TORONTO'S LAST MILE

Delivering to Communities in Public Urban Spaces

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Streets shadowed by skyscrapers, copious amounts of cars trying to navigate through the downtown core, and, communities that grow in density everyday –Toronto is lacking the infrastructure to accommodate the contemporary rise of e-commerce parcel delivery.

Goods moving to the ultimate destination, the 'last mile,' is not only credited to be the most expensive, inefficient, energy consuming phase in parcel delivery, but also contributes to the well-being of those in the city. As Toronto transitions from conventional markets to online shopping, every location in the city has become a last mile destination point. The resulting new and unaccustomed elements are transforming the basic physical and organizational structures in communities. These societal changes and increased demands on transportation and distribution networks are affecting systems of social comfort like safety and activity in neighbourhoods.

This thesis explores the impacts that delivery will continue to have in dense urban communities, addressing the need to rethink the daily interactions between delivery, people, and their relationship to street and building design. The architecture proposed to recognize society's shift in delivery is based on a freight on transit concept, where Toronto's subway stations are redesigned to act as a distribution network and are spaces for community delivery transactions. This new form of public space incorporates both functioning and sustainable interactions of micro-mobility delivery and self-collection lockers.

Ongoing urban issues of travel, environment, and safety in communities due to delivery needs to be addressed. The proposed design hopes to not only mitigate the 'last mile' problems in the urban context, but create public spaces that redefines metropolitan delivery, bringing a new narrative to *Toronto's Last Mile*.

ACKNOWLEDGEMENTS

To my supervisor, Marie-Paule Macdonald, thank you for the guidance, encouragement, and energy right from the beginning to the very end. Your positivity and confidence in me made this thesis possible.

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To my friends from architecture school, who have been by my side from our undergraduate degree all the way to our master's degree, I am happy to have shared this adventure together. Thank you for the memories filled with great conversation and laughter.

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INTRODUCTION

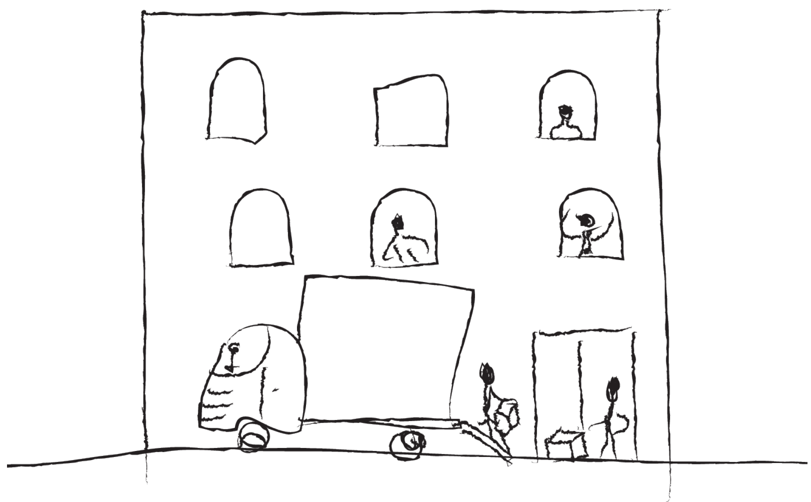

fig.0.2 Last mile problem sketch

The Last Mile Problem

The movement of your car idling as you wait behind a parked parcel van. The sound of waking up at 7 am to hear that delivery truck right below your window. The frustration you feel when someone has stolen your package-again.

Delivery is integrated into our everyday life. When you click to make that final order, most people are concerned with shipping costs, on-time delivery, or pick-up locations. However, in dense urban cities like Toronto, there is more to worry about than the logistics of your order.

Delivery in metropolitan cities are heavily influenced by the 'last mile,' "the delivery process from the last transit point to the final drop point of the delivery chain."[1] Typically, this is when you see parcel vans or box trucks driving around your neighbourhoods delivering door-to-door. From a distributor's perspective, the 'last mile' is the greatest challenge in delivery. It is the most time consuming because there is no bulk transportation, and therefore, the greatest expense, attributing up to 28% of an item's shipment cost.[2] In addition, there are huge environmental impacts associated with the greenhouse gas emissions that delivery vehicles produce as they drive back and forth to different locations across the city (*fig 0.3)*. Furthermore, a 2006 survey showed that the urban congestion in the nine largest cities in Canada cost a conservatively estimated $3.1–$4.6 billion yearly.[3] When congestion on roads impacts the transportation of both people and goods, it negatively affects the function and prosperity of that area.[4]

Delivery services have now coined the challenges of transportation in its final leg, 'the last mile problem.'[5] While 'the last mile problem' may seem to be just a concern for courier companies, the reality is that urban freight directly affects and is transforming the existing metropolitan community dynamics.

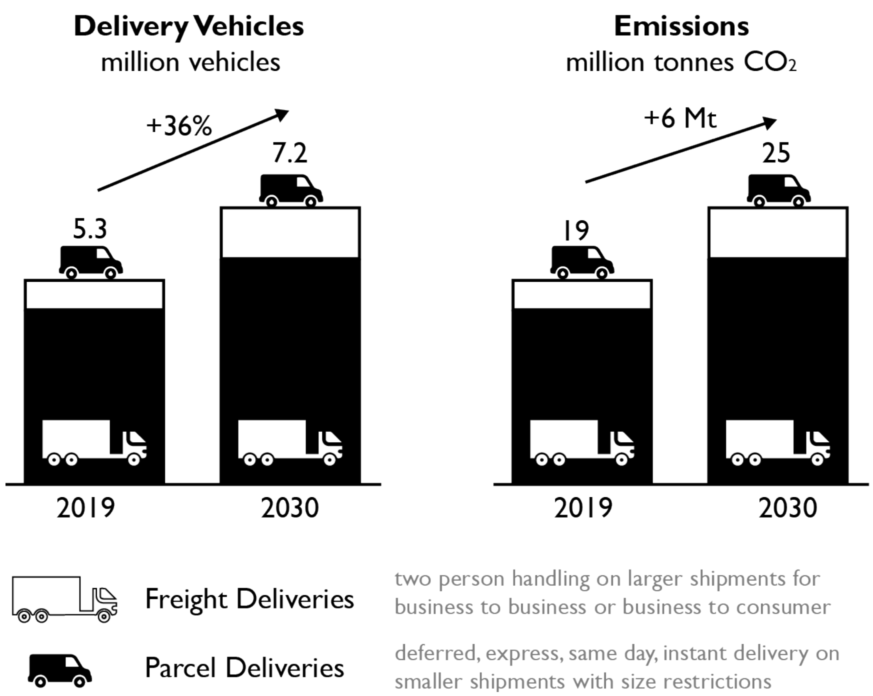

fig.0.3 Projected delivery vehicles and CO_2 emissions growth average in top 100 cities globally.

fig.0.4 Spadina Ave at Queen St W, Toronto

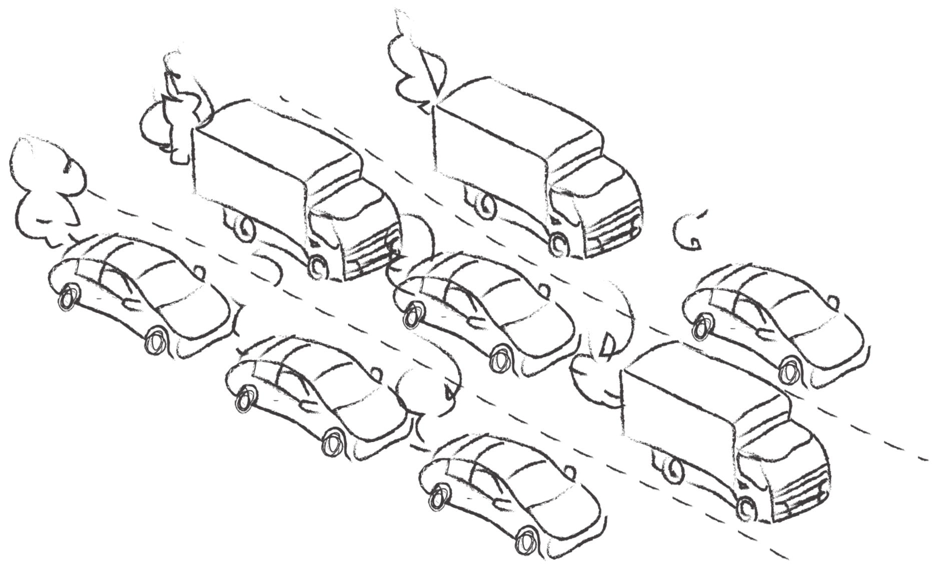

fig.0.5 Urban congestion sketch

A Growing City

Urban growth in the Greater Toronto Area is at a rapid increase. By 2046 Toronto's population will rise by 44.5 percent and in the Greater Toronto Area by 49.6 percent, together reaching 10.2 million people.[6] Needless to say, expanding the city's infrastructure and services to meet the needs of its growing population comes with concerns of new construction, ceaseless traffic congestion, and inadequate public spaces. Now added to the concerns are the implications from the 'last mile' in an age where fast and instant delivery is becoming extremely prevalent.

As the population in Toronto rises and as emerging trends of online delivery are becoming increasingly prominent in today's society, the city will struggle in its 'last mile.' E-commerce, electronic/internet buying or selling of products has more than doubled annually in Canada.[7] Statistics Canada found that there has been a 110 percent increase in sales between May 2019 to May 2020 (*fig 0.6)*.[8] Additionally, fast shipping guarantees like two-day or next-day delivery are becoming noticeably popular and successful (*fig 0.7)* - look at e-commerce giants like Amazon or Walmart, with their sales as a reflection of their prosperity (*fig 0.8)*.[9] This groundbreaking service is forcing both large and small retail shops to stay relevant and competitive by integrating an online platform and accommodating fast shipping and door-to-door delivery.[10]

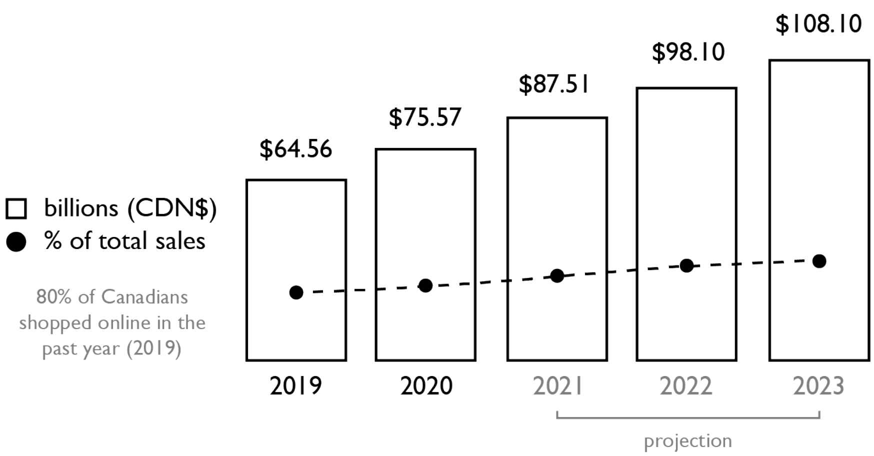

fig.0.6 **Retail E-commerce Sales in Canada**

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fig.0.8 Sales in U.S. dollar of the two largest grossing e-commerce stores in America

With retailers and consumers transitioning to online shopping there is increasing proof that e-commerce is here to stay. Systems of both traditional postal courier services and newer approach, crowdsourced shipping, the "method of fulfillment that leverages networks of local, non-professional couriers to deliver packages to customer's doors",[11] are creating unseen strains on city infrastructure. Furthermore, technology has revolutionized our access to products. Whether ordering from computers at home or apps on phones, advancements have allowed for instant and time-definite delivery to more 'last mile' destination points than ever.[12] This increase in urban freight means that delivery no longer involves just the individual consumer and retailer, delivery impacts the entire community dynamic.

There needs to be a call to attention that our city logistics must evolve to accommodate the repercussions from the rapid increase in online shopping. The underlying and soon to be major problems that the 'last mile' will produce in the city and in the daily activities in the community need to be resolved.

fig.0.9 Courier in Toronto

fig.0.10 Delivery to public urban spaces sketch

Delivery to Public Urban Spaces

Urban freight is transforming the very physical, environmental, and social infrastructure that make up and define downtown Toronto. In this thesis the contemporary rise of internet driven commerce and its relationship to people, public spaces, and architecture is discussed in three parts: *Delivery and Streetscapes, Integrating City Logistics,* and *Rethinking Toronto's Last Mile.*

Part 01

Delivery and Streetscapes is an introduction to the 'last mile problem' from an urbanite point of view, exploring Toronto's urban system and its relationship to parcel distribution in the metropolitan context. This chapter particularly focuses on the moving box trucks and parked parcel vans, as they are epitomes of transportation for consumer goods that use online shopping in busy cities. The analysis will first examine reports and media from other global cities that are facing these same issues of delivery vehicles on public infrastructure. Then, a comparison of major issues extracted from the reports will correlate with the types of streetscapes in downtown Toronto. Respectively, each classification of streetscape has its own delivery scenarios which are further studied by way of photographs, micro-street analysis in plan, section, and elevation drawings, and documenting traffic signage for loading zones. This methodology hopes to encompass the overarching conditions of safety during a delivery movement, the efficiency of transportation, and the general quality of life in communities that are disrupted by the 'last mile.'

Part 02

Integrating City Logistics is an introduction to current and emerging concepts and strategies used to improve freight transportation to urban areas. Three different and unique types of city logistic methods are discussed - each fulfilling a component to the delivery system. This chapter starts with the freight on transit (FOT) method. The analysis of FOT relies on case studies and reports of other cities that have piloted or already integrated the concept into their city infrastructure. The second concept is micro-mobility delivery, particularly cyclelogistics. This section will investigate the effects of micro-mobility contrasting it to some of the major issues in the 'last mile' of delivery as portrayed in *Part 01: Delivery and Streetscapes*. The last method discussed is self-collection lockers. This portion addresses the physical features of self-collection lockers and where, how and why it is used today.

Integrating all three strategies into city infrastructure come with both benefits and concerns. The purpose of this chapter is to explore city logistics from an architectural point of view. Seeking the potential of these strategies from not just an operational and logistics perspective, but as a possibility to implement a purposeful spatial presence in city infrastructure.

Part 03

Rethinking Toronto's Last Mile is a design proposal for an architecture and urban space that encompasses the research done in *Delivery and Streetscapes* and *Integrating City Logistics.* The proposed design hopes to create architecture in a public urban space that can change Toronto's delivery narrative. Based on a FOT model, goods are transported by leveraging the Toronto subway system to the innermost parts of the city. As the TTC subway entrances are currently being reconstructed to adhere to accessibility issues, this thesis proposes new designs for the City of Toronto to not only incorporate accessibility into their reconstruction of subway stations, but also city logistics. Three major typologies of subway stations are redesigned, each one being a specific station in downtown Toronto. This exploration reconstructs the subway entrances to create a dynamic area where parcels are unloaded, transported to homes through micro-mobility means, and uses self-collection services.

This final chapter aims to design a multivalent public space that is a part of people's community in where they work, live, or commute. This is in hopes of encouraging and creating a society where our habits and how we live can change the current and future narrative to *Toronto's Last Mile*.

Endnotes

1 J. Lindner, *Last Mile Logistics Capability: A Multidimensional System Requirements Analysis for a General Modelling and Evaluation Approach* (Technical University of Munich)

2 Hochfelder, Barry. "What Retailers can do to make the Last Mile More Efficient." *Supply Chain Dive*, last modified May 22, 2017, https://www.supplychaindive.com/news/last-mile-spotlight-retail-costs-fulfillment/443094/

3 "Road Transportation." *Government of Canada*, last modified July 13, 2020, https://www.tc.gc.ca/eng/policy/anre-menu-3021.htm.

4 Ibid.

5 "The Last Mile — the Term, the Problem and the Odd Solutions." *Stigo*, last modified Oct 4, https://medium.com/the-stigo-blog/the-last-mile-the-term-the-problem-and-the-odd-solutions-28b6969d5af8.

6 "Ontario Population Projections, 2018–2046 ." *Ontario Ministry of Finance*, date accessed Oct 1, 2019, https://www.fin.gov.on.ca/en/economy/demographics/projections/

7 "Online Shopping has Doubled during the Pandemic, Statistics Canada Says." *The Canadian Press*, last modified Jul 24, 2020, https://www.cbc.ca/news/business/online-shopping-covid-19-1.5661818.

8 Ibid.

9 McBride, Stephen. "Amazon has Finally Met its Match." *Forbes*, last modified Aug 24, 2020, https://www.forbes.com/sites/stephenmcbride1/2020/08/24/amazon-has-finally-met-its-match/#7915041c71c1.

10 Ibid.

11 Dolan, Shelagh. "Crowdsourced Delivery Explained: Making Same Day Shipping Cheaper through Local Couriers." *Business Insider*, last modified May 21, 2018, https://www.businessinsider.com/crowdsourced-delivery-shipping-explained.1.

12 Woudsma, Clarence. *Disrupting Stuff: Material Flows in the Platform City*, 7; Thomas Deloison et al., *The Future of the Last-Mile Ecosystem* (Cologny/Geneva: World Economic Forum, Jan 20), 5

01

Delivery & Streetscapes

Streets and their sidewalks, the main public places of a city, are its most vital organs

- Jane Jacobs

Streetscape

"The visual elements of a street, including the road, adjoining buildings, sidewalks, street furniture, trees and open spaces, that combine to form the street's character."[1]

Toronto's urban fabric is rich with various types of streetscapes. To understand the relationship between urban parcel delivery and the diverse characteristics of streets, it is fundamental to take a look at the different classifications of roads in Toronto. Categorizing roads is essential to understand the needs of the community in not only transportation infrastructure, but as well as protecting neighbourhoods against the negative repercussions of transit.[2] Ultimately, road classification systems are supposed to designate protocols on streets making it appropriate to the neighbourhood allowing it to flourish.[3] However, with the rise in parcel delivery, it is necessary to reconsider Toronto's current streetscapes and recognize any faults that would not be able to meet the needs of the community in a rising e-commerce era.

Delivery and Streetscapes begins with a glance at global media reports regarding delivery issues on public infrastructure. These delivery repercussions are categorized into the City of Toronto's classification of road types: Arterial, Collector, Local, and Laneways. Case studies on these street typologies are located in Toronto with an analysis of parcel van and box truck delivery implications. This analysis is compared to the comprehensive data reports to bring attention to a specific 'last mile problem.' While issues of delivery can occur on all road types, defining the most extrusive 'last mile problem' in each typology draws attention to the primary concerns of safety, pedestrian and vehicular circulation, and other neighbourhood activities for that street condition.

Toronto's city logistics are not evolving to meet the rise in e-commerce demands, and the city's streetscapes will undergo the same delivery consequences that many global cities are facing. Toronto needs to address its transforming streetscapes by introducing new measures and protocols to sustain and uphold its communities infrastructure.

Cycling with Trucks on Arterial Roads

"The primary function of an arterial road is to deliver traffic from collector roads to freeways or expressways, and between urban centres at the highest level of service possible." [4]

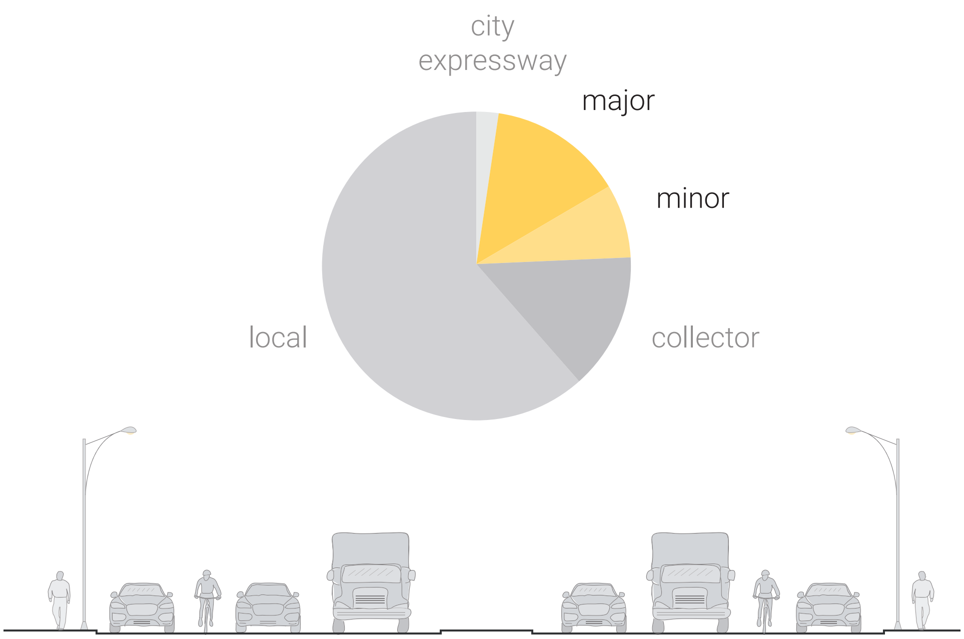


fig. 1.1 Ratio of Major & Minor Arterial Roads in Toronto and key characteristics

Major and minor arterial roads are common sights in downtown Toronto's road networking system. About 22 % of roads in Toronto are major or minor arterial roads (*fig. 1.1*). These high functioning streets are areas with heavy traffic, circulating greater than 20 000 vehicles daily at a speed limit of 40 to 60 km an hour.[5] They consist of pedestrian sidewalks on both sides and can procure bike lanes.[6] As Toronto leans towards a greener city, increased implementation of bike lanes can be expected on arterial roads. Cyclist safety will be an ongoing issue as the number of delivery vehicles on the roads continue to grow.

fig. 1.2 Cyclist in Toronto using a pool noodle to create a safe distance between cars

The rate of Torontonians cycling to work as their main mode of transportation is up city-wide, by 34% from 2006 to 2016 in some neighbourhoods.[7] However, cyclists are concerned as a safe network of high quality protected bike lanes and low speed routes are missing on Toronto streets.[8] In fact, it is estimated that the third greatest contributor to the global burden of disease and injury are road accidents.[9] A study in Europe found that "cyclists are 8 times more likely to suffer a fatal injury per kilometre of road travelled as compared to occupants of a motor vehicle", making cyclists one of the most vulnerable of road users.[10]

In general, motorized vehicles are dangerous to cyclists, however, trucks are especially hazardous due to their large size, lack of visibility, and truck drivers tend to reverse, drive, and park on cycle paths.[11] This is evidently seen in several countries where cyclists killed by a truck represents almost 30% of all cycling fatalities.[12] A large part of this issue is that cyclists must share the street with trucks with no physical barrier (*fig. 1.2*). "For example, in New York City alone, 15% of the bicycle networks and 11% of the truck networks are currently overlapping."[13] However, cycling accidents can be prevented by adding barriers between motorized vehicles and active transportation. "Studies in Denmark have shown that providing segregated bicycle tracks or lanes alongside urban roads reduced deaths among cyclists by 35%."[14]

As the amount of delivery trucks increase due to the rise in e-commerce, it is imperative to think about the safety of cyclists sharing a road with parcel and box trucks in dense urban cities. In Toronto, 65% of fatal cycling collisions took place in an urban environment, and as statistics show, trucks represent a large proportion of those accidents.[15] The city of Toronto needs to redevelop its city logistics to accommodate the rise in e-commerce delivery that will inevitably bring more trucks to the city's roads, endangering cyclists.

Arterial Roads - Case Study

The following are case studies of arterial roads in downtown Toronto. While cycling can procure on the majority of road types, arterial roads are areas of increased traffic and higher speeds, causing danger for cyclists. In the following street case studies, the adverse effects of three delivery situations with cyclists are denoted as *1*, *2*, and *3* on *fig. 1.3 Map of Arterial Roads in Downtown Toronto*.

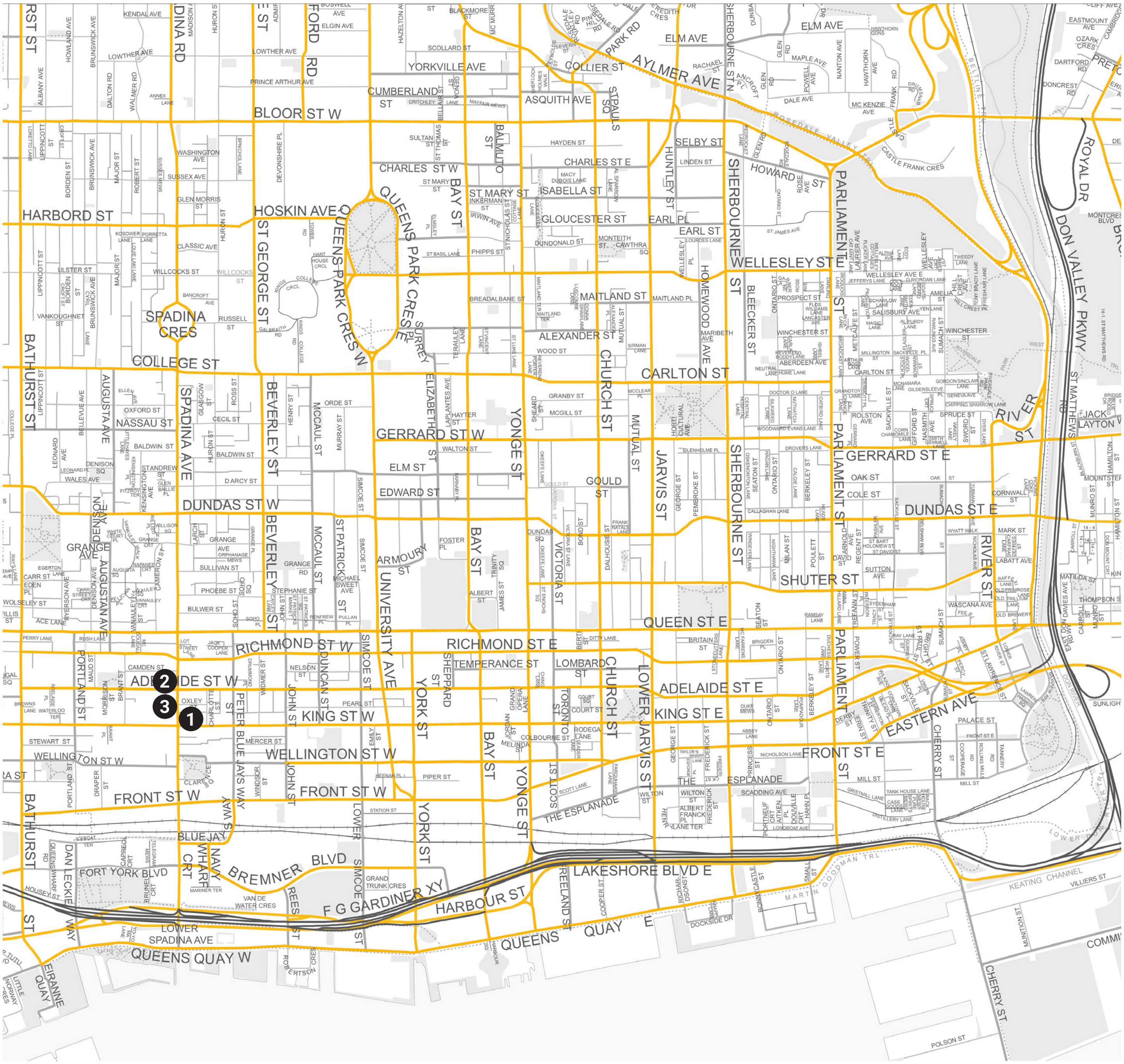
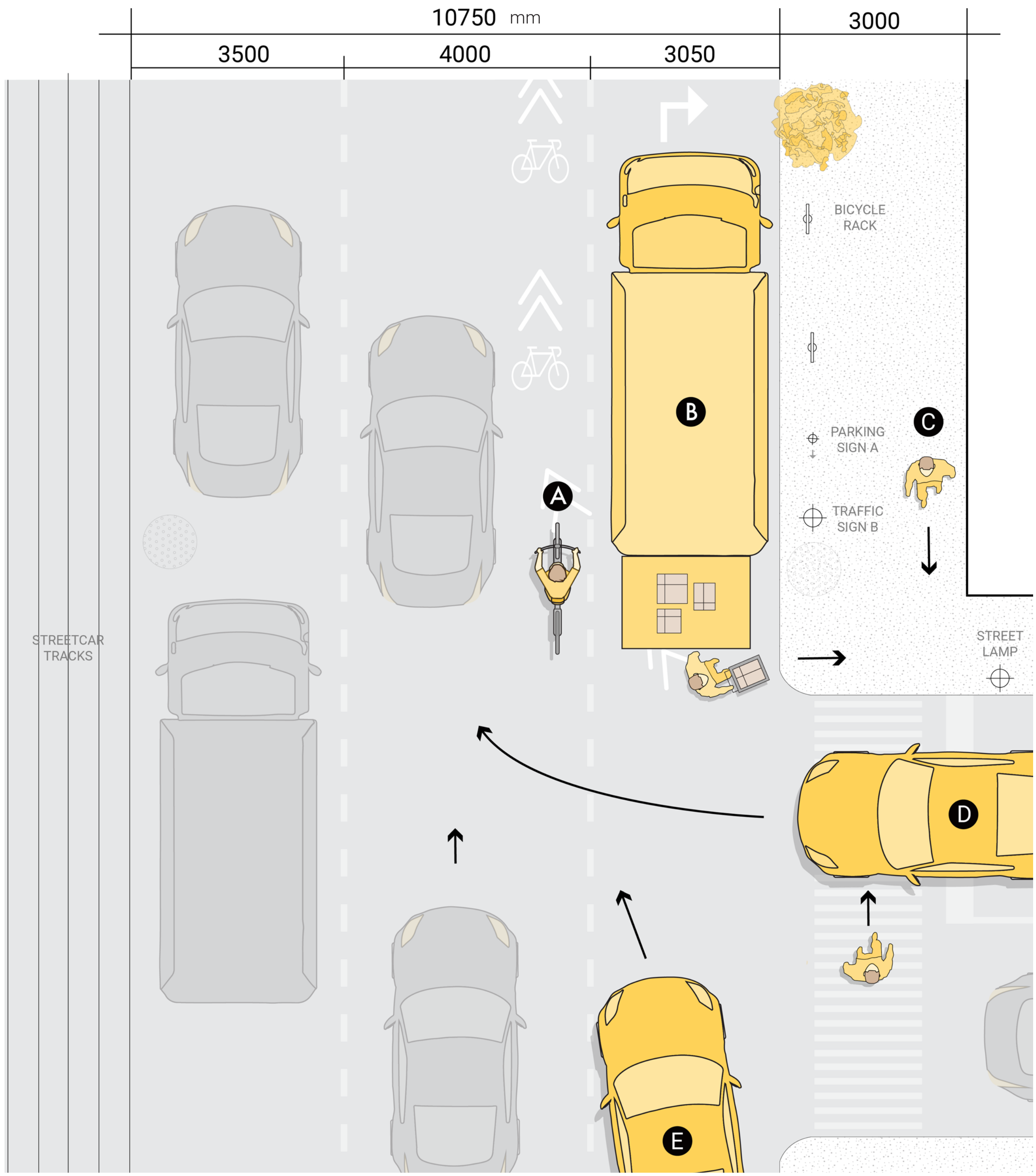


fig. 1.3 Map of Arterial Roads in Downtown Toronto



A cyclist in between moving vehicles & parked courier truck

B truck illegally parked & blocking right of way turning lane

C pedestrians & couriers interrupting flow on sidewalk

D car turning right must go into the next lane -watch for 2 types of vehicular traffic & pedestrian crosswalk

E car must switch lanes because blocked by truck

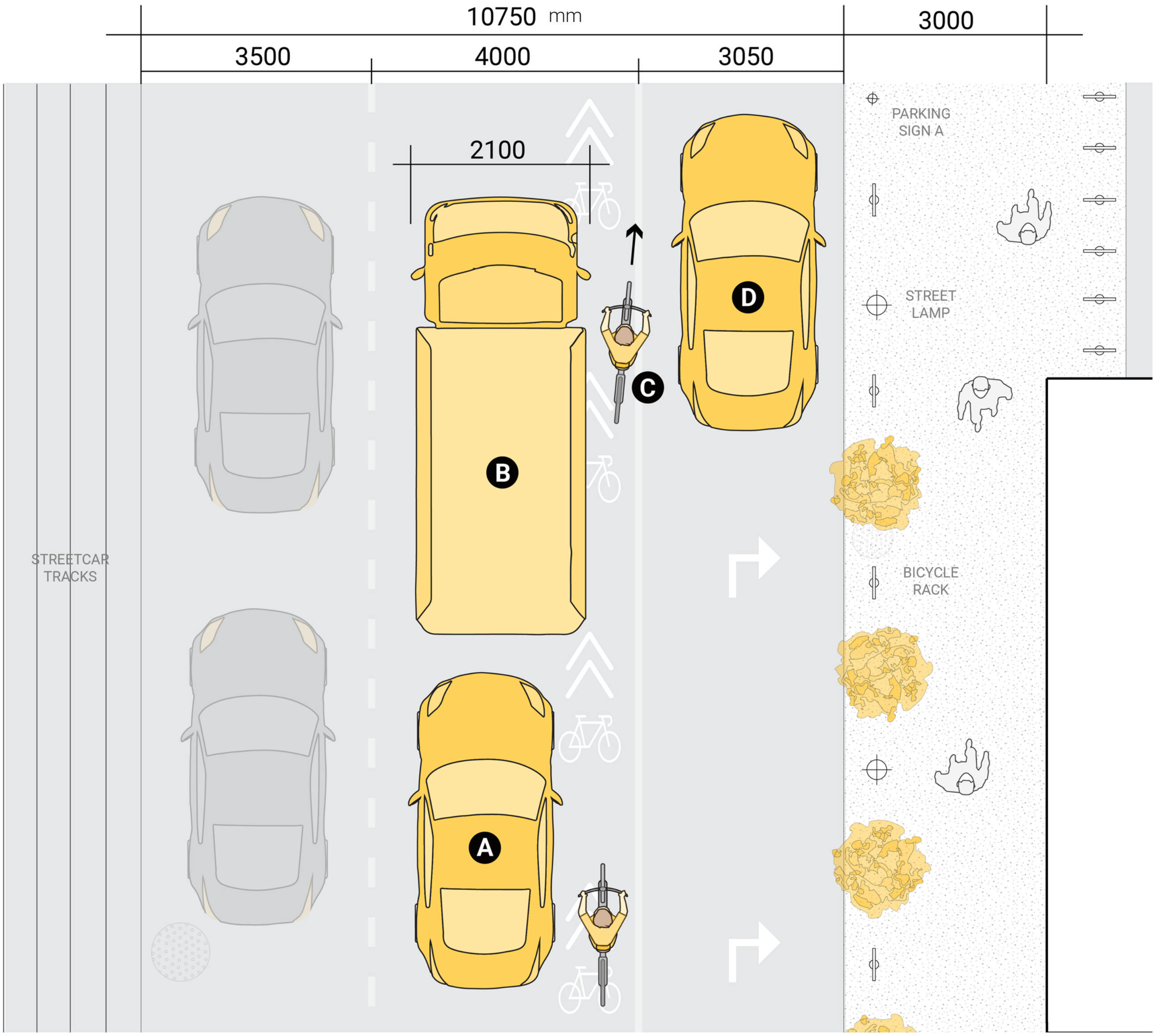
fig. 1.4 Arterial Roads- Analysis of Situation (1)

fig. 1.5 Arterial Roads- Image of Situation (1)

fig. 1.6 Arterial Roads- City Block Image of Situation (1)

(1) Arterial Roads

Situation (1) occurs on Spadina Avenue, a high capacity urban road that intersects with local road Oxley Street. There are high levels of pedestrian traffic and trucks stopping to deliver to the numerous retail shops on Spadina Avenue. Couriers must maneuver through pedestrian flow in order to reach the retail shops (*C* on *fig. 1.4*). Furthermore, in this situation, a delivery truck is parked on a no stopping zone that interferes with cars turning right on Oxley Street. (*B* on *fig. 1.4*). Vehicles turning right on Oxley Street are forced to move forward to safely turn into the following vehicle lane, and consequently, blocking a pedestrian crosswalk (*D* & *E* on *fig. 1.4*). To make matters worse, a bicycle lane with no safety barriers is in the midst of the situation creating a hazardous scenario for cyclists (*A* on *fig. 1.4*).



Ⓐ standard car sharing lane with a cyclist

Ⓑ box truck sharing lane with a cyclist

Ⓒ cyclist forced to squeeze inbetween a box truck & car

Ⓓ standard car in right turning lane

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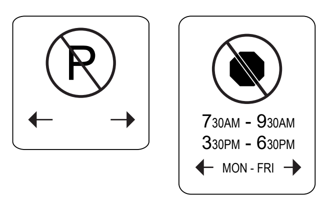


fig. 1.7 Arterial Roads- Analysis of Situation (2)

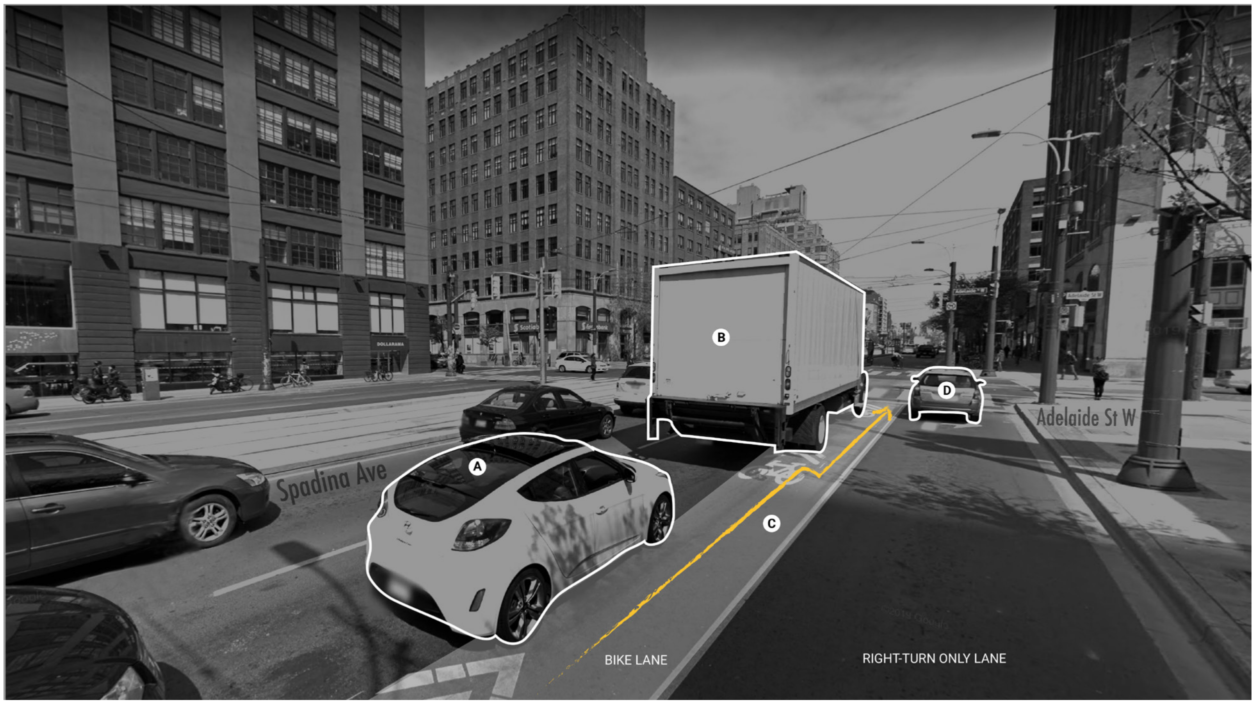


fig. 1.8 Arterial Roads- Image of Situation (2)

fig. 1.9 Arterial Roads- City Block Image of Situation (2)

(2) Arterial Roads

Situation (2) on Spadina Avenue at Adelaide Street West demonstrates an example of a standard car and box truck sharing the road with a cyclist (*fig. 1.8*). It is clear that the standard car gives more space for cyclists than a box truck (*A* & *B* on *fig. 1.7*). Additionally, the cyclist must be cautious of incoming traffic from the right turn only lane, as cyclists are in the vehicle's blindspot and dangerously close in proximity (*C* on *fig. 1.7*). Ultimately, cyclists become too close for comfort to vehicles when sharing lanes with trucks. To make matters worse, trucks have been parked illegally on the right turn only lane, such as in Situation (1), creating a threatening condition if cyclists are in between two trucks. This is analyzed in depth in Situation (3).

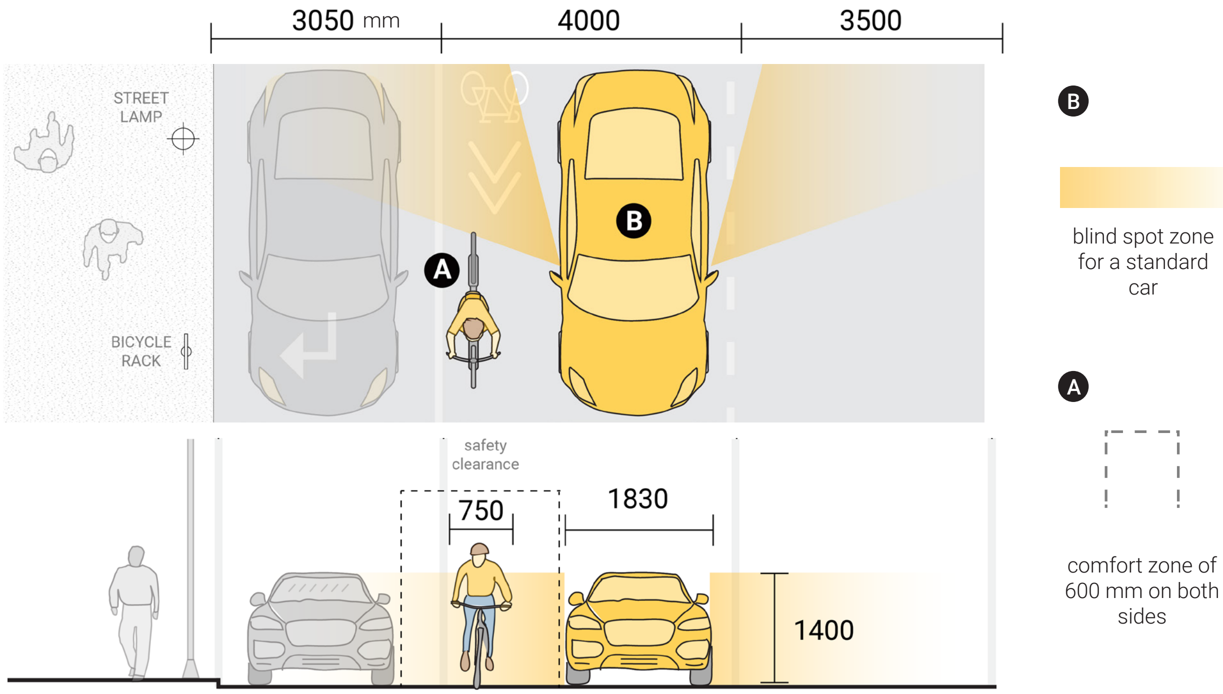


fig. 1.10 Arterial Roads- Analysis of Situation (3) : cyclist & car

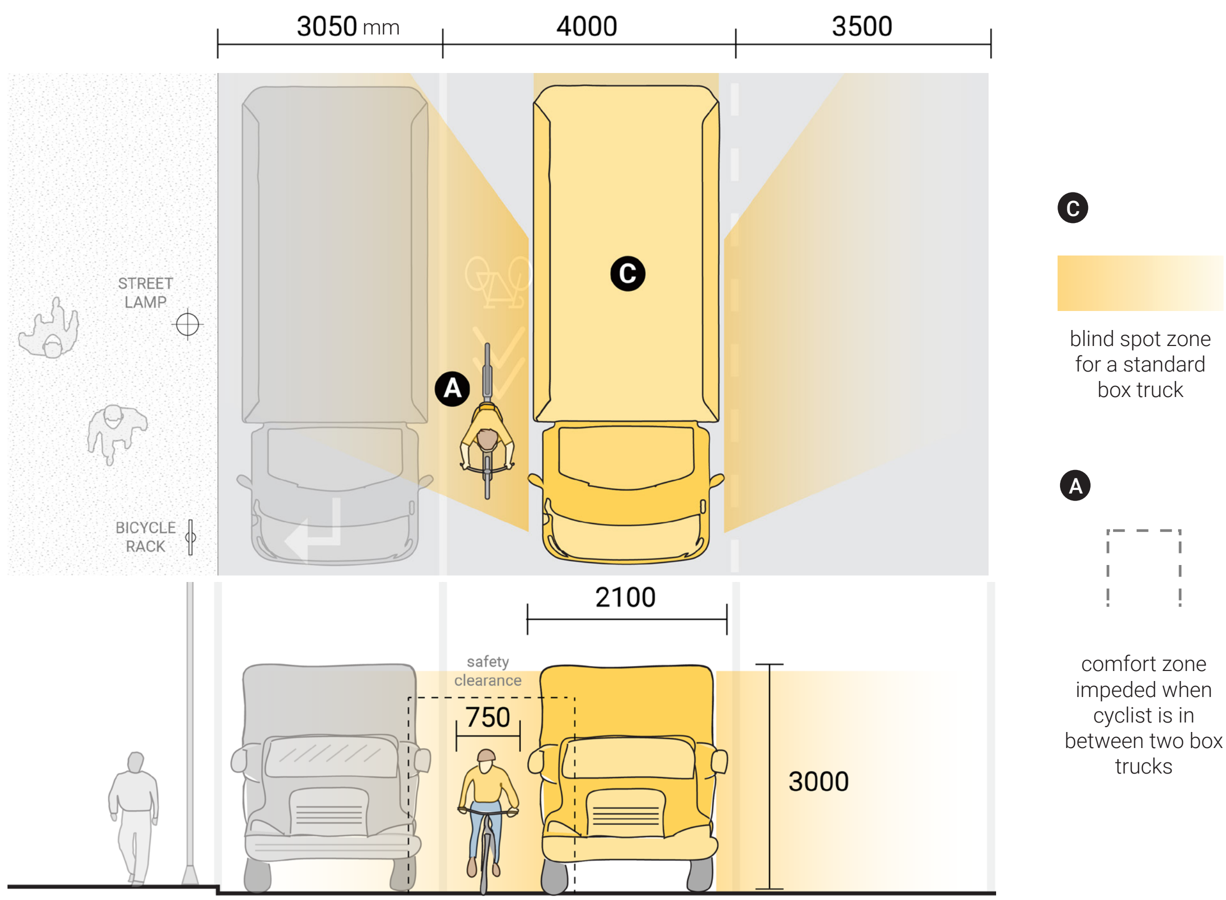


fig. 1.11 Arterial Roads- Analysis of Situation (3): cyclist & truck

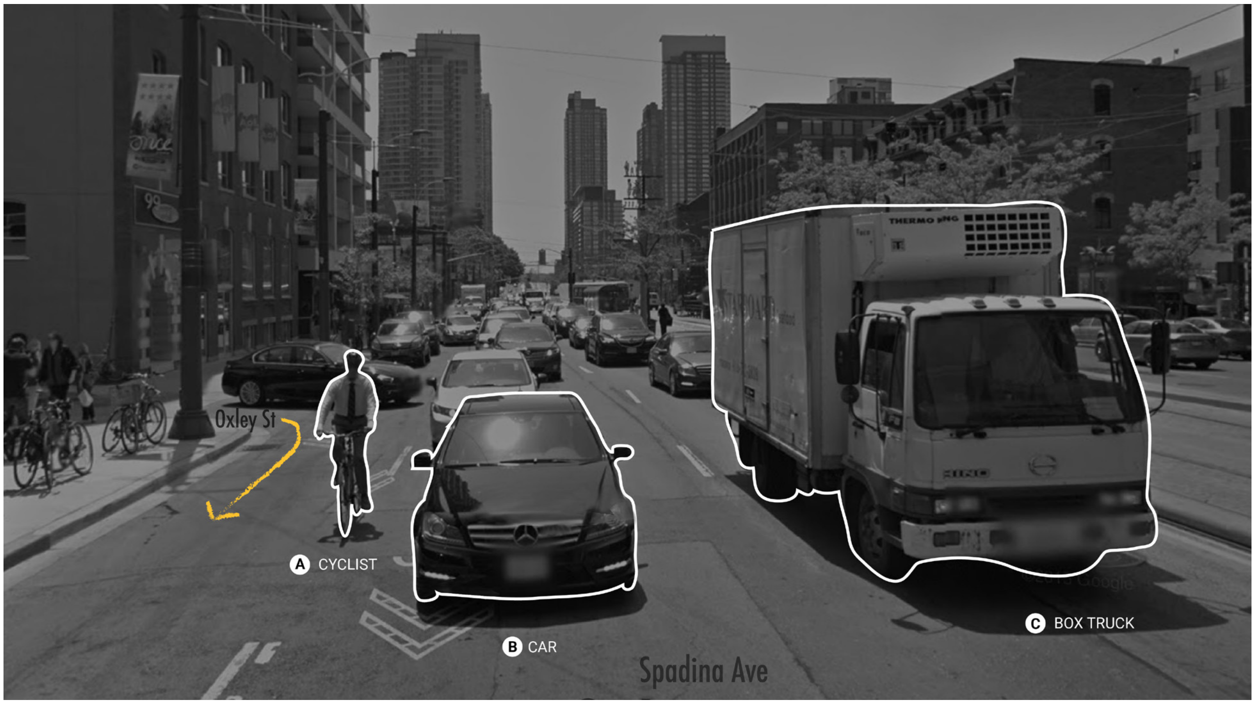


fig. 1.12 Arterial Roads- Image of Situation (3)

fig. 1.13 Arterial Roads- City Block Image of Situation (3)

(3) Arterial Roads

Situation (3) shows an example of a cyclist, car, and box truck all on Spadina Avenue at Oxley Street. *Fig. 1.12* demonstrates a clear image of scale and the relationship between the two types of vehicles and the cyclist. *Fig. 1.10* and *fig. 1.11* illustrate the safety issues that cyclists experience on bike lanes that are shared by vehicles with no barrier or protection. As depicted on *B* of *fig. 1.10*, the blind spot for the standard car is significantly less than for a box truck as seen on *C* of *fig. 1.11*. Additionally, clearance zones for cars passing bicyclists is 1 m.[16] This minimum is difficult to meet when a cyclist is driving in between two standard cars, however, the clearance zone is further impeded on when cycling in between two box trucks. Ultimately, when cyclists are sharing the road with a box truck or parcel van, their safety is at risk.

The Dynamic Curbside on Collector Roads

"A collector road or distributor road is a low-to-moderate-capacity road which serves to move traffic from local streets to arterial roads."[17]

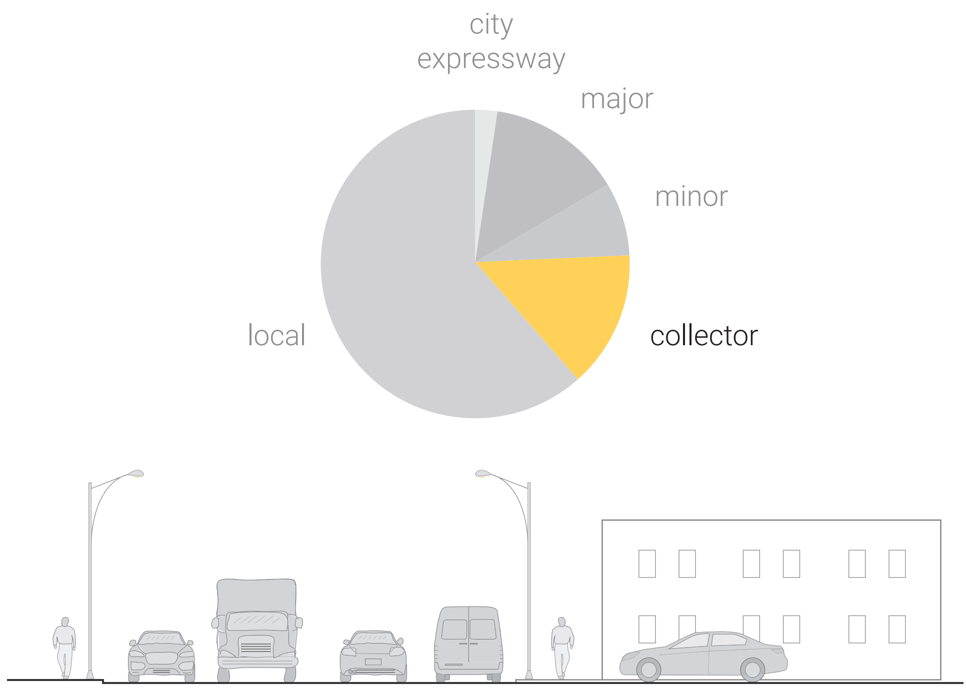


fig. 1.14 Ratio of Collector Roads in Toronto and key characteristics

Collector roads, also known as distributor roads, provide access to private property and traffic movement.[18] They make up about 14 % of roads in Toronto, occupying 2500 to 8000 vehicles per day and have sidewalks on both sides of the street (*fig. 1.14*).[19] Collector roads are smaller and have less traffic than arterial roads, however, more than local roads, serving to carry traffic between these two street typologies.[20] As delivery increases, parked courier vehicles will be commonly seen on collector roads due to their access to property. Parcel vans and box trucks, too big and inconvenient to pull into some small city driveways-if there are any- must park on the road, blocking not only vehicle traffic, but pedestrian flow as well. While the use of roads and sidewalks for a few moments of delivery may seem minute, there are increasing reports that the use of public space have escalated into an extensive 'last mile problem.'

New York City, a metropolitan area often compared with its similarities to Toronto's infrastructure and culture, faces a colossal city logistics dilemma. In recent years, jarring headlines regarding the rise in internet commerce such as "1.5 Millions Packages a Day: The Internet Brings Chaos to N.Y. Street," or "How your Amazon Delivery Helps to Clog the Streets," amongst many others, are bringing awareness to parcel couriers' use of public sidewalks and roads, calling attention to a now dynamic curbside.[21] According to a Bloomberg CityLab article, they interviewed someone who watched "on average, delivery trucks stayed parked for 21 minutes at a time, and two thirds of them were double parked" at the bottom of a residential building in Lower Manhattan.[22] In fact, for big delivery transportation companies, illegal parking tickets are accounted for in their business model, and agreements are even made with

fig. 1.15 Organizing parcels on the sidewalks of New York

cities to pay in one big lump sum.[23] The Bloomberg CityLab interviewee also noted that "pedestrians and other vehicles struggled to maneuver around them [trucks]." [24] In 2018, a UK study shows that on average, 62% of delivery time in the 'last mile' is parked at the curbside with drivers unloading, sorting, and delivering parcels on foot.[25] The reason is that courier drivers rather spend their time parked in one spot and walk to their different destination points rather than drive around in traffic to look for parking.[26] Albeit using the curbside may be more convenient for couriers, issues of blocking roads and pedestrian flow on sidewalks are a cause for major concern for city dwellers.

Metropolitan streets are not designed for fleets of box trucks as it is essentially "transplanting a suburban model of e-commerce delivery to a walkable, urban environment."[27] This proves to be the case in some New York neighbourhoods as boxes are strewn across the sidewalks for sorting (*fig. 1.15*). "They are using public space as their private warehouse…that is not what the sidewalk is for" says a resident living in Midtown Manhattan.[28] And although it is not currently evident that Toronto's sidewalks are flooded with internet bought parcels, one has to imagine how the city will handle it's booming online economy. The idea that the curbsides in New York have transformed into this dynamic location- a mini logistics centre, is a precedent for what Toronto's streets potentially could become if the rise in e-commerce delivery is not addressed.

Collector Roads - Case Study

The following are case studies of collector roads in downtown Toronto. While the dynamic curbside can procure on other road types, collector roads are areas of moderate traffic with access to properties and so the effects of delivery on public space is evident. In the following street case studies, the adverse effects of two delivery situations are located as *1* and *2* on *fig. 1.16 Map of Collector Roads in Downtown Toronto*.

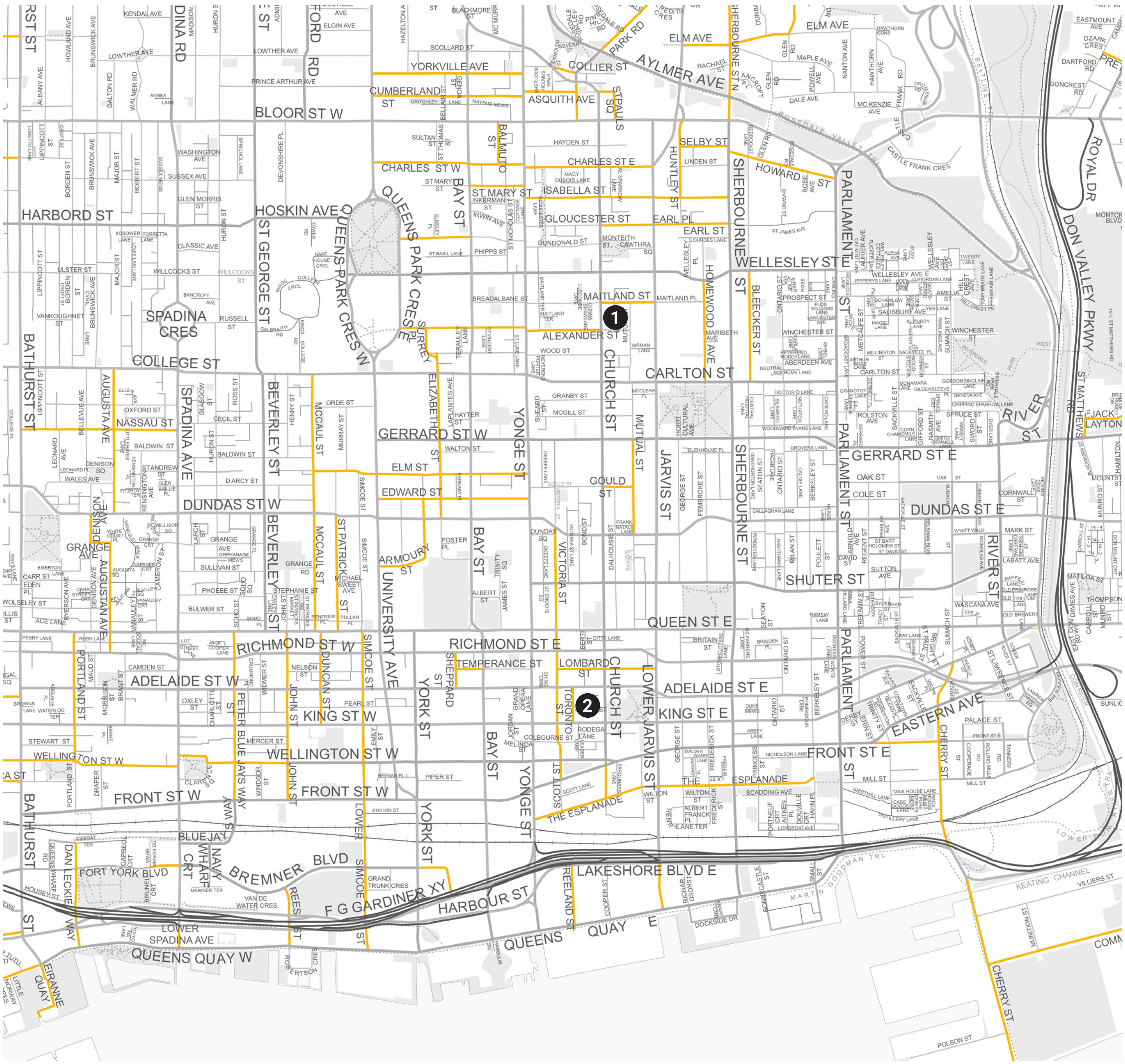
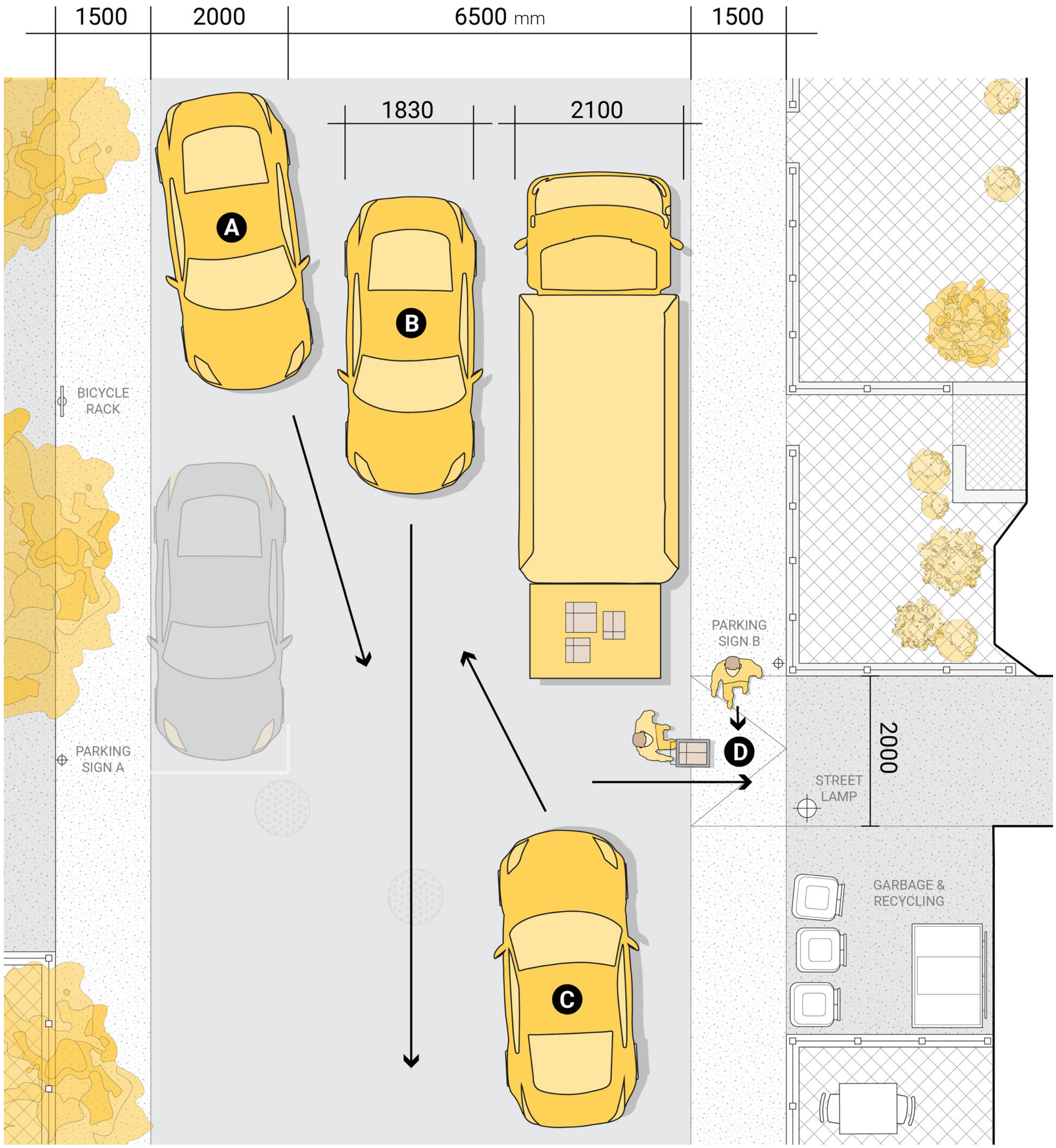


fig. 1.16 Map of Collector Roads in Downtown Toronto



- **A** parked car trying to leave but car B is blocking the way
- **B** car is in its right of way lane but must be cautious of car A & C
- **C** lane is blocked by delivery truck, must use opposite lane
- **D** pedestrian sidewalk blocked by couriers

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PARKING SIGN B

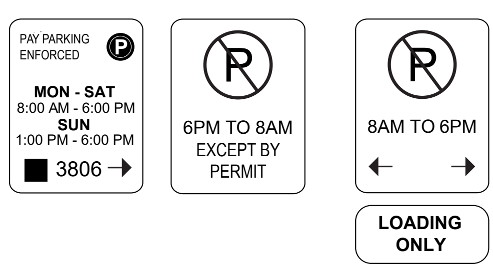


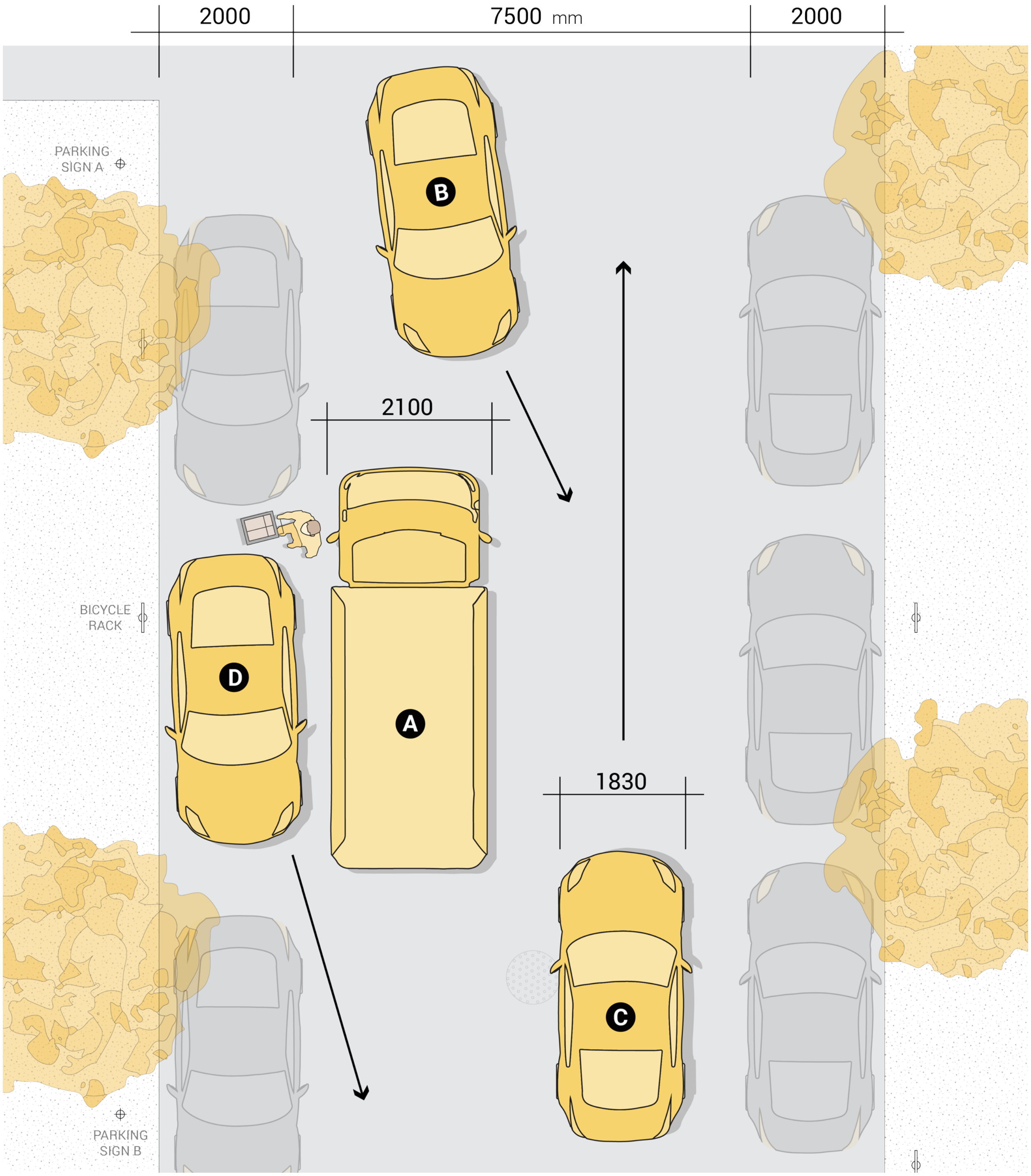
fig. 1.17 Collector Roads- Analysis of Situation (1)

fig. 1.18 Collector Roads- Image of Situation (1)

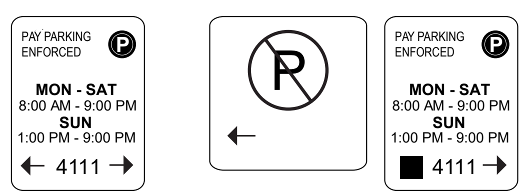
fig. 1.19 Collector Roads- City Block Image of Situation (1)

(1) Collector Roads

Situation (1) takes place on collector road, Maitland Street, which intersects with minor arterial road, Church Street. Maitland Street contains two lanes for opposite ways of oncoming traffic and one public parking lane. As seen in *fig. 1.17* the box truck parks and blocks its lane, forcing cars to switch lanes into oncoming traffic (*C* on *fig. 1.17*). Thus, cars in the oncoming traffic lane might have to wait for the car switching lanes while also being cautious of parked cars trying to leave (*A* and *B* on *fig. 1.17*). Ultimately, there is one lane for three types of traffic when one lane is blocked. Furthermore, the box truck is unable to fit in the 2000 mm wide laneway, meaning the designated delivery zone is too small. A traffic sign allows loading for large vehicles to be parked on the side. However, as mentioned before this impedes traffic flow. Trucks that are parked on the curbside also block the pedestrian sidewalk, making it difficult for both pedestrians and couriers (*D* on *fig. 1.17*).



PARKING SIGN A PARKING SIGN B



- **A** box truck double parked in opposite lane
- **B** lane is blocked by delivery truck, must use opposite lane
- **C** car is in its right of way lane but must be cautious of car B
- **D** car blocked by box truck

fig. 1.20 Collector Roads- Analysis of Situation (2)

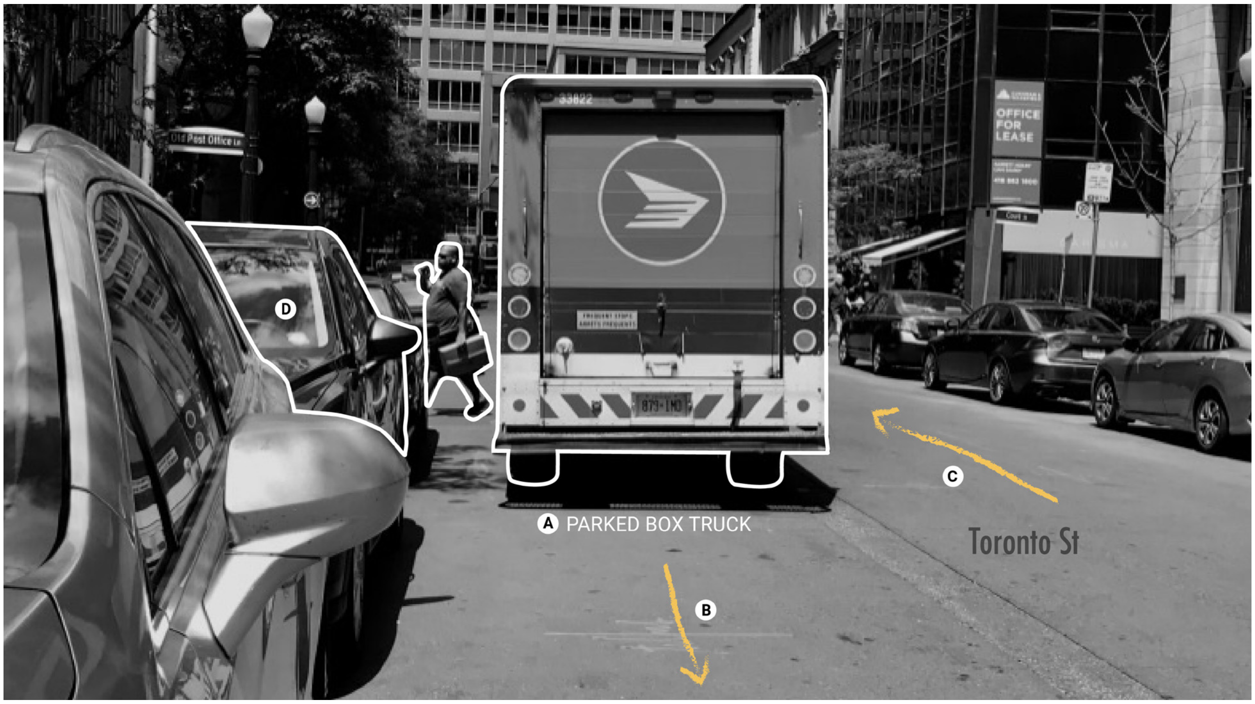


fig. 1.21 Collector Roads- Image of Situation (2)

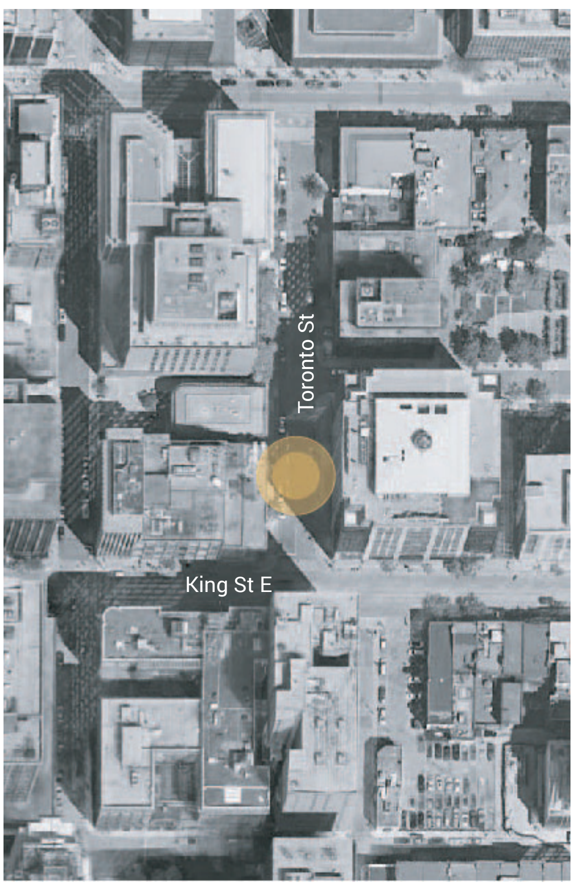


fig. 1.22 Collector Roads- City Block Image of Situation (2)

(2) Collector Roads

Situation (2) occurs on Toronto Street and showcases a double parked vehicle. In this scenario a Canada Post vehicle is illegally stationed parallel to a parked car in the opposite lane. Not only is this difficult for the driver of the parked car to leave (*D* on *fig. 1.20*), but it also forces two cars going opposite ways to share a lane (*B* and *C* on *fig. 1.20*). This can create a chain reaction causing traffic if there is only one lane, especially because Toronto Street intersects with busy arterial road, King Street East. Additionally, the courier must maneuver between parked vehicles and pedestrian flow on the sidewalk. If the courier had more parcels to deliver in this area, there could be a misuse of curbside and sidewalk, meaning public space would be further used for city logistics.

Pollution on Local Roads & Laneways

A laneway is "a narrow way or passage between walls, hedges, or fences."[29]

A local road is "a street that is primarily used to gain access to the property bordering it."[30]

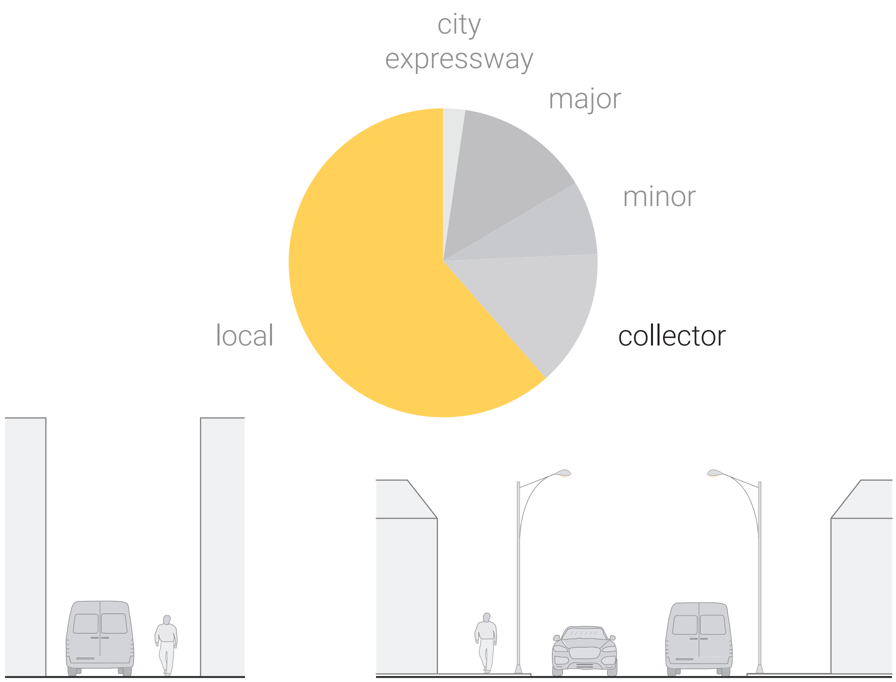


fig. 1.23 Ratio of Local Roads in Toronto, Laneway key characteristics (*left*) and Local Road key characteristics (*right*)

Local roads and laneways are abundant in downtown Toronto. Local roads gain access to private property, have low speed limits, usually less than 2500 vehicles a day, and sidewalks on at least one side of the road.[31] Laneways, or alleyways, are also used to access private property away from daily traffic flows and in dense metropolitan Toronto, they are a common sight. Alleyways have been the talk of much dispute with people questioning how they can be further utilized and be less neglected. Currently, the lane in between two buildings has been used as a service area, either for waste removal or as a loading zone.[32] As a consequence to Toronto's continuation of constructing condominiums, the number of alleyways are growing. With laneways and local roads becoming increasingly susceptible to e-commerce delivery, Toronto's residential streets will struggle against environmental pollution- air, noise, and visual- becoming ever more apparent in the city's neighbourhoods.

One of the most obvious 'last mile problems' for both courier companies and people who live and commute to cities is traffic congestion. This is especially true in urban street canyons-a street bordered by buildings, usually skyscrapers, on each side similar to the form of a natural canyon-as they amplify noise, trap and increase air pollution, and the sight of overcrowded vehicles are visual intrusions for those above and on ground.[33] This is increasingly frustrating for both drivers, city workers, and the residents living in the area. Adding to this cause are the surging numbers of delivery vehicles. A study done in the United Kingdom shows that the number of parcel vans increased by 82% from 1993 to 2015.[34] In the United Kingdom, these vans have contributed to 13.3 million tons of carbon dioxide in 2014, causing air pollution of 56 000 tons of carbon

fig. 1.24 Traffic Congestion in Toronto

monoxide emissions, 63 000 tons of nitrogen oxides, and 2200 tons particles (PM10).[35] In urban cities especially, these concentrated vehicle emissions significantly decrease air quality which have a huge impact on human health.[36]

With 28% of commercial vehicles total trip time spent circling to look for parking, the rise in parcel delivery on Toronto roads is making it difficult to strive for street safety, clean air and vibrant sidewalks.[37] In addition to delivery vehicles causing traffic that leads to visual and air pollution, parcel vans and box trucks have become known for their harmful levels of noise. According to the World Health Organization, noise pollution from overcrowded roads can be as damaging to our health as air pollution.[38] Sonic vehicular disturbances have been linked to psychological, cardiovascular, and other health disorders.[39] Nonetheless, starting and stopping, back-up beeper alarms, and night time deliveries, are essential to the delivery transactions, blind-spot safety, and efficiency in freight movement.

As streets in Toronto become congested with courier vehicles, the quality of city atmosphere and livability will continue to diminish. The caveat to Toronto's new, fast, and convenient internet shopping- environmental pollution, amongst many other 'last mile problems.'

Local Roads & Laneways- Case Study

The following are case studies of Local Roads and Laneways in downtown Toronto. While environmental pollution is all encompassing to our surroundings, those occupying residential areas accessed by local roads or reside by laneways are particularly vulnerable to their living conditions. In the following streetscape case studies, the adverse effects of two delivery situations are denoted as *1* and *2* on *fig. 1.25 Map of Local Roads and Laneways in Downtown Toronto*.

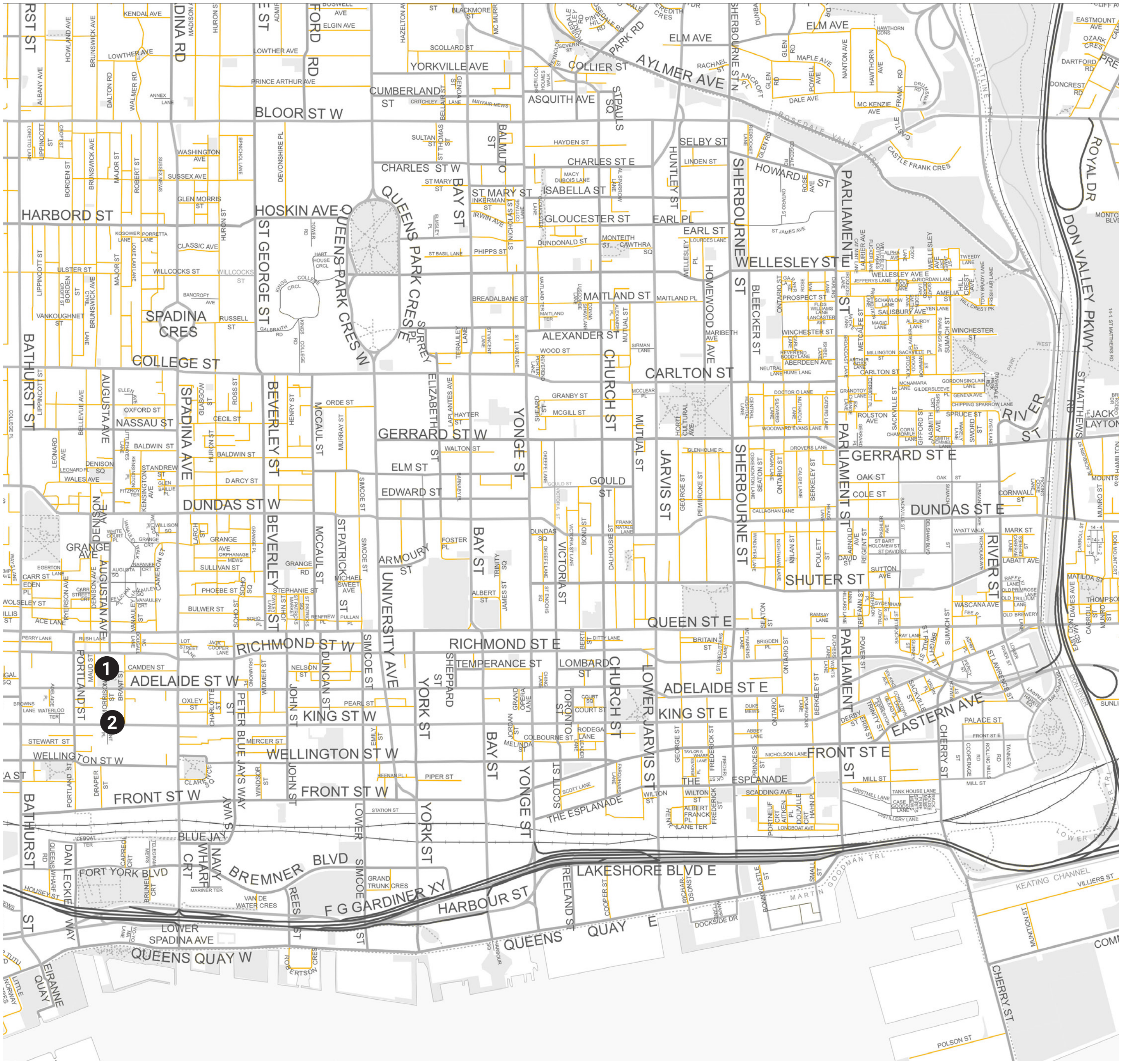
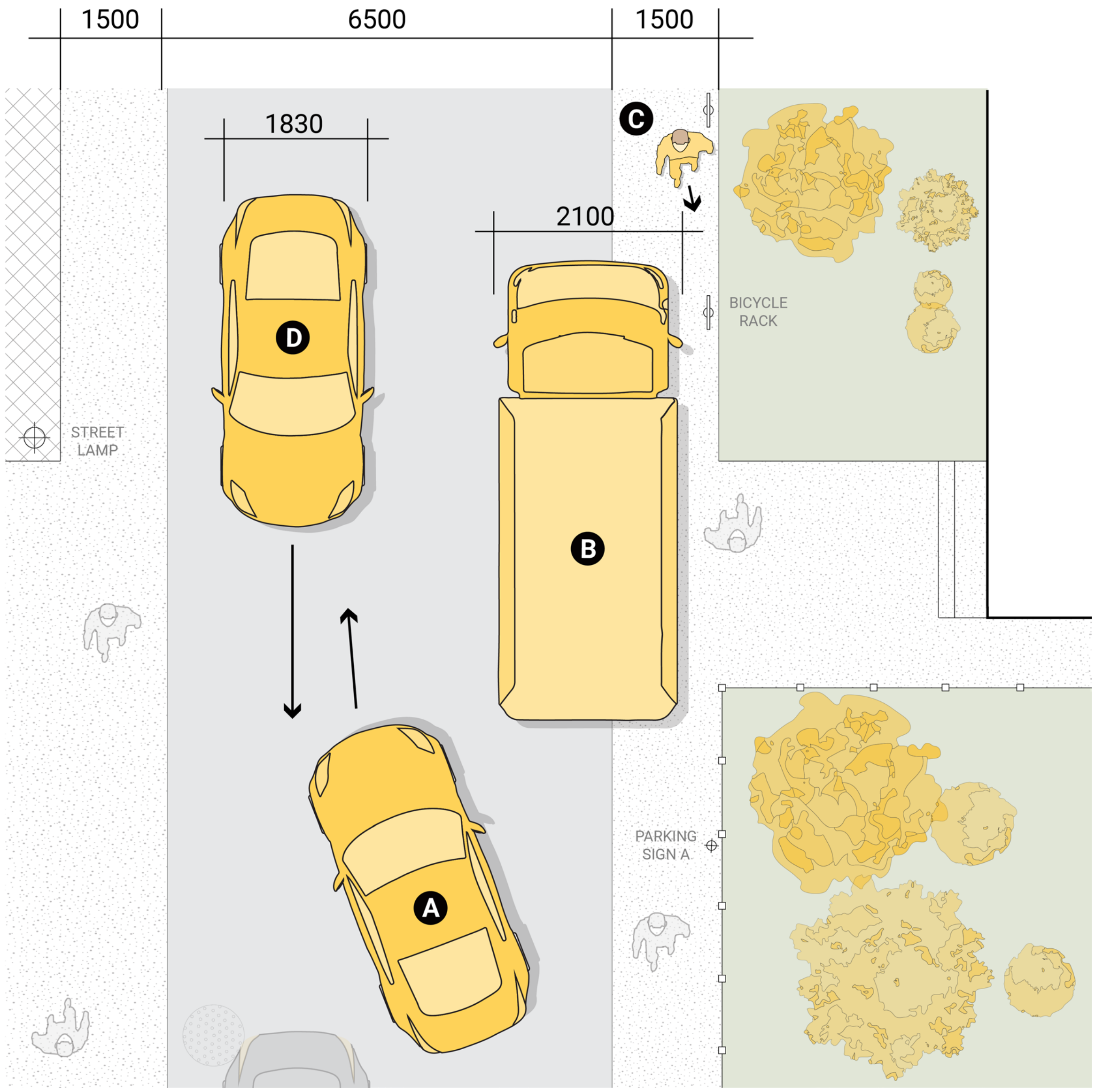
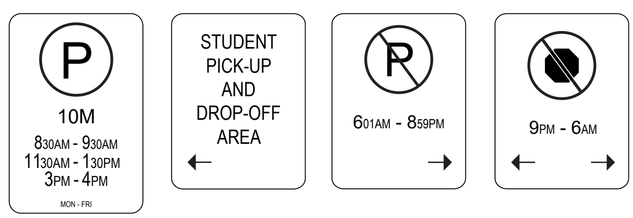


fig. 1.25 Map of Local Roads and Laneways in Downtown Toronto



PARKING SIGN A



- **A** lane is blocked by a box truck, must switch lanes to oncoming traffic
- **B** no loading zone, box truck half parks on sidewalk and half on road
- **C** pedestrian sidewalk is blocked by the parked box truck
- **D** must be cautious of oncoming traffic

fig. 1.26 Local Roads- Analysis of Situation (1)

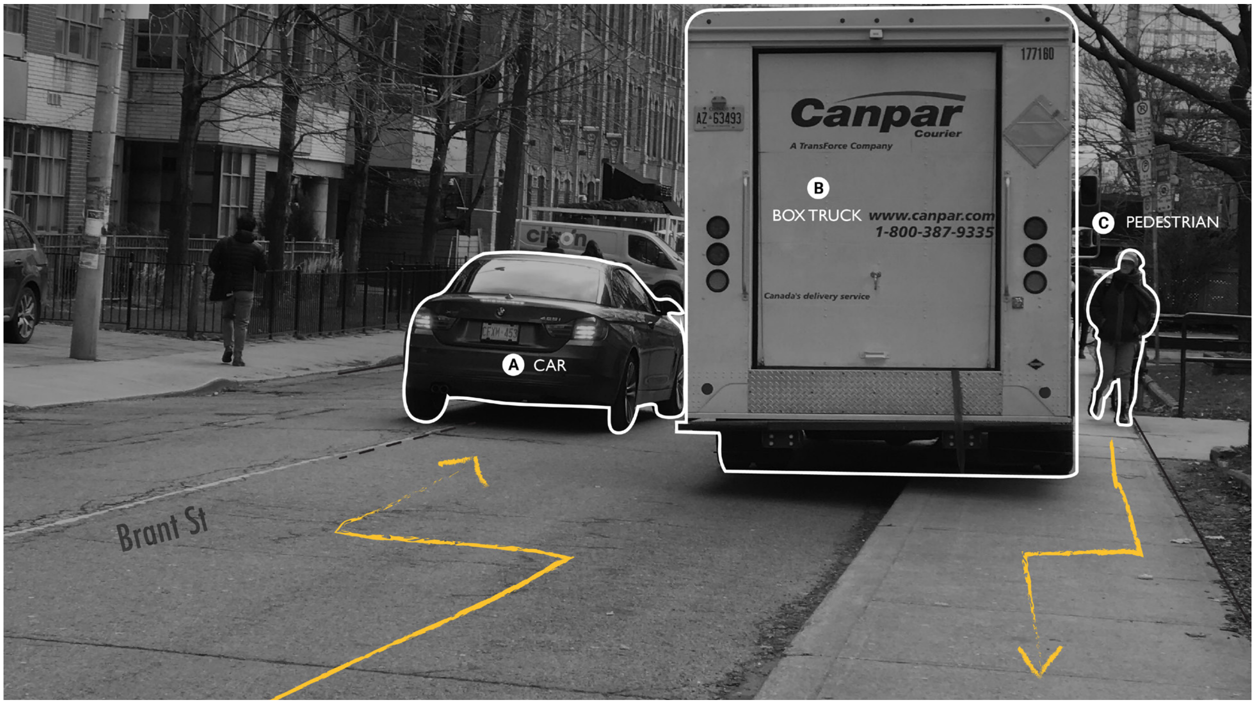
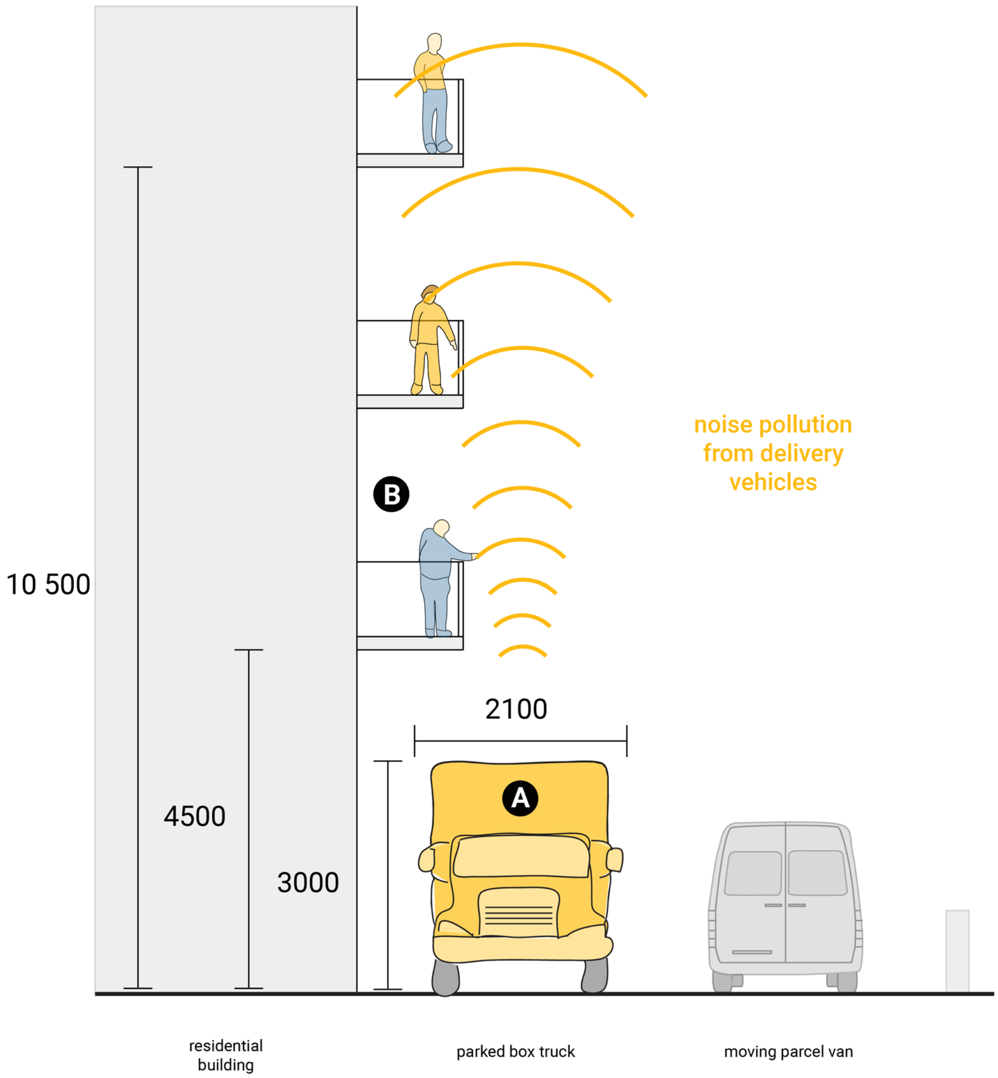


fig. 1.27 Local Roads- Image of Situation (1)

fig. 1.28 Local Roads- City Block Image of Situation (1)

(1) Local Roads

Situation (1) taken on local Brant Street is located in front of a public junior school, with two lanes for opposite ways of traffic flow. In this circumstance, a courier box truck is parking in the school's drop-off and pick-up zone. There is no designated loading zone, and so the courier parks half on the sidewalk and half on the road to prevent impeding on vehicle traffic flow as seen in the *Collector Roads* case studies. However, while two standard cars may try to squeeze in one lane (*A* and *D* on *fig. 1.26*), traffic is still slow and this altercation can cause vehicular incidents. In addition, the pedestrian sidewalk is being blocked. Pedestrians can either walk around a bicycle rack and on the grass (*C* on *fig. 1.26*), or however, if foot traffic is heavy, some may choose to walk on the road around the parked truck causing very dangerous circumstances for pedestrians on vehicular roads. This scenario creates numerous disturbances to the occupants in the school and apartment buildings that are on Brant Street.



A box truck and other delivery vehicles parked in a designated loading zone provided by a residential complex

B residents with balconies above the designated loading zone are distrupted with noise pollution from delivery vehicles

fig. 1.29 Laneways- Analysis of Situation (2)

fig. 1.30 Laneways- Image of Situation (2)

fig. 1.31 Laneways- City Block Image of Situation (2)

(2) Laneways

Situation (2) is an occurrence that happens very often in urban life. In this case, occupants living in a mid-rise residential building located on King Street West are susceptible to noise pollution. The first four stories are especially prone to loud noises and disruption (*A* and *B* on *fig. 1.29*). To make matters worse, open balconies are directly above the designated loading zones. It is easy to imagine that residents can be quite disturbed when listening to the sounds of vehicles and back-up beeper noises at any given time of day. While the residential complex has provided easy access for courier services to deliver off the main road, forgotten are the residents that live directly above the loading zone who are especially susceptible to environmental pollution.

fig. 1.32 Courier on sidewalk with crowd

Conclusion

Analysing different classifications of roads and their streetscapes in relationship to courier services is important to understanding how the 'last mile' can impact everyday city life. Whether it be traffic congestion, social comfort, or safety issues, documenting streets and how delivery functions in its final destination is fundamental to improving Toronto's urban freight infrastructure. By calling out the main concerns that can happen in delivery on each streetscape, the city of Toronto can start to understand the contemporary moves of city logistics. This analysis is needed in order to update policies or regulations, and create new infrastructure for the community.

The issue of inter-urban delivery needs to be addressed as there will be a continuous rise in fast and 'instant' delivery culture with more upcoming modes of courier transportation. New freight movement methods like drones, crowdsource shipping, or lifestyle couriers, amongst many others, are shaping and creating a new dynamic in Toronto's public spaces. This is further discussed in *Integrating City Logistics.*

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02

Integrating City Logistics

Streets are where life and history happen, & that places transportation at the cultural, social, & political center of cities.

-Janette Sadik Khan

fig. 2.1 Delivery truck in no truck zone

Current advances and new technologies for delivering freight are disrupting the traditional transportation model in urban cities.[1] Typically, light commercial vehicles, such as the box truck or parcel van, are the conventional methods used for e-commerce city logistics. As previously studied in *Delivery and Streetscapes*, the rise in internet shopping and the increased use of light commercial vehicles has numerous issues when delivering to urban areas. However, the advent of some contemporary methods of metropolitan cargo movement are aiming to improve these 'last mile problems'.[2] This chapter, *Integrating City Logistics*, hopes to identify and evaluate some of the non-traditional systems that are expected to improve the sustainability, efficiency, and overall operation of city logistics.

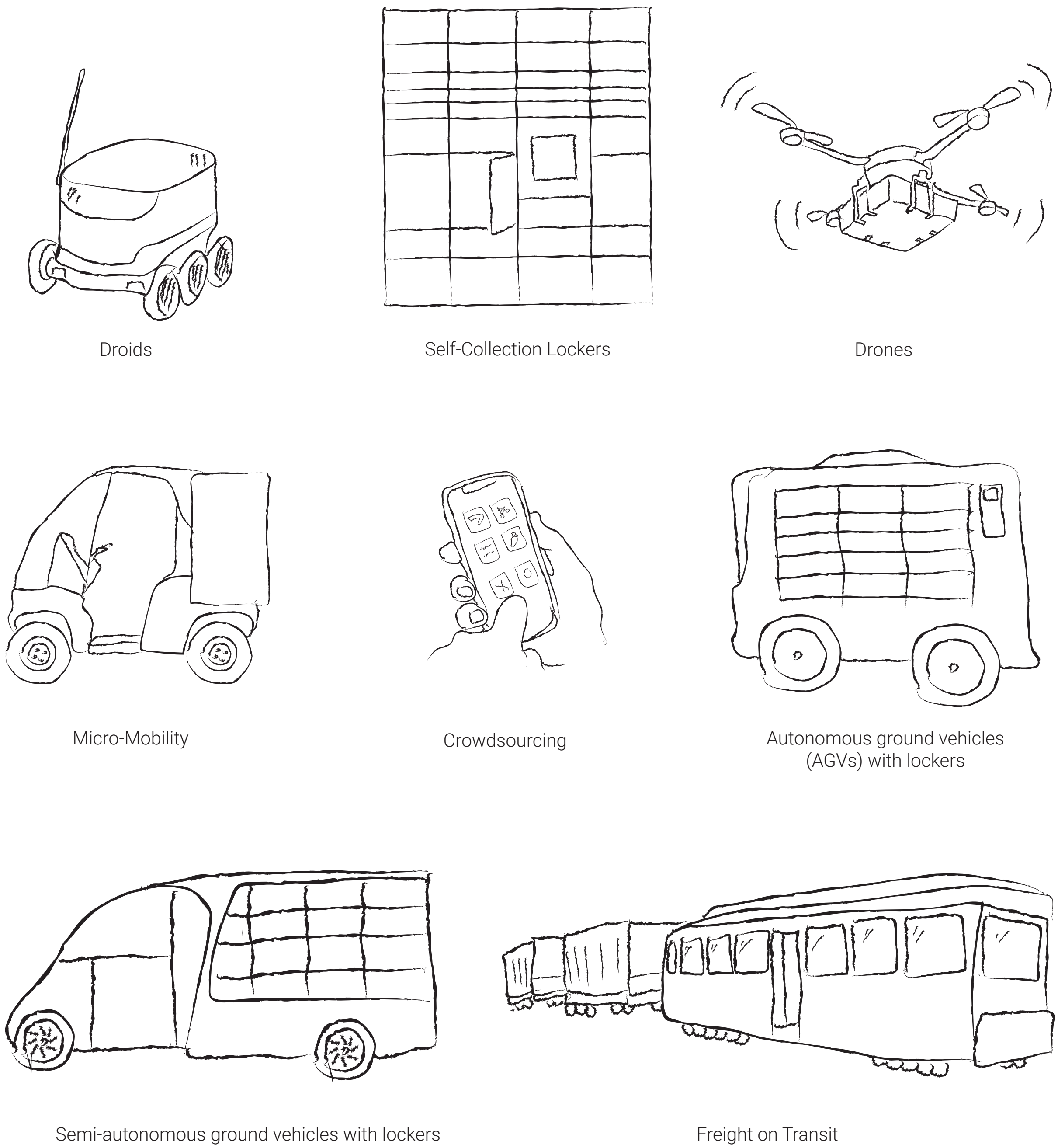

fig. 2.2 Types of non-conventional transportation models

It is anticipated that within the next decade, a number of autonomous transportation models will be used to deliver parcels[3]-taking form in autonomous ground vehicles, droids, and drones.[4] These methods, "characterized by a high degree of automation and asset intensity" are eventually expected to deliver 80 percent of items.[5] Benefits include a cost advantage of 40 percent over traditional delivery models and fulfilling customer preferences of high reliability, same day, and instant delivery.[6] However, the advantages of convenience and efficiency from these new technologies come with hurdles. Even though tech giants will likely start to push for new policies, current regulations from most major countries do not properly acknowledge the use of autonomous transportation vehicles.[7] Perhaps the holdback is because it is a relatively new concept-but it also sets alarms and creates a larger discussion regarding the 'slippery slope' of humanity, public privacy, and living in an automated society.

While there is a lot of trepidation when it comes to new autonomous methods of delivery, there are less extrusive models that are already integrated in today's society. One model, crowd logistics, "is a novel way of providing logistics services that taps into the dormant logistics resources and capabilities of individuals, using mobile applications and web-based platforms."[8] A type of crowd logistics, local delivery services-"rely on transport resources that the crowd has access to and make use of individual logistics capabilities such as picking up goods, driving, and delivering"-is already very popular in North America.[9] Examples are DoorDash, UberEats, and Postmates, which utilize public and current transport resources like vans, cars, scooters, bicycles, public transport, and walking to deliver items.[10]

It is clear that there are countless options to transport freight in urban areas that stray away from the traditional methods of delivery (*fig. 2.2*). While this thesis does not evaluate all advances in urban parcel movement, this chapter investigates three types of city logistics. The analyzed methods and its implementation into public space are freight on transit, micro-mobility delivery, and self-collection lockers.

Freight on Transit

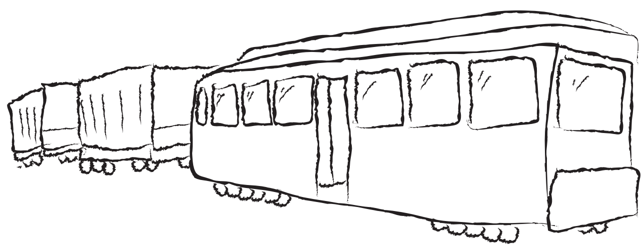

fig. 2.3 Freight on transit concept sketch

Freight on transit (FOT) is transportation "that uses public transit vehicles or infrastructure to move things other than people."[11] This is seen in forms of "moving goods alongside passengers on buses, attaching cargo trailers to transit vehicles, operating freight vehicles between transit trips on subway lines," amongst other modes.[12] The benefit of FOT is that it leverages an existing infrastructure,[13] and as a result, lowers costs because there is little adaptation and no new construction. Additionally, the potential to move goods outside the use of trucks means less environmental pollution, congestion, use of public space, pavement damage, and mitigating numerous other 'last mile problems'. Furthermore, it can take advantage of public transit that is underutilized outside of peak hours,[14] making use and advocating the need to create more transit systems for the public. However, while FOT is a great solution to traffic congestion and environmental pollution, there are still many obstacles to overcome-the idea of moving cargo and public transit users on the same system is an unconventional thought that still needs to be challenged.[14]

The following is a brief analysis on FOT models globally. These two are specifically chosen because the repurposed trams align with the thesis design proposal, *Rethinking Toronto's Last Mile*, where the Toronto Transit Commission (TTC) Subway system is repurposed to transport parcels between subway stations.

Cargotram-Zurich, Switzerland

Cargotram is a form of FOT between the public transit operator and a waste collection agency has been operational since 2003 (*fig. 2.4*).[15] Cargotram transports large waste items from drop-off points to treatment plants.[16] This project has proven to be successful in that it is an affordable solution that reduces the amount of trucks on busy Zurich streets,[17] as shown by the "annual elimination of 5,000 km of truck trips and 960 hours of idling time results in 37,500 liters of diesel saved and 5 tons of CO2 emissions saved annually."[18]

The major factors that made this achievement possible are low startup costs of converting old passenger trams into waste collecting vehicles, and that the existing passenger tram network is in proximity to their desired locations.[19]

fig. 2.4 Cargotram uses trailers attached to old passenger trams

TramFret - Paris, France

TramFret was a pilot project completed in 2011 between the city public transit operator, regional transportation agency, Paris City Government, and regional government.[20] TramFret experimented inserting empty trams into the existing rail network during passenger hours to see if it would interfere with regular passenger travel.[21] None of the additional streetcars disrupted the urban and social environment.[22] Working together

fig. 2.5 Moving freight onto TramFret tram

fig. 2.6 TramFret runs adapted freight trams scheduled in between passenger trams

with private logistics stakeholders, the hope is to co-exist in parallel with the new mode of transit and reduce delivery truck movement (*fig. 2.5, fig. 2.6*).[23]

FOT Conclusion

These models were studied for two reasons. One of the reasons is that the repurposed trams shows a precedent for what TTC Subway trams could look like if FOT is implemented. The second reason is that they are both successful projects. TramFret displayed that people and freight could coexist on the same transit network, and Cargotram showcased that collaboration between different stakeholders and organizing operational logistics, such as using cargo transit during low peak or night hours alongside maintenance and public use is possible.[24] That being said, FOT is still no easy feat. TramFret is still under experimentation as of 2017, and there are also other pilot projects that failed largely due to initial costs, economic uncertainty, physical feasibility, and political and public backup.[25]

The city of Toronto itself has seen reluctance to incorporate FOT in its TTC subway operations.[26] When subways are not used, these are critical moments for track maintenance, and if the capacity could exist-it would be used to extend passenger services.[27] Even if freight was moving alongside with TTC subway trams to prevent disruption of maintenance hours-like attaching a trailer-there is little enthusiasm to spend money on paying transit agencies to use the subway line and the additional staff needed to move goods.[28]

Perhaps to some, the initial expenditures and traditional organizational barriers outweigh the environmental and societal pros; and in the short term, it does not seem like a viable solution. But as the world is changing alongside a booming e-commerce industry, there needs to be development in how transportation is conventionally used. Operating models like Cargotram, prove that FOT can be beneficial under the right circumstances. The hesitation to use TTC subway lines may in fact be an opportunity to add and improve the existing public transit infrastructure and mitigate 'last mile problems' in doing so. Thus, this is the reason why FOT is explored on the TTC subway system in *Rethinking Toronto's Last Mile*.

Micro-Mobility Delivery

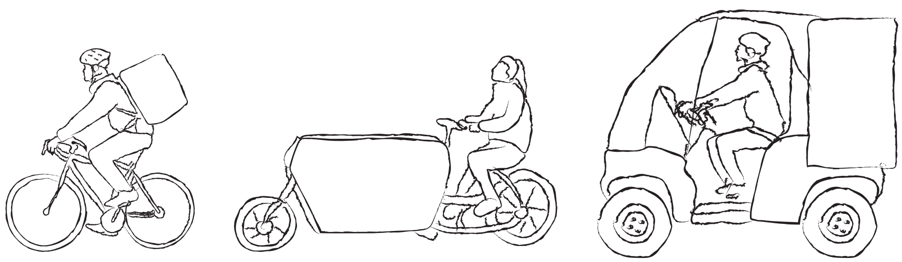

fig. 2.7 Micro-mobility delivery concept sketch

Micro-mobility delivery uses a spectrum of small and lightweight vehicles to deliver freight. Usually micro-mobility vehicles operate at low speeds of below 25 km/h.[29] Most common are bicycles and scooters including the public shared and electric powered variety.[30] However, micro-mobility vehicles can also take form in any small vehicle running on charged batteries like miniature electric cars.[31] These novel forms of transportation have been stated to be a key part of urban mobility in congested cities.[32] As there are many different types of micro-mobility delivery, this thesis will focus specifically on cyclelogistics because it is an integral part to the thesis design proposal in *Rethinking Toronto's Last Mile*.

Cyclelogistics

Cyclelogistics refers to "the integration of bicycles into the goods movement network" and "includes use of any bicycles to move goods, including a rider wearing a backpack, a bicycle with panniers, or cargo bikes and cargo tricycles."[33] Currently, cargo bikes are very popular in some European cities, and it is even a well established transportation method with major delivery companies like DHL and UPS (*fig. 2.8*)[34] These courier cyclists are replacing parcel trucks and vans that need to drive to congested city centres, and as a result, reducing the amount of fuel usage and parking tickets that are common within traditional delivery logistics.[35]

However, cyclelogistics is not a common delivery method in Toronto.[36] While it is seen in slighter forms, like cyclists who wear backpacks-whether that be for personal use or lately food delivery crowdsource shipping-it is not used at a larger scale.[37] If Toronto were to incorporate infrastructure for cargo bicycles, the city would reap numerous benefits. There would be an increased use of cycling-this means more and safer bike lanes- lower greenhouse gas emissions to help meet the City of Toronto's "goal of reducing GHG emissions by 80% by 2050," and decrease traffic congestion because cargo bikes have better efficiency in travel and parking than light commercial vehicles.[38] In fact, "DHL vans in Manchester are able to do 6-8 drops per hour, while Last-Mile's emissions-free electric cargo bikes make 10-12 drops per hour."[39] It is clear that there are both environmental and economic benefits when using cyclelogistics in the 'last mile' of transportation.[40]

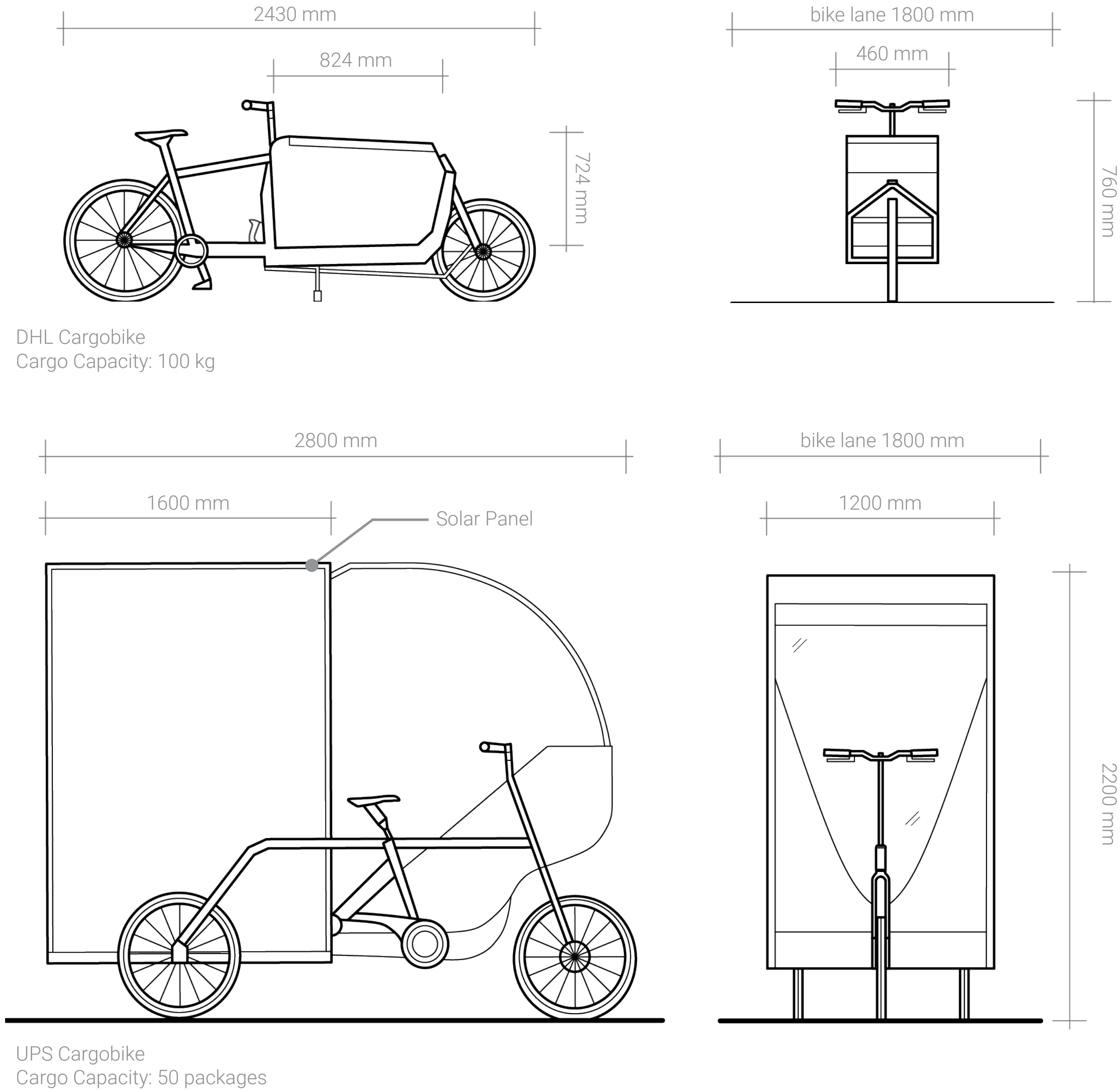

fig. 2.8 DHL and UPS Cargobike Details (estimate)

While cyclelogistics is a great solution to ease urban congestion and at the same time improve efficiency in Toronto's 'last mile,' there are limitations and barriers to be noted. Aside from a shift in traditional mindset that couriers are typically only truck or van drivers, there needs to be regulations for the types of cyclelogistics that are used in bike lanes (*fig 2.9*).[41] Larger and faster electric cargo bicycles may not fit on regular cycling infrastructure, and so there must be policy restrictions on the size and speed of these vehicles.[42] The other option would be to redesign bike lanes in Toronto to fit larger bicycles. This in turn would hopefully create more cycling infrastructure and improve the existing ones to be safer-like adding a physical barrier. This is in addition to accessible cargo bike parking with specific bike racks.[43] Furthermore, there are parcel size limitations that are required to fit in the carrier of cargo bikes.[44] However, even if parcels exceed e-commerce standard sizes, using bicycles to transport smaller parcels still mitigates the amount of trucks needed. Overall, for Toronto to consider implementing a larger scale of cyclelogistics there needs to be participation from courier companies, better cycling infrastructure, and classification of the different types of bicycles and their policies on bike lanes.

Backpack Cyclist Courier

Bike with Pannier

Cargo Bicycle

Cargo Tricycle

Cyclelogistics can be pedal-only or electric assist.

fig. 2.9 Types of Cyclelogistics

Micro-Mobility Delivery Conclusion

Micro-mobility delivery will play a major role in the future of 'last mile' city logistics. As seen in cyclelogistics, there are major benefits to this novel way of transportation. However, in order for micro-mobility delivery to work, new policies and infrastructure is critical. Furthermore, the cooperation between city designers and courier companies to create a respectable workspace for these cyclist couriers is essential. The use of cyclist couriers should be encouraged through not only safe cycling infrastructure, but also fair and just workforce employment. Unfortunately, this is sometimes not seen with 'life-style couriers'-"workers who are either contractors or self-employed"-and are "without pensions, limited or no guaranteed working hours, no holiday or sick pay and no guarantee of a living wage."[45]

By advocating for better cyclist treatment-in both the workforce and cycling infrastructure-there can start to be a discussion on designing the proper framework appropriate for this novel type of courier transportation. As previously seen in *Delivery and Streetscapes*, the effects that trucks have on cyclists are detrimental, so by encouraging the use of micro-mobility delivery, it is not only reducing the amount of trucks sharing roads with cyclists, but also increasing the visibility of cyclelogistics, thus promoting the need for better bike lanes. The possibility of a zero emission, more efficient, and safer form of 'last mile' delivery is why the infrastructure for micro-mobility delivery, particularly cyclelogistics, is later explored in *Rethinking Toronto's Last Mile*.

Self-Collection Lockers

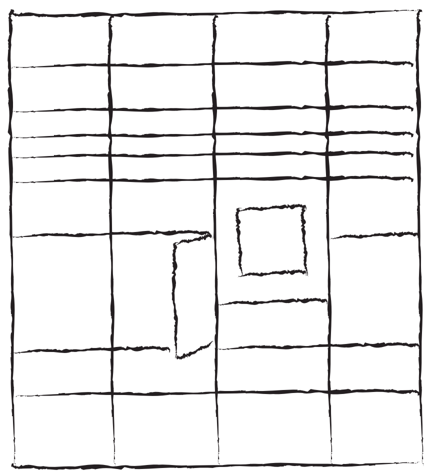

fig. 2.10 Self-collection locker concept sketch

Self-collection delivery is a "network of service points where operators pool and deliver their consignees' parcels, and consignees pay, collect or return their parcels."[46] These services can be stationary, mobile (ex., autonomous ground vehicles with lockers), attended, or unattended.[47] Typically, e-commerce parcel deliveries are made door-to-door, and as portrayed in *Delivery and Streetscapes,* it has huge strains upon the delivery system and on city livability. However, self-collection over home deliveries services have proven to be more economically and environmentally viable.[48] The following research focuses on the integration of attended or unattended stationary self-collection lockers because it is a fundamental component to the design proposal in *Rethinking Toronto's Last Mile.*

fig. 2.11 PigeonBox self-collection locker in Vancouver's SkyTrain station

Stationary Self-collection Lockers

Parcel locker systems have numerous benefits from an operational, societal, and sustainable point of view. Logistically, couriers do not have to drive door-to-door and only need to make one stop at a self-collection locker to serve a whole neighbourhood. Furthermore, as a result of consumers picking up their own parcels, there are minimal failed deliveries[49]-like shipping an item to the wrong addressee or stolen packages. By reducing these mishaps, this improves order fulfilment and saves logistic companies a substantial amount of money.[50] "It is estimated that £850 million could be saved if all home deliveries in London were successful at first attempts."[51] Additionally, from a purchaser's perspective it can eliminate inefficiencies of waiting at home for a delivery, a missed home delivery, and delays at post offices.[52] Lastly, from an environmental and sustainability standpoint, self-collection lockers reduce the amount of trucks needed on roads to make every home delivery. These lockers mitigate many of the 'last mile problems', such as, "road congestions, demand for curb-side parking, emissions of greenhouse gases, and improves urban liveability."[53] In fact, "up to 83% reduction of carbon emission could be achieved if consumers collect their parcels from self-collection facilities."[54] It is clear that for a number of reasons, the use of self-collection services is a valuable option for city logistics.

fig. 2.12 ASDA self-collection locker in parking lot with shelter and car loading

The operation of how stationary self-collection lockers are used remains typically the same throughout. Generally speaking, "notifications are often sent to consumers when their parcels are delivered to their service points. Consumers can then choose to pick up their parcels at their own convenience within a certain time window."[55] However, there are a few different varieties of self-collection lockers in terms of form, physicality, and location. For example, some self-collection lockers are in the entryway or parking lots in front of their operating store, like British supermarket brand Waitrose and Partners.[56] Meanwhile, the largest online retailer, Amazon, has lockers inside convenience stores and retail centres.[57] Another example is Canadian company, PigeonBox, who keep their lockers inside Vancouver's Skytrain public transit stations (*fig. 2.11*).[58] The business model for these companies varies as well. Amazon self-collection lockers can only be used for merchandise bought in their online store,[59] however, with PigeonBox, you can order from any e-commerce store available.[60] Service fee and return policies differ for each company too, with some charging users extra to use this service, or other companies returning items back if it is not picked up.[61] Furthermore, self-collection lockers can also vary in terms of physical presence. There are non-extrusive small lockers that align against the back of a wall, while there are also those that can expand over a substantial amount of space-some even provide shelter from weather (*fig. 2.12*). With the numerous types of self-collection lockers, one has to imagine what its presence could mean for city life.

Self-collection Lockers Conclusion

Although self-collection lockers prove to be better both environmentally and economically, the majority of consumers prefer at home deliveries.[62] Two studies done show that only 5.5% of deliveries in Singapore and 10% of online shoppers in France use self-collection services.[63] Despite society trying to become environmentally conscious, as well as the mishaps that can occur during door-to-door delivery, consumers still choose home deliveries as the conventional and less troublesome option. Therefore, when integrating self-collection services into the city of Toronto, it must be made easily available and incorporated into the daily lives of city dwellers for it to gain traction. A self-collection study notes that it is likely to be used if it "intersect[s] with the core daily activities of most consumers," like "within shopping centres that are connected to transport networks," or an "existing network of bus or train stations, and convenience stores."[64]

It is clear that the benefits of self-collection lockers should not be limited by the inconvenience of their location. Toronto's e-commerce trends are increasing and there needs to be a call to attention that the current model of city logistics is no longer sustainable. Consumers need to be aware that there are better options other than home deliveries that can be convenient and healthier for the living environment. Additionally, as companies shift towards self-collection services, attention should be brought to the potential use of numerous privatized self-collection lockers scattered in various parts of communities. Thus, the idea of introducing community public self-collection lockers, as well as encouraging people to use them, is further explored as an architectural proposal in *Rethinking Toronto's Last Mile.*

fig. 2.13 Bicycle courier vs. delivery van

Conclusion

With the introduction to new methods of city logistics, whether that be autonomous modes, or leveraging existing urban systems, it is important to understand the effects these novel conditions could have on city's streets, communities, and people. Freight on transit, micro-mobility delivery, and self-collection lockers are the methods that are further explored in hopes of encouraging an urban delivery movement that improves and adds to the environment and character of Toronto's streets. The proposed delivery models and how they can be successfully integrated into Toronto city logistics are comprised of the following:

1) Freight on transit requires cooperation between all stakeholders (financial, transit & courier management, public support, etc.)

2) Cyclelogistics requires a safe cycling infrastructure and workforce

3) Self collection lockers must be convenient, therefore, in close proximity to daily activities

The architectural design proposal, *Rethinking Toronto's Last Mile,* considers these three factors to create a collaborative relationship for delivering e-commerce parcels into Toronto's public urban spaces.

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03

Rethinking Toronto’s Last Mile

Designing a dream city is easy; rebuilding a living one takes imagination

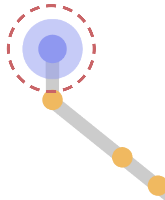
- Jane Jacobs

fig. 3.1 Subway station entrance under a mobile delivery advertisement & beside a parcel van

Proposal

Rethinking Toronto's Last Mile is an architectural intervention regarding Toronto's current and unsustainable model for city logistics. This proposal hopes to create a community space that integrates three novel methods of urban freight movement into the city's existing transportation infrastructure. The system introduced to Toronto's framework is based on co-modality, "integrating passenger and freight transport systems"[1] as an "efficient use of different modes on their own and in combination."[2] By designing a relationship between methods of freight on transit, micro-mobility delivery, and self-collection lockers; this thesis aims to create a comprehensive city freight movement that complements the daily activities in major locations of the downtown community- Toronto's subway stations.

01 City Distribution Centres



A Collaborative Transit System

This design proposal begins with an introduction to the concept of a co-modality system integrated into Toronto's infrastructure using freight on transit (FOT) on the existing TTC Subway lines (*fig. 3.2)*.

1) Subway stations that are either outskirt, or in less active areas are designated as city distribution centres. Usually delivery trucks receive their parcels from fulfillment centres and transport cargo door-to-door. However, in this system delivery trucks are driving from fulfillment centres to city distribution centres and unloading parcels from trucks onto repurposed subway vehicles.

2) These parcels that are sorted and consolidated in bulk get transported to subway stations that are in denser parts of the city where traffic congestion is predominant. These items are transported during low-peak and off hours through the subway network using a similar type of repurposed tram as described in *Integrating City Logistics*.

3) Once consolidated parcels have arrived at the designated subway station, they are unloaded and consumers can either choose to self-collect, or it is delivered door-to-door through micro-mobility means.

Incorporating FOT with systems of self-collection and micro-mobility delivery creates a dynamic public space for subway stations which is further explored as an architectural intervention.

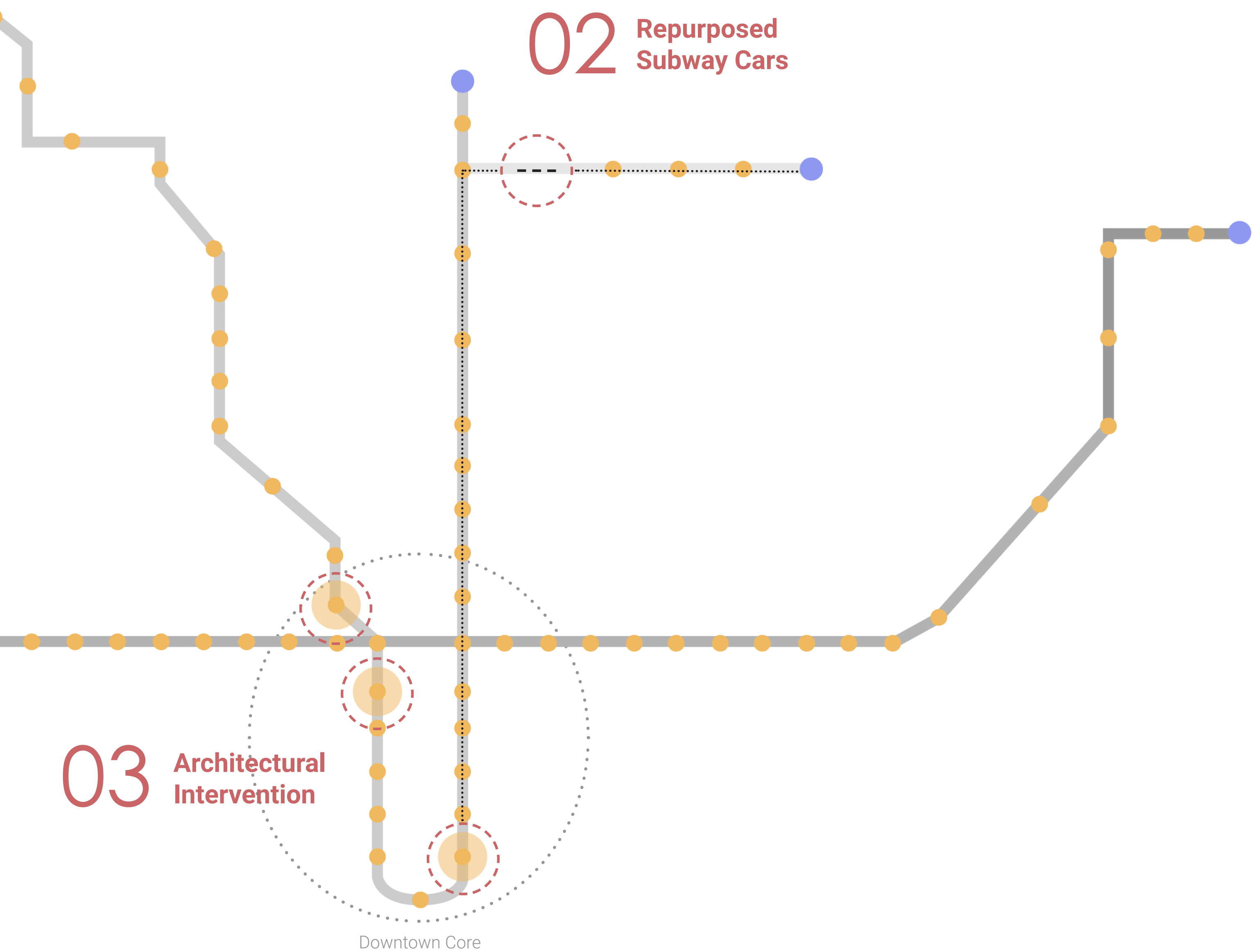


fig. 3.2 TTC Subway map as a co-modality concept sketch

The proposed architectural intervention occurs in the subway stations where parcels have reached their destination. While this proposal implements elevators for freight delivery using the TTC, this is also an opportunity to integrate accessibility on subway stations. Currently, Toronto is reconstructing to make all their stations accessible by 2025.[3] This thesis proposes to include accessibility and infrastructure for parcel collection to alleviate both 'last mile problems,' and encourage ridership for all.

Every subway station in Toronto is unique, and so this is a general concept for how parcel distribution and accessibility can be implemented (*fig 3.3)*.

1) On the subway platform, logistics workers unload consolidated parcels from repurposed subway cars. Barrier-free users can also use the elevators to move to the concourse level.

2) On the concourse level there is a service area to allow for parcel transportation away from public circulation. This also allows for barrier-free users to move between the ticket gates.

3) Parcels are distributed out at the street level through self-collection services or micro-mobility methods. Barrier-free users can also exit or enter the subway station from these elevators.

There are many components to the subway station that involve this novel parcel collection system. However, it is at the street level that incorporates the final stages of parcel collection for two main reasons. First, the street level is readily available for all users, not just subway commuters- this includes residents or people who work in the area. Secondly, the design on the street level is able to address other issues that Toronto is facing. These include rainfall flooding, lack of greenery in urban settings, poor visibility cues regarding the location of subway stations, inadequate wayfinding signage, and cycling infrastructure. This is further explored as different design proposals for three subway station typologies in downtown Toronto.

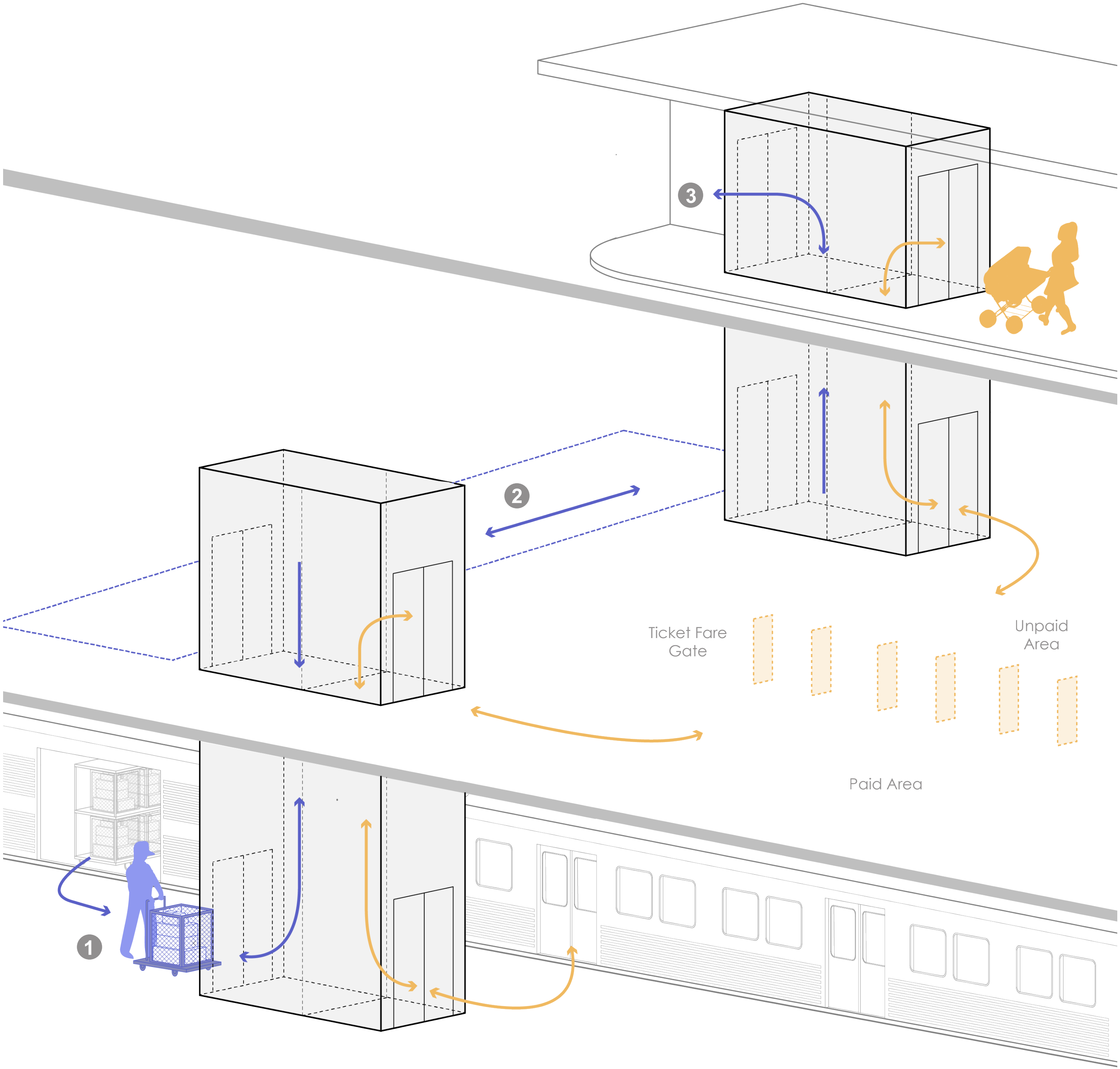


fig. 3.3 Subway Station elevator concept

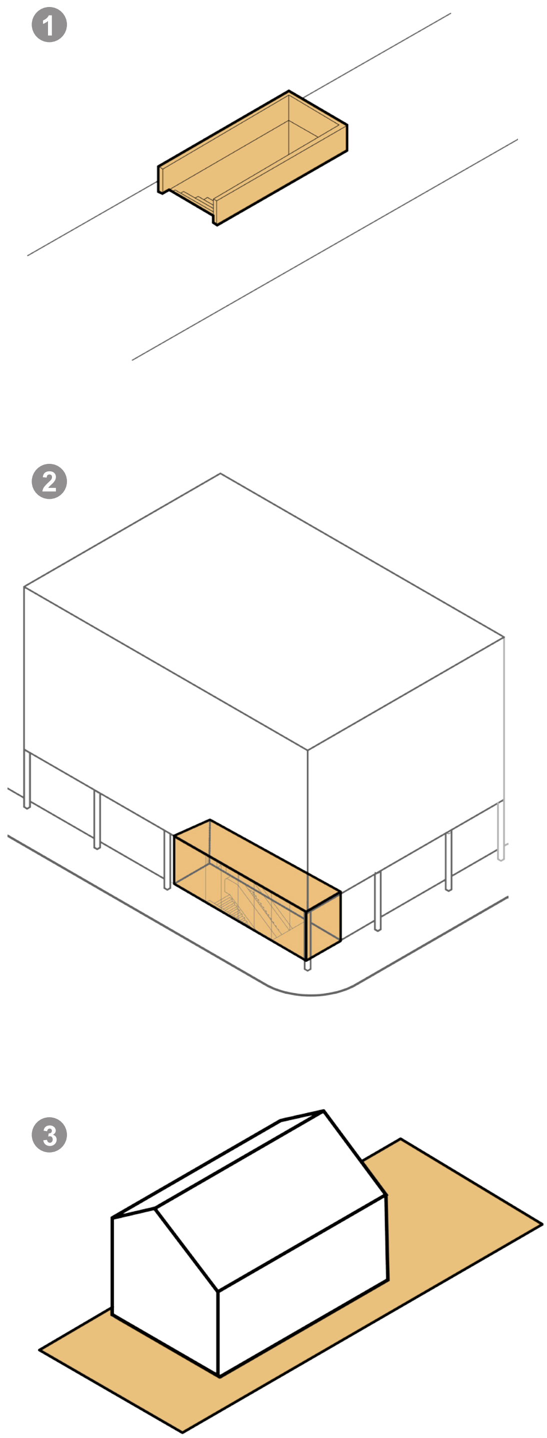


fig. 3.4 Subway Station Typologies

Three subway station entrance/exit typologies are redesigned in downtown Toronto (*fig. 3.4*). The following typologies consist of common entrances/exits in the city.

1) The typical stairs going down to the concourse level located in the middle of a sidewalk. The redesigned subway station will be Museum Station.

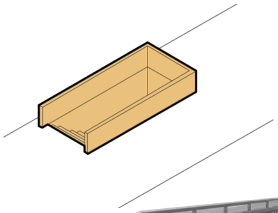
2) Entrances/exits that are part of a larger building and look like a building storefront. This proposal takes place at King Station.

3) Stations that belong to a single building or the main purpose of the building is as a transit station. Spadina Station is the given example.

The following page is a diagrammatic summary of the proposed transit system (*fig. 3.5*).

01 City Distribution Centres

Containerized cargo loaded from trucks to subway carts



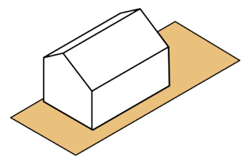
03 Architectural Intervention

Designated subway stations distribute parcels through self-collection or micro-mobility

1 Museum Subway Station

Stairs & Sidewalk

Cargo Tram Zurich

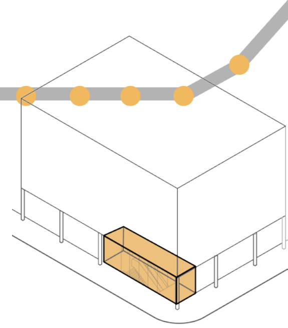


02 Repurposed Subway Cars

Subway trains transport parcels to subway stations in the densest areas of Toronto

3 Spadina Subway Station

Stand Alone Building



2 King Subway Station

Building Storefront

fig. 3.5 Summary of Proposed System

Design proposal 1 Museum Station

fig. 3.6 View of Museum station's exit stairs

fig. 3.7 View of Museum station's exit stairs with UofT building

Site Analysis

Museum station has four subway exits, two each on opposite sides of the street, Queens Park (*fig. 3.8*). Surrounding conditions include the Royal Ontario Museum and University of Toronto campus buildings. The design proposal focuses on the two subway exits that are closest to Charles Street (*fig. 3.7*). One exit is to remain the same (*fig. 3.6*), while the other is converted into an elevator core.

The Museum station design proposal takes advantage of the area's open and available space.

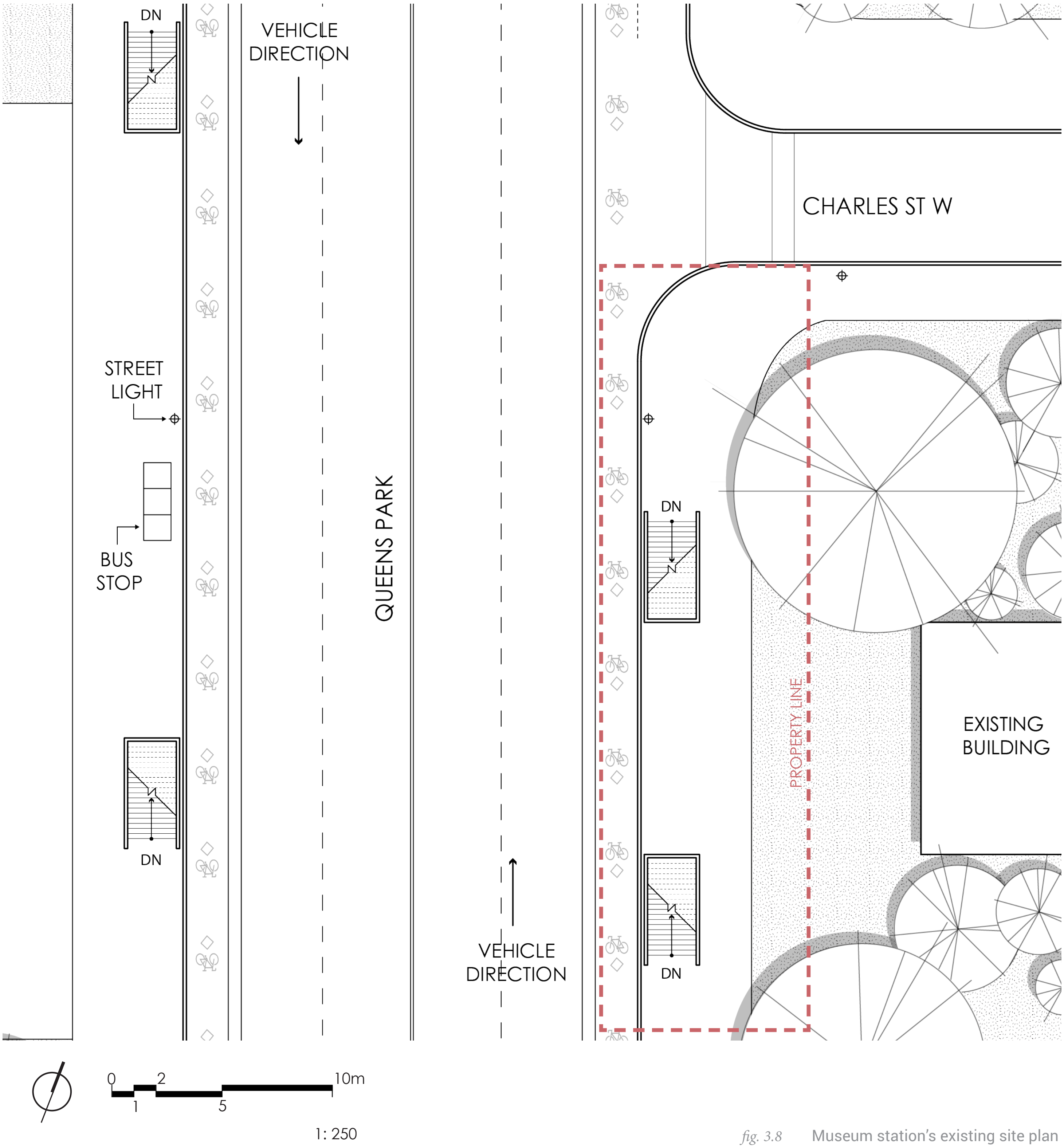


fig. 3.8 Museum station's existing site plan

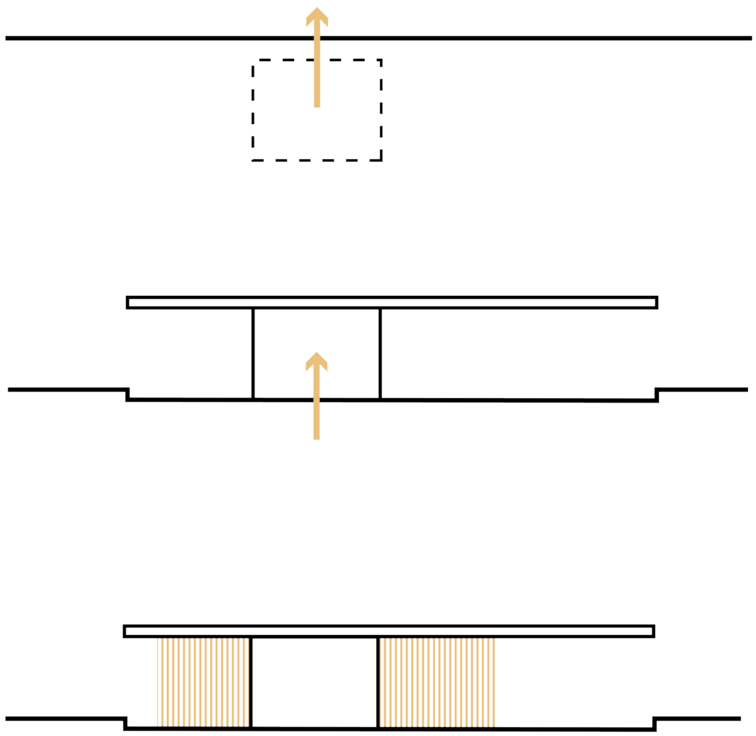


fig. 3.9 Museum station's parti diagram

Concept

The concept behind the redesign for Museum station is in its materiality and form. The structural concrete elevator core 'acts' as if it is pushing up the sidewalk from underground, bringing what would normally be underground activity to the street level. Using materiality of a heavy concrete roof against frameless glass walls to portray that the roof is held up by the elevator core. Locker wall systems are then integrated into the shelter to create spaces and movement of people.

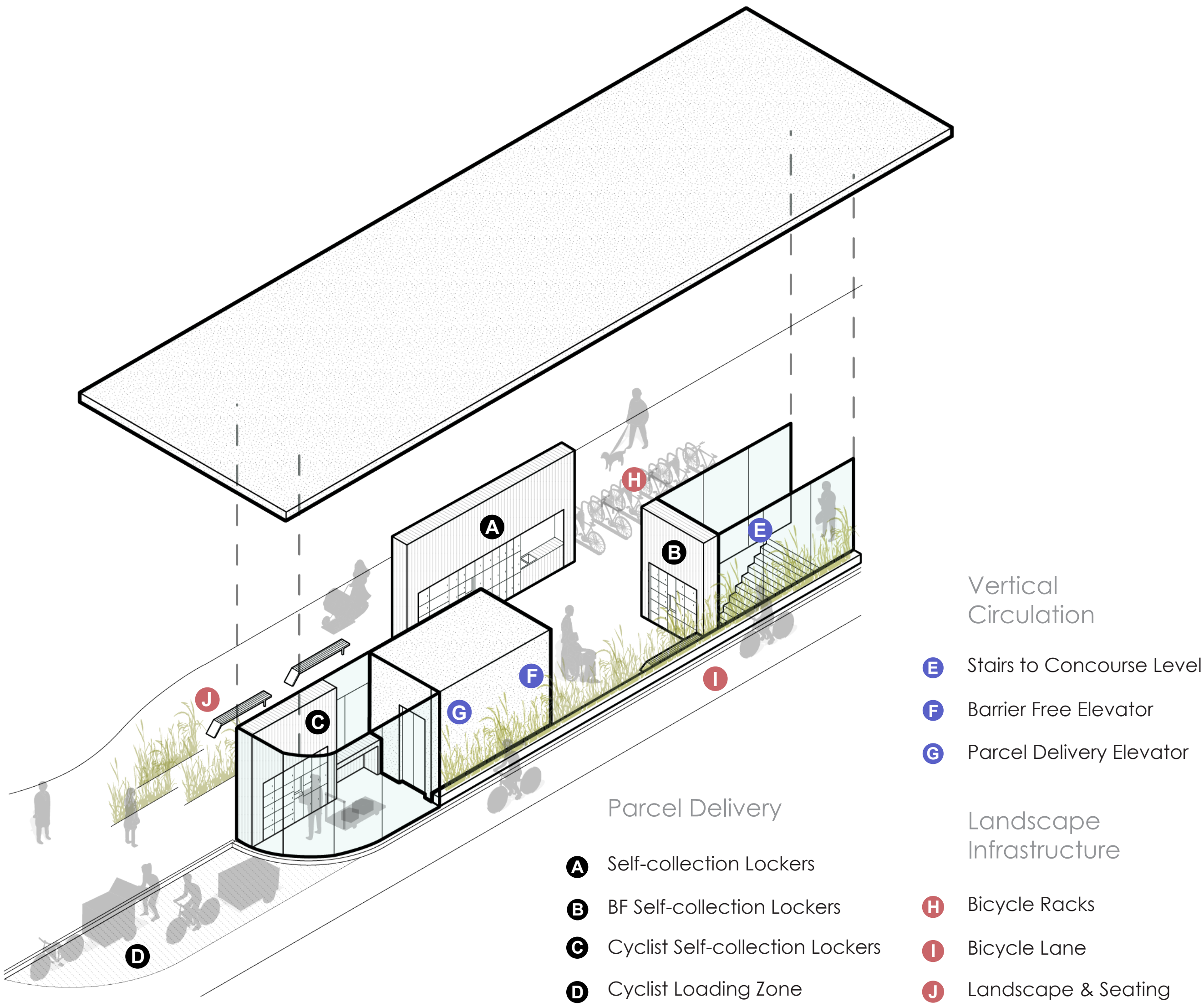


fig. 3.10 Museum station's program in axonometric

Program

Museum station can fit all ideal programs. That means there are three separate self-collection lockers in different areas for various people-high traffic users (*A*), a designated space for barrier-free or families with young children (*B*), and cyclelogistics self-collection (*C*). There are the existing stairs down to the concourse level (*E*) while on the opposite side there are two separate elevators-barrier-free (*F*) and parcel delivery (*G*). Landscape items include sheltered bike racks (*H*), a bicycle lane with a physical barrier (*I*), loading zones for cyclists (*D*), and outdoor seating with landscaping (*J*).

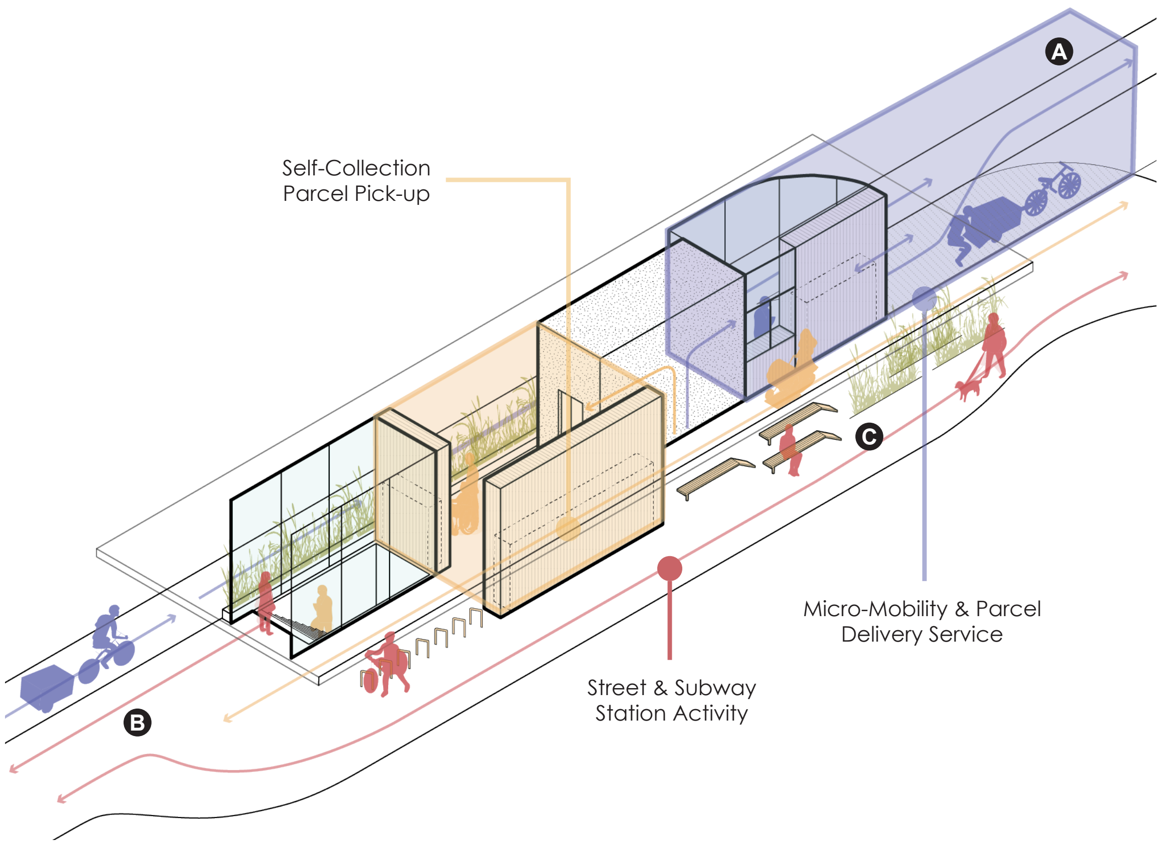


fig. 3.11 Museum station's circulation in axonometric

Circulation

The proposed self-collection lockers are not the typical metal box against a wall. These lockers have a grander purpose by being part of a structure that creates spaces and supports a shelter for different modes of activity. There are three main types of circulation. There is regular street and subway station activity separate from people who choose to self-collect (*red*). By creating areas for self-collection, users can take their time at the lockers whether that be at the higher traffic parcel lockers or at the BF zone (*yellow*). Additionally, while cyclelogistics share the bike lane with regular cyclists, couriers have a loading zone that parts away from cycling circulation. The cyclelogistics loading zone is directly connected to the parcel service zone (*blue*).

A
B
C

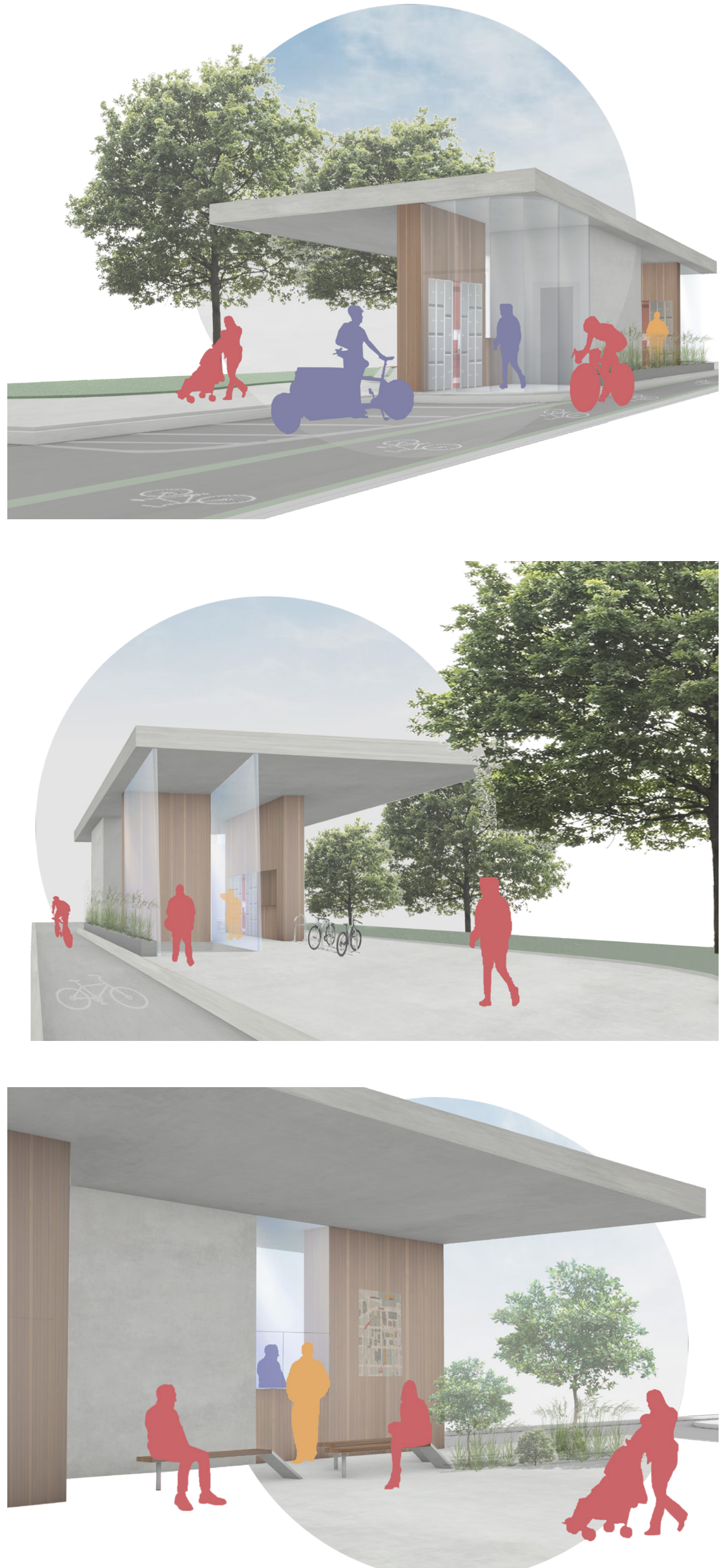


fig. 3.12 Views of Museum station's circulation

Plan

Taking advantage of the open greenery in front of the UofT campus building, a new sidewalk is proposed to create more space.

The cyclelogistics self-collection lockers are for courier cyclists only. Therefore, it is in a service area that can be secured during night hours while the other lockers are open 24/7. In the service area there is also a counter for a TTC information booth, or for logistic workers to manage the parcels that go into the self-collection lockers.

Bicycle racks and benches are placed underneath the shelter to protect from weather, while added greenery remains exposed to sunlight and rainfall.

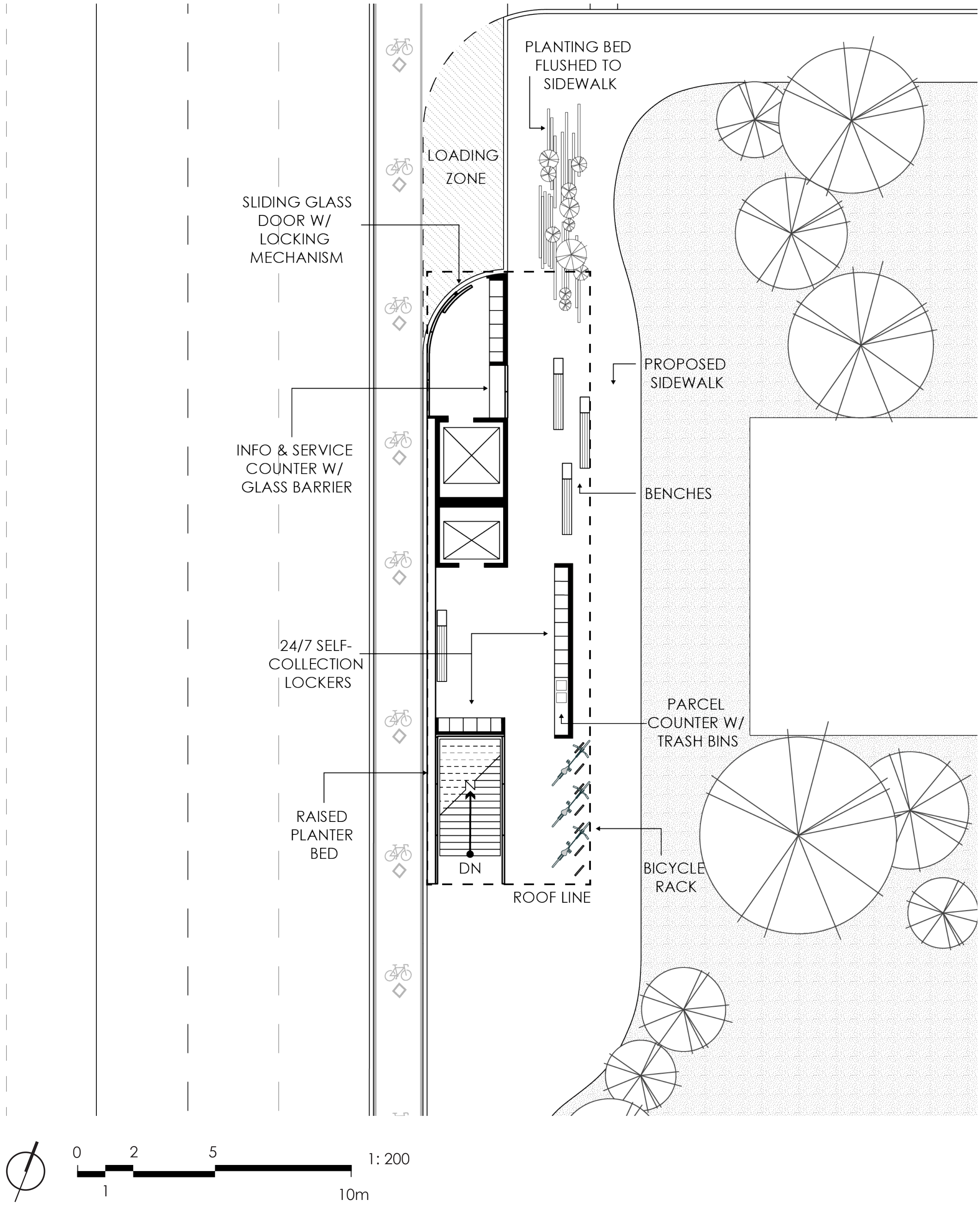


fig. 3.13 Museum station's ground plan

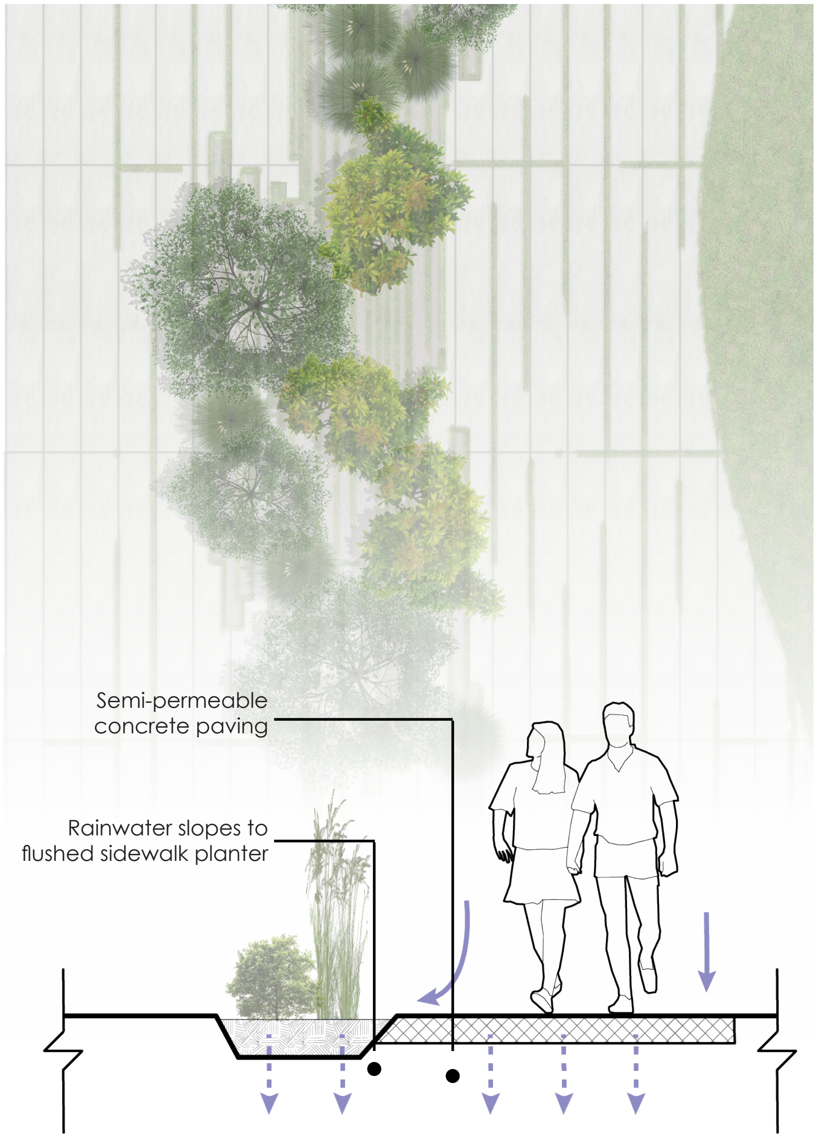


fig. 3.14 TYP. flushed sidewalk planter detail

Typical Rainwater Detail

Incorporating greenery improves city life by filtering harmful air pollutants, creating urban biodiversity, and for its visual appeal.[4] However, adding vegetation to metropolitan streets also improves city water management.[5] Toronto's stormwater dilemma is partly due to the city's asphalt and concrete construction. Thus, when proposing to build anything in the city, designs should strive to mitigate flooding issues.

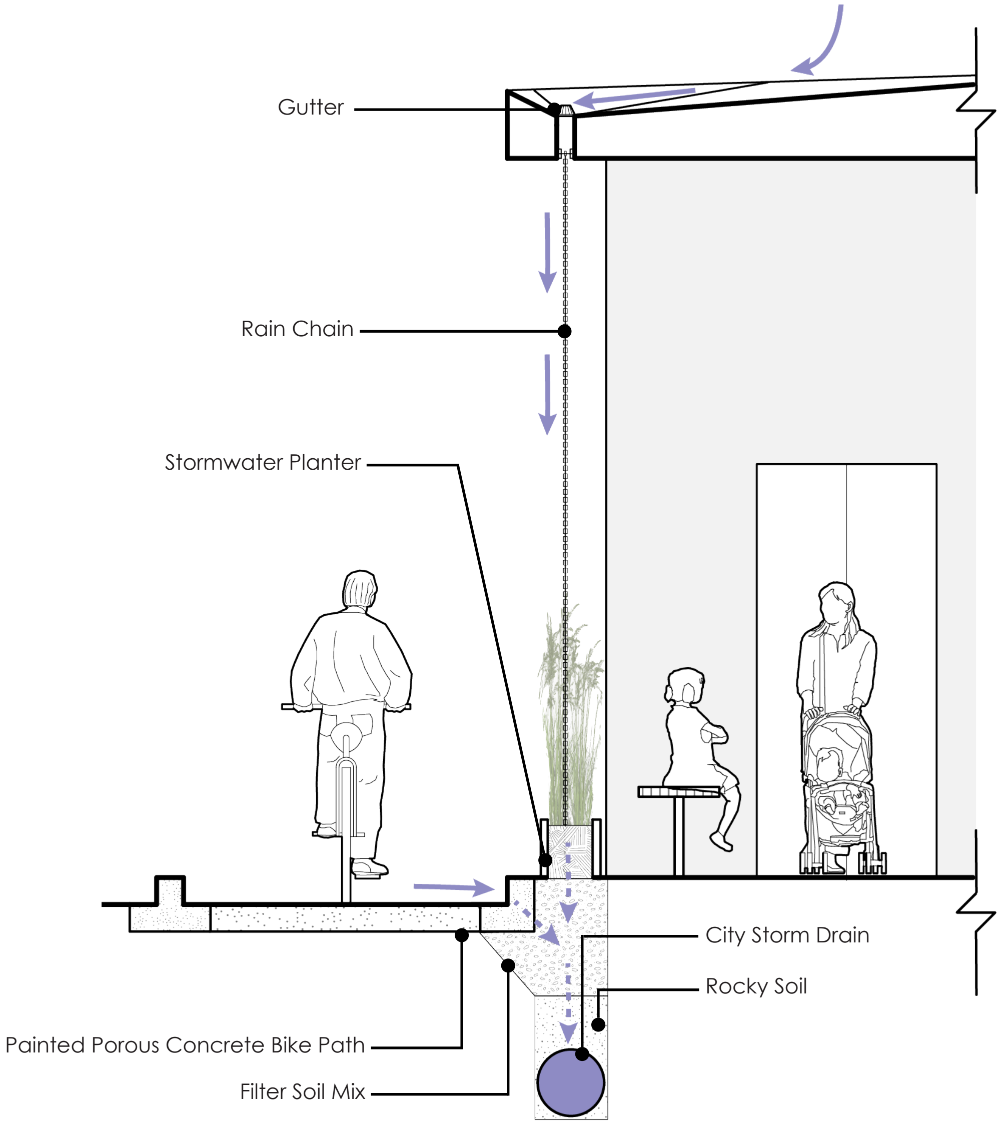


fig. 3.15 TYP. bike path & roof detail

The Museum station redesign proposes a rainwater system where the roof drains water into the planters and the proposed bike path is made up of a painted porous concrete (*fig. 3.15*). Furthermore, the proposed sidewalks are different from the typical square blocks, and instead are linear rectangular pavers that are spaced to allow water seepage. The linear rectangular pavers can be removed to form a pattern on the sidewalk for additional greenery (*fig. 3.14*). The permeable infrastructure and added greenery absorbs water to relieve heavy rainfall on Toronto's city storm drains.

fig. 3.16 Museum station rendering

Design proposal ❷ King Station

fig. 3.17 View of King station's exit

fig. 3.18 View of building nook

Site Analysis

The station exit at King Street West and Yonge- west side is below the corner of an existing office building (*fig. 3.17*). Beside the station is an empty nook where people stand under for shelter while waiting for the traffic lights to green at the intersection (*fig. 3.18*). While this space has collected trash in its corners, it has the potential to become a larger part of the public urban community. Furthermore, the area is surrounded by office and condominium high-rises whose lobby spaces can become overrun with parcels from the increase in online orders.

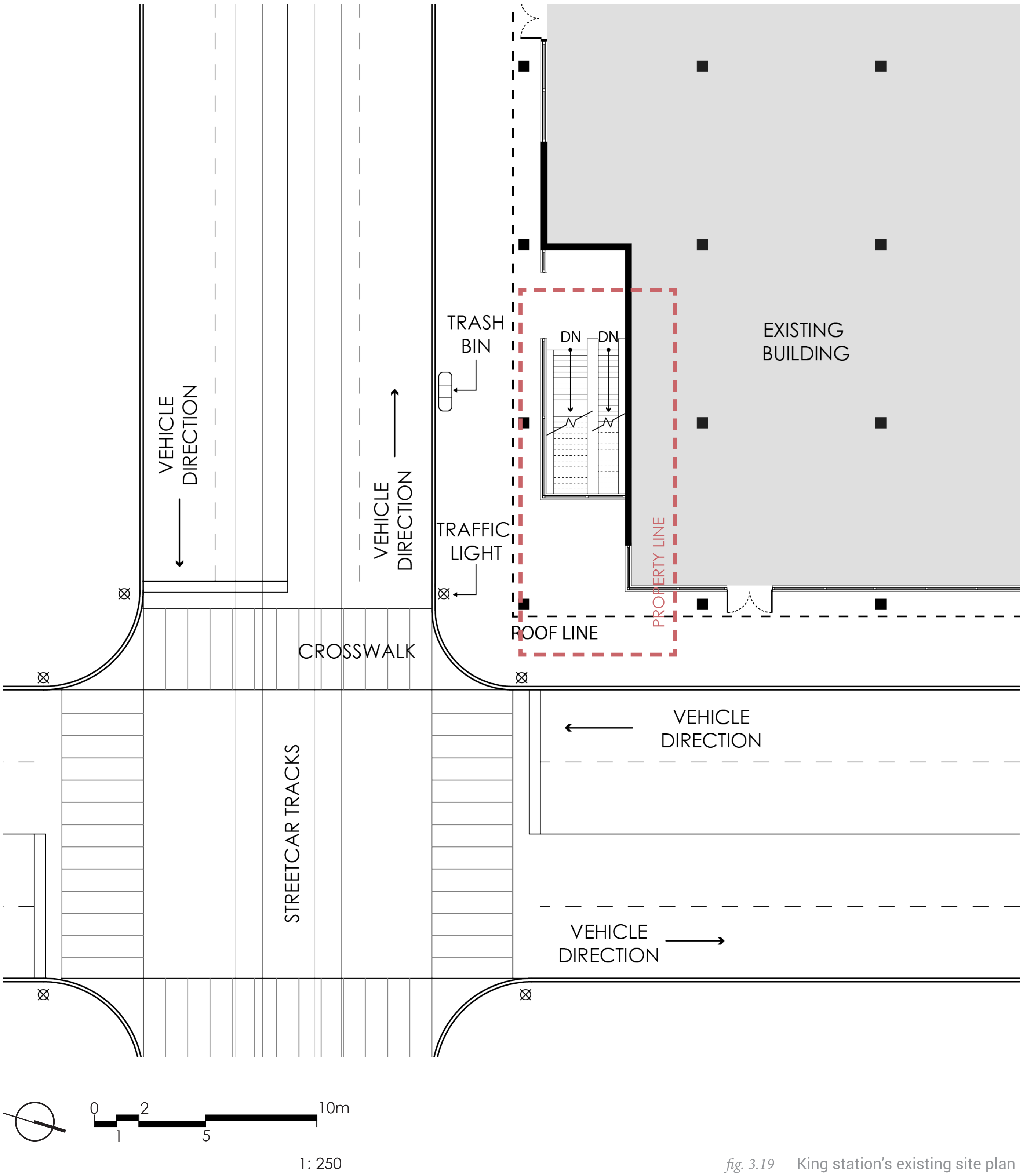


fig. 3.19 King station's existing site plan

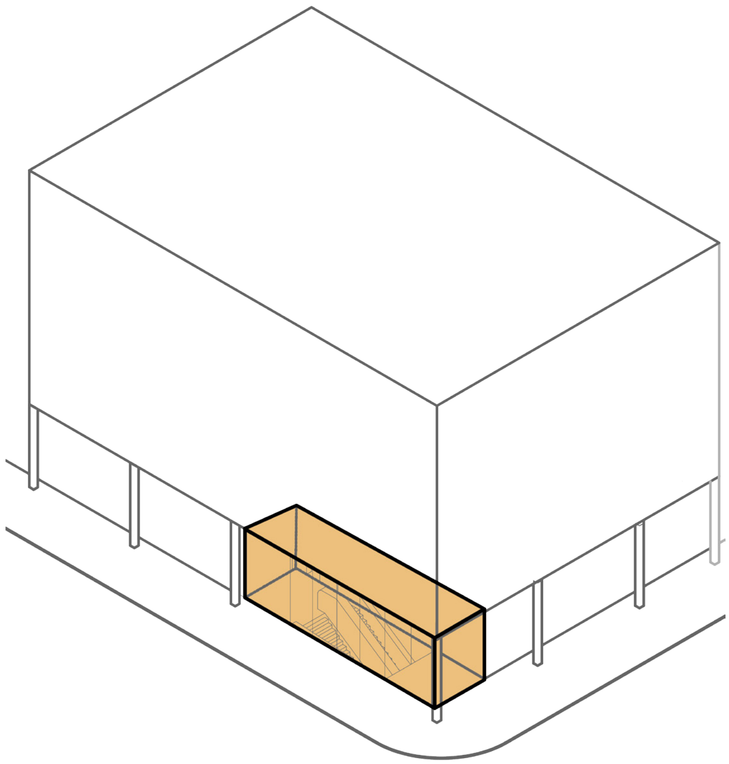


fig. 3.20 King station's typology

Concept

The concept behind the redesign of King station is based on its location and relationship to dense urban life. The subway exit is already a part of a larger building, so all structural elements are to remain the same. Since the design keeps its existing structural integrity and there is minimal space at the location, the proposed architecture is multi-purposed.

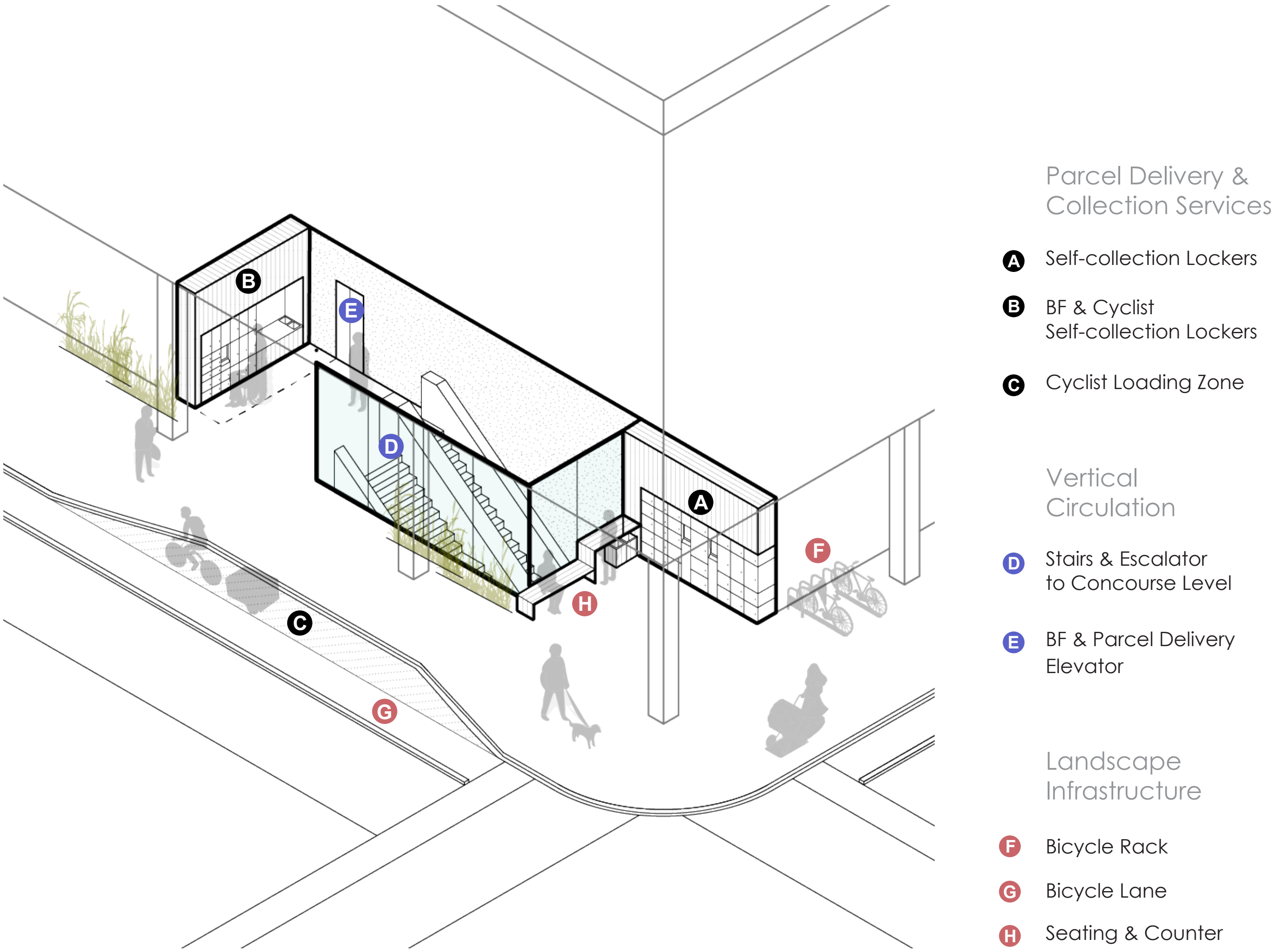


fig. 3.21 King station's program in axonometric

Program

Ideally, there are two separate ways in the elevator core for parcel collection and accessibility, however, King's exit is unable to accommodate for both. This station is an example of a shared elevator (*E*), and in conditions like these, operations during night hours is more probable. Cyclelogistics and barrier-free users also share self-collection lockers (*B*). High traffic self-collection services are integrated with a seating space and counter (*H*). Like all stations, there is added greenery, a bike lane with an area for loading parcels (*C*), and a sheltered bicycle rack by utilizing the extra overhang coverage (*F*). A separate service space is omitted in the programming as it is not essential, and self-collection lockers can be unattended.

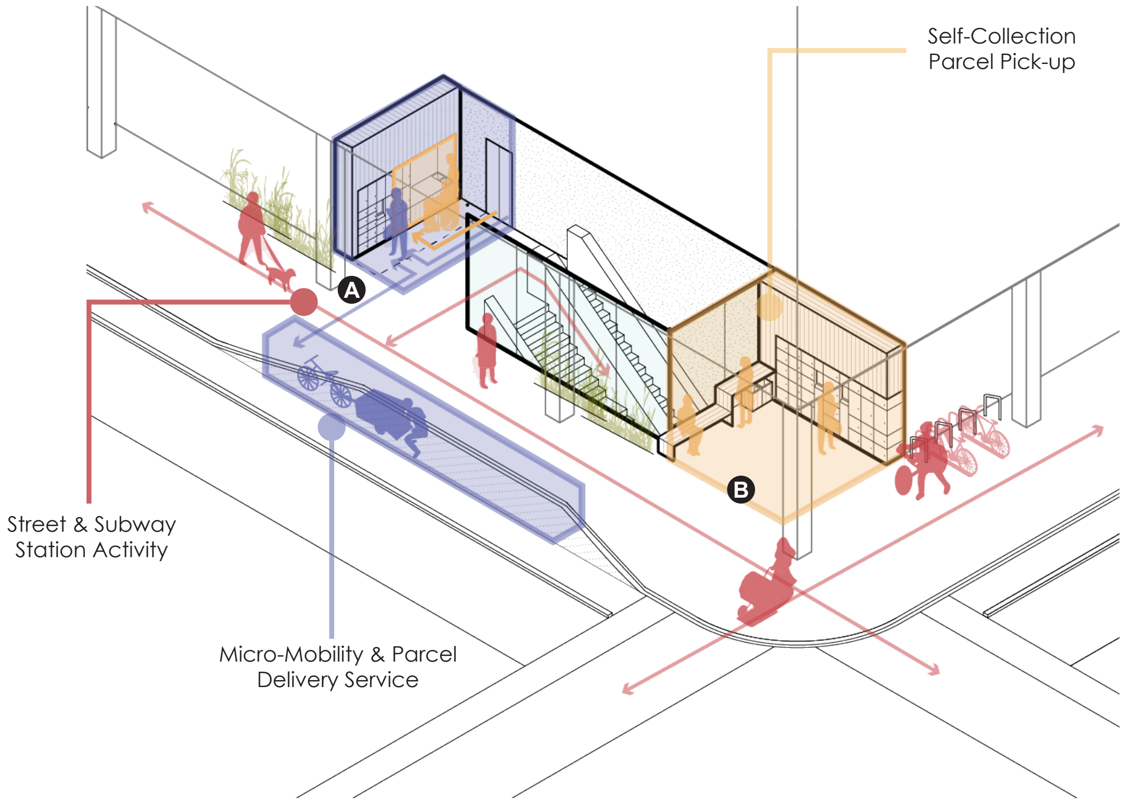


fig. 3.22 King station's circulation in axonometric

Circulation

King station is located at a busy intersection with congested street and subway station activity during its peak hours. Therefore, it is important that the community space not disrupt regular circulation but be a part of the flow of a city dweller's daily routine (*red*). The nook allows for self-collection services away from the high traffic sidewalk (*yellow*). Additionally, accessibility users are conveniently close to elevators and since their lockers are used less frequently, it can be shared with cyclist couriers. Furthermore, a cyclelogistics zone allows for loading and unloading away from moving city cyclists (*blue*).

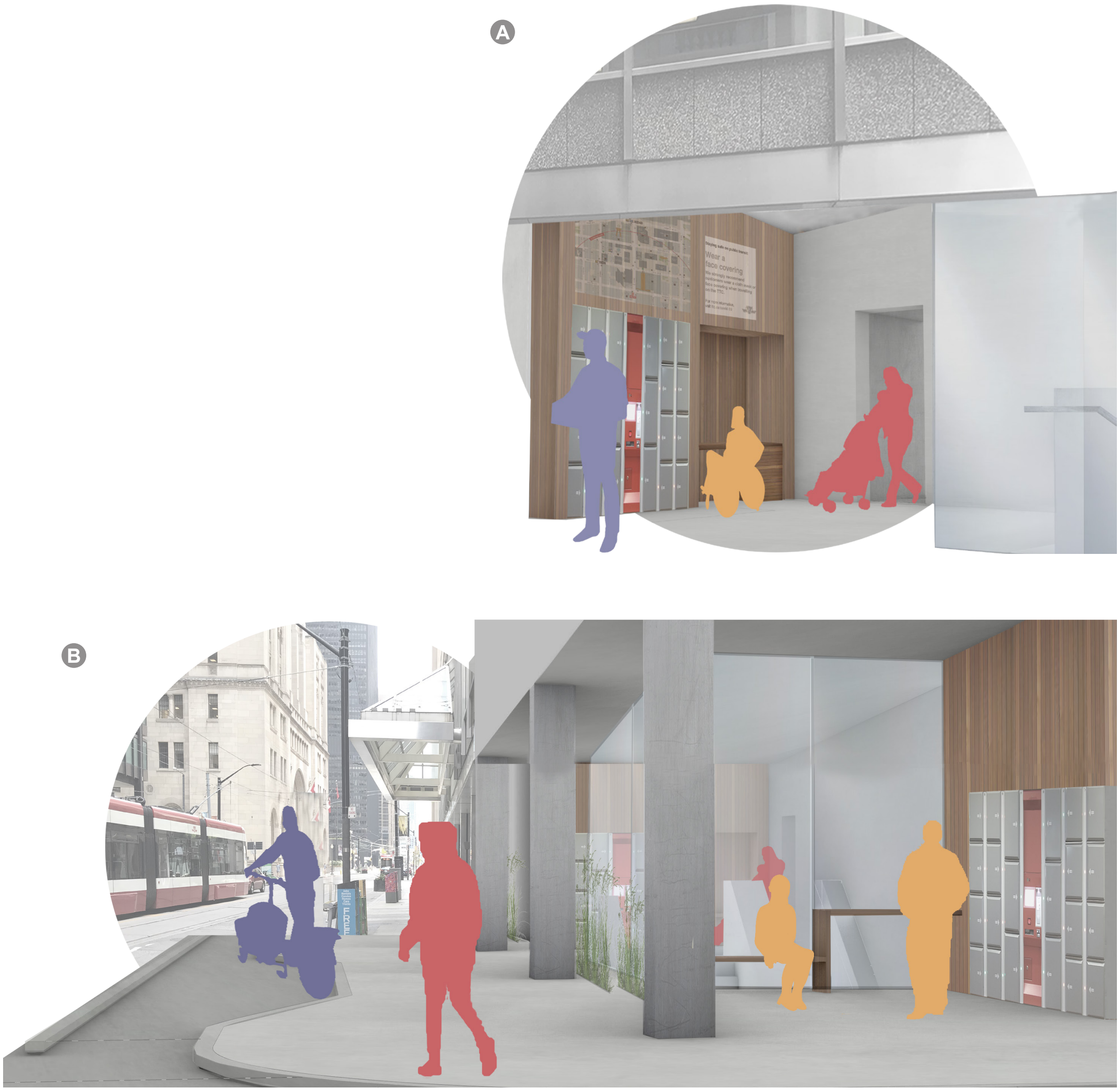


fig. 3.23 Views of King station's circulation

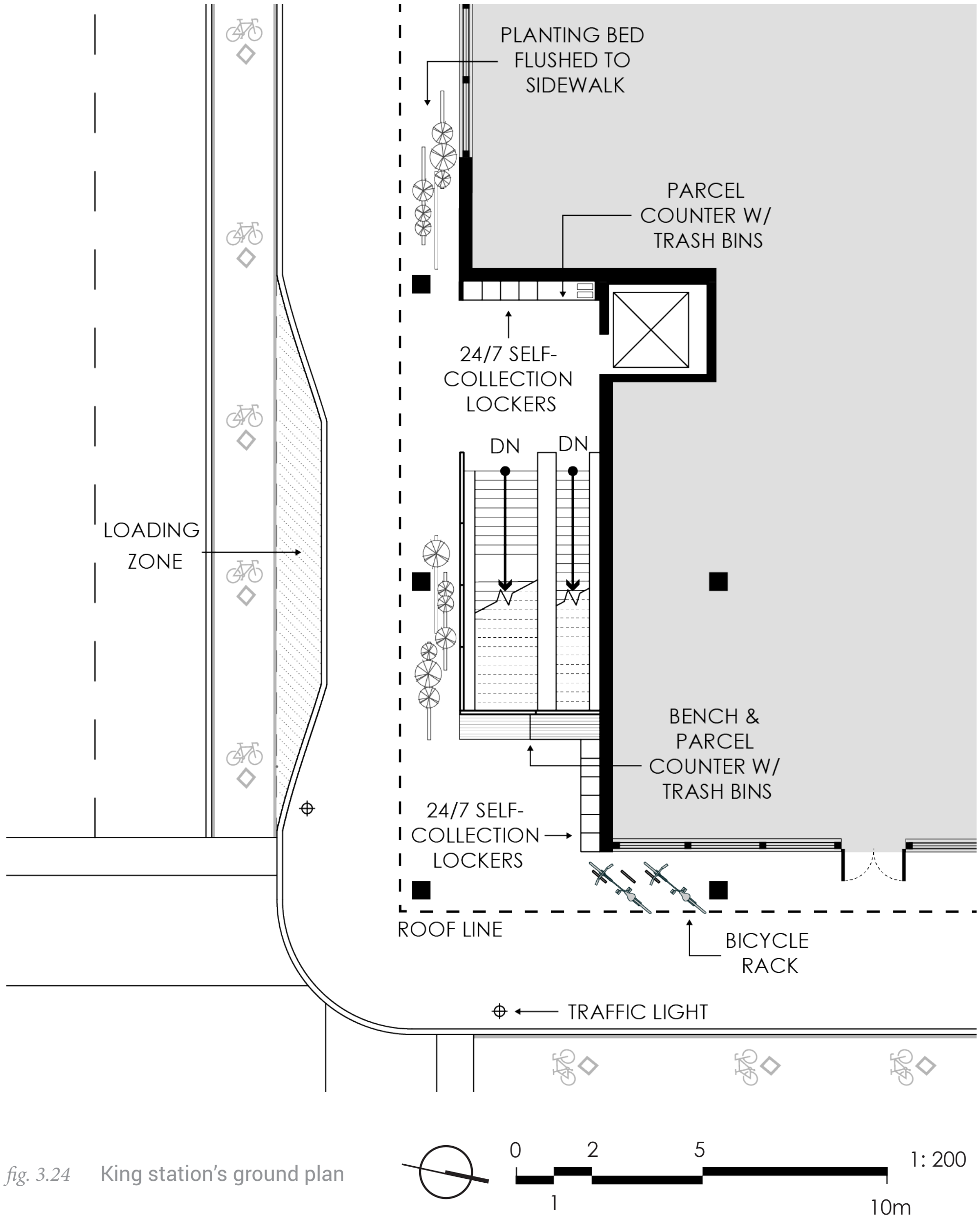


fig. 3.24 King station's ground plan

Plan

The new site includes a bike lane for safe cycling, and a narrow but long loading zone to not interfere with sidewalk traffic. This is to allow easy access to the 24/7 cyclelogistics self-collection lockers.

Flushed sidewalk greenery is added to improve the environment of the public community space, however, it is done minimally to not intrude on sidewalk circulation.

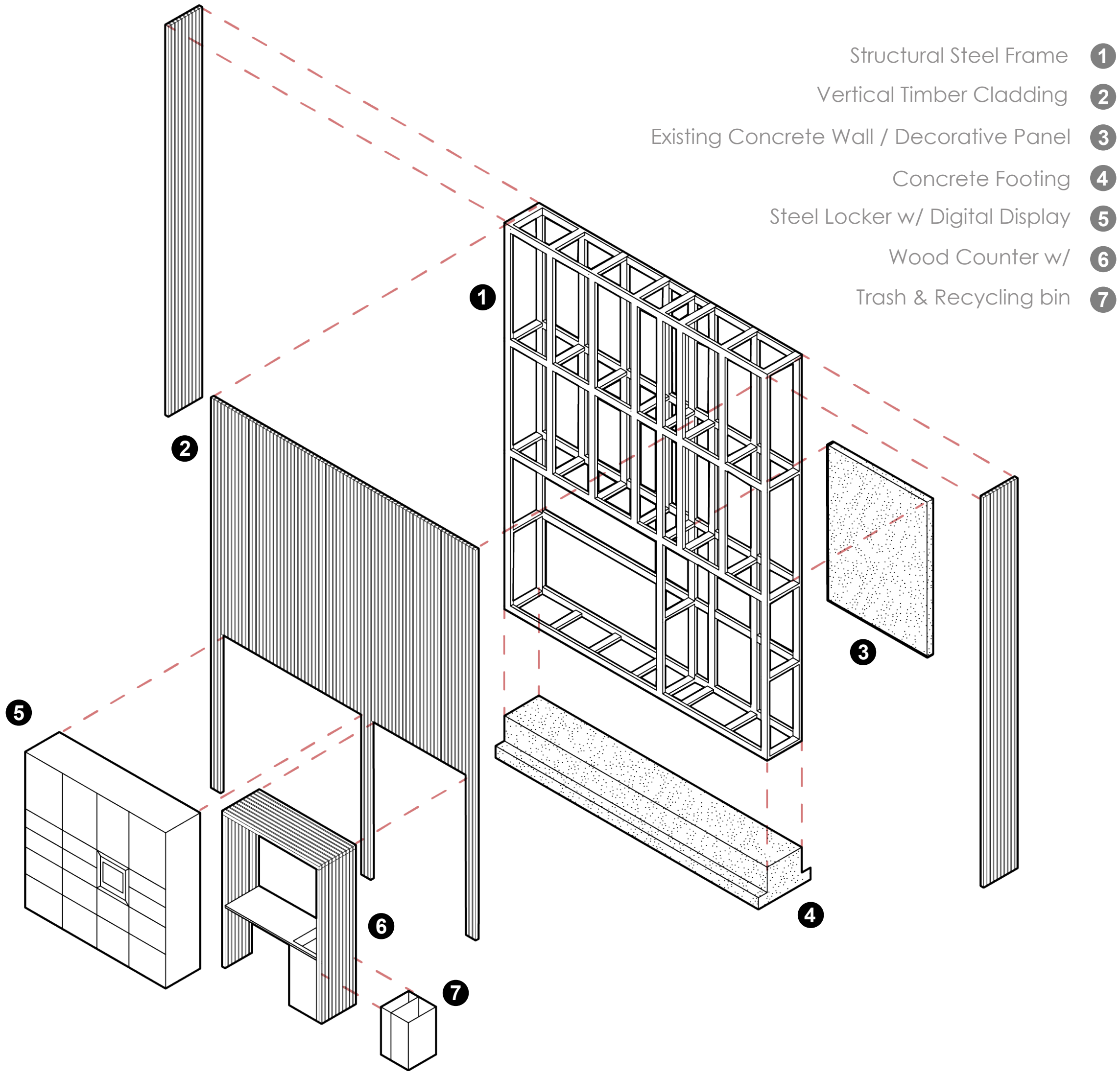


fig. 3.25 TYP. locker wall system construction

Typical Locker Wall System

The primary intention of the parcel collection wall system is for commuters, residents or office workers to collect their online orders. However, they are also integrated into Toronto's wayfinding system. These are typical drawings of how the self-collection lockers are constructed into structural walls (*fig. 3.25*), and how they are used as a wayfinding system throughout the station proposals (*fig. 3.26*).

Vertical timber cladding (*C*) is used alongside public and TTC branded metal self-collection lockers (*A*). This combination of lockers and timber cladding against the vernaculars of the existing area is a new architectural language for TTC stations. They act as clear visual cues to let people know where subway station entrances are located.

Another key component to the system is a counter for people to unpackage parcels. It is also important to note the different trash and recycling bins that are incorporated into the counter (*B*).

Furthermore, the locker wall systems can utilize the open wall space and work together with Toronto's wayfinding systems, such as TO360 (*D*). TO360's purpose is to make Toronto more walkable and understandable for not only residents, but tourists as well.[6] Their own signage has included small maps and arrows to attractions or landmarks, cycling information, transit stations, and the city districts.[7] Including wayfinding signage with locker walls means people can direct themselves. It is especially important to see clear signage when coming out from the subway stations underground, as this is where many people become disoriented.

The other purpose for these wall spaces are for public service announcements (*D*). TTC alerts have been posted on the walls as small posters, however, they are very easy to pass by and disregard. Large billboard-like signage grabs people's attention as they are coming up elevators or stairs.

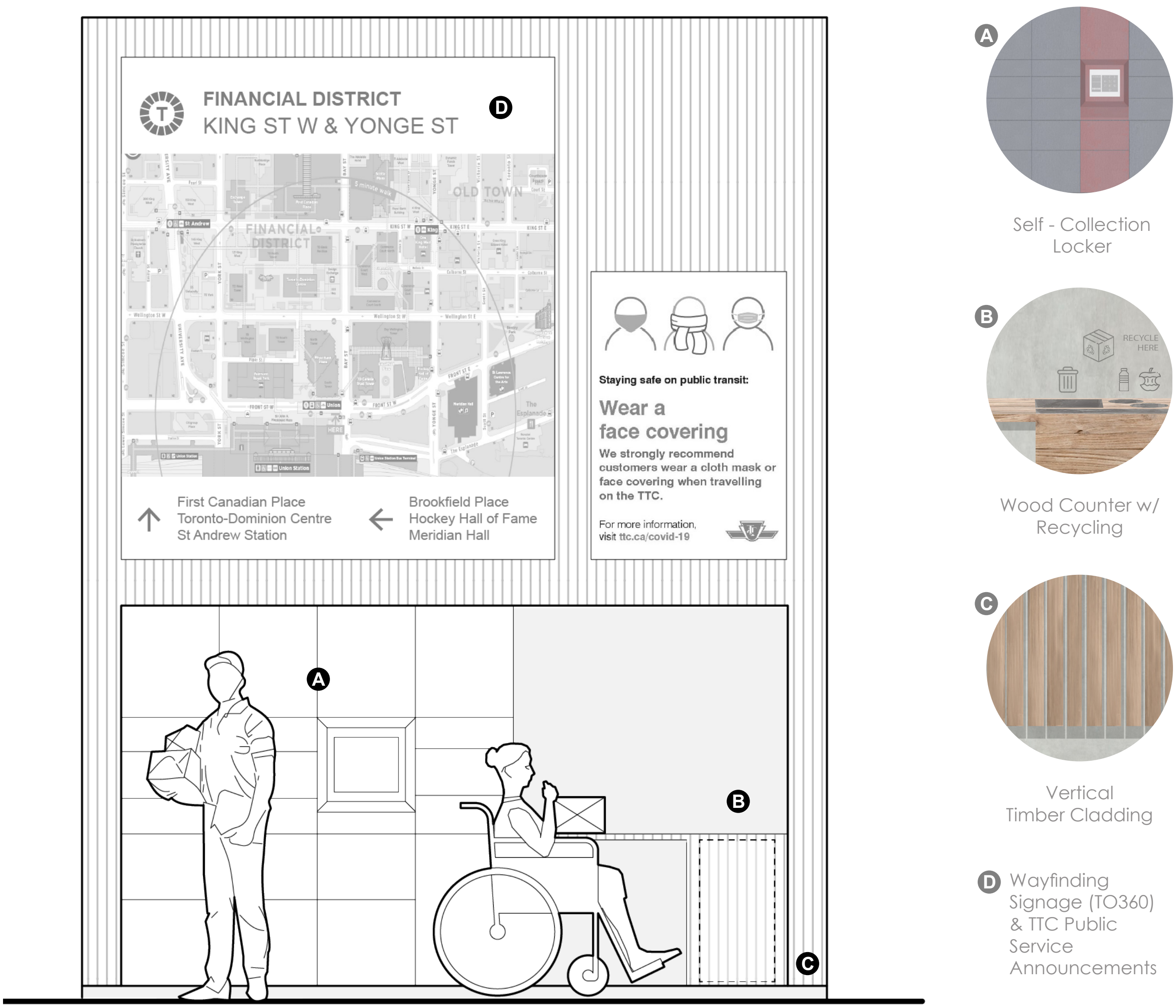


fig. 3.26 TYP. locker wall system detail

fig. 3.27 Museum station rendering

Design proposal ③ Spadina Station

fig. 3.28 View of Norman B. Gash House

fig. 3.29 Front of Norman B. Gash House

Site Analysis

The station exit at Spadina and Kendal is a unique condition. Not many know of the existing station that is inside the Norman B. Gash House (*fig. 3.28*). The house is in between two residential homes and has a large front yard that is used for bike racks. In addition, the station has a fenced backyard that is not in use. The two surrounding neighbours have already turned their backyards into an asphalt parking lot (*fig. 3.30*). Local residents and the Toronto Historical Board argued for "the preservation of the house to maintain the residential character of the area."[8] This may be a reason why the station is underutilized. This design proposal hopes to bring activity to this station while still preserving and keeping a clear indication of its original residential charm.

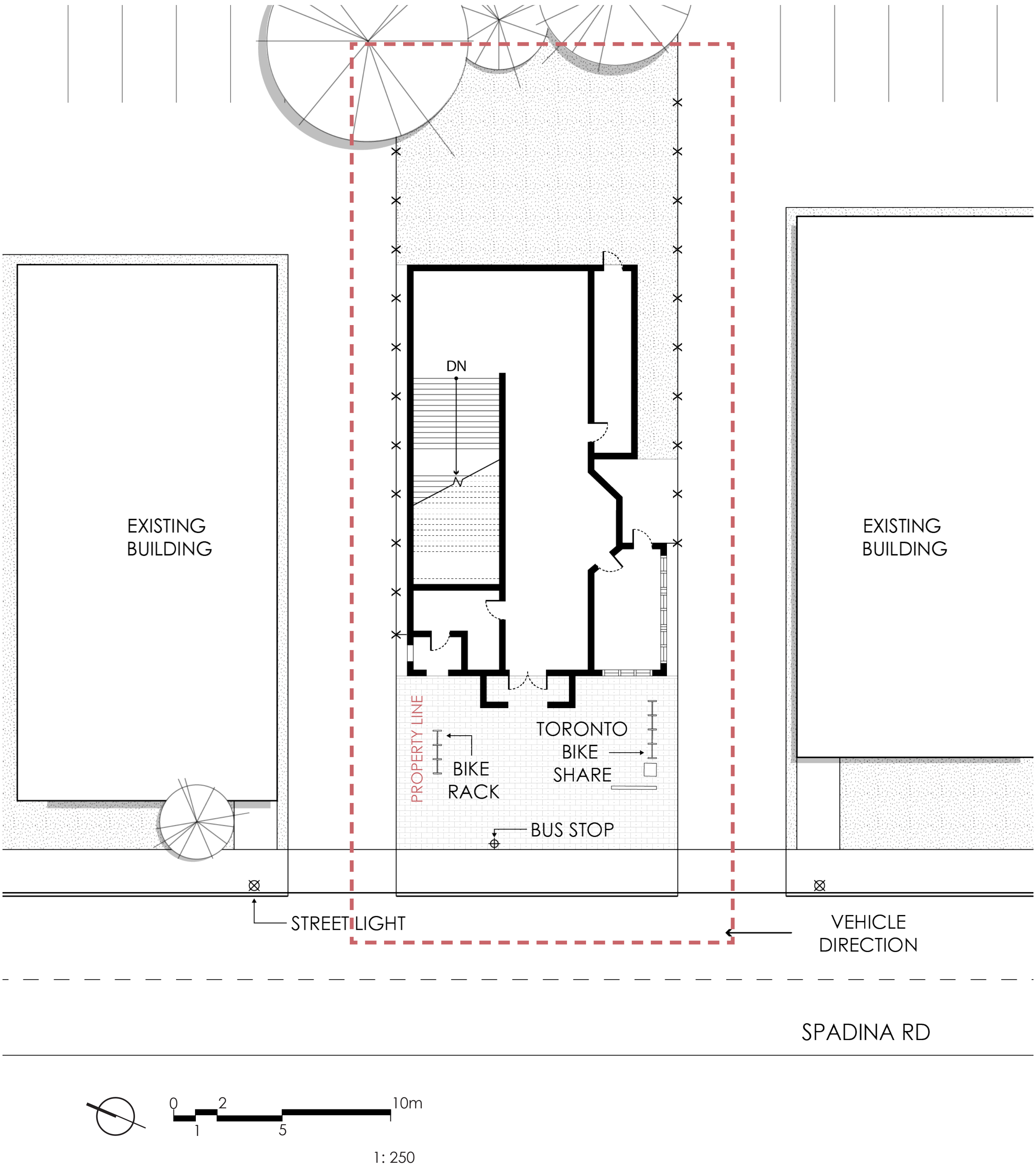


fig. 3.30 Spadina station's existing site plan

fig. 3.31 Interior of the Norman B. Gash House

fig. 3.32 Norman B. Gash House exterior side

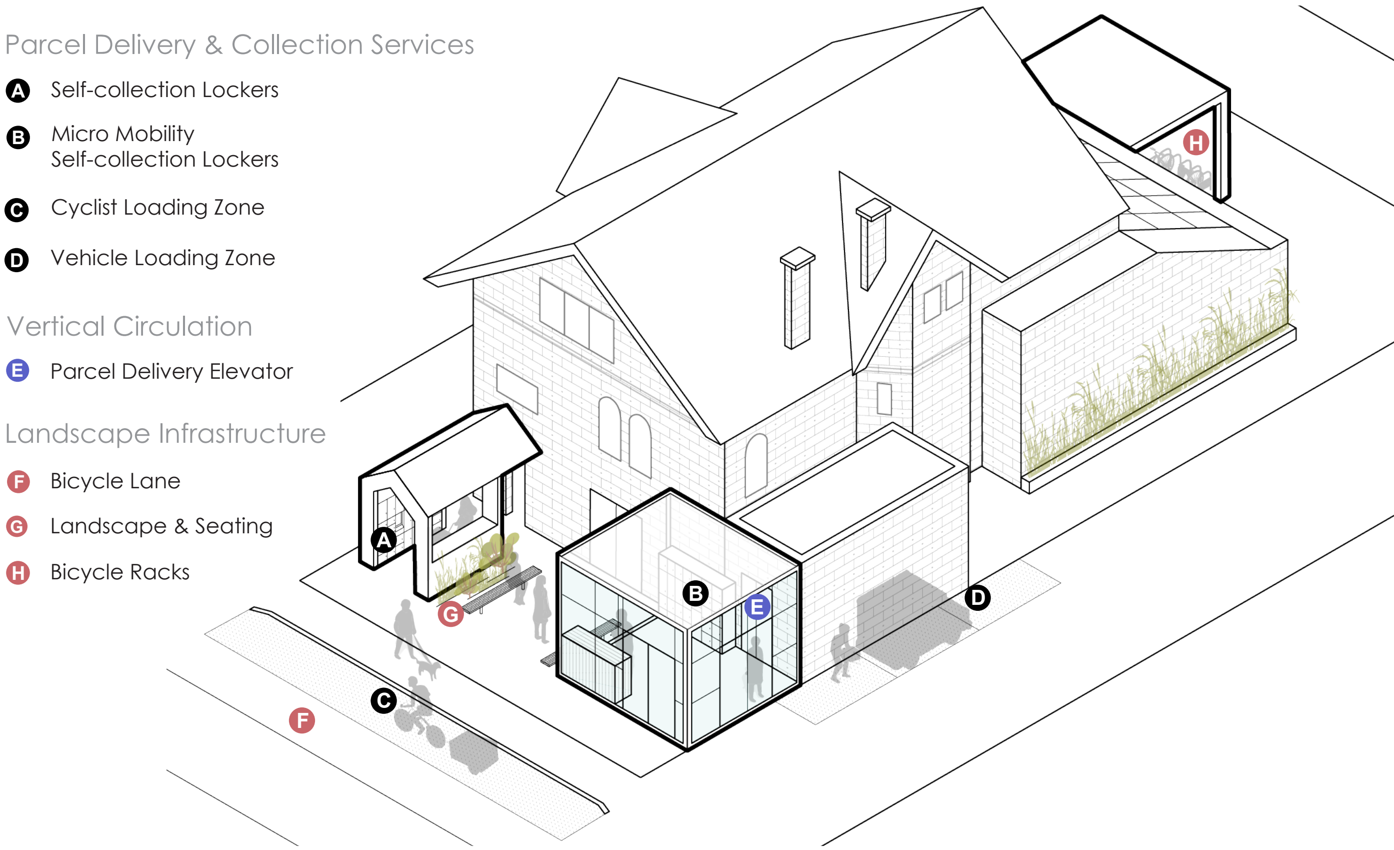


fig. 3.33 Spadina station's program in axonometric

Program

The site allows space for three separate self-collection services. There is a sheltered area for high traffic lockers with a counter (*A*). The inside of the house is taken advantage of to allow for barrier-free elevators and lockers. Furthermore, micro-mobility delivery has its own service area, including an information and service counter with operable hours (*B*). Outdoor seating space, landscaping (*G*), and bike racks (*H*) are added for community use. Additionally, while this proposal includes a bike lane with a physical barrier (*F*) and loading zone for cyclelogistics (*C*), the design also incorporates other forms of micro-mobility. Cycling is an all year round activity in Toronto, however, this may not always be feasible for cyclelogistics during harsher weather. While cyclelogistics is preferred, it is also important to include options for smaller electric vehicles in stations that can accommodate (*D*).

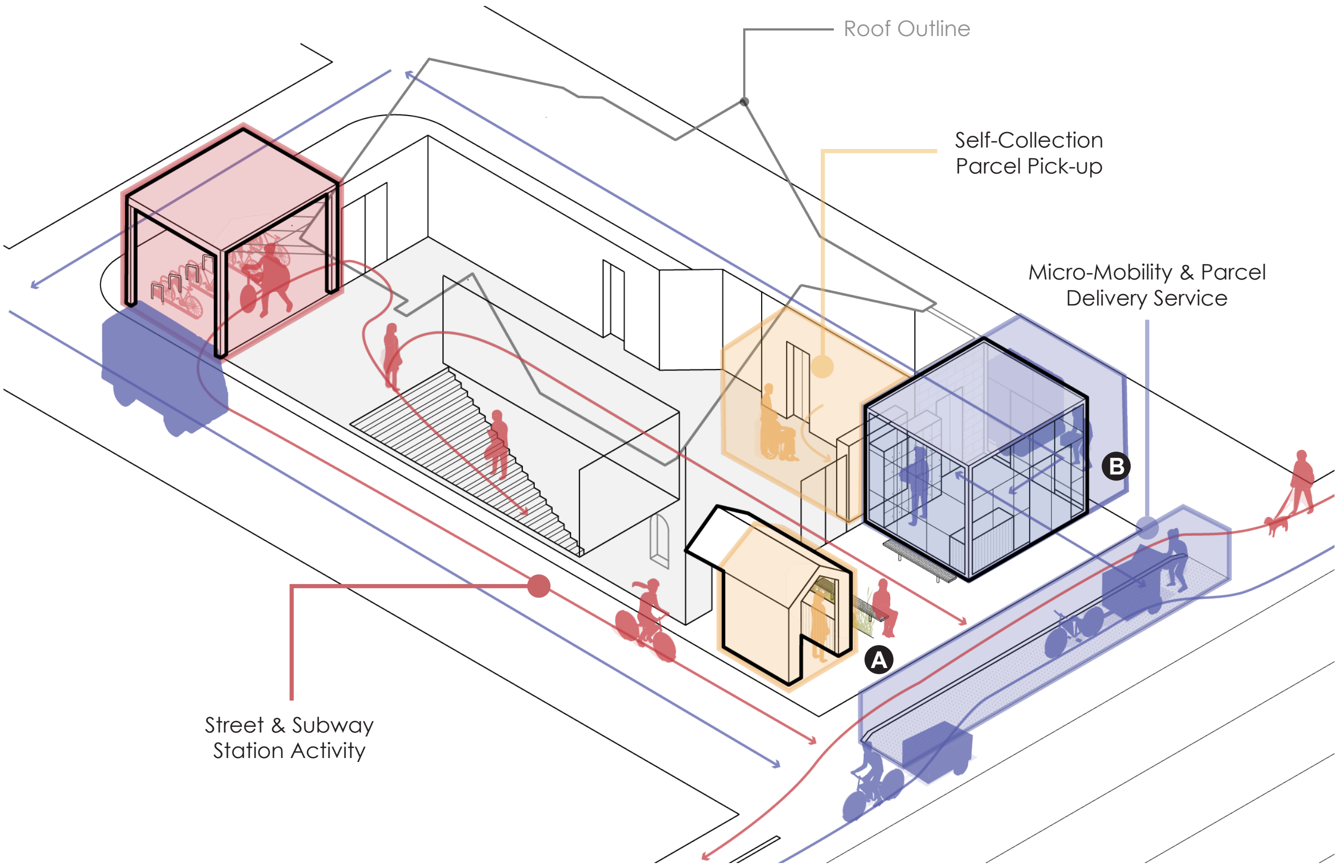


fig. 3.34 Spadina station's circulation in axonometric

Circulation

A new turn-around lane is proposed to take advantage of the unused space at the back of the house. This lane is for smaller electric vehicles and cyclists. People who use the bicycle storage can cycle on the new turn-around lane to merge their way back into the city's bike lanes.

Since this station is in a residential area, the small gathering space at the front is an idea based on elevating the traditional community mailbox. This space is where regular street and subway station activity occurs alongside self-collection services. Furthermore, the barrier free self-collection services are on the inside of the house and is conveniently close to the elevators.

fig. 3.35 Views of Spadina station's circulation

Plan

The original plan of the station could not be found, and the following is an estimate of the existing site conditions with the new proposals (*fig. 3.36*). There are existing mechanical service rooms and stairs to the upper levels, but these areas are closed. The proposed station only designs in spaces that the public has access to (exterior of the building and corridor to the stairs that go down to the concourse level).

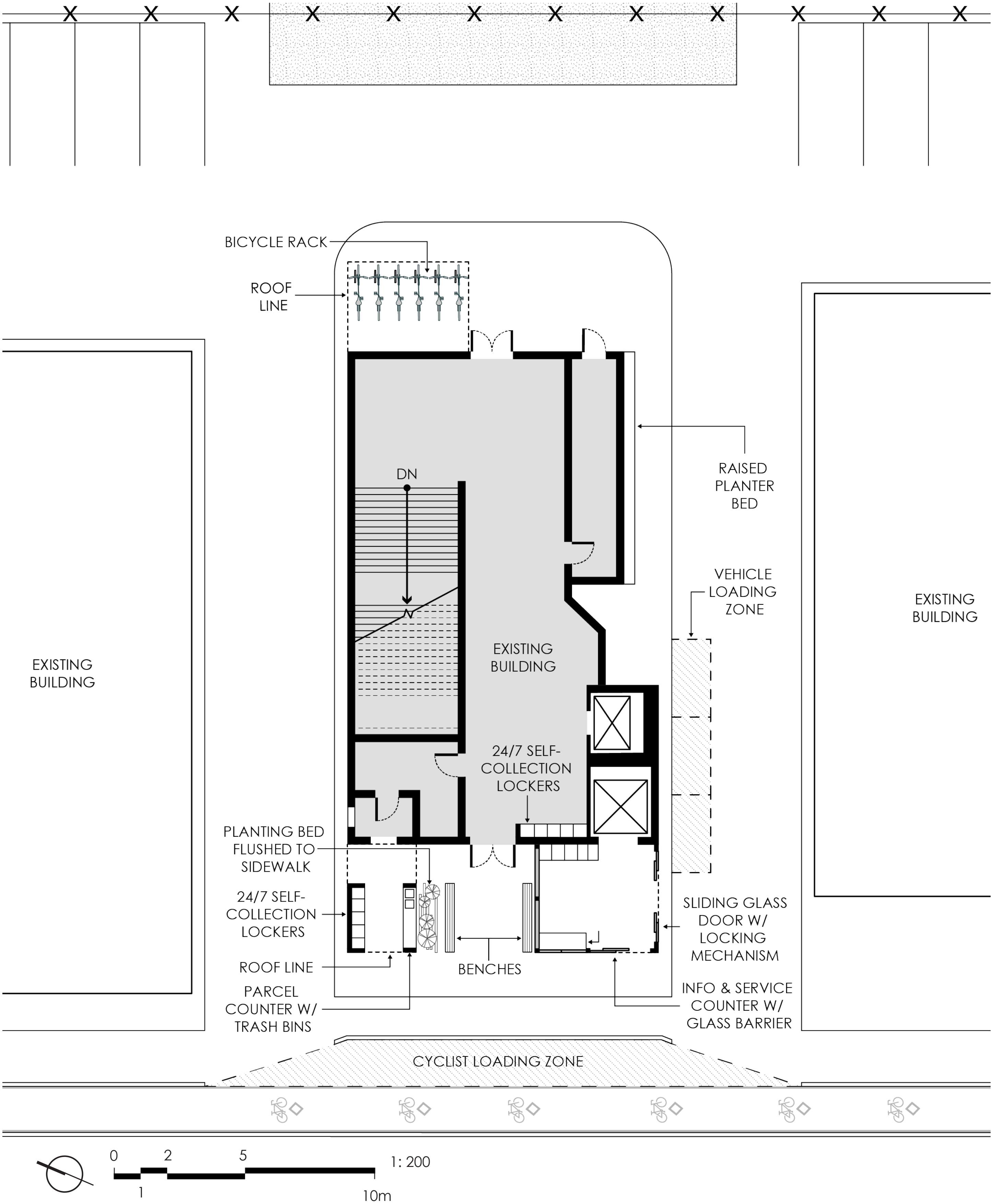
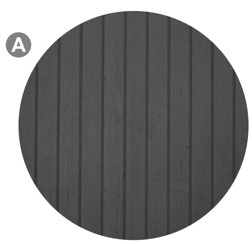


fig. 3.36 Spadina station's ground plan

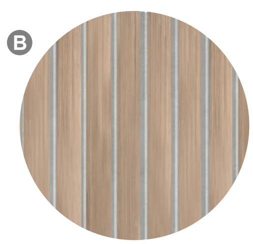
Typical Materiality

The Spadina house station exit has the same details and elements previously discussed. This station also uses a 'semi-permeable concrete paving to flushed sidewalk planter' detail to absorb water from rainfall before leading into city drains (*E*). The self-collection shelter uses black metal cladding on the exterior (*A*); and vertical timber cladding on the interior (*B*) alongside the locker system (*C*) and counter (*D*). The micro-mobility delivery and parcel service area is constructed with frameless spider glazing (*F*). Both individual structures are pavilions. When designing alongside heritage buildings, it is important to see a clear contrast of contemporary elements against the obviously preserved original building.

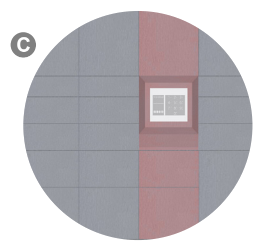
Exterior Black Metal Cladding



Interior Vertical Timber Cladding

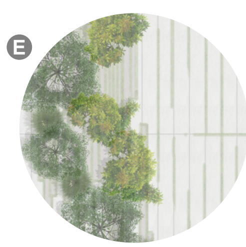


Metal Self-Collection Locker



Wood Counter w/ Recycling

Sidewalk Planter & Semi-permeable Concrete Paving



Frameless Spider Glazing

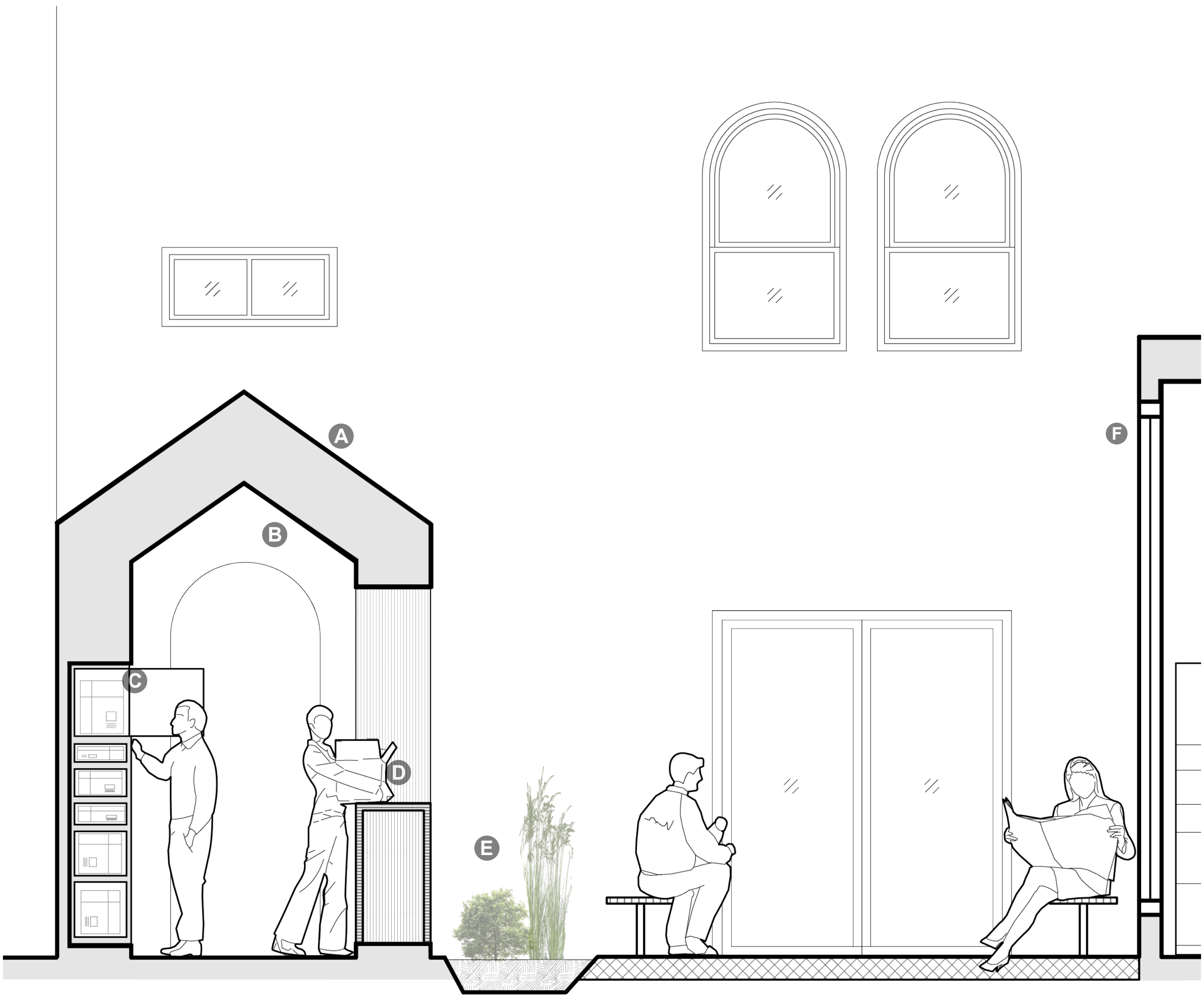


fig. 3.37 Locker to counter section & flushed sidewalk planter with materiality

Typical Streetscape Details

This detail shows the ideal policies for a new streetscape.

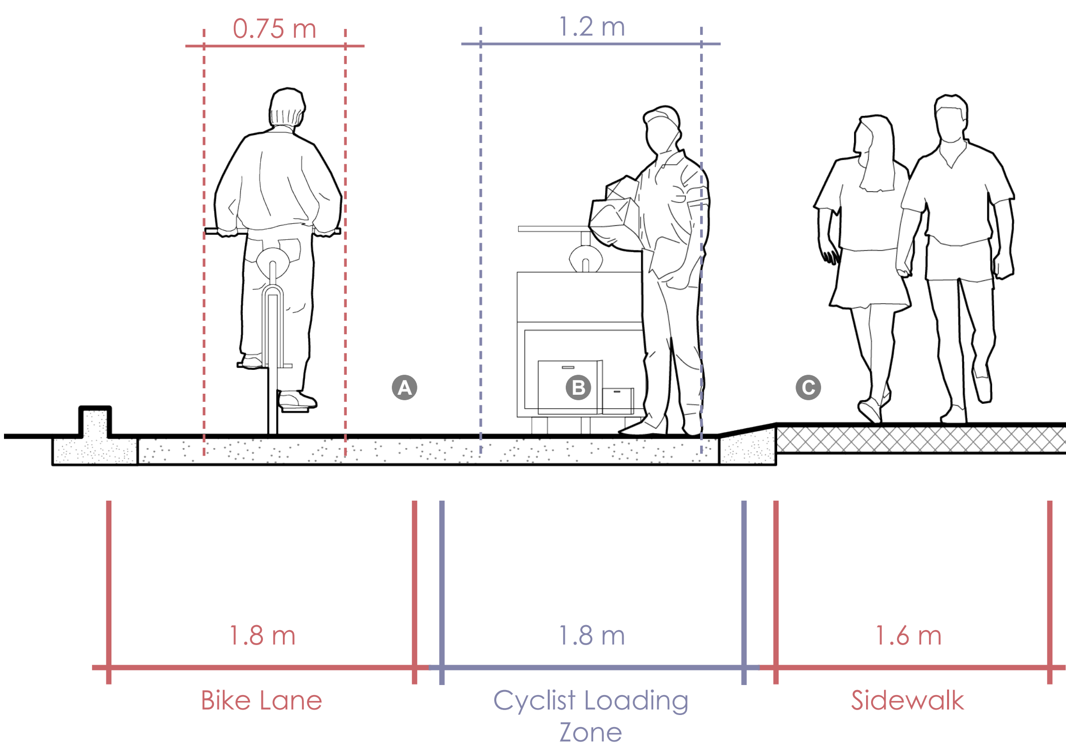
1) The City of Toronto's street guidelines require a minimum of 1.5 m for bike lanes. However, to include larger cargo bicycles, 1.8 m and a physical barrier should be enforced to keep courier cyclists safe.

2) Texture and colour can play an important role as a visual cue to differentiate vehicle and bike lanes. The proposal for these stations introduces painted porous concrete for new cycling infrastructure.

3) Loading zones should not only be implemented in front of subway stations, but also throughout the city for when couriers arrive at their destination points.

4) Separate areas for street circulation and self-collection is important to not impede on pedestrian flow, especially at busy stations like the King exit.

5) Micro-mobility service zones are ideal to prevent use of public sidewalks as areas for organizing parcels.



Ⓐ Painted Porous Concrete

Ⓑ Designated Loading Zone

Ⓒ Semi-permeable Concrete Paving

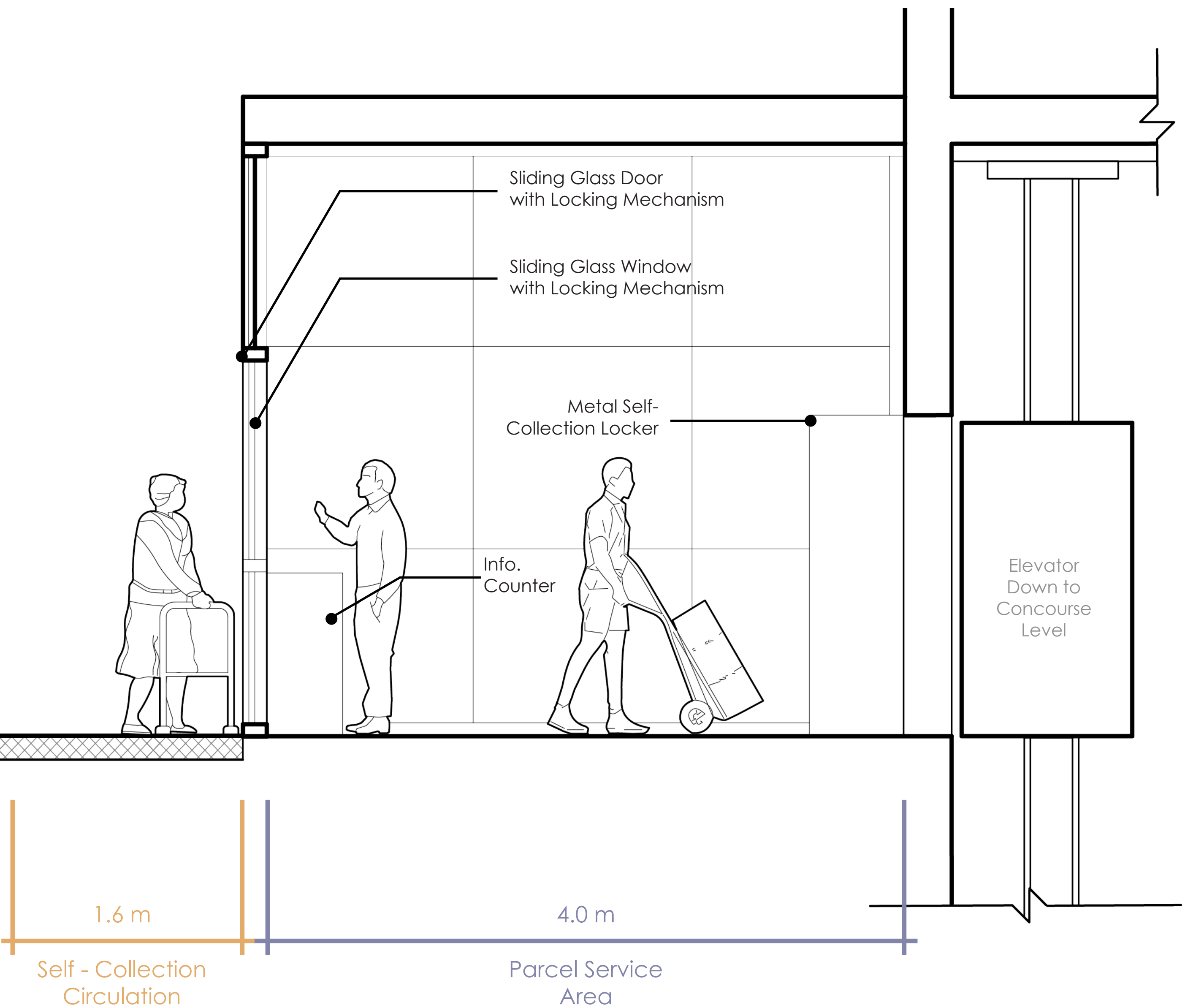


fig. 3.38 Proposed streetscape section

fig. 3.39 Spadina station rendering

fig. 3.40 Overall rendering of King Station proposal

CONCLUSION

Toronto is in an emerging era of delivery use. Online shopping is increasing, and so too are the many 'last mile problems'. The purpose of this thesis is to discover the repercussions that the 'last mile' has on Toronto's streetscapes, which goes hand in hand with the well-being of those living in a dense metropolitan city. Understanding how a booming e-commerce economy is affecting people and the urban fabric is essential when discussing city logistics. The conventional urban freight movement is no longer sustainable in this society, and the need for new methods is essential.

Current and future implementation of novel modes for city freight transportation is transforming traditional delivery networks. Thus, this design thesis explores the integration of new city logistics into Toronto's existing infrastructure. Methods of freight on transit, micro-mobility delivery, and self-collection lockers are further researched because it is designed into an all-encompassing system that can adapt to Toronto's urban environment.

This thesis hopes to bring awareness that in populated cities, there needs to be new infrastructure to handle e-commerce growth. Thus, the design proposal integrates innovative city logistic methods into Toronto's urban life; whether that be creating much needed bike lanes, addressing stormwater issues, proposing clear wayfinding signage, or adding accessibility and clear visual cues of subway stations.

Exploring new designs that integrate urban delivery as a part of a communal public space is fundamental to the current and forthcoming narrative of *Toronto's Last Mile*.

Endnotes

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APPENDIX

fig. 4.1 Museum station concourse level view 1

fig. 4.2 Museum station concourse level view 2

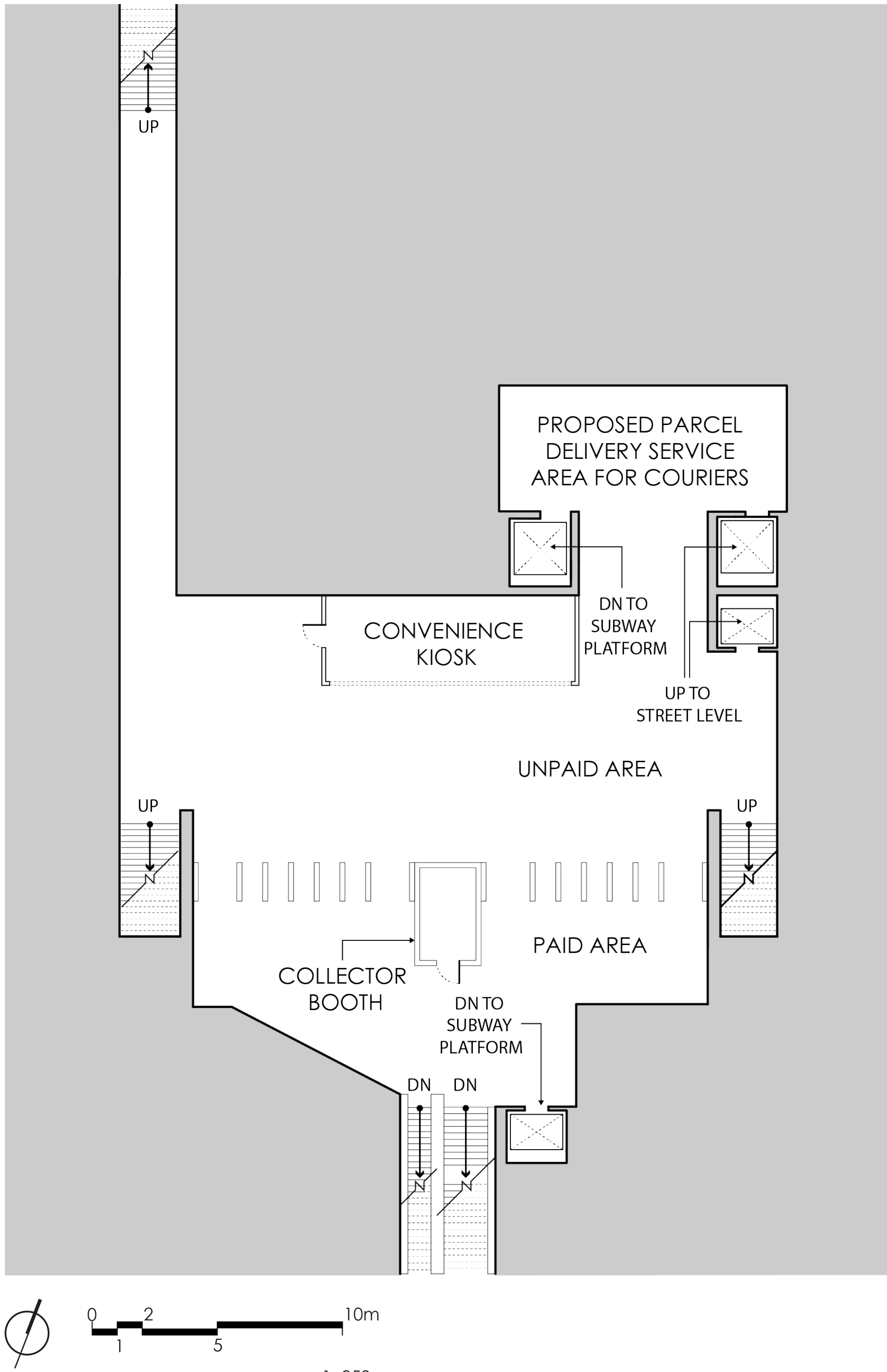


fig. 4.3 Museum station proposed concourse level

fig. 4.4 King station concourse level view 1

fig. 4.5 King station concourse level view 2

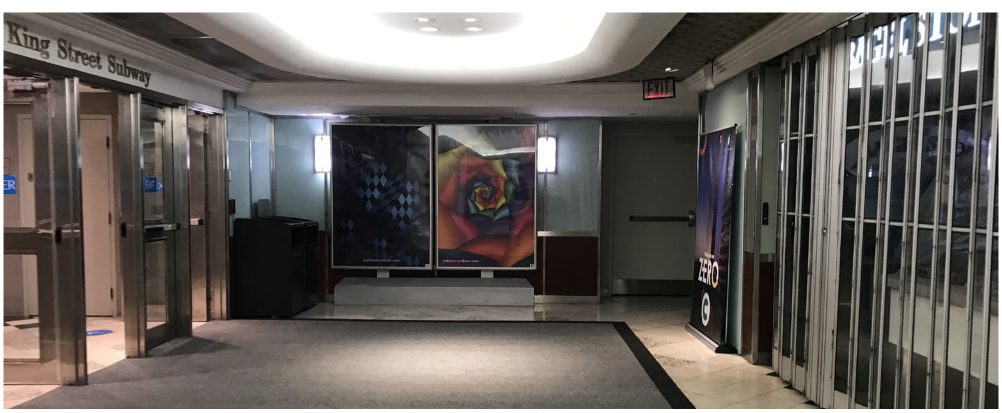


fig. 4.6 King station concourse level view 3

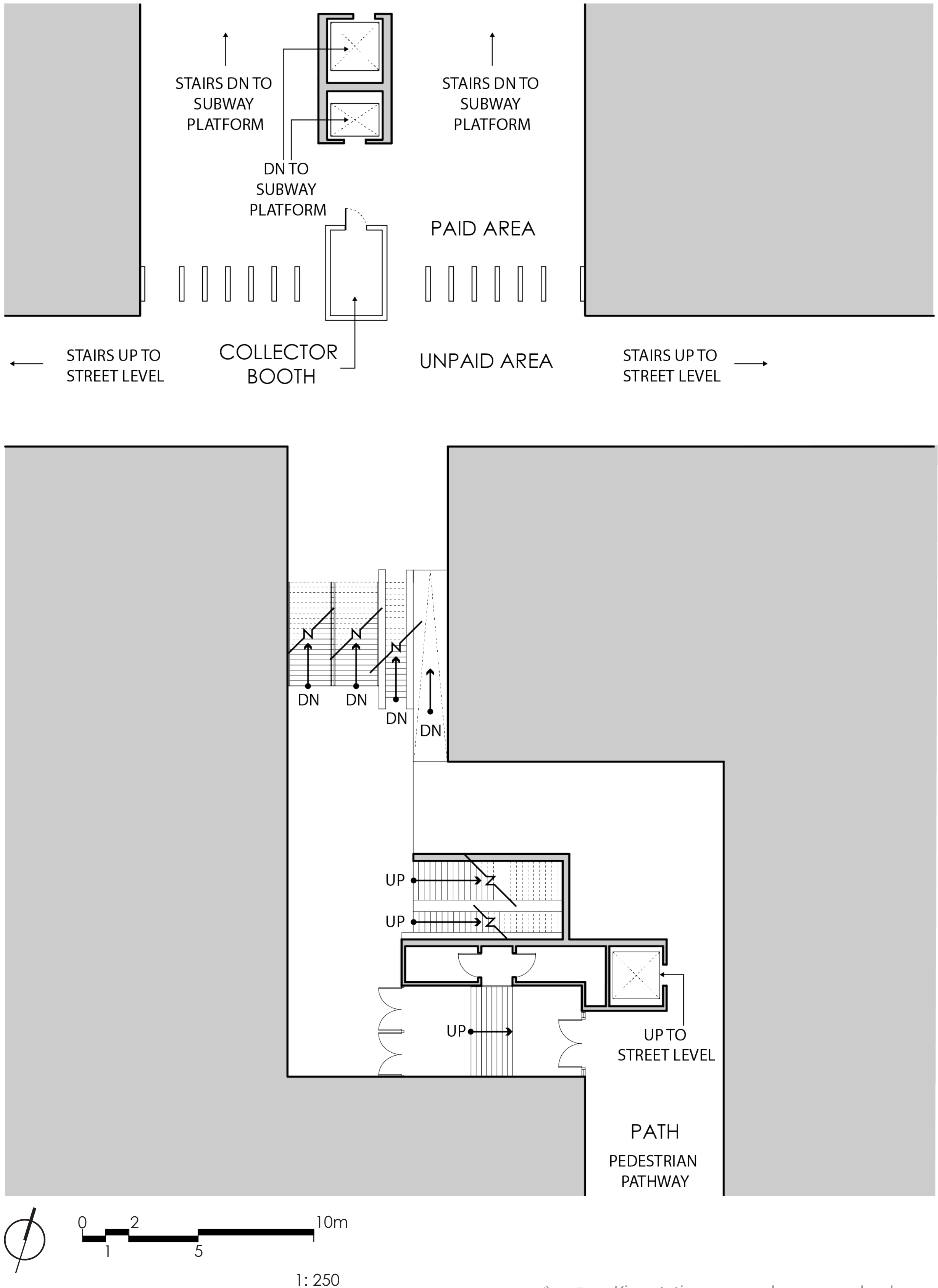


fig. 4.7 King station proposed concourse level

fig. 4.8 Spadina station concourse level view 1

fig. 4.9 Spadina station concourse level view 2

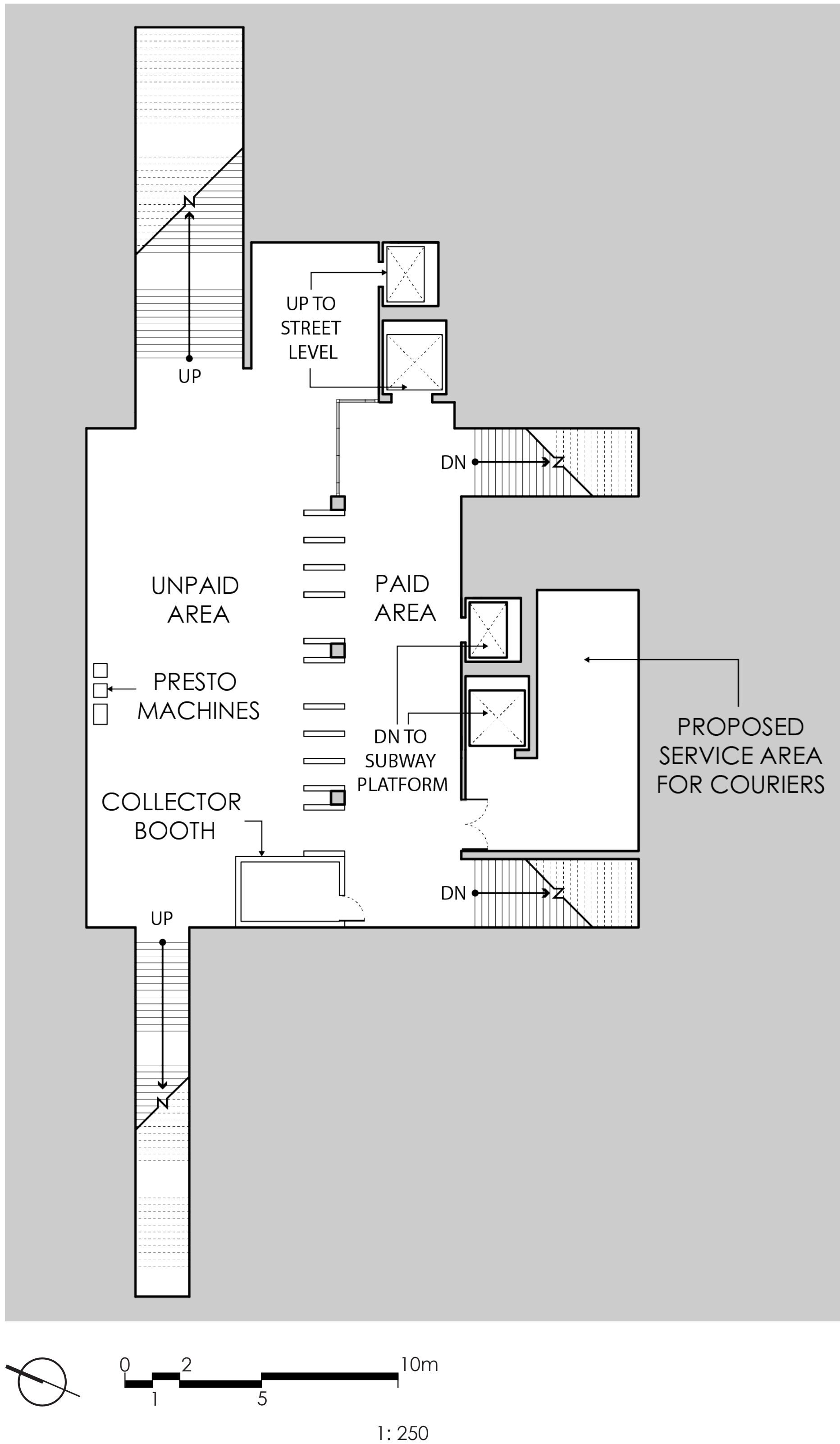


fig. 4.10 Spadina station proposed concourse level

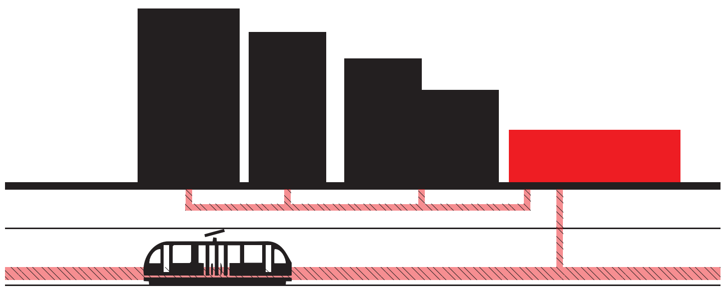


fig. 4.11 Initial thesis concept sketch 1

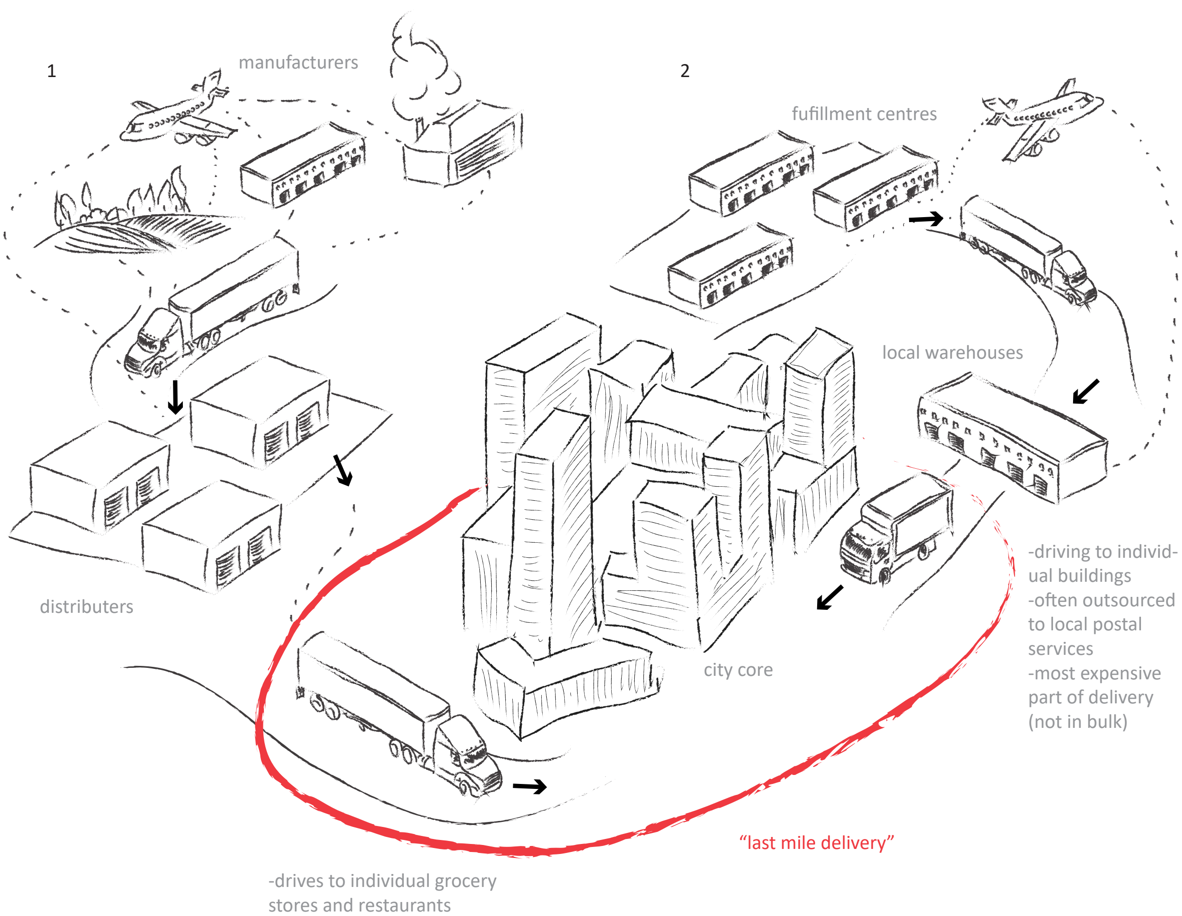


fig. 4.12 'Last Mile' concept sketch

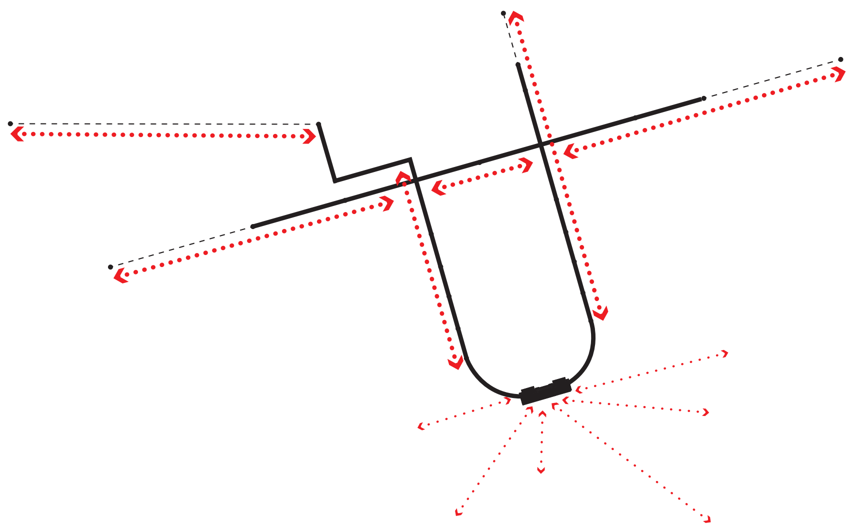


fig. 4.13 Initial thesis concept sketch 2

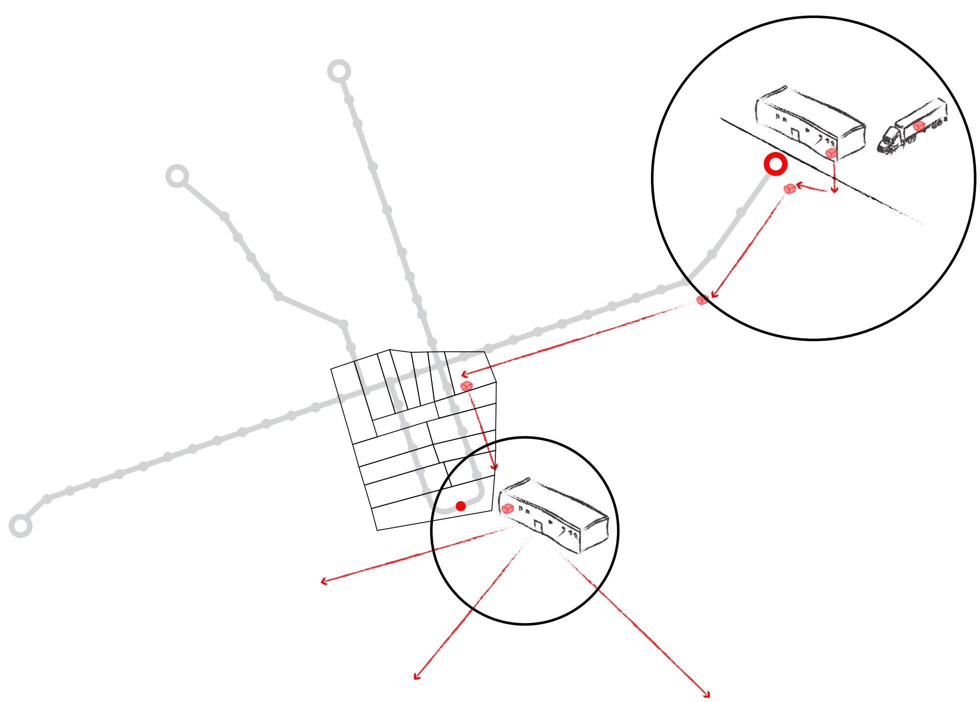
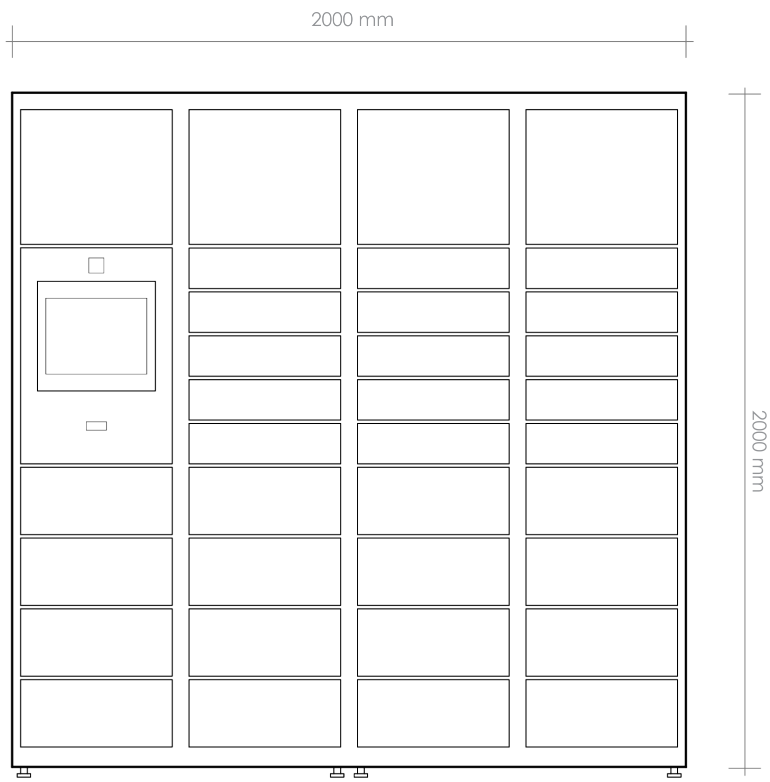


fig. 4.14 Initial thesis concept sketch 3



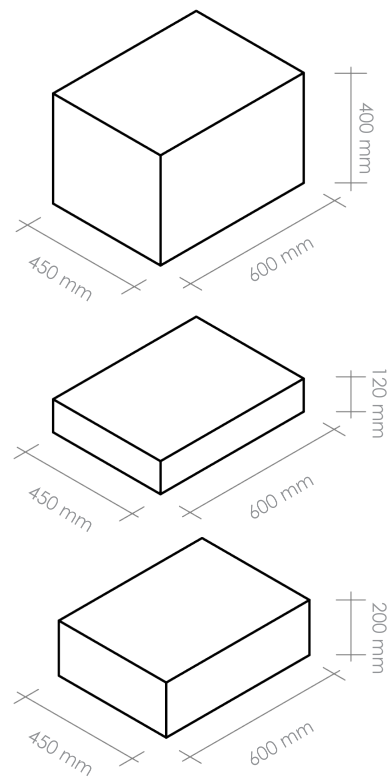
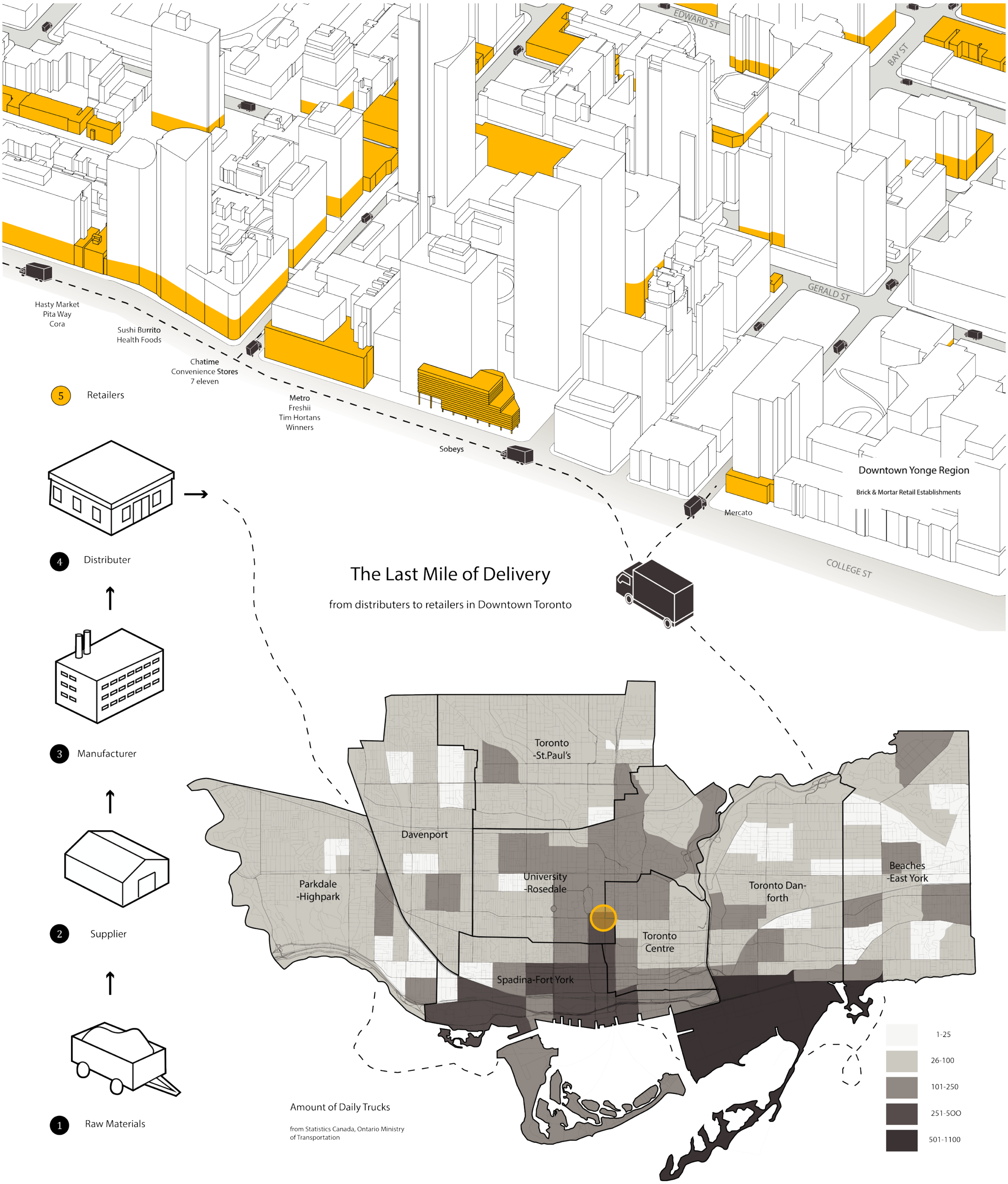


fig. 4.15 PigeonBox Vancouver self-collection locker drawing

fig. 4.16 ‘Last Mile’ delivery overview sketch (*right*)



EDWARD ST
BAY ST
GERALD ST
COLLEGE ST
Hasty Market
Pita Way
Cora
Sushi Burrito
Health Foods
Chatime
Convenience Stores
7 eleven
Metro
Freshii
Tim Hortans
Winners
Sobeys
Mercato
Downtown Yonge Region
Brick & Mortar Retail Establishments
5 Retailers
4 Distributer
3 Manufacturer
2 Supplier
1 Raw Materials
The Last Mile of Delivery
from distributers to retailers in Downtown Toronto
Toronto -St.Paul's
Davenport
Parkdale -Highpark
University -Rosedale
Toronto Centre
Spadina-Fort York
Toronto Dan-forth
Beaches -East York
Amount of Daily Trucks
from Statistics Canada, Ontario Ministry of Transportation
1-25
26-100
101-250
251-5OO
501-1100