



## STAFF REPORT INFORMATION ONLY

### Subway Air Quality

|              |                         |
|--------------|-------------------------|
| <b>Date:</b> | September 5, 2017       |
| <b>To:</b>   | TTC Board               |
| <b>From:</b> | Chief Executive Officer |

### Summary

---

On April 25, a Health Canada study entitled “The Urban Transportation Exposure Study (UTES)” was published in a peer-reviewed scientific journal. The UTES compared particulate matter (PM) exposures between major subway systems in Canada. The UTES purpose was to gather information about PM levels and did not draw conclusions about the impact of the PM levels on health. The UTES confirmed previous internal assessments that found that the PM is primarily iron from steel wheels and rails, and that PM concentrations are higher in an enclosed subway station than outside. On Tuesday, April 25, 2017, several media outlets published articles comparing TTC subway air quality to the air pollution in Beijing. The newspaper articles have caused harm to the TTC’s reputation and unnecessary alarm for some TTC employees.

The TTC Board requested a report that will address ways and means to study the potential impacts of air quality issues in the subway system and for information on whether any other major subway systems have undertaken similar work. This report presents the proposed study approach.

The TTC will be updating the subway air quality study to provide current information on the air quality in the underground portions of the subway and will determine employee exposures to airborne contaminants. See Attachment A for Terms of Reference. Toronto Public Health (TPH) will be invited to review the study methodology and will be provided with the final report.

TPH will undertake a health assessment focused on subway commuter exposure to air pollutants using well established assessment approaches that are commonly used in the environmental health field: Human Health Risk Assessment and Rapid Health Impact Assessment. These assessments will provide new, local information about the public health risk arising from particulate matter in the subway. As well, these risks will be considered in the context of the broader potential health impacts (both positive and negative) from commuting on the TTC subway system.

## Financial Summary

The cost of Subway Air Quality study is approximately \$400,000 and the cost of the health assessment by Toronto Public Health is \$100,000 for a total cost of \$500,000. Approximately half of this cost will be incurred in 2017 and will be accommodated within the 2017 Operating budget through under-expenditures in other areas. The funds for the remaining portion to be completed in 2018 will be incorporated into the 2018 Operating budget request.

The Chief Financial & Administration Officer has reviewed this report and agrees with the financial impact information.

## Decision History

At its May 18, 2017 Board meeting, Councillor Joe Mihevc put forth a Notice of Motion recommending that:

“TTC evaluate occupational exposures to fine particles and develop appropriate strategies to mitigate potential health impacts in consultation with responsible occupational health authorities; and further, that TTC provide support and resources to the Medical Officer of Health to oversee an independent study of the potential health impacts for passengers of air quality issues in the subway system, particularly in relation to mitigation measures that could be implemented.”

[http://www.ttc.ca/About\\_the\\_TTC/Commission\\_reports\\_and\\_information/Commission\\_meetings/2017/May\\_18/Reports/19\\_Notice\\_of\\_Motion\\_Air\\_Quality.pdf](http://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2017/May_18/Reports/19_Notice_of_Motion_Air_Quality.pdf)

At its May 18, 2017 meeting, the Board referred the above Notice of Motion for a report that will address ways and means to study the potential impacts of air quality issues in the subway system and for information on whether any other major subway systems have undertaken similar work.

## Issue Background

There is a substantial body of evidence that links ambient (outdoor) particulate matter exposure to a range of adverse health outcomes such as increased risk of cardiovascular and respiratory diseases, cancer and premature death. In addition, sensitive populations including children, older adults and those with pre-existing conditions are especially susceptible to the impacts of PM exposure.

Particulate matter refers to small particles in the air. PM has a wide range of sizes. PM<sub>2.5</sub> refers to particles with a diameter of 2.5 micrometres or less.

However, there is limited information about the potential health impacts of PM found in subway systems. Due to the numerous PM sources and structural differences among subway systems, generalizing the findings from one location to another is difficult.

Assessing the potential health impacts resulting from exposure to subway PM is challenging due to the preliminary nature of the studies conducted to date and lack of long-term exposure studies.

The purpose of the UTES was to better understand commuter exposure to air pollutants in metro systems across three Canadian cities. The UTES found that PM<sub>2.5</sub> exposures were higher in Toronto (95 µg/m<sup>3</sup>) than in Montreal (35 µg/m<sup>3</sup>) and Vancouver (19 µg/m<sup>3</sup>) which was based primarily on the different operating systems.

#### *TTC Subway Air Quality Study*

The TTC has conducted comprehensive subway air quality studies in 1977, 1980, and 1995. These were performed to provide information on the air quality in the underground portions of the subway and determined both employee and customer exposures to airborne contaminants. The 1995 study found that none of the 280 samples taken were above the occupational exposure limits for employees. It was determined that the subway air quality would not affect the health of employees or customers who do not have pre-existing serious respiratory conditions.

A comprehensive subway air quality study has not been completed in 22 years. In those past studies, PM<sub>2.5</sub> was never measured because it was not a contaminant of concern at that time. Respirable dust, which includes PM<sub>2.5</sub>, was measured because it has an occupational exposure limit.

#### *Other Subway Systems*

Numerous studies have examined the concentrations of PM on subway systems around the world. On systems with steel rails and wheels, elevated concentrations of PM<sub>2.5</sub> with high proportion of metals such as iron, manganese, chromium and other transition metals have consistently been found worldwide. Within the context of an individual's day, riding the subway may be a significant source of metals exposure.

Only a few studies have examined the potential health impacts resulting from exposure to PM from subway systems in humans. While these studies have examined healthy, asthmatic and worker populations, the small number of participants and exposure scenarios make generalizing the findings from one location to another challenging due to the numerous sources and structural differences between subway systems.

A 2004/2005 study conducted in New York compared PM exposures of subway workers, bus drivers and suburban office workers. Subway workers included station cleaners, overhaul shop workers, construction flaggers, track maintenance workers, track construction workers, refuse train workers, and operators and conductors. No significant differences were found between subway workers, bus drivers or office workers in terms of biological response. However, the small number of people and diversity in subway worker roles may have limited the conclusions that could be drawn from the subway worker group.

Another study in Korea studied the effectiveness of ventilation systems providing outdoor air to subway platforms for improving passenger health in subways. The study did conclude that these types of systems did enhance the indoor air quality level and minimized the health risk in subway platforms.

In a recent news article published in the Evening Standard, the London Underground will begin to use industrial vacuum cleaners and magnetic wands to remove dust from over 50 stations and five tunnels. This is part of a new underground air quality program that will ensure dust is kept to an absolute minimum.

The Information Report - Subway Air Quality has been prepared in consultation with the Medical Officer of Health and approved by the Safety, Security and Environment Executive Committee of the TTC.

## **Accessibility/Equity Matters**

The results of this work will enable a fact based evaluation of the need for any future measures to be taken to address the needs of sensitive populations.

## **Comments**

Health Canada and the Ministry of Labour have the responsibility to establish safe exposure limits for the public and employees, respectively. The TTC is responsible for complying with all applicable regulations. It is not the TTC's role to research or set workplace exposure limits.

The updated Subway Air Quality Study will characterize employee exposures to airborne contaminants and verify compliance with Ontario Regulation 833 – Control of Exposure to Biological or Chemical Agents, made under the Occupational Health and Safety Act. This regulation sets occupational exposure limits for airborne chemical agents.

PM2.5 dust samples will be collected for future reference to occupational standards when and if they are developed. Total and respirable (less than 10 microns) dust samples will be collected and compared to existing occupational exposure limits.

The study will identify and prioritize potential areas of risk and opportunities for managing these risks.

An occupational exposure limit is an upper limit on the acceptable concentration of a hazardous substance in workplace air for a particular material or class of materials. It is typically set by competent national authorities and enforced by legislation to protect occupational safety and health. It is an important tool in risk assessment and in the management of activities involving handling of dangerous substances.

The Ministry of Labour sets out occupational exposure limits in Ontario Regulation 833 (Control of Exposure to Biological or Chemical Agents) and other related Regulations.

Public exposures are distinct from employee exposures as they have to take into account vulnerable populations including those in various states of health (e.g., with respiratory illnesses such as COPD), infants, young children and the elderly.

Health Canada has indicated that in regards to public health, there are no directly comparable standards for PM<sub>2.5</sub> levels in the subway. Public exposure standards are normally for outdoor air, and are often averaged over 24 hours or even a year, which makes them difficult to apply to typical commuter exposure patterns.

### *Toronto Public Health – Health Assessment*

The UTES did not provide any information about what the measured PM concentrations mean for health. Toronto Public Health identified three key research questions for the assessment:

1. What is the health risk to transit users from air pollutants in the subway system?
2. How does the health risk change with mitigation strategies that have been implemented since 2011, or that could potentially be introduced to improve the air quality in the TTC subway system?
3. What is the overall impact to transit users of the TTC's subway system on their health and wellness?

To address these questions, TPH recommends application of a Human Health Risk Assessment in combination with a Rapid Health Impact Assessment. Both are established assessment approaches that are commonly used in the environmental health field. The detailed methodology can be found in Attachment B. Questions related to public health and/or their health assessments and methodology should be directed to Toronto Public Health.

## **Contact**

### **Contact Safety and Environment Department**

John O'Grady

TTC - Chief Safety Officer

416-393-4229

John.O'Grady@ttc.ca

## **Attachments**

Attachment A: Terms of Reference - Subway Air Quality Study

Attachment B: Toronto Public Health - Methodology for Health Assessment

## **Attachment A**

### **Terms of Reference – Subway Air Quality Study**

#### **Background**

Health Canada recently published a public health subway air quality study which was the source of great media attention, employee concern and four employee work refusals.

The TTC has conducted subway air quality studies in 1977, 1980, and 1995. These were performed to provide information on the air quality in the underground portions of the subway and determined both employee and customer exposures to airborne contaminants.

Previous air quality results reflected the improvements made over the years. The total dust levels at selected stations were reduced by 40 to 80% on average. Airborne lead levels were lowered almost to the detection limit of the analytical method used. Airborne asbestos was reduced to a level well below the Ministry of Environment and Energy Guideline for the general public. The most recent subway air quality study performed in 1995 found that not one of the more than 280 samples taken were above the former and current occupational exposure limits for employees. Based on the air quality results and professional judgment, it was determined that the air quality in the system would not affect the health of employees or patrons who do not have pre-existing serious respiratory conditions.

Initiatives such as the corridor cleaning program, station/tunnel washing, improved air filtration on the TR trains (air conditioning is on roof instead of below) and the T1 air duct cleaning program have been undertaken since the last study and are expected to have improved air quality.

#### **Purpose**

Updating the subway air quality study will provide current information on the air quality in the underground portions of the subway and will determine employee exposures to airborne contaminants.

This will be a follow up to previous subway air quality studies.

#### **Scope of Work**

The study will characterize employee exposures to airborne contaminants and verify compliance with Ontario Regulation 833 – Control of Exposure to Biological or Chemical Agents, made under the Occupational Health and Safety Act. This regulation sets occupational exposure limits for airborne chemical agents.

PM2.5 dust samples will be collected for future reference. Total and respirable (less than 10 microns) dust samples will be collected and compared to existing exposure limits.

The study will identify and prioritize potential areas of risk and opportunities for managing these risks.

## **Method**

### *Duration*

The study will be conducted over a one-year period (2017 and 2018).

### *Location*

The study will focus primarily on the underground portions of the subway system (tunnels and platform levels) during revenue service (some external stations that were previously used to establish outdoor background comparisons will also be repeated). Station locations have been selected to duplicate previous studies so long term comparisons can be made. Subway Transportation/work groups (i.e. that travel entire lines) will also be assessed.

### *Time*

Sampling will be conducted during regular operating hours, mostly during morning rush hour as this was how the previous study was conducted and would be considered the worst case scenario. It is expected that the morning rush hour presents the highest contamination levels for the following reasons:

- Contaminants from work done in the tunnels overnight may still be present
- The rush hour is concentrated over a short period of time

### *Sampling Methods*

Air quality will be evaluated using a combination of traditional occupational hygiene sampling methods and contemporary direct reading instrumentation. Both personal and area samples will be collected by third party consultants OHE Consultants or Pinchin Ltd. Laboratory analysis of samples will be performed by independent, accredited third party laboratories.

Since 2013, the TTC has had contracts with OHE Consultants and Pinchin Ltd. based on a competitive bid process for occupational hygiene services.

The JHSC will be consulted about the occupational sampling that will be undertaken and will be invited to be present at the beginning of testing to fulfill the requirements under the Occupational Health and Safety Act.

### *Exposure groups*

To make effective use of sampling time, job titles that are likely to work in similar environments have been grouped as follows:

- Employees who work in stations
- Employees who work on trains
- Employees who work in tunnels

The following job titles within each workgroup will be assessed, based on risk, professional judgement and previous JHSC input.

Employees are to be studied in the following order (track level, stations and inside trains) as part of the Subway Air Quality Study. These include:

| Similar Exposure Group | Job Title  |
|------------------------|--|
| Track Level            | Track Patroller  |
| Stations               | Traffic Checker<br>End Terminal Cleaner (Carhouse Helpers)<br>Station Janitor (BD West)<br>Collector/Crash Gate Attendant<br>(Dundas/Queen/Sheppard Line at subway platform)<br>Transportation Supervisor (Subway)<br>Station Supervisors<br>Transit Enforcement Officers (Subway) |
| Inside Trains          | Operators and Guards   |

Additional respiratory hazard assessments will be conducted for the following groups with specific maintenance activities that may generate/disturb dust.

| Similar Exposure Group | Job Title   |
|------------------------|---|
| Track Level            | Track Maintainer (afternoon crew)<br>Electrician Wiring and Service – Grade 1<br>(Track Level Crew)<br>Signals Technician – Grade 1 |
| Stations               | Maintenance Mechanic<br>Escalator Mechanic<br>Line Mechanic (Rail Vehicle Analyzers - platform)<br>Communications Technician        |

The following employees from each similar exposure group and representing each of the unions will be studied during the first round of sampling i.e. Track Patrol, Traffic Checker, Transit Enforcement Officers, Signal Technician – Grade 1 and Operators/Guards. These job titles have been identified as spending the greatest amount of time in the subway.



## *Contaminants*

The updated Subway Air Quality Study will characterize employee exposures to airborne contaminants and verify compliance with Ontario Regulation 833 – Control of Exposure to Biological or Chemical Agents, made under the Occupational Health and Safety Act. This regulation sets occupational exposure limits for airborne chemical agents.

The following chemicals will be evaluated – this is based on professional judgment, and input from both JHSC and public health agencies in previous subway air quality studies.

- Asbestos
- Crystalline respirable silica
- Dust (various respirable occupational fractions and PM2.5)
- Various metals (30 metals including aluminum, antimony, arsenic, barium, bismuth, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, tungsten, uranium, vanadium, zinc, zirconium)
- Diesel exhaust markers (CO and NOx)

## **Attachment B**

### **Toronto Public Health Methodology for Health Assessment**

The Urban Transportation Exposure Study (UTES) did not provide any information about what the measured particulate matter (PM) concentrations in the Toronto subway system mean for health. A health assessment focussed on air pollution exposure for commuters on the TTC would provide new, local information about the public health risk arising from PM in the subway. As well, these risks would be considered in the context of the broader potential health impacts (both positive and negative) from commuting on the TTC subway system. Toronto Public Health identified three key research questions for the assessment:

1. What is the health risk to transit users from air pollutants in the subway system?
2. How does the health risk change with mitigation strategies that have been implemented since 2011, or that could potentially be introduced to improve the air quality in the TTC subway system?
3. What is the overall impact to transit users of the TTC's subway system on their health and wellness?

To address these questions, TPH recommends application of a Human Health Risk Assessment (HHRA) in combination with a Rapid Health Impact Assessment (HIA). Both are established assessment approaches that are commonly used in the environmental health field.

#### **Proposed Workplan**

##### **1. Finalize methods**

HHRAs provide information about the type and severity of health impacts that may be expected from exposure to environmental contaminants. They follow a structured process that involves

1. determining the relationship between exposure and health outcomes;
2. assessing exposure for the situation at hand; and
3. combining that information to calculate any expected risk.

In most HHRAs, the relationship between exposure and health outcome is determined using established reference information published by recognized environmental health agencies. Available reference values for PM are derived from robust evidence that ambient (outdoor) PM is associated with health impacts including heart and lung problems. However, the information available for PM could be inappropriate for characterizing the risk from the subway air pollution. The PM identified in the TTC subway system is different from PM found in outdoor urban air with respect to its source, composition and characteristics.

As a result, additional information would be collected to finalize the methods. This includes a comprehensive literature review and a jurisdictional scan to learn about other similar systems around the world and to gather available information about PM concentrations and transit user exposures.

Consultation with experts in the field of risk assessment and air quality will be needed to review existing data about the health impacts of PM and the types of metals specifically found in the TTC, and the exposure patterns of subway users. The purpose of the review is to establish a valid method for estimating the potential health risks associated with exposure to the type of PM found within the TTC system.

## **2. Obtain exposure data**

Recognizing that the UTES study collected data from the TTC in 2010/2011, the health analysis would seek to characterize the health impacts associated with commuting on the TTC using up-to-date information. New information about the levels of air pollutants in the subway system will be collected by TTC during its occupational health study in 2017. This data will be shared with TPH to support the HHRA. In addition, Health Canada is seeking to conduct a new study to test the impact of several interventions on subway air quality. If this study proceeds, the data collected could significantly add to the exposure information available to support the HHRA.

## **3. Estimate the health risks resulting from exposure to subway air quality**

Once a valid method is established to estimate the potential health risk associated with exposure to the type of PM found within the TTC system, the method must be applied to the available exposure data. This is usually a mathematical process. In addition, context will be needed for the calculated risks so that it is easy to understand the level of concern they represent, if any. One way of doing this might be to compare calculated risks with levels typically considered to be acceptable (such as “one in a million”).

## **4. Summarize the relative health risks and benefits through an HIA**

HIAs provide information about the range of health impacts (positive and negative) that may be associated with a policy or project, including considering vulnerable populations. Conducting a rapid HIA will enable the risk of exposure from air pollution in the TTC to be considered within the context of potential risks and benefits of commuting by subway overall. The process for carrying out an HIA includes a scoping step to identify potential harms or benefits, and an analysis step to assess the impacts using available evidence, including who will be affected, the significance of the impact, and opportunities for mitigating risks.

The information gathered during the HHRA will be a key component of the overall rapid HIA. Other information needed to inform the HIA includes a review of mitigation strategies that could be effective in reducing PM exposures. As well, the HIA will summarize the health benefits of commuting via public transportation, to ensure that risk mitigation measures maintain and enhance these health benefits.