

TAC Environmental Achievement Award – Clean Roads to Clean Air Program

Protection and Enhancement of the Environment

Toronto's Transportation Services Division (TSD) is always looking for better methods to clean its streets and improve the environment.

In 2004, Toronto Public Health reported that air pollution contributed to 1,700 premature deaths, 6,000 hospitalizations each year and a cause of respiratory and cardiovascular problems, in Toronto. Ten years later, air pollution still has a serious impact on the health of Toronto's residents, despite improvements in air quality. Air pollution, in the 2014 [Path to Healthier Air: Toronto Air Pollution Burden of Illness Update](#) report, is estimated to give rise to 1,300 premature deaths and 3,550 hospitalizations each year in the City.

TSD developed and implemented the [Clean Roads to Clean Air Program](#) (CRCA) in 2005. The program helped to develop procedures and standards to evaluate the operational and environmental (PM₁₀ and PM_{2.5} efficiency) performance levels of various street sweeper technologies, and created a framework for continual assessment and improvement of sweeping practices. A significant outcome of the program was the development of two sweeper testing protocols: "Operational On-Street"; "PM₁₀ and PM_{2.5} Street Sweeper Efficiency"; and their respective performance criteria. These two testing protocols were adopted by the Environment Canada and Climate Change's (ECCC) Environmental Technology Verification Program (ETV) (<http://etvcanada.ca/>), which provides third party verification services.

In the development of the CRCA program a number of air quality monitoring and stormwater quality studies and tests were undertaken to understand the at-nose level ambient air quality; the impact of street sweeping on particulate matter and silt loading found on roads in terms of quantity and quality; and the entrainment of dust during sweeping and passing vehicles. The "[PM₁₀ and PM_{2.5} Street Sweeper Efficiency](#)" and "[Operational On-Street](#)" Test Protocols were developed to evaluate various street sweeping technologies with respect to:

- the removal of silt loading under various sweeping conditions typically encountered in Toronto;
- removal of fine particulate matter (PM₁₀ and PM_{2.5} – both considered toxic substances under the Canadian Environmental Protection Act) from roads;
- the concentration levels of fine particulate matter entrained into the air while sweeping; and
- a sweeper's ability to operate year-round effectively, including during winter periods.

As part of the CRCA program, the initial testing undertaken in a controlled environment, the result showed that best-in-class street sweepers reduced airborne fine particulate matter, at street level, by at least 21%.

The CRCA program defined a process that made it possible to obtain objective, quantitative results of environmental performance and provided the justification to

purchase environmentally efficient sweepers. By acquiring the best-in-class street sweeper, it has allowed the City of Toronto to remove significant quantities of road dust (an estimated additional 450 tonnes of PM₁₀ and PM_{2.5} annually irrespective of sweeping frequency) and reduce the amount of airborne fine particulate matter from its roads, year-round. Through the evaluation of a street sweeper's environmental performance, Toronto has been able to:

- reduce airborne Particulate Matter which contributes to GHG emissions;
- improve local air quality, which has benefited the general health of City residents, workers and visitors, by reducing acute and chronic exposure of fine particulates;
- remove toxic loads from City streets and ensured that particulate matter, that is typically washed down into catch basins to the storm sewer system, is significantly reduced; resulting in improved stormwater quality and a reduction in the cost of stormwater treatment; and
- permit sweeping during Smog Days and sweeping year-around.

Also, by having environmentally efficiency sweepers allows one to better protect green infrastructure built within the right-of-way. This is achieved by minimizing the displacement of road dust to adjacent boulevard areas where you might have permeable and porous surfaces needing to be kept clean to ensure they continue to be permeable. Natural waterways and surrounding fauna are also protected by removing the fine road dust (that often contains toxic substances) and silt loading from the surface of the road and not allowing it to enter the catch basins.

More recently in 2014, a [Street Sweeper Ambient Air Quality Monitoring Study](#) (Study) was undertaken in a real world environment to assess the environmental effectiveness of best-in-class sweepers in improving the ambient air quality on City streets. The results of the Study can be used as a basis for modifying service levels (frequency of sweeping), setting equipment and staff requirements and identifying operating and capital budget impacts. The Study measured the environmental performance of both a mechanical and regenerative-air street sweeper to obtain the following results:

- Ambient air quality concentrations levels of PM₁₀ and PM_{2.5}, measured at nose-level, pre and post street sweeping;
- Dust concentration levels during sweeping operation; and
- Silt loading removal from the paved road surface pre and post sweeping.

The Study results showed that best-in-class street sweepers can reduce airborne fine particulate matter, at street level, by at least 27%. This real world Study also validates and justifies that:

- Toronto's Test Protocols *should continue to be used* as the basis for evaluating the performance of street sweepers;
- *third party validation of street sweeper PM and operational performance under the Canadian ETV Program be continued; and*
- *best-in-class street sweeper procurement continue to be done through a RFP process.*

Please refer to the Appendix for additional information on the performance levels between mechanical and regenerative-air street sweepers and how various sweeping technology can impact the ambient air in a real world environment. The information also provides

evidence that inefficient sweepers can make the air at nose-level worse during and after sweeping by entraining fugitive road dust into the air. This dust will continue to be entrained with every passing vehicle and spread to the adjacent right-of-way and properties.

In addition, TSD submitted a report titled, [Street Sweeper Evaluation Results and Operational Considerations](#) in December 2015 and received City Council approval to proceed with a mixed fleet of sweepers to ensure sweeping can be done effectively under various operational conditions; especially in handling debris removal during spring clean-up, leaf collection, post storm event clean-up and expressway cleaning. Securing a mixed fleet of best-in-class sweeper technology, which could include regenerative-air, mechanical and other types of technology would ensure that both environmental and operational requirements are met.

The evaluation process provided has provided a framework for continuous development of new operational practices and procedures, ensuring that the City's street sweeping service would be delivered in a safe, environmentally sustainable, and in an efficient and effective manner.

Degree of Innovation

The CRCA program is comprised of a number of innovative approaches to mitigate the environmental impacts of fugitive road dust. For a complete summary of the air and stormwater quality studies, ambient air monitoring test, the environmental and operational requirements, health concerns and testing protocols please view the [Clean Roads to Clean Air presentation](#).

In order to continue the process established under the CRCA Program, which is based on continuous improvement in environmental performance, a triple bottom line approach and a leading edge procurement process tied to third party verification of environmental performance was established. This innovative procurement process was developed and utilized to purchase best-in-class street sweepers based on the PM₁₀ and PM_{2.5} efficiency and operational performance. Typically, heavy equipment is procured using a Request for Quote process, the proponent meets minimum specifications and an award is made to the lowest bid.

The City's procurement of the best-in-class sweeper used a Request for Proposal process, which used a base minimum specification and scored sweeper performance based on PM₁₀ and PM_{2.5} efficiency and operational criteria. In addition, maintenance and overall cost were also objectively evaluated to determine the most cost effective sweeper.

In addition, to the leading-edge Toronto Test Protocols, the Canadian ETV Program under the license agreement with Environment Canada adopted Toronto's Test Protocols and provided third-party Verification Certificates of environmental and operational performance for various sweeper technologies. The sweeper industry responded positively and embraced Toronto's Test Protocols and used their results to further improve the performance of their equipment by making further design modifications of their

sweepers in order to improve environmental performance. Many industry members see it as a best practice for the street sweeping equipment.

GLOBE Performance Solutions (GPS) is the independent verification organization which manages and delivers Canadian ETV program under a license agreement with ECCC. GPS offers a reliable assessment process for verifying the environmental performance claims associated with projects and programs, as well as technologies and technological processes. While the Prairie Agricultural Machinery Institute (PAMI) is an independent testing agency with experience and credentials in street sweeping testing. Canadian ETV relies on science, high-quality data, and recognized protocols to offer an independent assessment and verification of environmental performance claims. As a result, potential buyers and other parties can make informed decisions about purchasing and using environmental technologies.

For additional information on the:

- [ETV Certificate of PM Performance based on City of Toronto Protocols-Elgin Eagle Series FW Waterless Street Sweeper truck-mounted mechanical street sweeper;](#)
- [ETV Certificate of PM Performance based on City of Toronto Protocols-Elgin Crosswind NX truck-mounted regenerative-air street sweeper;](#)
- [ETV Certificate of PM Performance based on City of Toronto Protocols-Tymco DST-6 dustless regenerative-air street sweeper;](#) and
- [ETV Certificate of PM Performance based on City of Toronto Protocols-Tymco DST-4 dustless regenerative-air street sweeper;](#)

Lastly, TSD partnered and collaborated with a number of internal stakeholders, such as: Fleet Services, Toronto Public Health, Legal Services, Toronto Water, Purchasing and Material Management and external stakeholders, such as: University of Toronto, City of Hamilton, ECCC, Ministry of Transportation, GPS and PAMI. This engagement and consultation validated the objectives and built consensus to pursue the triple bottom line approach and incorporate environmental performance in the procurement of street sweepers. In recognition of this innovative and comprehensive approach the Clean Roads to Clean Air Program was recognized for its approach and received a StreetsTo Partnership Award.

Financial Implications

US Department of Transportation, recommendations for Benefit-Costs Analysis states that a social cost of environmental emissions (PM_{2.5}) is \$483,860/tonne. The implementation of efficient operational and environmental street sweepers has resulted in an additional removal of 9,000 tonnes of silt loading annually from the City's roads. Taking an accepted range of 3% to 5% of fine particulate matter in silt loading, the social cost savings would be in the range of \$130 to \$217 million annually.

In 2013 and 2014 the City of Toronto removed an average of 15,791 tonnes of silt loading from its streets at an average operating and maintenance cost of \$9.5 million. The deployment of efficient best-in-class street sweepers resulted in the effective removal of silt loading at a cost of \$603 per tonnes, see Tables 4, 7a, 7b and 8.

By deploying the most environmentally efficient street sweepers, and using a sweeping frequency that is most effective, has gone a long way toward improving air and storm water quality and overall human health in the community. This has ensured that road cleaning is being delivered in a cost effective manner.

Overall Applicability to Transportation

Including ECCC's ETV Certificates of environmental and operational performance and third-party verification in the procurement of sweepers, would allow jurisdictions to operate best-in-class street sweepers that have the highest operational, PM removal and entrainment efficiency. This would contribute to cleaner roads, improved air quality and establish a best practice for the industry. Another benefit is that– the best-in-class sweepers will substantially reduce the amount of fine road dust and silt loading being washed down catch-basins into the sewer system. This will result in improved storm water quality and reduced water treatment cost at treatment plants. Improving the ambient air quality has positive impact on human health and quality of life for City of Toronto residents and visitors. It supports sustainable transportation by creating an environmentally friendly environment for pedestrian and cyclists.

In addition, the CRCA Program meets the City of Toronto's Climate Change, Clean Air and Sustainable Energy Action Plan for both mitigation and adaptation criteria. It addresses mitigation by reducing the amount of particulate matter that is entrained in the air which contributes to the formation of Smog. It is adaptive in that it prevents particulate matter and other debris from being flushed down the catchbasins and/or accumulating in natural water systems. The debris and silt loading accumulation pose a risk and will likely cause flooding during extreme rain events. An efficient and effective street sweeping program decreases vulnerability and builds resiliency against flooding and facilitates the objectives of green infrastructure.

The International Organization for Standardization (ISO), led by ECCC has created a new standard to address environmental performance. ISO 14034 Environmental management --Environmental Technology Verification (ETV) will outline a process for verifying environmental technologies. This means that by following the standard, an independent party can effectively assess test results so that the results can be considered reliable, here in Canada, and abroad.

Here is a [video clip](#) that illustrates the value of the new ISO using the City of Toronto developed PM and Operational Test Protocols.