



REPORT
**METHODOLOGY USED TO CALCULATE THE ECONOMIC IMPACT
OF A FIRE DEPARTMENT'S OPERATIONAL
ACTIVITIES ON HIGHWAYS**

François Delorme
Dave Waterhouse



The *Service de sécurité incendie de Montréal (SIM)* is the official name of the City of Montreal's Fire Department. Throughout this document, we will refer to it as SIM.

Authors

François Delorme
Dave Waterhouse

Graphic design

Natacha Grenier

The information contained in this document is the property of the Centre de formation du Service de sécurité incendie de Montréal (the Montréal fire department's training centre) and may not be used, reproduced or circulated without the centre's written authorization.

1st edition

Legal deposit – 1st quarter 2018
Bibliothèque et Archives nationales du Québec
Library and Archives Canada
ISBN 978-2-7647-1590-1 (printed version)
ISBN 978-2-7647-1591-8 (PDF)

© Service de sécurité incendie de Montréal, 2018

Ce rapport est également disponible en français sous le titre *Méthodologie sur le calcul de l'impact économique des activités opérationnelles d'un service de sécurité incendie sur voie rapide.*

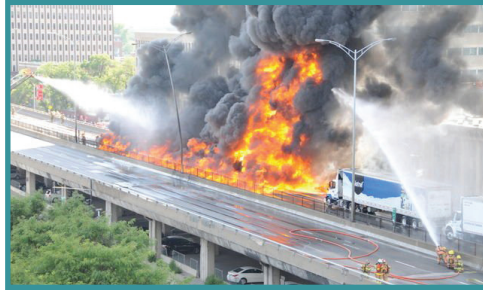
This report is also available in French under the title: *Méthodologie sur le calcul de l'impact économique des activités opérationnelles d'un service de sécurité incendie sur voie rapide.*

TABLE OF CONTENTS

BACKGROUND	5
APPROACH	6
METHODOLOGY	6
RESULTS	8
a) Economic costs	8
b) Cost of the operation	10
SCOPE OF STUDY	10
CONCLUSION	12



BACKGROUND



On August 9, 2016, a major collision involving five vehicles occurred on Highway 40 West near Lajeunesse Street in Montréal. A truck driver employed by EGGR Transport was killed in the accident when his tanker truck burst into flames. He died even before firefighters arrived at the crash site.

The accident was caused by the sudden braking of a Bombardier tanker truck transporting aviation fuel. According to the investigation report prepared by Quebec's workplace health and safety board, the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST), the sudden braking occurred after the truck's emergency brake was activated. The report indicates that Bombardier failed to "adequately monitor its tanker trucks after various emergency brake issues..."¹ However, the CNESST report states that the inadequate distance between the EGGR vehicle and the truck in front of it caused the collision and the subsequent fire.

The Service de sécurité incendie de Montréal (SIM), Montréal's fire department, was called to assist at the crash site. The operation involved saving and evacuating the people near the burning truck as well as extinguishing the inferno caused when the fuel tank ruptured upon impact, spreading fuel onto the road and extending the fire beyond the original site. A general alert was issued and more than 120 firefighters were sent to the site. It took a number of hours to bring the fire under control.

The pivotal role of Highway 40 as a major component of the city's transportation infrastructure and with regard to Québec's economy is a recognized, well-documented fact. In order to extend the scope of our initial study on the economic impact of the SIM's interventions,² presented in June 2017, we asked ourselves the following question: What is the economic value of the operation the SIM carried out on August 9, 2016?

It is important to note that this operation was considered a success given that it helped preserve, insofar as possible, the condition of the highway's infrastructure as well as that of the surrounding area. It also prevented any loss of life or injuries. The tragic death of the EGGR truck driver occurred before the firefighters arrived.

1 Commission des normes, de l'équité, de la santé et de la sécurité du travail. *Accident mortel sur l'autoroute Métropolitaine impliquant quatre véhicules lourds survenu le 9 août 2016*, investigation report, [Available online in French only], 2017, [<https://www.centredoc.cnesst.gouv.qc.ca/pdf/Enquete/ed004144.pdf>] (Consulted on November 1, 2017).

2 Delorme, François, and Dave Waterhouse. *Report: Analysis of the Economic Impact of the Service de Sécurité Incendie de Montréal's Interventions for Year 2015*, Montréal, Service de sécurité incendie de Montréal, 2017.

APPROACH

Our approach is based on the one used by the City of Phoenix in Arizona, which, in collaboration with the University of Virginia in Phoenix, estimated the economic value, rather than the cost, of firefighters' actions carried out on Interstate 10 on February 20, 2014.³ We therefore referred to their methodology in our attempt to answer our question.

METHODOLOGY

We used the following data and hypotheses for our analysis:

- > Cost of repairing the highway following the accident, including the reconstruction of a section measuring 100 m in length and three lanes wide in the westbound direction: \$1,000,000.⁴
- > The amount of time the highway was closed between the time the accident occurred and the reconstruction was completed: 13.5 hr for the eastbound direction (from 4 p.m. on August 9 to 5:30 a.m. on August 10) and 38 hr for the westbound direction (from 4 p.m. on August 9 to 6 a.m. on August 11).
- > Section in question: between the Acadie Blvd. on- and off-ramps and Saint-Hubert Street eastbound or Christophe-Colomb Street westbound. This section remained completely closed during the accident and during the reconstruction period, for a total of 38 hours.
- > Vehicle flow rate at the time of the accident in the section in question: 71 vehicles heading east and 73 vehicles heading west.⁵
- > Estimated average number of vehicles and people travelling in the section in question during the day and the hours affected by the closure during the accident: 159,032 vehicles transporting 181,296 passengers.⁶



³ Joshua, S. (2014), "Estimation of the Cost of Traffic Delay Due to the Major Fire in Phoenix near I-10 on Feb 20th 2014", Intelligent Transportation Systems and Transportation Safety, University of Virginia, Phoenix, Arizona.

⁴ Information provided by telephone by the Ministère des Transports du Québec (current name: Ministère des Transports, de la Mobilité durable et de l'Électrification des transports).

⁵ *Idem*.

⁶ Information provided by the Ministère des Transports du Québec (current name: Ministère des Transports, de la Mobilité durable et de l'Électrification des transports). The information available for this section is for the period from April 12 to July 6, 2015.

- > Average number of passengers per vehicle: 1.14.⁷
- > Average hourly wage for employees, Montréal region:⁸ \$23.06.⁹
- > Time spent waiting for drivers affected by the accident: due to a lack of observed and accurate data in this regard, we used three wait time hypotheses for our calculations, namely: 30, 60 and 90 minutes.
- > Total duration of operation: 7 hours and 45 minutes (from 4 p.m. to 11:45 p.m.).¹⁰
- > SIM resources used: 61 units (firefighters and vehicle: pumpers, aerial ladders, specialized hazardous material teams, etc.) and 17 SIM fire chiefs and senior managers.
- > Average operation duration for each responder: 4 hr.
- > Hourly cost of a SIM pumper with four firefighters: \$718.59.
- > Hourly cost of a SIM ladder truck with three firefighters: \$948.54.
- > Hourly cost of a SIM vehicle designed for operations involving dangerous materials, with four firefighters: \$1,092.26.
- > Hourly cost of a SIM protection and rescue vehicle with four firefighters: \$546.13.
- > Estimated average hourly cost of a SIM fire chief: \$310¹¹
- > Quantity of emulsifying agent used during the operation: 1,660 gallons,¹² namely: three 500-gallon trailer tanks and two 80-gallon pumper tanks. Four trailers and six pumpers were initially sent to the site to provide the emulsifying agent.
- > Cost per gallon of the emulsifying agent used by the SIM: \$46.20.¹³

7 Information provided by the Ministère des Transports du Québec (current name: Ministère des Transports, de la Mobilité durable et de l'Électrification des transports). The Phoenix study used the same information.

8 As of the date of the study. The information may have changed since that time.

9 Institut de la statistique du Québec. *Weekly and hourly earnings of employees, by administrative region and all of Québec, 2013-2017* [Available online in French only], 2017, [www.stat.gouv.qc.ca/statistiques/profils/comp_interreg/tableaux/tra_remuneration.htm] (Consulted on October 31, 2017).

10 Information provided by the SIM. The operation duration was calculated from the moment the first unit arrived at the site to the moment the last unit left.

11 The information regarding the hourly cost of the various SIM units was taken from the RÈGLEMENT SUR LES TARIFS DE L'AGGLOMÉRATION DE MONTRÉAL (EXERCICE FINANCIER 2017) RCG 16-055 [By-law concerning fees of the urban agglomeration of Montréal (fiscal 2017)].

12 Internal SIM information, validated with the lieutenant – instructor in charge of the procurement and supply of foam on the site during the operation.

13 Internal SIM information, 2017 unit cost.

RESULTS

a) Economic costs

Given the assumption that each driver is actively employed and likely driving to their place of work, the traffic delay represents a cost in economic terms. Drivers who are unable to proceed, or who are slowed down, are prevented from being at their job, for which they receive compensation. This situation also represents a loss of revenues for the employer as well as lost productivity. All these costs have an economic value for economists.

By intervening quickly and efficiently on Highway 40 on August 9, 2016, thereby reducing the time each driver waited in traffic, the SIM reduced the monetary losses of the drivers involved and minimized the losses of the companies whose employees were unable to reach their workplaces.

The operation carried out by the SIM resulted in economic benefits given that the less time people spend in traffic, the more quickly the economic system can be back up and running. Losses caused by waiting are therefore reduced.

The SIM's successful operation helped preserve the infrastructure of Highway 40 West. The scenario of a complete closure due to the incident would have resulted in major reconstruction costs. In addition to the direct costs related to infrastructure reconstruction, the drivers' additional wait time would also have to be taken into account given that they would have faced daily traffic delays during the entire highway reconstruction period. This scenario would have represented a major economic impact due to the loss of access to the highway.

It is important to add that companies would also have incurred additional losses (lost productivity, losses due to the transportation and distribution of goods and services produced, etc.) because the traffic would have been redirected, in part, to other roads in the area, resulting in more traffic and additional economic consequences for the entire economy of the metropolitan region.

The MTQ (currently referred to as the MTMDET: Ministère des Transports, de la Mobilité durable et de l'Électrification des transports) was unable to provide us with precise and comprehensive information on the wait time of Highway 40 users at the time of the accident for the following reason: the MTQ only calculates the vehicle flow rate on the highway, not on the on- and off-ramps and the surrounding access roads. It is nevertheless easy to imagine that the accident had as much of an impact on the access roads and on- and off-ramps as it did on the highway itself. The figures herein are therefore the result of the best possible estimates according to the data available.

We therefore began by calculating the cost of the average wait time using information provided by the MTQ, which varied between 30 and 90 minutes. We based our numbers on three scenarios: 30, 60 and 90 minutes. Our numbers are presented in the following chart.

Therefore, for a median wait time of 60 minutes, the total economic cost related to the accident would be 4.2 million dollars. If, however, the average wait time was only 30 minutes, the cost would be 2.1 million dollars. In the event of a 90-minute wait time, the economic cost of the wait time would be close to 6.3 million dollars.

The cost of driver* wait time due to the accident based on three scenarios

Wait time in min.	Vehicle flow rate	Number of passengers	Value in \$
30	79,516	90,648	2,090,343
60	159,032	181,296	4,180,686
90	238,547	271,944	6,271,029

* refers to drivers who were between the Acadie Blvd. on- and off-ramps and Saint-Hubert Street (East) or Christophe-Colomb Street (West)

We then used anecdotal evidence (observation and personal accounts) to take our wait time estimate further, placing it between 30 minutes and 4.5 hours, based on where the vehicles were situated on the highway and on the on- and off-ramps affected by the accident. This estimate seemed more credible than the three scenarios taken from the MTQ data.

The vehicles located very near the accident or near an off-ramp left the area very quickly, i.e. in about 5 minutes. However, the wait time began to increase exponentially immediately thereafter, as cars began to multiply on the highway and on the on- and off-ramps. Some people reported delays of 3.5 to 4 hours due to the accident.

We therefore set the median wait time at 2.5 hours, resulting in an economic value of \$10,451,715 related to the operation.

b) Cost of the operation

The cost of the SIM's operation in terms of resources involved (61 units and 17 SIM fire chiefs on the accident site for an average of 4 hours each) can be broken down as follows:

Ressource	Quantity	Unit cost	Duration	Total
Pumper	24	\$718.59/hr	4 hr	\$68,984.64
Aerial ladder	10	\$948.54/hr	4 hr	\$37,941.60
Hazardous material team	5	\$1,092.26/hr	4 hr	\$21,845.20
Protection and rescue team	9	\$546.13/hr	4 hr	\$19,660.68
Chief/senior manager	23	\$310.00/hr	4 hr	\$28,520.00
Emulsifying agent	1,660 gal	\$46.20/gal	n/a	\$76,692.00
				\$253,644.12

The cost of the SIM's operation: \$253,644.12.

SCOPE OF STUDY

Clearly, the SIM's operational response was exceptionally effective due to the department's internal expertise, the quick response time and the significant resources available when the tragedy struck (specialized hazardous material team, fire service instructors available to assist with positioning and supplying the pumpers, extinguishing foam available in large quantities, fire chiefs managing the logistics and coordinating operations, etc.). However, it is impossible to accurately measure the operational effectiveness of the response of the SIM's teams given the exceptional nature of the event. For the purposes of this study, the operation is therefore assumed to have been optimal.

What's more, the economic value presented here was largely underestimated, namely by approximately 50%. This was partly due to the fact that the proportion of people who waited 30 minutes at the beginning of the operation is no doubt much lower than the proportion of people who waited over two hours, which would increase the operation's economic value. In addition, the following aspects were not included in the calculation due to the limitations of our mandate. It is important to note that through the use of recognized calculation methods, it would have been possible to include them.

- > Due to the excessive heat of the initial fire caused by the fuel, the fire spread by radiation to two buildings located close to the site of the accident, north of the highway on Crémazie Street. The fire-fighting operations for the fires in those buildings each involved different types of resources. The building located at 555 and 561, Crémazie Blvd. East suffered the most damage. It is a three-storey commercial building with a financial institution on the ground floor and offices on the other floors. The other building is the 13-storey office building located at 565 Crémazie Blvd. East. The buildings and the companies inside each have an economic value that can be calculated.¹⁴ The firefighters' actions in those buildings therefore also represent an economic impact that was not taken into account in the final result.
- > For the purposes of calculating the economic value of the SIM's operation, only the vehicle wait time caused by the operation was calculated, and not the wait time following the operation, namely until both sides of the highway were reopened. There was clearly a wait time following the operation, although it was likely shorter than during the operation and a smaller number of vehicles were affected. This is significant in that it affects the results, making them even more conservative.¹⁵
- > The firefighters' operation prevented an interruption of air traffic in the corridor above the accident site, which constitutes an economic value that was not added to the final calculation.¹⁶
- > The SIM firefighters' ability to contain the liquid contaminants in the tanker truck and the quick extinction of the fire limited contamination of the ground and underground infrastructure (sewers, water treatment plant and watercourse). In addition, by applying foam quickly and on an ongoing basis, the firefighters were able to extinguish the fire, thereby limiting the atmospheric pollution. The total environmental impact of the fire was therefore limited, which also increases the economic value.¹⁷

14 Useful resource: Delorme, François, and Dave Waterhouse, *Report: Analysis of the Economic Impact of the Service de Sécurité Incendie de Montréal's Interventions for Year 2015*, Montréal, Service de sécurité incendie de Montréal, 2017.

15 The total period during which Highway 40 was closed due to the incident and to the highway reconstruction time was 13.5 hr in the eastbound direction and 38 hr in the westbound direction. (Internal SIM information: The operation duration was calculated from 4 p.m., when the first units arrived, to 11:45 p.m., when the last SIM unit left the site, for an operation duration of 7 hours and 45 minutes.)

16 For an idea of the economic impact of the SIM's operation on the activities of the Pierre Elliott Trudeau International Airport, consult: Aéroports de Montréal, *The Economic and Fiscal Impacts of The Activities at Montréal-Trudeau Airport Site*, 2015, [Available online], [http://www.admtl.com/sites/default/files/ImpactsTrudeau_ANG_final-Pages.pdf] (Consulted on November 1, 2017).

17 For an overview of how the economic value of an ecosystem can be determined, consult: Massicotte, Ève, *Évaluation de la valeur économique des biens et services écologiques: démarche, méthodes et exemple du lac Brompton*, 2012 [Available online], [https://www.usherbrooke.ca/environnement/fileadmin/sites/environnement/documents/Essais2012/Massicotte_ME_15-02-2012_.pdf] (Consulted on November 22, 2017) and Government of Canada, *Economic value of the environment*, 2013, [Available online], [<https://www.canada.ca/en/environment-climate-change/services/air-pollution/quality-environment-economy/economic-issues/value.html>] (Consulted on November 22, 2017).

- > Certain costs could not be included in our calculations due to their complexity or the difficulty in accessing data. For instance, the costs related to the drinking water used, the assistance provided by a contaminant collection company and the person-hours of individuals other than SIM responders who were on site throughout the operation (MTQ employees, police officers and SQ and SPVM staff members, MTQ and City of Montréal engineers, etc.) were not included in the total costs related to the SIM's operation.

CONCLUSION

The economic cost of an accident that occurs on a highway at rush hour is always very high because it increases with every passing second. That is why a quick response from emergency services is so vital. The accident addressed in this report occurred in August, a month when the car traffic volume is relatively low. Clearly, had it occurred during a busier period of the year, such as in October or February, an accident such as this one would have resulted in an astronomical economic cost.

With regard to the operation carried out on Highway 40 on August 9, 2016, given the estimated economic value of \$10,461,715, we can conclude that for each dollar spent by the SIM (the total cost of the operation was \$253,644.12), there was a return on investment of 4,120.62%. It can also be concluded that operations carried out on highways result in an added economic value that is significantly greater than operations conducted in commercial buildings where jobs are at stake. This is due to the economic value of the losses resulting from the time people spend waiting in their vehicles.

A comparison may be drawn between this study and the study conducted on the economic impact of the SIM's operational activities in 2015. That study demonstrated that, for fires in commercial buildings where jobs were at stake, the return on investment was 527.5%.¹⁸ A fire-fighting operation in a commercial building involves a set number of employees per building whose economic value is related to a single business sector. In the case of the operation carried out on August 9, 2016, on Highway 40, the vehicle flow rate and the countless number of drivers affected resulted in a much higher economic value given that the repercussions extended far beyond a single company to affect a vast number of companies, business sectors and families. These repercussions were directly related to the time the drivers spent waiting in their cars due to the traffic disruption.

¹⁸ Delorme, François, and Dave Waterhouse. *Report: Analysis of the Economic Impact of the Service de Sécurité Incendie de Montréal's Interventions for Year 2015*, Montréal, Service de sécurité incendie de Montréal, 2017, p.47.



Finally, this study has highlighted the importance of quickly assigning an adequate number of competent emergency resources. The effectiveness of any given operation relies not only on this fact but also on proven work methods and the availability of modern equipment. Given the unique characteristics of the infrastructure in Montréal, a major city and the province's economic hub, resources of this kind are clearly necessary.

Phoenix's fire department was the first to develop a methodology for calculating the economic value of a fire-fighting operation on a highway. Although we adapted their methodology to our reality, the limitations of the calculations presented herein demonstrate the extent to which the model can be improved. By sharing our approach, it is our hope that others will perfect it so further progress can be achieved.







