Air Quality in Halton

Air Monitoring Report 2015

The Regional Municipality of Halton | July 2016

Halton REGION

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Introduction

Air quality is affected by pollution emitted both locally and from other jurisdictions and brought to Halton Region by long-range and regional atmospheric transport. Air pollution sources include electrical energy generation and consumption, heating, transportation, industry, and biogenic (produced by living organisms or biological processes) and agricultural processes. Levels of air pollution are not only affected by the amount of pollutant emitted, but also by atmospheric processes, local geography, and meteorology such as wind speed and direction, relative humidity, atmospheric stability, rainfall, and sunlight intensity. Poor air quality poses a risk to human health and the environment in Halton Region and across southern Ontario. **Table 1** summarizes the sources of five common air pollutants and their effect on human health and the environment.

Table 1: Air pollutant summary table.

Pollutant	Sources	Effects
Ozone (O_3)	Ozone is not directly emitted but forms in the atmosphere when nitrogen oxides and volatile organic compounds react in the presence of oxygen and sunlight.	Short-term exposure to O_3 can irritate the eyes and respiratory tract. Children and people with pre-existing respiratory and cardiovascular conditions and those active outside during the summer months are at greatest risk. Ozone has been linked to increased hospital admissions and premature mortality and also contributes to climate change and agricultural crop loss and damages many synthetic materials.
Fine Particulate Matter (FPM or $PM_{2.5}$ – particles with a diameter of 2.5 micrometres or less)	$PM_{2.5}$ is a mixture of aerosol particles, both solid and liquid, with a wide range of sizes and chemical composition. It is emitted from natural and anthropogenic sources such as fuel combustion for transportation, industry, heating and power generation, agriculture burning, and forest fires. $PM_{2.5}$ may be 'primary' (emitted directly from a source) or 'secondary' (formed in the atmosphere from other emissions, e.g., SO_2, NO_x, ammonia and volatile organic compounds).	$PM_{2.5}$ affects the respiratory and cardiovascular systems. Elevated levels over a number of days can cause eye, nose, and throat irritation and can worsen symptoms of pre-existing conditions such as asthma, chronic obstructive pulmonary disease, and chronic bronchitis. Both short-term and long-term exposures have been linked to morbidity and premature mortality.
Nitrogen Dioxide (NO_2)	Most NO_2 in the atmosphere is not directly emitted but forms from nitric oxide (NO) which is formed during fuel combustion. NO_2 and NO together make up NO_x (nitrogen oxides).	NO_2 largely affects the respiratory system by increasing susceptibility to respiratory infections and worsening pre-existing conditions. People with asthma, chronic bronchitis, and chronic obstructive pulmonary disease have increased sensitivity to NO_2. NO_2 also contributes to acid rain.
Carbon Monoxide (CO)	CO is emitted primarily from incomplete combustion. Almost 90% of CO emissions in Ontario are from vehicles.	CO can cause headache, dizziness and disorientation and at high levels may lead to unconsciousness and respiratory failure. Ambient air levels in Halton Region are not considered a health risk, though in certain outdoor settings, CO from a nearby source can be hazardous.
Sulphur Dioxide (SO_2)	SO_2 is formed mainly from combustion of fuels containing sulphur. In Ontario, smelters and electric utilities are the major sources of SO_2. Petroleum refining, cement and concrete manufacturing are also important sources.	SO_2 aggravates asthma and can reduce lung function and worsen symptoms of respiratory and cardiovascular conditions. People with asthma or chronic heart or lung conditions are most susceptible. SO_2 also contributes to acid rain.

Sources of Information: Air Quality in Ontario 2011 (Ontario Ministry of the Environment); Air Pollution Fact Sheet 2013 (European Environment Agency) and Brook, R.D. et al., 2010.

Ambient Air Monitoring in Halton Region

The Ontario Ministry of the Environment and Climate Change (MOECC) operates two air quality monitoring stations in southern Halton Region as part of a network of 40 air quality monitoring stations throughout Ontario. One monitoring station is located in Burlington, at Highway 2 and North Shore Boulevard E., and one station is located in Oakville, at Eighth Line and Glenashton Drive.

As part of a comprehensive air quality program aimed at community air emissions, and to complement the southerly locations of the MOECC monitoring stations, Halton Region has an air monitoring station located in Milton on the south end of the property of the Bishop Reding School at 1120 Main Street East. The continuous air monitoring data collected at this site are used to generate the Air Quality Health Index (AQHI) for residents in Milton and Halton Hills. Real-time data are accessible from the Region's air quality web page: www.halton.ca/airquality.

Figure 1: Air quality monitoring stations. shows the locations of the three permanent monitoring sites in Halton Region. The Milton air monitoring station is equipped with monitors that measure the same five common air pollutants monitored by the MOECC: ground-level ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO). The air monitoring instruments are identical to those used in the provincial air monitoring network and are operated following MOECC protocols and are periodically audited by the MOECC. This enables comparison of air quality data collected in Milton by Halton Region to air quality data collected in Oakville and Burlington by the MOECC.

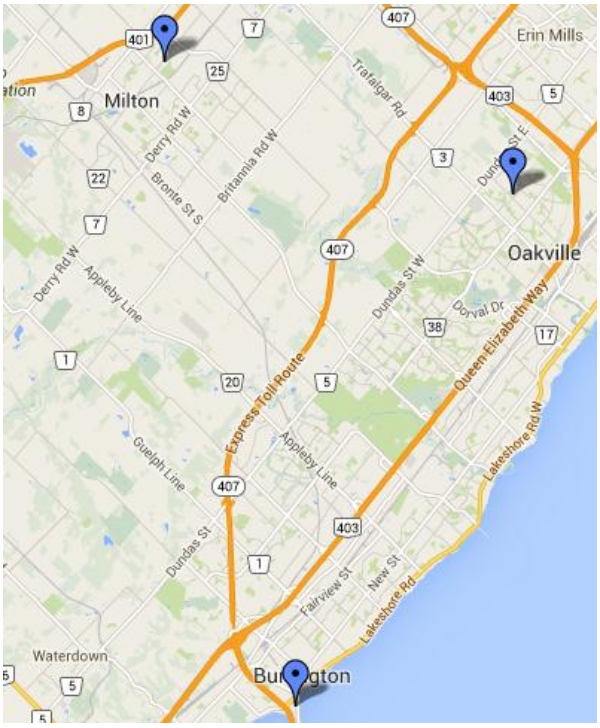

Figure 1: Air quality monitoring stations.

This is the seventh annual report on ambient air quality in Halton Region. The report focuses on the five common air pollutants, which in terms of adverse health effects are the most commonly studied pollutants (**Table 1**: Air pollutant summary table.). Air quality data collected from the Milton station are compared against air quality standards as well as 2015 air quality data available for Burlington and Oakville (http://www.airqualityontario.com/). Results of the federal Air Quality Health Index are also summarized.

Canadian Ambient Air Quality Standards (CAAQS)

The new Canadian Ambient Air Quality Standards (CAAQS) are more stringent than the previous Canada-wide Standards (CWS) and a new annual $PM_{2.5}$ standard has been introduced. See **Table 2** for the changes from the old CWS to the new CAAQS.

Table 2: Comparison of CWS to CAAQS for $PM_{2.5}$ and O_3.

Pollutant	CWS	CAAQS	
		2015	2020
Annual $PM_{2.5}$	n/a	10 µg/m³	8.8 µg/m³
24-Hour $PM_{2.5}$	30 µg/m³	28 µg/m³	27 µg/m³
8-Hour O_3	65 ppb	63 ppb	62 ppb

Ground Level Ozone (O_3)

Annual mean O_3 concentrations in parts per billion (ppb) for three monitoring locations in Halton Region (green circles) and for several other locations (blue circles) in the surrounding area for 2015 are shown in **Figure 2**.

Table 3 shows the summary statistics for O_3 in 2015, including the maximum 1 hour concentration in parts per billion (ppb), maximum 24-hour concentration (ppb), number of hours each monitoring station recorded above the one-hour ambient air quality criterion (AAQC) of 80 ppb, and the annual mean concentration (ppb). Annual mean O_3 concentrations do not vary much between municipalities, while the maximum hourly and daily values show some differences.

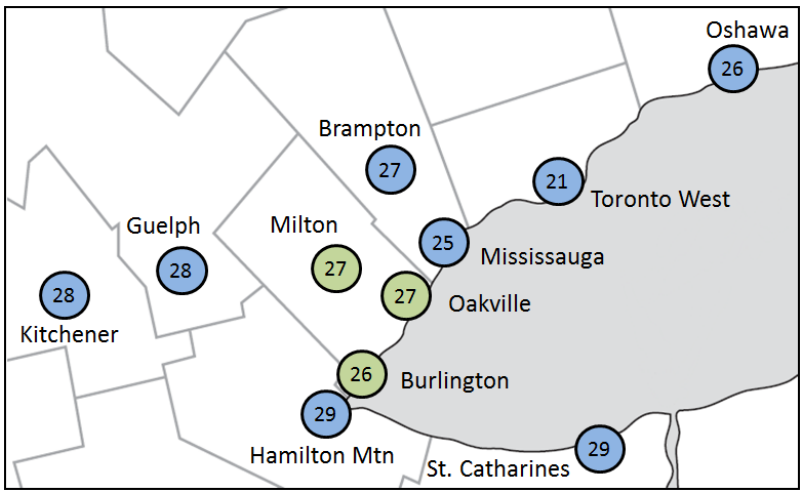

Figure 2: Annual mean ozone concentrations (ppb) in Halton Region and surrounding area, 2015.

Table 3: Summary statistics for O_3, Halton Region, 2015.

Monitoring Station	1-hr Maximum (ppb)	24-hr Maximum (ppb)	# of hours >80 (ppb)	Annual Mean (ppb)
Milton	80	60	0	27
Oakville	80	58	0	27
Burlington	84	53	1	26

The Canadian Ambient Air Quality Standard (CAAQS)

The 2015 Canadian Ambient Air Quality Standard (CAAQS) for O_3 is 63 ppb over an eight-hour averaging time. This value is calculated based on the fourth highest daily maximum eight-hour average concentration annually, averaged over three consecutive years (known as the “determination period”).

The CAAQS values for the 2015 determination period are shown in **Figure 3**: CAAQS for O_3 (ppb), Halton Region and surrounding area, 2015 determination period., for Halton Region (green bars) compared to other MOECC monitoring sites (blue bars) in the surrounding area. Of the comparison locations shown here, only Oshawa was below the CAAQS for O_3 (63 ppb) in 2015.

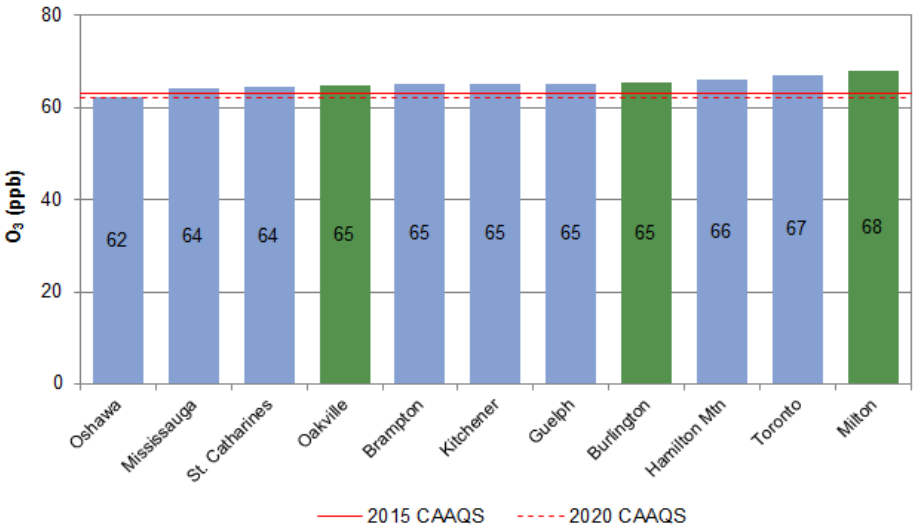

Figure 3: CAAQS for O_3 (ppb), Halton Region and surrounding area, 2015 determination period.

Fine Particulate Matter ($PM_{2.5}$)

The mean annual $PM_{2.5}$ concentrations in micrograms per cubic meter of air ($\mu g/m^3$) for three monitoring locations in Halton Region and for several other locations in the surrounding area for 2015 are shown in **Figure 4**.

Table 4 shows summary statistics for $PM_{2.5}$ in 2015. It is important to note that the annual mean is slightly higher than it has been in the past due, at least in part, to an improvement in monitoring technology in 2013. Caution should be used when comparing $PM_{2.5}$ measurements for 2013 and onwards to previous years.

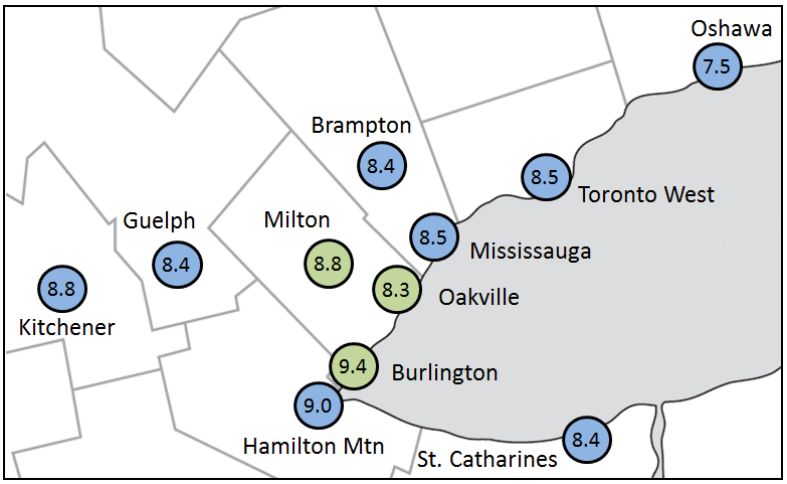

Figure 4: Mean annual $PM_{2.5}$ concentrations ($\mu g/m^3$) in Halton Region and surrounding area, 2015.

Table 4: Summary statistics for $PM_{2.5}$, Halton Region, 2015.

Monitoring Station	1-hr Maximum ($\mu g/m^3$)	24-hr Maximum ($\mu g/m^3$)	# of days >28 $\mu g/m^3$ [1]	Annual Mean ($\mu g/m^3$)
Milton	61	30	2	8.8
Oakville	55	34	1	8.3
Burlington	56	34	2	9.4

[1] # of days > 28 $\mu g/m^3$ refers to a 24-hour reference value.

The Canadian Ambient Air Quality Standard (CAAQS)

There are two Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$. One is 28 $\mu g/m^3$ based on a 24-hour averaging time, calculated from the 98th percentile measurement annually, and averaged over three consecutive years. The other is based on an annual average of 10 $\mu g/m^3$ calculated on a 3-year average of the annual average concentration.

Calculated metrics for the 24-hour $PM_{2.5}$ determination period in Halton (green bars) are shown in **Figure 5** compared to surrounding area monitoring sites (blue bars). All of the monitoring locations were well below the 24-hour CAAQS for the 2015 determination period.

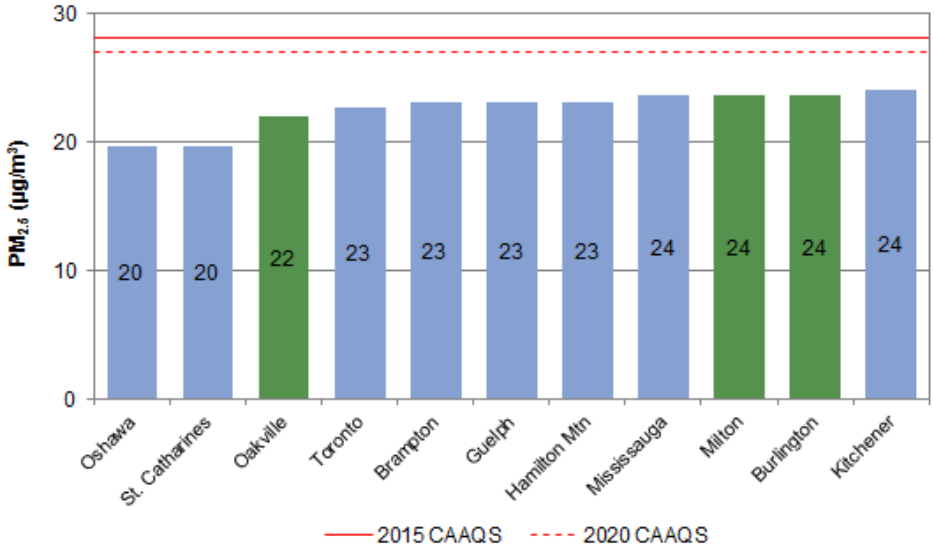

Figure 5: 24-hour averaging time CAAQS for $PM_{2.5}$ ($\mu g/m^3$), Halton Region and surrounding area, 2015 determination period.

Figure 6 shows calculated metrics for the annual $PM_{2.5}$ determination period in Halton (green bars) compared to surrounding area monitoring sites (blue bars). All of the monitoring locations were below the annual CAAQS of 10 $\mu g/m^3$ for the 2015 determination period.

CAAQS may be influenced by transboundary flows (TF) and exceptional events (EE) and these may be accounted for in CAAQS determination. Assessing TF and EE is important for air quality management purposes but is not important from the perspective of human exposure. In this report, TF and EE have not been assessed in the CAAQS determination.

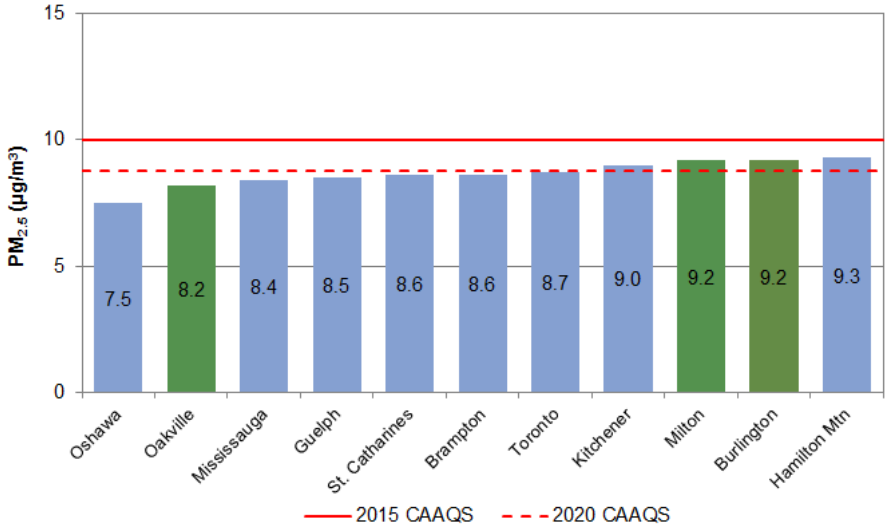

Figure 6: Annual CAAQS for $PM_{2.5}$ (µg/m3), Halton Region and surrounding area, 2015 determination period.

(Transboundary flows are the transport of air pollution across provincial and territorial boundaries, and between Canada and the United States. Exceptional events contribute to air pollution levels in an air zone which i) are not reasonably controllable or preventable, or ii) are caused by human activities which are unlikely to recur, or iii) are due to natural sources.)

Nitrogen Dioxide (NO_2)

Table 5 shows summary statistics for NO_2 for 2015. For Milton, Oakville, and Burlington the maximum 1-hr and 24-hr measurements are all well below their respective AAQC values.

Table 5: Summary statistics for NO_2 (ppb), Halton Region, 2015.

NO_2 (ppb)				Number of AAQC Exceedances	
	Annual Average	1-hour Maximum	24-hour Maximum	1-hr: 200	24-hr: 100
Milton	9	56	31	0	0
Oakville	7	52	33	0	0
Burlington	10	58	33	0	0

Carbon Monoxide (CO)

Carbon monoxide is measured in only a few locations across Ontario. The closest monitoring station to Halton Region that measures CO is Toronto West, located next to Highway 401 and Weston Road, and comparison statistics are provided in **Table 6**. For both Milton and Toronto West, the maximum 1-hr and 8-hr measurements are all well below their respective AAQC values. When comparing CO results it is important to keep in mind that the lower limit of detection for the CO monitor is around 0.08 ppm, and any values around this lower limit are unreliable and may be due to the "noise" of the monitor, rather than actual CO.

Table 6: Summary statistics for CO (ppm), Milton and Toronto West, 2015.

CO (ppm)				Number of AAQC Exceedances	
	Annual Average	1-hour Maximum	8-hour Maximum	1-hr: 30	8-hr: 13
Milton	0.18	1.0	0.5	0	0
Toronto West	0.25	1.3	0.8	0	0

Sulphur Dioxide (SO_2)

Sulphur dioxide is measured in only a few locations across Ontario. The closest monitoring station to Halton that measures SO_2 is Mississauga although historically this report has compared Milton results with Toronto West which also measures CO. This year, Mississauga results for SO_2 are added and comparison statistics are provided in **Table 7**. For all three monitoring stations, the maximum 1-hr, 24-hr, and annual average measurements are all well below their respective AAQC values. It is important to keep in mind when comparing the annual averages that the lower limit of detection for the SO_2 monitor is around 1 ppb, and any values around this lower limit are unreliable and may be due to the "noise" of the monitor, rather than actual SO_2.

Table 7: Summary statistics for SO_2 (ppb), Milton, Toronto West and Mississauga, 2015.

SO_2 (ppb)				Number of AAQC Exceedances		
	Annual Average	1-hour Maximum	24-hour Maximum	1-hr: 250	24-hr: 100	Annual: 20
Milton	1.1	19	5	0	0	0
Toronto West	1.0	15	4	0	0	0
Mississauga	1.1	35	5	0	0	0

Air Quality Health Index (AQHI)

The Air Quality Health Index was developed by Federal and Provincial governments in consultation with health professionals. The AQHI is a colour-coded health-based scale that indicates the level of health risk associated with local air pollution levels. The scale ranges from 1 to 10+ (
Table 8).

The AQHI is a communication tool which indicates:

- An air quality reading that ranges from 1 to 10+. A higher number indicates greater health risk.
- A category that describes the level of health risk associated with the index reading—low, moderate, high or very high health risk.
- Health messages tailored to an "at-risk" population and the general population.
- Current hourly AQHI readings and maximum forecast values for today, tonight and tomorrow.

Table 8: Air Quality Health Index health messages (Source: Environment Canada).

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population[1]	General Population
Low	1 - 3	Enjoy usual outdoor activities.	Ideal air quality for outdoor activities.
Moderate	4 - 6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7 - 10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	>10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

[1] The at-risk population includes children, seniors, and people of all ages with pre-existing heart & lung conditions.

Special Air Quality Statements (SAQS) are issued when forecast AQHI levels are predicted to reach high risk levels and to last for one to two hours. If a high risk AQHI level is forecast for a duration of at least three hours, then a Smog and Air Health Advisory (SAHA) is issued. No SAHAs were issued in Ontario for 2015. Two SAQS were issued for Halton-Peel. The first was on July 13th which also included the City of Toronto and York-Durham: AQHI readings did not reach the high risk category at any of the monitoring locations in City of Toronto, York-Durham or Halton-Peel. The second was on July 28th and included Sarnia-Lambton and the City of Toronto: AQHI levels did not reach the high risk category with the exception of 1 hour in Burlington. **Table 9** shows seven years of hourly AQHI readings from Milton. In 2009, 2010 and 2013 there were no readings in the high risk category (>6), however, in 2011, 2012, 2014 and 2015 there were 3 hours, 1 hour, 3 hours and 2 hours, respectively, at an AQHI reading of 7. The invalid readings are the total number of hours where an AQHI reading was not available.

Table 9: AQHI readings from Milton for seven years (per cent of hourly readings in low, moderate, high and very high risk categories).

	Low Risk (AQHI=1-3)	Moderate Risk (AQHI=4-6)	High Risk (AQHI=7-10)	Very High Risk (AQHI>10)	Invalid Readings
2009	84%	14%	0.00%	0%	2%
2010	83%	14%	0.00%	0%	3%
2011	85%	13%	0.03%	0%	2%
2012	85%	12%	0.01%	0%	2%
2013	86%	9%	0.00%	0%	5%
2014	84%	11%	0.03%	0%	5%
2015	86%	14%	0.02%	0%	1%

The AQHI for Milton can be viewed here (http://216.185.72.154/online.aspx?st_id=1;0).

Air Quality in Acton

The Health Department uses portable monitors to assess air quality in areas of the Region not covered by fixed-site monitors. To measure air quality in Acton, a portable sampler was installed at District One Fire Station (21 Churchill Road South) and operated for a period of one year from February 2014 to February 2015. Summary statistics for five common air pollutants are presented in **Table 10**.

The 12-month means for ozone and fine particulate matter are similar at both sites, which is expected given the more regional nature of these two pollutants. For nitrogen dioxide, the 12-month mean is higher at Milton than at Acton, and this too is expected as Milton is a larger community with more traffic and other NO_2 sources. The largest source of carbon monoxide emissions in Ontario is the transportation sector and higher CO levels in Milton than in Acton are expected. Another large source of CO emissions in Ontario is residential wood combustion and this may be contributing to CO levels in Acton. In any event, it should be noted that CO levels are near the lower measurement capability of the monitoring instrument and one should take care not to read too much into the differences between the two sites. For sulphur dioxide the differences between the two sites are expected: there is one large industrial source in Milton and nothing comparable in Acton. In Milton, 34% of the hourly SO_2 readings were zero and in Acton 79% of hourly SO_2 readings were zero.

No Ambient Air Quality Criteria (AAQC) were exceeded for any measured pollutant in either Milton or Acton during the monitoring period. Fine particulate matter, however, exceeded a 24-hour reference value of 28 $\mu g/m^3$ on a number of days (4 in Milton, 15 in Acton) and these results require explanation.

Table 10: Air Quality in Acton Compared to Milton (Feb. 2014 to Feb. 2015).

O_3 (ppb)	1-hour maximum	24-hour maximum	# Hrs >80	12-Month Mean
Milton	80	59	0	27
Acton	77	55	0	29

$PM_{2.5}$ (µg/m^3)	1-hour maximum	24-hour maximum	# Days >28 [1]	12-Month Mean
Milton	72	39	4	10.0
Acton	114	53	15	9.8

NO_2 (ppb)	1-hour maximum	24-hour maximum	# AAQC Exceeded	12-Month Mean
Milton	56	30	0	8
Acton	53	27	0	5

CO (ppm)	1-hour maximum	24-hour maximum	# AAQC Exceeded	12-Month Mean
Milton	0.93	0.36	0	0.14
Acton	1.97	0.48	0	0.17

SO_2 (ppb)	1-hour maximum	24-hour maximum	# AAQC Exceeded	12-Month Mean
Milton	25	5	0	1
Acton	16	3	0	0

[1] # of days > 28 µg/m³ refers to a 24-hour reference value.

The 1-hour maximum $PM_{2.5}$ concentration in Acton (114 µg/m^3) was measured on May 18th, 2014 for the hour beginning 21:00 (9 p.m.) on the Sunday evening prior to the Victoria Day Monday. This is almost certain to be related to fireworks which would be consistent with what the U.S. EPA sees in particulate matter results on July 4th in that country.

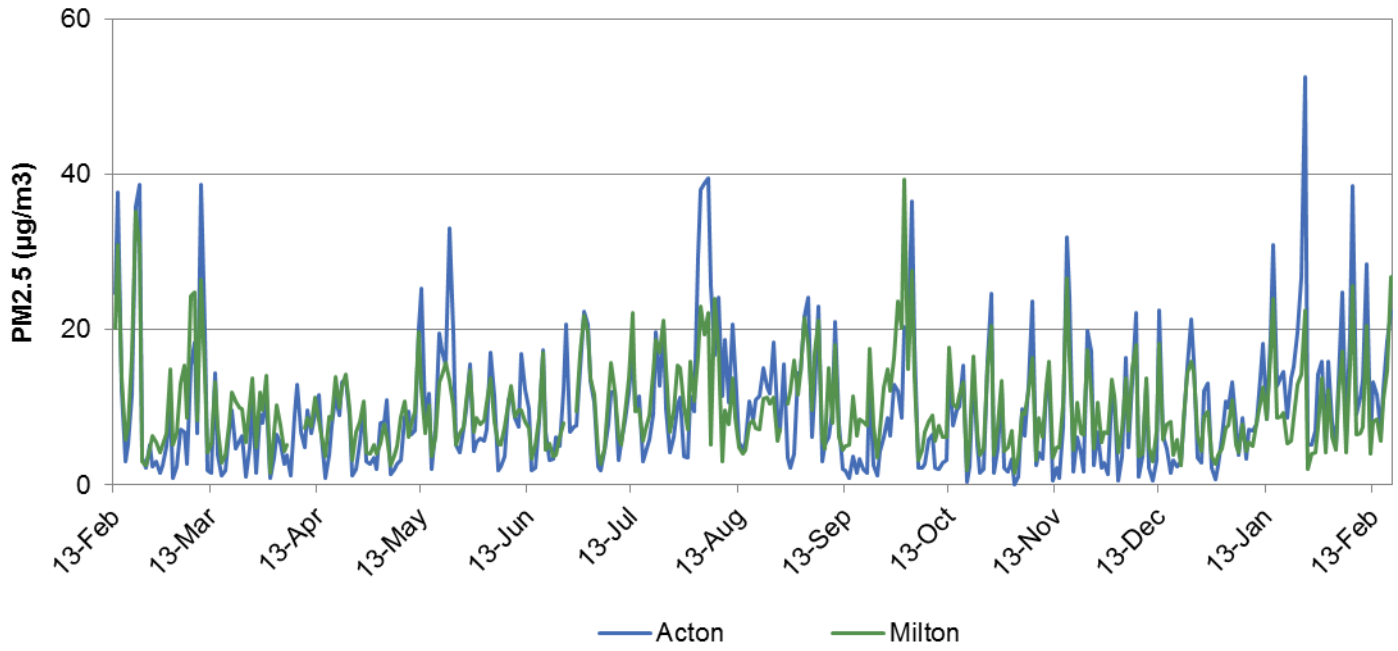

Figure 7: Daily average $PM_{2.5}$ concentration (µg/m3), Acton and Milton, February 2014-February 2015.

The 24-hour maximum average particulate matter concentration in Acton also was higher than in Milton. However, the levels of $PM_{2.5}$ in the two communities generally fluctuate together though the peaks are somewhat higher in Acton on some occasions (**Figure 7**). For example, during the first week of August 2014 air quality in the Greater Toronto-Hamilton Area was being influenced by wild fire smoke from western Canada

and the monitor in Acton recorded daily average particulate matter levels over 28 µg/m^3 while the monitor in Milton did not. In spite of these differences, the 12-month means for the two sites are very similar.

The Air Quality Health Index was calculated for Acton for each hour during the monitoring period. Results are shown in **Table 11** and compare favourably to the AQHI from Milton. In Acton only three hours were in the high risk category (>6) and in Milton only one AQHI reading was over 6.

Table 11: AQHI readings in Acton from February 2014 to February 2015 (per cent of hourly readings in low, moderate, high and very high risk categories) compared to Milton over the same period.

	Low Risk (AQHI=1-3)	Moderate Risk (AQHI=4-6)	High Risk (AQHI=7-10)	Very High Risk (AQHI>10)	Invalid Readings
Acton	86%	9%	0.03%	0%	5%
Milton	84%	11%	0.01%	0%	5%

Summary

Air quality data in Milton from 2015 were compared to 2015 data available from the MOECC for Oakville and Burlington. Results of the analysis indicated that average ambient concentrations of O_3 and $PM_{2.5}$ are relatively consistent among the Milton, Oakville, and Burlington monitoring stations. For NO_2, the 1-hour and 24-hour maximums are similar for all three sites though the annual average for Oakville is slightly lower than for Milton or Burlington. For CO the Milton monitoring station results were similar to those from the Toronto West monitoring station. For SO_2 the annual average and 24-hr maximum concentrations were similar across three sites (Milton, Toronto West and Mississauga), though the 1-hr maximum for Mississauga was higher than either Milton or Toronto West.

Due to an improvement in monitoring technology $PM_{2.5}$ measurements from 2013 onwards should not be compared to previous years.

Over a 12-month period (February 2014 to February 2015) air quality monitoring results from Acton compare well with results from Milton. An usually high 1-hour maximum $PM_{2.5}$ result from Acton is likely due to fireworks on the Sunday evening prior to the Victoria Day Monday, and in spite of more days over a $PM_{2.5}$ reference level in Acton, the 12-month means at the two locations were very similar as were the AQHI readings.

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