February 26, 2015

102 Avenue Corridor Review

for the City of Edmonton

Transportation Association of Canada

Road Safety Engineering Award Submission

Introduction

The City of Edmonton is Alberta's vibrant Capital City, and is one of Canada's largest municipalities, with over 800,000 residents. The City's population is expected to surpass one million residents over the next thirty years, which will place increasing pressures on its transportation system. The City recognizes the need to balance the needs of all road users – including drivers, pedestrians, bicycle users, and transit users.

Light Rail Transit (LRT) expansion is one of the City of Edmonton's top priorities for new infrastructure investment. In 2009, the City adopted a long-term LRT Network Plan that defines the future size, scale and operation of Edmonton's LRT system. Construction has now started on a new LRT route from Downtown to Southeast Edmonton - the *Valley Line LRT*. By 2020, this new low-floor LRT line will be complete, including a section through Edmonton's Downtown Core along 102 Avenue. The LRT alignment through Downtown Edmonton will run along 102 Avenue. 102 Avenue is an important east-west corridor and serves an important multi-modal function for LRT, cyclists, and pedestrians.

Recognizing the important multi-modal role of 102 Avenue, Edmonton City Council has approved a Downtown LRT Concept Plan for the corridor. City Council has also recently approved funding for the implementation of a physically separated cycle track on 102 Avenue prior to the completion of the Valley Line LRT.

The purpose of this study was to review the previously approved plans and designs for the 102 Avenue corridor to identify safety and operational issues for all modes of transportation and to develop mitigation measures and alternative concepts to address the identified issues. The previously approved concept included a mixture of modes within the street cross-section, including:

- a two-way LRT alignment along 102 Avenue, which would run along the north side of the street;
- a two-way bicycle facility along the centre of the corridor directly to the south of the two-way LRT alignment and between motor vehicle traffic;
- a single one-way eastbound general purpose traffic lane on the south side of the corridor; and
- sidewalks for pedestrians on both sides of the street.

During the preliminary design process and review for the *Valley Line LRT*, the City engaged peer and external design specialists to conduct a Peer Review of the original previously approved concept. Through this Peer Review, several operational and safety concerns were identified based on the designs. The Peer Review recommended that bicycle facilities be removed from the corridor and relocated to 102A/103 Avenue (a nearby east-west route). The recommendation to remove a mode of travel from 102 Avenue did not align with the overall intent of the concept plan endorsed by Council, and did not align with the City's Bicycle Transportation Plan, which identifies 102 Avenue as an important future bicycle route through

the City's Downtown Core. Urban Systems was retained to complete an independent review of the 102 Avenue corridor to further evaluate safety and operational characteristics and to identify recommended mitigation measures and/or alternate configurations to address issues and improve safety and operations for all road users while maintaining bicycle facilities on 102 Avenue if feasible.

Realized or Anticipated Benefits

Safety and operational analysis is critical with the implementation of LRT in combination with other modes, particularly vulnerable road users such as pedestrians and cyclists. In Edmonton, the design and construction of low-floor LRT is a relatively new concept. Combined with on-street bicycle accommodation along the same corridor, it is essential to ensure that safety is strongly considered and built-in to the design of these new facilities. 102 Avenue is envisioned as a high quality multi-modal corridor, with transit, pedestrian, and cycling facilities and the design set on 102 Avenue has the potential to pave the way for other parts of the City.

This study involved a comprehensive review of safety and operations for all users by a multi-disciplinary team of North American and European experts. Through the review completed by Urban Systems, a number of concerns were identified with the original design. Some of the key issues with the original concept are discussed below:

- **Cyclists were proposed to be placed in between LRT and motor vehicles.** The overall corridor concept included centre-running bi-directional bicycle facilities which position bicycle users in the centre of the street in between two-way LRT operations and one-way eastbound motor vehicle traffic. The placement of bicycle facilities in the centre of the street presents numerous conflicts at intersections and is not comfortable to people of all ages and abilities.
- **Lack of physical separation between motor vehicle travel lane and bicycle facilities.** The original design recommended that the 3.0 metre wide bi-directional bicycle facility be separated from a 3.55 metre eastbound vehicle lane by a 0.6 metre shyway. However, there is no indication that any physical separation will be provided within this shyway between the bicycle facilities and the eastbound motor vehicle lane. Based on the TAC Geometric Design Guide, a minimum of 1.1 metres of shy distance should be provided for motor vehicle travel speeds of 50 km/h or greater. Ideally, the bicycle facilities should exhibit a minimum of 1.0 metre shy distance between the motor vehicle lane, and some form of physical separation should be provided within this shy distance to enhance the safety and comfort of bicycle users. Considering the potential for both bicycle users and motorists to encroach into the adjacent travel lanes, bicycle users are at risk to side-swipe related collisions/conflicts. It is noted that this condition is expected to be further exacerbated with the presence of larger vehicles with wide mirrors (as the effective width can be up to 3.3 metres) and during inclement weather.

- **Lack of buffer between travel lane and pedestrian sidewalk.** For streets that do not exhibit on-street parking and that exhibit typical urban speeds (i.e. 50km/h or greater), a buffer between the motor vehicle lane and the sidewalk is desirable to enhance pedestrian safety and comfort. The width of the buffer between motor vehicles and pedestrians should be at least 2 metres. Under the original concept, on-street parking was not permitted and there was no buffer between the motor vehicle lane and the sidewalk. In addition, with the LRT along this corridor as well as significant residential development planned along this corridor, it is anticipated that pedestrian volumes will increase significantly in the future. Considering the limited sidewalk space and anticipated high pedestrian volumes, some pedestrians may be induced to walk very close to, or onto the motor vehicle lane, which is considered to be an undesirable outcome.
- **Lack of space for turning bicycle users to wait.** Although the original concept included eastbound bicycle facilities with bike boxes at all intersections, there was no space for eastbound bicycle users to wait if they were wanting to make a left or a right turn. In the westbound direction, no facilities were provided for bicycle users to wait if they were making a left or a right turn. This may result in conflicts between bicycle users, as turning cyclists may be stopping in the path of through travelling cyclists.
- **Potential for northbound turning bicycle users to slide across tracks as the turns are not perpendicular.** The original concept did not indicate any turn restrictions for bicycle movements, which can introduce safety issues for bicycle users turning northbound across the LRT tracks. As noted previously, without dedicated provisions for eastbound to northbound left turns or westbound to northbound right turns by bicycle users, there is a high likelihood that bicycle users will make this turn as a vehicular cyclist, and may cross the LRT tracks at an angle. As a result, the bicycle tires could get caught in the LRT rail tracks, resulting in severe injury collisions.
- **Long crossing distances on many cross streets.** Under the original concept, pedestrians were required to cross up to six travel lanes on some cross-streets, while several other cross-streets would require pedestrians to cross up to four travel lanes. Ideally, the crossing locations should be as short as possible to encourage safe pedestrian movements. Pedestrian crossings can be improved through the use of curb extensions, lane reductions, and curb radii reductions where feasible; and further enhanced through the provision of a Leading Pedestrian Interval.
- **Left turn motor vehicle movements.** Southbound to eastbound left turn movements in the original design required motorists to cross both the LRT tracks and the bicycle facilities before making the left turn onto 102 Avenue. Depending on the traffic volumes, there is a potential for motorists to queue on the LRT tracks or the bicycle facilities, which may present safety issues.
- **Vehicle swept path.** The turning geometry off the cross-streets in the original design, specifically for the northbound to eastbound right turn, may be challenging for some of the

design vehicles within the downtown core. These vehicles may sweep into the bicycle facilities or sidewalk and induce side-swipe related collisions/conflicts with the cyclists.

- **Conflict points at driveways and alleys.** In addition to intersections, the original design included several mid-block conflict points, which included driveways and alleyways which can act as conflict points.

The overall intent of the Council-approved Downtown LRT Concept Plan and subsequent preliminary design was to provide a high quality corridor along 102 Avenue that accommodates all modes of travel, including transit users, bicycle users, pedestrians, and motorists. As such, the types of collisions or conflicts along this corridor could involve pedestrians and cyclists, and if a vehicle and/or a LRT train are involved in a collision with a pedestrian or cyclist, the expected collision severity is likely to result in a probable fatality or very serious injury. Based on the Collision Risk Assessment Method outlined in the TAC In-Service Road Safety Review Guide, the severity rating for these types of collisions (i.e., those involving pedestrians and cyclists) are defined as extreme, which then translates to a high-risk rating. It is noted that this risk assessment is the same for all frequency ratings. That is, the high-risk rating is the same for frequent and rare collision events. With this in mind, the proposed concept should seriously consider the interfaces between the various modes of travel and take into consideration the low conspicuity of cyclists and pedestrians.

Overall, the placement of the bicycle users in between the motor vehicles and LRT vehicles presented a significant and high risk potential conflict, with potential for high severity collisions resulting in fatality or serious injury.

Based on the findings of this study, which included an international best practices review of how other cities have incorporated LRT and cycling facilities along the same corridor, the project team concluded that experience elsewhere demonstrates that bicycle facilities and LRT can safely operate within the same right-of-way, albeit with numerous design considerations to address safety and operational issues. As such, it was recommended by Urban Systems that the cross-section to modified by reversing the placement of the bi-directional bicycle facilities and the eastbound motor vehicle lane.

Ultimately, the study identified a number of design modifications and added features to be incorporated into the corridor design to improve safety for all users, including:

- a protected cycle track adjusted to a new location within the right-of-way than was originally proposed as shown in **Appendix A**, and **Figures 1** and **2** of **Appendix B**;
- improved protection for cyclists making turn movements across the LRT tracks as shown in **Figures 3** and **4** of **Appendix B**;
- reduced pedestrian crossing distances;
- widened sidewalks;
- added physical buffer space;
- incorporation of shyline offsets;

- addition of conspicuity markings and turn boxes; and
- dedicated signal phasing for each mode.

This design can serve as an example for other jurisdictions looking to safely design multi-modal corridors that include LRT. By providing safe, comfortable, and high quality facilities for transit users, cyclists, and pedestrians, it is anticipated that this will lead to significant behavior change and increased use of sustainable forms of transportation in Edmonton.

At present, this project is in the implementation stages. The LRT and the cycle track along 102 Avenue are scheduled for construction beginning in 2016 for completion by 2020. Until the work is implemented, it is difficult to quantify the benefits in terms of collision frequency or severity reduction as a baseline for this corridor is difficult to establish due to the significant change in nature of this corridor that is expected as the LRT is built and as Downtown development advances. However, research elsewhere demonstrates that this project will likely result in significant benefits in terms of increased cycling volumes and decreased cycling collisions, as the implementation of physically separated cycle tracks across North America has been consistently shown in research to significantly increase bicycle use and improve safety for all road users. In conjunction with the overall increase in activity along the corridor as a result of the LRT and significant redevelopment and intensification in the surrounding downtown area, it is anticipated that safety will be significantly improved for all road users and will contribute to an overall "safety in numbers" effect for pedestrians and cyclists in particular.

Degree of Innovation

A multi-disciplinary team was assembled to identify recommendations from various perspectives, including road safety, traffic operations, transit, and active transportation. The design identified improvements for all users without negatively impacting safety or operations and incorporated innovative best practices in multi-modal design to create a win for all users, including Edmonton's first cycle track design and enhancements for pedestrians and transit operations. The study demonstrated how all modes can safely be accommodated within the same right-of-way.

In addition to the traditional aspects of an in-service road safety review utilized to help identify the issues and opportunities associated with the bicycle facilities implemented, five key innovation strategies were leveraged, leading the successful outcomes previously discussed.

- **The analysis process cohesively evaluated safety, operational, and constructability issues across five different zones:** the corridor, stations, intersections, conflict points, and transitions/end points**.** This methodology ensured that all issues were identified with each zone, and that the complexity of multi-modal movement was analyzed at all locations along the corridor.
- **Modified design criteria were investigated and affirmed as part of the study.** The City of Edmonton prompted innovative solutions by affirming modal priority through the design

criteria utilized for the analysis and improvement recommendations. Specifically, a reduced design speed for motor vehicles and a restriction of access to emergency vehicles and garbage trucks and local vehicle access (ie. no through traffic) only allowed for reduced lane widths, reduced curve radii for the horizontal alignment, reduced curb return radii, and increased cross sectional width for bicycles, pedestrians, and transit passengers.

- **Separation of modes was strategically balanced between space and time.** The development of a recommended design concept utilized equal consideration of geometric separation and signal phasing separation to minimize the conflicts between all road users. Specifically, all signal phases which permitted potential conflict between turning motor vehicles and through moving bicycle users and pedestrians were eliminated. Turn restrictions were provided in conjunction with the LRT crossing to maximize travel time reliability for the LRT while still enabling permeability for pedestrians, cyclists, and the intersecting cross streets with 102 Avenue. Finally, physical separation for the bicycle lane was provided to encourage use by bicycle users of all ages and abilities. The width and design of this facility was carefully evaluated on a block by block basis to ensure adequate access for snow clearance and emergency access, while maximizing space within the pedestrian realm.
- **A thorough investigation of maintenance requirements and the feasibility of road design tactics was undertaken**. The City of Edmonton worked with roads maintenance departments to ensure the feasibility of all proposed cross section widths for snow clearance access (at a minimum of 3.1m). Collaboration with the Emergency Services also allowed for a creative strategy of separation to provide comfort for bicycle users, while also providing appropriate mountable curb access for fire truck set up through the corridor. Finally, the appropriate design vehicle for the City was confirmed and checked on all curb returns through the corridor to minimize vehicle turn speeds and pedestrian crossing distances, whilst ensuring appropriate access was provided for businesses along 102nd avenue.
- **International best practices were referenced to inform the recommendations.** Design and analysis guidance from across North America and Europe was referenced to bolster innovations, and understand at a greater level of detail what types of treatments have worked successfully in other jurisdictions. The National Association of City Transportation Officials (NACTO) Urban Street Design Guide, the NACTO Bicycle Facility Design Guide, and the CROW Design Manual for Bicycle Traffic (Netherlands) were all referenced as a starting point for design intervention considerations. Several specific case studies were also conducted with several cites in North America that have successfully integrated LRT and cycling facilities (including the City of Seattle's Broadway Streetcar and Cycle Track integration) to provide best practices and lessons learned for effective multi-modal integration for the City of Edmonton.

Transferability to Other Canadian Communities

This project demonstrates the union of road safety, engineering, and best practices for multi-modal corridors, showing how multi-disciplinary teams come together to evaluate designs and develop safety and operational strategies. This design can serve as an example for other jurisdictions looking to safely design multi-modal corridors that include LRT. By providing safe, comfortable, and high quality facilities for transit users, cyclists, and pedestrians, it is anticipated that this will lead to significant behavior change and increased use of sustainable forms of transportation in Edmonton.

The efforts of the 102 Avenue Corridor review align with Canada's Road Safety Strategy's goal of *"reducing fatalities and serious injuries caused by collisions on Canada's roads"* and Alberta's Traffic Safety Plan's goal to *"reduce traffic-related deaths and injuries in the province for all road users including drivers, passengers, pedestrians, cyclists and others".* The work completed through Edmonton's 102 Avenue Corridor Review is also contributing to three of the five pillars in the United Nations Decade of Action for Road Safety - road safety management, infrastructure, and road user behaviour.

The 102 Avenue Corridor Review focuses on safety improvements for vulnerable road users, which are the key target group under Canada's Road Safety Strategy. The study directly contributes by strengthening infrastructure elements in road safety. And as such, the multi-modal approach, assessment methodology, and many of the recommendations and best practices are transferable to other Canadian communities that are working to improve the safety of their multi-modal corridors for all road users, particularly vulnerable road users.

From a Provincial perspective, the 102 Avenue Corridor Review contributes to two priorities of the Alberta Traffic Safety Plan - improving road infrastructure and increasing vulnerable road users safety. The study and its recommendations, and the resulting action being taken by the City of Edmonton are focused on improving road infrastructure with a strong emphasis on vulnerable road users and is consistent with the recommendations in Alberta's Traffic Safety Plan to identify and implement the most effective countermeasures to reduce collisions.

The Alberta Traffic Safety Plan calls for a 15% reduction in the serious injury collisions for the 2013-2015 three year average compared to the 2008-2010 three year baseline average. The three year baseline average (2008-2010) for injury collisions involving cyclists is 212.3 with the resulting target being 180.5. While we are still in the 2013-2015 time frame, the three year average for 2011-2013 is 181.3 and trending further downward. The reduction of cyclists injuries and fatalities is correlated with the construction of bicycle infrastructure, and is presented in **Appendix B**, **Figure 5**.

The City of Edmonton and Urban Systems used a Safe Systems approach to the review and revised design of the 102 Avenue for the safety of all users, particularly for those most vulnerable. The 102 Avenue Corridor Review was a major initiative to assess the safety of cyclists in a multi-modal corridor with light-rail transit. The recommendations of this study incorporated best practices that could be implemented by others in similar situations.

Appendix A

Proposed Alternative 102nd Avenue Concept Design

URBAN systems

DECEMBER 19, 2014

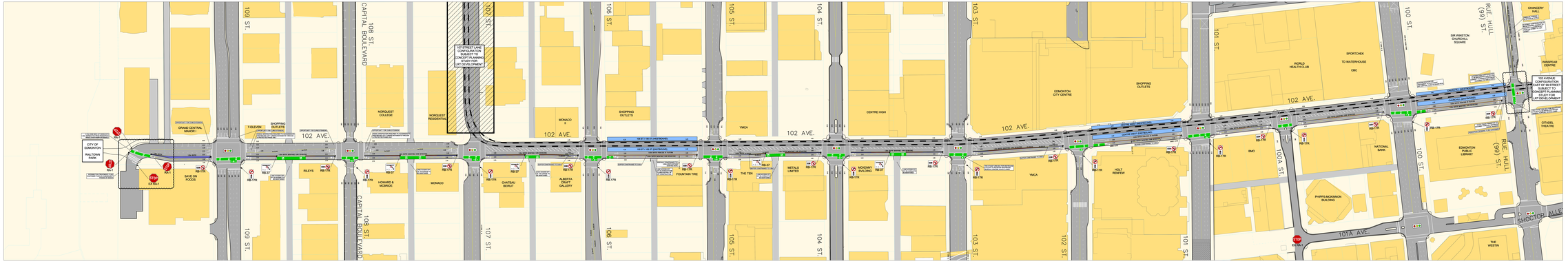
City of Edmonton - 102 Ave

City of Edmonton

Scale 1:50

102 Avenue Roll Plot - Ultimate

FIGURE 2



Appendix B

Supporting Figures

Figure 1: Typical Cross-Section (Non-Station Location)

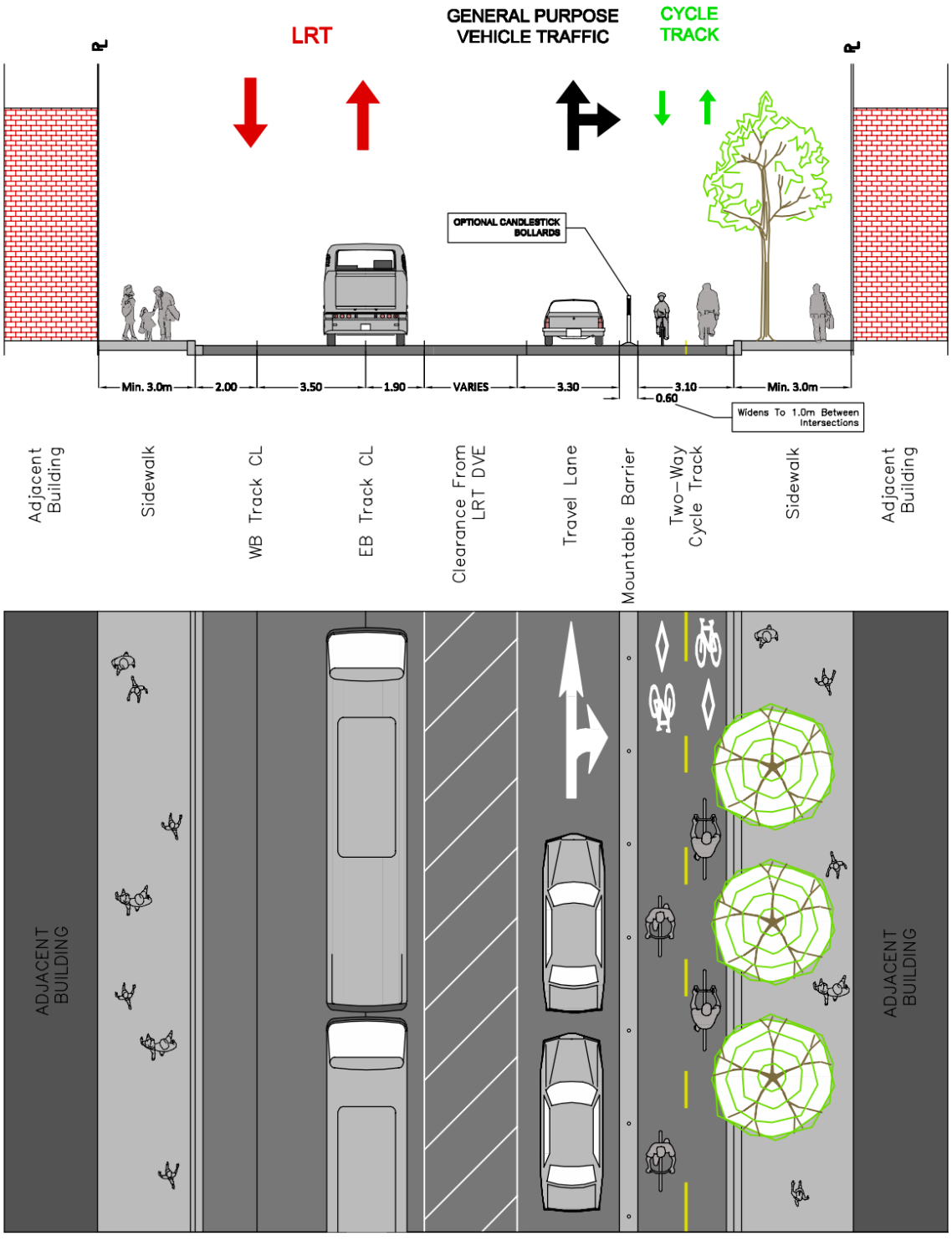


Figure 2: Typical Cross-Section (Station Location)

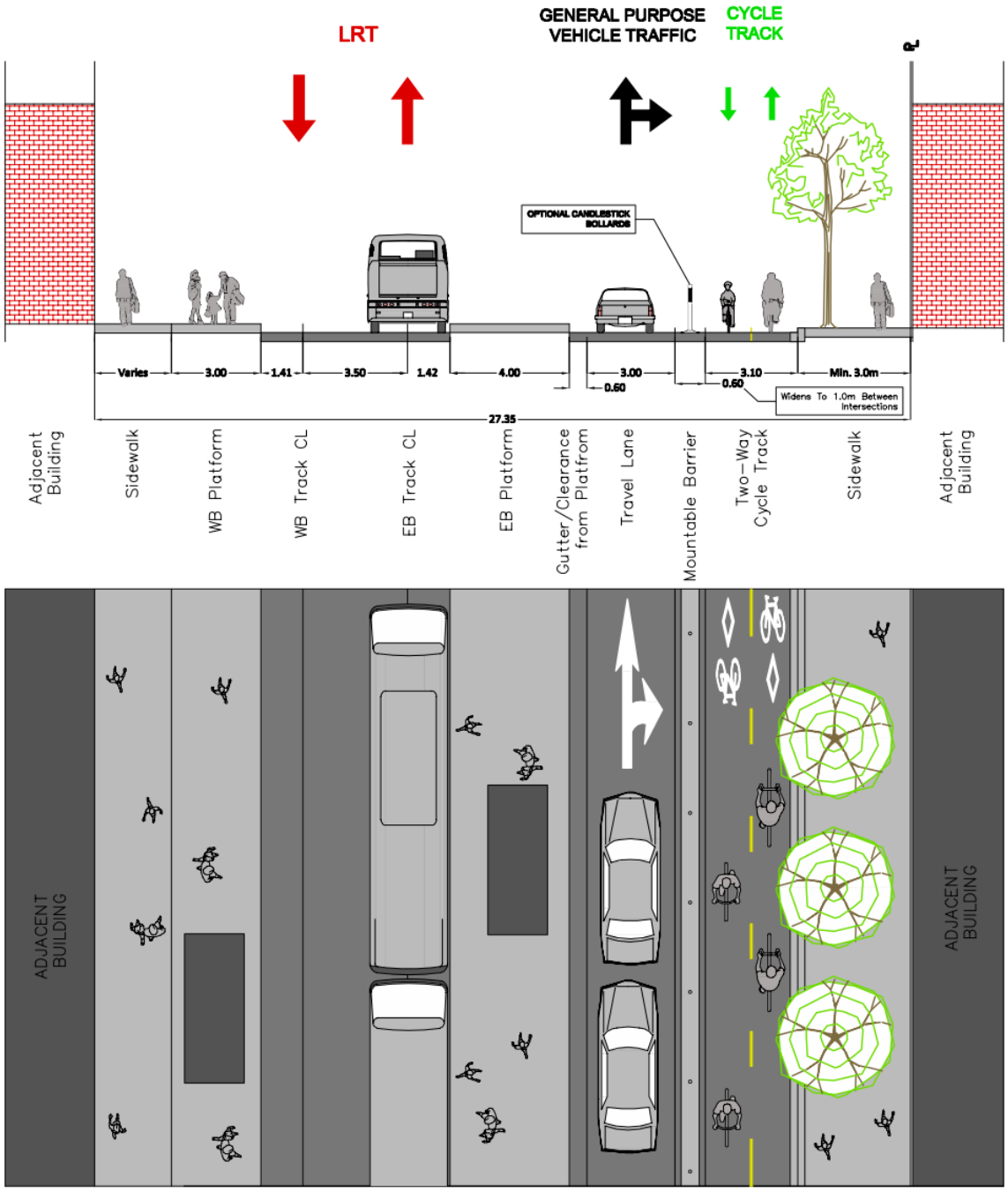


Figure 3: Typical Plan Concept (Non-Station Location)

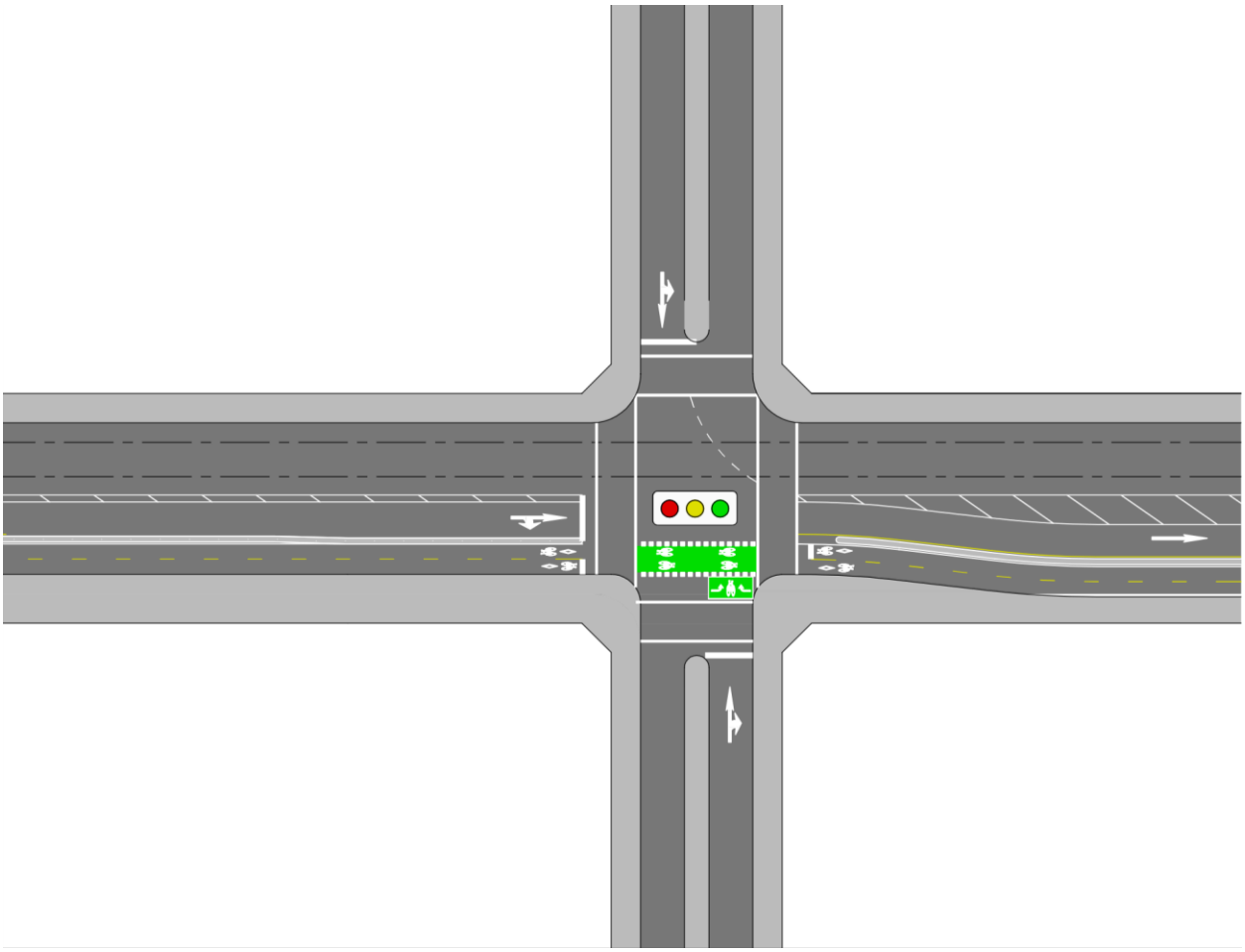


Figure 4: Typical Plan Concept (Station Location)

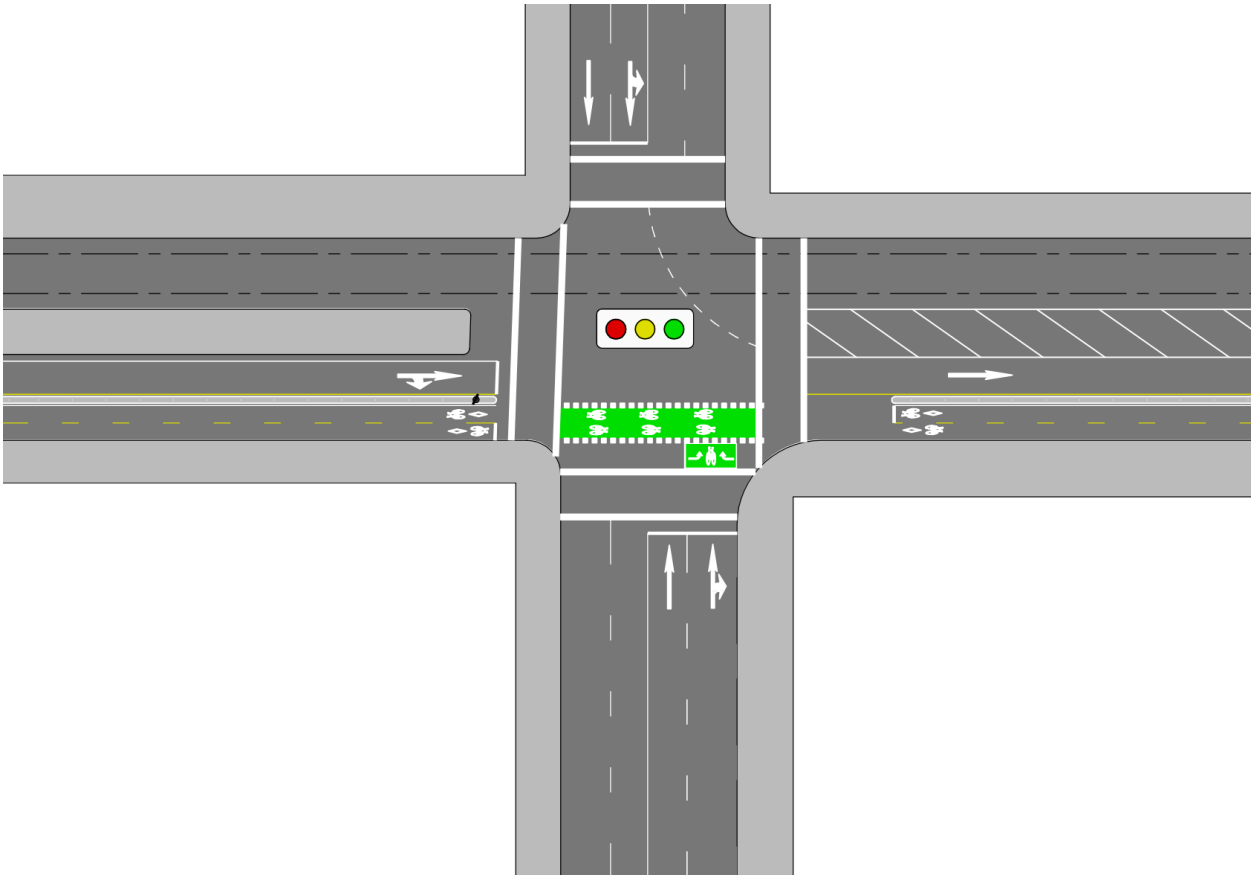


Figure 5: Total Kilometres of On-Street Bicycle Facilities and Total Cycling Collisions

Source: City of Edmonton Collision Data (2008 – 2013)