Effective Application of Complete Streets Design Principles for Enhancing Pedestrian Safety

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ABSTRACT

The Complete Street is rapidly being accepted and implemented in municipalities throughout the world to create a more inclusive and safe environment for all road users. The inability of many existing corridors to safely transport vulnerable road users to and from significant generators, while ensuring a road is also seen as a destination in and of itself, is an ongoing challenge municipalities face. Promoting the economic vibrancy of a corridor and the adjacent land uses through implementation of a safe, pedestrian-friendly, and aesthetically inviting corridor is quickly becoming a priority for many municipalities as antiquated design practices are superseded with new guidelines.

This paper explores a real-world example of applied design principles employed to enhance road safety within an urban setting through exploration of a case study. The case study project area will be reviewed to identify why the specific corridor and surrounding area was identified for conversion to a Complete Street/Grand Boulevard. Complete Street design recommendations and best practices will be reviewed prior to exploring which key components were applied to the specific case study. An emphasis will be placed on the case study's connectivity of a major transit hub to a significant shopping centre facility as well as the specific corridor enhancements applied to prioritize safe and efficient movement of vulnerable road users. A review of the custom roadway geometrics utilized to strike a balance between road safety, traffic operations, pedestrian accessibility, active modes, and transit will be explored.

Applicable design standards and guidelines referenced during the design of the case study project will be reviewed and Complete Street design principles that were modified or compromised during design and construction will be discussed. The paper will examine the challenges of implementing Complete Streets design principles which often employ customized geometrics and do not necessarily correlate with historically approved best practices and design guidelines. From concept development to construction, the review and approval process will be explored to highlight some of the design compromises that were made to reach a balanced end product.

The strategy for effective design and implementation of an urban corridor retrofit project will be presented with a breakdown of fundamental and applicable Complete Street best practices to create a safe and inviting experience for all road users.

INTRODUCTION

Complete Streets aim to "increase the attractiveness, convenience and safety of all modes of transportation by creating a new selection of multi-modal streets that emphasize different modes of transportation, incorporate elements of green infrastructure and function in the context of surrounding land uses" (The City of Calgary, 2012, p. 3-27).

As municipalities and local governments move toward adopting Complete Streets design principles through new policy initiatives, many of the existing roadway design guidelines and standards used for the past several decades are quickly becoming antiquated. Alternative modes of transportation are being increasingly promoted and city planners are comprehensively considering the integration between Complete Streets and adjacent land use. This has resulted in a marked increase in new roadway infrastructure projects requiring adherence to Complete Streets design policy and a surge in urban roadway retrofit projects in which existing corridors are being upgraded and enhanced to meet current Complete Streets design requirements.

While many cities have been quick to implement Complete Streets design fundamentals on a policy level, interdepartmental acceptance and understanding of these new design principles poses a significant risk when approving, designing, and constructing a Complete Street corridor. Outdated and superseded design guidelines and best practices may be referenced out of context and newly minted design principles overshadowed by competing interests. One department may consider safe and efficient pedestrian movement to be a leading priority of an urban retrofit project whereas another department may prioritize traffic operations. With many road right-of-ways often fixed in width, a fine balancing act is required to educate, inform, and direct municipalities to a "best fit" solution when considering a corridor enhancement project employing Complete Streets design convention.

As part of The City of Calgary's (The City) strategic and economic redevelopment plans, The City is " trying to catalyze private sector investment via public realm improvements along the 61st Avenue SW corridor" (The City of Calgary, 2015a, p. 6). Through completion of the *61 Avenue SW Greenway Corridor Preliminary Design Report*, several visionary plans and concept designs were presented to The City for consideration to facilitate approving the project for detailed design and construction. Converting 61st Avenue SW into a landmark Urban Boulevard is the first in many transformations for the area surrounding Chinook Centre and the Chinook Light Rail Transit (LRT) station in Calgary. The urban boulevard idea for this corridor took root in the 2008 *Chinook Station Area Plan*, which identified strategic and key infrastructure upgrades to the surrounding area. Specifically, the area adjacent to the Chinook LRT station including 61st Avenue was identified as "an exceptional candidate for Transit Oriented Development (TOD) since it is well located in relation to the desirable South Calgary market, it is part of the South Light Rail Transit (LRT) Corridor, encompasses a major regional retail shopping centre, and has a block and building pattern that can accommodate higher-density redevelopment" (The City of Calgary, 2008, p. 11). Four key strategies were considered as part of the corridor enhancements along 61st Avenue to improve the public realm. The corridor needs to be safe & secure, accessible, enjoyable, and adaptable (The City of Calgary, 2015a).

RELATED WORK VIA A CASE STUDY

On any given day more than 15,000 residents and visitors board at the Chinook LRT station, many of whom move as pedestrians between the Chinook LRT Station and Chinook Centre (The City of Calgary, 2008) along the 61st Avenue SW corridor in Calgary. With such significant pedestrian volumes utilizing the 61st Avenue corridor, The City was interested in developing a different vision for this space – one that entertains and engages the passing pedestrians, activates adjacent spaces, and drives economic development (The City of Calgary, 2015a).

As part of The City's *Municipal Development Plan*, the Chinook Station area was defined as a Major Activity Centre and identified as having a high potential for redevelopment through the *Investing in Mobility 2013-2024 Transportation Infrastructure Investment Plan* (The City of Calgary, 2008). Furthermore, the 61st Avenue SW corridor, being one of the busiest pedestrian corridors outside of the downtown core, was identified as requiring significant infrastructure enhancements to support both current and future anticipated development along the corridor. These enhancements include:

- A greenway corridor along 61st Avenue SW from MacLeod Trail to Centre Street (project limits revised to between MacLeod Trail and the LRT/CPR tracks during the detailed design phase),
- A pedestrian friendly transit plaza at the Chinook LRT station,
- Various pedestrian and cycling connectivity improvements to 61st Avenue SW, and
- A pedestrian overpass at 61st Avenue SW and MacLeod Trail (identified as a separate project but requiring in-depth coordination with the corridor project).

Detailed design of the 61st Avenue corridor was completed in early 2016 and construction began in spring 2016. The corridor upgrades are planned to be complete by end of summer 2017 with the majority of construction complete at the time of writing this paper. See **Figure 1** for a location plan identifying the project limits.

APPLICABLE DESIGN GUIDELINES

With respect to the 61st Avenue project case study, several municipal design guidelines were referenced including the following:

- The City of Calgary *Roads Construction 2015 Standard Specifications*
- The City of Calgary *Design Guideline for Subdivision Servicing 2014*
- The City of Calgary *2014 Complete Streets Guide*

In addition, the Transportation Association of Canada's *Geometric Design Guide for Canadian Roads* was referenced where applicable to complement the aforementioned municipal guidelines and specifications.

The City of Calgary approved the *Calgary Transportation Plan* (CTP) in 2009, which included "22 guiding policies for Complete Streets" (The City of Calgary, 2014, p. 2). Recognizing that "several of the new design elements did not align with the current Design Guidelines for Subdivision Servicing" (The City of Calgary, 2014, p. 1), The City committed to developing a comprehensive Complete Streets guide that would complement other City design guidelines and, in some cases, identify the direction for future urban road design.

The City's *Design Guideline for Subdivision Servicing* as well as the *Roads Construction 2015 Standard Specifications* were both revised in 2014 and 2015, respectively. The latest iteration of The City's *Design*

Guideline for Subdivision Servicing includes reference to The City's *2014 Complete Streets Guide* and provides additional design specifics within Section II: Roads which identifies the various design elements and cross sectional details associated with The City's various road classifications. While both of these documents provide an integrated approach to road design within The City, the *Roads Construction 2015 Standard Specifications* remains somewhat of a standalone document providing standard contractual specifications and requirements for roads projects as well as typical details and drawings for standard road construction items.

While The City has provided design practitioners with best practices through published design guidelines, Complete Street design has proven to be a very "made to order" approach and it is often difficult to apply standard design principles to such customized designs.

REVIEW OF COMPLETE STREETS DESIGN PRINCIPLES AND BEST PRACTICES

Reclassified as an Urban Boulevard, 61st Avenue required modifications to prioritize walking, cycling, and transit while still ensuring the corridor can carry high volumes of vehicular traffic. With Urban Boulevards representing both local and regional destinations, the complete integration with adjacent land uses, and providing connectivity to surrounding communities, this classification of street generally requires a delicate balancing act to take place in order to achieve a well-rounded design. A noticeable level of vehicular congestion is generally considered acceptable for an Urban Boulevard and green infrastructure mated with high-quality urban design represents the backbone of this classification of street (The City of Calgary, 2014).

The City of Calgary *2014 Complete Streets Guide* provided the basis for the selection and application of Complete Streets design best practices for the 61st Avenue corridor. The following represent the criteria applied to the 61st Avenue corridor to retrofit the roadway to an Urban Boulevard standard.

Lower Design Speed – Although neither the design or posted speed of the roadway were reduced, the existing 3.7m wide inside and 4.3m wide outside lanes were narrowed to 3.3m. Additionally, the existing parallel turn lanes and add lanes along the corridor were deleted with the desired outcome of lowering travel speeds through environmental design. Dedicated right turn lanes and channelized right turns were converted to shared through/right lanes with conventional curb return radii. Existing left turn lane storage was also reduced throughout the corridor. While these modifications will result in increased congestion, a significant benefit will be the resultant slower travel speeds bolstering driver awareness through providing additional available peripheral field of vision.

Review of Heavy Truck Traffic Routing through the Corridor – A comprehensive review of the existing and proposed heavy truck traffic routes was completed to verify delivery routes for some of the big box retail stores adjacent to the corridor. It was critical that through retrofitting the corridor to an Urban Boulevard a reasonable design vehicle was identified and referenced to ensure over designing the roadway was avoided. By verifying heavy truck routes adjacent to and through the project limits, several intersection curb return radii were reduced to further prioritize pedestrian safety by reducing intersection crossing distances.

Enhanced Roadway Medians – The existing concrete medians were widened to reduce the travel lane widths and provide for additional green infrastructure to be installed. In addition to narrowing the travel lanes, raised medians with low-maintenance landscaping contribute to the Urban Boulevard context by visually narrowing the road (The City of Calgary, 2014). The City of Calgary's *2014 Complete Street Guide* recognizes the benefit of medians in providing a pedestrian refuge space during crossing movements from an accessibility and waiting requirement standpoint.

Travelled Way Lighting and Improved Pedestrian Realm Illumination – Customized light standards were specified for the 61st Avenue project to both improve the existing corridor illumination levels and enhance the aesthetic environment. The specified light standards provide a roadside and pedestrian side luminaire installed at higher and lower elevations, respectively, to provide adequate lighting levels. The pedestrian-scale lighting adjacent to the sidewalk will provide an additional level of security through sound environmental design, especially for people walking and cycling at night (The City of Calgary, 2014).

Improved Design for Accessibility – The enhancements to the pedestrian realm need to consider roadway corridor users with reduced mobility and disabilities. All street furniture, street light standards, tree grates, sign posts, utility infrastructure, and any other potential obstructions are to be placed within the furniture zone of the pedestrian realm (The City of Calgary, 2014). Refer to **Figure 2** for a visual representation of the various public realm zones. Two wheelchair ramps providing tactile queues should be provided at each intersection corner and be aligned perpendicular to the intended path of travel (The City of Calgary, 2016).

Enhanced Public Realm Design through Improved Streetscaping – The existing sections of narrow concrete monolithic sidewalk and separate sidewalk throughout the corridor are not sufficient in carrying the significant daily pedestrian volumes between the Chinook LRT station and MacLeod Trail and Chinook Centre. The existing landscaped boulevard was showing signs of erosion and degradation due to the limited carrying capacity of the existing narrow concrete sidewalk (**Image 1** and **Image 2**). The boulevards were upgraded to include custom street furniture (bike racks, waste receptacles, and benches), trees with custom tree grates, and aesthetically significant street light standards within a hardscaped boulevard incorporating custom concrete and paving stones. The narrow sidewalks were replaced with extra wide shared multi-use pathways capable of handling pedestrian and cyclist traffic. The multi-use pathway was constructed with custom coloured, patterned, and textured concrete providing additional aesthetic value along the corridor (**Image 3**).

Green Infrastructure and Low Impact Development – The *Calgary Transportation Plan* stipulates, "all new and retrofit road and street designs should incorporate green infrastructure strategies to contribute to the environmental health and visual aesthetics of the urban fabric" (The City of Calgary, 2012, p. 3-37). The 61st Avenue project incorporates two sections of sub surface soil cells that aim to maximize on-site infiltration and moisture retention to provide a water source for the boulevard trees through biological uptake. Due to the overall increase in hardscaping throughout the project limits, the soil cells provide a reduction in effective impervious area reducing and attenuating offsite flow volumes while also providing quality improvements through fine filtration, extended detention, and infiltration (The City of Calgary, 2014).

Pedestrian Overpass – While not funded as part of the 61st Avenue Greenway Corridor project, a new pedestrian overpass is currently under construction linking the 61st Avenue corridor to the primary pedestrian generator within the project limits, Chinook Centre. The Chinook Pedestrian Overpass, planned for completion in 2018, replaces an existing at grade crossing at 61st Avenue and MacLeod Trail where pedestrians must currently cross nine lanes of traffic. Due to the high volumes of daily pedestrian traffic utilizing this crossing, the intersection of 61st Avenue and MacLeod Trail currently experiences operational challenges, which will be improved upon the deletion of the at-grade crossing. This facility will connect directly to the improved pedestrian realm along the south side of 61st Avenue at MacLeod Trail.

CONCEPT DEVELOPMENT AND DESIGN

One of the measures of success in developing a preferred concept was to ensure the design articulated a bold vision for redevelopment and intensification that capitalized on the significance of Chinook Centre as an employment and service centre and amenity area. The concept emphasized the importance of creating a strong pedestrian-oriented Urban Boulevard connecting the Chinook LRT station to Chinook Centre along 61st Avenue. The Urban Boulevard concept included new street trees, landscaped centre median, custom street furniture and lighting, and widened sidewalks connecting a public plaza at Chinook LRT Station with a new pedestrian bridge over MacLeod Trail, linking directly to the second storey of Chinook Centre.

This grand boulevard concept (**Figure 3** and **Figure 4**) was accepted by The City not only to create a more vibrant and inviting pedestrian experience but to encourage new investment along the corridor. Through new investment, The City aims to achieve a new street-oriented retail district with active building frontages creating a continuous, pedestrian-friendly streetscape that will strengthen the relationship between the LRT system and Chinook Centre.

Working closely with The City of Calgary and collaborating on a regular basis ensured a balanced approach was applied to the design and implementation of the 61st Avenue corridor. While the original mandate for this project was to place a heavy emphasis on pedestrian and active modes enhancements, The City underscored the importance of maintaining an acceptable level of service for motorists. Through valuable input from The City of Calgary Roads and Transportation Infrastructure groups, custom roadway geometrics were incorporated into the design to strike a balance between road safety, traffic operations, pedestrian accessibility, active modes, and transit. The following describes several of the enhancements applied to the 61st Avenue corridor project to achieve a safer and more pedestrian friendly environment:

- Reduced travel lane widths to 3.3m in both the east and west directions to encourage slower travel speeds and allow for a wider pedestrian space.
- Maximized the pedestrian realm width from the existing 1.5m separate walk (**Image 1** and **Image 2**) to a customized 4.6m width and enhanced the streetscape typology to include a custom coloured and patterned concrete surface to create a unique and memorable pedestrian experience (**Image 3**).
- Deleted the existing add-lanes and dedicated right-turn lanes, including associated channelized right turn ramps, along the corridor to encourage traffic calming and increase pedestrian safety through decreasing pedestrian crossing distances.
- Maintained short sections of left turn lanes throughout the corridor to eliminate negative offsets for opposing left turning vehicles and maintain acceptable traffic operations.
- Enhanced the existing boulevard to a hardscaped standard consisting of custom street furniture, custom paving stones, tree trenches, bike racks, and custom street lighting with double luminaires for both road side and pedestrian side lighting to bolster safety and the aesthetics of the corridor.
- Incorporated customized multi-use crossings with extra-wide wheelchair ramps throughout the corridor to accommodate both pedestrian and off-street cyclist traffic. Each corner at every intersection within the project limits contains offset wheelchair ramps situated perpendicular to the intended direction of travel.
- Widened and upgraded the existing concrete medians with a blend of custom patterned and coloured concrete and landscaped treatments. The existing medians did not include any softscaping and the introduction of low maintenace landscaping into the median provides an opportunity to beautify the corridor while also offsetting the additional designed impervious hardscape area from a stormwater perspective.

- In addition to the above point, a custom subterranean, low impact, modular suspended pavement system utilizing bioengineered soil to support enhanced tree growth and manage onsite stormwater through absorption, evapotranspiration, and interception was incorporated into the corridor design. With this underground system installed along the north side of the corridor for two city blocks, the pre-existing stormwater condition was improved from both a flow attenuation and quality perspective. The success of this system will be closely observed and may trigger the installation of similar systems throughout The City as the low impact/low maintenance design is intended to save costs and encourage larger, healthier tree canopies contributing to an aesthetically enhanced environment.
- Consolidated two bus stops into one to improve traffic operations for general traffic and better accommodate transit users based on existing usage trends.
- LRT transit plaza enhancements were brought into the design intending to provide short term improvements that would take place prior to more comprehensive redevelopment of the station and adjacent sites. The design focused on maintaining the existing bus loop and improving the access and experience for pedestrians with additional patterned hardscape, new trees, ornamental plantings, integrated public art, and custom street furniture. The enhancements were largely designed as an extension of the 61st Avenue corridor streetscape typology to link the Chinook LRT plaza to the corridor.

The City of Calgary is currently in the process of constructing the new Chinook Centre pedestrian overpass crossing MacLeod Trail at 61st Avenue. The City and Chinook Centre view this overpass as an extension of the 61st Avenue corridor, which will seamlessly direct the heavy pedestrian volumes safely over MacLeod Trail providing direct access to Chinook Centre. By removing the existing at-grade pedestrian crossing at MacLeod Trail and replacing it with a grade separated pedestrian overpass, there will be a marked improvement in both pedestrian safety and traffic operations at this intersection.

CUSTOMIZED DESIGN AND TRADEOFFS

During the detailed design phase of the project, the design evolved from what was presented in the *61 Avenue SW Greenway Corridor Preliminary Design Report* due in part to conflicting priorities within various business units of the approving authority. The City of Calgary's 2014 *Complete Streets Guide* was heavily referenced during preliminary design to ensure adherence to the Urban Boulevard roadway classification with an emphasis placed on pedestrian and active modes road users. However, it became clear during detailed design that the pendulum had perhaps swung too far in one direction as comments and questions regarding compromised traffic operations were being generated during the design review process.

A key-defining feature of an Urban Boulevard is that "a level of congestion appropriate for a dense urban area is acceptable for this street type" (City of Calgary, 2014, p. 8). This becomes difficult to quantify when referencing Complete Streets policy within The City of Calgary as this comment leaves significant room for interpretation of what defines an acceptable level of congestion.

The concept prepared as part of the 61st Avenue preliminary design included the removal of most of the dedicated left turn lanes throughout the corridor to allow for a wider, landscaped median to increase the available area for green infrastructure and bolster the aesthetic value of the corridor. Recognizing that shared left/through travel lanes will increase intersection delay and general levels of congestion along the corridor, the benefit of providing an enhanced aesthetic environment with unique landscaped treatments within the medians was to take precedence in keeping with The City's definition of an Urban Boulevard.

During detailed design reviews of the project, it became apparent that the priorities of one City business unit were not necessarily in alignment with the original guiding principles of the project to create a Complete Street through construction of an Urban Boulevard. The conventional roadway design requirement to prioritize and maximize traffic operations remained an important outcome for some while others wanted to compromise traffic operations and further enhance pedestrian safety and aesthetic value with the intent of boosting economic vibrancy throughout the corridor.

Through collaboration with multiple approving authority business units, a balanced approach to the design was ultimately reached. Left turn pockets (short sections of turn lanes just long enough for one or two vehicles) were incorporated into the design to allow for some improved capacity, reduce the negative offset between opposing left turning vehicles, and maintain longer sections of full width median to accommodate green infrastructure.

From a maintenance and operations perspective Complete Streets may not yet have a sufficient level of support with respect to defining policy and funding mechanisms. Specifically, The City of Calgary's Roads Maintenance Division manages annual budgets for all of The City's streets resurfacing and reconstruction, street sweeping, bridge rehabilitation, and snow and ice control (The City of Calgary, 2014). With often-limited operating budgets and resources, The City's Roads Maintenance Division may be hesitant to support new and retrofit Complete Streets infrastructure that may require an additional layer of maintenance and up-keep.

Furthermore, conflicting and contradictory legislation and policy often muddy the waters when it comes to proposing Complete Streets infrastructure. For example, if a Complete Street incorporates pedestrian refuge space within the roadway median, what defines a completed pedestrian crossing movement? Generally speaking, a pedestrian has begun a crossing movement upon stepping off of a curb and into the roadway space and has completed the movement upon reaching the opposing curb. If the refuge space within the median includes wheelchair ramps or concrete curb letdowns, the argument can be made that a pedestrian has completed a crossing movement upon reaching the median, as opposed to reaching the opposite side of the roadway. A technical complication arises if the pedestrian proceeds to "complete" the rest of the crossing movement to reach the other side of the street if the "don't walk" indicator begins flashing upon reaching the median or the half-way point of the crossing movement. If a pedestrian then executes the remainder of the crossing movement, are they contravening applicable laws and regulations? In such a case it would be unreasonable to expect a pedestrian to wait in the median until the following signal cycle begins and the "walk" indicator becomes illuminated. Likewise, it may be unrealistic to extend crossing times such that the average pedestrian reaches the median while the "walk" indicator is still illuminated as this extra time could have negative impacts on traffic operations at the intersection.

This concern was raised during the detailed design phase of the 61st Avenue Greenway Corridor project with two proposed solutions presented. The first solution was to provide pedestrian refuge space in the median without the use of wheelchair ramps or curb letdowns at the median. Rather, the median was to be entirely "cut through" and the asphalt surface paved through the median such that a pedestrian crossing the roadway would not encounter a physical curb structure until reaching the other side of the road. The other potential solution was to delete the pedestrian refuge spaces within the medians altogether. The latter solution was selected primarily due to potential maintenance issues with snow, gravel, and roadway debris collecting within the median refuge space without a curb letdown or wheelchair ramp directing material away from the area.

Another example of conflicting interests between the municipal planners and designers and The City's Roads Maintenance Division was with respect to the integration of low profile curb extensions throughout the 61st Avenue project limits. According to The City of Calgary's *2014 Complete Streets Guide,* curb extensions "significantly improve pedestrian crossing distances, visually and physically narrowing the roadway, improving the ability of pedestrians and motorists to see each other" (The City of Calgary, 2014, p. 29).

The governing design vehicle along the corridor was either an articulated bus or a heavy single unit truck, which defined the curb line geometry for most of the intersection curb return radii along the corridor. Exploring the applicability of curb extensions, there was an opportunity to include a second set of low profile curbs further into the roadway with which the more frequent, passenger car design vehicle would govern the geometry. The rationale of providing a pair of curbs at each intersection was to promote a safer pedestrian environment by encouraging passenger vehicles to follow a tighter turning radius. When the less frequent bus or heavy truck needed to navigate the intersection, the larger vehicle could mount the inner, low profile curb to accommodate the larger swept path. See **Image 4** for an example of such infrastructure.

Similar to the maintenance concerns raised during the design process regarding the median refuge spaces, there was significant hesitation with respect to implementing a curb extension with a mountable inner curb structure. The concern was that road debris, gravel, snow, and potential ice build-up would be difficult to remove with the existing fleet of City maintenance vehicles and equipment. Specifically, large snow plows would have a difficult time navigating these mountable curbs and may not achieve an acceptable level of contact between plow blade and road surface in these areas. While smaller maintenance equipment could likely clear these areas effectively, a limit on resources and available budget to maintain these curb letdowns with alternative equipment was presented as a significant constraint to the approval and implementation of this infrastructure.

Political pressure and public perception also played a contributing role in further modifying the design concept. The result was the removal of raised, one-way cycle tracks in preference for a wider pedestrian realm to accommodate shared uses via a multi-use pathway. At a policy level, The City of Calgary indicates "the importance of cycling as an efficient, non-motorized choice of transportation" (The City of Calgary, 2014, p. 33) and supports ensuring that "bicycle facilities are included in the design and operations of City facilities" (The City of Calgary, 2014, p. 33). Furthermore, The City of Calgary has committed to improving existing cycle routes and facilities throughout The City by constructing missing links within the overall network (The City of Calgary, 2014).

The City of Calgary's standard Urban Boulevard cross section includes the provision for bicycle lanes and the concept prepared as part of the *61 Avenue SW Greenway Corridor Preliminary Design Report* ensured adherence to this standard. Further enhancing the proposed cycle infrastructure, it was recommended during the concept design stage that cycle tracks be raised to sidewalk level with a flush level depressed curb separating the dedicated pedestrian space from cyclists. The cycle tracks would transition from sidewalk level to road level at each intersection through the use of ramps and narrow sections of concrete median to physically separate cyclists from vehicular traffic.

The decision to remove these cycle tracks, identified in the preliminary design concept, was ultimately made after careful consideration of the existing surrounding cycle network as well as planned future upgrades and additions to the network. Within the vicinity of the 61st Avenue project limits, the only existing bicycle facility is an on-street facility located west of Chinook Centre. Several planned or proposed facilities have been explored within the area but are not expected to be constructed in the near term. As important as The City's mandate to construct "missing links within the overall network", is the inverse responsibility of not constructing bike lanes to "nowhere". The design and implementation of a Complete Street is a fine balancing act and The City recognized the need to consider the public perception angle of this project. Rather than constructing a short, isolated section of cycle track as part of the 61st Avenue project, it was decided that cycle infrastructure within the project area be deferred until such time that a comprehensive and connected network was identified and approved for design and construction. Refer to **Figure 3** and **Figure 4** for a representation of the 61st Avenue concept presented within the *61 Avenue SW Greenway Corridor Preliminary Design Report*. Refer to **Figure 5** for a cross sectional view of the 61st Avenue corridor approved for construction after the aforementioned modifications and trade offs were incorporated into the design.

The following table summarizes some of the core Complete Streets design principles and best practices which were customized after development of the preliminary concept design.

Complete Streets Design Item	Modified Design	Rationale for Modifying Design Concept
Pedestrian refuge areas	Removal of median pedestrian refuge spaces	Interpretation of existing legislation and policy paired with road maintenance concerns
Curb extensions	Removal of curb extensions at intersections	Maintenance concerns and limited available capital operating budgets
Cycle tracks	Deletion of dedicated cycle track infrastructure	Lack of existing and planned surrounding dedicated cycle network and the perception of building a short segment of cycle track to "nowhere"
Lane consolidation	Reintegration of short left turn pockets	Balancing traffic operations and safety by reducing the negative offset between opposing left turning vehicles while ensuring majority of full width median is maintained for landscaping/stormwater management/aesthetic value of corridor
Widened and enhanced pedestrian realm	Further increased pedestrian realm width	The removal of the dedicated cycle track provided extra width to implement a wider, shared, multi-use pathway with multi-use crossings at intersection locations

CONCLUSION AND STRATEGY FOR EFFECTIVE DESIGN AND IMPLEMENTATION OF A COMPLETE STREET

New and retrofit urban roadway projects continue to be driven by ever changing policy initiatives to provide a complete experience for all road users. Many municipalities and local governments have begun adopting new roadway design guidelines providing direction for the design and implementation of Complete Streets. Practitioners must be aware of the challenges associated with approving and implementing what remains to be a relatively new and innovative approach to road design. Many of the best practices and standards associated with historical roadway design no longer apply in the urban Complete Streets context. While traffic operations and vehicular level of service remain considerations, many reclassified roadways now include policy initiatives to include dedicated infrastructure to promote alternative modes of transportation, often shifting the priority from vehicle to pedestrian or cyclist.

Prior to converting an existing municipal roadway to a Complete Street, standard practice requires a detailed review of the challenges and opportunities associated with roadway geometrics, traffic analysis, transit services and connectivity, safety, and existing and future adjacent land uses. Through the development of a concept design and preliminary design report, the overall form and function of a proposed Complete Street can be reviewed and approved for design and construction with a sound understanding of feasibility and constructability. A critical outcome of preparing a concept design and conducting a preliminary engineering assessment is the development of a list of guiding principles and project priorities, which can be used to direct and facilitate the design review process.

In the context of the 61st Avenue Greenway Corridor case study, a list of project priorities were identified during preliminary design, however, the lack of municipal support and understanding across all business units resulted in the ultimate dismissal of several fundamental Complete Streets project initiatives. New policy conflicted with

historical design best practices and innovative design competed with municipal budgetary and resource limitations. The case study identified that the implementation of new Complete Streets policy is often only possible when a comprehensive review of municipal expenditures and resources along with the needs of each business unit have been explored collaboratively. In the absence of such collaboration, conflicting priorities surfaced during the detailed design review process resulting in a significant design evolution from the originally identified concept design. While it is typical for designs to morph and evolve, it is important to reference the original guiding principles of a project to ensure the end product aligns with public policy and expectations.

During the concept development and preliminary engineering phases of an urban retrofit project, all municipal business units ultimately responsible for the review and approval of the design should be included in early discussions regarding the specific project priorities. Referencing the latest design guidelines and policy initiatives, a set of guiding principles and project priorities should be prepared to identify the preferred outcome of a Complete Street project.

Municipalities need to consider the impacts of introducing new Complete Streets policy and the often-limited budgets and resources available to maintain and operate new roadway infrastructure. If a project priority of enhancing pedestrian safety and connectivity through an urban corridor has been identified, an accompanying list identifying trade offs and design compromises is equally important to ensure reasonable project expectations are established. Determining project priorities and trade-offs allows municipalities to identify how best to reallocate maintenance budgets and resources. If limited operating budgets and available resources are eroding away at the opportunity to design and implement fundamental Complete Streets infrastructure, there may be opportunities to review municipal budgets on a larger scale. For example, the shift from prioritizing automobiles on an inner city Urban Boulevard and focusing on active modes of transportation may allow for operating budgets to be increased by lowering the construction cost of a roadway project. Often is the case that cycle and pedestrian infrastructure costs are lower to construct than conventional roadway infrastructure. By encouraging an acceptable level of roadway congestion, the removal of dedicated left and right turn lanes complete with signage, signals, and all associated surface work will reduce construction budgets drastically. Funds saved by reducing corridor construction costs directly associated with vehicular traffic may be reallocated to the operation and maintenance budgets available for debris and snow clearing of new Complete Streets infrastructure promoting pedestrian safety. In the specific case of 61st Avenue, the median pedestrian refuge spaces and low profile curb extensions may have been more readily accepted if the City's Roads Maintenance Division had a larger operating budget to maintain these areas with specialized equipment and dedicated resources.

As is the case with major roads projects, it is critical to examine the existing network along with planned upgrades on a macro level to ensure the project aids in optimizing the overall network through successful and complete integration. The same applies to isolated urban retrofit Complete Streets projects that include proposed bikeway infrastructure. In the case of 61st Avenue, policy and design guidelines identified that dedicated cycle infrastructure was indicated with an Urban Boulevard roadway classification. However, the lack of existing and near term planned bikeway network infrastructure within the surrounding vicinity of the project resulted in the decision to remove proposed sidewalk level cycle tracks late in the design process. The idea of building a short segment of cycle tracks to "nowhere" and the public perception associated with implementing a bikeway without adequate connectivity precipitated the ultimate decision to remove this planned infrastructure from the project. The City decided to defer new dedicated cycle infrastructure within the project limits until such time that a comprehensive cycle network strategy and planned upgrades within the surrounding vicinity are identified.

An early understanding of overall connectivity for all modes of transportation beyond the specific project limits is critical when considering what Complete Streets design items are to be included in the scope of a project. The identified policy initiatives with one project may not necessarily correlate with the "bigger picture" of planned

municipal upgrades and strategic priorities on a larger scale. When preparing a concept design for a Complete Street project, cycle infrastructure should be considered on the macro level to ensure consistency with municipal strategy and to identify appropriate staging and planned improvements.

Within the toolbox of Complete Streets best practices and design strategy, is a vast array of implementable infrastructure items, which contribute to a safer, more vibrant space for all road users. A critical step in the project process is to determine which Complete Streets best practices will contribute to a successful end product through early engagement. The balance between pedestrian safety, traffic operations, roads maintenance, public expectation, corridor redevelopment potential, and aesthetic value must be carefully analyzed and collaboratively discussed to ensure a successful and predictable project outcome. Through team collaboration and early engagement, a set of guiding principles can be founded with which a project mandate is created to ensure the effective application of Complete Streets design principles.

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FIGURES AND IMAGES

Figure 1 – Location Plan

Figure Courtesy of The City of Calgary *61 Avenue SW Greenway Corridor Preliminary Design Report*

Figure 2 – Public Realm Zones

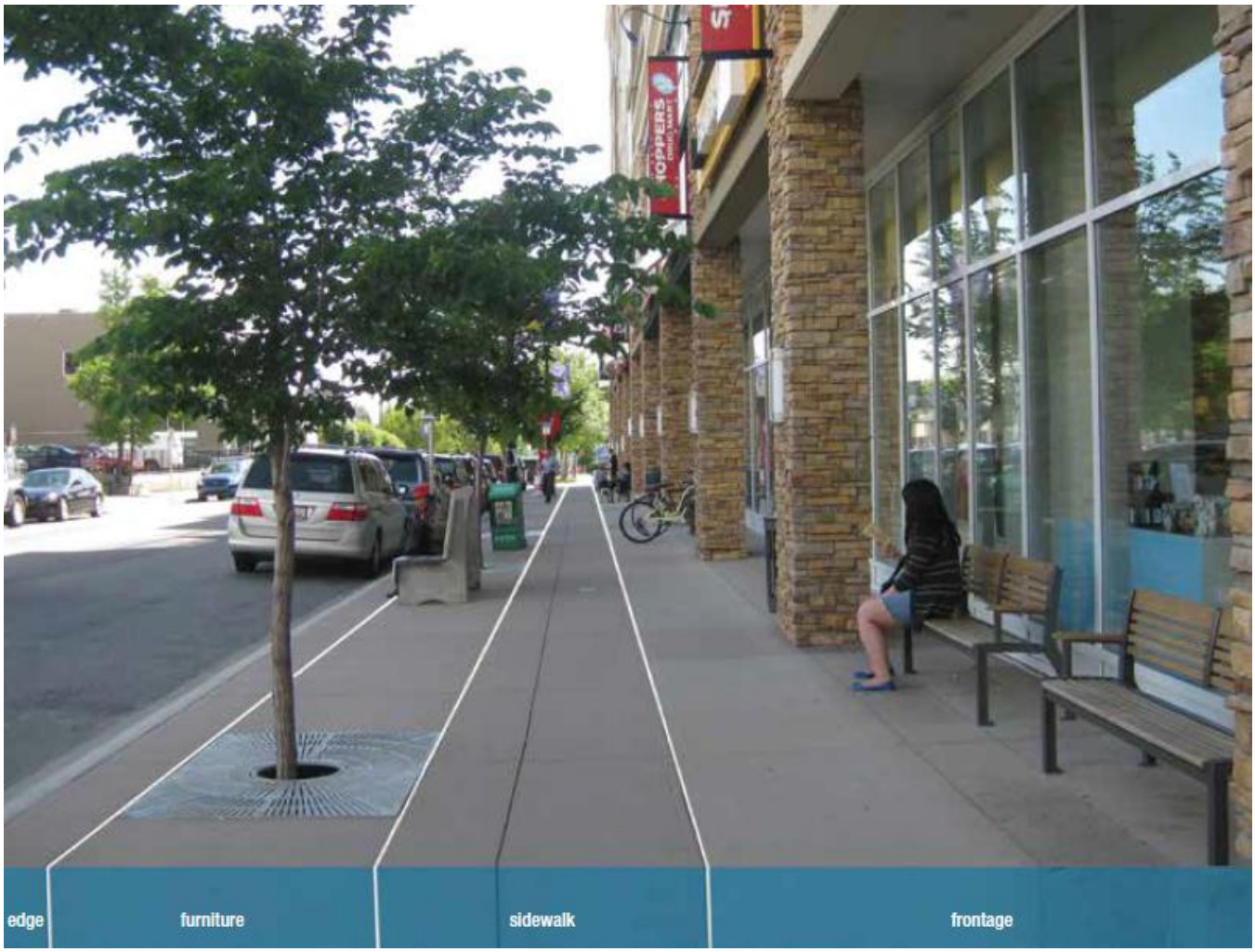


Figure Courtesy of The City of Calgary *2014 Complete Streets Guide*

Figure 3 – Preliminary Vision for 61st Avenue Greenway Corridor

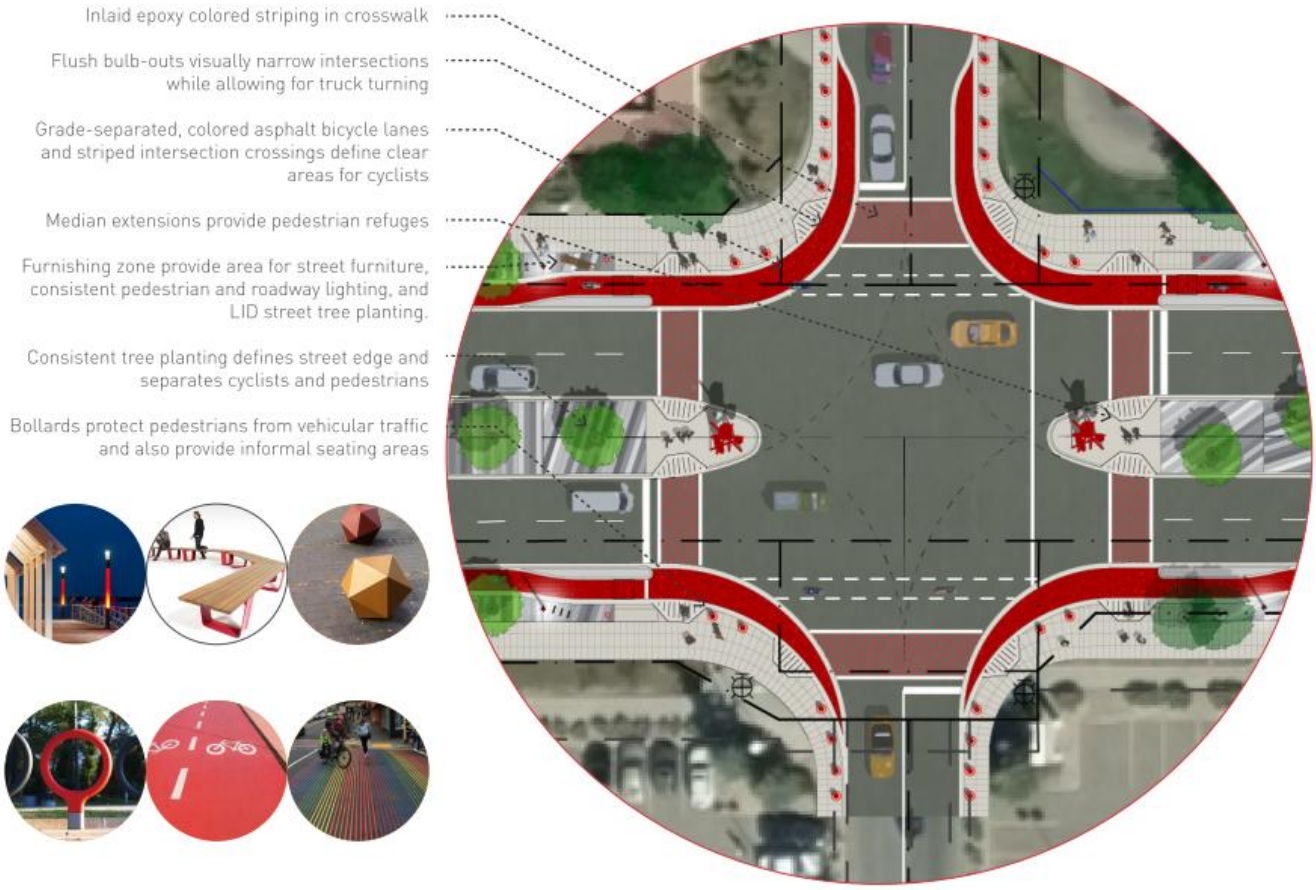


Figure Courtesy of The City of Calgary *61 Avenue SW Greenway Corridor Preliminary Design Report*

Figure 4 – Preliminary Typical Cross Section for 61st Avenue Greenway Corridor

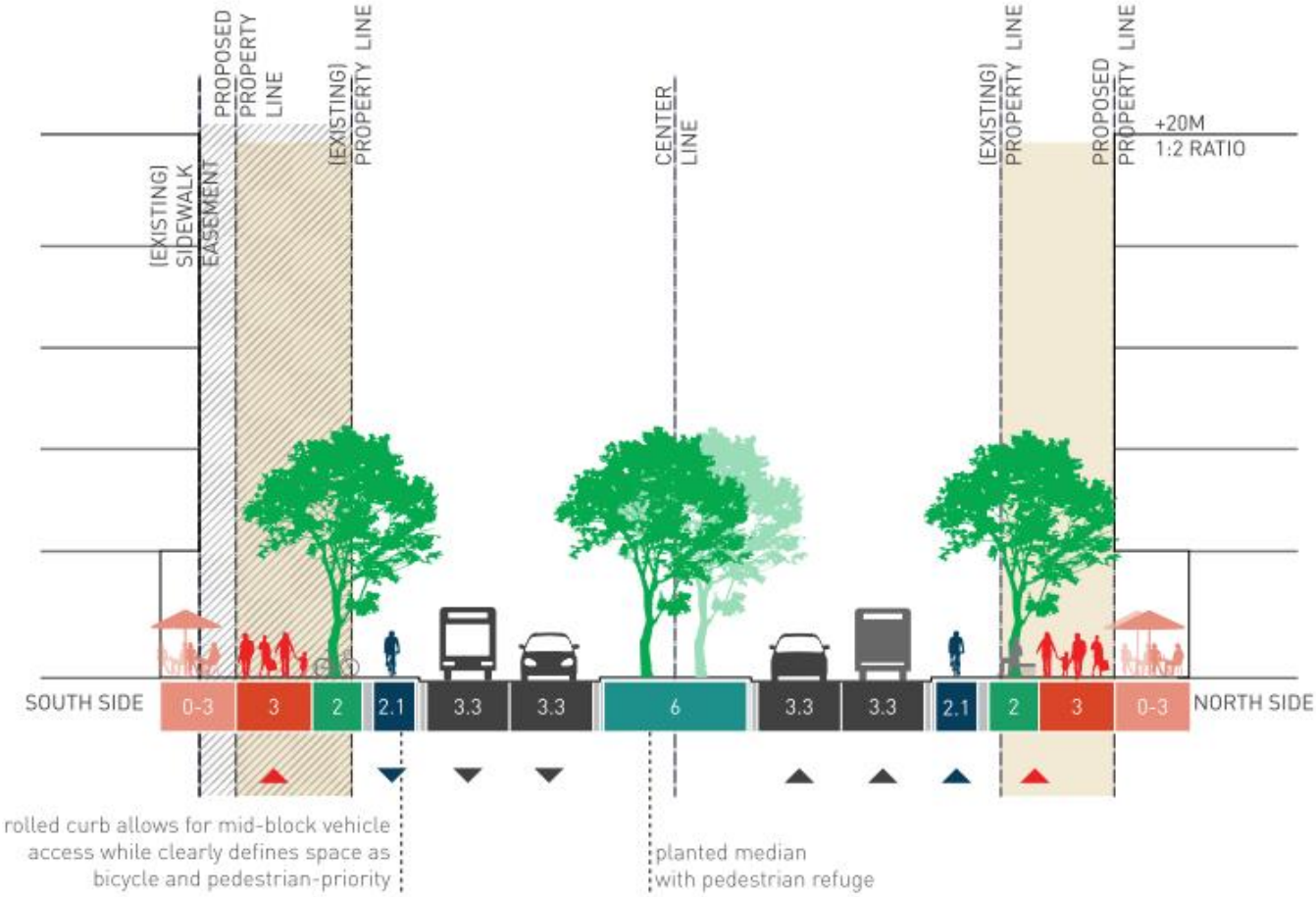
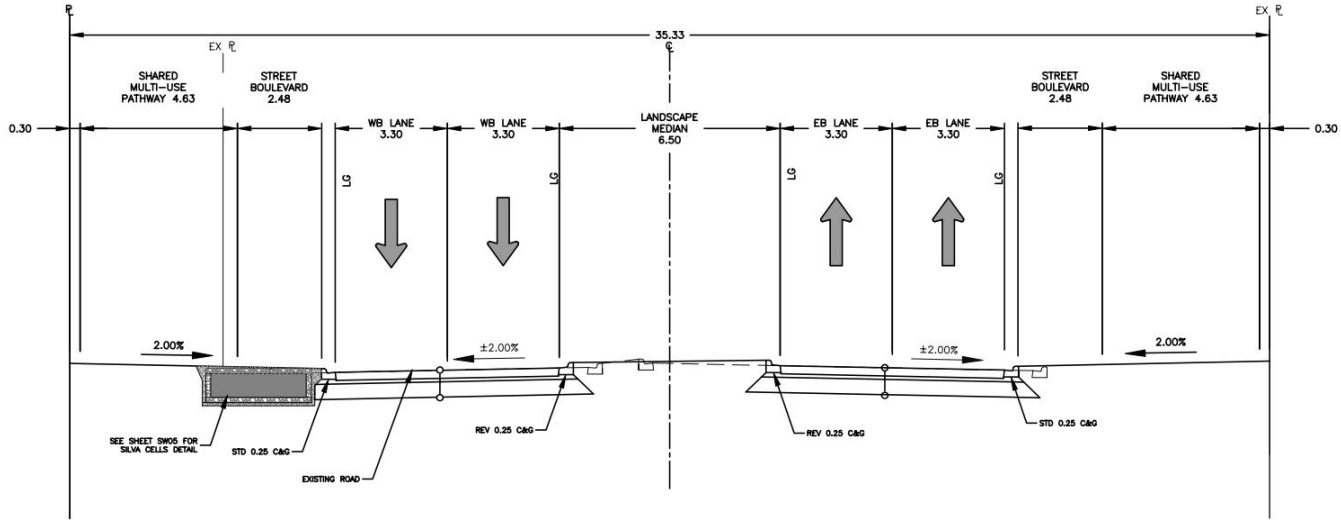


Figure Courtesy of The City of Calgary *61 Avenue SW Greenway Corridor Preliminary Design Report*

Figure 5 – Constructed Typical Cross Section for 61st Avenue Greenway Corridor



Note: Cycle lanes removed to provide a wider, shared multi-use pathway

Image 1 - Existing Separate Walk with Eroded Boulevard

Image 2 – Before Construction with Narrow Separate Walk, Degrading Boulevard, and Wide Travel Lanes

Image 3 – During Construction with Widened, Textured, and Coloured Pedestrian Realm, Trees and Custom Street Furniture within Paving Stone Boulevard, Reduced Width Travel Lanes, and Custom Public Artwork Component (Mural)

Note: Image captured during construction and does not illustrate the completed product

Image 4 – Example of Curb Extension with Mountable Inner Curb Structure