

**QUEEN ELIZABETH WAY / MARTINDALE ROAD
BRIDGE DEMOLITION DETOUR ANALYSIS**

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ABSTRACT

The Queen Elizabeth Way (QEW) in St. Catharines, Ontario, was closed in both directions to facilitate the demolition of the Martindale Bridge from midnight on Saturday, October 17 to 10am on Sunday, October 18.

All QEW traffic was diverted onto detour routes. The QEW has an AADT of approximately 66,400 vehicles at Martindale Road, and an hourly volume of approximately 1,800 vehicles from Saturday midnight to Sunday 10:00am. This is a particularly unique location given the limited parallel routes for crossing the Welland Canal and other watercourses. Due to the magnitude of the closure, a detailed Traffic Management Plan and Communications Plan were developed to ensure road users were provided ample advance notification and guidance to safely and efficiently navigate around the closure, or change their trip in space or time.

To monitor the effectiveness and performance of the planning activities and detour routes, travel time and traffic volume data were collected using in-vehicle Global Positioning Satellite (GPS) data loggers, as well as, in-pavement Inventory Count Management Station (ICMS) detection loops.

The analysis showed that the communications plan achieved a 38.9% reduction in volume from the area. There was no delay, or very little, on any of the detour routes. Detour routes were chosen because of their available residual capacity. During the QEW closure, police officers were used to increase the capacity at signalized intersections for the detoured traffic. All lanes of the QEW opened on schedule as well as the traffic management plan and communications plan were extremely effective in detouring traffic with minimal or no delay.

INTRODUCTION

This study is an analysis of the detour required for the full closure of the Queen Elizabeth Way (QEW) to facilitate the demolition of the Martindale Road bridge structure. The demolition took place during the early morning hours of October 18, 2009, as part of MTO contract number 2007-2027. The contraction contract was for the widening of the QEW from four lanes to six lanes from Highway 406 to the base of the Garden City Skyway.

The demolition occurred from midnight Saturday October 17, 2009 to 10 am Sunday October 18, 2009. Single lane closures began at 11pm and a full closure of the QEW was implemented at midnight, at which point all QEW traffic was diverted onto detour routes. The QEW has an AADT of approximately 66,400 vehicles at Martindale Road, and an hourly volume of approximately 1,800 vehicles from midnight on Saturday to 1 am on Sunday. This is a particularly unique location given the limited parallel routes for crossing the Welland Canal and other water courses. Because of the magnitude of the closure, a detailed Traffic Management Plan and Communications Plan were developed to ensure road users were provided ample advance notification and guidance to safely and efficiently navigate around the closure, or change their trip in space or time. It was important to conduct a thorough traffic operational analysis to measure the effectiveness of the planning efforts and detour routes.

The site investigations included visual observations, as well as the use of GPS loggers, in-road loop detectors and hose counters. The Martindale Road bridge structure is shown in Figure 1.



Figure 1: Aerial of Martindale Road Bridge

DETOUR ROUTE SELECTION

Two main corridors were affected by the closure. Given the uniqueness of the location, proper detour route selection and signing plans were critical to ensure motorists did not get lost or perform any illegal manoeuvres. The signed detour routes were as follows:

QEW: Toronto to/from Niagara/Fort Erie (QEW at 7th Louth Street to/from the QEW/Hwy 420 split).

Thorold Stone Road Detour:

Toronto Bound

QEW → Thorold Stone Road → Hwy 58 → Hwy 406 → QEW

Fort Erie Bound

QEW → Hwy 406 → Hwy 58 → Thorold Stone Road → QEW

Ontario Street Detour:

Toronto Bound

QEW → Ontario Street → Hwy 406 → QEW

QEW – HWY 405: Toronto to/from Lewiston USA (QEW at 7th Louth Street to/from Hwy 405/Stanley Avenue).

Thorold Stone Road Detour :

USA Bound

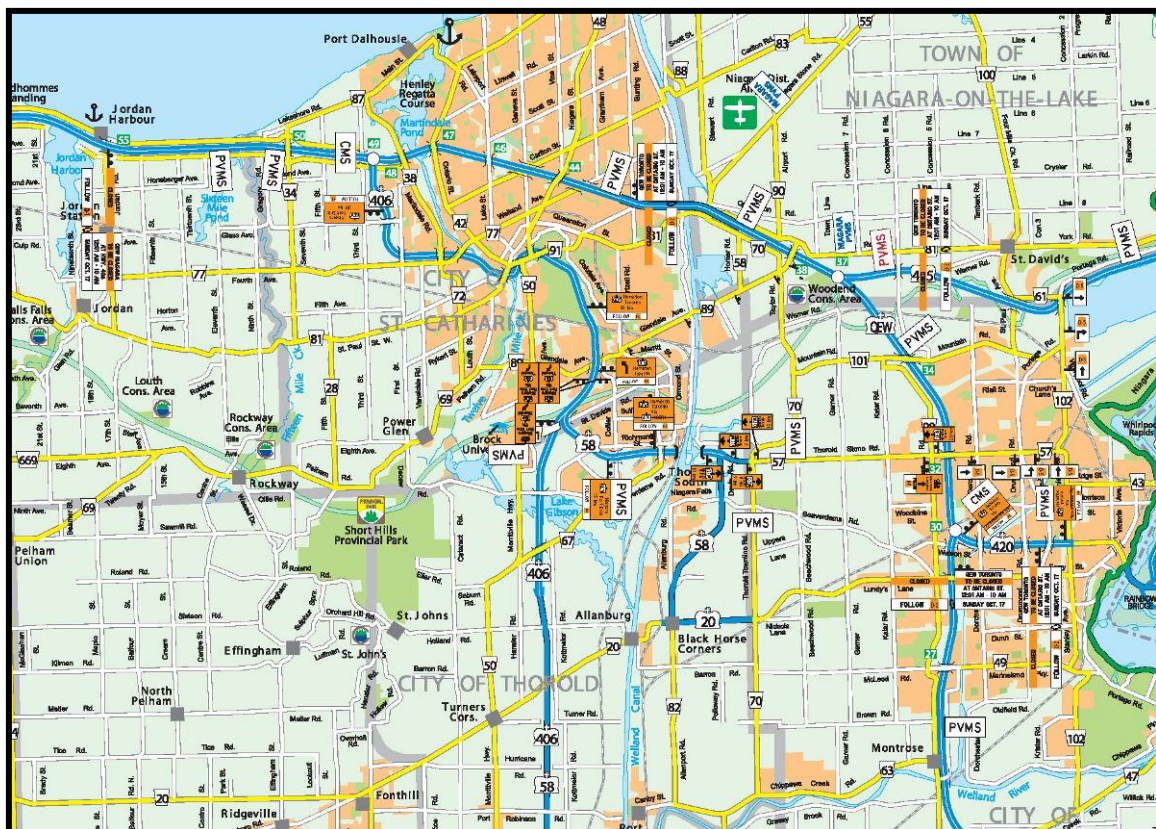
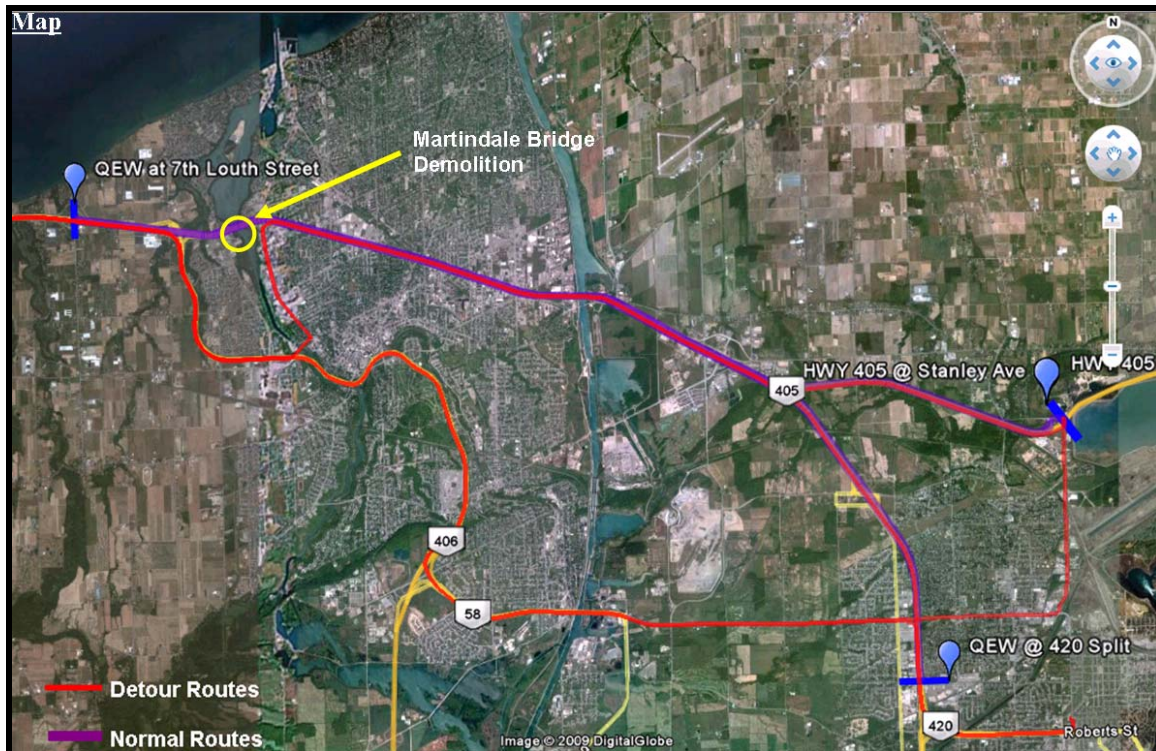
QEW → Hwy 406 → Hwy 58 → Thorold Stone Rd → Stanley Ave → Hwy 405

Ontario Street Detour:

Toronto Bound

Hwy 405 → QEW → Ontario Street → Hwy 406 → QEW

The routes are shown in Figure 2 and the signing plan is included in Figure 3.



COMMUNICATIONS PLAN

An important consideration of a full freeway closure is advance notification to the public. Given the large impact of this project, an extensive communications plan was developed. The following methods were used to disseminate pertinent information:

- **Electronic Signing:** Overhead Changeable Message Signs (CMS) and portable Variable Message Signs (PVMS) were used to display messages to motorists in the corridor 5 days in advance of the closure.
- **Press Releases:** Used to spread the word via media outlets.
- **Interviews with Weather Network and Radio Stations:** Conducted to spread the word via media outlets.
- **Stakeholder Notification:** Stakeholders were notified early in the planning process to garner their support, allow them to plan their operations accordingly and/or share information through their normal information channels. The list of stakeholders included:
 - Niagara Region, City of St. Catharines
 - Ontario Provincial Police and Niagara Regional Police
 - Federal border agencies
 - Ontario Trucking Association
 - Media: St Catharines Standard, Niagara Weekly, Welland Tribune, Niagara Falls Review, CHCH
 - Fire Services: St. Catharines and neighbouring municipalities
 - Niagara EMS
 - Casinos
 - Tourist information centres
 - NITTEC
 - Canada/U.S. bridge authorities
 - Churches west of Lake St in St. Catharines
 - Residents & businesses along Ontario Street

TRAVEL TIME STUDY

GPS loggers (GlobalSat, 2006) were used to measure travel times between specific locations along the network. The locations are marked in blue on the map in Figure 2. The summary of the travel times for the 8 possible route combinations are shown in

Table 1. Travel times for the detour routes were collected during the QEW closure as well as during free flow conditions to have a baseline comparison. These results were used for the delay analysis and for identifying which routes required a queue analysis.

Table 1: Results from Travel Time Study

No	Route	QEW Opened		QEW Closed and Taking Detour Route					
		Google Directions	Driving Time (mm:ss)	Detour	Google Directions	Free Flow (mm:ss)	Just Before Closure (mm:ss)	Initial Closure (mm:ss)	During Closure (mm:ss)
A	QEW-QEW Toronto Bound	11 min 19.6km	11:49*	TSR	23 min 23.6km	17:16/17:18	Same as free flow times*	Same as free flow times*	16:57
B	QEW-QEW Fort Erie Bound	11 min 19.6km	11:49	TSR	22 min 23.2km	17:08/16:11	Same as free flow times*	Same as free flow times*	15:54
C	QEW-QEW Toronto Bound	11 min 19.6km	11:49*	Ontario St	19 min 25.4km	19:28	Same as free flow times*	Same as free flow times*	18:29
D	QEW-QEW Fort Erie Bound	11 min 19.6km	11:49	Ontario St	20 min 24.7km	18:30	Same as free flow times*	Same as free flow times*	18:13
E	405-QEW Toronto Bound	12 min 19.0km	12:55*	TSR	31 min 28.2km	23:30	Same as free flow times*	Same as free flow times*	24:00*
F	QEW-405 USA Bound	11 min 18.9km	11:55	TSR	29 min 28.1km	22:58	Same as free flow times*	22:44	24:00*
G	405-QEW Toronto Bound	12 min 19.0km	12:55*	Ontario St	18 min 24.6km	19:28*	23:02	24:18	18:10
H	QEW-405 USA Bound	11 min 18.9km	11:55	Ontario St	19 min 23.8km	19:10	Same as free flow times*	Same as free flow times*	18:30*

* Calculated using different segments

TRAFFIC QUEUE/DELAY ANALYSIS

The queue and delay analysis was accomplished by analyzing the data in Table 1.

Regular QEW Travel Times

The normal travel time on the QEW and Hwy 405 for all four possible baseline routes (between end points as highlighted in blue in Figure 2) is approximately **12 minutes**. The four routes are:

1. All QEW: Toronto to Niagara/Fort Erie
2. All QEW: Niagara/Fort Erie to Toronto
3. QEW-HWY 405: Toronto to Lewiston USA
4. QEW-HWY 405: Lewiston USA to Toronto

1.1 Regular Conditions - Detour Routes: (9pm-11pm)

Based on free flow conditions, travel times using the detour routes from end point to end point would be as follows:

- 1) **Ontario Street Detour** (for all four baseline routes):
A travel time of approximately **20 minutes** was recorded resulting in an additional travel time of **8 minutes**.
- 2) **Thorold Stone Road Detour** (Between Toronto and Fort Erie/Niagara: both directions):
A travel time of approximately **17 minutes** was recorded resulting in an additional travel time of **5 minutes**.
- 3) **Thorold Stone Road Detour** (Between Toronto and Lewiston USA: both directions):
A travel time of approximately **24 minutes** was recorded resulting in an additional travel time of **12 minutes**.

In summary, the detours added between 5 and 12 minutes to the travel time, under free flow conditions.

1.2 Immediately Prior to Closure (11pm-midnight)

Queues were observed along the QEW just before the full closure was implemented commenced when 1 lane was closed in each direction to prepare for the bridge demolition. The queues extended for a maximum of **2 km** in the Toronto bound direction and **1 km** in the Niagara bound direction (Figure 4). Delays did not exceed **10 minutes** in any direction.

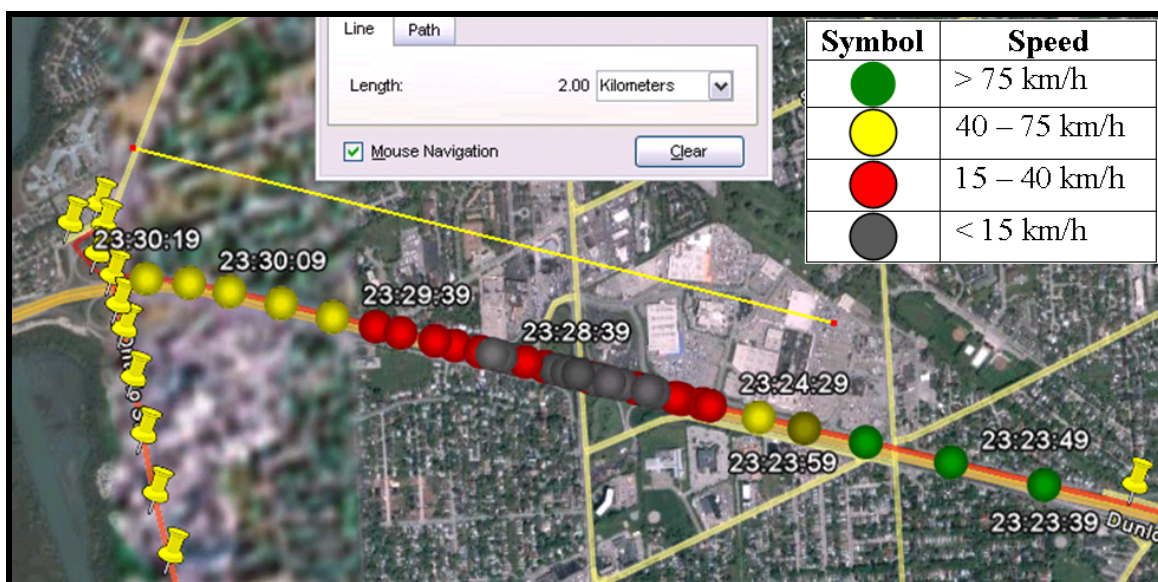
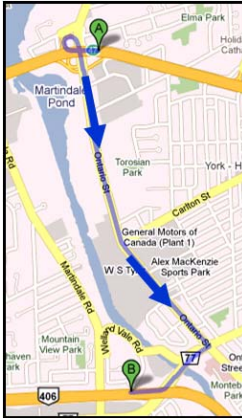


Figure 4: Queues and delays during single lane closure along QEW

1.3 Immediately After Closure (midnight-1am)

The QEW full closure occurred at midnight as scheduled. Toronto bound traffic was detoured onto Ontario Street and Niagara bound traffic was detoured onto Hwy 406.



On Ontario Street (Figure 5), all signalized intersections were controlled by police officers to increase the capacity for detoured traffic. The normal travel time along Ontario Street from the QEW to Hwy 406 in free flow conditions is 5 minutes. During the first hour after the QEW closure, the travel time on Ontario Street from the QEW to Hwy 406 was **10 minutes**, only 5 minutes more compared to free flow conditions.

Figure 5: Ontario Street Detour

For the QEW Niagara bound detour onto Hwy 406, no queues developed given that this is a two lane ramp and there is enough capacity to accommodate all the usual volume as well as the additional detoured QEW traffic.

The following was observed:

1) Ontario Street Detour (for all 4 baseline routes):

A travel time of approximately **24 minutes** was recorded, resulting in an additional travel time of **4 minutes** when compared to detour route free flow conditions, and an additional **12 minutes** when compared to using the QEW.

2) Thorold Stone Road Detour (Between Toronto and Fort Erie/Niagara: both directions):

A travel time of approximately **17 minutes** was recorded, resulting in an additional travel time of **0 minutes** when compared to detour route free flow conditions, and an additional **5 minutes** when compared to using the QEW.

3) Thorold Stone Road Detour (Between Toronto and Lewiston USA: both directions):

A travel time of approximately **24 minutes** was recorded, resulting in an additional travel time of **0 minutes** when compared to detour route free flow conditions, and an additional **12 minutes** when compared to using the QEW and Hwy 405.

1.4 During Closure (1am-2am)

After the initial queues from the first hour of the QEW closure dissipated and traffic volumes decreased, there were no more delays along the Ontario Street detour. In fact, travel times were shorter on this detour route compared to normal given that officers were controlling the signalized intersections and allowing vehicles along the detour route to get through the intersections without stopping.

During this time period the following was observed for the Ontario Street detour:

A travel time of approximately **19 minutes** was recorded resulting in a reduced travel time of **1 minute** compared to free flow conditions and an additional **7 minutes** compared to using the QEW.

1.5 During Remainder of Closure (2am-10am)

Based on free flow conditions and low volumes, it was no longer necessary for the police officers to control the signalized intersections after 2am.

In the hour prior to the 10am opening of the QEW, the location and extent of delays were similar to what was observed in the first hour of the QEW closure.

TRAFFIC VOLUME AND DIVERSION ANALYSIS

Traffic counts for the weekend of the demolition and the weekend after the demolition were taken at various locations along the detour routes to determine the amount of traffic that diverted. Given that the QEW was under construction it should be noted that loop counters along the QEW were not operational, therefore it was not possible to collect volume information along the QEW. Traffic count locations are listed below and shown in Figure 6:

1. Ontario Street Off-Ramp from QEW (10060)
2. Hwy 405 at Stanley (48610 Ramp 61)
3. Hwy 406 - 0.9 km W. of 4th Louth Ave (48720-0090) – *Southbound Counts*
4. Hwy 406 - 0.9 km W. of 4th Louth Ave (48720-0090) – *Northbound Counts*
5. Hwy 406 - Westchester (48715-0080) – *Southbound Count*

6. Hwy 406 - Westchester (48715-0080) – *Northbound Counts*
7. Hwy 58 – W. of Pine (32753) – *East Bound Counts*
8. Hwy 58 – W. of Pine (32753) – *West Bound Counts*
9. Hwy 58 – W. of Thorold Stone Road (32746) – *East Bound Counts*
10. Hwy 58 – W. of Thorold Stone Road (32746) – *West Bound Counts*
11. QEW – N. of McLeod (10032-0150) – *Combined Directional Counts*
12. QEW at Thorold Stone Road (10043-Ramp 24)
13. QEW at Thorold Stone Road (10043-Ramp 34)
14. QEW at Thorold Stone Road (10043-Ramp 43)
15. QEW at Thorold Stone Road (10043-Ramp 42)

In order to calculate the total diversion of traffic from the QEW, it was necessary to use 2006 QEW volumes (latest available counts). For the purposes of the analysis, it has been assumed there has been no increase in volumes on the QEW since 2006. This is a conservative assumption, hence the results, presented later in this paper, are conservative.



Figure 6: Location of volume counts

1.1 Ontario Street Section of Detour Route

The Toronto Bound QEW at Ontario Street was one of the most critical locations during the full closure. Typically, the Toronto Bound QEW carries 1,035 vehicles at Martindale Road from midnight to 1 am (based on 2006 data). During that same time period, 51 vehicles exit the QEW at Ontario Street. If nothing was done to help reduce traffic volumes, an additional 1035 vehicles would be detoured to Ontario Street. The maximum directional capacity of Ontario Street is less than 800 vph (1 lane each direction and signalized intersections). Figure 7 shows traffic volumes for the Ontario Street off-ramp during the night of the QEW closure and the weekend after.

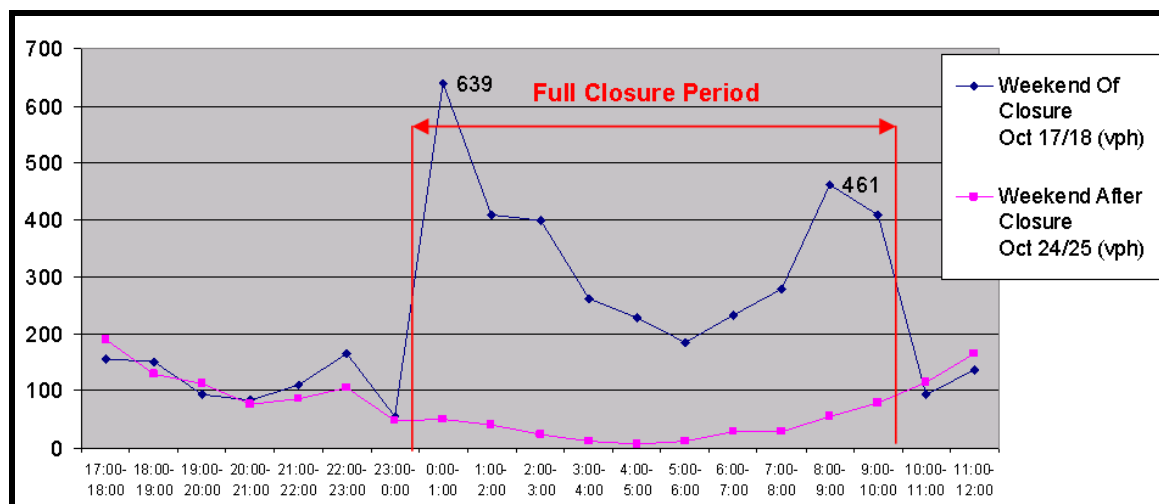


Figure 7: Volumes at QEW Off Ramp to Ontario Street

The peak hour occurred immediately after the closure when a total of **639** vehicles used the ramp as opposed to the usual **51** that would normally exit the QEW at that time. The increase in ramp traffic was only **588** vehicles, despite the fact that the Toronto bound QEW typically carries 1,035 vehicles. As a result of the reduced volume, and the presence of police officers at the signalized intersections, traffic flowed well on Ontario Street. As noted earlier, the delay on Ontario Street was only 5 minutes.

Diversion Rate for Toronto Bound QEW traffic at Ontario Street

It was possible to calculate the diversion rate by comparing ramp volumes during the QEW closure to typical QEW Toronto Bound volumes. This had to be done using 2006 mainline counts (most recent counts). The results are presented in Table 2.

Approximately 50% of motorists that would typically be on the QEW Toronto bound either decided not to drive at that time or chose to use the Thorold Stone Road detour.

Table 2: Diversion Rate for Toronto Bound QEW Traffic at Ontario Street

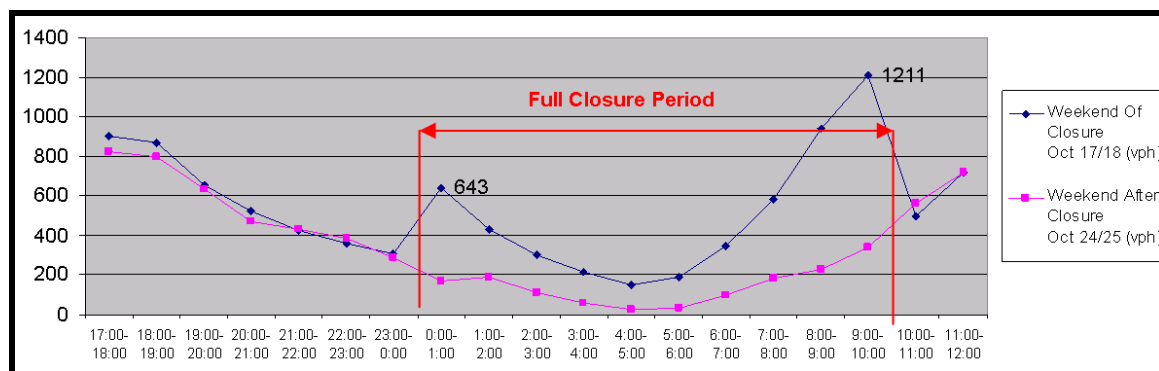
Typical Mainline QEW Toronto Bound Volumes at Martindale* (*Taken from 2006 Fall counts)	Mainline QEW Toronto Bound Volume Counts During Full Closure	Diverted Vehicles	Percent Diversion
1035	588	447	43.19%
760	369	391	51.45%
672	375	297	44.20%
522	250	272	52.11%
334	221	113	33.83%
333	173	160	48.05%
352	206	146	41.48%
379	250	129	34.04%
715	406	309	43.22%
1230	330	900	73.17%
6332	3168	3164	49.97%

1.2 Hwy 406 Section of the Detour Route

Niagara Bound Traffic

For the Niagara bound direction of the QEW, all traffic was diverted onto southbound Hwy 406 when the QEW closure was implemented. Given that the freeway to freeway ramp is two lanes, no queues developed and motorists slowed only slightly to make the required lane changes onto Hwy 406.

The increase in volumes on Highway 406 represents the traffic that would have taken the QEW but was diverted to Hwy 406. The volume increases for the southbound direction of Highway 406 (Niagara bound) are shown in Figure 8.

**Figure 8: Southbound Volumes on Highway 406 North of 4th Louth Ave**

The total volume increase on Highway 406 Niagara bound during the QEW closure was 3,574 vehicles compared to the 6,017 vehicles that normally travel on QEW Niagara bound. Volume data under normal conditions and during the closure are shown in Figure 9.

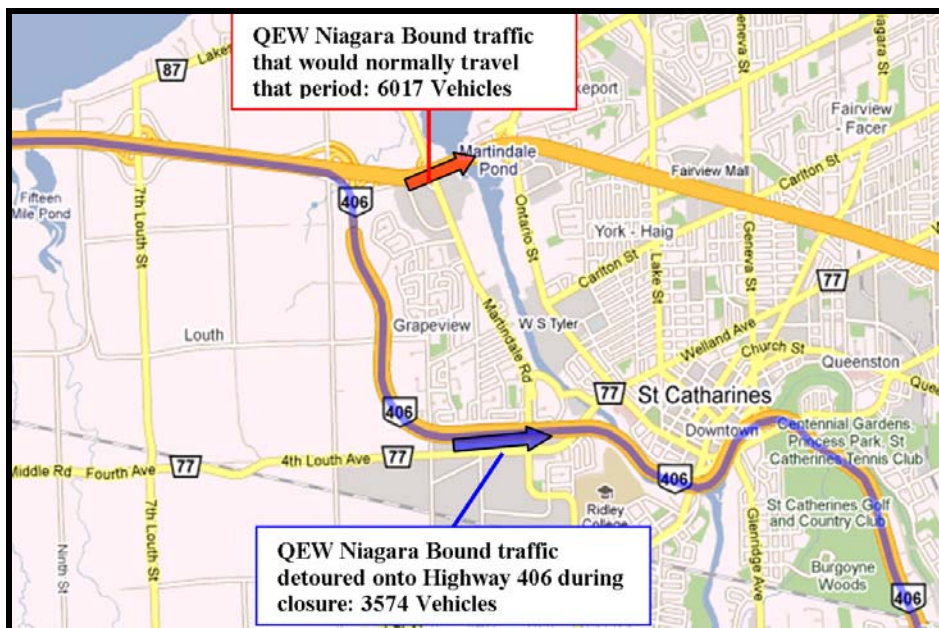


Figure 9: Hwy 406 Niagara bound Traffic Flows

In order to determine the effectiveness of the communication plan in regard to QEW Niagara bound traffic, diversion rates were calculated and are presented in Table 3. The overall diversion rate was 40.6%.

Table 3: Percent Reduction in Niagara bound Traffic

From-To	QEW Traffic during closure at Martindale (Diverted to 406)	Existing QEW Traffic at Martindale (2006 Data)	Percent Reduction
0:00-1:00	473	646	26.8%
1:00-2:00	242	390	37.9%
2:00-3:00	195	232	15.9%
3:00-4:00	155	175	11.4%
4:00-5:00	123	144	14.6%
5:00-6:00	157	180	12.8%
6:00-7:00	249	401	37.9%
7:00-8:00	401	702	42.9%
8:00-9:00	708	1331	46.8%
9:00-10:00	871	1816	52.0%
Total	3574	6017	40.6%

Toronto Bound Traffic

For the Toronto bound direction of the QEW, motorists had the choice of taking the Thorold Stone Road detour or stay on the QEW and be forced off at Ontario Street. Both detour routes eventually lead to Hwy 406 northbound, and then back onto the QEW.

The volume increase for Highway 406, north of the 4th Louth Ave interchange, represents the total volume of traffic that would have taken the QEW but had to take a detour route instead. This volume increases on Hwy 406 (Toronto Bound) are shown in Figure 10.

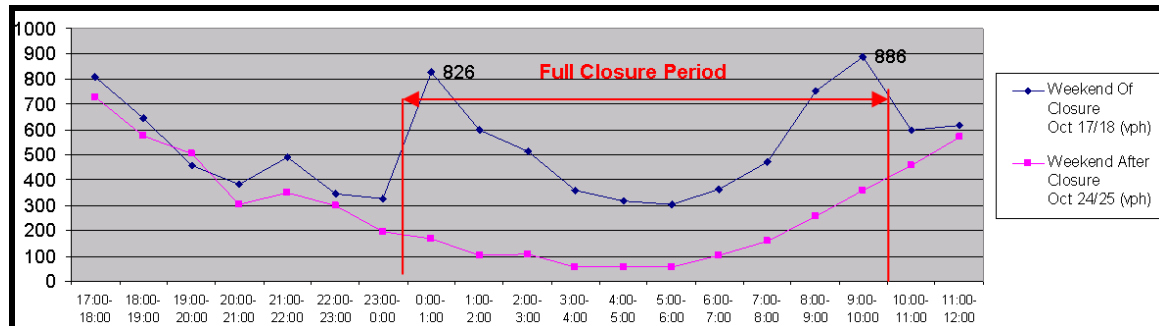


Figure 10: Northbound Volumes on Highway 406 North of 4th Louth Ave

The total volume increase on the northbound direction of Highway 406 during the closure was 3,975 compared to the 6,332 vehicles that would normally be on QEW Toronto bound. The flow of normal and detoured traffic is illustrated in Figure 11.



Figure 11: Toronto bound Traffic Flow during closure

In order to determine the effectiveness of the communication plan in regard to QEW Toronto bound traffic, diversion rates were calculated and are presented in Table 4. The overall diversion rate was 37.2%.

Table 4: Percent Reduction in Toronto bound Traffic

From-To	QEW Traffic during closure at Martindale (Diverted to 406)	Existing QEW Traffic at Martindale (2006 Data)	Percent Reduction
0:00-1:00	657	1035	36.5%
1:00-2:00	495	760	34.9%
2:00-3:00	407	672	39.4%
3:00-4:00	305	522	41.6%
4:00-5:00	263	334	21.3%
5:00-6:00	249	333	25.2%
6:00-7:00	262	352	25.6%
7:00-8:00	315	379	16.9%
8:00-9:00	495	715	30.8%
9:00-10:00	527	1230	57.2%
Total	3975	6332	37.2%

Total Traffic Diversion in Area

From the volume counts on Highway 406, both directions, it was possible to determine the total increase in traffic volumes during the closure. This increase represents the total number of motorists affected by the full closure of the QEW. Comparing the increase in Hwy 406 traffic volume to the existing QEW traffic volumes (based on the 2006 traffic counts for the same time), it was possible to determine the overall diversion rate for the Toronto bound and Niagara bound directions.

Adding the traffic volumes in both directions from midnight to 10am gives the total number of vehicles that are usually on the QEW. This number is 12,349. The total number of vehicles affected by the closure who had to use a detour route are 7,549. This gives a total diversion rate or reduction of traffic through the area of 38.9%. This is the traffic that “disappeared” from the network. The significant volume reduction can be attributed to the advance notification that was given to the public. The extensive communication plan was effective in diverting many motorists in time or space.

Optional Toronto bound Thorold Stone Road Detour Route diversion rate

The Thorold Stone Road detour route in the Toronto bound direction was an optional detour for motorists. They were not forced off the QEW at this point, however this alternate was highly recommended since motorists would not have to use Ontario Street. The variable messaging signs informed Toronto bound drivers that the QEW would be closed at Martindale Road and they should use the Thorold Stone Road detour. Although many motorists did use this detour, a large number chose not to, or were not familiar with it. It was calculated that 807 motorists used the Thorold Stone Road detour. Accordingly, 20.3% of all drivers in the Toronto bound direction chose this option. It should be noted that all motorists entering the QEW downstream of Thorold Stone Road had no choice but to proceed to Ontario Street.

1.3 Thorold Stone Road Optional Detour Route Exit

The QEW on and off ramps at Thorold Stone Road were monitored to ensure queues did not develop at the ramp terminals.

For the QEW Toronto bound off ramp to Thorold Stone Road, the volume increases are shown in Figure 12.

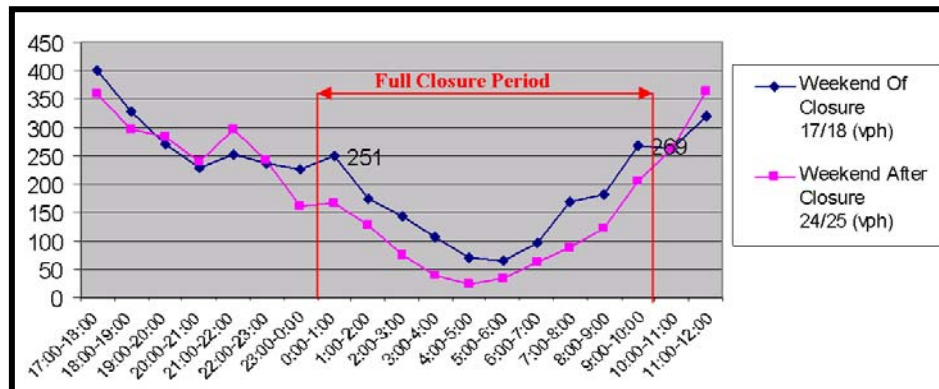


Figure 12: Ramp volumes from QEW to Thorold Stone Road

The increase in volumes reflects those drivers who elected to take this alternate detour route.

For the Thorold Stone Road Niagara bound on ramp to QEW, the volume increases are shown in Figure 13.



Figure 13: Ramp volumes from Thorold Stone Road to QEW

It is noted that the increase in volumes at this location is not as prominent as other locations. This fact implies that some motorists were not intending to drive all the way to Niagara/Fort Erie or beyond, but had destinations upstream of the end of the detour.

The peak volumes at the on-ramp to QEW were all lower than available capacities. No queues or delays were experienced at this location.

1.4 Hwy 405 Traffic

Data collected on Hwy 405 at Stanley Avenue indicated that there was very little volume on Hwy 405 during the hours of the closure. The ministry had decided not to install any signing on the Toronto Bound Hwy 405. All motorists thus proceeded to the Ontario Street detour. For QEW eastbound motorists that needed to access Hwy 405, detour signing guided motorists to Hwy 406, Hwy 58, Thorold Stone Road, Stanley Ave, and then to Hwy 405.

SUMMARY

Major findings of the detour travel time analysis and traffic volume analysis are as follows:

- Despite the full closure of the QEW, travel times on the detour routes were only **5 to 12 minutes** longer compared to driving on the QEW. Free flow conditions were experienced throughout the network with the exception of the Toronto bound direction at Ontario Street immediately after the closure and immediately before re-opening.
- The longest queues experienced were on the Toronto bound QEW during the single lane closure at Martindale between 11pm and midnight. Queues varied from **1 km to 2 km** in length. However, this only produced delays of **5-10 minutes**.
- After the closure began, the greatest delay was for Toronto bound motorists who were forced off at Ontario Street. It took an additional **12 minutes** to drive the detour route compared to driving on the QEW. This is a significant achievement considering the normal traffic volumes on the QEW at that time are much larger than the available capacity on Ontario Street.
- In the QEW Niagara bound direction, all the traffic was forced onto Highway 406 during the QEW closure. The ramp is two lanes wide, therefore no queues or delays developed.
- Delays and queues experienced on the detour routes were well within acceptable ranges for a freeway closure. In fact, traffic flow on the detour routes was much better than could ever be expected
- The use of Inventory Management Counting Stations (IMCS) and Global Positioning Satellite (GPS) loggers were effective means of collecting volume and travel time data.

- **38.9%** of motorists who normally travel the QEW during the 10 hour period adjusted their trips by choosing a different time or different route, or didn't travel altogether. This significant reduction in volume was critical to the successful operation of the detour routes. The extensive traffic management plan and communication plan were highly effective.

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