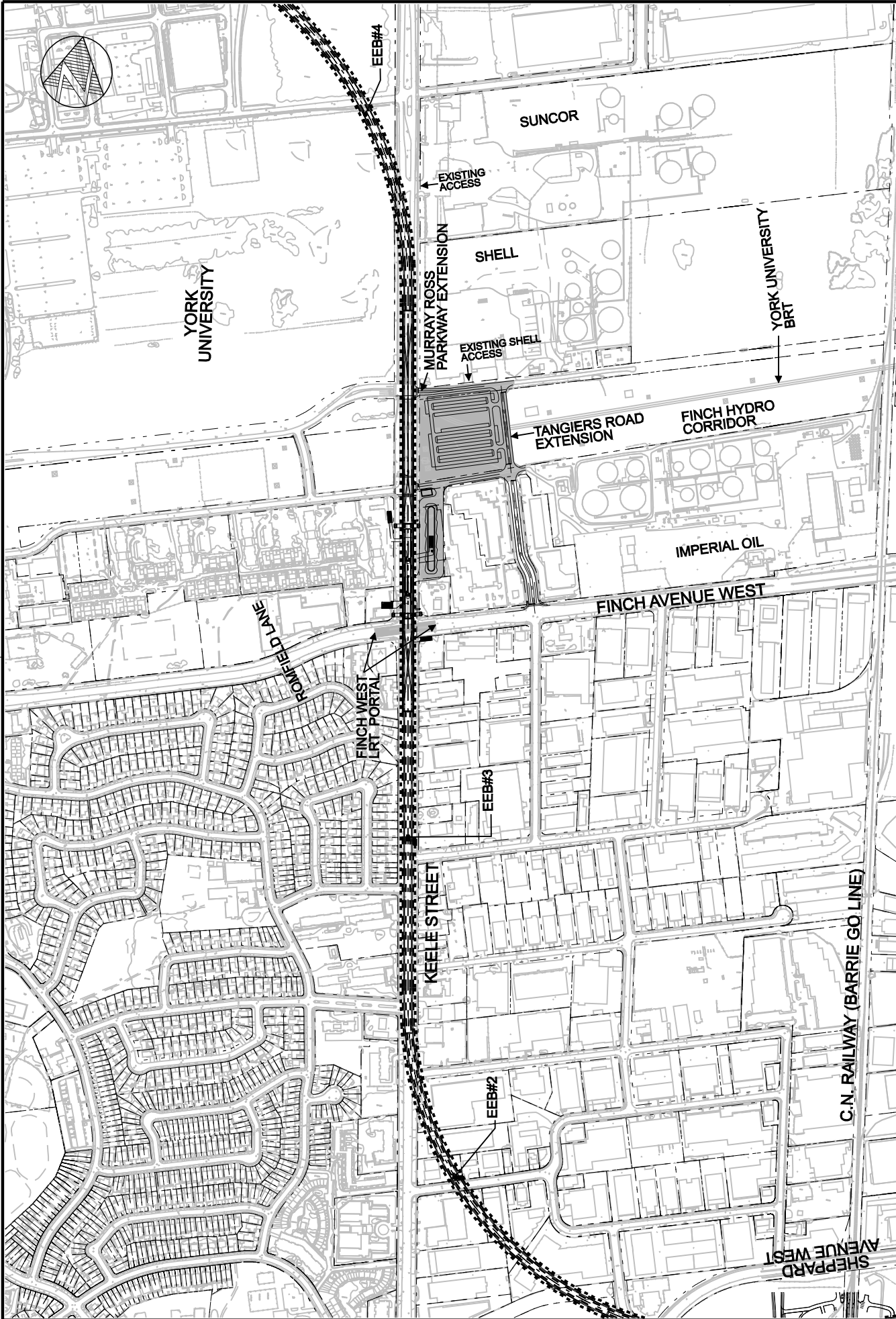
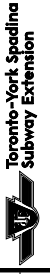


FIGURE 1

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Plot Date: 12-JUL-2010



Dwg. No. **Figure 1**

Sheet No.

TORONTO-YORK SPADINA SUBWAY EXTENSION

FINCH WEST STATION
& FINCH WEST LRT
SITE AREA

DRAWN	-----
CHECKED	-----
CORRECT	-----
SCALE	-----

ISSUED FOR
INFORMATION ONLY
NOT FOR CONSTRUCTION

BLDG. REF. No.

FILE

SHEET No.

DRAWING No.



STAFF REPORT ACTION REQUIRED

Transportation of Inflammable Liquids Over Subways

Date:	May 31, 2010
To:	Public Works and Infrastructure Committee
From:	General Manager, Transportation Services
Wards:	Ward 8
Reference Number:	P:\2010\ClusterB\TRA\TIM\pw10015tim

SUMMARY

By-law No. 72, enacted by the former Municipality of Metropolitan Toronto back in 1954, is a by-law which is still in effect that regulates the transportation of inflammable liquids on former Metropolitan roads over subways.

The preferred design of the Finch West LRT includes an underground LRT station at the intersection of Keele Street and Finch Avenue West. With the proximity of three major tank farms to the Keele/Finch intersection, a high volume of tanker trucks transporting inflammable liquids currently travels through this intersection. By-law No. 72, as amended, would prohibit these tanker trucks from continuing their use of this intersection in the future because they would pass over the proposed underground LRT station. As a result, they would be required to travel circuitous routes to access and egress these tank farms.

Since the enactment of former Municipality of Metropolitan Toronto By-law No. 72 in 1954, there have been significant safety improvements in tanker truck design as well as stricter regulations in the related fire and engineering codes. Furthermore, a recent independent risk analysis has concluded that continuing the transportation of inflammable liquids at this location, once the LRT station is in operation, would result in an acceptable level of risk to public safety. Therefore, this report recommends an exemption to By-law No. 72 which would allow tanker trucks to continue to use Finch Avenue West and travel over the underground LRT station. The implication of not granting the exemption is that the station would have to be designed at-grade in order for these tanker trucks to continue to use the Keele/Finch intersection, which would actually result in a higher risk to the transit passengers using this station.

RECOMMENDATIONS

The General Manager, Transportation Services recommends that:

1. City Council amend former Municipality of Metropolitan Toronto By-law No. 72 to provide an exemption to the general prohibition such that the transportation of inflammable liquids would be permitted along or upon Finch Avenue West from Tangiers Road to Romfield Lane over the proposed LRT station;
2. The General Manager, Transportation Services, report directly to City Council on the appropriateness of a similar amendment to former Municipality of Metropolitan Toronto By-law No. 72 that would provide an exemption to the general prohibition and permit the transportation of inflammable liquids on the section of Keele Street under which the Spadina Subway Extension will operate, upon completion of an appropriate risk analysis; and
3. The appropriate City Officials be authorized and directed to take the necessary action to give effect thereto.

Financial Impact

There is no financial impact associated with the adoption of the recommendations contained within this report.

ISSUE BACKGROUND

In March 1954, the former Municipality of Metropolitan Toronto enacted By-law No. 72, “To regulate the transportation of inflammable liquids on Metropolitan roads over Rapid Transit subways”. This by-law, as amended, remains in effect and Section 1 of this by-law states that, “No person shall transport any inflammable liquid along or upon any portion of a road included in the Metropolitan Road System under which is located any part of a subway of the Rapid Transit system of the Toronto Transit Commission or upon which is located any entrance or exit to such a subway.” By-law No. 72 does provide exemptions to the Section 1 prohibition. However, the exemptions are not applicable in the case at hand.

COMMENTS

The Finch West LRT is one of seven rapid transit lines proposed as part of the Transit City initiative. The Finch West LRT is proposed to operate from Yonge Street in the east to the campus of Humber College in the west. At Keele Street, the Finch West LRT will intersect the Spadina Subway Extension in proximity to the Finch West Subway Station. The Spadina Subway Extension will run directly below Keele Street between St. Regis Crescent and The Pond Road. The Finch West LRT Transit Project Environmental Assessment was approved by the Minister of the Environment on May 20, 2010 and

detailed design is underway. Meanwhile, the Spadina Subway Extension is nearing the completion of detailed design, with tendering and construction scheduled to commence in early 2011.

The preferred design for the Finch West LRT in the vicinity of Keele Street is for the LRT to run underground, between the road surface and the Spadina Subway Extension tunnel. The east transition ramp for the LRT from the surface to the underground station will start west of Tangiers Road while the west transition will start east of Romfield Lane (see Attachment 1). The underground design is preferred to an at-grade design mainly due to superior pedestrian connectivity between the LRT and the subway. The underground connection also received more support from attendees at the Public Information Centres held for the Finch West LRT project.

Three major fuel terminals, commonly referred to as tank farms, are located just east of Keele Street and just north of Finch Avenue West. Tanker trucks servicing two of these facilities (Shell and Suncor) currently use Keele Street for access/egress while those servicing the third facility (Imperial Oil) use Finch Avenue West for access/egress.

In conjunction with the construction of the Spadina Subway Extension, Tangiers Road will be extended north from Finch Avenue West to Murray Ross Parkway. As a result, tanker trucks that currently use Keele Street between Finch Avenue West and Murray Ross Parkway will be able to use the extension of Tangiers Road to directly access Finch Avenue West. Most of these tanker trucks will be destined for Highway 400 and will therefore want to travel west along Finch Avenue West from Tangiers Road. Consequently, assuming the preferred design of the LRT, these tanker trucks would pass over the underground LRT station which would be in contravention of By-law No. 72.

In order to evaluate the risks associated with tanker trucks transporting fuel in proximity to the underground LRT station, two studies were undertaken on behalf of the Toronto Transit Commission (TTC). Delcan Corporation prepared the "Tanker Truck ByLaw Study" in February 2010 while DMA Technical Services prepared the "Finch West LRT Risk Assessment Report" in April 2010. The Delcan study reviewed the practices of other jurisdictions, and collected crash and spill data. This study documented only one tanker truck spill in the Greater Toronto Area in the six-year period from 2003-2008. The DMA study made use of the Delcan data and compared the risks associated with the underground LRT station option with an at-grade LRT station option, using a combination of quantitative and qualitative factors including the potential public reaction. The DMA study concluded that the underground LRT station option poses less of a public safety risk than the at-grade option. This study also concluded that allowing loaded tanker trucks to travel on the subject section of Finch Avenue West, assuming the proposed design of the Finch West LRT station, poses a risk that is within an acceptable range. A significant factor in this conclusion is the improvements in vehicle design, and relevant fire and engineering codes since By-law No. 72 came into effect in 1954. The TTC Safety Department has reviewed the DMA report and concurs with the conclusion.

Based on the Delcan and DMA studies, an exemption to By-law No. 72 for the subject section of Finch Avenue West is appropriate. There would be implications for the TTC if the subject exemption was not granted. Although some rerouting of tanker trucks is planned (as noted above), these vehicles will still require access to Finch Avenue West in any event. A complete relocation of the tank farm operation would be prohibitively costly and impractical. Therefore, if tanker trucks have to operate in this vicinity, the TTC would have to construct an at-grade LRT station at Keele Street in order to avoid contravention of By-law No. 72. This is not TTC's preferred design for the reasons noted above, and more importantly, it has been documented as the riskier design option in terms of public safety compared to the underground option.

The Canadian Petroleum Products Institute (CPPI), which represents the petroleum transportation industry, has expressed concern regarding the significant operational impacts that would result should their tanker trucks not be permitted to travel on Finch Avenue West. In fact, the CPPI is seeking not just a local exemption to the by-law, but a City-wide repeal of the by-law.

Staff of City Transportation Services, Risk Management and both the TTC's Finch West LRT Project Team and Safety Department are in agreement that an exemption to By-law No. 72 for the subject section of Finch Avenue West is appropriate. However, in the absence of site-specific risk analyses in other areas of the City, a City-wide repeal of By-law No. 72 is considered inappropriate at this time. Staff of Legal Services have also been consulted in the preparation of this report.

It is recognized, however, that a similar situation exists for the section of Keele Street impacted by the Spadina Subway Extension which services the tank farm sites. Therefore, a risk analysis is also being conducted for the affected section of Keele Street to determine the appropriateness of a similar exemption. The results of this risk analysis should be available shortly and can be provided to City Council for consideration with this report.

CONTACT

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Manager, Transit Projects
Telephone: 416-392-8508 Email: mmaguir@toronto.ca

SIGNATURE

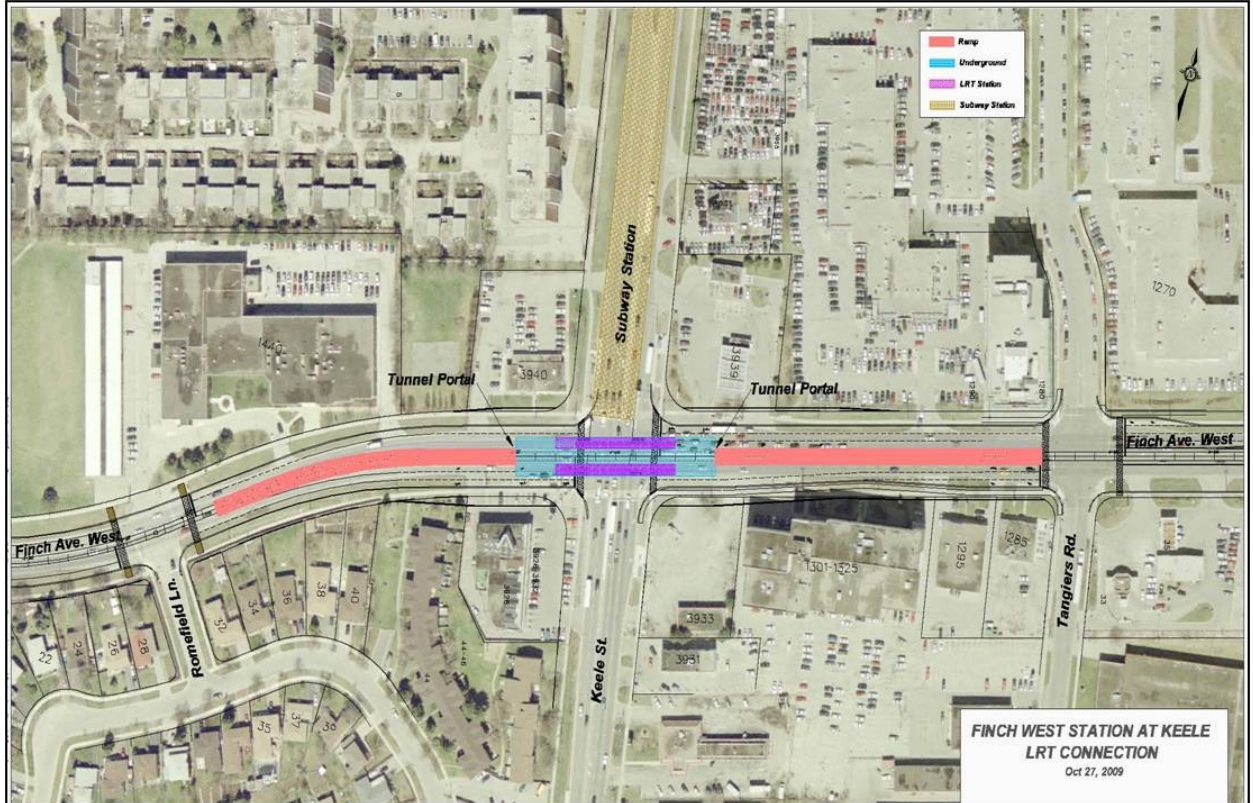
Gary Welsh, P. Eng.
General Manager, Transportation Services

ATTACHMENT

Attachment 1 – Finch West LRT Alignment and Station

Attachment 1

Finch West LRT Alignment and Station





STAFF REPORT ACTION REQUIRED

Transportation of Inflammable Liquids Over Subways on Keele Street

Date:	June 28, 2010
To:	City Council
From:	General Manager, Transportation Services
Wards:	Ward 8
Reference Number:	P:\2010\Cluster B\TRA\TIM\cc10017tim

SUMMARY

Public Works and Infrastructure Committee, at its meeting on June 15, 2010, recommended the adoption of the report titled “Transportation of Inflammable Liquids Over Subways” (PW34.8). The report recommended an amendment to former Municipality of Metropolitan Toronto By-law No. 72, which regulates the transportation of inflammable liquids, that would allow the transportation of these liquids by tanker trucks along Finch Avenue West over the proposed LRT station.

In considering the report, the PWI Committee also directed the General Manager, Transportation Services, to report directly to City Council on the appropriateness of a similar amendment to the by-law that would permit the transportation of inflammable liquids on Keele Street, in addition to Finch Avenue West, over the proposed Spadina Subway Extension upon completion of an appropriate risk analysis.

The risk analysis has been completed and this report, which is based on the results of this analysis and is submitted in response to the direction of the PWI Committee, recommends a similar exemption to By-law No. 72 that would permit the transportation of inflammable liquids on Keele Street, between St. Regis Crescent and The Pond Road. If this exemption is not granted then costly modifications to the tank farm sites in the area would be required in order for tanker trucks to necessarily avoid the use of Keele Street. The introduction of this circuitous routing by these tanker trucks would result in additional risks to public safety.

RECOMMENDATIONS

The General Manager, Transportation Services recommends that:

1. City Council amend former Municipality of Metropolitan Toronto By-law No. 72 to provide an exemption to the general prohibition such that the transportation of inflammable liquids, along or upon Keele Street between St. Regis Crescent and The Pond Road over the proposed subway, would be permitted; and
2. The appropriate City Officials be authorized and directed to take the necessary action to give effect thereto.

Financial Impact

There is no financial impact associated with the adoption of the recommendations contained within this report.

ISSUE BACKGROUND

In March 1954, the former Municipality of Metropolitan Toronto enacted By-law No. 72 being a by-law “To regulate the transportation of inflammable liquids on Metropolitan roads over Rapid Transit subways”. This by-law, as amended, remains in effect and Section 1 of this by-law states that, “No person shall transport any inflammable liquid along or upon any portion of a road included in the Metropolitan Road System under which is located any part of a subway of the Rapid Transit system of the Toronto Transit Commission or upon which is located any entrance or exit to such a subway.” By-law No. 72 does provide exemptions to the Section 1 prohibition. However, the exemptions are not applicable in the case at hand.

At its meeting on June 15, 2010, the Public Works and Infrastructure Committee approved PW34.8, “Transportation of Inflammable Liquids over Subways” which recommended that:

1. City Council amend former Municipality of Metropolitan Toronto By-law No. 72 to provide an exemption to the general prohibition such that the transportation of inflammable liquids would be permitted along or upon Finch Avenue West from Tangiers Road to Romfield Lane over the proposed LRT station.
2. The General Manager, Transportation Services, report directly to City Council on the appropriateness of a similar amendment to former Municipality of Metropolitan Toronto By-law No. 72 that would provide an exemption to the general prohibition and permit the transportation of inflammable liquids on the section of Keele Street under which the Spadina Subway Extension will operate, upon completion of an appropriate risk analysis.

COMMENTS

The Toronto-York Spadina Subway Extension (“TYSSE”) is designed to operate directly below Keele Street between St. Regis Crescent and The Pond Road. This project is nearing the completion of detailed design, with tendering and construction scheduled to commence in early 2011.

Three major fuel terminals, commonly referred to as tank farms, are located just east of Keele Street and just north of Finch Avenue West. Tanker trucks servicing two of these facilities (Shell and Suncor) currently use Keele Street for access/egress while those servicing the third facility (Imperial Oil) use Finch Avenue West for access/egress.

In conjunction with the construction of the TYSSE, Tangiers Road will be extended north from Finch Avenue West to Murray Ross Parkway. As a result, tanker trucks that currently use Keele Street between Finch Avenue West and Murray Ross Parkway will also have the option of using the extension of Tangiers Road to access Finch Avenue West.

As requested by the Public Works and Infrastructure Committee at its meeting on June 15, 2010, a risk analysis was undertaken in order to assess the appropriateness of an exemption to former Municipality of Metropolitan Toronto By-law No. 72 for the subject section of Keele Street. This risk analysis was undertaken by DMA Technical Services, the consultant who performed a similar analysis for Finch Avenue West in the vicinity of Keele Street. The DMA study concluded that allowing loaded tanker trucks to travel on the subject section of Keele Street poses a risk to public safety that is within an acceptable range. This study also concluded that truck traffic on Keele Street is safer compared to rerouting tanker trucks to Tangiers Road. A significant factor in this conclusion is the improvements in vehicle design, and relevant fire and engineering codes

since By-law No. 72 came into effect in 1954. The TTC Safety Department has reviewed the DMA report and concurs with the conclusion.

Based on the results of the most recent DMA study, an exemption to former Municipality of Metropolitan Toronto By-law No. 72 for Keele Street between St. Regis Crescent and The Pond Road is appropriate. There would be implications for the TTC if the subject exemption is not granted. A complete relocation of the tank farm operation would be prohibitively costly and impractical. Therefore, costly circulation modifications at some of the tank farm sites would be required to change the routing from Keele Street to Tangiers Road. As noted above, routing tanker trucks to Tangiers Road is riskier in terms of public safety.

The TTC's Chief General Manager, the TYSSE Project Team and the TTC's Safety Department are in agreement that an exemption to By-law No. 72 for the subject section of Keele Street is appropriate. Staff of Legal Services have also been consulted in the preparation of this report.

CONTACT

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SIGNATURE

Gary Welsh, P. Eng.
General Manager, Transportation Services

ATTACHMENT

TYSSE Alignment on Keele Street – St. Regis Crescent to the Pond Road

EXECUTIVE SUMMARY ONLY



TTC Finch West LRT Risk Assessment Report

Revision Number: 1

Prepared For

Toronto Transit Commission

Prepared by



DMA Technical Services Inc.
Chatham, Ontario, Canada

April 2010

File D09.123



EXECUTIVE SUMMARY

Background

The Toronto Transit Commission (TTC) contracted DMA Technical Services Inc. (DMA) to conduct a risk assessment regarding their proposed underground Light Rail Transit (LRT) station link to the Toronto-York-Spadina Subway Extension (TYSSE). The TTC's proposed LRT/subway link at the intersection of Keele and Finch will require an exemption from Toronto By-Law 72. By-Law 72 limits the transportation of flammable materials in a parallel direction above underground subway operations. Finch Avenue West is currently a route for Tank Trucks carrying flammable fuels to access Highways 400 and 401.

A report by Delcan, the TTC's Environmental Assessment consultant for this project, recommended TTC seek the By-Law exemption. The Delcan report is titled Tanker Truck By-Law Study Report and dated February 2010. Delcan found only two cities with relevant By-Laws (e.g. Chicago's is similar to Toronto's By-Law but allows exceptions for deliveries). The Delcan analysis of Ontario Ministry of Environment (MOE) data showed that Tank Truck overturn accidents were rare in urban areas, so the risk of a major spill in Toronto is low.

The TTC has considered the following options for the intersection of Keele and Finch:

- Underground station – preferred by the TTC based on best management practice and customer preference for transfer, however, subject to By-Law 72, since Tank Trucks will run parallel to the relatively short LRT underground section on Finch.
- Above Ground station – also a practical option but it may still be subject to By-Law 72 as there will have to be surface openings to connect to the subway.
- Rerouting of Tank Truck traffic off of Finch – not practical due to the compensation for business loss and infrastructure costs involved.

Worst Case Scenarios

The following scenarios were defined by the TTC and DMA as worst case for the public safety risk analysis purposes of this report:

UNDERGROUND - A Tank Truck overturn and major spill into one of two entry/exit ramps for the LRT is considered to be a low probability but high consequence fire /explosion risk.

ABOVE GROUND - Three scenarios were considered:

1. A Tank Truck collision accident at the intersection is considered to be a higher probability but lower consequence than the underground scenario above.
2. A pedestrian/vehicle collision with the LRT bringing a greater number of people to the intersection is also considered to be a higher probability but lower consequence than the underground scenario.
3. A Tank Truck overturn and major spill into one of the passenger entry/exit stairways from the LRT to the subway is considered to be a lower probability and lower consequence fire / explosion risk than the underground scenario.

Risk Analysis

Risk is defined as the multiplication of probability times consequence of an event and can be mitigated by reducing either probability or consequence or both. There is no such thing as “zero” risk or absolute safety. Risk management decisions usually involve a trade off based on a comparison of the benefits, costs and risks of each option.

DMA used data from the Ontario Ministry of Environment (MOE), Transportation Canada (TC), the Ontario Ministry of Transportation (MTO) and local data from the City of Toronto and the TTC in our risk analysis. In any risk assessment there is no “right answer” as many assumptions are made during the process. It is important to make reasonable assumptions (i.e. defensible based on some data) and keep the analysis simple. Transparent analysis using high quality publically available data and broad participation of stakeholders is the key to determining the ultimate acceptability of any risk.

DMA conducted a semi-quantitative risk analysis using the TTC Hazard Identification and Risk Assessment (HIRA) process. The HIRA process used by the TTC is recognized by the American Public Transportation Association (APTA). Probability calculations were made for the worst case scenarios based on available historical data and were used to compare the likelihood of the scenarios. Additionally, there are other qualitative factors that must be considered before making any final judgement as to the acceptability of the risk.

Public “outrage” is a term developed in depth by Peter Sandman of Rutgers University (www.petersandman.com). Essentially Sandman states that the risks that kill people are not necessarily the risks that upset people. Risks that are voluntary are more acceptable than risks that are forced onto people. One of the solutions to reduce public outrage is public participation.

The TTC has sponsored public meetings with respect to the Finch West LRT project. Two relevant excerpts from the Transit City Open Houses report titled Etobicoke-Finch West LRT, July-August Summary Results Report, dated August 2008:

- Overwhelming general support for the new LRT on Finch.
- Preference for underground connections to subway because it reduces the need for stairs and provides shelter from winter weather conditions.

Refer to the complete DMA report for more detailed calculations and discussion of the semi-quantitative, quantitative and qualitative risk analyses. The risk analyses for the options are summarized in the following table. The colour coding in the table means:

- RED represents an Unacceptable risk,
- YELLOW represents an Undesirable risk, and
- GREEN represents an Acceptable risk.

Note: The DMA report is consistent with the Delcan findings and DMA’s risk analysis method and conclusions were independently reviewed and endorsed by the TTC Safety Department.

Summary of Risk Analysis

RISK FACTOR	UNDERGROUND STATION	ABOVE GROUND STATION
Tank Truck Overturn with Major Spill and Fire Scenario entering either entrance/exit ramps or other opening.	<ul style="list-style-type: none"> ✓ Probability is low (less than 1/100,000) ✓ There is no worst case consequence scenario evident from data ✓ Engineering controls (e.g. tanker compartments and LRT curbs) in place to reduce consequence (see HIRA for other examples) ✓ Consequence can be further reduced by additional engineering controls (e.g. detection) and operational controls (e.g. emergency plans for evacuation) 	<ul style="list-style-type: none"> ✓ Same as Underground ✓ Probability is even lower than Underground since the openings will be much smaller ✓ Openings can also be strategically located and protected (e.g. curbed)
Tank Truck or Vehicle Collision affecting LRT operation at intersection	<ul style="list-style-type: none"> ✓ Not a factor in this option as any surface accident should have minimum effect on underground operation 	<ul style="list-style-type: none"> ✗ Probability is high (>1/1000 and < 1/10,000) ✗ There has been a worst case consequence scenario of an LRT collision with a Gasoline Tank Truck resulting in multiple fatalities. ✗ Difficult for the TTC to reduce consequence further as traffic safety involves people and other factors beyond their control
<p>Notes:</p> <ol style="list-style-type: none"> 1. <i>The Underground Station Tank Truck Spill scenario probability was calculated to be approximately 100 times less than an Above Ground Station Tank Truck Collision scenario.</i> 2. <i>Additionally, based on Transport Canada data, a spill involves a fire only 10% of the time.</i> 3. <i>Thus, the worst case fire scenario is even lower (likely less than 1/1,000,000), further increasing the relative margin of public safety for the Underground Station option compared to the Above Ground Station option.</i> 		

RISK FACTOR	UNDERGROUND STATION	ABOVE GROUND STATION
Vehicle / Pedestrian Collision at Intersection	✓ Not a major factor in this option as the majority of pedestrian transfers will be underground	<ul style="list-style-type: none"> ✗ Probability is high (LRT pedestrian volume will at least double the risk) ✗ Consequence is real (not hypothetical) as evidenced by the cluster of Toronto pedestrian fatalities this year ✗ TTC can reduce risk to customers with station design (e.g. physical barriers) but it is difficult to control risk to customers before entering or after exiting station
Potential for Outrage	✓ Probability for outrage is low given customer participation and preference. Outrage is higher for low probability / high consequence events but the Delcan research and this risk assessment should allay any rationale public concerns.	✗ Probability for outrage is low as these stations are common throughout the world and people are willing to accept the risk because use of an LRT is voluntary. However, the issue of pedestrian safety and a high volume of Tank Truck traffic at Keele and Finch have the potential for outrage to be high, since exposure to Tank Trucks is not voluntary.
By-Law 72	✗ Despite the research and risk assessment, the City may not grant the By-Law exemption for other reasons.	✓ Arguably the By-Law is not applicable to this option.

Limitations to DMA's Risk Analysis

There were no Tank Truck overturn accidents with spill accidents in Toronto on arterial roads such as Keele and Finch. There was only one identified for Ontario (Vaughan) from the years 2003 to 2008. Since the Underground probability calculations were based on a statistically small number of events (i.e. 1 accident in 6 years), the assumptions were varied to see if there was any substantial change in risk. For example, the "initial" event probability, the number of Tank Truck overturn accidents with a spill, could easily change tomorrow with a second accident. How will this affect the overall conclusions of our risk analysis?

The initial event probability was reduced from 1 in 6 years to 1 in 10 years. The Underground probability remained in the same order of magnitude ($>1/100,000$ but $<1/1,000,000$) and the relative safety factor is approximately 200 times better than Above Ground. The initial event probability was then increased from 1 in 6 years to 2 in 7 years. The Underground probability remained in the same order of magnitude ($>1/100,000$ but $<1/1,000,000$) and the relative safety factor is reduced to approximately 67 times better than Above Ground.

DMA tested a variety of realistic scenarios and naturally the probabilities and relative safety factor changed accordingly, however, the overall conclusions of our risk analysis did not. The Underground Station was always a better choice than the Above Ground station from a public safety perspective.

The calculations are relative not absolute probabilities for the Keele and Finch intersection but still are useful for comparing the Underground to the Above Ground station options. The Underground station probabilities are in the order of magnitude generally considered to be acceptable risk (i.e. a chance between 1 in 100,000 and 1 in a million). Probability can always be refined but this makes the analysis more complicated and less transparent.

Conclusions

Based on the results of the combined semi-quantitative (HIRA), quantitative (Probability Calculations) and qualitative (Outrage) analyses, it is the professional opinion of DMA that the risk falls in an acceptable range. As mentioned in the study method, however, there is “no right answer” in any risk assessment, however, the Underground Station option is better from a public safety perspective compared to the Above Ground Station option.

The concept of Toronto By-Law 72 is hard to argue against, however, it was created in 1954 based on the fire and engineering codes in place at the time. As Delcan stated, there has been substantial improvements made to modern fire and engineering codes addressing the risks of hazardous material use and transportation.

It is the professional opinion of DMA that an exemption to By-Law 72 to permit an Underground LRT Station at Keele and Finch represents a small public safety risk to the City of Toronto.

Note: The purpose of any risk analysis also includes continuous improvement. Several risk mitigation ideas were identified during the course of this analysis and will be communicated to the Finch West LRT design team.

A handwritten signature in blue ink, appearing to read 'D. Meston', is written over a light blue rectangular background.

David A. G. Meston, P. Eng.

April 12, 2010

Date

EXECUTIVE SUMMARY ONLY



TTC TYSSE Finch West Station Risk Assessment Report

Revision Number: 1

Prepared For

Toronto Transit Commission

Prepared by



DMA Technical Services Inc.
Chatham, ON Toronto, ON

June 2010

File D10.050



Background

The Toronto Transit Commission (TTC) contracted DMA Technical Services Inc. (DMA) to conduct a risk assessment regarding their proposed underground subway station at Keele and Finch as part of the Toronto-York-Spadina Subway Extension (TYSSE). The TYSSE risk assessment is a logical follow up to a similar analysis conducted for the Finch West LRT project.

The TTC's proposed Finch West subway station at the intersection of Keele and Finch will require an exemption from Toronto By-Law 72. By-Law 72 limits the transportation of flammable materials in a parallel direction above underground subway operations. Keele Street is currently a route for Tank Trucks carrying flammable fuels to access Highways 400 and 401.

A report by Delcan, the TTC's Environmental Assessment consultant for the related Finch West LRT project recommended the TTC seek the By-Law exemption for the LRT project. The TYSSE project team felt the same logical arguments applied to the Finch West subway station and the section of subway operating under Keele Street.

The Delcan report is titled Tanker Truck By-Law Study Report dated February 2010. Delcan found only two cities with relevant By-Laws (e.g. Chicago's is similar to Toronto's By-Law but allows exceptions for deliveries). The Delcan analysis of the MOE data showed that Tank Truck overturn accidents were rare in urban areas, so the risk of a major spill in Toronto is low.

The TTC has considered the following options for the Finch West subway station:

- Planned underground subway station design, north of the intersection at Keele and Finch (Drawing 1) is subject to By-Law 72, since Tank Trucks will run parallel to the subway on Keele from around St. Regis Crescent to The Pond Road. (Drawing 2.)
- Rerouting of Tank Truck traffic off of Keele onto Finch via Tangiers (Drawing 2). By-Law 72 wouldn't apply.

Without a By-law exemption, rerouting of Tank Truck traffic means:

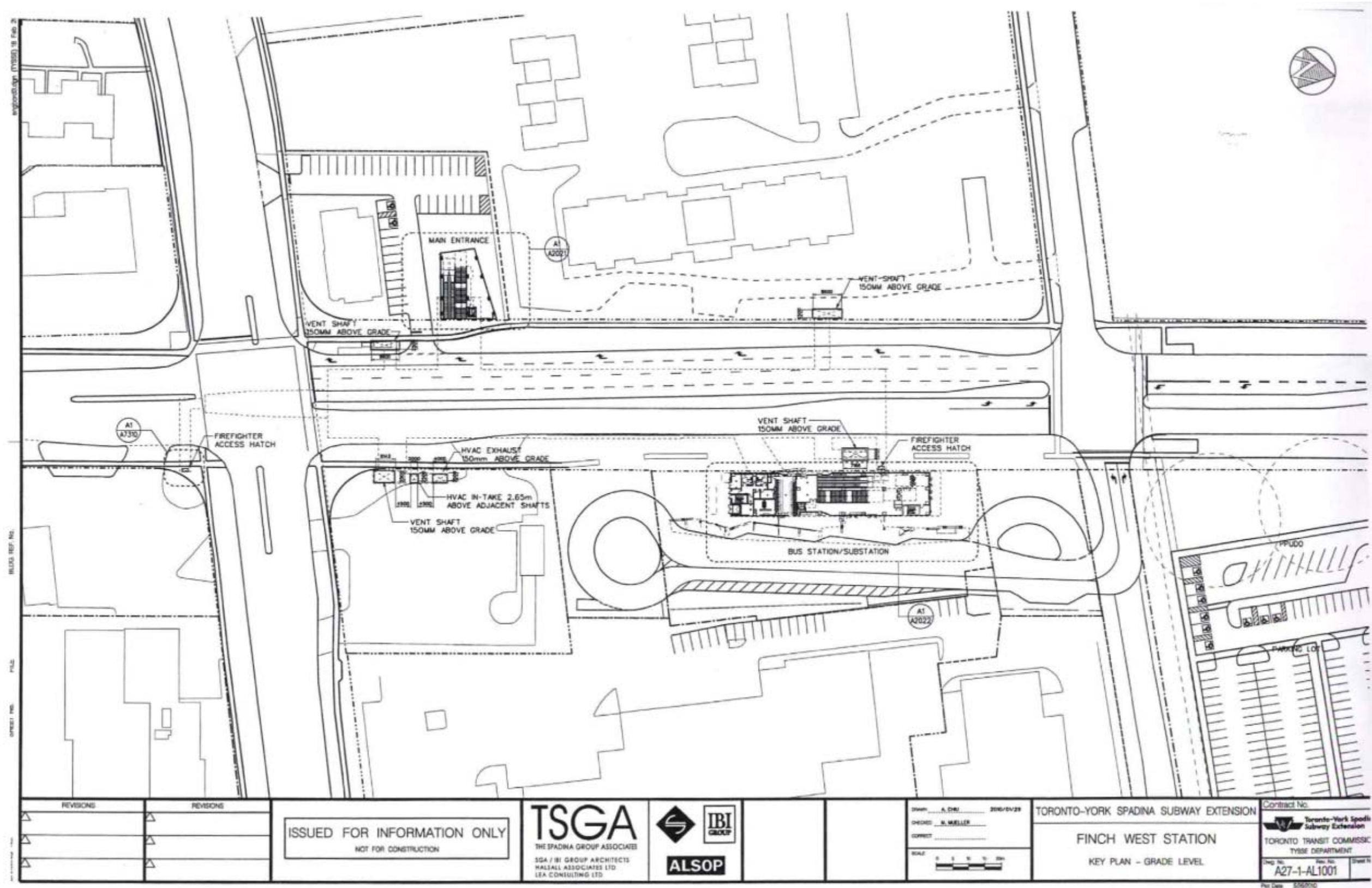
- There will be significant disruption to operations while the internal site modifications are constructed on the Shell site to facilitate alternate access arrangements.
- It would be necessary to obtain an alternate means of access through the adjacent property to the north, causing disruption there.
- Tanker trucks will have to use Tangiers Road, a collector street, to access Finch Avenue, instead of Keele Street, an arterial roadway.
- Significant public expense due to the infrastructure costs involved and compensation to Shell, Petrocan and others for business loss.

The objective of the study is:

- To compare the relative risks of allowing Tank Truck on Keele Street above subway operations versus re-routing traffic off of Keele onto Finch via Tangiers.
- To determine the acceptability of the risk from Tank Truck traffic on Keele Street above subway operations for the identified worst case scenarios.

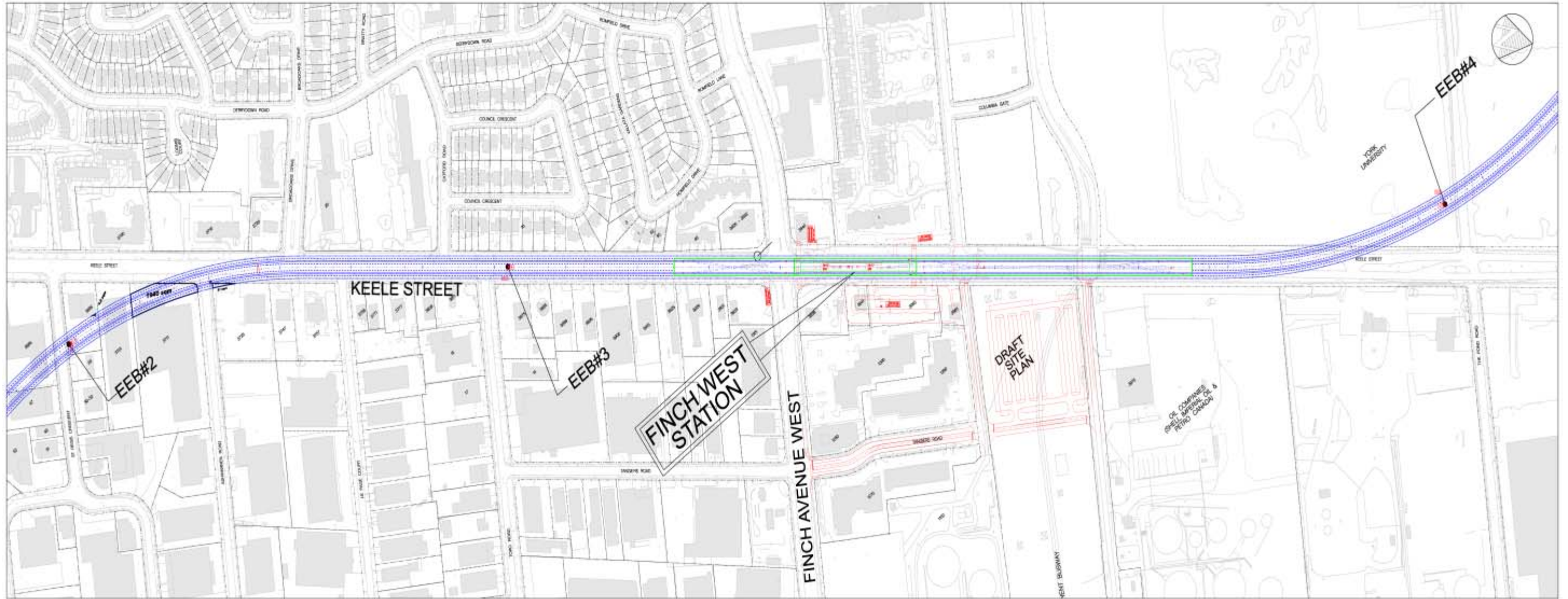


Drawing 1



REVISIONS	REVISIONS	ISSUED FOR INFORMATION ONLY NOT FOR CONSTRUCTION	TSGA THE SPADINA GROUP ASSOCIATES SGA / IBI GROUP ARCHITECTS HALLSALL ASSOCIATES LTD LEA CONSULTING LTD			DRW: A. DEM CHKD: M. WELLS CORRECT	2016/01/28	TORONTO-YORK SPADINA SUBWAY EXTENSION	Contract No.

Drawing 2



Worst Case Scenarios

The following scenarios were defined by the TTC and DMA as worst case for the public safety risk analysis purposes of this report.

TANK TRUCK TRAFFIC ALLOWED ON KEELE

A Tank Truck overturn and major spill from a traffic accident could result in one of the following scenarios:

1. A major spill entering the station from one of the subway openings is considered to be low probability but could pool and present a fire/explosion risk.
2. Heavier-than-air hydrocarbon fumes entering the station and concentrating above the LEL (Lower Explosive Limit) could present a higher (but still low) probability and higher consequence fire /explosion risk compared to Scenario 1 above.
3. Smoke from a surface fire entering the station could present a higher probability but lower consequence risk than Scenario 1 or 2 above.

TANK TRUCK TRAFFIC RE-ROUTED OFF KEELE

The scenario considered here for comparison purposes was a Tank Truck collision accident at the Finch and Tangiers intersection (possibly with the Finch West LRT)

Risk Analysis

Risk is defined as the multiplication of probability times consequence of an event and can be mitigate by reducing either probability or consequence of both. There is no such thing as “zero” risk or absolute safety. Risk management decisions usually involve a trade off based on a comparison of the benefits, costs and risks of each option.

DMA used data from the Ontario Ministry of Environment (MOE) and Transportation Canada (TC) from the Delcan report as the baseline for analysis. Additional data from the Ontario Ministry of Transportation (MTO) and local data from the City of Toronto and the TTC were used in the risk analysis and calculations.

In any risk assessment there is no “right answer” as many assumptions are made during the process. It is important to make reasonable assumptions (i.e. defensible based on some data) and state them clearly and generally keep the analysis simple if the results are to be understood and ultimately accepted. Transparent analysis using high quality publically available data and broad participation of stakeholders is the key to determining the ultimate acceptability of any risk.

DMA conducted a semi-quantitative risk analysis using the TTC Hazard Identification and Risk Assessment (HIRA) process. The HIRA process used by the TTC is recognized by the American Public Transportation Association (APTA).

Semi-Quantitative (HIRA) Results

HIRA is an alpha-numerical “risk scoring” method that uses the matrix in Figure 1 to evaluate the level and acceptability of a risk. Probability is ranked as A, B, C, D or E and multiplied by the Consequence ranked as 1, 2, 3 or 4. The matrix illustrates the trade off between probability and consequence for any risk.

Figure 1 – Risk Assessment Value Matrix

Consequence	1 Catastrophic	2 Critical	3 Marginal	4 Negligible
Probability				
A Frequent	1A Unacceptable	2A Unacceptable	3A Unacceptable	4A Acceptable with review
B Probable	1B Unacceptable	2B Unacceptable	3B Undesirable	4B Acceptable with review
C Occasional	1C Unacceptable	2C Undesirable	3C Undesirable	4C Acceptable
D Remote	1D Undesirable	2D Undesirable	3D Acceptable with review	4D Acceptable
E Improbable	1E Acceptable with review	2E Acceptable with review	3E Acceptable with review	4E Acceptable

Each of the worst case scenarios described is summarized below.

TANKS TRUCKS ALLOWED ON KEELE

For a Tank Truck Overturn accident resulting in a major spill:

Scenario 1 – Spill enters station

To start, the probability of an Overturn accident on an arterial road such as Keele is “Remote” (verified by the quantitative risk analysis). The driver’s skill level, vehicle design (e.g. lower centre of gravity, anti-roll suspensions), low speed limit and city traffic congestion reduce this probability. The size of spill resulting from an Overturn is also limited by vehicle design (e.g. rollover protection on tanks, multiple/smaller fuel compartments).

It is possible for a spill to enter one of the multiple subway openings. The most likely spill location would be the Keele and Finch intersection from a vehicle accident involving a Tank Truck turning. Openings in close proximity to the intersection include 2 large vent shafts for subway operation, 2 smaller shafts for Service room HVAC intake /exhaust and 1 Fire Fighter Access (FFA) hatch. TTC station design criteria are:

- If ventilation shafts or HVAC shafts are within the road right of way they would be flush with the concrete walkway/boulevard. For shafts of any nature not within the road right of way, as is the case for this proposed preliminary station design, said shafts shall be a minimum of 1 m above grade. (This is a revision to Drawing 1.) This would mitigate or eliminate the spill infiltration scenario.
- The FFA opening is a floor mounted access panel which will be at sidewalk/boulevard level. If the spill jumps the curb and progresses over the FFA panel it will seep into the panel drainage which goes down to subway track level and eventually into a platform level sanitary pumping station. Sanitary pumping stations have submersible pumps and due to their nature are Class 1 Div 2 in electrical classification (explosion rating).

Based on the risk controls described above, the probability of a spill presenting an underground fire / explosion risk was revised to “Improbable”. (The spill is more likely to enter the City storm sewer.) Additionally the consequence was revised from “Catastrophic” to “Critical”. A large spill entering the station could pose a significant risk with the large number of people in the station at peak hours; however, it also means any large spill would be reported quickly. Given the TTC emergency response plans and proximity of Toronto Fire Services (e.g. 2 blocks away), logically the consequence is reduced.

Scenario 2 – Fumes enter station

If a spill occurred, the initial probability of fumes entering the station was also rated as “Remote”. Hydrocarbon fumes (e.g. gasoline or diesel) are heavier than air and given the raised shafts as described in Scenario 1, the probability is further reduced. If fumes were drawn into the station platform area, the rate of natural air changes (every 2 minutes at peak) should prevent fumes from reaching a critical level (e.g. lower explosive limit or LEL). The probability of fumes presenting an underground fire / explosion risk was revised to “Improbable”.

Fumes entering the station could pose a significant risk with the large number of people in the station at peak hours, however, experience has shown any fumes or smells are reported quickly. Hydrocarbons have a distinct odour and are likely to be reported before a critical level is reached. TTC also reduces the consequence further with emergency plans and design:

- TTC has a chemical/biological incident practice and procedure for this scenario. In essence once recognized, train operations are in a hold pattern - stop and stay at their location, until responding fire services investigate the scene and give the all-clear signal.
- Typically internal ventilation systems do not intake air from the station but from the outside air shaft.

For these reasons and the risk control described in Scenario 1, the consequence was revised from “Catastrophic” to “Critical”.

Scenario 3 – Smoke enters station

If a spill occurred that resulted in a surface fire, the initial probability of smoke being drawn into the station was considered to be higher than the previous scenarios and rated as “Occasional”. Smoke is treated with the same priority as fire by TTC emergency protocol. TTC has a well established and practiced 3 Level Response to a smoke scenario. All employees who work at track level in a station are aware of this protocol through their Subway Rule book training. Key operational emergency and design risk controls include:

- All station service rooms have fire detection. Typically smoke detection is used.
- The Transit Control Centre notifies the fire service based on communication with the Station Collector or by activation of the station fire alarm system which is transmitted to Transit Control.
- On detection of smoke within a room with smoke detection the associated room ventilation system is shutdown.
- Air handling units extracting outside air will contain duct smoke detectors which will shutdown the associated unit on alarm and will notify the Station Collector and Transit Control via the station fire alarm system.
- Transit Control also notifies Power Control. The subway ventilation shaft dampers can be operated from Power Control to isolate outside smoke from entering into the subway system.

For these reasons and the risk controls described in Scenarios 1 and 2, the probability of smoke from a surface fire presenting a risk to underground operations was revised to “Improbable” and the consequence was revised from “Catastrophic” to “Critical”.

Overall, for each worst case scenario, the HIRA results showed the risk to be an “Improbable” probability multiplied by a “Critical” consequence which yields a risk score of 2E. This score represents a “green zone” risk or “Acceptable” risk, provided there is periodic review by TTC Operations and TTC Safety to check and prevent any degradation of the risk controls over time. (TTC Safety has fire safety expertise on staff and conducts regular fire safety audits.)

TANKS TRUCKS RE-ROUTED FROM KEELE

In contrast, the alternative that re-routes Tank Truck traffic off Keele to Tangiers minimizes the worst case subway risk scenarios (there will still be Tank Truck traffic on Finch) but transfers this risk to the LRT. The HIRA results showed the risk to be a “Remote” probability multiplied by a “Critical” consequence which yields a risk score of 2D. This score represents a “yellow zone” risk or “Undesirable” risk to the LRT project, since Tanks Trucks will now be turning left in front of the LRT.

In summary, the risk of allowing Tank Truck traffic on Keele over the subway is acceptable and preferable to transferring the risk to the LRT project.

Quantitative (Probability) Results

Probability calculations were made for the worst case scenarios based on available historical data and were used to compare the likelihood of the scenarios. The risk of a Tank Truck Overturn accident with major spill /fire scenario while the public is present at the Finch West Station to be 1 in 540,000. Given the spill must occur in proximity to one of the subway openings and the risk management controls described above in the HIRA, this risk is reduced and estimated to be at least 1 in a million.

Qualitative Results

Additionally, there are other qualitative factors that must be considered before making any final judgement as to the acceptability of the risk.

With any risk analysis, there are other issues that simply can't be quantified. For example, in their report, Delcan mentions improvements in Tank Truck vehicle design including anti-roll suspensions, ABS braking, rollover protection on tanks, lower center of gravity, improved weight distribution, improved venting and speed management. Clearly these improvements have reduced both the probability and consequence of a Tank Truck accident but it is difficult to quantify the risk reduction based on the limited data available to DMA.

Public "outrage" is a term developed in depth by Peter Sandman of Rutgers University (www.petersandman.com). Essentially Sandman states that the risks that kill people are not necessarily the risks that upset people. Risks that are voluntary are more acceptable than risks that are forced onto people.

One of the solutions to reduce public outrage is public participation. The TTC has sponsored public meetings with respect to the TYSSE project. Public safety relating to Tank Truck traffic on Keele was not raised as an issue in the Environmental Assessment report or Open House meeting minutes.

To summarize, the final decision in any risk analysis must be made based on a combination of both quantitative and qualitative factors including the potential for public outrage.

Refer to the complete DMA report for more detailed calculations and discussion of the semi-quantitative, quantitative and qualitative risk analyses. The risk analysis for the options are summarized in the following table. The colour coding means:

- RED = Unacceptable risks,
- YELLOW = Undesirable risk, and
- GREEN = Acceptable risk.

Note: The DMA report is consistent with the Delcan findings and DMA's risk analysis method and conclusions were independently reviewed and endorsed by the TTC Safety Department.

Summary of Risk Analysis

RISK FACTOR	TANK TRUCKS ON KEELE	TANK TRUCKS RE-ROUTED
<p>Tank Truck Overturn with Major Spill resulting in:</p> <ol style="list-style-type: none"> 1. A major spill entering the subway station 2. Fumes entering subway station 3. Smoke from a surface entering subway station 	<ul style="list-style-type: none"> ✓ Probability is low (less than 1/1,000,000). ✓ There is no worst case consequence scenario evident from the literature. ✓ Engineering controls (e.g. Tank Truck compartments and subway ventilation design) in place to reduce the consequence (see HIRA for other examples). ✓ Consequence is further reduced by additional operational controls (e.g. rapid detection and emergency plans for evacuation). 	<ul style="list-style-type: none"> ✓ Risk eliminated without any Tank Truck traffic operating above subway.
<p>Tank Truck or Vehicle Collision affecting LRT operation at Tangiers and Finch</p>	<ul style="list-style-type: none"> ✓ Not a factor as there is not a change in existing traffic patterns for Tank Trucks. 	<ul style="list-style-type: none"> ✗ Probability is higher (approximately 1/3000) ✗ There has been a worst case consequence scenario of an LRT collision with a Gasoline Tank Truck resulting in multiple fatalities. ✗ Difficult for the TTC to reduce risk as traffic safety involves people and other factors beyond their control

Note: The probability calculations indicate that it is approximately 200 times safer to leave existing Tank Truck traffic on Keele (subway risk) compared to re-routing Tanks Trucks to Tangiers (LRT risk).

RISK FACTOR	TANK TRUCKS ON KEELE	TANK TRUCKS RE-ROUTED
Potential for Outrage	✓ Probability for outrage is low given customer open houses and this option represents the status quo. Outrage is higher for low probability / high consequence events but the Delcan research and this risk assessment should allay any rationale public concerns.	✗ Probability for outrage is higher as this is a visible change to the traffic patterns.
By-Law 72	✗ Despite the research and risk assessment, the City may not grant the By-Law exemption for other reasons.	✓ The By-Law is not applicable to this option.

Limitations to Probability Calculations

There were no Tank Truck overturn accidents with spill accidents in Toronto on arterial roads such as Keele and Finch. There was only one identified for Ontario (Vaughan).

Since the probability calculations for the Underground option were based on a statistically small number of events (i.e. 1 event in 6 years), the assumptions were varied to see if there was any substantial change in risk. For example, the “initial” event probability, the number of Tank Truck overturn accidents with a spill, could easily change tomorrow with a second accident. How will this affect the overall conclusions of our risk analysis?

The initial event probability was reduced from 1 in 6 years to 1 in 10 years, assuming no events in the next four year period. The original probability of a major spill affecting the subway remained in the same order of magnitude (>1/100,000 but <1/1,000,000) and the relative safety factor is approximately 277 times better than for a Tank Truck collision affecting the LRT.

The initial event probability was then increased from 1 in 6 years to 2 in 7 years, assuming a second event in the next year. The original probability remained in the same order of magnitude (>1/100,000 but <1/1,000,000) and the relative safety factor is reduced to approximately 67 times better than for a Tank Truck collision affecting the LRT.

DMA tested a variety of realistic scenarios and naturally the probabilities and relative safety factor changed accordingly, however, the overall conclusions of our risk analysis did not. From a public safety perspective, the subway risk from Tank Truck traffic on Keele was always a better choice than the LRT risk from re-routing Tank Truck traffic to Tangiers.

Conclusions

Based on the results of the combined semi-quantitative (HIRA), quantitative (Probability Calculations) and qualitative (Outrage) analyses, it is the professional opinion of DMA that the risk falls in an acceptable range. As mentioned in the study method, however, there is “no right answer” in any risk assessment. Stakeholder participation is also important to manage potential outrage.

The concept of Toronto By-Law 72 is hard to argue against, however, it was created in 1954 based on the fire and engineering codes in place at the time. As Delcan stated, there have been substantial improvements made to modern fire and engineering codes addressing the risks of hazardous material use and transportation.

It is the professional opinion of DMA that an exemption to By-Law 72 to permit Tank Truck traffic on Keele Street above the subway represents a small public safety risk to the City of Toronto.

Note: The purpose of any risk analysis also includes continuous improvement. Several risk mitigation ideas were identified during the course of this analysis and will be communicated to the Finch West Station design team.

A handwritten signature in blue ink, appearing to read 'D. Meston', is written over a light blue rectangular background.

David A. G. Meston, P. Eng.

June 23, 2010

Date