THE PEMBINA HIGHWAY BUFFERED BIKE LANES PROJECT – A SOLUTION TO MANAGING CYLCISTS, BUSES AND PEDESTRIANS AT TRANSIT STOPS

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ABSTRACT

Pembina Highway is a vital north-south link in the City of Winnipeg's Regional Transportation Network connecting the University of Manitoba, the Central Business District, the Perimeter Highway and the Inner Ring Strategic Road Network. It is considered a mixed use corridor and includes diverse multi-family housing options. The subject section of Pembina Highway between Chevrier Boulevard and Plaza Drive is a six-lane divided arterial road and truck route with approximately 48,000 vehicles per weekday, over 600 transit buses per weekday, highly utilized by cyclists and there is moderately high pedestrian activity.

Prior to 2012, this portion of Pembina Highway was a critical gap in the City's Active Transportation Network. With limited alternative streets available to cyclists that carry less vehicular traffic, Pembina Highway needed a dedicated facility to accommodate the cycling demand. Environmental scans of other jurisdictions revealed that the existing traffic and road characteristics of Pembina Highway are quite unique. Through various decision making techniques and stakeholder consultations, the City determined that a buffered bike lane would be the optimal solution. A design solution was also required to manage the high volumes of buses and pedestrians with cyclists at the transit stop locations.

One example from Portland and a bus-stop island concept utilized by Austroads set the stage, showing the bus stop intercepting the buffered bike lane with the cyclists going behind the bus-stop and in front of the sidewalk. The City took this concept, and further developed it to:

- Accommodate local conditions and climate for use and maintenance;
- Ensure Transit requirements for bus platforms were met;
- Improve way-finding measures to aid pedestrians with vision impairments;
- Modify the geometry to ensure cyclists slow down;
- Reduce the potential for pedestrian and cyclist conflict at the stop.

The construction of this project is currently substantially complete with total completion expected in the spring of 2013.

This paper will present the results of a comprehensive process to validate the design and engineering effectiveness, and provide a detailed description of the following:

- Geometric design and rationale behind the detailed design of the City's Buffered Bike Lane Bus Stop;
- Innovative methods used for way-finding;
- A description of the pavement markings;
- Comprehensive stakeholder involvement;
- Snow clearing methods, and;
- Recommendations for next steps.

INTRODUCTION

All modes of transportation must be carefully considered when designing active transportation facilities. This became very evident and relevant in the subject project on Pembina Highway in Winnipeg. Through sound collaborative and engineering processes a design for active transportation facilities that accommodates multiple and diverse users became a welcomed reality in Winnipeg.

The need for a cycling facility on this segment of Pembina Highway was determined through various methods of route analysis. Analyzing current trends in the implementation of existing cycling facilities within the City of Winnipeg based on vehicular speed and volume variables determined that a separated active transportation facility would be the preferred treatment.

The numerous private approaches along this stretch of roadway increased the likelihood of interrupting the cyclists path of travel by motorists waiting to access the roadway, providing a discontinuous vertical alignment. An off street facility would also bring cyclists closer to the property line resulting in

difficulties for motorists leaving the private property to react to fast moving cyclists. Therefore an on-street separated facility was required. Existing right-of-way constraints and vertical drainage was analyzed and the chosen facility introduced a buffered bike lane on the curb side of both directions of travel. This was accomplished by widening the roadway approximately 2.5m towards the median and shifting the lanes of travel over. The previous roadway cross-section is shown in Figure 1.

In the continued engineering of the street right-of-way, it was realized that the overall width of the on-street buffer and the bike lane would force a bus to pull over considerably from the right most travel lane to access the bus stop, resulting in less than ideal remaining travel widths creating unnatural and potentially unsafe driving conditions for the drivers. Functionality of transit would be reduced if buses are delayed in passenger drop off or in getting back into traffic. This has a cost in terms of lost time to transit and increased need for more buses to maintain the level of service. The design had to sustain buses on street without the need to pull off the route of travel. This created a conflict between buses and cyclists at the bus platform area.

The buses would also continually block the bike lane interrupting the cyclists path of travel resulting in a frustrating experience for cyclists.

The existing typical bus stops along Pembina Highway included pedestrian sidewalks and a simple concrete bus platform including a shelter. It was assumed an off-street facility such as a multi-use path or separate bike path could create a significant expanse where potential conflicts between cyclists and pedestrians walking and accessing the various bus stops could occur. We had to ask ourselves if the introduction of a separate cycling facility meant a real or perceived increase in negative interaction between buses and cyclists, cars and cyclists, cyclists and transit riders and cyclists and pedestrians on the sidewalk. This notion of perceived conflict was confirmed after initial consultations with users both internal and external to the City of Winnipeg.

The City performed a literature search to identify solutions to managing all the transportation modes at bus stops.

1. Literature Search

   The following research provided a background of existing and related information

   a. *Portland Design*

      An example of an existing transit stop was identified on a low volume street in Portland in which the cyclists rode behind the bus stop to avoid a stopped bus. This concept inspired our conceptual design.

      Link: http://www.humantransit.org/2011/01/bicycle-vs-transit-problems.html

   b. *Austroads Design*

      Cycling Apects of Austroads Guides provided a variety of options with details of geometry including the on and off ramps for the cyclist. This information was utilized by Winnipeg to aid in developing our ramp geometry and to evaluate options. Austroads also present various alternatives for how pedestrians access the bus stop from the sidewalk.

   c. *NACTO Urban Bikeway Design Guide*

Following the completion of our design the new NACTO Bikeway Design Guide issued a similar suggestion that consideration be given to wrapping the bike lane around bus stop using a cycle track as shown in Figure 2. NACTO falls short on providing design details of how to implement their suggestion.

d. Cycle Slabs

Cycle slabs made from clay are used extensively in the United Kingdom and various European countries. Feedback from Prof. Marcus Ormerod of the University of Salford near Manchester, U.K. indicated local jurisdictions are limiting new installations of these way-finding tools until further research is completed on slipping issues in their climate conditions. These cycle slabs are intended to warn pedestrians that they are entering areas of potential conflict and help aid in distinguishing between the cycle areas and the pedestrian areas.

The final Winnipeg design was developed by integrating various design attributes from the above sources. Also incorporated are the City of Winnipeg Universal Design Policy and Accessibility Design Standards, local philosophies for pedestrian design and the Highway Traffic Act.

The chosen design created the opportunity for transit riders, other pedestrians and cyclists to share space. A need to resolve the potential increased probability of pedestrian and cyclist collisions was evident, especially if the pedestrian has significantly reduced vision. The design warranted the bus platform be significantly separated from the sidewalk making the entrance to the bus more difficult to locate for those who are visually impaired to see the stop. This also left the design with the potential for pedestrians with vision loss to inadvertently travel toward the street via the bike lane as opposed to maintaining a straight route along the sidewalk.

The City looked at a variety of methods to improve way-finding measures to aid pedestrians of varying abilities to find and access the stop. The City engaged and consulted key public stakeholders to gain feedback and validation of different ways to increase the comfort and ease of use for pedestrians with vision impairments when crossing the cycle path at the stop. The City consulted with its internal Access Advisory Committee and Active Transportation Coordinating Group. Input was also utilized from the expertise and experience of the Canadian Institute for the Blind, the Vision Impaired Resource Network, and the University of Salford, U.K. Tactile maps were developed and used to provide an inclusive process which aided in full participation.

The overall design is shown in Figure 3. Cyclists ride in the buffered bike lane up to the stop and deflect up the ramp, onto their delineated path and down the ramp and back onto the buffered bike lane. If no bus is present and it is safe, the cyclist has the choice to stay on the street. Cyclists are to yield to the pedestrian at any location throughout the bus stop platform. Pedestrians access the bus stop by crossing the cycling path. There are texturized and coloured markings on the sidewalk and the cycle track. These are cues to assist people in way-finding through this complex site. A unique yellow concrete cycle tile was modeled after a McCormick Concrete cycleway tile used in England to warn cyclists and pedestrians that there is an increased chance of interaction at this site.

DISCUSSION

1. Geometric Design Features

   The geometric design of the stop is shown in Figure 4. Rationale is described as follows:

   Design Vehicles – The City of Winnipeg's articulating bus and the standard low floor bus.

   Length of Bus Stop Platform– The required length of the stop must accommodate either design vehicles as well as both design vehicles simultaneously. The resulting bus stop length was either 18.9m or 26.5m long.

   Depth of Stop Platform – The required depth of the stop must accommodate the buses deployed wheelchair loading ramp, a required set-back of the shelter from the roadway for snow storage and street furniture. It also must accommodate a predetermined number of transit riders as they wait to board the bus.

   Bus Shelter Location – The shelters were consistently located at the head of the stop to ensure consistency. These shelters also prompt users who are blind that they are near a stop or that a bus has arrived due to the deflection of air and (echo) sound off of the shelter.

   Elevations – The sidewalk, cycle path and bus stop are all at a consistent height with 2% cross-fall from the back of the sidewalk to the front of the curb. It was debated if the bike path should be depressed to create an island with a pedestrian 'bridge' or curb ramps, but this would introduce drainage issues in the depressed section. It would also restrict the available locations for pedestrians to cross, potentially create tripping hazards, may not influence cyclists to slow down at the stop, and may not provide enough level area for cyclists to manoeuvre around a pedestrian.

   Cycle Ramp Slope and Deflection – The ramps are sloped up to a minimum of 5% to act as a ramp and are deflected at an angle of 20 degrees. The intent is to encourage cyclists to slow down but not generate any discomfort.

   Cycle path width – The path width was reduced from 1.8m to 1.2m to provide a feel of tightening to encourage the cyclist to slow down through the bus stop.

   Cycle lane width – The cycle lane width on the road is 1.8m.

   Buffer width - The painted buffer width is 0.6m. This painted buffer in addition to the one-way 1.8m bike lane should enable enough room for cyclist to pass another cyclist.

   Sidewalk Width – The sidewalk width is 1.5m which is the minimum width required in Winnipeg.

   Poly-Post and Permanent Pavement Markings – Permanent longitudinal pavement marking will be installed along this segment in spring 2013 to aid in identifying the lane designations as the overall pavement width is quite wide. The City is also intending to install poly-posts with-in the buffer area to aid in visual separation. Seasonal use of these features is still under evaluation.

2. Pedestrian Way-finding Measures

   The following describes the rational for each of the way-finding tools:

a. *Cycle Slabs* – new cycle slab designs were directly derived from a combination of the U.K. cycleway tile model and the standard domed detectable warning surface tiles used at curb ramps. These pavers were fabricated out of concrete to mitigate the slipping issues that were reported in the U.K. and to improve permeability and drainage. The through-body yellow colour adds contrast to make them more visible. They are used to cue pedestrians of varying abilities and cyclists that they are entering or exiting a zone with potential conflicts between pedestrians and cyclists. It also it intended to aid pedestrians of varying ability to distinguish between the cycle area and the pedestrian area. See Figure 5.

b. *Yellow Detectable Directional Tiles* – Bus stops can be quite extensive due to the length of the design vehicles. To aid in locating the head of the bus stop, a yellow fiberglass elongated domed tile 0.3m wide was installed in a strip from the back of the sidewalk to the head of each stop. The need for this strip is to aid pedestrians with vision impairment in locating the head of the stop. The use is solely for aiding in directing people. Typically if multiple buses are queued the bus drivers are trained to move to the head of the stop once it has cleared should they observe a pedestrian with vision impairment waiting. See Figure 6.

c. *Charcoal Pavers* – charcoal concrete paving bands were used to distinguish the sidewalk, cycle lane and bus stop from each other. They are not easily detectable with a ball cane but can provide visual cues for people with good vision. Other options discussed were coloured concrete or coloured pavers for the whole bike lane.

d. *Blue Paver Square* – the square markings outlined with transit blue pavers adjacent to the transit flag post function to identify the head of the stop.

3. In-Service Evaluations

An in-service evaluation was performed using varying facility users to determine the comfort level, ease of use and to help us understand the effectiveness of way-finding measures. This test helped the City determine whether the shared use space was safe and usable by pedestrians and cyclists. The following are observations identified during our evaluation. See Figure 7.

a. Pedestrians of Varying Abilities

i. People with Average Vision

Typical congregations of pedestrians would stand spread out over the area including the cycling path. They would need to cross the cycling path to leave the shelter to get to the stop. Having all the design features at the same grade assists cyclists in manoeuvring around pedestrians.

ii. People who are blind and use a cane for navigation

Users who are blind found the bus shelters to be an auditory landmark, and the grassed boulevard leading up to the stop aided in a cane users term, "shore-lining". There was mixed responses about the paving band separating the sidewalk from the cycle path, one found it to be a nice extension from the grass and a few others found it to be of negligible benefit. They had difficulty feeling the cycle slab ribs under their feet. One user who is blind suggested that the design leads all users to be cautionary when approaching. With all the markings, it becomes intuitive to slow down and approach the area with caution. It reminded a person to be increasingly aware of their surroundings.

The yellow directional strip became easier to use once it was understood and initially found.

The cycle slab tile is installed with the ribs perpendicular on the pedestrian sidewalk and parallel on the cycle track. The variance in the orientation of the ribs were hard to distinguish because of the chamfers in the paver stones, but pedestrians who are blind stated they didn't necessarily need to know the specific area of the cycle path. This would also require an educational program, and may not be as effective for new comers to the site.

Users who are blind with canes felt uncomfortable exiting the shelter when leading with a cane onto the cycle path.

Untrained users who are blind may not anticipate the way-finding measures and could potentially stride over them or consider them as rough sidewalk, particularly if they use a dog for navigation.

iii. People who are blind and use dog guides for navigation

Textures didn't convey much information or benefit to the dog guide user. When getting off the bus the dog took the pedestrian in the direction they needed to go. They would quickly move out of the bus stop away from other people and cyclists. If cyclists use the path at the same time, the dog will hesitate before crossing.

The bus shelter provides a valuable cue to find the general area of the bus stop.

When the pedestrian stepped on the textured pavement they did not stop to examine the type or direction. They found it not much different than walking across a man hole cover, grates around trees, damaged concrete etc. This is different than a person who sees it and knows what to expect or can see the difference.

iv. Person with low vision

Please note that there are more people who are legally blind that have some functional vision than there are people with no vision at

all. Yellow colour was chosen to accommodate those with some vision.

v. Wheelchair users

Wheelchair users found the cycle slabs very bumpy to go over.

vi. Person with reduced balance

The pedestrian with reduced balance felt uncomfortable and had difficulty walking across the cycle slabs. It might be assumed that this could be similar to older adults or persons with gate difficulties.

A questionnaire as shown in Appendix A was sent out to the users after the evaluation. Their findings are as shown in Figure 8.

b. Cyclists

The cyclists had to navigate outside the bike lanes on almost every pass. They did so to avoid pedestrians that were everywhere. They did not have to stop for pedestrians. The cyclist recognized the painted cycling symbols on the pavement and followed that cue. Cyclists were cautious of the cycle slabs at first, but they did not have any negative impact on maneuverability. Overall the cyclist felt comfortable and safe. See Figure 9.

c. Transit Operators

Transit has not had any performance or functional issues to date. Transit was able to deploy and effectively uses their wheelchair ramp.

d. Streets Maintenance & Traffic Services

i. Snow Clearing Operations

Snow clearing this facility has been a challenge. The project was completed in late fall just before the first snow fall. The operators lack experience in clearing these stops and more training and resources will be required. Given there is more space to clear and less storage, the snow clearing operations budget should be increased.

The majority of the poly-posts that had initially been installed in fall did survive the first snow clearing. The bus stops are cleared with loaders and the cycle lanes are cleared with 1.5m wide sidewalk plows. This resulted in a narrow windrow along the buffer which presented hazards to winter cyclists. Motorists often would drive over the windrow knocking over large pieces of hard snow and this windrow would melt very slowly. The bike lane was constantly wet. See Figure 11.

The 1.5m clear opening was also too narrow to allow any maneuverability of the sidewalk plow.

ii. Poly-Posts

Poly-posts were adhered to the pavement prior to the winter to aid in identifying the cycle lane but by spring they have all disappeared. The lane line paint has also disappeared resulting in driver confusion on this segment

as the pavement appears very wide. The City is currently investigated permanent and removable bollard to find a more economical solution as well as evaluating their seasonal usage.

4. Construction Issues

    a. *Cycle Slab Fabrication*

    The cycle slabs were fabricated as per the City of Winnipeg Standard Construction Specifications CW 3330 and were through-body coloured with yellow. The fabricator produced a few samples for the City to approve the colour. There were many iterations of the orientation of the ridges versus the slab, the chamfers on the ridges and molding techniques to make the ridges strong and durable to resist snow clearing damage. The resulting as-built geometry of the slabs is shown in figure 10. These cycle slabs have not yet endured a Winnipeg winter so an evaluation of ridge durability has yet to be completed.

CONCLUSIONS AND RECOMENDATIONS

Overall the design works well. Only two participants mentioned discomfort in its use. There was no mention of concerns for the safety or interruption of service to transit, the cyclist or the pedestrian.

Generally, cyclists were easily able to manoeuver around pedestrians. This is likely due to a reduction in speed, the many cues, markings and sufficient level space to manoeuver. All pedestrians were able to safely find the sidewalk when departing the bus. Positive findings from the evaluation showed the single level/grade bus stop facility option is the most inclusive approach.

Further research and investigation is needed to determine a solution for the poly-posts to ensure stability during snow clearing. The clear opening of the ramps should be at least 1.7m to accommodate snow clearing operations. Further in-servicing is required after at least a year of use to gain feedback from a broader range of cyclists and pedestrians.

It is important to note that way-finding measures have different levels of effectiveness for users of different needs and abilities. In order to maximize the effectiveness of way-finding measures, they must be consistently applied to each site. Developing strict application guidelines to ensure consistency in their usage will enhance knowledge of their purpose. Additional training is required to make these tools as functional as possible to the end user. As Winnipeg moves forward with implementing this design, the City is intending to support Manitoba Public Insurance to educate the public on their use.

REFERENCES

Austroads – *Cycling Aspects of Austroads Guides,* Austroads Ltd., Sydney Australia. www.austroads.com

NACTO, *Urban Bikeway Design Guide,* National Association of City Transportation Officials, New York, U.S.A. www.nacto.org

Footway Crossings and Tactile Paving, http://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/cyclingengland/2011/01/b05_footway_crossings_and_tactile_paving.pdf, Cycling Embassy of Great Britain

FIGURES

Figure 1 – Previous conditions along Pembina Highway

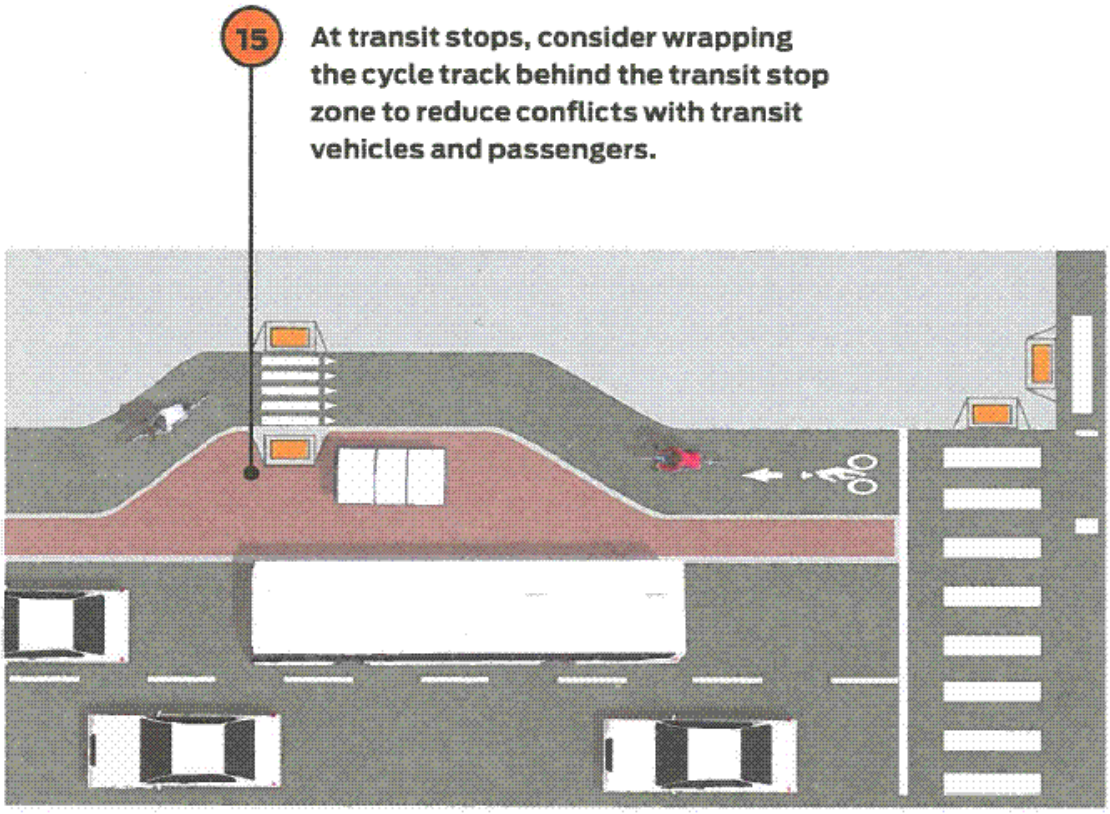

Figure 2 – Suggested treatments in the NACTO Urban Bikeway Design Guide

Figure 3 – Overall view of the bus stop

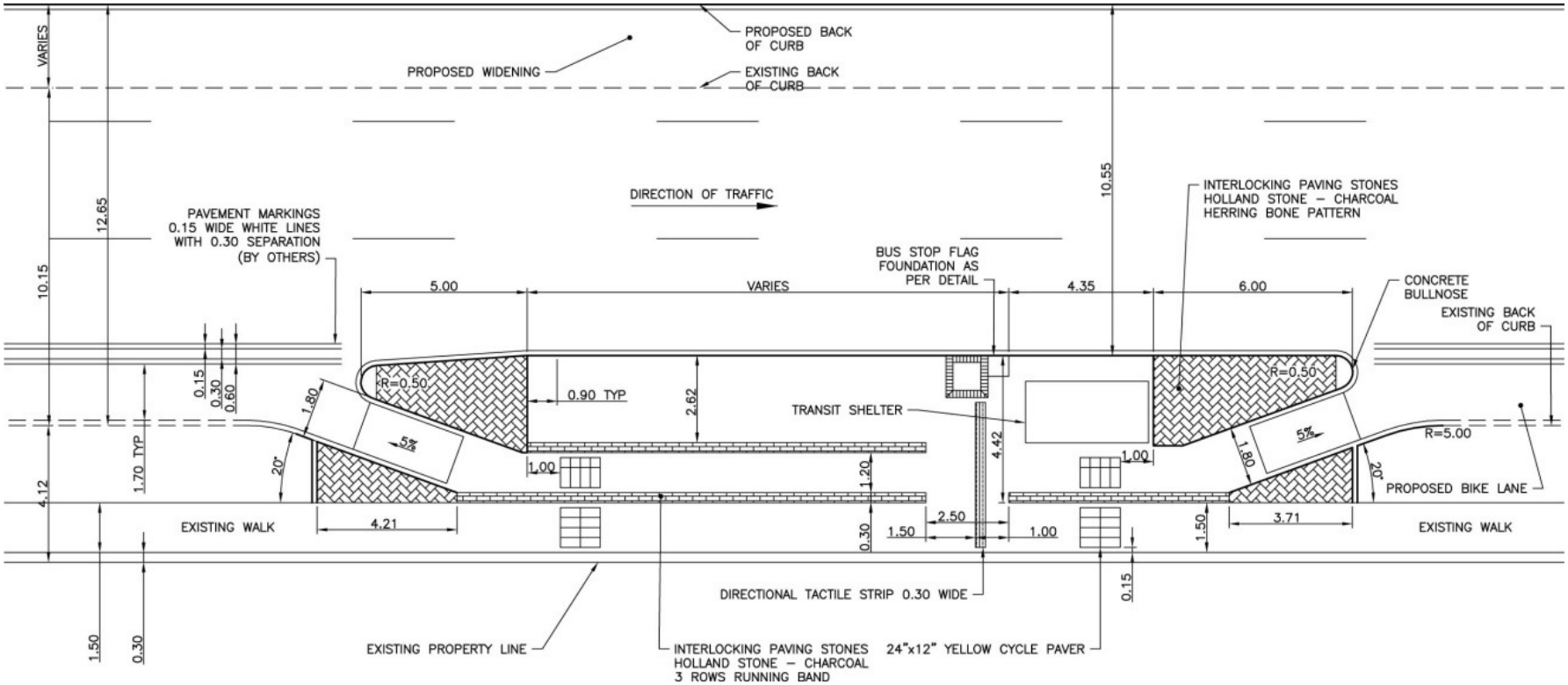

Figure 4 – Geometric Design Details

Figure 5 – Cycle Slab pavers and paving bands

Figure 6 – Detectable directional strip leading to the head of the bus platform

Figure 7 – A variety of users exiting the bus from both doors towards the sidewalk

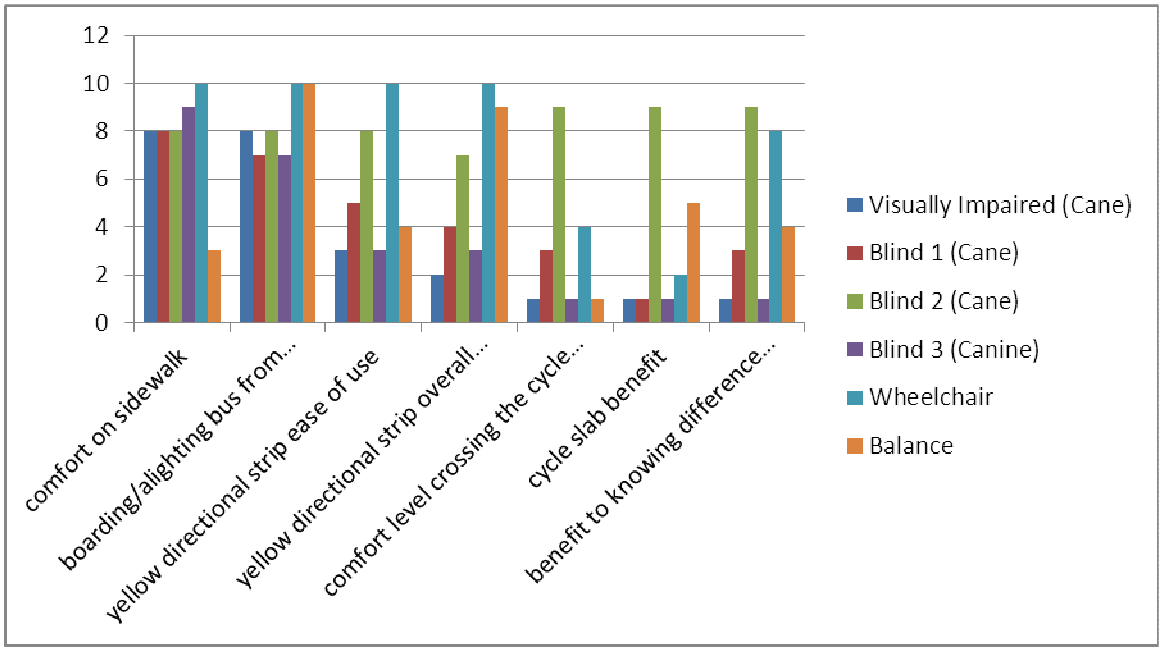

Figure 8 – Weighted feedback from questionnaire by various pedestrians

Figure 9 – A cyclist using the approach ramp

Figure 10 – Typical winter environment and snow clearing difficulties

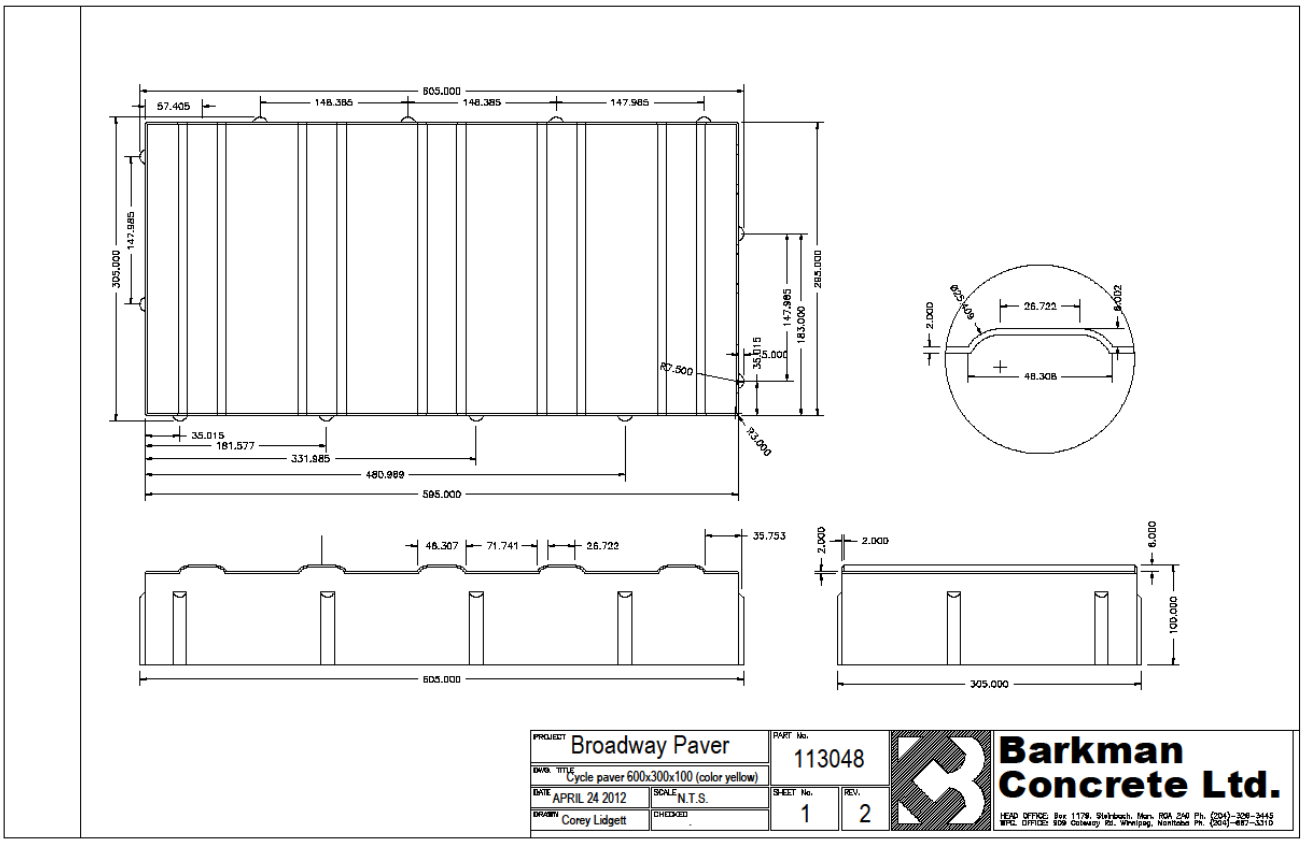

Figure 11 – Final fabrication drawing for the yellow concrete cycle slab pavers

APPENDIX A – EVALUATION QUESTIONNAIRE

The City very much appreciates your time from Friday and values your input from the evaluation performed on Friday of the Pembina Bus Stop trial design. We took careful notes but would like to ask a few more questions to ensure our findings are complete. Also over the weekend you may have had some additional time to consider your experiences.

On a scale of between 1 (being low) and 10 (being high) please rate the following:

1. Overall, please rate your comfort level while walking along the sidewalk?

2. Overall, please rate your comfort level boarding the bus and departing from the bus moving to and from the sidewalk?

3. Please rate how easy the yellow directional strip was to locate?

4. Please rate the benefit level of the yellow directional strip from the sidewalk to the head of the bus stop in assisting in finding the head of the stop?

5. Please rate the comfort level of the yellow cycle slab pavers as you walked or wheeled across them?

6. Please rate whether the square cycle slab pavers located at the beginning and the end of the transit platform area provided you any assistance or benefit in potentially identifying the area where cyclists and pedestrians may interact?

7. Please rate whether the orientation of the ribs on the cycle slab pavers were more distinguishable from each other, would there be a benefit in knowing what area is for cyclists and what area is for pedestrians?

8. Now that you have had a chance to think about your experience, do you have any other comments about the usability of this bus stop design?