivers have liability, pedestrians have less liability,
Pamela Gough	Walk Toronto Steering Committee member	Also suggested "Dignity" might be a thread to follow instead of "Empowerment"
Daniella	Walk Toronto Steering	Interested in different responsibility levels

Who gave the feedback?	Relationship to the project	Feedback
Levy-Pinto	Committee member	if dispersing responsibility among diff groups can guarantee it gets done, to ensure predictability and accountability
Daniella Levy-Pinto	Walk Toronto Steering Committee member	Accessibility of handout: can't read with a screen reader: need to fix that.
Micheal Black	Walk Toronto Steering Committee member	He voiced that looking at the word empowered and the potential of it as Walk Toronto has not worked on it much. Empowerment is looked at in terms of equity so he suggested combining empowering and equity.
Micheal Black	Walk Toronto Steering Committee member	He shared that what is predictable is that unpredictable events, such as intense storms, happening more frequently.
Micheal Black	Walk Toronto Steering Committee member	He finds that homeowner and occupants don't take the requirement to shovel less than 2 centimeter snowfall very seriously with minor snowfalls and snow accumulation can provide problems. Not sure how we can improve this? How can we get homeowners to be less negligent ?
Micheal Black	Walk Toronto Steering Committee member	Hitting Paywalls was a problem in the past for Walk Toronto research. If we are able to provide PDF for studies that are paywall would be appreciative instead of us just referencing them
Micheal Black	Walk Toronto Steering Committee member	City processes: can they be updated so the City is authorized to spend extra during snow emergencies? These huge storms used to be freak things, now they happen more frequently. Even though they are unpredictable to an extent, we can predict that they will happen + need processes in place to address them
Adam Cahoon	Walk Toronto Steering Committee member	Suggestion: I want the snow cleared, but in a responsible way, that doesn't do damage to pedestrians and pet owner's pets through liquid melt or salt haphazardly in excessive amounts. ● Salt gets into the ballbearings of my

Who gave the feedback?	Relationship to the project	Feedback
		wheelchair and after a while it starts to affect the performance of the wheelchair operation.
Adam Cahoon	Walk Toronto Steering Committee member	Noted BlogTO already has an article: People are complaining about snow. Thought BlogTO can be "clickbait-y" it can get the message out about peoples' opinions in the city
Dylan Reid	Walk Toronto Steering Committee member	He understands how we are understanding the word empowerment and thinks that 311 is a good example and important to remember. ● 311 was a huge source of frustration for the people the Walk Toronto people talked to
Dylan Reid	Walk Toronto Steering Committee member	He likes the 8 word framework concept.
Dylan Reid	Walk Toronto Steering Committee member	Predictability should be measurable with: service standards met or better, people being able to count on all transit stops being cleared in all windrows in 24 hours after a storm safely.
Dylan Reid	Walk Toronto Steering Committee member	Accountability is about if there mechanisms for measuring these results such as: does City respond, does the City share their stats, and is that information guaranteed.
Dylan Reid	Walk Toronto Steering Committee member	Interested in the concept of bristle plows: what are their applications + how well do they work?
Dylan Reid	Walk Toronto Steering Committee member	Most people don't know about the 2 centimeter limit. Could there be more intentional communications from the City, e.g. "today it's going to snow lightly so the City won't clear it"
Dylan Reid	Walk Toronto Steering Committee member	Downplay shared responsibility: the City needs to step up!
Dylan Reid	Walk Toronto Steering Committee member	Not so much the temp but the predictability of the weather on a 20-year timeframe is the more important discussion point: focus on the changes in

Who gave the feedback?	Relationship to the project	Feedback
		precipitation
Doug Vallery	Walk Toronto Steering Committee member	Note: Because Doug was unable to attend the interim presentation live, he sent his comments via email. These comments are his verbatim feedback.
Doug Vallery	Walk Toronto Steering Committee member	**INTERRELATED VALUES Framework**: There are a number of words here - i am wondering if simplifying and grouping the list would help: • Accessible & Equitable (addressing standards and social justice) • Sustainable, Integrated and Adaptable (addressing service levels) • Empowering, Predictable and Accountable (All stakeholders are involved in a process of engagement: snow clearance action and outcomes (everyone invited to get involved in monitoring, reporting, corrective action and performance review)
Doug Vallery	Walk Toronto Steering Committee member	**RECONCILING DIFFERENT LEVELS OF RESPONSIBILITY** • City services cannot be relied on in terms of timing and quality of service; therefore private entities must undertake/overlap the work; frequently duplicating the sidewalk clearance but not addressing the eventual city residue (windrows). • Sidewalks and users are at risk when the "action level" criteria of 2 centimeter of snow is not met; freezing rain and small quantities of snow can cause hazardous conditions that become the sole responsibility of the private proprietor. • Coordinating responsibilities could achieve efficiencies, savings and improved performance.
Doug Vallery	Walk Toronto Steering Committee member	**ALLIES we should KEEP IN MIND:** • The Money in the System: The private sector (commercial and residential

Who gave the feedback?	Relationship to the project	Feedback
		property management) is likely matching or exceeding the public sector contribution; with little or no coordination between delivery of services "at the boundaries" and a poor overall performance. (As an example, my buildings are paying $15,000 + HST annually for .2 km of sidewalk.) • Additional Research Subjects: Commercial and Residential Property Managers; Building Superintendents; ALL citizens; Private snow clearance contractors. • Local Teams: one snow clearance model that may be more effective - local teams with both mechanical equipment and shovels who can deliver a "snow clearance plan" on a block-by-block basis (frequently commercial and residential management firms have small tractors also used for waste bin pulling) - this could be a joint model supported by both the private entities on the block as well as the public sector.
Doug Vallery	Walk Toronto Steering Committee member	**RE-ARTICULATE "EMPOWERING" [alternative word]**: Perhaps "*Engaging*" - include all deserving groups and stakeholders to engage in the "system" of monitoring, reporting and accountability which could lead to a higher level of performance.
Doug Vallery	Walk Toronto Steering Committee member	**MEANINGFUL MEASURE of PREDICTABILITY/ACCOUNTABILITY:** • Current Measure: recorded Slip-and-Fall incidents is likely a record of only a fraction of all incidents • Current Measure: 311 request or complaint calls; again, a subset of all issues • Current Measure: Property managers are legally required to maintain logs of winter maintenance activities for insurance purposes, however, this is not

Who gave the feedback?	Relationship to the project	Feedback
		a public record • NEW MEASURES?: Local "monitors" reporting the actual conditions and deficiencies in real time • NEW MEASURES?: Online reporting system with response teams available 24/7 to correct deficiencies - the pictures below are of my observations last year which were never reported - I would be happy to upload observations and photos if I was confident that action would be taken. In the area I walk daily, snow clearance all last year was non-existent or abysmal.
Pamela Robinson	Studio supervisor	Think about the variability and getting communities mobilized. Look at polycentric governance, to get people involved.
Pamela Robinson	Studio supervisor	Have a conversation about the 311 data: this is a matter of civic importance and this 311 data will be able to help with complaints, and it is also valuable because it showcases the differences between the different levels and hierarchy between individuals and the City. ● Dive into the 311 data (for what did we look at)
Pamela Robinson	Studio supervisor	"We do not mention the transformTO report, some of our value are included in that report - including equity", we should mention aspects from other groups like City of Toronto to show that we are mirroring their values
Pamela Robinson	Studio supervisor	"10 yr later: more specific in terms of what has changed, could bring in some numbers about City budget, percentage of renters, number of 100-yr snowstorms"
Pamela Robinson	Studio supervisor	"Point about contract areas hard to understand without a visual - questions to be raised about what

Who gave the feedback?	Relationship to the project	Feedback
		this means in terms of staffing and service delivery"
Pamela Robinson	Studio supervisor	"Need to reference auditor general report, point out what is missing from City"
Pamela Robinson	Studio supervisor	"When talking about values - predictable for whom? Accessible for whom? We can be explicit about who is being well/marginally/poorly served"
Pamela Robinson	Studio supervisor	"Need better queue-up and conclusion about interrelated values example - this will link back to what happens next - can show connections but also points of disconnect, then mention again values and scale thing in order to show how we are using these"
Pamela Robinson	Studio supervisor	"Need to quantify our work, can show the work, before introducing our framework, adds credibility - can mention how many things we read, the meetings we have had, the walk, etc."
Pamela Robinson	Studio supervisor	"Important to introduce the framework clearly, so ppl know this is our guide and is linked back to our research question"
Pamela Robinson	Studio supervisor	"Walkto as client gives us 6 perspectives not bound by politics, we don't want to focus on what is possible but what should be - project v different bc the City is not the client"
Pamela Robinson	Studio supervisor	"Considerations: geography (hills), Lived vs living experience! TTC stops, delivery couriers, trash day! - stroller & snow, different City departments need to talk, success -> who's actually going to able to have the impact, baseline of # of kilometers of sidewalks, park trails, hierarchy of snow clearing, language access, literacy levels, overlap" ● Emory's comment about Garbage Day is that certain things happen on certain days of the week. There are times on the sidewalk that are not always there.

Who gave the feedback?	Relationship to the project	Feedback
Pamela Robinson	Studio supervisor	Disaster planning: Could be in other contexts: Tsunamis? Floods? Might be good to f/u with Emory abt this b/c they do research on libraries as safe havens
Pamela Robinson	Studio supervisor	Open Government: TO is a signatory city for the open government project (OGP) -- accountability metrics already exist! So we don't need to reinvent the wheel here.
Pamela Robinson	Studio supervisor	Question quarterback: Need to tee up responses to questions more smoothly. Don't speak beyond our research base, and have a more concrete plan about who's going to "own" different sections.
Pamela Robinson	Studio supervisor	Climate mitigation piece is still important -- Keira W comments
Pamela Robinson	Studio supervisor	Connect back to core values in Q&A!
Emory Davidge	Mentor	Language: Language- gendered caregiving, residents vs citizens, stakeholder vs. interested holder
Emory Davidge	Mentor	Core values: Empowering (groups empower themselves), predictability /accountability - how?
Emory Davidge	Mentor	Deliverable: discussion guides - take a lot of time (40hrs), so consider how to do this efficiently
Keira Webster	Mentor	"As a listener who doesn't have all the context, there are some scoping pieces we should address - talk about desired outcomes, what does success look like as a team, what do we hope to bring to the client"
Keira Webster	Mentor	"What does changing climate mean for Toronto - what do we anticipate the change to be, we don't know exactly what it will be but how do we plan for

Who gave the feedback?	Relationship to the project	Feedback
		that unknown. ● In future work link to mitigation, we need to adapt but also mitigate - more bike lanes, wider sidewalks etc that go with a shift in modes - future-forward and anticipating things that might come up"
Keira Webster	Mentor	Would be the best resource to talk about other cities and their responses to how snow is cleared as she has experience being in 21 different cities and also works with people who have over 51
Keira Webster	Mentor	Confusion about "3 values" wording on research question slide, she honed in on our use of this terminology and wondered why we didn't address them again, we need to clarify.

Final presentation period (November 28, 2023)

Who gave the feedback?	Relationship to the project	Feedback
Pamela Gough	Walk Toronto Steering Committee member	● Comments on snow day engagement idea 　○ TDSB is not a fully sufficient reach: there are 4 boards operating in TO (public French, public English, Catholic French, Catholic English) 　○ The TDSB doesn't often close for snow days b/c they offer a lot of care responsibilities thru their daycares + COVID means that in the case of a lot of snow, schools might just go virtual for a day 　○ Likes the idea, but maybe need to investigate different distribution channels (maybe the library? Girl Guides/Boy Scouts? Other community groups?)

Who gave the feedback?	Relationship to the project	Feedback

Michael Black	Walk Toronto Steering Committee member	● Social infrastructure
		   ○ Newcomers + first winter – not knowing how to dress or move safely in winter – part of coping with winter overall!
		   ○ Liked 2-way communication point

Adam Cahoon	Walk Toronto Steering Committee member	● TTC: economic impact of lower ridership during snow events? ● Public health perspective: dealing with isolation in winter. "Zoom life" used to be better earlier in the pandemic – things are a lot more isolated again. ● Maybe tie in that point when discussing social infrastructure
Dylan Reid	Walk Toronto Steering Committee member	● Be more specific about the "private snow clearing" piece when we criticize it: it's not quite clear. ● Communications piece crucial: liked that we ID'd the comms required. When is it going to snow? How much? ● What was the info we learned from St. John's? – budgeting, community engagement, high degree of public interest ● Best practices really great! – loved international lens, loved that we highlighted feasibility vs need in City operations – liked the winter as an asset too
Daniela Levy-Pinto	Walk Toronto Steering Committee member	● Elaborate re: Holland? Interested about the energy used to power the heated sidewalks ● Comment: Communications still weren't accessible – that needs to be forefronted with all comms in the future ● Exports can sometimes make things inaccessible

Appendix C: Additional context for the eight core values

The following items include excerpts to offer further context around the rationale for why the core values mirror City language and takeaways from our literature review.

ACCESSIBLE
- *Meeting Accessibility Standards: AODA*: "public spaces that are newly constructed or redeveloped … shall meet the accessibility requirements set out in the AODA Design of Public Spaces Standards, including … recreation trails, outdoor play spaces, [and] exterior paths of travel" (Accessibility Unit, n.d.).
- *Toronto Pedestrian Charter:* "Toronto [is] a city in which residents and visitors of all ages and abilities can enjoy walking in a safe, convenient and comfortable urban environment" (City of Toronto, 2002, p. 3).
- *Multi-Year Accessibility Plan:* "Ensure people with disabilities can access and benefit from the same goods, services and facilities in an equitable way as others." Additionally, the "City of Toronto's goods, services and facilities will be provided to people of all abilities in a manner that respects the inherent dignity, diversity and abilities of all individuals" (City of Toronto, 2020).

EQUITABLE
- Social equity is aimed at ensuring, "barrier-free access for all transportation system users, as well as providing equitable service levels to all neighbourhoods for all trip types" (Transportation Services, 2019, p. 1). Additionally, health equity is defined by the City of Toronto as a principle that, "all people should be given the opportunity to reach their full health potential and not be disadvantaged from doing so based on race, ethnicity, religion, gender, age, social class, socioeconomic status or other socially determined circumstances. In achieving this aim, municipalities should provide equitable distribution of resources needed for health, access to opportunities available, and support offered to people negatively impacted. The City will promote equitable health outcomes resulting from automated mobility, [such as] increased safety and injury prevention, active transportation and physical activity, shared travel modes, network connectivity and greenspace, as well as reduced noise, air pollution, and traffic congestion" (Transportation Services, 2019, p. 9).
- *Systems Approaches to Urban Planning: Mixed, Conditional, Adaptive and Other Alternatives:* "Systems approaches possess an ability to deal with large numbers of interacting variable relations. They are here connected to citizen information systems (distinguished from management information systems) and to mixed, adaptive, conditional models for urban planning. This permits flexible and continuing responses to dynamically changing urban conditions, including citizen attitudes and reactions, as well as to changing economics and technologies" (Cooper et.al.,1971).

INTEGRATED

- *Systems Approaches to Urban Planning: Mixed, Conditional, Adaptive and Other Alternatives:* Mixed, adaptive models mean, "mixtures of decision making entities must be allowed for as in, a possible competing or complementary objectives on the part of participant more, allowance must be made for the fact that the objectives of various participants may vary from period to period as, indeed, the participants may vary" (Cooper et.al.,1971).
- *Tools of a System Thinker:* "Understanding causality leads to a deeper perspective on agency, feedback loops, connections and relationships, which are all fundamental parts of systems mapping … all systems are dynamic and often complex; thus, we need a more holistic approach to understanding phenomena. Synthesis is about understanding the whole and the parts at the same time, along with the relationships and the connections that make up the dynamics of the whole… Essentially, synthesis is the ability to see interconnectedness" (Acaroglu, 2017).

PREDICTABLE

- Adam Cahoon: Individuals can sometimes wait days before it is possible to leave their home.
- *Meeting Accessibility Standards: AODA:* "The City shall provide public emergency procedures, plans and public safety information to the public upon request, in an accessible format with appropriate communication support in a timely manner" (Accessibility Unit, n.d.).

ACCOUNTABLE

- Daniella Levy-Pinto: "Interested in different responsibility levels if dispersing responsibility among different groups can guarantee it gets done, to ensure predictability and accountability."
- Pamela Gough: "Consider tragedy of the commons, like the approach taken with Great Lakes responsibility levels, we can use this approach to hold different people responsible and operate. It may be difficult, but we should quantify what each level is responsible to commit to."
- *Toronto Auditor General's Report:* If the service fails to meet expectations, then there should be acknowledgement of what did not work, and plans for future improvements (Toronto Auditor General, 2023c).

ADAPTABLE

- *Meeting Accessibility Standards: AODA*: "The City of Toronto shall ensure that every area that interacts directly with the public develops and publishes a process for receiving and responding to feedback about how services and programs are delivered to people with disabilities." (Accessibility Unit, n.d.)

ENVIRONMENTALLY SUSTAINABLE

- *Corporate Strategic Plan*: "We are committed to fighting climate change and preparing our city government, our economy, our ecosystems, and our communities, especially the

most vulnerable communities, for a changing climate…Many staff work directly on the priorities in this Plan – ensuring financial sustainability, helping us be a well-run city, creating housing that's affordable and helping Torontonians along the housing continuum, keeping Toronto moving, investing in our people and neighbourhoods, and addressing climate change" (City of Toronto, 2019a).

- Adam Cahoon: "I want the snow cleared, but in a responsible way, that doesn't do damage to pedestrians and pet owner's pets through liquid melt or salt haphazardly in excessive amounts. Salt gets into the ball bearings of my wheelchair and after a while it starts to affect the performance of the wheelchair operation."

- *Poisoning the environment, poisoning ourselves: The bane of winter road salt*: "Road salt slowly percolates into soil and groundwater, making its way into ecosystems long after we've forgotten the last snowstorm…the use of deicing salts is triggering a massive increase in… salinity in cold regions worldwide … salt kills roadside vegetation, harming not just the plants but the animals that alight on them, such as butterflies and birds. [Additionally,] salt moves through the ground into drinking water and flows into nearby water bodies, threatening fish and other aquatic species. Winter after winter, chloride accumulates in a lake or pond, turning fresh water saltier over time" (Dybas, 2023).

- *Mainstreaming Bicycling in Winter Cities: The case of Oulu, Finland*: "The literature review, and research findings indicate that cycling can be mainstreamed when accounted for in policies, both hard and soft, infrastructure and culture" (Pratte, 2011).

- Keira Webster and Pamela Robinson: The climate mitigation piece is important and in future work link the need to adapt but also mitigate with more bike lanes, wider sidewalks, etc. that go with a shift in modes that is future-forward and proactive.

AFFIRMING
- *Transforming planning and policy making processes at the intersections of climate, equity, and decolonization challenges*: "Wisdom and insight is sourced from culture, history, people, and possibility and is deeply grounded in place-based and relational practice. Together they can inform the evolution of policy making and planning processes in ways that may result in more significant shifts than are possible when working within dominant systems that have oppression, inequity, and exploitation of humans and nature baked in." (Cole & Low, 2023).

- Adam Cahoon: It's important to push back against 311's procedure of telling callers to wait as snow hardens. The 311 experience can be very discouraging.

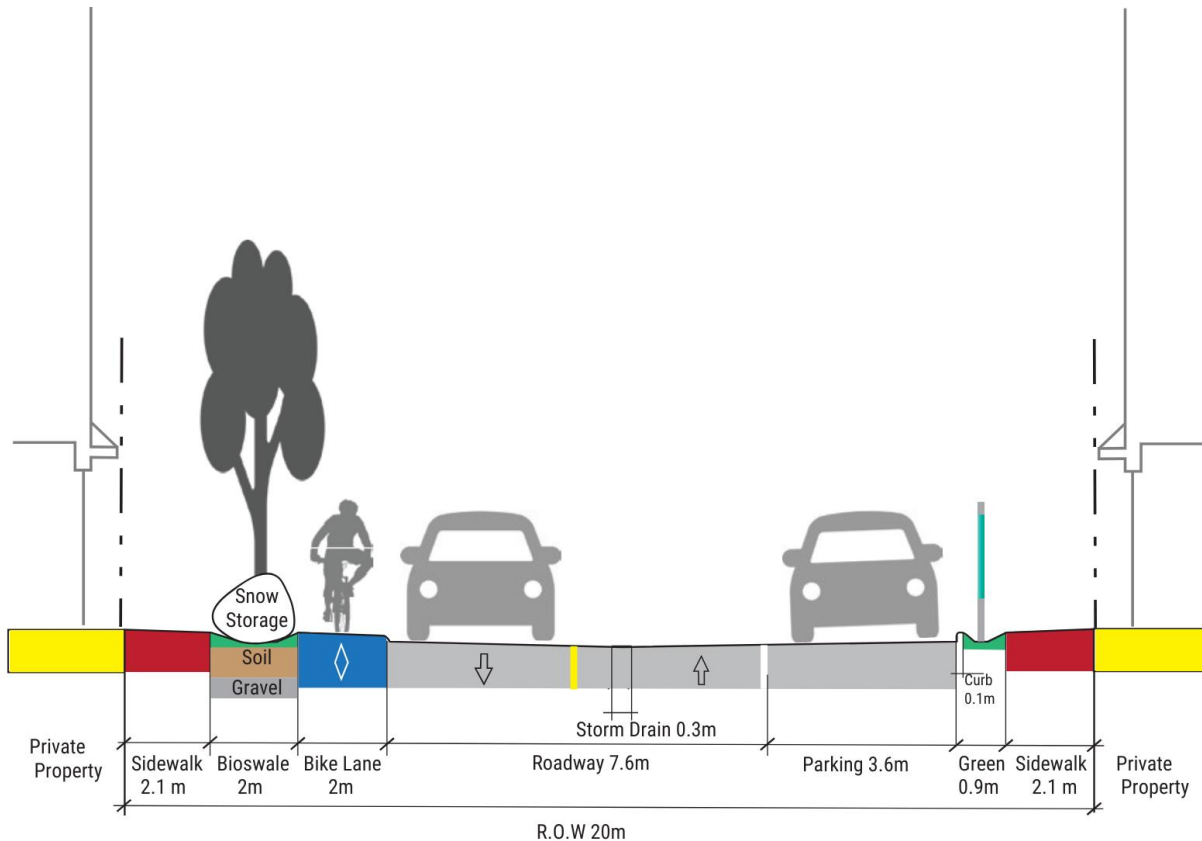# Appendix D: Speculative urban designs for winter streets

Parliament Street: Toronto conceptual application to a great street and priority retail Street

Winter friendly street elements include:
1. Green streets
2. Bioswale (natural salt and contaminant filtration)
3. Shelterbelt (natural windbreak)
4. Snow storage
5. Street sloping toward center
6. Storm drain
7. Porous sidewalk materials
8. Remove one lane of parking
9. Raised bike lane
10. Pedestrian lighting

(Caetano-Macdonell, 2023).

Private Property | Sidewalk 2.1 m | Bioswale 2m | Bike Lane 2m | Roadway 7.6m | Storm Drain 0.3m | Parking 3.6m | Green 0.9m | Sidewalk 2.1 m | Private Property

Snow Storage — Soil — Gravel — Curb 0.1m

R.O.W 20m

This cross section streetscape illustration shows how Parliament street could be divided up with a new winter friendly design. The roadway is reduced by one lane, simplifying parking to only one side of the street, with the addition of a new elevated bike lane on the other side. The road would be regraded to slope down towards the middle of the street with a storm drain relocated from the road edge to the center. Both sides of the roadway would have a green buffer between the parking lane or bike lane and sidewalk. The green buffer would have more dense trees, vegetation, and bioswales that could accommodate shovelled or plowed snow. The green buffer would have lighting poles that provide lighting specifically for pedestrians (Caetano-Macdonell, 2023).
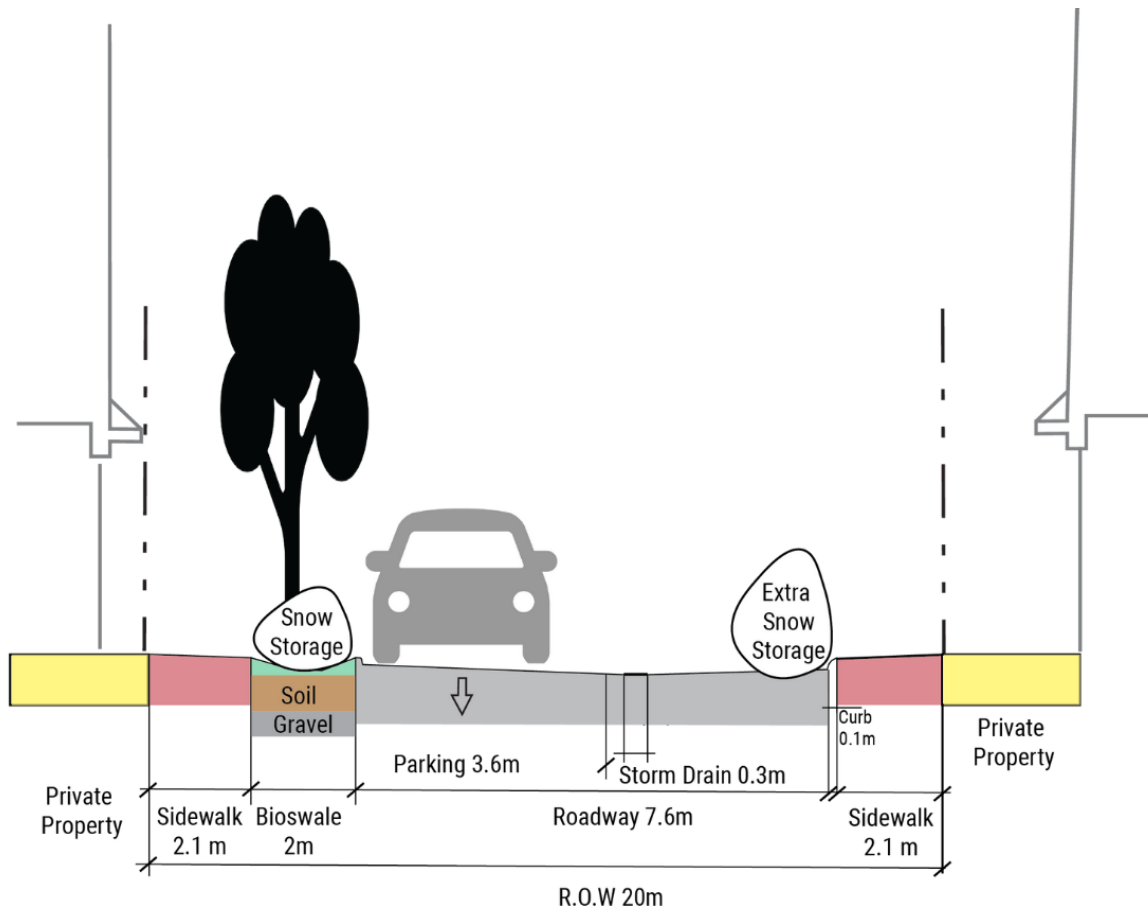
Ontario Street: Toronto conceptual application to a one-way residential street

Winter friendly street elements include:
1. Porous sidewalks
2. Bioswale with filtration
3. Snow storage
4. Shelterbelt and natural windbreak
5. Street sloping

(Caetano-Macdonell, 2023).

Figure labels: Snow Storage · Soil Gravel · Parking 3.6m · Storm Drain 0.3m · Extra Snow Storage · Curb 0.1m · Private Property · Private Property · Sidewalk 2.1 m · Bioswale 2m · Roadway 7.6m · Sidewalk 2.1 m · R.O.W 20m

This cross section streetscape illustration shows how a one-way residential street with sidewalks on both sides and a green buffer on one side could be designed with winter-friendly elements. The road would be regraded to slope down towards the middle of the street with a storm drain relocated from the road edge to the center. The green buffer would have more dense trees, vegetation, and bioswales that could accommodate shovelled or plowed snow.

Recommended Feature	Element Impact
Expand green streets	Updates to the green streets approach should include a winter lens to accurately account for Canadian conditions. This would include guidance on green infrastructure drainage, changes to the street tree planting plan, and changes to the snow storage allocation on the street. These changes improve pedestrian safety and comfort, encourage greater active transportation, and reduce the amount of salt needed for sidewalks. The reduction of salt usage is critical as, "salt toxicity affects songbirds… biologists [have] concluded that road salt as a mortality factor has long been underestimated" (Dybas, 2023).

Recommended Feature	Element Impact
Bioswales with nature-based solution filtration	Bioswales are vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream (National Association of City Transportation Officials, 2013; Meristem Design, 2023). Road salt and contaminants could more effectively be filtered out of rain and snowmelt if it was naturally filtered before it gets to the watersheds (Dybas, 2023). Bioswales are the most effective type of green infrastructure, as a vegetation street edge provides critical infiltration, evapotranspiration, water quality improvement, and temporary storage of water during storm events (McPhearson, Kabisch, & Frantzeskaki, 2023; National Association of City Transportation Officials, 2013). This addition to the streetscape could increase connectivity, ecosystem space, reduce grass/impermeable grounds, reduce floods, improve water retention, and expand pedestrian spaces.
Shelterbelt and nature-based solution windbreaks	Increasing the density of street trees along the street edge increases the provision of snow storage areas throughout the city, thereby reducing snow removal costs and increasing safety (Sherwood's Forest Tree Farm, n.d.; Urban Systems, 2000). The use of shelterbelts is understood, in a city setting, to stop heavy winds from changing snow patterns, to reduce the impact of wind on pedestrians, and to create a snow buffer for easier sidewalk removal (Agriculture and Agri-Food Canada, 2010). The selection of street trees should include a combination of plants, shrubs, and deciduous and evergreen trees for wind protection. Evergreen trees remain full and flush all year round, providing shelter from winter storms when planted in strategic locations (Agriculture and Agri-Food Canada, 2010). Additionally, it is important to select vegetation near roadways that can withstand exposure to sand, salt and ice melters with little maintenance throughout the year (City of Edmonton, 2016). To improve tree health, the City can select cold and salt-resistant species. Wherever practical, trees should be grouped together instead of planted in rows to improve vegetation health, biodiversity, and provide protections from wind (City of Edmonton, 2016).
Planned snow storage	Snow storage should be located in areas that maximize sunlight and snowmelt, by conducting sun/shadow studies and planning for filtration. Areas of streetscapes should be designed to include snow storage in areas that will not compromise pedestrian safety or occur in an unplanned way.
Street sloping towards center of the street	Sloping roads down towards the centerline alleviates problems with water pooling at the edge of roads and sidewalks. In addition, roads have a downward slope to funnel snow and melt toward a drain in the middle. This moves the possible drainage and slush away from the edge and sidewalks (Urban Systems. 2000; Caetano-Macdonell, 2023).

Recommended Feature	Element Impact
	We see similar recommendations in Edmonton's sidewalk and boulevard design which include clear, barrier free pedestrian-through spaces adequate for street space, cleaning, and snow clearing equipment (Fricson and Ranson, 2011). Water pooling can be further redirected to impact vehicles more than pedestrians if storm drains are relocated to the centre of roadways. However this recommendation would need to be implemented in combination with street sloping changes mentioned above.
Porous sidewalks	"Permeable pavement results in an annual median snow or ice cover three times less than that of regular pavement" (Dybas, 2023).
Remove 1 lane of parking	If one lane of parking is removed on the predominantly shaded side of the street, this can make room for a green boulevard design with a wider footprint and greater snow storage capacity.
Raised bike lanes	Raising bike lanes on roads reduces risk from piling snow on the street edge and water flooding the bike lane. Raised bike lanes may also increase visibility of cyclists to the vehicles. Winter maintenance strategy should include snow clearance plans that prioritize high traffic bike lanes, resulting in cyclists being able to trust the City and predict conditions reliably (Urban Sustainability Exchange, n.d.).
Increase the use of pedestrian lighting features	Including more lighting on the street directed at sidewalks and pedestrians, rather than the roadway, improves safety and visibility. This would demonstrate a prioritization of pedestrian safety and comfort, decreasing the gap created by street lighting only aimed at roadways. Examples of intentional design decisions that utilize lighting and activation of outdoor spaces for cultural events exist in Sweden and the Netherlands (Caetano-Macdonell, 2023; Dialog, 2021).

(Caetano-Macdonell, 2023)