New Mobility White Paper

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Vaughan Transportation Plan

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1 Introduction

The City of Vaughan (herein referred to as the "City") is one of Ontario's fastest-growing cities and home to approximately 300,000 residents and employs over 180,000 people. By 2051, it is anticipated that the City will grow to approximately 570,000 residents and 350,000 jobs. In response to this growth, the Vaughan Transportation Plan (VTP) is being developed to update the City's Transportation Master Plan - a blueprint for moving people and goods sustainably for the next 20 years and beyond.

This paper provides a background review on New Mobility solutions, recommendations for pilot programs, and potential requirements for policies, infrastructure, and services.

2 What is New Mobility?

Future mobility or "**New Mobility**" refers to a service, mode, transportation infrastructure, or a combination of these that leverages new digital communication platforms and data to connect travelers to mobility options to move, share and use the transportation infrastructure[1]. New Mobility may refer to solutions that leverage Autonomous, Connected, Electrified, and Shared (ACES) technologies and the data collected and generated to enable effective services. These include new modes, services, and infrastructure, which hold both potential benefits and risks for the transportation network.

The following subsections provide a review of New Mobility technologies and services. For each type of technology or service, a high-level description is provided, followed by potential benefits, risks, implementation challenges, and mitigation methods. Case studies illustrate how these technologies or services have been implemented and lastly, anticipated timing is discussed.

[1] Alameda County Transportation Commission. (2020). *New Mobility Framework, Draft Technology Categories*. Alameda County, CA. Alameda County Transportation Commission.

2.1 New Mobility Technologies

2.1.1 Connected and Automated Vehicles (CAVs)

Description

Autonomous vehicles (AVs) use technology to automate aspects of the driving system by either operating vehicle features or the entire driving process. The Society of Automotive Engineers (SAE) defines six levels of automation for AVs, which range from 0 ("No Automation") to 5 ("Full Automation"). Levels 0-2 require a driver to monitor the driving environment. Levels 4 and 5 require no human intervention and can be considered fully "driverless" vehicles. Potential applications of AVs in the transport network have been widely explored in academia for car-sharing, ride-hailing, private ownership, goods movement, and public transit. Connected vehicle (CV) technology allows vehicles to communicate with each other (vehicle-to-vehicle, V2V), with infrastructure (vehicle-to-infrastructure, V2I), or with "everything" (vehicle-to-everything, V2X), which includes interactions with other modes such as pedestrians and cyclists. Many in the automobile industry believe that AVs must be connected to speed their deployment and access the full benefits of driverless technology[2], and often refer to CVs when discussing AVs (or vice-versa). For this reason, the concept of connected and automated vehicles (CAV) is discussed together in this paper.

Specifically, V2V technology will allow for platooning or "co-operative driving" (safely grouping vehicles closely by communicating with one another), lower headways, and higher speeds. V2V platooning is anticipated to be highly beneficial for the trucking industry and leads directly to better utilization of freeways. Similar to how vehicle automation has different levels, these types of technologies exist along a spectrum. AV technology will first exist without being connected, and potential benefits of cooperative driving will require further proliferation to be realized.

The CAV ecosystem involves far more than the vehicle itself. In the CAV Readiness Plan developed by the Ministry of Transportation for Ontario (MTO), three aspects of infrastructure readiness were presented[3]:

1. **Technology.** Refers to electronic equipment that may be present at the roadside, located on a person (e.g. cellphones or wearable technology), or other infrastructure. With CAVs, information (from these technology sources) can be communicated with the vehicle directly to support decision-making.
2. **Physical Infrastructure.** Involves changes to freeways, highways, roads, parking infrastructure, transit infrastructure, and any other infrastructure needs. These need to be planned well in advance due to long capital planning and funding timelines.
3. **Communications, Privacy, and Cybersecurity (CPC).** Refers to data protection, user privacy, and cybersecurity of the increasingly connected transportation network and the development of safeguards to ensure privacy and defense against security breaches.

Policymakers have opportunities to shape the impact of CAV within their jurisdiction. Some concerns include the level of regulation, safety standards, liability implications, and methods to encourage adoption through infrastructure improvements, financial incentives, or dedicated highway lanes. Some of the policy-making concerns fall beyond municipal jurisdiction (with

[2] Eno Center for Transportation. (2017). *Adopting and Adapting: States and Automated Vehicle Policy*. Washington, DC: Eno Center for Transportation.
[3] Ministry of Transportation for Ontario. (2020). *CAV Readiness Plan Final Report*. Toronto, ON. Ministry of Transportation for Ontario.

many at the provincial level). To ensure that CAV implementation is consistent, there is a need to develop policies/standards across regional boundaries.

Benefits

- **Improved road safety.** Vehicle collisions result in vehicle damage, personal injury, and lives lost. Human error is deemed to be responsible in over 90% of vehicle collisions[4], and by removing the human element of driving from the road through CAVs, many of these can be prevented. Issues such as distracted driving or driving under substance influence may be taken out of the picture with CAVs. Collisions are also a large factor in creating traffic delays, which will be reduced as well.
- **Decreased congestion.** CAVs have the potential to reduce traffic delay through two primary methods: by reducing traffic delay by decreasing the number of vehicle collisions and enhancing vehicle throughput in the transport network through connected technology (through co-operative driving). Additionally, a decrease in total vehicle-kilometers-travelled (VKT) due to AV proliferation could lead to a further decrease in congestion, but it is inconclusive whether an increase or decrease will occur [5].
- **Reduced per-kilometer costs.** Estimates for per-kilometer AV costs (total annual costs divided by annual mileage) range between $0.65 and $0.95, with the potential to decline to between $0.50 and $0.80 as AV technology becomes available for cheaper vehicle models[6]. For shared vehicles, the per-kilometer costs are estimated to range between $0.40 and $0.55, and for shared rides (i.e. in a Robo-taxi fleet), the per-kilometer cost is estimated to be between $0.16 and $0.30. Some estimate even greater per-kilometer cost savings in automated fleets, below $0.10[7]. For AV transit or shuttles, operational costs per-kilometer would also be much lower as well.
- **Increased accessibility.** CAV has the potential to provide a means of accessible travel for those less mobile or for those unable to self-operate an automobile, such as the elderly, disabled, and underaged populations. This benefit is contingent on the affordability and acceptability of accessible CAV solutions. The vehicle must have sufficient capabilities (ramps and other assistive technology) and an advanced user interface to accommodate a range of users.
- **Land use pattern shifts.** CAV technology is anticipated to reduce or eliminate parking needs in city centers, which can be freed for other uses and increase density. The impact of CAV technology on land use is also paradoxical, with experts split between this scenario and another scenario, where existing land use patterns such as urban sprawl development are perpetuated by CAVs.
- **Increased fuel efficiency.** Achieved through their ability to communicate their maneuvers with each other, which can reduce sudden braking, and encourage platooning of vehicles with low headway through speed harmonization. In addition, CAVs are also anticipated to be electric vehicles (EVs), which generate fewer emissions throughout their lifecycle.
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[4] Maddox, J. (2012). *Improving driving safety through automation, congressional robotics caucus*. National Highway Traffic Safety Administration.
[5] Anderson JM, Nidhi K, Stanley KD, Sorensen P, Samaras C, Oluwatola OA.(2014). *Autonomous vehicle technology: A guide for policymakers*. Rand Corporation.
[6] Littman, T. (2020). *Autonomous Vehicle Implementation Predictions, Implications for Transport Planning*. Victoria, BC. Victoria Transport Policy Institute.
[7] Irem Kok, etal. (2017*). Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries*, RethinkX (www.rethinkx.com).

Risks and Implementation Challenges	Mitigation
AV Transition	
As AVs increase in prominence on the road network, existing roadway infrastructure may be unable to handle operations for both CAV and non-CAV users. As described, the connected operation involves V2I (and supporting systems), V2V (other vehicles to communicate with), and V2X. In addition, road users may lack familiarity with CAVs before the technology achieving full market penetration. Grush (2016) discusses the costs associated with transitioning to CAVs, claiming that cognitive transition costs (e.g. disruption of established habits) are significant and could delay a shared-vehicle world[8]. A lack of standards is another challenge for connected vehicle deployment. Original Equipment Manufacturers (OEM) may have different V2V or V2I technology resulting in a significant barrier to implementation due to risks associated with investing in a single OEM's vehicle or infrastructure.	• Facilitation of the transition to an automated future will involve participation from the government at all levels. The City has already participated as part of the Advance Connectivity and Automation in the Transportation System (ACATS) program in the development of MTO's CAV readiness plan. • As this plan identifies future actions needed to make this transition, the City should continue to collaborate with MTO as a valuable partner in this program. • Another tool to facilitate this transition is the transportation planning process, and leveraging existing processes such as modelling, simulation, and data analytics to inform decision making. As new technologies manifest in the transportation field, the City should explore opportunities to advance transportation planning policies and framework accordingly. • To enable the collaboration above, additional investment and guidance from upper tier government to kick-start this transition would be beneficial also.
Increase in VKT	
Compared to existing vehicles, where a driver must sit behind the wheel, the time cost of driving is significantly reduced with CAVs. Since the driver no longer needs to take control during their in-vehicle time, the time could be used for completing other tasks (e.g. sleeping, working, reading, watching television, etc.) With decreased travel time costs and increased convenience of travel, induced demand occurs. This risk becomes problematic when CAVs are introduced as personal ownership and	• To mitigate the risk of additional VKT, the City should plan for and promote alternatives to CAV ownership in the future. A possible mitigation measure for this is the Mobility-as-a-Service (MaaS) model which could drive costs down. MaaS is further described in **Section 2.2.2**. Pricing strategies can also be used as a method to mitigate additional VKT with tools such as congestion pricing and road tolling used to manage demand and incentivize other modes.

[8] Grush,B., Niles, J. (2016) *Ontario Must Prepare for Vehicle Automation: Automated vehicles can influence urban form, congestion and infrastructure delivery*. Residential and Civil Construction Alliance of Ontario.

alternative means to access this technology have not been adequately promoted.	• Oregon piloted a VKT tax for 5000 volunteer motorists, called Orego, in 2015[9]. This consists of a 1.8 cent fee for each mile driven on Oregon roads, where the fee goes directly into the State Highway Fund for construction, maintenance, and preservation of roads and bridges. Participants received a credit for fuel tax and remote emissions testing. Participants with EVs received reduced registration fees.
Increase in Urban Sprawl	
CAVs also could lead to urban sprawl as commuters can move further from their workplace yet also (essentially) not lose utility of their commute time. CAVs increase the willingness of users to travel longer distances, effectively lowering the opportunity cost of travel time.	• The City can mitigate this risk by providing zoning regulations and exploring road/distance/congestion pricing schemes. In scenarios where these do not exist, sprawl can be perpetuated. • Evidence has been shown that there would be fewer negative land-use impacts under shared and appropriately priced AV models.
Economic Disruption	
In the existing economy, revenues from parking charges are a source of steady income for many cities. By making parking less essential, CAVs may eliminate this revenue stream, partly or entirely. In addition, driving is a task that employs many individuals (e.g. truck drivers, taxicab drivers, school bus drivers, municipal bus drivers, deliverymen, etc.), many of whom could need to find new jobs. Auxiliary jobs related to driving in the economy could also be impacted.	• As industries related to goods movement may be impacted by the rise of automation, new employment opportunities generally come with innovation. • Although lost revenues from parking are likely, these could be partially offset through CAV benefits such as reduced accident costs, congestion, emissions, and increased productivity. In addition, opportunities for taxation are possible with CAVs as well. A common proposition is a VKT tax (which has been piloted in the state of Oregon), which would be further simplified as VKT can be logged easily in newer vehicles[10]. Another proposition is a luxury tax associated with private ownership of CAVs, which could help to promote a shared-vehicle future, reducing overall network operational costs and VKT.

[9] MyOrego. (2021). *Orego Why it matters.* Salem, OR. Oregon Department of Transportation.

[10] Ratner, S. (2018). *Taxation of Autonomous vehicles in Cities and States, 71 Tax Law 1051.* American Bar Association – Section of Taxation. https://ssrn.com/abstract=3285525

	• The City can provide valuable input by encouraging innovation through a transportation innovation plan, monitoring the impact of automation, and coordinating with higher levels of government to share and leverage any lessons learned.
Policy and Integration	
Policymakers have opportunities to shape the impact of CAV within their jurisdiction. Some concerns include the level of regulation, safety standards, liability implications, and methods to encourage adoption through infrastructure improvements, financial incentives, or dedicated highway lanes.	• Some of the policy-making concerns fall beyond municipal jurisdiction (with many at the provincial level). The City should seek to encourage innovation through a transportation innovation plan and coordinating with higher levels of government. In addition, the City should continue to monitor policy initiatives from other local municipalities, leveraging lessons learned from their experiences to apply locally.

Case Study

Autonomous Vehicle Innovation Network (AVIN), Ontario, Canada. Established in 2017, AVIN is an initiative driven by the Government of Ontario to capitalize on the province's economic potential to innovate in the CAV and smart mobility sectors. It is also intended to concurrently enable the planning of the province's transportation and infrastructure networks for future mobility transformation. It includes a demonstration zone located in Stratford, Ontario.

(Photo Credit: Automotive Parts Manufacturer's Association, 2020)

AVIN has five objectives[11]:

1. Foster the commercialization of Ontario-made advanced automotive technologies and smart mobility solutions;
2. Showcase Ontario as the leader in the development, testing, piloting, and adoption of the latest transportation and infrastructure technologies;
3. Drive innovation and collaboration among the growing network of stakeholders at the convergence of automotive and technology;
4. Leverage and retain Ontario's highly skilled talent; and
5. Harness Ontario's regional strengths and capabilities and support its clusters of automotive and technology.

The network includes six testing regions with focus areas such as human-machine interface, multimodal and integrated mobility, and artificial intelligence. Building on the success of the AVIN initiative, the province will transition to Ontario Vehicle Innovation Network (OVIN) which will taking over its responsibilities in April 2022 with a similar mandate.

[11] Autonomous Vehicle Innovation Network. https://www.avinhub.ca/about/

Anticipated Timing
Long-term (longer than 10 years). As discussed, CAVs involve levels of automation that range from 0 to 5. Many driving actions that fall under lower levels of automation already exist (e.g. cruise control, obstacle detection sensors, self-parking vehicles). However, market penetration of vehicles at levels 4 and 5, which require no driver intervention has not been achieved, nor is anticipated for the near term. A prediction of AV penetration was developed by Litman (2018) based on a literature review and historic deployment trajectories of other vehicle technologies and innovations such as hybrid vehicles and automatic transmissions. AVs are generally expected to have 50% market penetration by 2050, with minimal (below 20%) market penetration within the next 10 years[12].

[12] Litman, T. (2018). *Autonomous Vehicle Implementation Predictions.* Victoria Transport Policy Institute.

2.1.2 Electrification

Description

Our current transportation system uses fossil fuels as the energy source for internal combustion engines (ICE). Electrification specific to mobility looks to replace this energy source with electricity stored in batteries or hydrogen to power the Electric Vehicle (EV). Transportation is the highest contributor of greenhouse gas (GHG) emissions across all industries, and electrification has many potential benefits, but also many barriers to widespread adoption.

Organizations such as transit agencies, municipal service providers, and goods movement companies are considering a transition to electric fleets. Key design and operational strategies depend on the number of vehicles in the fleet, vehicle design, charging speed, charging frequency, and making them a suitable investment for the specific use case[13]. As the fleet is electrified, operators will need to change their process to accommodate different fueling times and considerations for spare vehicles and off-peak charging must be made. In addition, managing electrical demand by levelling out energy usage can keep infrastructure costs lower for both the utility company and the organization looking to invest.

Benefits

- **User cost savings.** A study conducted in October 2020 compared the nine most popular EVs on the market were compared to the bestselling, top-rated, and most efficient ICE vehicles in their class[14]. For all EVs that were analyzed, the lifetime ownership costs were thousands of dollars lower than all comparable ICE vehicle costs, with most EVs offering savings between approximately $7,500 and $13,000. Cost savings from purchasing a used EV between 5- to 7-years old were even larger, between two to three times larger on a percentage basis.
- **Allowing for updated energy sources.** Electrified mobility looks at using batteries or hydrogen that store electricity to power the vehicle, but the ultimate source of that power could come from a variety of sources, which include fossil fuels, nuclear, or renewables. Whereas our current system relies on fossil fuels, electrified mobility allows for other energy sources, which can be continuously upgraded.
- **Reduction in GHG emissions.** The same abovementioned study looked at the difference in GHG (specifically carbon-based) emissions that would be emitted, which was estimated at 4,096 pounds per year (compared between the same vehicles). It is important to note that although EVs do not directly create emissions, the generation method used for the energy used to power them and energy consumption level on a life cycle basis must also be considered.

Risks and Implementation Challenges	Mitigation
Power Infrastructure Gap	
Existing power grids are not designed to support a scenario where transportation relies on them so heavily. As an example, in 2019, EVs consumed 40% more	• To mitigate this infrastructure gap, the City should develop a city-wide electrification plan that will prioritize investment in EV infrastructure, examine planning policies to support EV

[13] Merkel, J. (2020). *How to design electric vehicle charging infrastructure by coordinating with utilities and managing electric demand*. Missoula, MT. HDR Inc.
[14] Harto, C. (2020). *Electric Vehicle Ownership Costs: Today's Electric Vehicles Offer Big Savings for Consumers*. Consumer Reports.

electricity than in 2018[15]. This demand is expected to increase six to eleven times (in different scenarios). This can result in potential issues with power infrastructure supply meeting demand, particularly as this increased demand from transportation compounds with existing energy peaks.	adoption, and explore potential funding sources for these initiatives. In addition, this plan should examine the ability of the existing grid to meet additional demand from electrified mobility, and coordinate with providers to build out improvements as needed.
Availability of Charging Infrastructure	
The availability of charging infrastructure at origins and destinations is a major barrier to widespread adoption. In addition, longer trips may be infeasible or inconvenient if quick charging is unavailable at intermediate points within the trip. There is a need to construct, provide and support direct current fast charging (DCFC) in the network. DCFC charging can provide 80% power in 20-30 minutes, which enables travel to/from and along with key nodes in the transport network. These types of chargers make it feasible for EV owners to take longer trips than the range of their vehicles. However, this charging performance comes at a higher price as they cost more to install, and also have higher fees for the user.	• The City can identify key nodes within its jurisdiction that could warrant DCFC charging and identify funding sources through a city-wide electrification plan. • Currently, DCFC charging in Vaughan is available near three locations: Vaughan Metropolitan Centre, Vaughan Mills (Tesla-compatible only), and at Alectra Utilities' office. • To facilitate trips of longer distances, the City can seek to collaborate with other municipalities and regional authorities to ensure that trips terminating and originating in Vaughan are feasible through the provision of charging infrastructure.,
Weather Impacts on Vehicle Performance	
EVs are more impacted by weather than ICE vehicles, with reduced efficiency due to battery performance (being more resistant to charging and poorer at holding its charge in cold weather). Research undertaken by the Idaho National Laboratory found that variations in weather can affect the range of plug-in vehicles by more than 25%[16]. This would result in a user needing to charge more than typical. Research is currently being undertaken to further control battery temperature to enhance EV efficiency in cold climates, and this challenge could be overcome as EVs mature further.	• Although the impact on EVs due to weather has been noted to reduce vehicle range in cold weather, this impact could come unnoticed to city drivers as their trips (generally work or recreational-based shorter distance) would still be attainable. Availability of charging infrastructure at key nodes and workplaces can mitigate this risk. • This risk would have the largest impact on vehicles that travel longer distances, notably buses and shuttles. A study undertaken in 2019 examined the relationship between ambient temperature and vehicle range for fuel cell electric buses (FCEBs) and battery electric buses (BEBs) for six different

[15] International Energy Agency (2020). *Global EV Outlook 2020*. International Energy Agency, Paris, France.
[16] Office of Energy Efficiency and Renewable Energy (n.d.). *Maximizing Electric Cars' Range in Extreme Temperatures*

	transit agencies[17]. Efficiency (in terms of rate of fuel consumption) was shown to decrease by 32.1% for BEBs and 28.6% for FCEBs with a temperature drop from between 10-15° to -5-0° Celsius. The loss in vehicle range between the same temperature drop was larger, with 37.8% for BEBs compared to 23.1% for FCEBs. • A smaller decrease in vehicle range due to temperature change is an important consideration for transit agencies in cold climates when choosing between BEBs, FCEBs, and the third alternative of plug-in hybrid buses.
Adoption Cost Barriers	
Costs of EVs are decreasing as battery production costs have also been decreasing. For heavy-duty/transit vehicles, energy (or fuel) and operations and maintenance costs for EVs have also been shown to be lower. However, upfront investment on a per-vehicle cost basis is much higher, which dissuades adoption. For personal EVs, the initial cost was (on average) $12,000 USD more than traditional combustion engine vehicles in 2019[18]. This initial cost difference is a barrier for car owners and transport agencies from further adopting EVs. Similar to the challenge with connected vehicles, EV and charging infrastructure interoperability is a key requirement to encouraging broader adoption.	• Many states and provinces offer incentives for individuals and industries to adopt EVs. These come in different forms, varying from vehicle purchase rebates to tax credits for vehicle charging. Although not responsible for implementing these, the City can keep individuals and businesses informed of these rebates and plan through a city-wide electrification plan. • The break-even point for EVs with ICE is $100/kWh for battery technology. Bloomberg New Energy Finance (BNEF), a provider of research on clean energy and advanced transport, estimates that this will happen in about two years[19]. As battery prices drop below this point, EVs will become even more attractive from a price perspective.
Decreased Revenues	
Traditional vehicle ownership is a large revenue source for the government. As the government offers incentives for consumers to adopt EVs, they become a more attractive alternative for individual consumers as well as for industry. As	• As consumers shift towards choosing a vehicle with the latest innovation, EVs are growing in popularity and increase in market penetration. Governments should prepare for a reduction in revenue from fueling taxes and look

[17] Henning, M., Thomas, A. (2019) *An Analysis of the Association between Changes in Ambient Temperature, Fuel Economy and Vehicle Range for Battery Electric and Fuel Cell Electric Buses*. Urban Publications, Cleveland, OH.
[18] McKinsey & Co. (2019). *Making electric vehicles profitable*.
[19] Henze, V. (2020). *Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh*. BloombergNEF.

gasoline and diesel consumption decreases, revenue from excise, carbon, provincial, and sales tax will decrease as well.	towards other opportunities to make operational improvements in the energy life-cycle and alternative sustainable revenue generation methods.

Case Study

Electrifying Montréal Strategy, Québec, Canada. The City of Montréal has developed an electrification strategy with ten strategic goals:

1. Incorporate transportation electrification needs into the planning and management of the City's housing stock.
2. Convert the municipal fleet to electric vehicles.
3. Implement an economic development action plan to develop a local transportation electrification sector.
4. Create an institute on electrification and intelligent transportation.
5. Electrify the public transportation network.
6. Participate in the Réseau électrique Métropolitain (REM) project.
7. Implement the electrification measure set out in the parking policy.
8. Roll out a network of charging stations to support the desired gradual conversion of Montréal's automobile stock.
9. Implement a framework to facilitate the private-sector roll-out of a self-serve network of electric vehicles.
10. Ensure ongoing collaboration with public and private partners in the electrification initiatives in the promotion of sustainable mobility.

For the eighth listed goal specifically, the City of Montréal has joined Hydro-Québec's electric circuit, which will power the electric charging network with clean and renewable energy. The City of Montréal has acquired a set of 240-volt charging stations. The installation project is aiming to finish in 2020, which in the end will offer a network of approximately 1,000 charging stations.

Toronto Transit Commission (TTC) Fleet Electrification, Ontario, Canada. The TTC currently has the largest fleet of battery electric-powered vehicles in North America, with a size of 59 vehicles[20]. Electric buses provide a more sustainable alternative to diesel buses, decreasing air and noise pollution. Intending to run a zero-emissions fleet by 2040, the TTC purchased its first 30 electric buses in November 2017. The buses are from three different suppliers and are currently being tested against winter conditions.

Moving forward, the TTC board has approved the 2020-2029 Capital Budget and Plan, which includes a recommendation to leverage technical requirements developed based on the first-year test results of eBus vehicles to procure 300 additional all-electric long-range buses from 2023 and 2025. In addition, recommendations were made to coordinate with Toronto Hydro and Ontario Power Generation to ensure that the utility providers can support vehicle charging infrastructure to support the TTC's 2040 target for a zero-emissions fleet.

Zero Emission Bus Transitions: In addition to the TTC, it is noted that several agencies across Canada are conducting battery electric and hydrogen fuel cell bus trials as well as full fleet transition plans.

[20] Chung, E., et. Al. (2020) *What cities can learn from the biggest battery-powered electric bus fleet in North America.* https://www.cbc.ca/news/technology/electric-buses-transit-1.5823166. Toronto, ON. CBC.

Municipal fleet transition plans: Municipalities in Canada are also considering transitioning municipal vehicle fleets to zero-emissions including light-duty operations and maintenance vehicles, school buses, and waste collection trucks.
Anticipated Timing
Already here (currently exists). With local projects to further electrify transit service underway, and consumer options for EVs available in the market becoming more popular, electrification is taking place already in many locations. Its growing impact is evident, and the City should investigate the opportunity to leverage electrification for efficiency, costs, and environmental benefit.

2.1.3 Shared Mobility and Micromobility

Description

According to the Society of Automotive Engineers (SAE), shared mobility is "the shared use of a vehicle, motorcycle, scooter, bicycle, or another travel mode… [that] provides users with short-term access to one of these modes of travel as they are needed"[21]. The shared aspect of mobility can either be the vehicle (e.g. scooter, bicycle) or the trip itself (as in, sharing a ride with another person). Shared mobility is a blanket statement that covers bike-sharing, car-sharing, microtransit, ridesharing, ridesourcing, and scooter sharing, but that also covers public transit and rail.'

Micromobility, a term often used in conjunction with shared mobility, is typically a vehicle that is low speed (under 50 km/h), light weight (less than 45 kilograms) and can be personally owned or part of a shared fleet[22]. Many have turned to micromobility in light of COVID-19, as it also provides a low-cost travel alternative that is physically distanced.

In Fall 2020, MTO developed the term "**On-Demand Microtransit**" (ODMT) that is aligned with what is referred to as Demand-Responsive Transit (DRT) in other jurisdictions. The use of this term is intended to reduce confusion when using the term "microtransit". ODMT is used as the term to describe this type of service in the remainder of this report. Some key characteristics of ODMT service include:

- Vehicle routes and timing determined by passenger demand, with vehicles being deployed based on location and number of customers, sized based on customer needs;
- **Rides** are requested at a specific time and stop by smartphone or web application, with dial-in options also available;
- Service design is based on community needs and based on the existing local context of municipalities.

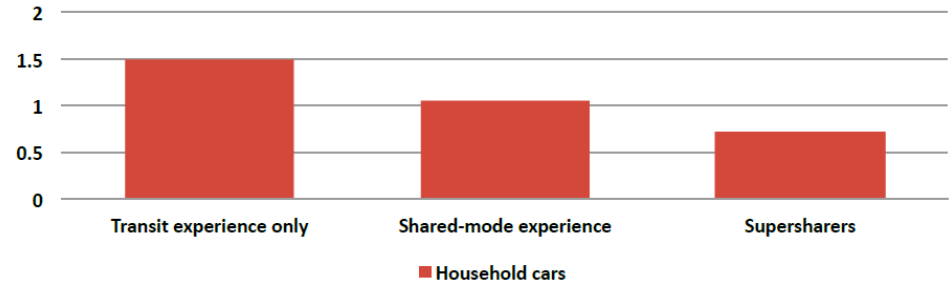
Benefits

- **Complement public transit use and provide a solution to the first-last mile problem.** A study by the Shared-Use Mobility Center (SUMC) showed that instead of competing for the same user, public transit and shared modes complement one another by serving different trip types, or by acting as a replacement where one mode is unavailable[23]. This study involved interviews with public agencies, private mobility operators, capacity and demand analysis of public transit and ridesourcing, and surveying over 4,500 transportation network users. As an example, ridesourcing trips were used for recreational and social trips, most commonly used late at night and especially on weekends, which are periods where transit is least available. Other modes, such as bike-sharing, scooter sharing, and ODMT also complement public transit as last-mile (or first-mile) transit options.
- **Decrease in personal vehicle ownership.** In the same abovementioned study by the SUMC, three groups of users were surveyed: one that hadn't used a shared mode (aside from public transit), ones who have used a shared mode before, and ones who had used a shared mode for both discretionary and non-discretionary travel in the last three months (called "supersharers"). Among these three groups, the last group was

[21] Society of Automotive Engineers. Shared Mobility. https://www.sae.org/shared-mobility/
[22] Fischer, Pam Shadel. (2020). *Understanding and Tackling Micromobility: Transportation's New Disruptor*. Hackettstown, New Jersey. Governers Highway Safety Association.
[23] Shared-Use Mobility Center. *Shared Mobility and the Transformation of Public Transit*. Chicago, IL. American Public Transportation Association.

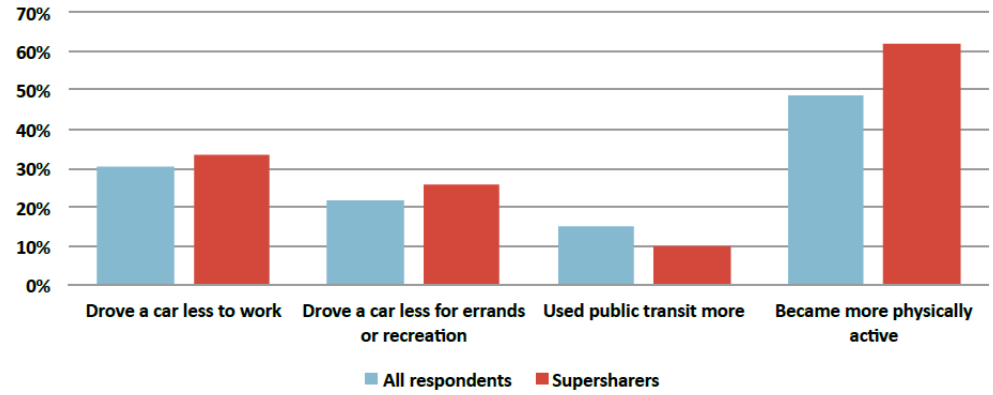
found to have significantly lower household vehicle ownership – 1.5, 1.05, and 0.72 cars per household, respectively. The latter group of users also spent less on transportation on a net basis.

Household vehicle ownership, by shared-mode experience (SUMC, 2016)[24]



- **Increase in active transportation use and promotion of public health.** Shared modes include many active options. In the abovementioned study, the SUMC found that shared mobility leads to decreased personal vehicle use both for discretionary and non-discretionary trips, with an increase in public transit use. Most notably, respondents showed significant increases in physical activity since starting to use shared modes.

Lifestyle changes since starting to use shared modes (net change) (SUMC, 2016)



Risks and Implementation Challenges	Mitigation
Equity, Inclusiveness, and Accessibility	
Shared mobility has the potential to improve quality of life for low-income and vulnerable populations, which generally show higher reliance on public transit. These mobility options can be used as first-and-last-mile solutions. There are, however, risks to shared mobility when it comes to equity and accessibility. Low-income and minority populations may find difficulty accessing these services due to cost barriers, despite these services being relatively low-cost. Paying an additional fare	• To ensure that shared mobility is accessible and inclusive, the City can look to explore policies that can encourage and make shared mobility mainstream. These could include incentives, tax credits, subsidies, and pilot programs. • To minimize digital barriers, the City should look into providing digital trip information through screens or kiosks, and also providing services through non-digital means such as a call

[24] Shared-Use Mobility Center. *Shared Mobility and the Transformation of Public Transit*. Chicago, IL. American Public Transportation Association.

for the first-and-last-mile ride may be infeasible for these groups. Elderly and disabled populations may also find difficulty accessing these services due to physical or digital barriers.	center for micromobility transit or ride-hailing services. • To minimize physical barriers, the City should encourage and incentivize shared mobility modes, specifically ridesharing, and ridesourcing (as other shared modes may not be viable). • In 2019, the City of Oakland piloted Adaptive Bike Share for people with disabilities[25]. The program provided a staffed pick-up and drop-off point that let users leave their wheelchair (or another mobility device) and allow them to pick it up after their trip.
Standards, Safety, and Regulation	
Micro mobility and shared mobility devices lack regulation and industrial standards, which leads to variations in speed between vehicles of the same class. In addition, recreational or inexperienced users may be unaware of regulations, and how these vary across different locations. As these vehicles evolve, regulation at the federal, regional and municipal level needs to evolve accordingly, prioritizing public interests of health and safety as well as liability.	• International standards are being drafted through organizations such as ASTM International and ISO, but these vary in terms of limitations for speeds, mechanical structure, safety, and electrical systems. SAE International, which provides the levels of automation standard for CAVs, has also provided the J3194 standard which defines the weight, width, top speed, and power source of six types of vehicles, powered bicycle, powered standing scooter, powered seated scooter, powered self-balancing board, powered non-self-balancing board and powered skates[26]. • In Ontario, O. Reg. 389/19 *Pilot Project – Electric Kick-Scooters* came into force in January 2020, which describes broad conditions for a five-year e-scooter pilot. Under the Highway Traffic Act, a definition for the e-scooter mode was provided in vehicle dimension, power, speed, and safety requirements (minimum age and helmets). Municipalities have the opportunity to enroll in the pilot as well.

[25] Nonko, E. (2019). *Lessons from Oakland's Adaptive Bikeshare Pilot*. Oakland, CA. Next City.
[26] Santacreu, A. (2020). *Safe Micromobility*. International Transport Forum, Corporate Partnership Board.

	• The City can selectively participate in provincial micromobility pilots similar to the e-scooter pilot described above, which will likely be avenues to shape policy and regulation for these modes. Provincial regulation can help to form the City's regulation for these modes and compatibility between these can facilitate the user experience.
Right-of-Way (ROW) Considerations	
As shared modes proliferate, existing ROW may not be suitable to accommodate them. In addition to ROW, managing the curb also becomes difficult as more modes (such as transit, shared modes, or for goods movement and parking) seek to utilize this limited space.	• Currently, cities seek to design complete streets, which enables safe use and supports mobility for all modes within the right-of-way. As a more diverse set of modes is adopted within the network, their interaction with other existing modes must be considered. Geometric changes can be made to the ROW to accommodate new modes with local context in mind. • Curb management involves creating an inventory of curbside space and managing its use to maximize mobility. NACTO's guidance, *Curb Appeal* (2017), looks at curbside management in a transit-focused approach and is a good resource to consult. Many municipalities have developed curbside management strategies, which the City can explore. In addition, software solutions exist to help manage curbside space.
Lack of Multimodal Integration	
Shared mobility presents an opportunity to shift away from personal vehicle ownership. A barrier from accessing this goal is lack of integration, specifically where a combination of public transit and first/last-mile shared mobility option cannot compete with self-driven auto trips.	• The City can explore Mobility-as-a-Service (MaaS) alternatives that can integrate mobility services from start to finish, with payment and information through a single platform. MaaS is further described in **Section 2.2.2**. A single access point ensures that the services that a user needs for their trip are planned for, paid for, and make real-time information available. • In terms of infrastructure, providing hubs such as a Mobility hub can help to bridge the integration gap. Mobility hubs can allow users to access shared and sustainable modes that

	can act as first/last-mile options in one place. This service concept is further described in **Section 2.2.3**.
Regulation and Oversight	
Shared mobility modes such as ridesharing, car-sharing, and bike-sharing have been incorporated into planning processes. However, other concerns related to policy, regulation, and oversight such as zoning, data privacy, and insurance exist[27]. Municipalities' role in addressing these concerns may often be unclear. In addition, municipalities could be made responsible for mobility sharing systems that are unsustainable within the market.	• For the City to plan for future mobility, developing metrics to monitor the economic and travel impact of shared mobility can help to ensure that planning decisions are data-driven. This could include monitoring changes in vehicle-kilometers-travelled (VKT) and mode shift. Municipalities should seek to limit revenue risks and form effective partnerships with private operators. • Locally, the City can leverage zoning to help incorporate shared mobility by reducing auto parking spaces, incentivizing parking for other modes (e.g. bike or scooter), and promoting densification in new development. • In Calgary, shared electric scooters have quickly increased in popularity, accompanied by additional regulation. These included limiting maximum speeds in specific areas and adding fines for reckless behavior and collisions. In response to the added popularity, share-and-go parking zones have been added, similar to the Mobility hub concept discussed in **Section 2.2.3**.
Case Study	

[27] Shaheed, Susan. 2016. *Shared Mobility: Current Practices and Guiding Principles.* Washington, DC. U.S. Department of Transportation, Federal Highway Administration.

Communauto car-sharing system, Montréal, Canada. Communauto is a car-sharing system that was launched in 1995 and originally operated in four metropolitan regions in Québec. The service has since been expanded from Québec to seven cities in Ontario, Calgary, Edmonton, Halifax, and Paris (France). In Montréal and Québec City specifically, the OPUS card (which is used for transit payment) is also the access card for Communauto vehicles.

Communauto has a fleet of 2,000 vehicles and focuses on short intracity trips[28]. All new vehicles added to the fleet since 2012 have been electric or hybrid vehicles. All vehicles are non-smoking, and 12% of the fleet is equipped with baby car seats. Trips are priced by the hour, by kilometer travelled, and include gas, insurance, and car maintenance.

Bike Share Toronto, Ontario, Canada. The Bike Share Toronto system was launched in 2011 by PBSC under the Bixi brand and was taken over by the Toronto Parking Authority in 2014. An expansion for this bike-sharing system was most recently announced in June 2020, with a total of 6,850 bikes, 625 stations, and 12,000 docking points[29]. The program is now in 20 wards and includes the use of pedal-assist electric bicycles (e-bikes) at no additional cost.

The system network has expanded by 680% over the past 5 years, and year-over-year ridership has increased by 22%. The highest ridership day (of all time) was May 23, 2020, with 20,911 rides. To promote active transportation and the bike-sharing service, the system occasionally offers free rides on Wednesdays.

Anticipated Timing

Near-term (less than five years). Shared mobility already exists within the City in the form of bike-sharing and car-sharing, and improved access can serve as a competitive first-and-last-mile travel option. Pilots for micro-mobility shuttles and e-scooters are underway in many large Canadian cities.

[28] Communauto. https://communauto.com/mobilityday/index_en.html?uitp
[29] Bike Share Toronto 2020 Expansion. https://bikesharetoronto.com/news/expansion-2020/

2.1.4 Application of New Mobility to Goods Movement

Description

According to the US Environmental Protection Agency (EPA), goods movement is the distribution of freight (including raw materials, parts, and finished consumer products) by all modes of transportation including marine, air, rail, and truck[30]. In Ontario, goods movement is foundational to the economy, and nearly 40% of the economy consists of industries that are goods movement intensive (e.g. manufacturing, retail, forestry, mining, construction)[31]. In 2016, Ontario's transportation system carried 56% of Canada's international trade, and 66% of Canada-US trade.

Goods movement is a transportation industry that involves many different modes and will certainly be impacted by future mobility. In the future, the goods movement looks to be heavily impacted by other technologies and trends such as CAVs, electrification, and micro-mobility. In addition, the proliferation of new modes specifically for goods movement purposes will continue to transform the industry, such as drones, cargo e-bike, and autonomous delivery. Although Goods movement is not attributed to a single mode or specific technology, it is described last and separately in this section as it faces unique challenges while also not being tied to personal use.

Benefits

- **Solving the first/last-mile problem with future mobility.** The first/last-mile problem is significant in goods movement, as companies must find a way to deliver materials or products to the end consumer. The amount of effort to transport from the nearest distribution center to the end-user is significant, and automating this process using types of CAVs or drones can streamline this difficult process. Alternatively, using sustainable modes for first/last-mile deliveries (e.g. e-cargo bike Zedify in the UK) has proven to be successful as well[32].
- **Truck platooning.** Platooning is a technique to wirelessly convoy trucks to a lead truck closely together for fuel efficiency purposes[33]. This falls under level 3 automation under SAE's defined levels. This is anticipated in the near term and will be followed by driverless platooning and then fully driverless individual trucks.
- **Reduced emissions through electrification.** Long haul trucking produces significant emissions as trucking vehicles, which have high mass, require greater amounts of fuel to stay moving, and emit far more GHGs than the average vehicle. Electrification is a challenge as these vehicles will need to be charged and will most likely need to visit multiple charging stations as they travel long-haul routes.
- **Cost savings for manufacturers.** A 2018 study found that mainstreaming of self-driving long-haul trucks could cut manufacturers' transport costs by 30% through

[30] US Environmental Protection Agency. (2020). *Ports Primer 5.1 Goods Movement and Transportation Planning*. https://www.epa.gov/community-port-collaboration/ports-primer-51-goods-movement-and-transportation-planning
[31] Casey, M. (2019). *Initiatives Supporting Ontario's Goods Movement: Presentation to Smart Freight Symposium*. Toronto, ON. Ontario Ministry of Transportation.
[32] Forbes. (2020). *Cargobike Delivery Service Zedify Raises £300,000 From Green Angel Syndicate*. https://www.forbes.com/sites/carltonreid/2020/07/03/cargobike-delivery-service-zedify-raises-300000-from-green-angel-syndicate/?sh=28bcc57a6ec6
[33] McKinsey. (2018). *Distraction or Disruption? Autonomous trucks gain ground in US logistics.* https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics#

2040, if aggressively adopted by industry[34]. However, manufacturers hesitate due to barriers to entry, such as prohibitive costs, immature technology and safety concerns.

- **Highway safety.** Large trucks in the goods movement industry are often involved in collisions and can result in fatalities due to their overwhelming size. Automated trucking eliminates risks related to driver fatigue, which can arise during long-haul routes.

Risks and Implementation Challenges	Mitigation
Economic Disruption	
Goods movement is an industry that employs many individuals (e.g. supply chain and logistics staff, truckers), many of which could be impacted. Auxiliary jobs related to driving in the economy could also be impacted.	• Mitigation for this risk is discussed in **Section 2.1.1**.
Introduction of Delivery Modes	
Future goods movement involves the introduction of new modes, such as autonomous delivery vehicles, cargo e-bike, and drones. Some of these new modes will occupy ROW, interact with existing traffic, and demand curbside space.	• Understanding which modes are most likely to proliferate as a result of goods movement in the future can allow for better planning. The City can leverage the Transportation Innovation Program (TIP) further described in this document to manage and prepare for New Mobility specific to goods movement. • In response to increased demand for the e-bike/cargo e-bike mode, MTO has proposed O. Reg. 369/09, which defines the e-bike mode and proposes a cargo e-bike pilot[35]. Specifically, the policy aims to amend the definitions for existing classes of motor-assisted bicycles (moped) and limited-speed motorcycles, as well as defining the e-bike mode through dimension and power standardization. In response to stakeholder suggestions to encourage innovation, MTO has also suggested a cargo e-bike pilot with broader vehicle and operator/passenger requirements. • Curbside management has been planned for in many municipalities through a city-wide strategy, which the

[34] PwC. (2018). *Industrial mobility: How autonomous vehicles can change manufacturing.* https://www.pwc.com/us/en/industries/industrial-products/library/industrial-mobility.html
[35] Ministry of Transportation for Ontario (2020). *Power-Assisted Bicycle (E-bike) and Cargo E-bike Pilot Program Proposals*. Ministry of Transportation, Road Safety Program Development Office, Toronto, ON.

	City can investigate further. Software solutions exist for this purpose as well.
Cost Barrier	
Industries that require goods movement often own their fleet. Electrifying or automating their fleet comes with significant costs and may not be reasonable if the fleet is already operating well. Incentivizing electrification can be difficult as manufacturers look to maximize profit and may value the social benefit of reduced emissions differently.	• Governments can provide tax incentives for electrifying the fleet, or rebates. • Since making investments without proven return in increased goods movement efficiency is difficult for manufacturers, governments should look to partner with startups and innovators in CAV technology.
Case Study	
Loblaws Autonomous Delivery Vehicles, Toronto, Canada. Loblaws is partnering with Gatik, an AV company, to make short-haul deliveries[36]. The vehicles will pick up grocery orders and deliver them to pick-up points for customers. This partnership was announced in November 2020, and will officially start in January 2021, running until March 2022. It will consist of five vehicles delivering over 2,100 grocery orders per week. They will run with AV operators at the start of the pilot but will transition to full driverless operation near the end of the pilot. To test the vehicle system, Loblaws has been using one AV since January 2020 to deliver grocery orders to employees at their Brampton head office, with over 10,000 successful autonomous kilometers.	
Anticipated Timing	
Near-term (less than five years). With innovation in goods movement leading to greater business efficiency for manufacturers, proven solutions will be adopted by industry. Pilots such as the Loblaws AV delivery demonstrate firms' desire to invest to gain advantages by leveraging future mobility for goods movement.	

[36] Loblaws. (2020). *Future is bright with self-driving* trucks. https://www.loblaw.ca/en/future-is-bright-with-self-driving-trucks/

2.2 New Mobility Infrastructure and Service Concepts

2.2.1 Smart Cities

Description

Smart cities refer to the use of technology to enhance the quality of life for citizens and promote sustainable development[37]. The smart city concept involves linking municipal services and systems through the Internet of Things (IoT) sensor technology to support greater citizen interaction and government efficiency. The spending for smart city initiatives is $81 billion (2019) and is projected to reach $158 billion by 2022[38].

Inherently, this term has widespread application and has implications for many different sectors, primarily infrastructure, government challenges relating to regulation. and data security and privacy. In a transportation-specific context, there is a need to develop the systems to support New Mobility, particularly to provide V2I connectivity for vehicles.

Benefits

- **Real-time data collection to drive responses in real-time.** Data collection is conceptualized to occur as citizens carry out day-to-day tasks, such as transportation, healthcare, and education. One example of this is intelligent transportation systems management and operations, which can dynamically route traffic to optimize throughput in the network. As data is continually collected, smart cities leverage this data to promote greener and safer urban environments, while also continually improving municipal operations.
- **Demand-based pricing.** For many services such as parking, pricing them appropriately (according to marginal cost) can be a challenge. By implementing smart pricing according to demand and drivers' willingness to pay, parking availability can be ensured. San Francisco's SFpark program monitors 8,200 of the city's curbside parking spaces. The City adjusts prices dynamically intending to maintain a 15% vacancy rate to eliminate the need for drivers to cruise around searching for available spaces[39].
- **Increased interaction and participation between citizens and government.** In Jakarta, Indonesia, research conducted on several smart city tools showed that citizens were more willing to voice concerns since they would not need to directly interact with government officials. In addition, as citizens could share and receive information relevant to their concerns, survey respondents felt part of the government, helping to solve problems proactively[40]. In a transportation context, feedback on transit or other mobility services provided by the government can be obtained through increased interaction.

Risks and Implementation Challenges, Mitigation

Lack of Infrastructure to Support New Mobility	
New Mobility largely involves the connectivity between vehicles with other	• In terms of infrastructure, V2I requires sensors to communicate specific

[37] Ismagilova, E., Hughes, L., Rana, N.P. et al. (2020). *Security, Privacy and Risks Within Smart Cities: Literature Review and Development of a Smart City Interaction Framework*. Inf Syst Front.
[38] Statista (2019). https://www.statista.com/statistics/884092/worldwide-spending-smart-city-initiatives/
[39] Hamilton, Emily. (2016). *The Benefits and Risks of Policymakers' Use of Smart City Technology*. Arlington, VA. Mercatus Center, George Mason University.
[40] Putri, D., CH, M., Tanaya, J., Canares, M. (2017). *How do citizens benefit from a smart city? A case study of Jakarta, Indonesia*. Washington, DC. World Wide Web Foundation.

vehicles, infrastructure (soft and hard), and also with other road users (pedestrians / other modes). Many of the benefits discussed for New Mobility technologies require V2I connectivity to be realized, which will be driven by the Smart City movement. For this to be realized, there is an existing infrastructure gap that must be overcome. Some applications of V2I include red light violation warning, curve speed warning, stop sign gap assist, spot weather impact warning, reduced speed/work zone warning, and pedestrian in signalized crosswalk warning[41].	infrastructure characteristics to vehicles. This would require sensors to communicate the location of signals and their status to allow for optimized vehicle activity. • For roadways with specific characteristics such as curves and stop signs, the V2I system is intended to communicate when it is safe to proceed and how to do so. For temporary roadway characteristics such as weather and work zones, V2I is intended to communicate the situational change and inform the vehicular response. Lastly, for infrastructure to communicate pedestrian location within an intersection, sensors are needed or some method to communicate with personal communication devices. • The City can explore methods to leverage ITS to support existing mobility while keeping in mind that new mobility will require new infrastructure to support V2I connected transportation.
Increased Data Sharing and Accessibility	
Increases in data do not necessarily result in increased available data. Data silos (also called warehouses) are where data is stored by agencies. Individual branches and levels of government often have their data warehouses and may be reluctant to share between other public agencies. For the smart city concept to be realized, there is a need for data to be shared effectively between the public and private sectors, but also to citizens. Navigating citizens' privacy when collecting and using data is also a challenge.	• To make the Smart City concept a reality, a need for increased data sharing and accessibility exists. Best practices for data sharing safely should be further explored by the City. The City currently provides open GIS data related to city services, businesses, proposed/ongoing developments, and zoning. • Data security and privacy standards will likely be established at the federal level. The City should seek to coordinate activities with other government agencies. The City will also need to consider how it will manage data related to citizens' activity, and how it will manage datasets from private providers.
Benefits	
Helsingin Bussiliikenne Oy (HelB), Helsinki, Finland. HelB is a fully owned bus service by the City of Helsinki in Finland, but in a competitive market where it must bid against other private operators to serve bus routes in the city[42]. As a result, HelB needed to find ways to operate more efficiently to compete with the private market. HelB partnered with Microsoft	

[41] Walker, J. (2016). *FHWA Vehicle-to-Infrastructure Deployment Guidance & Products.* US Department of Transportation.
[42] Berst, J., et al. (2015). *Smart Cities Readiness Guide.* Seattle, WA. Smart Cities Council.

and CGI to install sensors on all buses in its fleet, which generate more than four million lines of data each day. HelB analyzed the data and visualized locations within the city where trouble spots occurred (e.g. places where sudden braking often occurs) and could find solutions to help drivers pass through these areas more smoothly. Some outcomes of HelB's smart transportation monitoring include:

- Overall fleet fuel consumption decreased by 5%;
- Customer satisfaction among HelB riders increased by 7%;
- Bus driver performance monitoring, which detected speed and braking and provided information back to drivers to improve their efficiency and safety; and
- Sensor data about engine temperature and fuel consumption, which allowed HelB to identify mechanical issues at an early stage and proactively address them.

Anticipated Timing

Long-term (longer than 10 years). Although there are existing smart aspects of cities that are in place, putting them together in a city-wide capacity across all sectors does not currently exist. With many regulatory barriers in place and difficulty sharing warehoused data publicly, smart cities have many aspects that need to be defined and clarified before the concept becomes reality.

2.2.2 Mobility-as-a-Service (MaaS)

Description

MaaS is described as "a distribution model that delivers users' transport needs through one single interface of a service provider, combining different transport modes to offer tailored mobility packages[43]". Although the interpretation and description vary greatly, MaaS is intended to improve the consumer mobility experience by integrating information, payment, services, and policies.

MaaS is often used as a blanket statement to cover a variety of mobility services, which have included:

- bike-sharing (e.g. Citi Bike in New York, Santander Cycles in London);
- e-scooter sharing (e.g. Lime, Roll, Bird – which have become quite popular in Calgary);
- car-sharing (e.g. Zipcar, Car2go);
- ride-hailing services, like traditional taxi service (e.g. Uber, Lyft, DiDi in China); and
- ride-sharing services (e.g. Lyft Line, UberPOOL).

Although MaaS is used to describe the above services, it is ideally a service concept that "integrates different mobility services and provides one-stop access through a common interface"[44]. MaaS case studies that meet this description are further discussed below.

Benefits

Potential benefits of MaaS include:

- **Capacity optimization within the transport network.** MaaS can improve network efficiency by ensuring that capacity is best optimized to meet demand. In peak hours, excess demand can be "redirected to under-utilized routes or other transport modes"[45].
- **Better intermodal connectivity and trip planning.** As transport services are connected through a single platform, information can be easily accessed. In addition, ticketing and payment integration will contribute to the seamless use of multiple modes and increase the number of intermodal trips.
- **Business opportunities and increased private-sector revenue streams**. MaaS providers will likely be private enterprises that will need to partner with the public sector to bring these services to the mainstream. On a wider scale, opportunities for media, food/coffee companies, advertising, and entertainment to be included within the MaaS service offering could be explored as well. For transit agencies, MaaS presents an opportunity to reach a previously inaccessible market and increase their market share.
- **Environment and health benefits.** MaaS has the potential to decrease private vehicle use and ownership. This shift results in benefits such as air quality improvements, noise reduction, improvements to the landscape and urban realm, and

[43] Arias-Molinares, D., Garcia-Palomares, J. (2020). *The Ws of MaaS : Understanding mobility as a service from a literature review.* IATSS Research, Volume 44, Issue 3, Pages 253-263.
[44] Karlsson, I.C.M., et al. (2019). *Development and implementation of Mobility-as-a-Service – A qualitative study of barriers and enabling factors.* Transportation Research Part A: Policy and Practice, Volume 131, 2020, Pages 283-295.
[45] Kamargianni, M., et al. (2018). *Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead.* MaaSLab - UCL Energy Institute Report, Prepared for Transport for London

increased physical activity as users shift towards active modes such as walking and biking.

- **User travel cost savings.** Since MaaS is an alternative to personal vehicle ownership, it can relieve households of costs related to car ownership. In a survey undertaken by University College London for Transport for London, this cost relief was estimated at £2,802 per annum (approximately $4,800 Canadian dollars)[46]. For households who don't use personal vehicles, cost savings will also exist through MaaS plans, which are conceptualized as the bundling of mobility packages at a discounted rate.
- **User travel time savings.** MaaS' reduction in user travel time is created by avoiding congested roadways and networks by recommending a better trip through real-time information, and by streamlining transfers between networks by pre-payment.

Risks and Implementation Challenges	Mitigation
Infrastructure Barriers	
MaaS is a service concept that relies heavily on transport and communications infrastructure[47]. For areas where the existing transport infrastructure is already failing to provide reliable service, realizing the abovementioned benefits becomes more difficult. In addition, the provision of real-time information, both to users and service providers, requires a good connection, which may not always be in place.	• For the City to provide MaaS at a level where its potential benefits can be realized, there may be a need to update transport and communications infrastructure or to compromise by understanding that not all benefits can be realized and quantifying tradeoffs through business case analysis. Identifying areas in transport and communication infrastructure where improvements can be made provides futureproofing that goes beyond MaaS applications.
Data and Regulation	
To deliver an integrated system, data must be shared between private and public sectors rapidly and on a repeated basis. Mobility data would need to be standardized and made available while being anonymized to meet privacy regulations, which can seem like an impossible compromise.	• Data-related issues will pop up as digitization continues. It will be important for municipalities (including the City) to create regulations that can encourage innovation and provide privacy.
Digital Exclusion and Accessibility	
Digital exclusion happens when efforts to move services online are disadvantageous to low-income groups, including disabled and elderly populations[48]. MaaS is not exempt from potentially contributing to this issue, as marginalized populations may not be able	• The City can investigate alternative methods to offer MaaS in the future, such as using a telephone service to minimize digital barriers that prevent an older population from accessing MaaS benefits.

[46] Kamargianni, M., et al. (2018). *Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead.* MaaSLab - UCL Energy Institute Report, Prepared for Transport for London
[47] Nur, K., et al. (2019). *Could Mobility as a Service solve our transport problems?*. Birmingham, England. The Institution of Engineering and Technology.
[48] Low Incomes Tax Reform Group. (2012). *Digital Exclusion*. London, England. The Chartered Institute of Taxation.

to access the above-mentioned benefits, either due to digital or cost barriers.	This could be offered in tandem with a smartphone application. • To mitigate against issues where services are inconsistent across different populations, introducing a "mobility bill of rights" can be beneficial. This document would establish minimum standards for service, ensuring that private mobility providers equitably serve the population. • The City can also investigate providing subsidies to minimize cost barriers. The streamlined process of having payment integrated within a single platform allows subsidies to be applied easier by governments and can allow low-income groups to access MaaS benefits.

Case Study

UbiGo, Gothenburg, Sweden. A commercial pilot of MaaS called UbiGo was undertaken in 2013/2014, the first-ever deployment of MaaS. This was achieved through a web-based smartphone application that combined public transport, car-sharing, rental car service, taxi, and bike-sharing services all into one application. The service provided 24/7 technical support, travel guarantees, and bonuses for sustainable travel choices.

- Participants showed a 50% reduction in private car use, and increases in the use of bike-sharing, car-sharing, trams, local buses, express buses, and trains. In addition, participants were also shown to have positive attitude shifts towards bus/tram, bike-sharing, and car-sharing modes[49].
- 97% of participants in the pilot project wanted to remain customers, and the service was officially launched at the beginning of 2019[50].

Anticipated Timing

Medium-term (5-10 years). MaaS platforms have been launched in many European cities such as Gothenburg, Helsinki, and Vienna, and are being launched in countries such as Singapore and Germany[51]. This demonstrates that there is potential for MaaS locally, although local infrastructure (in comparison to the abovementioned pilot cities/countries) may not be as well suited for immediate adoption.

[49] Sochor, J. (2016). *Benefits of Mobility as a Service: Evidence from the UbiGo MaaS pilot in Gothenburg, Sweden.* Melbourne, Australia. Chalmers University of Technology.
[50] About Ubigo. https://www.ubigo.me/en/about-ubigo
[51] Goodall, W., et al. (2017). *The Rise of Mobility as a Service*. Deloitte University Press.

2.2.3 Mobility Hubs

Description

A Mobility Hub is an integrated mobility interchange for multimodal systems[52]. These hubs are conceptualized to leverage emerging technologies and improve transportation efficiency, providing a single access point for multimodal systems such as bike-sharing, ridesharing, and car-sharing. In general, Mobility Hubs are envisioned to serve as intermediate transfer points, located between transit hubs to provide connection to trip ends.

These hubs may also be on a smaller scale, such as an integrated bike share and bus stop, or on-street car-sharing. Although Mobility Hubs currently exist and are used to organize existing mobility, the service concept will continue to evolve to accommodate future mobility in aspects such as charging for electrified vehicles.

Benefits

Potential benefits of Mobility hubs include:

- **Providing "first-mile", "last-mile" solutions.** This problem is centered on existing transit services providing the core of a trip, but that users must generally complete the first and last portions of their trip on their own (often by another mode), which makes transit a less compelling option compared to SOV travel. A Mobility hub is a one-stop service point, where many of the modes that can be used for a user's trip, such as bike-sharing, ride-sharing, and car-sharing are found.
- **Decreasing single-occupant vehicle (SOV) travel.** In the past, the Smart Commute program demonstrated successful shifts in mobility behavior[53]. Emerging technologies and an increase in sustainability awareness are pushing individuals to make non-traditional travel choices such as car-sharing, ride-sharing, and bike-sharing through the rapidly developing pay-per-use economy. The provision of a Mobility hub increases access to mobility alternatives, which can lead to shifts in travel behavior.
- **Establishing public-private partnerships.** The concept of a Mobility hub involves a public facility that serves as a multimodal interchange. Many of the modes being integrated at these hubs, specifically car-sharing, ride-sharing, and potentially micromobility are from private-sector providers, and fostering these partnerships is beneficial. Past partnerships with the Smart Commute program, car-sharing companies such as Uber and Lyft, and local parking authorities can be leveraged, and developed further.
- **Providing additional travel choice and capacity without network expansion.** Traditionally, adding capacity or choice requires changes in the network, either by reconfiguration or expansion. Mobility hubs provide additional capacity and choice with less land impact and less cost as well. In addition, there are alternatives to build hubs on a smaller scale and to tailor facilities based on local context, providing different facilities based on an understanding of local context.

Risks and Implementation Challenges	Mitigation
Decreased Accessibility	
As the number of modes that are integrated into a single location increase,	• For best practices on integrating multiple modes into a mobility hub, Metrolinx's

[52] City of Toronto. (2017). *ConsumersNext: Final Report*. Toronto, ON. City of Toronto.
[53] HDR. (2018). *Weston Highway 7 Secondary Plan Phase 1, Transportation Needs Assessment Report*. Vaughan, ON. City of Vaughan.

the number of potential conflict points between them also increase. In addition, wayfinding becomes more difficult.	*Mobility Hub Guidelines* (2011) can be used as a reference[54]. This guide provides necessary provisions to reduce conflicts between vehicles, pedestrians, and cyclists, applicable to Mobility hubs. This guide is currently undergoing review and update. • To streamline wayfinding at Mobility hubs, providing wayfinding tools according to a regional standard that is consistent with the wider network can simplify the user experience. As an example, Metrolinx has most recently been testing new wayfinding design standards through their wayfinding pilot project, and lessons learned from this project could be applied to new Mobility hubs[55].
Digital Connectivity and Integration	
Coordinating different parts of a traveler's trip allows this conceptual hub to function effectively. These parts may include payment, reservation for shared modes, and information.	• The Mobility hub concept functions well with the MaaS concept, where the integration of reservations and payment exists. The hub allows for a location to transition between parts of a trip and different modes, and increasing connectivity through MaaS can simplify the user experience. • In addition to the above, providing trip information through digital display can help users better plan for their trip. Examples of information displayed could include arrival times of nearby transit services and the number of available vehicles at the car and bike-sharing stations. The City of Toronto installed several TransitScreens in 2015, which provided key trip information for system users [56]. The TransitScreen can be used at Mobility hubs to inform users of the local network.
Planning and development risk	
Existing regulations and planning processes may not be fully suited for the implementation of this conceptual hub. In addition, land acquisition from private owners may be required.	• To mitigate this risk, the City should consider implementing Mobility hubs as a pilot program alongside another development application with project partners such as Smart Commute. Success in the pilot of this concept will

[54] Metrolinx. (2011). *Mobility Hub Guidelines for the Greater Toronto and Hamilton Area*. Toronto, ON. Metrolinx.
[55] Metrolinx. (2020). *Wayfinding Harmonization Project Fact Sheet*. Toronto, ON. Metrolinx.
[56] HDR. (2018). *Town of Innisfil Transportation Master Plan Update Final Report*. Innisfil, ON. Town of Innisfil.

	lead to streamlined approvals and accelerated development. • If land from private owners is required for Mobility hubs, plans should be made on how the land will be secured, financing sources to construct, and anticipated maintenance of these hubs should be made in advance as well.

Case Study

ConsumersNext Secondary Plan, Toronto, Ontario. Located at Sheppard Avenue East and Victoria Park Avenue, the Consumers Road Business Park employs over 18,000 people and is one of the most concentrated areas of office jobs. As part of this plan, the City of Toronto is implementing a Mobility Hub to induce mode shift away from the single-occupant vehicle and to facilitate the last mile of travel. Within the study area, several large-scale and small-scale Mobility hubs are proposed.

Mobil.Punkt, Bremen, Germany. In Bremen, car-sharing was determined as a method to help curb parking space demand[57] because shared vehicles are used throughout the day and typically do not require parking spaces. Two "mobil.punkt" (mobile points) stations that provided access to public transit, car-sharing, bicycle stands, and taxis were piloted in 2002, with a third added in 2007[58]. In addition, stations have computerized booths to help users plan their trips or connect to a call center where staff can book taxis and car share vehicles[59]. Today, Bremen, a city with a population of around 570,000, has more than 110 hubs, with 19,000 users[60]. Similar hubs exist in the German cities of Nuremberg and Dresden and have most recently been rolled out in the Norwegian city of Bergen.

(Photo Credit: Multi Mobility, Sophia von Berg, 2015)

- A study carried out in 2017 that looked at the effectiveness of the project showed that there was a relief rate of around 16 vehicles per car-sharing vehicle, which represents the amount of public space saved by implementing the car-sharing system.
- In Bremen alone, a Swiss study showed that every car-sharing user reduces the burden on the environment by around 200 to 290 kilograms of CO_2[61].

Anticipated Timing

Near-term (less than five years). With car-sharing, bike-sharing, and ride-sharing systems already in place at a local level, the opportunity to better integrate these systems through a

[57] Civitas Mobility Solutions. https://civitas.eu/measure/mobilpunkt-interchanges-between-car-sharing-public-transport-and-cycling
[58] Nationale Stadt Entwicklungs Politik – Mobil.punkt Project Description. https://www.nationale-stadtentwicklungspolitik.de/NSP/SharedDocs/Projekte/WSProjekte_ENG/Bremen_mobilpunkt.html
[59] Aono, S. (2019) *Identifying Best Practices for Mobility Hubs*. Vancouver, BC. Prepared for TransLink.
[60] Mobil.Punkt English Homepage. https://mobilpunkt-bremen.de/english/
[61] What is Mobil.Punkt. https://mobilpunkt-bremen.de/mobil-punkte/

Mobility hub already exists. In addition, the presence of similar hubs in other places in the world indicates that this infrastructure concept can be realized today.

3 Relevant Policies

This section summarizes and discusses relevant provincial, regional and local policies relating to New Mobility. This policy section is intended to provide a baseline understanding of relevant policies to guide consultation and form recommendations according to the local context.

3.1 Provincial Policies

3.1.1 Metrolinx 2041 Regional Transportation Plan (RTP)

In March 2018, Metrolinx adopted the 2041 RTP, which is the successive plan to *The Big Move*, the GTHA's first long-range transportation plan[62]. The 2041 RTP is centered around a common vision for the GTHA and provides emphasis on a system that provides safe, convenient, and reliable connections, and supports a high quality of life, a prosperous and competitive economy, and a protected environment.

Some relevant priority actions for Metrolinx relating to future mobility from the 2041 RTP plan include the following:

- **Strategy 4: Integrate transportation and land use**
  - Focus development at Mobility Hubs and Major Transit Station Areas along Priority Transit Corridors identified in the Growth Plan;
  - Embed TDM in land use planning and development; and
  - Rethink the future of parking.
- **Strategy 5: Prepare for an uncertain future**
  - Develop a regional framework for on-demand and shared mobility;
  - Develop a region-wide plan for autonomous mobility;
  - Coordinate across the region to improve climate resiliency of the transportation system;
  - Proactively prepare for a future with low-carbon mobility options;
  - Develop a regional transportation big data strategy; and
  - Develop a strategy for innovation in mobility.

3.1.2 Greater Golden Horseshoe Transportation Plan

The Ministry of Transportation for Ontario (MTO) is currently developing a long-term transportation plan for the Greater Golden Horseshoe (GGH) region to ensure that our future transportation supports prosperity and quality of life until the horizon year of 2051. The GGH is a key urban region centered around the City of Toronto and is home to 9 million people and 4.5 million jobs.

To support the plan, draft policies in 11 policy areas have been developed to address 38 policy intents. Among these policy intents, the following are some that are most relevant to New Mobility:

- Create a comprehensive active transportation network;

[62] Metrolinx. (2018). *2041 Regional Transportation Plan*. Toronto, ON. Metrolinx.

- Integrate active transportation supportive features into new development;
- Ensure that user privacy and security are maintained through all data collection and storage practices;
- Leverage connected and automated vehicle technology and other emerging mobility technologies to encourage optimal use or the transportation network;
- Support the development and effective implementation of Mobility-as-a-Service technologies;
- Manage and reduce the impact of the transportation system on existing and valued land uses;
- Incentivize more sustainable modes of travel;
- Discourage single occupancy vehicle use; and
- Support first- and last-mile improvements.

3.1.3 CAV Readiness Plan

In March 2020, MTO released its CAV Readiness Plan for the Greater Toronto and Hamilton Area (GTHA)[63]. The plan has five focus areas: Infrastructure Readiness, Operational Readiness, Institutional Readiness, Public Levers, and Pilots. Specifically, the readiness guidelines are aimed at establishing the first four to enable pilot-testing in urban and rural areas.

The outcome of this plan was the identification of five program areas, which were:

1. CAV Development Streams. Task forces to identify CAV impacts and how to address specific needs such as accessibility;
2. Development of CAV Modelling Tools. Develop a system dynamics model and simulation model updates to existing long-term transportation planning analysis tools.
3. Pilot Projects Program Management. Managing pilot projects to gather data and evaluate CAV and infrastructure, test designs and identify regulatory needs in a coordinated approach to reduce agencies' cost and time.
4. Data Needs and Management Plan. Defining needs for data standards and creating a data management plan and a data-sharing model.
5. Development of a Regional Mobility Platform Strategy. Developing an integrated strategy for fare, trip planning, and both private and public services through a region-wide approach for shared mobility.

3.2 York Region Policies

3.2.1 York Region Transportation Master Plan

As part of York Region's 2016 Transportation Master Plan, the second plan objective is to develop a road network fit for the future[64]. Under this objective, the Corridor Evolution Strategy (5.3.1) looks to meet today's mobility needs while ensuring corridors can be adapted in the future to meet changing travel needs, including CAVs. Congestion Management (Strategy 5.3.4)

[63] Ministry of Transportation for Ontario. (2020). *CAV Readiness Plan Final Report*. Toronto, ON. Ministry of Transportation for Ontario.
[64] York Region. (2016). *The Regional Municipality of York Transportation Master Plan.* York Region.

looks to leverage CAVs and their potential to improve regional travel times and road capacity by regulating demand.

3.2.2 York Region OnDemand Transit Strategy

York Region has operated a Dial-a-Ride (DAR) service since 2007 in the Town of Newmarket, replacing a conventional bus service with an accessible vehicle. The service has continued to operate, and other York Region Transit (YRT) routes were also converted across the region. In January 2016, YRT piloted Mobility On-Demand (MOD) services in the Towns of East Gwillimbury and Georgina, building on the popularity of TNCs such as Uber and Lyft, specifically aimed at travelers that were not within 500 meters of existing YRT service. This service is booked in advance through the YRT's Mobility Plus Contact Centre and is delivered using available vehicles already in operation for Mobility Plus. Travelers pay the regular YRT fare and can travel on any YRT service for up to two hours.

In 2017, York Region Council endorsed the YRT Mobility ON-Demand Strategy to help guide staff with the implementation of future services. This strategy identifies goals at short, medium, and long-term horizons and potential service expansion areas, potential uses of technology, communication plan, and rebranding options.

In 2019, YRT piloted MOD for travelers going to and from the Aurora GO station that used a self-serve mobile application to book their ride. This service is operated on a first-come, first-served basis, with rides being booked on the same day of travel. Using the new MOD mobile application, travelers can book a ride for immediate pick-up, but travelers can still call the Mobility Plus Contact Centre if they require assistance. This service was expanded in June 2019 and will be further expanded in the Town of East Gwillimbury, replacing existing transit routes in non-peak times.

York Region staff continues working with Metrolinx to deliver service to and from GO stations in the Greater Toronto Area to support multi-modal travel. YRT's MOD service has increased 155%, with an annual operating savings of $450,000 from a reduction of fixed-route service in low-demand areas.

3.2.3 Readiness for Transportation Technology Advancements

In September 2019, York Region provided an update on transportation technology advancements and looked at the region's readiness[65]. Overall, the region is continuing to adopt and integrate new technology, preparing for accommodating new technology and is planning for impacts of long-term, disruptive technologies.

Some technology solutions adopted include Bluetooth and wi-fi sensors, bus monitoring systems to minimize idling, pedestrian warning systems, and GPS pre-emption for emergency vehicles. Initiatives and pilots to position the region for impacts of new technology include:

- iCity-CATTS Program collaborating with the University of Toronto to develop transportation models that exploit real-time signal control;

[65] York Region. (2019). *York Region Readiness for Transportation Technology Advancements*. York Region.

- Municipal Alliance for Connected and Autonomous Vehicles in Ontario (MACAVO), a partnership to identify and coordinate CAV testing sites;
- Automatic Bus Shuttle (National Smart Vehicle Demonstration and Integration Trial), a project that seeks to integrate semi- and fully autonomous shuttles/pods and buses as first-mile/last-mile applications; and
- Dedicated Short Range Communication Pilot, a pilot to test onboard and roadside technology to facilitate traffic signal priority to York Region Transit and GO buses.

3.2.4 Lane Designation Bylaw Update – E-Bikes and E-Scooters

In November 2020, York Region went to Council to request bylaw updates related to the e-bike and e-scooter modes in response to Ontario's Highway Traffic Act Reg. 369/09 and 389/19, permitting their use in designated bicycle lanes and HOV lanes on regional roads[66]. This update intends to update existing regulations to recognize vehicles that already exist at the provincial level and increase the efficiency of the regional road network. In the previous existing bylaw, only bicycles, tricycles, and unicycles were recognized. The following limitations for e-bikes and e-scooters for the bylaw update were defined according to the above-listed Ontario regulations.

3.3 City of Vaughan Policies

3.3.1 Vaughan Official Plan (June 2019 Office Consolidation)

Vaughan's Official Plan (VOP), adopted by Vaughan City Council in September 2010, outlines numerous policies that affect the design of Vaughan's streets[67]. Critically, one of the VOP's eight goals is to support mobility without a car. As such, the VOP includes planning and design policies to make walking, cycling, and transit use realistic options for getting around and recognizes the integrated roles of land use, urban design, and transportation decisions. It emphasizes that the primary consideration for enhancements to the street network are to support transit, rapid transit, cycling, walking, and that new roads and the redesign of existing streets should have a balanced right-of-way that supports all needs. Infrastructure should be designed to be sustainable and resilient.

In addition, the VOP identifies a 50% transit modal split as a goal for the Vaughan Metropolitan Centre and Regional Intensification Corridors by 2031, with a 40% target for other Intensification Areas. The VOP also promotes Transportation Demand Management (TDM), while also supporting goods movement in a manner that balances economic benefit and adverse impacts.

3.3.2 Green Directions Vaughan

Green Directions Vaughan, last updated in 2019, is the City's community sustainability and environmental master plan[68]. It is a guide to a more sustainable future by addressing environmental, cultural, social, and economic values, and influences the City's operational and regulatory activities. It is also an Integrated Community Sustainability Plan and is recognized as a platform to request federal funding.

[66] York Region. (2020). *Lane Designation Bylaw Update E-Bikes and E-Scooters.* York Region.
[67] City of Vaughan. (2019). *City of Vaughan Official Plan 2010 Volume 1 2019 Office Consolidation*. Vaughan, ON. City of Vaughan.
[68] City of Vaughan. (2019). *Green Directions Vaughan: 2019 Sustainability Plan*. Vaughan, ON. City of Vaughan.

Goal 3 of Green Directions Vaughan is "To ensure that the City is easy to get around with a low environmental impact" and includes many objectives relevant to future mobility. Specifically, the following objectives were noted:

- 3.1.2 – Plan and implement a complete streets framework and guidelines to create a safe and attractive environment for all modes of transportation.
- 3.1.3 – Maintain non-vehicular networks, such as pedestrian and cycling pathways to support active transportation and enhance safety, accessibility, and adaptability.
- 3.2.1 – Develop a framework for first-mile, last-mile initiatives to promote transit use.
- 3.2.2 – Implement a fine grain network of streets and block lengths to allow pedestrians, cyclists, transit vehicles, automobiles, and goods and services vehicles to move efficiently, in accordance with City Official Plan and Master Plans.
- 3.3.2 - Collaborate with York Region and seek community partners to implement transportation demand management initiatives to reduce traffic congestion and promote transit and active transportation.

In addition to the specified objectives above, the City is planning to create a Smart City Office and Task Force and is also a member of the World Council on City Data. The City has also had several Smart City achievements, including becoming the first city to join US Ignite (a Smart Gigabit Community), beginning its digital transformation through its Digital Strategy, and Mackenzie Vaughan Hospital, Canada's first smart hospital. The City is looking towards becoming a recognized smart city to increase resilience.

3.3.3 Vaughan Community Climate Action Plan

In June 2019, the Mayor of Vaughan and Members of Council declared a climate emergency in the City, joining a list of 31 Canadian municipalities that are deepening their commitment to climate action[69]. Vaughan's Community Climate Action Plan was developed before this declaration through the engagement of citizens and stakeholders between September 2013 and January 2014. The purpose of this plan is to provide the community with practical ways to reduce GHG emissions from community sources.

Section 7 of the Community Climate Action Plan looks at actions and opportunities to reduce GHG emissions on the move. The primary objectives are to reduce reliance on cars and for the community to choose more efficient vehicles and take more sustainable forms of transportation, and for the City to encourage sustainable transport through policies and land use planning. It describes specific actions and opportunities.

Actions relevant to future mobility listed within the community climate action plan include:

- Implementing land use planning policies identified in the Transportation Master plan, such as: focusing development in centers and corridors, creating complete communities, and strengthening the relationship between land use and transportation planning.

[69] City of Vaughan. (2014). *Community Climate Action Plan for Reducing Community Greenhouse Gas Emissions*. Vaughan, ON. City of Vaughan.

- Implementing active transportation and TDM initiatives outlined in the City's TMP, such as developing TDM programs, encouraging alternative modes, and supporting the development of car-sharing and bike-sharing programs.
- Implementing the "transit first" approach outlined in the City's TMP, including rapid transit expansion, improving access to GO service, and transit fare and service integration.

In addition, opportunities such as anti-idling efforts, EV charging stations, and alternative fuels were identified as other potential avenues to reduce GHG emissions.

3.3.4 Relevance to City Policies and Initiatives

To understand how the above-listed policies are relevant to future mobility, a matrix table was developed to visually represent the correlation. Relevance is looked at by individual objectives, where existing. **Table 3-1** shows the relevance of technologies, infrastructure, and service concepts presented in **Section 2** to the City of Vaughan policy discussed in **Section 3**.

Table 3-1: Relevance of Future Mobility Technologies and Concepts to City Policies and Initiatives

	CAVs	Electrification	Shared Mobility	Goods Movement	Smart Cities	MaaS	Mobility Hubs
Green Directions Vaughan							
3.1.2 - Complete Streets for all Modes	☑	☑	☑	☑	☑	☑	☑
3.1.3 - Maintain non-vehicular networks			☑		☑	☑	
3.2.1 - Develop framework for first/last-mile initiatives	☑		☑	☑	☑	☑	☑
3.2.2 - Implement fine grain network of streets			☑	☑	☑		☑
3.3.2 - Collaborate with York Region to implement TDM			☑		☑	☑	☑
Vaughan Community Climate Action Plan							
Land-use planning policy changes	☑	☑	☑	☑	☑	☑	☑
Implement AT and TDM initiatives (car/bike-sharing)	☑		☑		☑	☑	☑
Implementing "transit first" approach		☑	☑		☑	☑	
Vaughan Official Plan							
Support moving around without a car	☑		☑		☑	☑	☑
Increase transit modal split		☑	☑		☑	☑	
Promote TDM initiatives	☑		☑		☑	☑	☑
Support goods movement	☑	☑		☑	☑		

3.4 City of Toronto Policies

3.4.1 Automated Vehicles Tactical Plan

In October 2019, the City of Toronto's AV Tactical Plan was approved by City Council[70]. This plan provides actions to help prepare for the introduction of highly automated vehicles on city streets, in public transit, or for municipal services use. This document provides the City of Toronto's understanding of AV technology and outlines the investment and initiatives underway to prepare for it. This plan outlines the strategic vision through seven high-level directions:

1. Social Equity and Health;
2. Environmental Sustainability;
3. Economic Sustainability;
4. Privacy;
5. Road Safety and Security;
6. Integrated Mobility; and
7. Transportation System Efficiency.

The City of Toronto is aiming to be "AV ready" by the end of 2022, and the tactical plan concludes with five individual projects that align with this goal, which include an automated shuttle pilot and transportation innovation zone, which are further discussed below.

3.4.2 Electric Mobility Strategy Framework

The City of Toronto, as part of its TransformTO program, developed an electric mobility strategy framework in July 2018, which is intended to guide the development of Toronto's electric mobility strategy[71]. The City of Toronto's Electric Mobility Strategy has the goals of:

- Enabling the city to achieve GHG reduction potential through transportation electrification;
- Convert passenger, freight, and transit vehicles from gasoline to electric or low-carbon renewable fuels;
- Ensure the City of Toronto is well-positioned to realize benefits associated with electrification;
- Maximize social benefits associated with electrification; and
- Support and foster collaboration between the City of Toronto and local innovators and entrepreneurs for low-carbon mobility.

As this electric mobility strategy framework will fall within TransformTO, the City of Toronto's wider climate action strategy, it has broader goals of advancing social equity, enhancing the local economy, improving public health, and creating resilient communities and infrastructure.

[70] City of Toronto. (2020). *Automated Vehicles Tactical Plan Technical Report*. Toronto, ON. City of Toronto.
[72]City of Vaughan. (2021). *Activate!Vaughan Innovation Program.* Vaughan, ON. Vaughan Economic and Cultural Development.

4 New Mobility Initiatives

Initiatives related to future mobility in the City and other local municipalities in the Greater Toronto Area are discussed in this section.

4.1 City of Vaughan

4.1.1 Vaughan Shared Mobility Feasibility Study and Pilot

The City completed a study in 2019 to complete a first/last mile solution feasibility study to reduce the reliance on the park-and-drive mode at Rutherford GO by offering other access modes. The study was motivated by significant construction activity near Rutherford GO that would worsen congestion and disrupt parking and traffic flow in an already busy corridor. Four main alternatives were assessed: micro-transit (or ODMT), AV shuttles, TNC partnerships, and micro-mobility. These alternatives were evaluated according to a framework built on measuring how well these solutions address strategic financial, economic, and market-readiness objectives.

The following findings resulted from this study:

- All four levels of government (the City, York Region, Metrolinx/MTO, Transport Canada) support innovative mobility solutions at transit stations like Rutherford GO. York Region would be the primary partner for any pilot as it has exclusive authority over public transit;
- The proposed service area includes 75,000 residents who also make up nearly two-thirds of Rutherford GO drive-and-park users;
- ODMT was the recommended mode as it can serve the service area effectively, can be delivered with low environmental impact, and is a proven market-ready solution with previous pilots in the GTHA;
- Potential cost estimate of $323,000 (50% provided through grant funding from higher levels of government) for planning, operations, and evaluation over a period of 21 months; and
- Performance monitoring was identified as a key item that will ensure high-quality service and expertise to build out similar future first/last mile services at similar nodes in the City.

In June 2020, the City summarized findings from the abovementioned study for a Shared Mobility Pilot. This service mode provides benefits that include access to a more sustainable mode, but also a mode that maintains physical distancing, drawing from lessons learned from Belleville's public transit in response to COVID-19. The City will look to partner with York Region Transit to pilot this service.

The City has also developed an implementation plan for ODMT service:

1. Service Delivery. ODMT service would operate as first/last mile transit feeder within the Rutherford GO study area, with virtual stops (not door-to-door), turnkey operation by a contractor, and fare consistent with YRT (and a $1 fare for Presto cardholders connecting to/from GO service).

2. Public Engagement. The City identified six phases for the implementation of ODMT and has engagement plans for outreach and marketing of the service.
3. Performance Monitoring. Service performance will be monitored from three perspectives: the customer, the City, and wider society. It will monitor the travel experience, cost-effectiveness, and wider impacts such as shifts in VKT, reduction in GHG emissions, and effectiveness in mode shift.

4.1.2 Activate!Vaughan Smart City Challenge

In February 2021, the City's Economic and Cultural Development launched the Activate!Vaughan Smart City Challenge, which is a pitch competition designed to connect high-potential start-ups and scale-ups to entrepreneurship opportunities and mentorship[72]. The Smart City Challenge focuses on four main themes: Electric Mobility, Municipal Services Route Optimization, Age-Friendly Communities, and Intelligent Placemaking. The program involves four main phases:

1. Reverse Pitch and Rapid Scoping. Experts provide the problem statement for each theme, describing the context of each problem statement;
2. Mentorship. Qualifying participants will be provided one-on-one mentorship with exports from the City, Vaughan Public Libraries, Alectra Utilities, Mackenzie Health, and Mackenzie Innovation Institute;
3. Pitch Challenge. Participants record and submit their pitch video, with a total of $25,000 in grant funding available; and
4. Commercialization Program. Winning ventures will be provided support (through workshops and focused mentorship) and an invitation to deeper consultation with program partners.

4.2 City of Toronto

4.2.1 Rouge Hill GO Automated Shuttle Pilot

In October 2020, the City of Toronto signed an agreement with Local Motors to deliver a pilot of an automated shuttle that would connect local residents to and from Rouge Hill GO station, starting in Spring 2021[73]. This trial will be delivered by a partnership between the City of Toronto with TTC and Metrolinx, with funding from Transport Canada. The purpose of this pilot is to "test and deploy an automated shuttle to fill an existing unmet need in the public transit system".

Local Motors, the private partner responsible for providing shuttle service, has experience deploying automated shuttles in business parks and neighbourhoods in California, Florida, and Belgium. The proposed shuttle, Olli 2.0, is a 3D-printed, zero-emission AV, with an accessibility ramp and audio and visual announcements. It will operate at low speeds (20 km/h) and data will be collected to evaluate trial results against project objectives. An on-board attendant will oversee operations and can take control of the vehicle if needed.

[72] City of Vaughan. (2021). *Activate!Vaughan Innovation Program.* Vaughan, ON. Vaughan Economic and Cultural Development.
[73] City of Toronto. (2020). *Automated Shuttle Trial Public Consultation Report: Phase 1*. Toronto, ON. City of Toronto.

The pilot program will service the West Rouge Community, located on the southeast corner of Scarborough. It is located in a geographical gap, where it is outside of the TTC's service coverage area of 400 metres (or a five-minute walk). The shuttle will travel on the road from the community to Rough Hill GO during morning and evening peak hours, and passengers would ride for free.

4.2.2 Exhibition Place Transportation Innovation Zone

A Transportation Innovation Zone (TIZ) was established Q2 2020 at the Exhibition Place grounds to understand emerging transportation technologies prior to implementation, foster economic development, support COVID-19 recovery efforts, and provide knowledge sharing across the region[74]. The City of Toronto is developing a Transportation Innovation Challenge to invite and manage trials at the TIZ until 2025.

The TIZ will provide benefits to the public by providing transparency as to how transportation trials are selected and monitored in Toronto, providing opportunities to interact with technologies, and supporting local development. Likewise, the TIZ provides benefits to participants of the Transportation Innovation Challenge by providing a real-world environment for testing, and access to partners in industry, academia, and staff from the City of Toronto.

The City of Toronto published its Transportation Innovation Framework in November 2020 for online public comment. It describes the TIZ area, purpose, and eligible organizations to participate. It describes how applications will take place by online portal, and applicants will need to describe their solution along with measures to protect, safety, accessibility, and privacy while testing. City staff will review applications and provide feedback for resubmission, keeping the process iterative.

All trials will initially take place at the TIZ at Exhibition Place and will involve applicants testing their solutions and monitoring, evaluating, and collecting data. Starting in Q3 2021, temporary innovation zones may be set up elsewhere for trials that need different testing environments. The City of Toronto looks to support innovation by allowing for participants to return to conduct trials, and also support participants as their technologies grow, providing support and deployment according to scale. Although the City of Toronto is not in a position to provide funding, the Transportation Innovation Challenge is designed to connect participants with external funding opportunities, by establishing a proven track record and demonstrating value to investors and funders through the TIZ.

4.3 Durham Region Transit

4.3.1 Whitby Autonomous Vehicle Electric (WAVE)

The Whitby Autonomous Vehicle Electric (WAVE) shuttle[75] is a pilot project to learn how autonomous technologies can contribute to safer, more sustainable and connected transit operations. The WAVE service is operating as Durham Region Transit (DRT) Route 300 (300 Port Whitby WAVE), with a trained safety attendant on board at all times.

[74] City of Toronto. (2020). *Transportation Innovation Framework.* Toronto, ON. City of Toronto.
[75] https://connectwhitby.ca/ridethewave

The project is supported by the Government of Ontario in funding through the Autonomous Vehicle Innovation Network (AVIN), led by the Ontario Centre of Innovation (OCI). The pilot is also being delivered through funding and the support and experience of local, national and international partners. These include SmartCone Technologies, AutoGuardian By SmartCone, the Region of Durham, Durham Region Transit (DRT), the Town of Whitby, Metrolinx, Nokia Canada, Ontario Tech, Durham College and other partners. The project incorporates Smart infrastructure to align with the Region's Vision Zero objectives. The shuttle manufacturer of the vehicle used in the pilot is Local Motors, who have ceased operations at the time of this writing.

The pilot program was launched in summer 2021, suspended in December 2021 following a collision involving a safety attendant who was in the shuttle at the time. Following a Durham Region Police Services investigation, it was found that the shuttle was operating in manual mode at the time of the collision and that the autonomous hazard mitigation safety systems were not engaged when the incident occurred. The pilot project was considered concluded in February 2022 by Durham Region's Transit Executive Committee. More than 250 passengers had the opportunity to ride the WAVE shuttle over the course of the four-month pilot with a total of 2,390 kilometres driven in both autonomous and manual mode (including set up time).

4.4 York Region / CUTRIC

4.4.1 National Smart Vehicle Demonstration and Integration Trial

The Canadian Urban Transit Research and Innovation Consortium (CUTRIC) is championing the first trial of its kind in North America, deploying half-a-dozen electric low-speed autonomous shuttles (eLSAs) in Markham, Ontario[76]. This will enable hundreds of residents to share the zero-emission service from York Region Transit (YRT) as a means of reaching local transit hubs without driving their personal vehicles. The shuttles, which can carry between 12 and 22 passengers, will use standardized Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication protocols, as well as world-class cybersecurity controls, to ensure safe, precise and efficient navigation and service. While the YRT eLSAs will operate without drivers, on-board conductors will ensure safe boarding and disembarking.

In conjunction with the trial, CUTRIC has recruited five research institutions — Queen's University, the University of Calgary, the University of Quebec in Trois Rivieres, the University of Toronto, and the University of Windsor — to advance the operation, design, and consumer acceptance of eLSAs. Likewise, CUTRIC's National Smart Vehicle Demonstration and Integration Trial is addressing the high capital costs of eLSA deployment by working to ensure that systems from different manufacturers can interoperate, and developing an innovative model for joint ventures involving public and private funding and financing.

[76] https://cutric-crituc.org/project/national-smart-vehicle-demonstration-integration-trial-phase-i/

5 Consultation

To initialize a conversation about New Mobility with other municipalities and authorities, a questionnaire was developed and circulated to the City of Toronto, Ministry of Transportation for Ontario (MTO), Transport Canada and York Region. Responses were received in questionnaire format from MTO and York Region, and meetings were held with the City of Toronto and Transport Canada to discuss New Mobility in a similar format. This section summarizes responses and discussions from the consultation phase, which are categorized into New Mobility Technologies (in **Section 5.1**); Planning for New Mobility (in **Section 5.2**); and Policies and Initiatives (in **Section 5.3**).

5.1 New Mobility Technologies

As part of consultation, the municipalities were asked to identify which technologies were key areas of focus in the short (1-3 years) and long (>5 year) periods. The following areas were provided:

- Connected and Automated Vehicles;
- Electrification – Transit, Freight and Personal Auto;
- Shared Mobility – Auto/Ride Sharing, Micromobility;
- Smart Cities – Connected Infrastructure and Transportation Information Management Systems (TIMS); and
- Regional Mobility-as-a-Service (MaaS) Platform.

Two additional areas of focus were also identified by MTO, Remotely Piloted Aircraft Systems (RPAS) and On-Demand Microtransit (ODMT).

CAVs and Electrification were noted to be major focus areas for all municipalities. Other focus areas, however, were noted to vary by jurisdiction. Micromobility was an example of this, where local municipalities are invited to self-define how the mode is allowed to operate to best achieve potential benefits.

5.2 Planning for New Mobility

Several infrastructure/regulatory gaps to implementation were also identified through consultation:

- **Regulatory Frameworks, Liability and Minimum Maintenance Standards** – Current legislative frameworks currently assume that a human is in control of the driving task, which will need to be updated in the future. For many newer transportation modes, namely micromobility, joint and several liability was identified as a regulatory gap. Additionally, for these new types of vehicles, maintenance standards will need to be updated to ensure that these vehicles are safe.
- **Costs and Procurement** – Municipalities have limited capital and operational budgets to provide transportation services, and there is a lack of GTHA-wide standards to define consistent requirements. For new technologies, there are few reliable and practical vendors.

- **Talent and New Skills** – To understand, plan for, and integrate new mobility technologies, infrastructure and service concepts, there is generally a requirement for a skillset that goes beyond the typical civil engineering discipline and scope of knowledge. Developing this talent locally can help to bridge this gap. Additionally, there is also cybersecurity risks that come with sharing data more widely. Some municipalities are taking on staff specifically for cybersecurity roles (in addition to an already existing IT department).
- **Physical Infrastructure Gap** – There is currently a lack of public Electric Vehicle Supply Equipment (EVSE) infrastructure, particularly fast chargers, which support long-distance travel. A lack of EVSE was also noted in northern/rural Ontario, non-residential buildings, and multi-residential buildings (where residents would not have a personal garage). Additionally, most existing infrastructure is not able to provide V2I connectivity.

5.3 Policies and Initiatives

Policy development is centered around common focus areas for new mobility, such as cybersecurity and privacy, electrification, micromobility. For certain technologies such as micromobility, legislation is downloaded to municipalities to pass their respective by-laws. Transport Canada is working actively to produce regulation on noise requirements for EVs (to allow the visually impaired to know when EVs are nearby), and consultation on low-level automation and driver assistance to see which other technologies to prioritize for regulation.

Partnerships are also being evaluated, as sectors are changing to reflect changes in the market. “Invitation to Partner” is a new type of procurement and adding negotiated RFP (which adds a negotiation period to the regular RFP period) is an effective way to add flexibility to procurement. Partnering with private companies allow public agencies to benefit from expertise and efficient and innovative solutions, while allowing for risk transfer.

Equity and accessibility are also a focus, as transportation should be available for all. For many projects, equity lenses are being applied to look at where investment has been focused historically, and neighborhood improvement areas where improvements could be made. York Region has commissioned a research paper on transportation equity, which will be shared with the City. MTO is working on developing a framework for transportation access and inclusion in three main areas: representation; access, safety, and security; and distribution of benefits and costs. Examples of equity frameworks include Gender-Base Analysis plus (GBA+), applied by the federal government, Title VI and Environmental Justice Analysis in the United States, and Distributional Impact Appraisal as applied in the United Kingdom. Transport Canada is investigating accessibility for remote communities, as well as taking part in a stakeholder group that discusses challenges in accessibility and equity (which is led by Carleton University).

6 Recommendations

This section summarizes recommendations based on the overview of New Mobility technologies and service concepts, best practice, policy and initiatives' review, and consultation with other municipalities, by:

- Identifying methods to address gaps in the short-term and medium to long-term timeframes;
- Identifying near term opportunities to use New Mobility in the next five years; and
- Discussing a proposed framework for a Transportation Innovation Program (TIP) to guide the development of new technologies through a framework.

6.1 Identify Use Cases

Gaps identified through consultation fall into three categories:

1. **Regulatory Gaps:** A gap in legislation or missing framework to define standards or categorize New Mobility technologies or services.
2. **Infrastructure Gaps:** A gap identified in infrastructure required to enable New Mobility technologies, either physical or a missing standard.
3. **Resource Gaps:** A gap that involves a missing resource required to deliver New Mobility projects or programs.

This section describes actions in the short (5-10 years) and medium to long term (10+ years) to address the gaps that were identified in each category. Some actions are already in progress or complete, which is noted within this document.

6.1.1 Regulatory Gap Actions

6.1.1.1 MICROMOBILITY

Micromobility regulation is currently an ongoing topic of focus in mobility as levels of government may have different definitions of vehicles and different governing authority over them. Joint and several liability is also an ongoing risk. The following short-term actions are recommended:

- Continue to engage in regular discussion with other municipalities and levels of government, with the aim of identifying emerging modes and opportunities within the City to achieve transportation objectives.
- Establish where and how micromobility devices can be used in the City, through a framework and internal working committee (**Complete**).
- Develop a "New Mobility Policy" (**In Progress**) which involves the following:
    - Committing the City in managing and accommodating future mobility in a way that would support the City's sustainable transportation and environmental goals (in alignment with other City plans, such as *Green Directions Vaughan*).
    - Establishing "Transportation Innovation Programs" (TIP) to learn about emerging technologies and approaches in New Mobility, and how these could be leveraged to meet Vaughan's mobility needs and objectives. These programs would

support technology research and development, while also developing and supporting local talent and encouraging local economic vitality in support of the New Mobility Policy.
    - Determining if, where and how different vehicles should be used within Vaughan (e.g., Pilot areas, rentals, sharing methods, etc.), and establishing methods to manage joint and several liability risks.

The following medium to long-term actions are recommended, at a general timeframe of ten years, but can be undertaken once the New Mobility Policy has been adopted by Council and the TIP concept is being implemented:

- Consult with the public and other local stakeholders in areas of interest and conduct additional pilots to test technologies and collect data on the effectiveness of potential solutions to transportation problems.
- Determine where devices would be permitted to operate and how they would be regulated based on findings from pilots and other general transportation data sources (e.g., transit ridership data, collision data, traffic delay information).
- Leverage micromobility more widely as a first- and last-mile connection through the micro-mobility/mobility hub concepts.

6.1.1.2 CONNECTED INFRASTRUCTURE CYBERSECURITY AND PRIVACY

While connected infrastructure has the potential to improve the transportation systems, there is also an increase in the potential for cybersecurity risk. Mitigating system vulnerabilities as a result of increased connectivity is important to protect the safety and privacy of roadway users. The following short-term actions are recommended:

- Coordinate with IT staff to review existing projects' threat and risk assessments and opportunities for improvement for future projects that involve data collection or active connection to infrastructure.
    - Examples of connected infrastructure to consider for the future include adaptive signals (would need to be coordinated with the wider York Region), camera systems, and sensors for preventative road maintenance.
- Identify opportunities to incorporate Privacy Impact Assessments (PIA) for new projects, which is a risk management process that helps institutions ensure that they meet legislative requirements and identify the impacts their programs and activities will the privacy of individuals[77].

The following medium to long-term actions are recommended:

- Continue to monitor cybersecurity initiatives with higher levels of government. As an example, Transport Canada has an ongoing project to develop tools and guidance for cybersecurity of traffic data.

[77] Office of the Privacy Commissioner of Canada. (2020). *Expectations: OPC's Guide to the Privacy Impact Assessment Process.* Ottawa, ON. Government of Canada.

- Investigate staffing for cybersecurity purposes, as needed. The City of Toronto has recently added a Chief Information Security Officer (CISO) position and supporting team.

6.1.1.3 VEHICLE AND INFRASTRUCTURE STANDARDIZATION

One of the key barriers to adoption of new technology such as connected vehicles and EV's lies in a lack of interoperability between different vehicle, telecommunications or charging infrastructure manufacturers. One of the key goals of CUTRIC's National Smart Vehicle Demonstration and Integration Trial is to achieve standard V2V and V2I protocols between more than one OEM.

6.1.2 Infrastructure Gap Actions

6.1.2.1 ELECTRIC VEHICLE (EV) CHARGING INFRASTRUCTURE

A barrier to increased proliferation of EVs is lack of charging infrastructure and/or further upstream infrastructure to support increased electric network demand. The following short-term actions are recommended:

- Propose requirements for EV charging or provide the necessary connections to install EV charging in the future for new developments or in policy language for Secondary Plans.
- Support EV charging retrofit programs as existing developments may not currently have the requisite infrastructure for installation. Look into opportunities for EV charging streetlights in residential or urban areas (further discussed in ***Maximizing Value for Transportation Infrastructure Value*** white paper).
- Install EV charging stations and/or upgrade existing charging systems and provide visitors with EV charging needs, keeping alignment with Green Directions Vaughan.
- Coordinate with utility companies to ensure that support of the growing EV charging and vehicle network is feasible going forwards.
- Support the goods movement industry in Vaughan as these transition to electric fleets.
- Lead by example – the City should conduct a study to guide the transition its own municipal fleets to zero-emission vehicles

The following medium to long-term actions are recommended:

- Coordinate with other municipalities and agencies to identify and install charging infrastructure to support long-distance travel.

6.1.2.2 ROADWAY DESIGN AND IMPLEMENTATION STANDARDS FOR AV

To implement new mobility vehicles, roadways must be designed in a compatible manner, and standards should exist to ensure that consistent implementation and procurement is undertaken regionally. The following short-term actions are recommended:

- Continue to participate in OVIN, Ontario Smart Mobility Readiness Forum, and other public forums to stay informed on emerging trends in transportation relating to CAV.
- Participate and contribute to conversations surrounding implementation standards and roadway design, with transportation staff on technical advisory committees to provide City-specific perspectives for new standards.

The following medium to long term actions are recommended:

- Support development of GTHA-wide design, operations and standards for CAV and requisite connected infrastructure to support them, ensuring that the City is well positioned for these newer modes.

6.1.3 Resource Gap Actions

6.1.3.1 CAPITAL AND OPERATIONAL FUNDING

For municipalities, there are generally annual allocations of capital resources to deliver projects, and new mobility projects may not be accounted for and present additional costs. The following short-term action is recommended:

- Investigate funding sources, such as the Enhance Road Safety Transfer Payment Program by Transport Canada, or the Smart Cities challenge, which could be used to fund studies related to enhancing road safety for vulnerable road users or related to micro-mobility.

The following medium to long-term actions are recommended:

- Identify annual budget for new mobility studies and infrastructure spending to address regulatory and infrastructure gaps.
- Identify opportunities to bundle new mobility opportunities and infrastructure into wider studies, such as secondary plans, EAs and other residential development.

6.1.3.2 STAFFING, RESOURCING, AND TALENT

Similar to limitations on funding, there is also a limited number of staff available to deliver projects. Additionally, new mobility presents a need for new frameworks and methods to analyze new modes and emerging opportunities. The following short-term action is recommended:

- Ensure that existing staff are monitoring new mobility technologies on the horizon (e.g., CAV, Micro-mobility, Electrification, shared mobility), and including them in the planning process.

The following medium to long-term actions are recommended:

- Assign new mobility programs (e.g., a micromobility program, CAV program, shared auto program, etc.) to specific staff to manage, and take on additional staff to support or lead these initiatives, as needed.
- Investigate taking on staff with additional capabilities beyond the typical transportation engineering skillset (e.g., data science, artificial intelligence, advanced transportation systems).

6.2 Near Term Opportunities

Although **Section 6.1** describes actions in the short (5-10 years) and medium to long term (10+ years), opportunities also exist in the near-term (<5 years). Near term opportunities involve

initiatives that address gaps in the transportation network using New Mobility and could be undertaken in the next five years. Many of these involve ongoing focus areas and initiatives passed down from higher levels of government. An example of this is the provincial government allowing municipalities to use Safe Restart Agreement funding towards new initiatives such as ODMT to explore replacing low ridership routes and provide first/last-mile connections. This funding has generally led to multiple municipalities testing this mode, which has potential, particularly as transit recovers in the post-pandemic phase. The following are some near-term opportunities that the City can undertake:

- Shared micromobility (shuttle) or ODMT pilot focused on serving the West Vaughan employment area, which has a warehouse/industrial focus. This service could connect major employers (e.g., Costco, Home Depot, in the area and connect to higher order transit to ensure that employees have frequent (or on-request) service.
- ODMT service to connect directly to planned rapid transit projects in Vaughan, leveraging lessons learned from the ongoing Rutherford/Maple GO procurement process and service operation.
- Mobility hub concept implementation and electric micro-mobility TIPs within new development areas such as Weston and Highway 7, Vaughan Metropolitan Centre, Promenade Centre, and Vaughan Mills as intermediate connections between major rapid transit stops to final destinations. These could be used to pilot new modes to bridge the first-/last-mile connection to high-order rapid transit options.

New Mobility areas of focus generally change with ongoing trends, and funding opportunities to explore new modes and services will reflect latest trends. The City should continue to monitor areas of focus for higher levels of government and downstream funding to support pilots that have potential benefit to provide additional travel choices to residents and visitors.

6.3 Transportation Innovation Program

The purpose of the Transportation Innovation Program (TIP) is guide and manage the implementation and development of new technologies. New Mobility requires a different method of testing and implementation, and new modes or services should be trialed and evaluated prior to wider use to ensure safety for vulnerable road users.

After a technology or service completes the TIP, further procurement or scaling could be undertaken. A model of procurement that could be leveraged is the “Negotiated RFP” which allows for negotiation with proponents on contract terms, such as technical specifications, commercial implications, and prices beyond what is outlined in the initial RFP. Innovative solutions benefit from the negotiated RFP process, compared to the traditional RFP which is better for projects with clear specifications, deliverables, and evaluation criteria. The negotiated process leads to better outcomes with new technologies as these come with high complexity and uncertainty.

The TIP framework can follow a five-step process, as follows:

1. **Invitation to Partner** – The City will put forth a problem or challenge and invite potential partners to submit a proposal outlining how they would work with the City, residents and

stakeholders to design, build or use an existing design as a solution. This procurement model brings forth an innovative mindset to address a municipal problem.

2. **Application Process** – The City will put forth an application form, where participants will apply by providing basic information about their solution and their proposed measures for safety and performance monitoring during trial.
3. **Trial** – The City will define a trial period, during which selected participants will trial their solutions in a controlled test site. Proposed test sites should be representative of the municipal problem or challenge (i.e., if it is related to snow clearing, a winter outdoor site would be logical, or if it is active transportation related, then a site with high AT volumes or a City-owned park). Generally, roads that do not fall under the Highway Traffic Act (HTA) would be good to use as sites, as typical roadway restrictions would not apply.
4. **Monitoring and Evaluation** – The City will evaluate participants' solutions based on performance, impacts and benefits per the issued problem or challenge. Data will also be collected by participants to inform future iteration, as needed. Individual solutions by participants will not be evaluated against each other by the City, and proprietary data will also not be collected by the City.
5. **Next Steps** – The City can help successful solutions by supporting scaling and commercialization. Beyond the TIP, the solution may be prepared to be implemented in a wider existing process, or to be procured.

Overall, the TIP process timeline will vary depending on the challenge and could be season-specific depending on what the challenge itself is. From a resource perspective, the process will require City staff to work on an ongoing basis with program participants and also review applications. This process may require a dedicated manager to oversee the process.

From a cost standpoint, the TIP should have minimum requirement. Examining another local program that is similar, the City of Toronto's TIZ program, it was noted that the costs would largely be mitigated by an application fee paid by prospective applicants, and a fee for usage of the trial site paid by the participant. The City of Toronto does not offer funding to participants. It is anticipated that a cost-similar model would be undertaken by the City and would be fairly cost effective.

Appendix A: Full Consultation Summary and New Mobility Questionnaire

Memo

Date:	Thursday, August 26, 2021
Project:	Vaughan Transportation Plan
To:	City of Vaughan
From:	HDR
Subject:	VTP New Mobility Consultation Summary

Introduction

HDR has been retained by the City of Vaughan (the City) to undertake the City-wide Transportation Master Plan Update, also known as the Vaughan Transportation Plan (VTP). As part of this plan, the City is examining potential impacts of New Mobility technologies and seeking to manage these through a transportation innovation program.

To initialize a conversation about New Mobility with other municipalities in the GTA, a questionnaire was developed and circulated to the City of Toronto (CoT), Ministry of Transportation for Ontario (MTO), Transport Canada (TC), and York Region (YR). Questionnaire responses were received from MTO and YR, and consultation meetings were undertaken with CoT and TC on July 19, 2021, and July 23, 2021, respectively. **The New Mobility Questionnaire** can be found at the end of this memo.

This memo summarizes the questionnaire response received and notes taken from consultation meetings with municipalities and transportation authorities. It generally follows a similar format to the questionnaire, organized into (1) New Mobility Technologies; (2) Planning for New Mobility; and (3) Policies and Initiatives.

1. New Mobility Technologies

As part of the new mobility questionnaire, the first two questions identified focus areas of the four respondents in the short (1-3 years) and long (>5 years) terms. These are summarized in **Table 1** and **Table 2** for the short and long terms, respectively Additionally, it should be noted that MTO identified two additional areas of focus that were not options in the questionnaire: Remotely Piloted Aircraft Systems (RPAS) and On-demand Microtransit (ODMT).

Table 1: Short-term (1-3 years) new mobility focus areas

Focus Area	City of Toronto	MTO	Transport Canada	York Region
Connected and Autonomous Vehicles	☒	☒	☒	☒
Electrification – Transit	☒	☒	☒	☒
Electrification – Freight	☒	☒	☐	☐
Electrification – Personal Auto	☒	☒	☒	☐

Shared Mobility – Auto / Ride Sharing	☐	☒	☒	☒
Shared Mobility – Micromobility (i.e. e-scooter, bike sharing)	☒	☒	☐	☒
Smart Cities – Connected Infrastructure	☒	☒	☐	☒
Smart Cities – Transportation Information Management Systems (TIMS)	☒	☒	☐	☒
Regional Mobility-as-a-Service (MaaS) Platform	☐	☒	☐	☒

Table 2: Long-term (>5 years) new mobility focus areas

Focus Area	City of Toronto	MTO	Transport Canada	York Region
Connected and Autonomous Vehicles	☒	☒	☒	☒
Electrification – Transit	☒	☒	☐	☒
Electrification – Freight	☒	☒	☐	☐
Electrification – Personal Auto	☒	☒	☒	☐
Shared Mobility – Auto / Ride Sharing	☐	☐	☐	☒
Shared Mobility – Micromobility (i.e. e-scooter, bike sharing)	☐	☐	☐	☒
Smart Cities – Connected Infrastructure	☐	☒	☐	☒
Smart Cities – Transportation Information Management Systems (TIMS)	☐	☒	☐	☒
Regional Mobility-as-a-Service (MaaS) Platform	☐	☒	☐	☒

Some general observations are that CAVs and electrification are major focus areas for all municipalities, but also that focus areas depend greatly on jurisdiction. As an example, transit electrification and regional MaaS were not the most important focus areas for respondents as they would generally be initiatives led by transit agencies (such as TTC or Metrolinx). Micromobility is another jurisdictional example, where TC is less involved in the space and is more dependent on local municipalities self-defining how the mode is allowed to operate to best achieve potential benefits. CoV has indicated that the above are all important to have as focus areas, but that the level of focus achievable depends greatly on the resources available.

Additional details for specific focus areas are discussed in the following section.

Connected and Automated Vehicles (CAV)

CoT has prepared their CAV tactical plan and have temporary staff for this purpose. The plan includes short-term actions but is a long-term vision.

York Region is a part of CUTRIC's National Smart Vehicle Joint Procurement Initiative, which is an ongoing dialogue for joint procurement of technically integrated and interoperable autonomous and connected smart shuttles to achieve shared mobility applications.

MTO is engaged in several activities (e.g. testing, R&D, collaboration) to prepare Ontario for the deployment of CAVs. MTO has allowed testing through its Automated Vehicle Pilot Program since 2016 on Ontario roads under certain conditions, supported CAV development through the Autonomous Vehicle Innovation Network (AVIN), and has been testing innovative intelligent transportation technologies for road safety.

For TC, CAVs are also a focus, specifically in the areas of infrastructure readiness, safety elements and to inform future testing and pilots. TC and National Resources Canada (NRCan) are both involved in CAV research. There is work ongoing in the CAV space, specifically in the non-regulatory space such as providing testing guidelines (with new guidelines to come in August). These new guidelines will cover operational practices, guidance for low-speed shuttles, how to engage with local first responders, engaging municipalities, selecting routes for testing. Consultation with municipalities was undertaken for these new guidelines as well. TAC inventory (called Inventory of CAV initiatives in Canada) is published online and offers information on what is ongoing in Canada in the CAV space, specifically who is leading projects and what the project scopes are.

Electrification

Transit electrification is a TTC priority, with pilots currently underway and primarily lead by the TTC. Electrification for freight and personal auto is undertaken through CoT electrification strategy that runs primarily through its Environment & Energy Division. These are included as part of a wider Climate Change plan that aims to achieve a goal of 100% transportation using zero-carbon energy by 2050. Additionally, a pilot project with Toronto Hydro for on-street EV charging is also ongoing.

York Region supports electrification as part of the region's overall Energy Conservation and Demand Management Plan and also as part of the regional goal of achieving net-zero greenhouse gas (GHG) emissions. Transit buses currently create 60% of York Region's overall corporate GHG emissions. Electric buses will be phased in as diesel buses require replacement and as infrastructure improvements are made to support a fully electric fleet, significantly reducing GHG emissions.

Ontario has made recent investments in EV manufacturing and establishing requirements for reserved EV parking. The province announced in its 2021 Budget that it is investing $56.4 million over the next four years to create the Ontario Vehicle Innovation Network (OVIN). OVIN will build on successful elements of AVIN, accelerating the development of next-generation electric, connected, and autonomous vehicle and mobility technologies, as well as supporting Ontario's role as the manufacturing hub of Canada.

TC announced $2.5B for public transit electrification (in March 2021). Federal rebates for EVs exist and are available through the iZev program. TC is still looking at ongoing road safety issues with conventional vehicles today, with an additional focus on safety elements of electrification (e.g., battery safety programs through the UN).

Shared Mobility

Auto and ride-sharing are generally less of a priority for CoT. Shared micromobility devices such as scooters are not an organizational priority, but bike sharing is. For e-scooters specifically, Council unanimously voted (May 2021) to not join MTO's e-scooter pilot due to safety, liability, and persons with disability concerns. E-scooters are not yet on Toronto streets at any significant volume. There is enforcement for reckless riding, but also limitations on police resources.

Regulation and liability issues currently exist as there are many different forms of e-micromobility, and it is difficult for CoT to regulate each mode accordingly. Current e-scooter users are doing so at their own risk, and if CoT were to formally permit their operation, they would be put at risk, specifically for joint and several liability, which allows a plaintiff to recover their entire claim for damages from one of several negligent defendants. Joint and several liability unfairly burdens municipalities as they may be seen as the party with the "deepest pockets" for plaintiffs to pursue. CoT has been negotiating with the province to reform joint and several liability, which would redefine distribution of damages between government, manufacturers, and e-scooter companies.

Micromobility is still largely viewed as a recreational mode, and it is not anticipated as a class of vehicle for which standards would be developed. A potential solution (proposed by TC) is to work with MTO to bring recommendations to the Canadian Council of Motor Transport Administrators (CCMTA), to coordinate policies and standards across provinces and territories. For example, logistics companies trying to procure cargo e-bikes would develop a consistent standard nationwide. CoT foresees innovations similar to the "microcar" from Frank Stronach (Magna), a single-person electric-powered vehicle that fits in typical bike lanes, to continue to emerge.

Micromobility is currently one of the MTO's priorities as many of these vehicles align with Ontario's commitment to minimize transportation impacts on the environment, encourage innovation within transportation methods, reduce barriers to business, and increase road safety.

For TC, micromobility and shared mobility are focus areas that are being followed and to be understood from the equity and accessibility lenses. TC has the authority to regulate vehicles that will operate on roads. Under TC's Motor Vehicle Safety Act (MVSA), a vehicle is something that is designed to be on roads that use means other than muscular power exclusively, and the current interpretation is that anything that below 32 km/h would not fall under the MVSA and is excluded from meeting those regulations (as of Feb 2021). Micromobility devices do, however, fall under the definition of a vehicle (and are subject to recall and defects regime under the consumer product safety act), allowing Health Canada and Transport Canada to work together to step in as needed.

Manufacturers of micromobility devices are required to self-certify that they meet regulatory requirements, and compliance and enforcement teams exist to monitor or audit them periodically. When the vehicle is imported, CBSA will ensure that the national safety mark is present or that it will operate below the 32km/h and is therefore allowable in Canada. There is nothing specific to micromobility for product recalls, but for specific parts (such as batteries) they would fall under the consumer act. The general expectation for safety regulations is that it will

be the responsibility of the Province to provide guidance on micromobility devices to municipalities.

On-Demand Microtransit (ODMT)

York Region Transit (YRT) currently operates Mobility On-Request (MOR), which is an ODMT service that uses sedans, minivans, or small buses for low-demand areas. Currently, booking a trip must be made two hours before the trip by phone or through the app, and trips can be paid for using PRESTO. YRT's goal is to expand MOR services further to deliver cost-effective services to areas with lower demand and/or areas where a fixed-route service is not feasible.

As part of MTO's phase 2 funding under the Safe Restart Agreement (SRA) funding for transit Ontario asked municipalities whether ODMT (or other service concepts) would be better suited for low performing, cancelled, or new routes rather than traditional fixed-route services, particularly in light of the COVID-19 pandemic. Phase 3 SRA funding allows for up to 50% of the total to be used towards ODMT studies and pilots.

Smart Cities / MaaS

For CoT, Smart and Connected Infrastructure is an ongoing priority in typical operations. CoT currently has a Connected Community / Smart City Project Team, which uses technology and data to improve convenience and connectivity. Some ongoing projects include trialing the provision of free Wi-Fi to apartment neighbourhoods, COVID-19 chatbot to answer questions about CoT services and business support, and provision of open data.

Within CoT, Transportation Information Management Systems (TIMS) undergo continuous upgrades to provide travel time information and road condition information through variable message signs. CoT is moving from loops to cameras for detection, and a smart signals pilot (leveraging SCOOT / SCAT signal systems) is currently underway. TTC is the local lead for MaaS, and it is less of a priority for CoT relative to other focus areas identified.

YRT is currently working on MaaS through their MOR service. The vision is to provide a seamless travel experience through the creation of a single mobile application that manages start-to-end trip planning and fare payments, incorporating all available YRT services and integrating third-party provider options.

MTO is interested in understanding infrastructure needs and evaluating readiness for new technologies to make timely and cost-effective investments. MTO is also working with Metrolinx, PRESTO, and other partners to investigate opportunities for a MaaS solution in the Greater Golden Horseshoe (GGH) and beyond.

TC has an ongoing study in progress looking at smart mobility, with a focus on urban centers that involve key interviews with transport / urban planners and a heavy municipal policy scan. It is in its final stages and is intended to help understand the adoption of innovations in mobility, and how far along they are – similar to readiness tests of various urban centers. Micro mobility was included as part of this study, and the experience as municipalities adopt them is covered in the study itself.

Additionally, Infrastructure Canada previously issued their Smart Cities Challenge, which encourages municipalities to submit proposals to meet their self-defined challenge statements through the use of data and connected technology. The challenge had three prize tiers, one prize of $5M for communities with populations under 30,000, two prizes of $10M for communities under 500,000, and one prize of $50M open to all communities regardless of population.

2. Planning for New Mobility

Infrastructure / Regulatory Gaps to Implementation

For CoT, joint and several liability for micromobility was identified as a regulatory gap. TC has a general "disinterest" in vehicles slower than 32km/h. MTO has created "pilots" under the Highway Traffic Act (HTA) but has left a sentiment of downloading risks and policy-making responsibility onto municipalities, which may not be a sustainable approach in the long term.

For new vehicle types, there may also be a need to update Minimum Maintenance Standards (MMS) to make sure vehicles are safe. These could vary by municipality as well, as a lot of mobility innovation is coming out of warmer climates, with less consideration for cooler climates which have impacts on parts such as batteries and sensors.

York Region identified a gap in annual operating and capital budget to accommodate requirements for new mobility. Additionally, there is a lack of GTHA-wide standards to clearly define the consistent design and implementation requirements. For new technologies, there is a lack of provincial regulation on operating autonomous and electrical vehicles, and most technologies are premature for large-scale implementation. From a procurement standpoint, there are also few reliable and practical technology vendors for mobility technology. Support from upper levels of government, in particular financial support through grants or loans, is crucial for the deployment of an electric bus fleet and its associated facilities (e.g., Brampton's federal loan to purchase 450 zero-emission buses).

MTO identified the following gaps for CAVs:

- *Legislative and regulatory framework* – Ontario's current legislative framework currently assumes that a human is in control of the driving task and will need to be updated as this may not be the case for CAVs.
- *Education and Awareness* – Preparing our transportation system for CAV technology will require consistent and meaningful engagement with the public, and there may be a need to correct misinformation about the capabilities and limitations of CAV technology.
- *CAV Industry Readiness* – There is a need to bridge the evolving and converging technology and automotive sectors, supporting research and testing and stimulating the economy through investment.
- *Physical and Digital Infrastructure* – CAV technology is expected to introduce complexities and opportunities to Ontario's existing transportation system. There is a need to integrate CAVs into infrastructure, assets, and contracts to improve operations.

MTO also identified the following infrastructure gaps:

- Public Electric Vehicle Supply Equipment (EVSE) / Charging Infrastructure, particularly fast chargers that support long-distance travel.
- EVSE in non-residential buildings and northern/rural Ontario.
- EVSE in multi-unit residential buildings and for residents without garages.

TC identified a talent gap that exists, as the need to understand, plan for, and integrating these technologies typically goes beyond the typical civil engineering discipline and scope of knowledge. TC is interested in developing this talent locally. Additionally, TC is also looking to understand how the procurement of automated vehicles will occur.

TC also identified a gap between the "hype" of new technology and the reality of what can be implemented on the ground. Not all innovation is technological and looking at proven strategies (e.g., transit priority, TOD, on-demand transit systems, social and equity analyses/lenses to analysis) and applying them appropriately can also yield significant benefit.

There is also a cybersecurity risk that comes as a result of increased connectedness. Since it is necessary to effectively share data between different parties, it is important to evaluate how to do so without increased exposure to new vulnerabilities in our systems.

Ongoing Initiatives

AUTOMATED SHUTTLE TRIAL

CoT released their Automated Vehicles Tactical Plan, which was approved by council in October 2019, and is currently running an AV shuttle trial in the West Rouge neighbourhood of Scarborough. The purpose of the trial is to operate it until failure since RFI responses noted that below -10°C, batteries may no longer operate. CoT noted that a similar pilot conducted in Vancouver found out salt spray will affect sensors. For these reasons, the project has not been deemed a pilot but a trial that aims to test the limits of the technology and see what they are before implementing more permanent solutions.

TRANSPORATION INNOVATION ZONE

CoT created their Transportation Innovation Zone (TIZ) in response to being approached by companies that wanted to test technologies that did not fit within current regulatory frameworks. The TIZ at Exhibition Place provides a place for technologies to be tested since the testing area is a park whose roads are not subject to the Highway Traffic Act. This provides flexibility and allows CoT to monitor results.

The TIZ program is used to create challenge-based trials in a controlled environment to solve City challenges by exploring new technology. The first challenge, which was conceptualized as an Automated Sidewalk challenge was unable to be completed because of COVID-19 and stayed as a tabletop exercise to educate innovators on how to work with CoT and on procurement. There is no current formal link between TIZ and other innovation centres like AVIN. CoT has made it clear that technologies are not being evaluated against each other and wants to avoid concerns around proprietary information from innovators.

CARGO E-BIKE PILOT PROGRAM

MTO developed a cargo e-bike pilot program that allows municipalities to choose where and how cargo e-bikes can be used. The program defines helmet requirements, the minimum age

for operators, and vehicle size and speed restrictions, allowing for municipalities to self-define where they can be used, parking, monitoring, and insurance requirements. The program will run between May 2021 and May 2026.

CoT is taking part in MTO's cargo e-bike pilot. E-bikes weighing below 120 kilograms were made allowable as they generally have fewer challenges with parking because of their size. FedEx has been testing e-bikes in this weight class in CoT. E-cargo operators are looking for support with overnight and temporary parking for deliveries, but currently, CoT is not able to provide additional parking spaces. CoT is, however, connecting with CreateTO to try and create new spaces within new developments. CreateTO is a city agency that was launched in 2018 by CoT to manage its real estate portfolio and manage the development of CoT buildings and lands for municipal purposes.

OTHER PLANS AND INITIATIVES

York Region's Travel Smart Program is a five-year tactical program developed to identify, prioritize, plan and schedule initiatives to better manage the most significant areas of delay. In York Region's upcoming Transportation Master Plan (TMP) update's Background Study, there will be a focus on innovative transportation advancements and technologies, as well as policies that support transportation options/choices and support equity/access for marginalized people/communities. The TMP update will have a future-readiness focus. In YRT's 2021-2025 5 Year Business Plan, there is also mention of expanding MOR service and technology further.

MTO has also been collaborating with partners on Remotely Piloted Aircraft Systems (RPAS), and also has representation at the federal ZEV working group to discuss zero- and low-emission vehicles (e.g., battery, plug-in, and hydrogen fuel cell).

MTO's priorities in the short- and long-term are outlined in Ontario's regional transportation plans:

- Connecting the Southwest: A Draft Transportation Plan for Southwestern Ontario;
- Connecting the North: A Draft Transportation Plan for Northern Ontario; and
- Greater Golden Horseshoe (GGH) transportation plan.

Transportation 2030 is TC's transportation strategy which covers all modes of transport (air, marine, trucking, rail). It focuses on applied research for five main themes: The Traveller; Safer transportation; Green and innovative transportation; Waterways, coasts, and the north; and Trade corridors to global markets. TC is also interested in increasing stakeholder engagement, with a focus on innovation policy, CASE (connected, automated, shared, electrified) vehicles as well as logistics/supply chain fluidity. To that end, TC is interested in funding studies that examine up-and-coming questions that arise (e.g., an ongoing CAV study looking at equity challenges for different deployment strategies).

Additionally, TC has developed the Enhanced Road Safety Transfer Payment Program (ERSTPP), which funds projects that help create nationally consistent tools that address road safety challenges. It requires municipalities to work with provinces and territories and the payment could be used to fund projects around developing regulation and frameworks for micromobility.

3. Policies and Initiatives

Policies

Cybersecurity is a top priority for CoT, which has hired a Chief Information Security Officer to enable digitization, provide cyber support to Toronto residents for equitable outcomes, and to improve quality of life by becoming a global leader in urban cyber innovation. Threat and Risk assessments are becoming standard for new projects, as well as Privacy Impact assessments.

MTO's electrification priorities are embedded in MTO's regional transportation plans, including the draft Southwest Transportation and Northern Transportation Plan, which include future-ready actions and policies. The province has also committed to working across levels of government and with stakeholders to support EVs by evaluating infrastructure readiness. The province has committed to working across government and with key stakeholders to consider approaches that support low-carbon vehicles, including electric and hydrogen infrastructure.

For micromobility, MTO has set broad vehicle parameters and allows municipalities to pass their respective by-laws to allow vehicles to operate and define where operation is permissible. Municipalities will thereby be responsible for educating the public on safe operation and integrating micromobility into communities. This approach is undertaken because municipalities know best how to integrate these devices and dictating where they can operate (while prohibiting their operation where it is unsafe). MTO does, however, provide best practice documents to support municipalities in developing their pilots.

TC is ongoing in the development of tools and guidance concerning the cybersecurity of traffic data. This project takes place over a longer term and is currently in progress over two years. Draft regulation was published a few months ago by TC on noise requirements for HEVs, PHEVs, and BEVs to allow the visually impaired to know when an EV is driving by, developed in alignment with the international community. TC has also been doing pre-regulatory consultation on low-level automation, driver assistance technologies (e.g. lane-keeping assist, AEB) to see which features to prioritize for regulation.

Partnerships

Currently, CoT is starting to explore how to engage partners for transportation. Public, Private, and NGO sectors are changing to reflect more wholesale changes in the market. "Invitation to Partner" is one new type of procurement that is viable. CoT's automated shuttle trial had a "negotiated RFP" which adds a negotiation period to the end of the RFP period to provide additional flexibility during procurement. Difficulties exist when working with the private sector since data-sharing could be an issue, but partnerships with academia or centres of excellence (such as AVIN/OVIN) may have greater potential success.

York Region anticipates potential financial benefits through shared funding, which is particularly important when limited by tax levies and development charge funding constraints. By partnering with private companies, public agencies benefit from years of expertise, and innovative solutions. Additionally, through these partnerships, the Region can transfer risks to a third party when implementing new technology solutions to meet demand (e.g., Mobility On-Request app).

MTO launched AVIN in 2017 and it features a CAV demonstration zone, six development sites across southern Ontario, and three funding programs that facilitate partnerships between businesses, technology companies, industry, and academia. AVIN launched the Ontario Smart Mobility Readiness Forum in June 2020, which provides a platform for municipalities and transit agencies to build capacity and knowledge on emerging technologies. The forum most recently held an event focused on on-demand microtransit on July 8, 2021.

Equity and Accessibility

CoT is developing ways to address equity and is currently planning to apply an "equity lens" towards transportation projects. Some key questions being asked are:

- Where has investment been focused on historically?
- Do we need to focus on Neighbourhood Improvement Areas?

As part of the TMP update, York Region has commissioned a research paper on Transportation Equity to advance their understanding of the topic. This document will be shared through the TMP Partnership Advisory Group / TAC to the City later this year.

MTO is currently working to develop a framework for transportation access and inclusion that encompasses equity in terms of three main areas: representation; access, safety, and security; and distribution of benefits and costs. The aim is to achieve these by external- and internal-facing policies. Some examples of frameworks include gender-based analysis plus (GBA+) as applied by the federal government, Title VI and Environmental Justice Analysis as applied in the US, or distributional impact appraisal as applied in the UK.

For TC, a department within their strategic innovation team is looking at accessibility for remote (northern and otherwise) communities coast-to-coast. The group is part of forums with non-government partners for equitable/accessible transportation. TC also sits on a stakeholder group that discusses challenges in accessibility and equity, led by Carleton University. TC is currently working on a workshop for CAVs to better understand what challenges may arise and how they can be mitigated from the equity/accessibility perspective.

New Mobility Questionnaire

Introduction

HDR has been retained by the City of Vaughan (the City) to undertake the City-wide Transportation Master Plan Update, also known as the Vaughan Transportation Plan (VTP). As part of this plan, the City is examining potential impacts of New Mobility technologies and seeking to manage these through a transportation innovation program.

New Mobility refers to a service, mode, transportation infrastructure, or a combination of these that leverage new digital communication platforms and data to connect travelers to mobility options to move, share and use the transportation infrastructure. Examples of New Mobility technologies include connected and autonomous vehicles (CAVs), electrification, shared mobility and micro mobility. These technologies interact in infrastructure and through service concepts such as smart cities, Mobility-as-a-service (MaaS) and mobility hubs, and also impact existing industries such as goods movement.

The City of Vaughan is looking to collaborate with public sector partners to open up a broader conversation on challenges related to New Mobility and share lessons learned from past/ongoing initiatives.

To initialize this conversation, we have prepared a questionnaire which will be sent to GTA municipalities, regional authorities and provincial/federal agencies to fill in. Feel free to pass this questionnaire to your colleagues who may be best suited to answer these questions. The questionnaire is organized into: (1) New Mobility Technologies; (2) Planning for New Mobility; and (3) Policies and Initiatives.

Questionnaire

1. New Mobility Technologies

a. What types of New Mobility options (technologies or services) is your organization focusing on as priorities in the short term (1-3 years)? (select all that apply)

- ☐ Connected and Autonomous Vehicles
- ☐ Electrification – Transit
- ☐ Electrification – Freight
- ☐ Electrification – Personal Auto
- ☐ Shared Mobility – Auto / Ride Sharing
- ☐ Shared Mobility – Micro Mobility (i.e. e-scooter, bike sharing)
- ☐ Smart Cities – Connected Infrastructure
- ☐ Smart Cities – Transportation Information Management Systems (TIMS)
- ☐ Regional Mobility-as-a-Service (MaaS) Platform
- ☐ Other – please specify below:

Why are these the current focus?

b. What New Mobility options (technologies or services) is your organization focusing on as priorities in the long-term (> 5 years)? (select all that apply)

- ☐ Connected and Autonomous Vehicles
- ☐ Electrification – Transit
- ☐ Electrification – Freight
- ☐ Electrification – Personal Auto
- ☐ Shared Mobility – Auto / Ride Sharing
- ☐ Shared Mobility – Micro Mobility (i.e. e-scooter, bike sharing)
- ☐ Smart Cities – Connected Infrastructure
- ☐ Smart Cities – Transportation Information Management Systems (TIMS)
- ☐ Regional Mobility-as-a-Service (MaaS) Platform
- ☐ Other – please specify below:

2. Planning for New Mobility

a. What are the primary infrastructure or regulatory gaps to implementation in the short and long term?
b. What support or direction would you want upper tier government to provide when it comes to new mobility (i.e. additional guidance from Transport Canada)?
c. How is your organization planning for New Mobility? Do you have documentation on your planning efforts that could be shared (i.e. program management process, annual budget allocation, dedicated staffing, initiative costs)?

3. Policies and Initiatives

a. MTO has released their CAV readiness plan, which present policy objectives and program management for several focus areas. Are there similar plans for other aspects of new mobility, such as readiness for widespread micro mobility or mass electrification?
b. What would public-private partnerships in transportation innovation look like? Is your organization currently engaging private partners for this purpose?
c. How can policy help ensure that everyone has access to transportation in an equitable and accessible way and minimize barriers? Any examples?

Thank you!

Thank you for your time in sharing your input on New Mobility and lessons learned from your experiences. Your participation and opinions are greatly appreciated!

If you have any questions, please feel free to reach out to:

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