



# Report for Information

## Internal Audit Quarterly Update: Q1 2018

**Date:** May 29, 2018

**To:** Audit and Risk Management Committee

**From:** Head of Internal Audit (Acting)

### Summary

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This report provides an update on TTC Internal Audit activities. It includes the results of two major audits completed in accordance with the Department's approved 2018 Flexible Audit Work Plan. Specifically:

**Surface Collisions and On-Board Incidents:** Our audit focused on the delivery and outcome of safety initiatives implemented to reduce surface collisions and on-board incidents. We concluded that there is a fundamental need to pursue road collision risk mitigation strategies more aggressively and holistically to address root causes of surface incidents, and to improve transparency in the evaluation and reporting of safety initiative outcomes. Management has acknowledged its need to address identified issues and will present a comprehensive Management Action Plan to the Audit and Risk Management Committee on July 10, 2018.

**Subway Track and Tunnel Work:** Our audit focused on track access management controls and key safety measures in place to protect track level workers. While initiatives to improve track access management and reduce safety risk exposures for track level workers have been made, we concluded that significant efforts need to continue. Management has acknowledged its need to address identified issues and will present a comprehensive Management Action Plan to the Audit and Risk Management Committee on July 10, 2018.

### Financial Summary

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The recommendations in this Report have no additional funding implications beyond the costs of the Internal Audit Department that were included in the 2018 Operating Budget and approved by the TTC Board on November 28, 2017.

### Equity/Accessibility Matters

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There are no accessibility or equity impacts associated with this report.

## Decision History

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This report provides an update on the status of the Department's 2018 Flexible Audit Work Plan, approved by the Audit and Risk Management Committee on February 15, 2018.

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2018/February 15/Reports/6 TTC Internal Audit 2018 Flexible Audit Work Plan.pdf](http://www.ttc.ca/About%20the%20TTC/Commission%20reports%20and%20information/Commission%20meetings/2018/February%2015/Reports/6%20TTC%20Internal%20Audit%202018%20Flexible%20Audit%20Work%20Plan.pdf)

## Issue Background

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The Internal Audit Department is required to provide regular updates regarding the status of planned assurance projects (see Attachment 1 - Status of 2018 Flexible Audit Work Plan as at May 29, 2018) and other activities.

## Comments

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### *Completed Projects*

#### **(1) Surface Collision and On-Board Incidents (see Attachment 2 - Internal Audit Report - Surface Collisions and On-Board Incidents for more details)**

In response to a negative trend of bus and streetcar pedestrian fatalities noted in 2014, TTC Management developed the "12 Point Safe Service Action Plan" (SSAP) framework to address a wide range of road safety strategies. When presented to the TTC Board in January 2015, many of the initiatives outlined in the SSAP were only conceptual.

Since launching the SSAP in January 2015, the total number of bus collisions per Surface Service Delivery Group data in absolute terms has increased by 25.8% as at the end of 2017, and as a normalized average of total miles, by 16.9%. In the case of streetcars, the total absolute number of collisions has dropped since 2015, but the normalized average per service mile has remained unchanged. And finally, the moving annual average of public injuries has increased by 19% per Corporate Safety's Q3 2017 statistics.

TTC is self-insured but pays an additional premium of \$1.3 million out of the operating budget to supplement coverage. Claims triggered as a result of accidents can take years to settle, and even if TTC is found not to be responsible, costs are incurred to defend TTC's position. Cumulative litigation and claim costs in 2016 and 2017 were over \$33 million and \$20 million respectively.

We concluded that there is a fundamental need to pursue road collision risk mitigation strategies more aggressively and holistically to address root causes of surface accidents, and to improve transparency in the evaluation and reporting of safety initiative outcomes. Specifically:

- Eliminating surface vehicle road risks through the proactive implementation of engineered controls and technology may be the most effective means for reducing collisions/on-board incidents and ensuring sustainable safety changes. The potential to mitigate surface vehicle road collisions with pedestrians/cyclists through physical design and infrastructure solutions is also high but requires support and coordination with external parties. Clear accountability for coordinating the efforts of varied parties and driving necessary change to improve public safety would assist in this matter; and all commitments must be tracked and progress regularly reported out to ensure these critical initiatives are completed within reasonable timeframes.
- The effectiveness of all operator training programs, supervision and communication campaigns must be evaluated to ensure goals and objectives are achieved. Holistic evaluation and monitoring of measurable outcomes assist management in strategic decision making and transparent reporting to stakeholders.
- Consistent and accurate capturing of incident source data that supports granular data analytics for a variety of purposes will support safety initiative improvements and greater corporate transparency.

## **(2) Subway Track and Tunnel Work (see Attachment 3 - Internal Audit Report - Subway Track and Tunnel Work for more details)**

Work at track level is inherently risky and one of the most hazardous environments for TTC workers. The TTC has experienced near miss incidents and worker fatalities over the years, each of which gets investigated by the Ministry of Labour. Recommendations for improvements are usually put forth following investigations, as well as, through APTA audits.

The need to enhance track level safety programs was identified in the 2014 APTA Audit report. Per Management, overall risk mitigation strategies involve a system of administrative and engineered controls that focus on track access management, behaviour at track level and implementation of new technologies.

While initiatives to improve track access management and reduce safety risk exposures for track level workers have been made, we concluded that significant efforts need to continue. Specifically:

- Effective monitoring and performance of independent safety checks that ensure track level workers are completing work in accordance with TTC safety rules and guidelines is required to establish a robust track level safety culture.
- The use of portable gas monitors is considered to be a “last line of defence” to reduce the risk of track level workers being overcome by hazardous internal combustion gases. More rigorous enforcement of gas monitor usage and analysis of

high alarm incidents are required to ensure track level worker exposure to hazardous gases is minimized.

- TTC's subway service duration limits the nightly maintenance window to an average of 180 minutes (300 mins on Sundays), which impacts the efficiency and effectiveness of track level work and exposes subway infrastructure to accelerated deterioration. Completion of an evaluation of actual ridership and revenue associated with TTC's late-night subway service (after midnight runs) would ensure current intensity of service and impact on subway infrastructure (and vehicle) asset maintenance costs are warranted.
- Necessary safety procedures, set-up activities and post track work preparation for service cumulatively reduce the already tight time-frame available for crews to work productively at track level.

An international CoMET/Nova Benchmark study (2016 data) ranked TTC fourth amongst 34 participants in terms of subway service density or network utilization, which is a function of train frequency, train length and car capacity. In another Nova 2014 comparison study, it was noted that TTC's total available time to work productively at track level was between 30 and 225 mins less than the other ten participants, and their average maintenance window was almost 2hrs more than TTC.

If the maintenance window was to be increased by 2 additional hours, 5 nights a week, Audit estimates the opportunity for improved productivity by the Track Maintenance and Structure Maintenance sections within the Subway Infrastructure Department alone to be valued at approximately \$3.38 million. Increasing the available maintenance window at track level would also reduce overtime and potentially the need for weekend closures by these two groups. Structure Maintenance Management estimates the annual overtime for this Section could be reduced by 75%, which in 2017, would be equal to approximately \$945K. It is reasonable to assume productivity improvements and material overtime savings could be realized by other groups that complete maintenance and capital project work at track level if the maintenance window is extended.

- In April 2016, the Operational Planning group within Subway Infrastructure launched its use of an ITS internally developed application to streamline the process for submitting, reviewing and scheduling track access requests, i.e., the Subway Track Access Request System (STARS). The intent was to use STARS to schedule only track access time/space requests in a centralized manner, leaving other track level job resource scheduling and work planning to be decentralized and handled by track access requesters.

Continued ITS support and expanded functionality of STARS is required to improve scheduling efficiencies, monitor scheduling deviations and enhance safety of track level workers. In particular, the feasibility of expanding STARS functionality to capture the full cycle of track level access from request creation, updates, changes through to completion, including details of individual crew members/employees descended to track and work cars deployed. Unique track access request numbers

generated within STARS could then be issued for all track level work documentation to facilitate reconciliation to job briefings and completeness of data analysis. Where possible, the use of technology to leverage and increase the accuracy of recorded job briefing details and integration with STARS data needs to be evaluated.

Also, internal quality control processes and mechanisms for verifying reported explanations for schedule deviations, and holding persons accountable for planned job cancellations and no shows should be developed (e.g., a demerit point system), including establishing KPIs that assess the decision making performance of Track Access Controllers and sectional management's utilization of scarce resources, such as night shift work force, work cars and the track level maintenance window.

### ***In-Progress Projects***

In accordance with Internal Audit's 2018 Flexible Audit Work Plan, Internal Audit has initiated work for the following audit projects:

**Emergency Management:** Preliminary audit planning work is underway to gain a better understanding of critical safety risks posed by unplanned emergencies and key controls in place to mitigate such risks. Where appropriate, our review will leverage the investigation work completed by various parties following the January 30/18 platform overcrowding incident and lessons learned from the planned Emergency Exercise to be completed in Q2 2018. Follow-up of related matters identified in our 2016 Delays Management audit will also be included.

**Capital Contract Reviews:** Audit work to ensure compliance with key contract terms and conditions for a number of select capital contracts has begun. Criteria for selection of contracts include the dollar value and nature of expenditures incurred to date.

**Ongoing Support to Special Investigations Group:** Internal Audit continues to provide support to the TTC's Special Investigations Group on an as required basis.

### ***Departmental Initiatives***

Recruitment efforts and other means for securing audit staff in support of the Department's internal restructuring and professional development of existing staff continue. Specifically:

- Interviews for the vacant Audit Manager position are underway. All candidates are professionally accredited;
- An audit retiree, who served as a dedicated capital audit resource prior to his retirement, was selected to conduct capital contract reviews for six months. The depth of his experience is facilitating the timely completion of this work and re-establishing the audit process to be followed for future capital contract reviews;

- An Audit Manager was seconded in January 2018 to the Finance Department to temporarily serve in the role of Manager of Financial Statements. The current incumbent has been assigned to the SAP project. An extension to this arrangement has been made at the request of Finance to provide continued support leading up to, and post implementation of SAP;
- Opportunities to second interested staff into the Internal Audit Department are being pursued; and
- Personal Development Plans that address mandatory training requirements and areas of interest for existing audit staff are being prepared and pursued where practical.

## Contact

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## Signature

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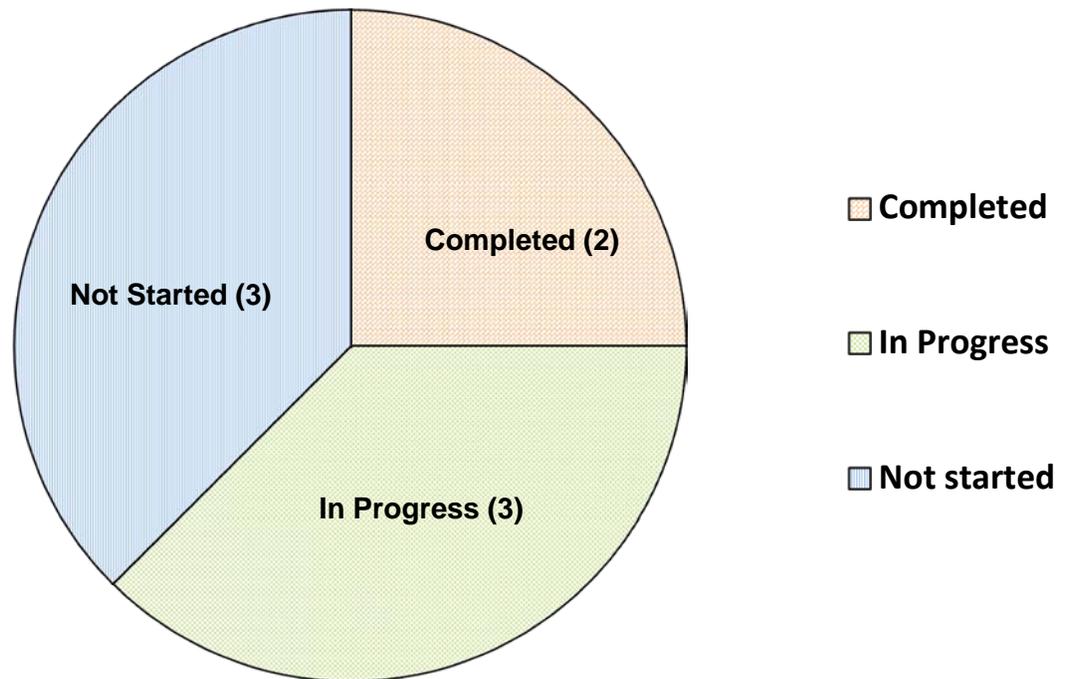
Christine M. Leach, CPA, CA, MAcc, CISA  
Head of Internal Audit (Acting)

## Attachments

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Attachment 1 - Status of 2018 Flexible Audit Work Plan (Assurance Projects) - Q1 2018  
Attachment 2 - TTC Internal Audit Report - Surface Collisions and On-Board Incidents  
Attachment 3 - TTC Internal Audit Report - Subway Track and Tunnel Work

## Status of 2018 Flexible Audit Work Plan (Assurance Projects) as at May 2018



Completed (2)	In Progress (3)	Not Started (3)
Surface Collisions & On-Board Incidents	Emergency Management	Surface Bus Service Evaluation
Subway Track & Tunnel Work	Capital Contract Reviews	Subway Infrastructure Asset Management
	Ongoing Support: Special Investigations Group	Fare Evasion/Revenue Protection

# Internal Audit Report – Surface Collisions and Onboard Incidents

## EXECUTIVE SUMMARY

### Purpose of Audit

TTC Management and the Board have a duty of care to take every precaution reasonable for the protection of customers and other road users. The physical/emotional trauma and compounding effects of fatalities and injuries involving TTC vehicles can be significant for all parties. Personal injuries and fatalities are terrible in and of themselves, and the impact they may have on employee morale, mental health, and absenteeism, public confidence, and TTC's reputation can be far reaching. They may also trigger material TTC insurance claims, litigation and vehicle repair costs.

In response to a negative trend of bus and streetcar pedestrian fatalities noted in 2014, TTC Management developed the "12 Point Safe Service Action Plan" (SSAP) framework to address a wide range of road safety strategies and presented it to the TTC Board in January 2015. The purpose of the SSAP was, and continues to be, to reinforce good safety behaviours and adopt a holistic approach to safety improvement to drive down risk of bus and streetcar collisions and pedestrian fatalities.

Since launching the SSAP in January 2015, the total number of bus collisions per Surface Service Delivery Group data, in absolute terms, has increased by 25.8% as at the end of 2017, and as a normalized average of total service miles, by 16.9%. There were five bus related fatalities during this period, but only two were deemed preventable. In the case of streetcars, the total absolute number of collisions has dropped since 2015, but the normalized average per service mile has remained unchanged. The total number of streetcar related fatalities was five, with two being deemed preventable by TTC management. Specifically:

Year	Service Miles	Collisions	Collisions/100K miles
<b>BUS</b>			
2015	83,313,201	2459	2.95
2016	87,655,489	2834 (+15.3)	3.23 (+9.54%)
2017	89,645,746	3094 (+9.2%)	3.45 (+6.74%) (+16.9% over 2yrs)
<b>STREETCAR</b>			
2015	8,666,179	680	7.85
2016	8,169,830	522 (-23.2%)	6.39 (-18.57%)
2017	7,137,510	562 (+7.7%)	7.87 (+23.23%) (+0.3% over 2yrs)

Near miss incidents are not currently recorded and tracked by surface divisional management. Lack of close call event data and analysis of near miss patterns and trends impacts management's ability to address this population of incidents, and effectively mitigate related safety risks.

Per Corporate Safety Q3 2017 statistics, the moving annual average of public injuries has increased by 19%, with collisions between surface vehicles and pedestrians/cyclists being the

highest area of concern. These collision and fatality trends suggest further work needs to be done to address underlying root causes of accidents and road safety risks.

TTC is self-insured but pays an additional annual premium of \$1.3 million out of the operating budget to supplement coverage. Claims triggered as a result of accidents can take years to settle, and even if TTC is found not to be responsible, costs are incurred to defend TTC's position. Cumulative litigation and claims costs in 2016 and 2017 were over \$33 million and \$20 million respectively. A preventable bus incident fatality that occurred on July 18/17 has yet to be processed through the judicial system and is pending court outcome. The final claims settlement is likely to be high and may increase the MTO Safety Violation Rate. If the Safety Violation Rate exceeds a certain threshold, it can jeopardize TTC's ability to operate its commercial vehicles.

Given the significant impacts collision and on-board incidents can have on TTC and its customers, Internal Audit added the audit topic of Surface Collisions & On-Board Incidents to its 2018 Flexible Audit Work Plan.

### Overall Conclusion

We concluded that there is a fundamental need to pursue road collision risk mitigation strategies more aggressively and holistically to address root causes of surface accidents, and to improve transparency in the evaluation and reporting of safety initiative outcomes. Specifically:

- **Engineered Controls/Technology & Infrastructure:** Eliminating surface vehicle road risks through the proactive implementation of engineered controls and technology may be the most effective means for reducing collisions/on-board incidents and ensuring sustainable safety changes. The potential to mitigate surface vehicle road collisions with pedestrians/cyclists through physical design and infrastructure solutions is also high but requires support and coordination with external parties. Clear accountability for coordinating the efforts of varied parties and driving necessary change to improve public safety would assist in this matter; and all commitments must be tracked and progress regularly reported out to ensure these critical initiatives are completed within reasonable timeframes.
- **Effectiveness Measures:** The effectiveness of all operator training programs, supervision and communication campaigns must be evaluated to ensure goals and objectives are achieved. Particular attention should be given to the actual impact and deterrence effect of the new Rules Compliance Program and the trend of GPS data and LiDAR speed tests. Holistic evaluation and monitoring of measurable outcomes assists management in strategic decision making and transparent reporting to stakeholders.
- **Data System Efficiencies:** Consistent and accurate capturing of incident source data that supports granular data analytics for a variety of purposes will support safety initiative improvements and greater corporate transparency. However, reliance on any one individual to maintain a critical system and produce necessary reports puts continuity of its use at risk.

### Background

During 2014, two pedestrians died after being struck by streetcars. Then, in the latter half of 2014, several video recordings were made public of TTC bus operators running red lights. In response to these incidents, the CEO at the time initiated a review of operator training, supervision and

relicensing, as well as, a communications campaign to reinforce the need for operators to drive defensively and to adhere to the rules of the Highway Traffic Act (HTA).

Also, towards the end of 2014, an adult woman and a 14 year old girl died as a result of injuries in separate incidents after being struck by a TTC bus making a turn. Given the very serious nature of these tragic events, the CEO directed that the review already under way at that time be expedited and that it include consultation with other agencies for comparison and to seek out best practice.

Given the concern over the number of fatal collisions involving TTC buses and streetcars during 2010-2014, and that Management views any fatality as unacceptable, regardless of culpability, a comprehensive program to reverse the 2014 trend was begun. Recognizing that a number of factors affect surface vehicle operating safety, including recruitment, training and supervision of operators, management and scheduling of routes, design and maintenance of equipment, public education and awareness, and use of advanced technology for warning and detection systems among others, Management developed a framework (the "12 Point Safe Service Action Plan") to address a wide range of safety strategies.

When presented to the TTC Board in January 2015, many of the initiatives outlined in the Safe Service Action Plan (SSAP) were only conceptual. An update of SSAP initiatives and results of the collaborative efforts of multiple departments was provided to the TTC Board in March 2017. The goal of the Plan was, and continues to be, to reinforce good safety behaviours with a heavy emphasis on communications, while at the same time, taking a holistic approach to surface safety improvement.

Up until the end of 2016, tracking of specific SSAP Action Item progress was led by the Service Delivery Group Safety Manager. Efforts to meet and share past experiences with the SSAP, as well as, new ideas continue to be led by the new Acting Service Delivery Group Safety Manager.

### **Audit Objective and Scope**

The objective of this audit was to review the status of actions and outcomes identified in the 12 Point SSAP Framework introduced to the TTC Board in January 2015, in conjunction with a review of collision/on-board incident investigation and root cause analysis processes. The audit work was completed in accordance with Internal Audit's 2018 Flexible Audit Work Plan and took into consideration risk analyses conducted by the Risk Management Office.

### **Summary of Key Outcomes**

Based on discussion and review of Internal Audit's observations, Executive Management has acknowledged its need to address:

- Engineered Controls and Technology
- Infrastructure
- Operator Training
- Operator Management
- Data Collection and Analytics

Management Action Plans (MAPs) to address Internal Audit's observations and identified risk/control gaps will be prepared and presented by Service Delivery Group management to the ARMC on July 10, 2018.

## DETAILED DISCUSSION

**Audit Observation #1:**      **A roadmap that clearly outlines task responsibilities, interdependencies and timeframes for evaluating and implementing selected technology based solutions and engineered controls as part of safety initiatives will improve accountability and transparency of progress being made.**

**Engineered Controls and Technology**

In January 2015, Management identified for the TTC Board a number of new technologies being evaluated as part of the SSAP Framework:

- Forward Facing Dash Cameras and Use of Video footage for incident investigation
- VISION (previously referred to as CAD/AVL) to monitor vehicle operation and operator behaviour in real-time
- Collision Avoidance Systems
- Operator Fatigue Detection Systems
- Vehicle Turning Warning Systems

Implementation of these technology based solutions and other engineered controls may significantly reduce the risk of accidents as they function independent of Operator behavior. In addition to preventing customer/employee trauma, investment in these new technologies may lower litigation and claims costs.

New surface vehicles are equipped to support the use of front facing cameras. At the time of our audit, TTC Legal was in the process of finalizing its business case outlining the benefits of TTC's expanded use for safety purposes and claims handling based on feedback from key parties. Legal planned on submitting a final report to the Information and Privacy Commissioner of Ontario (IPC) advising of TTC's intent to implement exterior facing cameras on a date 2-3 weeks from the date of the business case submission.

The VISION system was originally anticipated to commence in 2016, but the revised timeline is estimated to be April 2019. Per Management, the ability to monitor vehicle acceleration, speed and location in real-time will facilitate proactive safety management, and assist staff to observe and assess traffic conditions, operator behaviours and immediately adjust routes, schedules or driver practices as necessary.

Bus Transportation Management is currently reporting progress to TTC's Safety Governance Committee (SX) on the implementation of electric door operators on the bus fleet. Electric door operators are capable of being interlocked with propulsion and offer enhanced obstacle detection capability. A 2018 order for 325 buses will be the first to have electric door operators; all future bus orders will require electric door operators; and retrofitting the existing fleet with front door interlock systems is being explored.

Progress on the evaluation of warning and alert systems identified in 2015 and new emerging best practices has been less explicit. New Vehicle Procurement Management has requested KPMG to conduct a study that includes: identifying currently available Autonomous Vehicle (AV) technology for all modes of surface vehicles and systems that are available through Original Equipment Manufacturers and third party vendors; assessing the maturity of the technologies; and recommending an AV implementation/maturity plan for TTC.

### **Audit Observation #1 - Management Action Plan Considerations:**

- The use of interior/exterior video footage and VISION data to proactively monitor Operator behaviour and adherence to select rules (e.g., white line, posted speed limits) need to be developed. Legal should be consulted to ensure public safety and privacy expectations (employee/public) are reasonably balanced.

- The results of the KPMG study and feasibility of procuring existing audio/visual pedestrian/operator warning/alarm systems and/or fatigue management technology should be explicitly evaluated, taking into account VISION capabilities. The progress and implementation status of the various items should be regularly presented to the SX; and then the effectiveness of these technologies and impact in terms of reducing accidents monitored thereafter.

<p><b>Audit Observation #2:</b></p> <p><b>Infrastructure</b></p>	<p><b>Corrective actions and root causes of surface incident ‘hot spots’ that require coordination with external parties would benefit from strategic corporate support and improved tracking.</b></p>
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Management has prepared and presented to the SX and/or other parties a number of materials that highlight the results of incident root cause and “hot spot” trend analysis. Recommendations for mitigating collision and contact risks have been put forth for consideration. This includes the following:

- Overview of Streetcar Pedestrian Collisions (March 2015)
- Pedestrian Safety Analysis - Streetcar Transportation (June 2015)
- Bus to Bus Collision Prevention Plan (May 2016)
- Streetcar/Auto/Cyclist Collision (Oct 2017)
- Streetcar/Pedestrian Collision (Nov 2017)
- Streetcar/Pedestrian Safety Initiative (Spadina) (March 2018)

These presentations highlight a variety of reasonable Action Plans and expectations for progress to be monitored until completion and for outcomes to be measured. However, in cases where implementation appears to require City of Toronto support, identification and explanation of constraints that hinder progress are not being effectively captured and transparently communicated to garner corporate support and strategic intervention.

For example, streetcar/pedestrian “Hot Spots” where incidents of streetcar and pedestrian contact are assessed to be high have been relatively consistent since 2015 (e.g., Spadina), and detailed studies performed to identify contributing factors have highlighted the same root causes and infrastructure recommendations to remedy. Tracking of collisions at high incident locations throughout the bus and streetcar network continue, but progress regarding suggestions to install yellow tactile warning strips along raised streetcar tracks, dedicated lighting at Right of Ways (ROWs) or signalized pedestrian crossings and lighting (or some variation) at mid-block points or predictable points between longer controlled intersections does not appear to have advanced since first identified as desirable action plans in 2015. Accountability and explanations of progress is not evident, making it difficult for TTC management to determine alternative strategies to pursue infrastructure action items if required.

Management recognizes that customer behaviour, and the behaviour of pedestrians and other road users is critical input to safety on, and around, a TTC vehicle. The need to work with the City of Toronto is paramount and safety messages delivered from different and broader platforms are presumed to have bigger impact. Therefore, TTC staff continues to coordinate public communication campaigns and outreach programs with Toronto Police Services and other community organizations to educate and message safety tips.

**Audit Observation #2 - Management Action Plan Considerations:**

- Per Management, the TTC has been requested to form a Traffic Safety Liaison Committee with the City of Toronto to work on traffic safety initiatives. Corporate accountability for taking the lead in coordinating each element of Collision/Incident Risk Mitigation and Corrective Action Plans needs to be clearly assigned with timelines to meet current Corporate Incident Reporting and Investigation Program requirements; and like many corporate safety programs, actions should be prioritized, progress tracked

until completion, and outcomes measured against established criteria. Transparent identification of barriers to success, including necessary intervention with the City of Toronto or other external parties, may aid in strategizing and gaining necessary support.

<p><b>Audit Observation #3:</b></p> <p><b>Training and Recertification</b></p>	<p><b>Evaluating the effectiveness of formal training and post-training programs, and analyzing the impact of divisional management training actions will support decisions to revise and improve as deemed appropriate.</b></p>
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The nature of driving is inherently risky, especially on congested roads. The repetitive motion driving entails can unintentionally invoke periods of declined focus and awareness of one’s surrounding, especially if one is fatigued. Operators can become complacent, especially where means for identifying those that demonstrate unacceptable actions are weak. Consequently, the quality and frequency of ongoing training is a critical preventive control in reducing road safety risks.

In January 2015, Management reported that a wide ranging initiative to review TTC’s approach to training new operators and recertifying operators throughout their driving career with TTC would be conducted. A number of elements within this initiative were identified, including transit agency benchmarking, curriculum reviews, record keeping systems and re-certification timelines.

In January 2017, a number of revisions to the Bus Initial and Bus Recertification programs were introduced that address many of these elements, including: additional seat time; defensive driving and distracted driver curriculum content; and redesigning the sequencing of Bus and Streetcar Initial training curriculum to meet adult education principles.

The frequency of TTC’s current Bus Recertification cycle is 5 years. This is high compared to other transit agencies per the Training and Development Department’s Benchmark research (April/15):

TTC	New York	Ottawa	Edmonton	Mississauga	York Region	Brampton
5yrs	1yr	3yrs	10yrs	4yrs	3yrs	2yrs

Training and Development staff estimates the cost to lower the Bus Recertification cycle from 5yrs to 3yrs would be approximately \$900K. Per Management, a request to reduce the recertification cycle was rejected during the review of TTC’s 2016 and 2018 Operating Budget submissions.

To compensate, Operators deemed to be high risk may receive a 3 day Safe Driving course. Since inception of this training option in Sept/17, 15 Operators have received this training. Of these, 8 Operators have not had any incidents since receiving this training as of mid-March/18. The next scheduled training of 7-8 high risk operators is scheduled for April 2018.

Other Operators have received a 1 day Assessment for Defensive Driving (ADD) course at the discretion of divisional management. Such training is typically provided to an Operator following an incident, suspension reinstatement, or reaching a high demerit risk score. Per Service Delivery Group data, 615 Operators completed ADD training in 2016 and 703 in 2017. Preliminary review of post ADD training indicates there are positive short term effects being realized in that the majority (54%) of operators who received ADD training in 2017 have not had a post ADD training incident as at March 27/18. For those that did, 77% of the incidents were deemed non-preventable.

A review of MTO Commercial Vehicle collision and conviction data for 2017, stratified by years of service, suggests operators with 3 or less years of experience account for over 40% of the accidents. Per Management, a contributing factor may be that CBA rules govern route assignment processes such that more challenging routes may be crewed with less experienced Operators, which inherently increases the

risk of collisions and incidents. According to a research paper (“Strategies to Prevent, Reduce and Mitigate Bus Collisions”, Florida Department Transportation, March 2016), “rookie operators” are at the greatest risk for collisions.

**Audit Observation #3 - Management Action Plan Considerations:**

- Additional training costs associated with reducing the recertification period should be evaluated holistically, taking into account claims paid for injuries/fatalities as a result of collisions and onboard incidents, vehicle repairs, related employee trauma and/or absenteeism following accidents, etc., as prevention of just one severe case could realize significant benefits. For example:
  - The number of claimants that received a settlement payment greater than \$100K was 28 in 2016, and 26 in 2017; and these single large payments accounted for over \$15.6M and \$6.2M in 2016 and 2017 respectively.
  - Costs to repair vehicles damaged as a result of collisions are not separately tracked but absorbed as an operating cost. Lack of tracking limits the ability to include vehicle repair costs in any cost/benefit analysis or impact assessment but amounts can be reasonably assumed to be material.
- An evaluation of the effectiveness of training and post-training ride check/mystery rider programs should be conducted, including trend analysis of results for each program. Also, ADD training programs provided at divisional management discretion and 3-day training provided to high risk operators as support. If positive trends are noted, consideration should be given to proactively scheduling Operators for these levels of training, possibly as alternatives to implementing the full 3 day Recertification Program for all Operators on a 3 yr cycle to obtain greater coverage and frequency.
- A diligent program of overt and covert ride along inspections, annually prepared in conjunction with, and between, probationary periods until the 3<sup>rd</sup> year anniversary date is met, could enhance support for less experienced drivers. Aggregate results of noted observations could then be analyzed to support tailored safety initiatives for this group of less experienced Operators.

**Audit Observation #4:**                      **Measuring the impact of operator risk assessment, performance monitoring and deterrent programs will aid in identifying where further safety messaging is required and value added activities may be pursued to reinforce good safety behaviours.**

**Operator Management**

Since 2015, emphasis has been placed on communications with operators to encourage adherence to the HTA and to embed a new road safety culture that stresses the need to “Operate to Conditions”. Seasonal topics and risk hazards have also been highlighted. For example, “Back to School”, Autumn Operation (dark clothing, slippery leaves), Winter Safety, and Day-light savings, etc. In practical terms, operators are expected to obey signals and speed limits, take it easy in areas of construction, bad weather, and congestion, and to always put safety first over schedule adherence. Messaging has been delivered via notices, poster campaigns, safety talks, TTC-TV slides, videos, texting and face-to-face talks conducted by supervisors.

The objective of any communication campaign, is to increase the intended audience’s awareness of relevant issues, and ultimately, to invoke positive change in behaviours. Therefore, the act of posting materials and talking about safety does not in and of itself achieve the intended objective of the communication and the messaging of the need for change.

The Corporate Safety Assurance group conducts a number of covert safety checks to validate select controls designed to mitigate identified hazards. For example, Bus and Streetcar Defensive Driving Behaviour checks are performed for a representative sample of vehicles to provide reasonable assurance that operators are performing their duties in accordance with TTC Annual Defensive Driving (ADD) checklist items. The overall level of conformance is reported to Transportation management, and if it falls below a current threshold of 75%, corrective actions are expected to be implemented. While details are requested for presentation at a future SX meeting, Corporate Safety does not evaluate the action plans. Per Corporate Safety, the purpose of these safety checks is to identify systemic non-conformance for local divisional management. Individual operators observed are not named but details that facilitate identifying specific operators checked can be requested by divisional management. As this does not appear to be current divisional management practice, value derived from these safety checks could be greater if observed operators were identified on the safety checklist.

A Rules Compliance Program (RCP) was initiated during the last quarter of 2017. The intent is to enforce operational “rules” and provide feedback to Operators for educational and safety awareness purposes. Specially trained Supervisors observe Operators both secretly and overtly, and tally observed incidents of noncompliance on checklists. Results of the audits are input into a Service Delivery Group database by the applicable supervisor, summarized weekly, compared to target compliance rates and a summary report is regularly prepared and sent to divisional management. Standard Operating Procedures have been prepared outlining the processes to be followed when completing these compliance checks for both Bus and Streetcar.

Since 2015, GPS data obtained from randomly selected buses has been used to identify speeding infractions. The GPS Speed Compliance procedure states data will be analyzed for speeds equal to or greater than 10KMH over the posted speed limit, but only the threshold of 70KMH is used for testing. This limits the ability to monitor adherence to posted speed limits in school zones and residential areas. It has been explained that further refinement and tailoring of testing to actual posted speed limits is not practical; and that the intent of the program is to deter high speeds, not catch violators.

In 2017, GPS data was analyzed and observations were made for 1,409 randomly selected buses. Results indicate 116 (8%) Operators violated the 70KMH speed criteria. Of these, 101 Operators were counselled, 9 were placed on notice and 6 were suspended. The target compliance rate is 95%; and actual compliance across the divisions ranged from 85% to 98%.

Management acknowledges that high speeds are more likely to occur on certain routes but maintains the random spot checks serve as a deterrent to speeding for all operators and supports compliance to posted speed limits. Since first launching the program, the overall rate of noted speed violations system-wide has dropped from 11.6% (2015) to 8.2% (2017). Further, Management identified only 2 bus collisions out of 3,094 where speed was noted as a contributing factor to the accident; and one streetcar collision out of 562 in 2017.

The Transit Enforcement Unit (TEU) measures the speed of TTC vehicles using radar (LiDAR). The locations and times for LiDAR tests are determined by TEU based on provided GPS speed test results, and a standardized form is used to capture the details required by all parties. The expectation is that Transit Enforcement Officers (TEOs) are only required to record incidents where speed violations occur. Initially, Supervisors accompanied the TEO, but it was determined in mid-2016 that this was no longer necessary. However, the expectation was set that any speed violation equal to or in excess of 30KMH is to be reported immediately; but officers should not pursue any vehicle under any circumstances.

During the period between the inception of the LiDAR program in early 2015 and Period 1, 2018, a total of 23,628 LiDAR observations have been made. Of these, 113 (0.5%) violations have been reported. The target compliance rate of 95% has consistently been surpassed, ranging from 97% to 100% per month. In 2017, of the 12 violations reported, only 4 operators were counselled. Per Management, similar to GPS data speed audits, the LiDAR testing program is intended to serve as a transparent, deterrence to operator speeding. Management regards the low rate of violation to be an indicator of the program’s success, and attributable to a number of factors: that LiDAR tests are overt; they have become more predictable as they

are scheduled the same time and days of the week; and the frequency of the test is a function of limited TEU staff availability.

An Operator Risk Registry application and demerit point system has been developed within the Service Delivery Group. The Registry was implemented in Bus Transportation in July 2016 and in Streetcar Transportation in January 2017. Operators are assigned demerit points regardless of culpability when involved in a collision/onboard accident. Points are assigned based on the nature and severity of the incident. Points are also assigned if they are observed violating rules under the Rules Compliance Program and GPS/LiDAR speed checks.

The intent of the demerit point system is to identify high risk operators, i.e., those with a high cumulative score of points, and then provide early intervention and support as deemed appropriate by divisional management. For example, operators at risk for a serious accident may be counselled (e.g., face-to-face interview with management), provided with ride along sessions (with a Supervisor, Training Dept. Instructor or plainclothes Supervisor), sent for formal training (e.g., an 8hr Assessment of Defensive Driving course (ADD) or a 3 day Safety Program, which involves class training and driving time.

Actions taken by divisional management as a result of investigations are recorded in the Operator Risk Registry. Depending on the nature of the incident and culpability assessed, an Operator may be counselled, sent for training, suspended or dismissed in accordance with progressive discipline principles.

Audit's review of incident information recorded in the Operator Risk Registry for ten randomly selected Operators indicates that the classification of the incident is a critical factor in deciding the action to be initiated by divisional management. However, final determinations as to operator culpability are based on individual judgment calls, and are not subject to any peer review or consensus protocol.

Similarly, while anecdotally certain recorded actions taken by management in response to recorded incidents seem reasonable, there are no means or quality control checks to ensure decision making is consistent across all divisions. Audit acknowledges that the specific and unique details of each incident would need to be considered to support final disciplinary decisions, but analysis of trends in management actions taken and subsequent incident occurrences for identified operators following these actions is not currently being done to ensure consistency and assessment of their effectiveness.

The Corporate Incident and Investigation Reporting Program defines a "near miss" as an incident where no ill health, injury, damage or other loss occurs but had the potential to do so under slightly different circumstances. There is an expectation that near misses will be reported. The APTA Rail Safety program has also identified that actively pursuing and analyzing near miss/close call data is a best practice. However, surface divisional management does not currently record and track near misses, and so there is no visibility to such events at the group or corporate level. Lack of 'close call' data and analysis of near miss patterns and trends impact management's ability to address this population of incidents, and effectively mitigate related safety risks.

According to a research paper ("Effective Practices to Reduce Bus Accidents", Transit Cooperative Research Program, Washington, 2001), Safety Awards and Recognition Programs that provide Operators with a graduated series of awards for increasing periods of time without occurrence of a preventable accident can positively impact Operator behaviour. TTC's "Safe Operator" program recognizes Operators of all modes for cumulative years of service, without an at-fault collision.

### ***Audit Observation #4 - Management Action Plan Considerations:***

- Clear effectiveness measures and the means by which behavioural change will be assessed need to be established as part of any communications campaign in order to evaluate the success of the campaign and value to the organization. For example, employee survey questions on a given topic administered before a communications campaign will establish a base line that can then be compared to post communication survey results to provide an objective measure of the impact of the campaign on the intended audience's awareness of the topic. Similarly, conducting before/after focus groups, etc.

- The Rules Compliance Program is relatively new. As results data continues to be gathered and analyzed, it should be regularly reviewed to ensure appropriate content is added on a going forward basis, including critical “operate to condition” elements. Clear effectiveness measures should be established to assess the actual impact the program is having on influencing positive safety behavioural change. Similarly, efforts should be made to record the results of Corporate Safety’s covert Defensive Driving Behaviour checks by operator and to assign demerit points for noted non-compliance with posted speed limits and other critical elements in the same manner as is being done for the Rules Compliance Program. The design and use of a dashboard that presents RCP compliance rates, by division, will improve management oversight and provide greater transparency to the Safety Committee and other parties. Results could support the development of hazard specific risk mitigation strategies, including targeted training programs.
- The approach for deterring operator speeding and monitoring adherence to posted speed limits will need to be reviewed following the full implementation of VISION and availability of actual, real-time speed data. In the meantime, the value of conducting random GPS Data speed tests in the same manner should be evaluated, i.e., should tests for all divisions be conducted using the same speed threshold versus: (i) Testing only select divisions where risks of speeding are higher; (ii) Reducing the threshold to test adherence to actual posted speed limits for target routes (i.e., ‘hot spots’ where speed violations have been identified, even anecdotally, as a safety concern); and/or (iii) Eliminating the tests altogether, keeping in mind the potential impact this decision may have on deterring speed violations for all operators. Similarly, the value of TEU LiDAR speed tests and the potential to tailor their future use.
- A standard, documented process for monitoring operator risk scores and trends before and after management’s corrective actions are provided should be developed. This could serve as a means of assessing the consistency and effectiveness of the selected management actions, i.e., to determine whether the risk of accidents and incidents has been reduced.
- Public corporate messaging and preliminary causal assessments following serious incidents can have legal implications. Corporate communication protocols should be well understood so as not to compromise TTC’s legal position in moments of duress and shock. To demonstrate due diligence and reduce the risk of bias or misjudgement in final incident culpability decisions, clear classification criteria and causal factor considerations should be defined and documented.
- Embedding peer group assessments, robust quality checks and rigorous consensus decision making around final classifications would further improve incident investigation and reporting processes (ie., the Montreal transit model). Summation, comparison and post incident evaluation of operator management trends could further reduce risk of bias, improve consistency in the application of progressive discipline and solidify corporate messaging to Operators of “safety first” and the need to operate to conditions.
- Clarification of expectations and processes for reporting and analyzing surface near misses will facilitate greater insight into close call patterns and trends so appropriate remedies can be put in place to improve collision risk mitigation strategies. Near misses can identify whether the incident is driver error, or another driver’s error, or environment conditions on which the vehicle operates (guideline as noted by the Government of Western Australia, Public Transport Authority).
- The increments of time required for safety awards should be benchmarked against other transit agencies, and means for giving more visibility to award recipients explored (e.g., featuring awarded individuals on divisional TV’s). Opportunities for bestowing positive feedback to those operators observed to do well during Rules Compliance and other safety audit checks should be considered to reinforce corporate safety messaging and behaviours.

<p><b>Audit Observation #5:</b></p> <p><b>Data Collection and Analytics</b></p>	<p><b>Leveraging technology to capture source incident/ investigation data in a timely and consistent manner could facilitate greater granular data analytics and improve efficiency in the data gathering process.</b></p>
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Multiple and siloed databases are being used to capture and analyze collision/onboard incident data and results of investigations. Specifically, all investigations are conducted and details are noted manually on standardized forms. The content of each form is input into the Corporate Safety Incident Management database to generate corporate KPIs and Safety program records. These same forms are also input by divisional staff into the Service Delivery Group database (SRMM) for purposes of managing operators and meeting other specific transportation divisional management needs as they emerge and change.

While the databases and analyses being conducted by these two groups are for different purposes, collision/incident figures are not reconciled to ensure consistency in the source data details captured. Variances in reported collision numbers identified require further explanation. Per Management, differences may be partially attributable to the fact that Corporate Safety removes duplicate incidents (e.g., if a collision involves two buses, it is counted as one incident), does not include “alleged” incidents, and only reports incidents where an injury was reported at the time of the collision. The duplication of efforts to manually input the same source of data (i.e., incident report details) contributes to administrative inefficiencies and risk of error.

Per Corporate Safety management, while contributing factors and root cause information for incidents are determined through the investigation process, such information is not easily extracted from the current corporate database, hindering the ability to perform aggregate analysis. The weaknesses of this corporate system are to be addressed through the purchase and implementation of an enterprise SH&E Management System Software.

In the absence of a corporate system that facilitates more granular data analytics, reports are produced and analysis performed by staff responsible for maintaining the Service Delivery Group database in response to queries prompted by Transportation management. Initiatives that have resulted from using this data include the development of the Operators Risk Registry (demerit point system) and historical tracking of operator management actions taken in response to Operator incidents, the Rules Compliance Program and HTA violations (eg. counselling, training). Data has also been used to identify collision ‘hot spots’ and support speeding deterrent programs. But the Service Delivery Group database and Operator Risk Registry tool have not been subject to quality assurance testing, and Management’s reliance on a single individual to maintain the system and produce the necessary reports puts continuity of its use at risk.

The Training and Development Department (T&D) receives monthly data from the Ministry of Transportation (MTO) regarding collisions, convictions and inspections involving TTC Commercial Motor Vehicles over 4500kg (i.e., buses and non-revenue vehicles) based on police reports and MTO records. This source of information is independent of the internal reports generated by Corporate Safety and the Service Delivery Group. T&D staff inputs all MTO pointed records into an excel spread-sheet that identifies employee numbers and work locations. A report is then sent to applicable work locations for verification and T&D staff follows up on anomalies to ensure erroneous MTO demerit points are identified and reversed. Work locations are expected to take appropriate actions with the identified employees.

MTO assigns demerit points for collisions based on assessed impact (i.e., fatal injury, personal injury, property damage and no impropriety), convictions in accordance with a code table, and defects noted during safety inspections. An overall Safety Violation Rate for TTC is calculated and monitored by MTO. MTO may issue warning letters if the Safety Violation rate reaches 35% or following serious incidents. Sanctions may be levied if the rate reaches 50%, in which case, the TTC’s ability to operate its commercial vehicles may be at jeopardy. TTC’s Safety Violation rate trended up in 2016, but reversed in 2017 until Q3 2017 when it peaked at 25.8% due to a bus fatality in July/17. The conviction status for this fatality is still pending court

outcome. The overall rate as at Q4 2017 was 22.9%, but results of the case may cause the Safety Violation Rate to increase.

T&D staff analyzes the MTO data to identify main driver behaviours and actions attributing to the MTO calculated Safety Violation rate. A quarterly report that highlights the rolling two year average of such things as fatalities, collisions, and convictions is prepared and sent to local management to assist in their supervision of operators and other employees that drive TTC MTO registered vehicles. A review of the rolling two year average results indicates TTC is being assigned demerit points for only 20% of the collisions.

### ***Audit Observation #5 - Management Action Plan Considerations:***

- Per management, the functionality and data analytic needs of all stakeholders was anticipated and evaluated as part of the business case for an enterprise Safety, Health & Environmental Management system. However, during the implementation of this new system, and of the VISION communications system, efforts must be made to consolidate databases where possible and/or consider interfaces between corporate and group level tools (e.g., SRMM-Operator Risk Registry) to ensure single data source input reduces administrative inefficiencies. Reconciliation and differences in the use and interpretation of data should be understood by management to minimize confusion and ensure internal consistency of corporate messaging of trends.
- It is imperative that Board members are provided with relevant statistics and KPIs that facilitate a thorough understanding of safety risk mitigation strategies and outcomes thereof. To increase corporate transparency and support for SSAP initiatives, collision and related information and metrics could be reported quarterly to the TTC ARMC, and annually to the Board. Particular attention could be given to measuring safety action items that have funding/budgeting implications so as to ensure cost/benefit analysis has been reviewed holistically with a risk lens, and that members understand the implications of their decisions and requirement to exercise due diligence with respect to safety.

# Internal Audit Report – Subway Track and Tunnel Work

## EXECUTIVE SUMMARY

### Purpose of Audit

Work at track level is inherently risky and one of the most hazardous environments for TTC workers. Among the hazards are moving revenue trains and work cars, high voltage traction power, rail switches, tripping hazards, heavy material handling, extreme weather, confined spaces, working from heights and exposure to asbestos, emissions, noise and low visibility.

The TTC has experienced near miss incidents and worker fatalities over the years, each of which is investigated by the Ministry of Labour. Recommendations for improvements are usually put forth following investigations, as well as, through APTA audits. The need to enhance track level safety programs was identified in the 2014 APTA Audit report.

Per Management, overall risk mitigation strategies involve a system of administrative and engineered controls that focus on track access management, behaviour at track level and implementation of new technologies. Initiatives designed to improve track governance and ensure strict control over track access were launched in 2016 with the introduction of the Subway Track Access Request System (STARS). Safe behaviour at track level is managed by enforcing Subway Rule Book expectations and the provision of gas monitors to detect unsafe levels of emissions. Adoption of the Permanent Work Area Warning (PWA) system that warns train operators of workers at track level is also underway, but is not expected to be completed until the end of 2019.

Given the significant safety risks and need for enhanced safety at track level for all workers, Internal Audit added the topic of Subway Track & Tunnel Work to its 2018 Flexible Audit Work Plan.

### Overall Conclusion

While initiatives to improve track access management and reduce safety risk exposures for track level workers have been made, we concluded that significant efforts need to continue.

Specifically:

- Effective monitoring and performance of independent safety checks that ensure track level workers are completing work in accordance with TTC safety rules and guidelines is required to establish a robust track level safety culture.
- More rigorous enforcement of portable gas monitor usage and analysis of high alarm incidents are required to ensure track level worker exposure to hazardous gases is minimized.
- TTC's subway revenue service hours limit the nightly maintenance window duration, which impacts the efficiency and effectiveness of track level work and exposes subway infrastructure to accelerated deterioration. Actual ridership and revenue associated with TTC's late night subway service (after mid-night) needs to be reviewed to ensure current intensity of service and impact on subway infrastructure asset maintenance costs is warranted.

- Continued ITS support and expanded functionality of the Subway Track Access Request System (STARS) is required to improve scheduling efficiencies, monitor scheduling deviations and enhance safety of track level workers.

## **Background**

In April 2016, the Operational Planning group within Subway Infrastructure (SI) launched its use of an ITS internally developed application to streamline the process for submitting, reviewing and scheduling track access requests. Realizing the complexities involved to fully implement the initial vision for STARS, SI management and ITS reached mutual agreement on the functions to be delivered by the end of 2018. The intent was to use STARS to schedule only track access time/space requests in a centralized manner, leaving other job resource scheduling and work planning decentralized.

The position of Track Access Controller (TAC) was created in response to the 2014 APTA recommendations. It was envisioned that the TAC will be the singular authority for implementing, modifying and coordinating all track access booking requests and activities to be completed during the nightly maintenance window, with due regard for the safety related requirements of the work involved.

In support of behavioural management, a number of safety checks are expected to be performed by various groups within the TTC. The intent is to encourage safe behaviour at track level by monitoring compliance with all legislative requirements, internal policies, procedures and rules.

Portable gas monitors are to be used by track level workers to reduce the risk of being overcome by internal combustion engine gases in subway tunnels, etc. They are considered to be a “last line of defence”, and a critical control as identified by the Risk Management Office (RMO), because they are programmed to instantaneously detect, measure, warn and log exposure to hazardous gases. Installation of GESI units on all internal combustion engines will provide additional protection. Finally, Forepersons are to confirm through Transit Control that system ventilation fans and dampers are configured and operational as planned.

## **Audit Objective and Scope**

The objective of this audit was to review processes and controls in place to schedule requests to work at track level, with particular attention on the scheduling of work to be completed by SI Sections during the maintenance window after revenue service hours. Performance of safety inspections and assurance checks was reviewed, as well as, the adequacy and level of adherence to portable gas monitor procedures. This audit work was completed in accordance with Internal Audit’s 2018 Flexible Audit Work Plan and took into consideration risk analyses conducted by the RMO.

A review of resource planning and crew deployment strategies was not done as part of this audit as it was determined that such undertakings are performed in a decentralized manner by those groups requiring access to track level. Track level resources are managed by SI Sections in conjunction with work planning activities—which drive track access request planning—and as such, practices differ significantly because each Section is responsible for different critical assets. Track access request resource planning will be considered as a relevant element of future Asset Lift-Cycle Management audit work for select critical assets.

A review of the subway ventilation system was also not included in the scope of this audit. The Plant Maintenance Department is responsible for the maintenance of this safety critical asset, not Subway Infrastructure. The Engineering, Construction & Expansion Group is managing the ventilation replacement and upgrade project. As such, a stand-alone audit of the life-cycle management of this critical asset may be conducted at a later time, which could include a review of fan protocols and the SCADA system.

### **Summary of Key Outcomes**

Based on discussion and review of Internal Audit's observations, Executive Management has acknowledged its need to address:

- Safety concerns
- Staff Accountability
- Management Practices

Management Action Plans (MAPs) to address Internal Audit's observations and identified risk/control gaps will be prepared and presented to the ARMC on July 10, 2018 by Operations Management.

## DETAILED DISCUSSION

<b>Audit Observation #1:</b>	<b>Effective monitoring and performance of independent safety checks that ensure track level workers are completing work in accordance with TTC safety rules and guidelines is required to establish a robust track level safety culture.</b>
<b>Track Level Safety</b>	

At the onset of our audit, it was evident that expectations for the performance of track level safety inspections had been established amongst various groups, i.e., Corporate Safety, Safety Consultants embedded within Subway Infrastructure (SI), Track Access Controllers (TACs), a designated SI Foreperson and by each SI Section. The focus of these inspections included ensuring work zone conformance and the use of appropriate personal protective equipment (PPE) by SI track level workers.

However, Audit noted that independent safety checks were not completed consistently or as frequently as expected, especially during non-revenue hours, due to a lack of corporate and departmental safety consultants' presence at track level. Also, there was no evidence that past results of sectional and departmental safety inspections were being analyzed and acted upon, or that non-compliant individuals were being held accountable. Without rigorous safety monitoring, management's efforts to enforce track level safety requirements and support corporate messaging of "safety first" may be hindered. Specifically:

- Corporate Safety Assurance Checks: Riding inspections during revenue service occurred twice annually on select days in 2015 through to 2017. These checks are intended to provide independent "snapshots" of work zone set up and personal protective equipment usage at track level as trains pass by. However, behaviour under these circumstances may not be representative of behaviour exhibited at track level during non-revenue hours. Results are measured and tracked, but non-compliant employees are not identified, making it difficult to seek out and counsel individuals demonstrating unsafe behaviour. Overall compliance with identified criteria over the period 2015-2017 ranged between 64% to 78%, with adherence to PPE expectations being the lowest element at 34% to 69%
- Designated Safety Consultants embedded within the Subway Infrastructure Department: No evidence of any night safety inspections being done by this group since 2007 was found. The explanation offered was that available resources focused on other work, such as reviewing internal and Ministry of Labour incident investigations, and did not typically perform work at night. However, in November 2017, all safety consultants within the Operations Group were consolidated, with the expectation that safety consultants will be required to spend 15% of their time working night shifts (i.e., approximately 40 days per year) conducting safety inspections and engaging with night track workers. Schedules, procedures and documentation requirements relating to this initiative were still in development as of May 2018, but expected to begin with an initial focus on PPE compliance.
- Subway Infrastructure Riding Inspections: In response to Q1 2017 Corporate Safety Assurance Checks results, an SI Foreperson was designated in June 2017 to perform monthly work zone conformance audits of track level crews in the same manner as Corporate Safety, i.e., riding inspections during revenue hours only, in addition to other duties. Based on Audit's review of available documentation, eight inspections were completed in August 2017, and one in November 2017, covering 26 crews. Results were not analyzed, but suggested a PPE compliance rate of 84% over the August to November 2017 period per Audit's analysis. Given the lack of independence and potential for the SI Foreperson to be biased, the integrity of these checks is questionable.
- Track Access Controllers (TACs): The TAC position was created in response to the 2014 APTA Audit recommendation to enhance track level safety programs. It was envisioned that TACs would conduct track level inspections to provide assurance that track level workers were completing their work/tasks in a work zone consistent with the track access request submitted/approved, and in accordance with applicable safety rules, procedures and work methods. Three TACs started in the position in January

2016, but no inspections were completed after September 2016 due to a decrease in staffing level. Efforts to make alternative arrangements for one of the remaining two TACs to gain access to track level accompanied by other staff—as required by safety protocol—were not evident. Inspections completed prior to September 2016 were regarded as ‘spot checks’, the purpose of which was to educate and deter unsafe behaviour rather than to identify noncompliant workers. Therefore, results were not analyzed. In January 2018, the number of TACs returned to its full complement of three, therefore safety inspections have resumed. Audit noted that a Standard Operating Procedure outlining the TAC Conformance Checks had only been drafted in February 2018, and other tasks/responsibilities of the TAC had not yet been defined or outlined.

- Subway Infrastructure Sectional Checks: Each of the four Sections within the Subway Infrastructure Department has established the requirement for Forepersons or Supervisors to conduct track level safety inspections. The lack of independence associated with these inspections puts the results at risk of being biased. A comparison of each Section’s inspection checklist form indicates the general considerations are similar (e.g., PPE, work zones, job briefings), but the criteria used to assess compliance differ in detail and extent. Evidence to support completion of these checks also varied. For example, three Sections have not been completing the inspections according to the initial frequency established. Explanations offered by two sections (Signals and Electrical) were that they were not performing a large number of jobs at track level, and another (Structure Maintenance) questioned the objectivity of the results, and therefore, the value of performing them.

### ***Audit Observation #1 - Management Action Plan Considerations:***

Noted safety assurance deficiencies were brought to Management’s attention during our audit, and so preliminary actions to address noted concerns have already been initiated and going forward expectations to improve track level safety monitoring communicated. Management should continue their efforts and consider the further need to:

- Re-design (possibly standardize) inspection criteria and documentation, analysis and reporting requirements to facilitate monitoring of trends and identification of violation root causes, e.g., design a Rules Compliance Program appropriate for track level work.
- Review and clarify roles and responsibilities of all relevant parties involved with track level safety inspections, especially during nonrevenue hours, keeping in mind the objectivity of results is greatest when inspections are performed by staff with greater independence. The aim should be to ensure Senior Management’s commitment to safety is consistently visible to track level workers to prompt and sustain cultural changes.
- Re-establish safety check frequency expectations for all relevant parties to align with quantity of work performed at track level by each section to ensure reasonable and meaningful coverage given limited resources; and monitor adherence accordingly against appropriate KPIs.
- Establish disciplinary protocols to address incidents of unsafe behaviour by individuals, which take into account noted severity and frequency of non-compliance. Opportunities for bestowing positive feedback to those workers observed to be completing work in a safe manner should also be considered to reinforce corporate safety messaging and preferred behaviours.

<b>Audit Observation #2:</b>	<b>More rigorous enforcement of portable gas monitor usage and scrutiny of high alarm incidents are required to ensure</b>
<b>Portable Gas Monitors</b>	<b>track level worker exposure to hazardous gases is minimized.</b>

The use of alarmed gas monitors to detect unsafe levels of emissions produced by propane, gasoline, diesel and other internal combustion equipment whenever they are used underground (including tunnels, stations and any other enclosed areas) has been identified as a critical “last line of defence” control. Responsibilities and expectations of usage have been outlined in a corporate procedure, supplemented by Subway Infrastructure departmental procedures. Specifically, each SI Section is required to appoint a Docking Station Contact (DSC) to administer and monitor the usage of the gas monitors.

Total annual rental costs for TTC-wide use of gas monitors are approximately \$0.3M. All four SI Sections have secured MX4 and/or MX6 gas monitors through the Industrial Scientific contract. Structure Maintenance and Track Maintenance account for 42% and 35% of SI’s 114 portable gas monitors on record at the time of this audit, respectively; followed by Electrical (14%), Signals (5%) and monitors reserved for Corporate Safety’s use (4%).

Audit obtained iNet data regarding device usage directly from Industrial Scientific, and records maintained by the Sections and Corporate Safety’s iNet Administrator. Based on analysis of the data, it appears gas monitors are not being used in accordance with applicable procedures. Specifically, Audit noted the following:

- **Compliance with Bumping Rules:** Both corporate and departmental procedures require gas monitors to be “bump” tested at the beginning of each shift to ensure the unit is properly calibrated and functioning, and then again at the end of each shift, to ensure data is downloaded from the monitor onto the iNet system in a timely manner. The downloading of data triggers automated recording of all alarm incidents that occurred since the last bumping session. Audit reviewed bumping data associated with a sample of 31 instances of known device usage over the period January 2017 to January 2018. Proper bumping at the beginning *and* at the end of the shift was noted for only one instance. For 11 instances, *no* bumping was done at the beginning or at the end of the shift, which puts reliance on the device and timely data download at risk. For the remaining 19 instances, bumping occurred either before the shift *or* at the end of the shift, but not both which is unacceptable. Finally, of the 25 instances where bumping did not occur *at the end* of the shift, the time lapse between the occurrence date of the alarm incident and the administrator’s awareness of the event ranged between 1 day to 2.5 months, hindering the timely investigation of high alarm incidents and actions taken in response.
- **Gas Monitor Utilization Criteria:** Corporate procedures for both MX4 and MX6 gas monitors state: units must be used to monitor for the presence of hazardous gases in the work area/zone; that sensors on the instrument should be appropriate for the expected contaminant gases; and units must be worn or held in order to be ‘representative of potential personal exposure’. However, both corporate and departmental procedures do *not* specify whether each member of the crew should be carrying a monitor, or that one monitor per crew is sufficient. The monitors are currently assigned to Forepersons and Assistant Forepersons, i.e., not every single track level worker is assigned a monitor. There are no clear criteria for assessing the specific need for monitors given the location/nature of work to be performed. Therefore, in the absence of any stipulated rules or guidelines, the decision of how many monitors to use, and when, for any given job rests with the Foreperson.

Historical bumping data is indicative of the extent of use of each device. Over the review period of January 2017 to January 2018, Audit noted there were 274 working days. As not all track level jobs require the use of a gas monitor, a bumping frequency of greater than 100 times or more during the review period for any particular device was assumed to be indicative of frequent usage. Only 17% of Subway Infrastructure’s 114 gas monitors were bumped 100 times or more over the review period, and the proportion of gas monitors bumped 100 times or more varied by cost centre – ranging from 0% to 50%.

Further, large time lapses between bump sessions may be indicative of infrequent device usage and/or potentially a lack of use when they should have been. Audit's snapshot review of the bumping history for the same 114 units as of Feb 7, 2018 showed: 18 (16%) devices had never been bumped or charged—keeping non-active units as “spares” contravenes corporate policy which requires all instruments to be assigned to individuals for follow-up purposes, and is unnecessary as the vendor is able to provide replacement monitors via UPS within one day when requested per the Corporate Safety iNet Administrator; 6 (5%) monitors were not bumped for 300 days or more; and 7 (6%) were not bumped for over 90 days. In contrast, only 31 (27%) had been bumped in the last 24 hours, and 13 (11%) in the last 7 days, suggesting more frequent usage.

The extent of understanding and enforcing bumping rules, and monitoring gas monitor usage varied amongst the SI sections. For example, the DSC within Track Maintenance was on medical leave for over 2 months starting February 2018, and the temporary replacement was unclear on the procedures and responsibilities to be fulfilled in his absence. The Track Maintenance Section Manager expected that 30 out of 40 MX4 monitors would be bumped frequently but data showed only 1 out of 40 had been bumped frequently.

- High Alarm Incidents and Investigations: Over January 2017 to January 2018, there were 60 high alarm incidents recorded. Both corporate and departmental procedures require each high alarm incident to be investigated and explanations reported to the Section DSC and Corporate Safety's iNet Administrator. Details provided should indicate the time, location, equipment being used (i.e., contributing factors) and action taken in response to the alarm.

The expectation per corporate policy is that when a high alarm goes off, all exhaust generating equipment should be shut down and workers are to leave the immediate work area until the gas level returns to below the High Level Alarm threshold. Where the high alarm has sounded for more than 15 mins, employees are to be vacated and Transit Control staff is to be advised. However, the policy does not provide further guidelines on how to account for the presence and safety of the vacated crew, or how to ensure workers return to the work site once emission levels decrease to an acceptable level.

Audit cannot verify what actions were taken at the time of the high alarm incident, but did review documentation submitted to the DSC and Corporate iNet Administrator to explain the cause of high alarm incidents and reported actions taken. Audit reviewed 27 out of the total 60 high alarm incidents and noted only one incident was proactively disclosed to the Corporate Safety iNet Administrator. The remaining 26 instances required prompting from the iNet Administrator or DSC for explanation, and even then, brief explanations with limited details were provided via emails for only 14 (51%) of the incidents. There is no assurance that the remaining incidents were followed up and the lack of clear device assignment hinders the ability to hold forepersons accountable for actions taken, if any, in response to the alarms.

Finally, the existing procedures are silent as to what extent the alarms should be followed up. An incident may have multiple alarms and the duration of each alarm is measured in seconds. Each Section's DSC—who may not have the technical knowledge to assess what are the potential risks associated with alarms of certain length/frequency—cannot judge whether each and every high alarm incident needs to be followed up.

- Peak Readings: Departmental procedures require peak readings of gas monitors to be examined and recorded on the Job Briefing form. Per discussion with the Corporate Safety iNet Administrator, the intent of this requirement is to prompt the review of gas monitor usage data at the end of each shift. Then consideration is to be given as to whether the level of hazardous gas the crew had been exposed to is reasonable/acceptable, and whether any work practices should/could be changed to improve the working environment, especially where the reading is hovering just below the alarm threshold for extended periods of time. However, the specific manner in which this expectation is to be fulfilled is not clear. For example, procedures are not clear on whether peak readings from *all* monitors used by a crew should be reflected in the Job Briefing.

Audit reviewed a sample of 56 Job Briefing forms prepared for Track Maintenance and Structure Maintenance work for two nights and noted 52 jobs appeared to require the use of gas monitors based on the nature and location of the work. Of these, only 30 (58%) forms reported a gas monitor number, therefore implying usage, but none recorded a peak reading as required. This suggests roles and responsibilities of all parties involved in the daily device usage, alarm readings reporting, monitoring of actual emission levels and track level workers' exposure to harmful gases are not clear or being effectively enforced.

**Audit Observation #2 – Management Action Plan Considerations:**

In conjunction with Corporate Safety, Operations Management should review, update and expand applicable corporate and departmental procedures associated with the utilization and monitoring of gas monitors used at track level to ensure:

- Adequate resources are appointed to assume and execute expected Docking Station Contact (DSC) responsibilities, with particular attention given to Track Maintenance. Each DSC must fully understand the realm of his/her responsibilities and the need to work in conjunction with the Corporate Safety's iNet Administrator to monitor device utilization.
- An accurate inventory of active monitors assigned to individuals is maintained, and the status of device bumpings monitored for follow-up and accountability purposes. Gas monitors not in active use should be returned to the vendor to reduce rental costs.
- Investigation of high alarm incidents is timely and sufficiently documented by the DSCs to facilitate analysis of trends and cumulative exposure of workers to hazardous gases over periods of time. Complete information, including actions taken in response to high alarms, should be collected and forwarded to Corporate Safety's iNet Administrator. Thresholds and guidelines regarding when alarm incidents need to be reported and followed up should be defined by taking into account trend analysis results to avoid "alarm fatigue".
- Track level workers understand and are properly trained on the usage of devices, including bumping requirements and alarm incident response protocols. Emergency plans and processes to be followed in case of high alarms need to be understood by all workers, the details of which should be covered during safety talks and nightly job briefings.
- Compliance with critical nightly procedural expectations is incorporated into on-site safety inspections and periodic audits are conducted of gas monitor usage and bumping information.

<p><b>Audit Observation #3:</b></p> <p><b>Track Level Maintenance Window</b></p>	<p><b>TTC's revenue subway service hours limit the nightly maintenance window, which impacts the efficiency and effectiveness of track level work and exposes subway infrastructure to accelerated deterioration.</b></p>
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**Limited Track Level Maintenance Window**

Per an international CoMET/Nova benchmark study of "Metro Key Performance Indicators (2016 data)", TTC ranked fourth amongst 34 participants in terms of subway service density or network utilization—a standardized method that measures operated passenger capacity compared to network size. This KPI reflects the 'intensity of utilization of the metro network', which is a function of train frequency, train length and car capacity. The study asserts high train frequency may reflect a good use of fixed infrastructure, but the intense impact on asset utilization should be warranted by ridership demand, i.e., recognizing the need to balance competing objectives of making subway service more available for customers versus the costs associated with accelerated deterioration of subway infrastructure and assets due to an increase in daily

use. The study comments that TTC offers relatively high levels of capacity primarily due to larger trains and higher frequencies across its entire, relatively small network.

TTC track level work starts once the system is fully cleared of revenue trains. TTC's subway system is closed to the public at 1:30am and opens at 6:00am on week days and Saturdays, and at 8:00am on Sundays. However, trains continue to run through the system until approximately 2:30am and re-enter the system at around 5:30am, leaving an average total available daily maintenance window of 180 minutes (300 minutes on Sundays as service preparation starts around 7:30am).

Night shift work typically runs from 10:30pm to 7am, including a 30-minute unpaid meal break. Per discussion with Subway Infrastructure management, track level set-up activities typically start at 2:45am and Transit Control requests crews to complete work and start clearing the track at 5:00am. Work activities expected to be performed out-side of this track level access time period include employee roll-call, safety-talks/briefings, work car preparation, and tools maintenance, etc.

Before track level work can begin, crews, tools, materials and work cars must arrive at designated work locations. Once authorized by Transit Control to descend to track level, each crew requires time to set up its safe work zone and, if required for the job, complete a power cut. Work car logistical problems and mechanical difficulties may be experienced during this time. These necessary safety procedures, set-up activities and post track work preparation for service cumulatively reduce the already tight time-frame available for crews to work productively at track level.

No analysis has been conducted to capture data that breaks down the maintenance window into meaningful estimates of time required to set up/remove work zones, cut/restore power, dispatch/return work cars and complete actual work at track level. The ability to capture and track critical timing points is being explored by the STARS ITS project team as part of their efforts to bring the TACs and Transit Control into STARS. Tracking of such information could support work method development and facilitate improved work planning and performance monitoring.

In a Nova comparison study, "Track Possession Timings" (2014), it was noted that given TTC's subway service hours, and taking into account estimated time required for set-up and safety check activities, as well as post work preparation for service, TTC workers' total available time to work productively at track level was between 30 and 225 mins less than the other ten participants. Further, the average maintenance window of these other participants was almost 2hrs longer than that of TTC.

If the maintenance window was to be increased by 2 additional hours, 5 nights a week, Audit estimates the opportunity for improved productivity by SI's Track Maintenance and Structure Maintenance Sections alone to be valued at approximately \$3.38 million. Such a change would also reduce overtime and potentially the need for weekend closures by these two groups. Based on payroll data, Track Maintenance and Structure Maintenance incurred overtime costs of \$4.58M and \$1.26M respectively in 2017. Structure Maintenance Management estimates that if the maintenance window was to be extended by 2 hours, 5 nights a week, the annual overtime for this Section could be reduced by 75%, which in 2017, would be equal to approximately \$945K. It is reasonable to assume productivity improvements and material overtime savings could be realized by other groups that complete maintenance and capital project work at track level if the maintenance window is extended.

### ***Track Level Maintenance Window Utilization***

TTC's current business process for monitoring schedule adherence and actual usage of the available track level maintenance window relies heavily on the manual reconciliation of the 'advanced run sheets' to the 'final night run sheets'. The 'advanced run sheet' outlines job details for all track access time and space requests processed and approved in the Subway Track Access Request System (STARS), and scheduled to be completed during the upcoming night maintenance window. This document is shared with all parties concerned at 3:30pm. Between 10pm and midnight, sectional management on duty at night—Forepersons and Assistant Forepersons—phone the TAC to confirm details for the scheduled job (i.e., name of the person-in-charge, ventilation requirements, etc.). Alternatively, the Foreperson may cancel the scheduled job altogether or request track access for a different job. All changes are recorded by the TAC in the "Final

Run Sheets” (i.e. schedule of work at track level) in a spread-sheet. Consequently, the data in the Final Run Sheets are prone to error and cannot be easily utilized for reporting or analysis, making it difficult to assess the judgment being exercised by the TACs/Forepersons and the impact of the schedule deviations.

The decision to cancel/revise/add a job through the TAC ultimately rests with the sectional Forepersons and Assistant Forepersons. Per sectional management, deviations from schedules are often prompted by emergency requests (e.g., Structure Maintenance’s Inspection Team identified urgent repair work), weather (e.g., heavy snow requires all crews to be applied to snow removal) or worker absenteeism (e.g., planned work car operator calls in sick). The TAC aims to accommodate all requests for ad-hoc job additions, provided it is safe to do so given the jobs already scheduled for the same time, in the same or nearby space. Reasons for phoned-in cancellations are to be provided and recorded by the TAC via the use of a reason code but Audit noted the recording of a cancellation code has not been strictly enforced. Further, the TAC is not in a position to verify the reason provided.

Based on available 2017 scheduling data manually gathered by the Subway Infrastructure Planners, a total of 15,558 track access jobs/work zones were scheduled by the Planners using STARS over Q2-Q4, 2017, and reported use of the work zones per TAC final run-sheets ranged from 76% to 81% for this same period. Sections within Subway Infrastructure accounted for approximately 58% of the total requests and established work zones, with the Track Maintenance and Structure Maintenance sections accounting for the majority. Therefore, Audit selected two nights and followed up with management of these two sections to review job briefing documentation prepared for completed track level work and to obtain explanations of the noted schedule deviations.

Audit noted a lack of formal process or readily available records that capture the rationale for schedule deviations and demonstrate reasonable supervisory oversight is exercised by management within these two sections for such decisions. There was also no clear trail to support decisions made regarding how labour resources were actually used during the shift; or how the repercussions of schedule changes were managed with respect to crew reassignments. These limitations in process and gaps in documentation make it difficult to hold persons accountable for their decisions to deviate from schedule and to assess the overall impact of these deviations on maintenance window utilization and actual maintenance outcomes.

### ***Audit Observation #3 – Management Action Plan Considerations:***

To maximize and optimize the track level maintenance window, Management should:

- Evaluate actual ridership and revenue associated with TTC’s late-night subway service (after midnight runs) to ensure current intensity of service and impact on subway infrastructure (and vehicle) asset maintenance costs are warranted.
- Conduct in-depth analysis of TTC’s current subway infrastructure asset management approach, resource planning and crewing methods, work car dispatching techniques and work methods to identify opportunities for maximizing productivity and transparency of resource utilization at track level. The cost/benefit of using third party consultants to compare TTC processes with best practices and mechanisms for recording/analyzing resource utilization should be considered.
- Work with ITS to determine the feasibility of expanding STARS functionality to capture the full cycle of track level access from request creation, updates, changes through to completion, including details of individual crew members/employees descended to track and work cars deployed. Unique track access request numbers generated within STARS should be utilized in all track level work documentation to facilitate reconciliation to job briefings and completeness of data analysis. Where possible, the use of technology to leverage and increase the accuracy of recorded job briefing details and integration with STARS data should be evaluated.
- Internal quality control processes and mechanisms for verifying reported explanations for schedule deviations, and holding persons accountable for planned job cancellations and no shows should be developed (e.g., a demerit point system), including establishing KPIs that assess the decision making

performance of TACs and sectional management's utilization of scarce resources, including night shift work force, work cars and the track level maintenance window.

<b>Audit Observation #4:</b>	<b>Continued ITS support and expanded functionality of the Subway Track Access Request System (STARS) is required to improve scheduling efficiencies, monitor scheduling deviations and enhance safety of track level workers.</b>
<b>Subway Track Access Request System</b>	

In 2013, Subway Infrastructure management identified the need to simplify and alleviate issues experienced in the manual coordination of track level work zones, planned work times, resource requirements, work cars and work plans. Based on TTC's Information Technology Services Department's assessment, a decision was made to build an in-house subway track access request system (STARS). The system was to be delivered in multiple phases so users could evaluate the business benefits early and provide feedback to the ITS project team.

Implementation of STARS to date has improved the efficiency of scheduling track access requests (TARs), particularly in terms of streamlining, centralizing and digitizing track access submissions, and capturing the demand for non-direct labour resources (i.e., work cars, work car operators, and power cutters). Additional functionalities are expected to be delivered by the end of 2018, bringing total STARS project costs to an estimated \$2.57 million. However, the opportunity to realize the original vision which prompted this project would require further commitment and funding. Areas where enhancement may be made include:

- **Data Analytics and Resource Planning:** STARS is presently only accessible to Requesters and SI Planners. While track access time/space conflicts are flagged within STARS, the Planners must intervene and consult with applicable parties to resolve them, scheduling shared work zones outside of STARS where feasible. Applications for other user groups (i.e., Track Access Controllers and Transit Control) are expected to be launched by the end of 2018. Until then, scheduling changes prompted by Forepersons and made by Track Access Controllers (TACs) at night, sometimes last minute, continue to be recorded in Excel spread-sheets and therefore are prone to error. The lack of accessible schedule variance data and actual work details being captured nightly in STARS limits management's ability to hold persons accountable for schedule deviation decisions, and to analyze the impact thereof on planned maintenance/capital work. Efforts are being made by the Senior Planner to compare the final run sheets (i.e., work schedule reflecting TACs' changes) to the run sheets produced earlier in the day through STARS by the Planners to identify cancellations, no shows and ad hoc add-ons, and to calculate the actual number of TARS completed each quarter. However, these scheduling KPIs are susceptible to error and are time consuming to prepare, so are only done when time permits. STARS is also limited to capturing information the Planners require to schedule each request and is not set up to facilitate job level planning.
- **Capturing Safety Critical Details in STARS:** STARS was to enhance the safety of track level workers by producing a visual schema that shows clear boundaries of planned work zones during non-revenue hours. This function is not yet available but is expected to be delivered by the end of 2018. Also, STARS prompts Requesters to enter safety critical information—ventilation and hazards—but such information is not mandatory. When such information is input into STARS, it is to be considered by the Planners, discussed with stakeholders during weekly production planning meetings, and confirmed by the TAC on the given night. However, completeness of such information and assurance that proper ventilation is being provided on the given night is not a function of STARS. Finally, STARS does not capture planned or real-time crewing information, or facilitate cross-referencing to hard-copy Job Briefing Forms or other Work Logs prepared and maintained by SI Sections as records of individuals who descended to track level to complete work. Therefore, there is no readily available information or means for informing Transit Control in a timely manner of who is actually at track level in the case of an emergency.

#### ***Audit Observation #4 – Management Action Plan Considerations:***

Management should consider:

- Developing performance metrics that monitor scheduling decisions made by SI Planners and subsequent scheduling change decisions made by TACs to enhance accountability of these positions.
- If STARS is deemed the appropriate tool, Subway Infrastructure management and the STARS ITS Project Team should define/establish formal requirements for future STARS modules/project phases to facilitate:
  - capturing of data required to automate reporting of scheduling KPIs and to develop maintenance window utilization KPIs relevant for each Section;
  - tracking of labour resources used at track level (i.e., names and employees numbers of employees at track level)—planned and actual—to improve TTC safety records; and
  - transparency over the availability of work cars, work car operators, power cutters, and the ability to schedule these non-direct labour resources centrally to maximize and prioritize the utilization of these scarce resources.