Subject: Zero Emission Bus Program Update Report

File Number: ACS2023-TSD-ES-0003

Report to Transit Commission on 10 October 2024

Submitted on October 1, 2024 by Renée Amilcar, General Manager, Transit Services Department

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Ward: Citywide

Objet : Bilan du Programme des autobus non polluants

Numéro de dossier : ACS2023-TSD-ES-0003

Rapport présenté au Commission du transport en commun

Rapport soumis le 10 octobre 2024

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REPORT RECOMMENDATION

That the Transit Commission receive this report for information.

RECOMMANDATION DU RAPPORT

Que la Commission du transport en commun prenne connaissance du present rapport.

EXECUTIVE SUMMARY

In June 2021, Council approved the purchase of zero-emission conventional buses for all future fleet needs, provided they meet operational requirements and subject to funding and financial agreements (ACS2021-TSD-TS-0009). As part of the pilot project, Transit Services committed to providing updates to Transit Commission based on key performance metrics.

The performance metrics in this report include Mean Distance Between Failure (MDBF), kilometers travelled, and a mileage comparison to the diesel buses.

An adoption agreement was signed with New Flyer Industries to supply 51 buses with a staggered delivery schedule; 6 buses scheduled in Q4 2024, 16 in Q1 2025, and the additional 29 buses in Q4 2025.

An adoption agreement was signed with NOVA Bus in April 2024 for 51 buses, also following a staggered delivery schedule. OC Transpo will receive four buses from NOVA in Q1 2025 with the remaining 47 expected to be delivered in Q4 2025 through to Q1 2026.

This report provides an update on a number of significant projects that are required to house, maintain, charge, and operate the zero-emission buses. These projects fall under civil and electrical engineering, and training. There is also a section for the critical information technology upgrades.

BACKGROUND

In January 2020, Council approved the Climate Change Master Plan. Council committed to reducing the City's corporate GHG emissions to 2012 levels by 2040. The OC Transpo diesel-powered conventional bus fleet was identified as a major contributor of the City's corporate GHG emissions (ACS2019-PIE-EDP-0053).

In June 2021, Council approved the purchase of zero-emission conventional buses for all future fleet needs, provided they meet operational requirements and subject to funding and financial agreements (ACS2021-TSD-TS-0009).

The Zero Emission Bus (ZEB) Pilot Project was initiated to support the transition to zero-emission buses. The pilot fleet consists of four New Flyer XE40 electric buses. The buses began to arrive in Ottawa on September 17, 2021, and were placed into revenue service February 7, 2022.

As part of the pilot project, Transit Services committed to providing updates to Transit Commission based on key performance metrics. The first update was provided on May 11, 2023, via the Pilot Performance and Evaluation report (ACS2023-TSD-TS-0006) and the second update provided in March 2024 (ACS2024-TSD-ES-0001).

Staff have continued to provide regular updates on the status of the vehicle procurement and infrastructure implementation.

DISCUSSION

Pilot Project Update Data

The Zero Emission Bus (ZEB) Pilot Project began in September 2021 with the arrival of four New Flyer XE40 electric buses, with a capacity of 525 kWh. The buses were put into service in February 2022 and, as outlined in the ZEB Pilot Performance and Evaluation report (ACS2023-TSD-TS-0006), met or surpassed the range and efficiency data provided by New Flyer. The initial evaluation report included performance metrics for Mean Distance Between Failure (MDBF), availability of electric buses and Charger Infrastructure, mileage, efficiency, diesel savings and GHG emission reductions, and maintenance and operations costs. The conclusion of the Pilot Performance and Evaluation was that the battery electric buses can successfully operate in revenue service in Ottawa, as an alternative to diesel buses.

Updated Key Performance Indicators (KPIs)

After two years in service, the electric buses are approaching 650,000 kilometres on the road. The electric buses have been performing successfully on revenue service blocks longer than 10 hours and driving distances exceeding 200 kilometres, on a regular basis.

Mean Distance Between Failure, or MDBF, is an industry standard metric used to evaluate the performance of conventional and electric buses. It is a measure of the number of failures which place a bus out of service compared to in-service mileage; a high MDBF indicates greater reliability.

OC Transpo calculates MDBF by including any incident that takes a bus out of service. These incidents are categorized and evaluated by our reliability team to determine if they are added to our MDBF calculation. If a bus is taken out of service and no fault was found, that still counts towards the MDBF of the bus because it disrupted service. The

current small fleet size of the E-Bus means there can be large MDBF fluctuations from any defects.

MDBF comparison between OC Transpo (all defects that take a bus off the road, such as damage to the bus, or a requirement for an enhanced interior clean) and Original Equipment Manufacturer (OEM) defects, as outlined in the chart below, can add to the point that fluctuations in MDBF are large with such a small fleet.

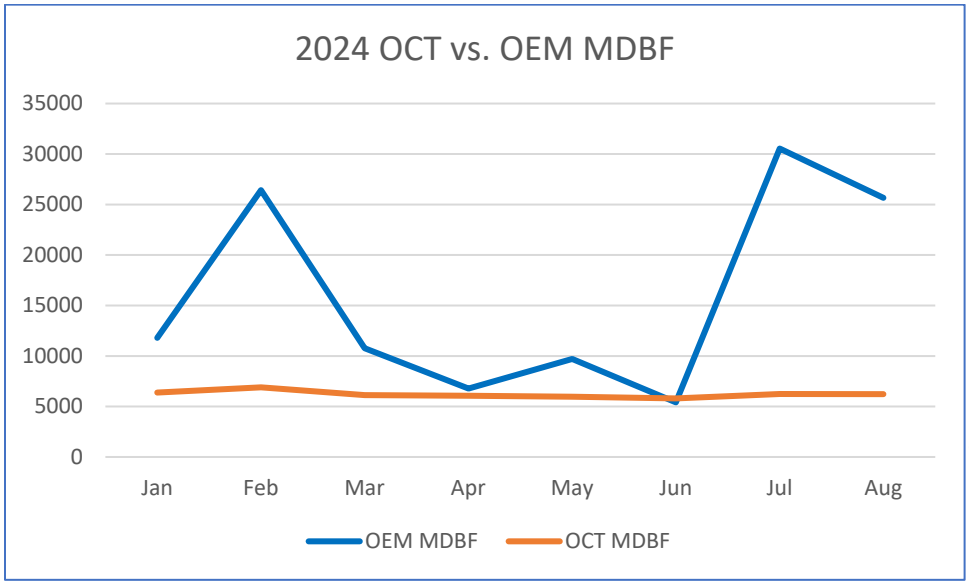

Table 1: OCT vs. OEM MDBF – 2024 YTD

The average monthly MDBF for the ZEBs in 2023 was 6,100 kilometres. The average MDBF for 2024 year-to-date is 6,214 kilometres, which is in line with our diesel fleet MDBF average of 6,169 kilometres.

Defect Item	Corrective Action
ABS Sensors, Radius Rods, Brake Chambers	Analysis of defects has identified that the replacement interval should be 2 years, adjusting replacement intervals in M5 maintenance software.
Operator Range Anxiety Continues	Three instances in 2024 where operators ended trips with more than 15 per cent State of Charge. Training and increased familiarity will reduce these failures. Range charts have

	been provided to the TOCC.
TPMS (Tire Pressure Monitoring System)	Report being finalized to increase accuracy (e.g. removing nuisance alarms, No Fault Found work orders).

The electric-bus target mileage has been set to 55,000 kilometres per bus per year. In 2023, the electric buses exceeded that target by running approximately 61,000 kilometres each. In 2024, the electric buses continue to exceed the monthly targets and are projected to exceed the 2024 annual target.

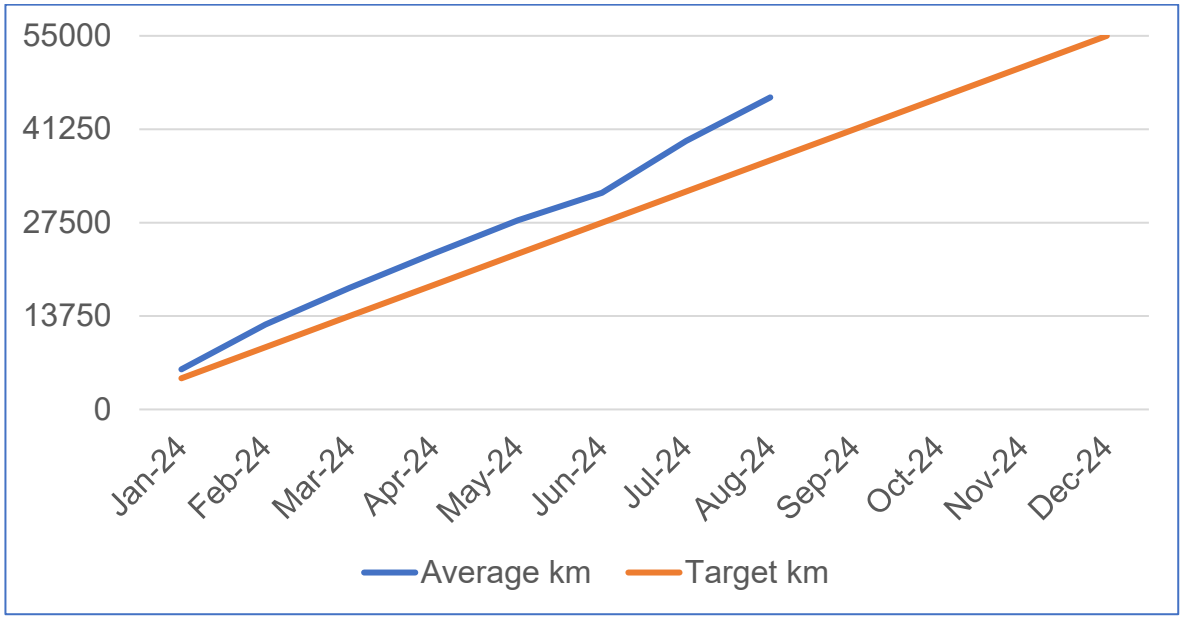

Table 2: E-Bus Target and Actual Kilometres (2024)

Additionally, Table 3 demonstrates that electric buses are comparable to the average mileage of the diesel fleets; indicating that the transition to an electric-bus fleet should not have an impact on service capacity.

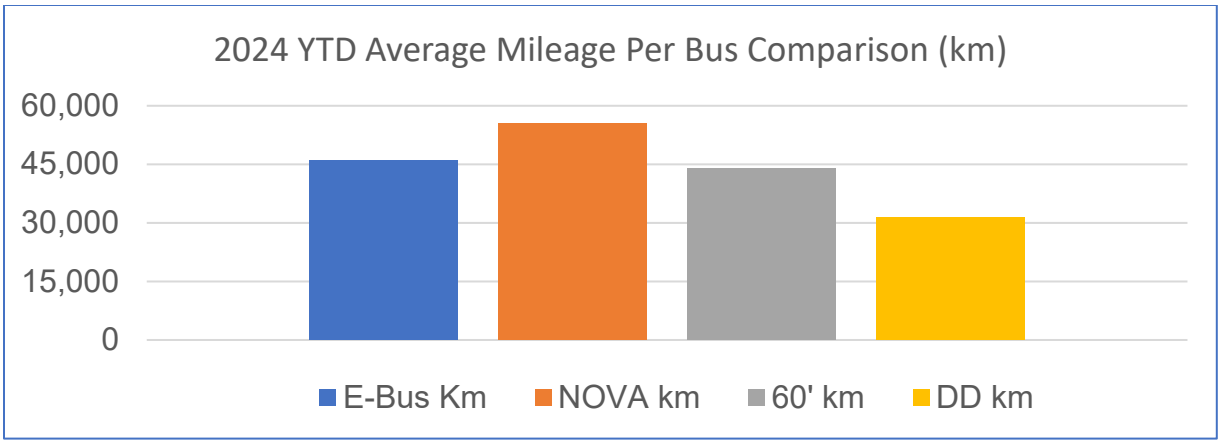

Table 3: Mileage comparison of electric buses to diesel buses to double-decker (DD) (km)

Electric Bus Procurement Status Update

The Auditor General's Sprint 2 Audit of Zero-Emission Buses (ACS2022 OAG BVG 0008) focused on the tendering process for 40-foot electric buses. Transit Services management agreed with the recommendations within the audit and outlined a plan to address some of the recommendations through a collaborative procurement process with Toronto Transit Commission (TTC). By joining other transit agencies in the procurement of Zero Emission Buses, OC Transpo has been able to standardize vehicle specifications and provide operations and maintenance benefits.

TTC contracts were shared with OC Transpo in 2023. TSD reviewed the proposals and worked with the bus manufacturers on commercial and technical amendments to align to OC Transpo's specific requirements.

In December 2023, an adoption agreement was signed with New Flyer Industries to supply 51 buses to the City. These buses were procured with a staggered delivery schedule, with 22 buses scheduled in Q4 2024 and the additional 29 buses in Q4 2025.

An adoption agreement was signed with NOVA Bus in April 2024 for 51 buses, also following a staggered delivery schedule. OC Transpo will receive four buses from NOVA in Q1 2025 with the remaining 47 expected to be delivered in Q4 2025 through to Q1 2026.

New Flyer's lead bus, or first bus of the order, is currently in production and is expected to be delivered in October 2024, with a NOVA lead bus expected for January 2025. New Flyer has informed the City of a 1 – 2-month production delay impacting 16 of the 22

buses originally scheduled for Q4 2024, that should now arrive in Q1 2025.

New buses undergo third-party quality inspections at the OEM production facilities before being accepted into OC Transpo's bus fleet. Additionally, when vehicle production is completed, buses will be delivered to a local vendor site to undergo a Post Delivery Inspection (PDI). Any defects identified by the inspection are repaired by the vendor. Once the inspection is successfully completed, the buses are then finally delivered to OC Transpo for final on-board system commissioning. The expected time to complete all inspection activities is typically 3-4 weeks per bus; 8 weeks will be required for the first NOVA electric bus complement as they will be new to the bus fleet and will require additional testing and training.

Zero Emission Bus Program – Procurement Change Update

In June 2021, Council approved the purchase of zero-emission conventional buses for all future fleet needs, provided they meet operational requirements and subject to funding and financial agreements. Section 5.1 of the staff report (ACS2021-TSD-TS-0009) identified the market limitations of high-capacity electric buses with only two manufacturers at the time offering this bus configuration, as well as a lack of real-world testing to evaluate their reliability. This section also outlined that in the event of no notable improvement in the market adoption, or in battery ranges of high-capacity electric buses, transitioning to only 40-foot electric buses or continuing to purchase diesel buses may be required in Phase 1 of the ZEB Program.

In Q4 2024, the market for high-capacity electric buses still remains largely unchanged and has further shifted focus to 40-foot alternatives. In addition, there has not been significant improvement to full-charge battery range of high-capacity electric buses since 2021, and only one model is currently available in the Canadian market.

Due to the current market limitations of high-capacity electric buses, the ZEB Executive Steering Committee has directed Phase 1 of the ZEB program to shift from a mix of 196 40-foot Electric buses and 154 60-foot articulated electric buses, to procure exclusively 40-foot buses. The Executive Steering Committee also took into consideration the positive results of the 40-foot electric bus pilot, proving their abilities to meet all of the City's operational and service delivery requirements.

The overall impact of this procurement direction has been mitigated with the update to the Transit Services Fleet Plan, by the shift of the high-capacity service ratio of the bus

fleet from 40 per cent to 15 per cent, which aligns with OC Transpo's post-pandemic ridership and O-Train Stage 2 Extension projects.

In 2025, staff will start planning future phases of the ZEB Program. A review of available technologies, facility requirements, and energy options will be completed to determine the suitable zero-emission bus technology and future locations for Phase 2 of the Zero Emission Bus Program beyond 2027. Additionally, staff are exploring a future high-capacity ZEB Program of two 60-foot electric buses and two hydrogen buses. Staff will provide future updates on this potential pilot to the Transit Commission.

Table 4 is a visual representation of the ZEB program's updated delivery schedule.

	2024			2025											2026												2027											
	Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
40' ZEB	***26 Buses***																																						
												80 Buses																												
																		124 Buses																						
																												120 Buses											

Table 4: Updated E-Bus Delivery Schedule

ZEB Program Infrastructure Update

Civil Infrastructure

Civil infrastructure work continues to prepare the facilities for the installation of electrical infrastructure and complete necessary building lifecycle updates. This work includes the following updates:

- Roof structural reinforcements were required for the electrical dispenser installation (pantographs).
- Cleaning of the underside of the roof structure to remove staining from previous diesel bus storage (South Garage).
- Concrete repairs to floor slabs and sidewalks.
- Replacement of the existing sprinkler system with an upgraded system.
- Replacement of existing floor-trench drains (South Garage), catch-basins, and below-grade sanitary piping that are at end of life.
- Replacement of existing lighting with LED lighting.
- Emergency walkway and egress improvements.
- Replacement or repair of roof rainwater leaders in South Garage.

- Installation of high-speed, fabric roll-up doors.
- Replacement and realignment of existing line painting for bus lanes and walkways.
- Cleaning and painting of all existing walls, and all existing and new piping.

Phase 1 of the St. Laurent South Garage civil infrastructure project was substantially completed in July 2024. Phase 2 is currently in the design stage and is scheduled for completion in Q3 2025. The electrical infrastructure projects are being implemented in phases as the civil infrastructure projects are completed. The South Garage electrical infrastructure projects are scheduled for completion in Q1 2026. Once both the civil infrastructure and electrical infrastructure projects are completed, the south garage will have the capacity to park and charge 142 electric buses.

The North Garage civil infrastructure project is under design and is scheduled for construction completion in Q2 2026. The North Garage electrical infrastructure projects are scheduled for completion in Q4 2026. Once both the civil infrastructure and electrical infrastructure projects are completed, the North Garage will have the capacity to park and charge 104 electric buses.

A new parking structure, covering the existing exterior bus parking lot at 1500 St. Laurent, is scheduled for completion in Q3 2027. Currently in the design stage, this new garage will have the capacity to park and charge 80 electric buses when completed.

Finally, there is a required high-voltage maintenance bay construction project that will increase capacity for electric bus maintenance. This project is scheduled for completion in Q2 2025.

Electrical Infrastructure

The Auditor General's Sprint 4 Audit of Zero-Emission Buses (ACS2023-OAG-BVG-0006) focused on the electrical infrastructure design-build contract between the City and Envari. The City entered into a design-build agreement with Envari in June 2023 to establish the electrical infrastructure required to support the ZEB Program. Since signing the agreement, the following work has been completed:

- The pilot charging infrastructure has been relocated to maintain the operation of the pilot electric buses and Transit Services are currently preparing the south garage for the installation of the electrical infrastructure.

- The procurement of dispensers and chargers for the first 30 buses.

Transit Services, in collaboration with Envari, are also in the phase of preparing, installing, and commissioning 30 dispensers and eight chargers, with a target completion of Q4 2024. To increase capacity past 30 dispensers, the facility requires the construction of a new offsite and onsite electrical substation and related onsite distribution infrastructure to support the additional power required for the remainder of the facility fit-up for chargers. Design of the offsite substation began in Q2 2024, and construction is expected to be completed in Q4 2027. Design of the onsite substation is underway and is expected to be completed in Q1 2025. Construction of the onsite substation is scheduled to be completed in Q4 2025. The procurement for the long lead items listed below have been completed for the onsite substation:

- Generators – Two 4MW generators have been procured to provide backup power to support the charging infrastructure. They are expected to arrive onsite in Q4 2024 and installed in 2025 when civil works have been completed.
- Transformers – Two 44kV/13.8kV transformers have been procured to support the charging strategy proposed for the St. Laurent site. These two units are planned to arrive onsite in Q3 or Q4 2025.
- Switchgears – Two 13.8kV switchgears with eHouses, protection, and control devices have also been procured and expected to arrive in Q2 2025.

As part of the integration with the charging infrastructure, an Energy Management System (EMS) will be procured to control and optimize the charging of electric buses. This system will balance the energy requirements for charging while reducing the electrical peak demand and associated cost of electricity. Transit Services has identified the EMS requisite specifications and are assessing installation with the first phase of chargers and dispensers in Q4 2024.

As part of the program, the electrical infrastructure at 1500 St. Laurent must be upgraded in order to provide adequate power for the bus charging infrastructure. The current electrical service at the site has adequate capacity to charge a total of approximately 30 electric buses. The City, through Envari, reached an Offer to Connect agreement with Hydro Ottawa in March 2024 to upgrade the electrical service at the site to provide the necessary additional capacity to charge the future electric bus fleet at 1500 St. Laurent. The electrical service upgrade to the site includes the following:

- Interim 44kV Service Supply (October 2025)

- Permanent 44kV Service Supply (Q4 2027)
- Offsite Transformer Station 230/44 kV (Q4 2027)

In parallel with the design and installation of the substation, dispensers and chargers will be designed and procured for the remaining locations at St. Laurent to achieve a total of 326 dispensers located across all three garages (North Garage, South Garage, and the new garage).

Zero Emission Bus - Staff Training Requirements

The training program for employees on E-Bus requirements, specific to their job position, is underway and is building upon the foundation of the original E-Bus Pilot Program. There is now a standard prerequisite introductory course provided to all staff who may interact with the bus as part of their work. Approximately 100 Transit Fleet and Facilities Maintenance (TFFM) employees and approximately half of the OC Transpo Bus Operators have received this training.

The Training and Development team has also begun providing this training to the remaining TFFM employees as well as select TFFM employees for the second-tier prerequisite course which provides more in-depth working knowledge of the electric buses. This training is designed specifically for supervisors, garage attendants, mechanics, and body technicians servicing the buses.

All Transit Services staff working with electric buses will receive varying levels of Lock Out, Tag Out (LOTO) training corresponding with their job duties. Training ranges from basic knowledge of LOTO procedures to more advanced verification of zero voltage and working with e-bus batters for certified technicians. Supervisory staff will also be trained on theoretical portions of the curriculums to provide proper oversight of policies and procedures.

Training requirements range from Bus Operators, who will require four hours of additional bus training, through to Maintenance staff who require 240 hours of specialized training. Training schedules for staff are designed in cohorts so that the current daily service requirements for both buses and staff are still met and so that the training is completed in advance of the delivery of new zero-emission buses to ensure all staff are prepared for the transition to an electric-powered bus fleet. In addition, the manufacturers of procured zero-emission buses will provide onsite onboarding support for a period of two years to enhance the transition period.

Information Technology Upgrade Requirements

As Transit Services prepares for the delivery and integration of 350 more Zero Emission Buses into the conventional bus fleet, staff have committed to a variety of software upgrades to address identified limitations and deficiencies of the existing bus maintenance software:

1. **Hastus Booking Software:** The Hastus software is used to manage the work assignments of bus and train operators to their respective vehicles. The current version of this software was introduced to Transit Services prior to the delivery of the first electric buses and is currently unable to build a work schedule given the E-bus range and required charge times required to meet service. As such, any bookable work for bus operators driving an E-Bus must be inputted manually by staff, which will be rectified in the upcoming software upgrade.
2. **Yard Management Software:** Transit Services yard management software has been in place since the early 2000's and is used to assign blocks of work to the bus fleet, including fueling needs and parking locations. This software will be replaced, expanding functionality to electric buses and their unique characteristics compared to traditional buses.
3. **CleverCAD Bus Data:** CleverCAD is used by the Transit Operations Control Centre (TOCC) to monitor and manage daily transit service delivery, through cancelling and filling trips, diverting buses when needed, and communicating with bus operators to provide support. This software update will provide additional E-bus data to the TOCC and improve their decision making.
4. **Energy Management System:** This is a new software to Transit Services and will integrate information from the ZEB charging infrastructure to the yard management and bus maintenance internal software systems.

Throughout these upgrade processes, Transit Services, in conjunction with the City's Corporate IT structure, actively facilitates security reviews of each technology required for the ZEB Program and ensures software risks or vulnerabilities are mitigated or addressed.

FINANCIAL IMPLICATIONS

Funding for the planning and feasibility assessment of Phase 2 of the Zero Emission Bus Program will be submitted as part of the 2025 budget process for Council consideration and approval.

LEGAL IMPLICATIONS

There are no legal impediments to receiving this report for information.

CONSULTATION

Transit Services Department has provided several updates to Transit Commission and Council. Additionally, the funding for the ZEB Program has been approved through the budget process.

ACCESSIBILITY IMPACTS

OC Transpo is committed to meeting their legislated obligations under the *Accessibility for Ontarians with Disabilities Act,* (2005), the Integrated Accessibility Standards Regulation, 191/11, as well as the Accessible Canada Act (ACA, 2019). Accessibility has been integral to the procurement process for zero-emission vehicles. Staff have considered the concerns expressed by the City's Accessibility Advisory Committee and other accessibility stakeholders about the low levels of noise produced by electric vehicles and the increased risk this poses to pedestrians, particularly those who are blind or partially sighted. Staff mitigated this risk by outfitting the City's first four pilot battery-electric buses with an Acoustic Vehicle Alerting System (AVAS).

In 2022, staff also engaged stakeholders in two orientation sessions to familiarize them with the AVAS. These sessions involved testing the AVAS on-street in different locations and under different scenarios, as well as identifying the other accessibility features on board the vehicle. The feedback received was positive. As a result, all future zero-emission buses will be equipped with the equivalent AVAS technology, and the same on-board accessibility features.

OC Transpo continues to monitor new developments in legislation, regulations and emerging AVAS technology, and to monitor and respond to feedback from accessibility stakeholders and customers with disabilities.

CLIMATE IMPLICATIONS

The ZEB Program is part of the City's Climate Change Master Plan. The continuous transition of the bus fleet to ZEBs continues to improve TSD's GHG emissions.

RISK MANAGEMENT IMPLICATIONS

The ZEB Pilot Program has undergone an audit by the City's Auditor General. TSD has responded to all the Auditor General's recommendations and provided Transit

Commission with regular updates. Council has approved the budget for the first procurement of zero emission buses.

RURAL IMPLICATIONS

Rural implications have been taken into consideration in the development of the ZEB Program. The City's transportation network, including light rail transit, is designed to provide options for all residents.

TERM OF COUNCIL PRIORITIES

The 2023-2026 Term of Council Priorities include:

- A city that is more connected with reliable, safe, and accessible mobility options.
- A city that is green and resilient.

DISPOSITION

Staff will continue to monitor and provide updates to Transit Commission on the performance and procurement status of the ZEBs.