CHAPTER 7
Air Quality

7.0 Air Quality: Key Findings

Climate change projections and exposure pathways

- Climate change impacts (increased temperatures, longer growing seasons and precipitation patterns) to air quality relevant to York Region include:
    - Stagnant air masses during hot summer days contributing to poor air quality events
    - Long-range movement of air pollutants caused by wildfires
    - Increased allergenicity of pollen and length of pollen season
- The most common air pollutants associated with health impacts in Canada include ground-level ozone, fine particulate matter, nitrogen oxides and sulphur dioxide
- The main sources of air pollution in York Region include traffic-related air pollutants, industrial and residential emissions and transboundary pollutants
- Air quality in York Region has improved in the past few decades due to increased air quality regulations and decreasing emissions. However, ground-level ozone concentrations have remained similar over the past 10 years

Population sensitivity

- Substantial research highlights how individuals are at greater risk, particularly those with existing cardiovascular and respiratory conditions (e.g., asthma, allergies, and heart disease), seniors and children
- 70% of York Region residents are aware of the AQHI tool. 63% of York Region residents surveyed who were familiar with the Air Quality Health Index (AQHI) changed their behaviour at least half the time

Adaptive capacity

- Existing environmental monitoring activities include real-time AQHI conditions and short-term forecasts. Wildfire events are also integrated with federal air quality monitoring and forecasting
- Provincial and federal agencies provide notifications to the public and stakeholders for adverse air quality episodes
- Of 28 long-term care homes surveyed in York Region, 25 have reported that they have a plan to address poor air quality episodes
- Addressing local air pollution can have important direct and indirect co-benefits for health through supporting climate change mitigation

Health impacts

- Further analysis and modelling are required to estimate the burden of illness related to air quality and to estimate future climate change impacts

Recent trends:

- Health Canada estimates 230 annual non-accidental deaths attributed to above background levels of fine particulate matter; 25 annual respiratory deaths due to chronic exposure to ground-level ozone; 82 annual emergency department visits and 16 annual hospital admissions attributable to above background levels of ground-level ozone in York Region in 2010
- Fine particulate matter levels have decreased from 2000 to 2011 resulting in a 2.65% decrease in estimated premature mortality in York Region

Climate change will have important implications for air quality as weather conditions (e.g., temperature, wind, humidity and rainfall) play a large role on air pollutant chemistry, transport and build-up in the environment. Air quality can be impacted by chemical compounds or air pollutants and from the production of airborne allergens and/or aeroallergens (e.g., pollen from plant species and/or fungal spores from mould).

With respect to climate change impacts to air quality, the following impacts are most relevant to the York Region context:

- Stagnant air masses during hot summer days contributing to more favourable conditions for poor air quality events
- Longer growing season and thunderstorm events that may increase exposure to aeroallergens and fungi
- Longer dry and warm summer periods that may increase wildfire risk in other parts of Ontario or North America and contribute to increased smoke and levels of particulate matter that can impact air quality in York Region

This chapter provides information on existing air quality issues within York Region that relate to climate change, including current health outcomes and potential future impacts. Estimating current impacts from air quality and projecting future impacts of climate change in York Region is complex. It would require the use of climate change projection models, air quality models and understanding the projected exposure and vulnerability of the population. As a result, developing specific estimates within York Region was out of scope for this vulnerability assessment.

Additionally, wildfire events are noted in this chapter but are not discussed in detail due to the limited local information on wildfire risk in York Region. While an important consideration, wildfires are likely to occur in higher risk areas such as northern Ontario and western Canada. It should be noted that wildfire events in other parts of Ontario or Canada could also impact air quality in York Region depending on meteorological conditions. The Extreme Weather section of this report provides more context on wildfire events through an emergency planning lens.

This chapter notes the impacts of air quality on health and provides baseline health information relating to respiratory outcomes commonly associated with poor air quality exposure. However, recent hospital data for health outcomes, such as asthma and seasonal allergies, are not sufficient indicators for exposure to adverse air quality. The information is presented to provide a baseline understanding of potential respiratory outcomes as they may relate to air quality. Information is also provided on key air quality impacts, such as current air quality trends, poor air quality events and pollen, and how climate change may impact future air quality in York Region.

7.1 HEALTH IMPACTS FROM AIR POLLUTANTS

The wide-ranging health impacts from air pollution are well established, with substantial research supporting linkages between acute and chronic air pollution exposure and human health outcomes. Numerous studies have involved large populations and shown significant associations between various air pollutants and health outcomes such as the Canadian Census Health and Environment Cohort (CanCHEC) air pollutant exposure study.[120]

The most common health impacts associated with exposure to air pollutants include:

- Increased incidence of cardiovascular impacts and risk of myocardial infraction, angina, arrhythmia, hypertension, heart failure and stroke
- Respiratory impacts such as exacerbation of asthma and allergies, development of asthma in children and exacerbation of chronic obstructive pulmonary disease (COPD)
- Premature mortality, particularly for seniors[121]

Air pollution has also been categorized by the International Agency for Research on Cancer (IARC) as a carcinogen as a result of sufficient evidence on the mechanism causing cancer and from animal and human studies.[122]

7.1.1 Air pollutants of concern relating to climate change

While air pollution can be composed of thousands of different chemical compounds, certain pollutants are more common and there is strong evidence of their impact on human health. These common air pollutants include ground-level ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x) and sulphur dioxide (SO_2). Even very low concentrations of air pollutants can result in adverse health impacts, particularly for vulnerable individuals. For many of these pollutants no threshold has been identified below which no adverse effects on health may occur.

From a climate change perspective, ground-level ozone and fine particulate matter are more commonly researched due to their influences on poor air quality episodes. Exposure to O_3 results in acute and chronic damage to the respiratory system through increased airway reactivity, airway permeability, airway inflammation, reduced lung function and increased respiratory symptoms.[123]

Ground-level ozone is produced when NO_x and volatile organic compounds (VOCs), which come from natural and human sources such as local traffic and combustion sources, react with sunlight and stagnant air.[124] Ground-level ozone formation increases with greater temperatures and sunlight. In general, O_3 levels can often be highest in areas surrounding large cities and towns.[123] Stable, dry and hot conditions result in the most pollution build-up and O_3 production as abundant sunlight and heat are present for photochemical reactions in Canada. Lower levels of O_3 are associated with moderate, cool and moist weather.[125]

Fine particulate matter ($PM_{2.5}$) refers to particulate matter that is smaller than 2.5 microns in diameter and has been commonly linked to adverse impacts to human health.[123] Due to its small size, $PM_{2.5}$ is able to penetrate deep into the respiratory system when inhaled. In Ontario, residential fuel consumption (wood smoke for fireplaces and wood fueled stoves) accounted for 56% of $PM_{2.5}$ emissions in 2016.[123]

Exposure to $PM_{2.5}$ causes symptoms such as coughing or difficulty breathing, decreased lung function, aggravates asthma and COPD symptoms and development of chronic bronchitis, heart attack and arrhythmias.[126] The Environmental Burden of Cancer in Ontario report found that $PM_{2.5}$ in air pollution is one of the top three environmental carcinogens in Ontario, accounting for 290 to 900 new lung cancer cases annually.[72] The risk from exposure to $PM_{2.5}$ varies over a lifetime. It is higher in early childhood, lowering in healthy adolescents and young adults and increases again in middle age through old age as the incidence of heart and lung disease and diabetes increase.[126]

In general, local sources play a larger role in $PM_{2.5}$ levels in York Region with less impact from transboundary pollutants from the United States.[123] While these reflect the most common sources in Ontario, wildfire episodes can also increase $PM_{2.5}$ levels, with transboundary movement potentially playing a larger role.

7.1.2 Aeroallergens

Climate change is increasing the allergenicity of pollen, the amount of pollen produced and is potentially extending the length of the pollen season. Aeroallergens consists of organic particles, such as pollen and fungal spores, which are released from plants and mould. For individuals with pollen allergies, exposure results in congestion, sneezing, itchy eyes and allergic reactions. Existing allergies can also increase the severity of symptoms for those with asthma and other respiratory illnesses.[5] Each species has its own unique time period for the production and release of pollen. For example, tree pollen is released in the spring and ragweed in the fall.

Pollen has been associated with serious diseases, such as stroke and myocardial infarction.[127,128] Weichenthal et al.[128] found the risk of myocardial infarction was 5.5% higher on high pollen days than on low pollen days on same day exposures. This was based on data from Ontario cities collected during the pollen season (April to October) between 2004 and 2011. The study hypothesized that histamine responses may have contributed to coronary artery spasm. However, further analysis is required to better understand the relationship between aeroallergens and various health outcomes in York Region.

7.1.3 Combined effects

The combined effect of air pollutants, allergens and/or extreme temperatures can place individuals at greater health risk.[4] For example, exposure to aeroallergens and air pollutants significantly increased asthma hospitalization.[66] Additionally, Vanos et al.[64] found the relative risk of mortality for 12 Canadian cities related to $PM_{2.5}$ tripled in hot weather environments when compared to moderate weather while the risks from O_3 doubled. Similar studies have shown greater health impacts from O_3 with increasing temperatures.[5]

More research is needed to understand how exposures to allergens, air pollution and other weather variables such as extreme heat, interact to impact health risks. It is not currently clear which factors may act as precursors increasing sensitivity to other exposures, how individual sensitivities may differ for combined exposures or if a time lag can occur between different exposures. Some studies have suggested allergens combined with exposure to air pollutants may act synergistically to intensify allergic response and increase respiratory illnesses in the future.[129] Exposure to O_3, $PM_{2.5}$ and traffic-related air pollutants may alter the allergenicity of aeroallergens, increasing the frequency and severity of allergic reactions.[130] Exposure to O_3 has also been shown to increase airway responsiveness to allergens, while exposure to particulate matter and allergens has been linked to increased innate and adaptive immune responses implicated in the pathophysiology of airway disease.[66]

Heat, air pollution and aeroallergens can be significant to respiratory health when combined; however, their relative impacts on health may differ. Cheng et al.,[65] found the health burden due to heat is greater than air quality during extreme heat events.

Vulnerable populations

Air quality affects everyone's health, but certain groups are more likely to be adversely impacted. See Chapter 4 for more information on vulnerable populations in York Region. Populations more likely to be impacted by poor air quality include:

- **Individuals with pre-existing conditions**: Individuals with chronic diseases, particularly of the respiratory and cardiovascular systems, are at risk from exposure to air pollution that can result in increased chest tightness, coughing, wheezing and difficulty breathing.[4,5] Pre-existing conditions most at risk include asthma, COPD, hypertension and/or pre-existing heart conditions and diabetes. Air pollution levels that do not appear to affect healthy populations may cause trouble breathing for individuals in this group. Allergy sufferers may also experience more frequent and intense allergies due to changes in the pollen season

- **Children**: Children have faster breathing rates and smaller body sizes than adults, which can increase their exposure to airborne pollutants. Their lungs and immune systems are not fully developed, making them particularly sensitive to exposure from contaminants. Children who are active outdoors during the summer when air pollution is highest are particularly at risk[4,5]

- **Pregnant women**: Physiological changes, such as increased blood and plasma volumes and respiration rates can make women more vulnerable to pollutant exposure during pregnancy. There is also increased potential for adverse effects to the fetus during critical development stages. Long-term exposure to $PM_{2.5}$ has been associated with premature births and low birth weights[126]

- **Seniors:** Seniors may have functional and physiological limitations that impede their ability to acclimate. They may also suffer from pre-existing conditions that increase vulnerability to air pollution. Epidemiological studies of air pollutants show greater risk of adverse health effects in senior populations, including hospital admissions and premature mortality[5]

- **Outdoor workers and recreational activity:** Occupational exposure to extreme heat and air pollutants can increase the vulnerability of individuals. Similarly, people who spend time working or exercising outdoors during poor air quality days have increased exposure to air pollution and may be more vulnerable[131]

- **Individuals with low socioeconomic status:** Low-income individuals and those living in densely populated, urban areas typically have increased exposure to air pollutants, particularly traffic-related air pollution, when compared to rural areas. Studies have shown that low-income neighbourhoods tend to have higher rates of poor health outcomes attributed to air quality[5]

7.2 LOCAL HEALTH IMPACTS IN YORK REGION

A 2017 Health Canada assessment modelled the health impacts attributed to O_3, $PM_{2.5}$ and nitrogen dioxide in Canada.[132] The study estimated the following health impacts within York Region:[132]

- 230 non-accidental deaths attributed to above background levels of $PM_{2.5}$
- 25 respiratory deaths attributed to chronic exposure to O_3
- 82 ER visits and 16 hospital admissions attributable to above background levels of O_3

Certain pollutants have decreased in concentration over time, such as $PM_{2.5}$. In York Region, fine particulate matter concentrations decreased by almost 3 $\mu g/m^3$ between 2000 and 2011 and premature mortality was estimated to decrease by 2.65%.[132]

Hospital cases in York Region: Health outcome data are presented to provide a baseline understanding of trends for respiratory outcomes in York Region. It should be noted the information is different from the Health Canada estimates that modelled health impacts using the latest scientific research.

Table 7.1 presents the rate of emergency department (ED) visits in York Region from 2007 to 2017 for asthma, seasonal allergies and exposure to air pollution. Over the 11-year period, there were 22,045 ED visits for asthma and 249 ER visits for seasonal allergies.[50] There were only 24 cases of ED visits related to air pollution exposure, likely due to challenges in linking health conditions to air quality.

In general, the yearly ED visit rate for seasonal allergies is increasing while asthma rates are decreasing. Asthma case counts are substantially higher than allergies. This may relate to the severity of asthma conditions that require emergency medical attention. Many cases of seasonal allergies may be less severe and involve contact with family physicians. In terms of seasonal allergies, children 1 to 4 years of age had the highest ED visit rates, followed by those 5 to 9 years of age and those 85 years of age and older. Decreasing year over year asthma rates may be partly explained through improvements in air quality conditions, better management and treatment of asthma conditions or other changes in demographics other than age, such as increased immigrant populations.

Table 7.1. Case counts and age-standardized rates of emergency department visits for seasonal allergies and asthma between 2007 and 2017 in York Region.

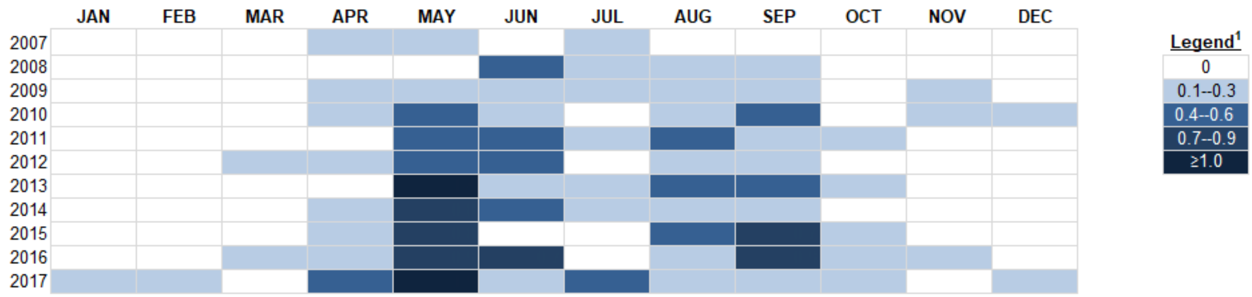
Case counts and rate per 100,000 population		
	Seasonal allergies (J301 and J302) [1, 2]	Asthma (J45)[2]
2007	5 (*)	2,296 (234.6)
2008	14 (1.4)	2,267 (225.2)
2009	13 (1.2)	2,056 (198.0)
2010	15 (1.4)	2,074 (196.5)
2011	17 (1.6)	1,949 (181.7)
2012	16 (1.4)	1,935 (176.9)
2013	32 (2.8)	1,952 (177.3)
2014	23 (2.0)	1,919 (170.4)
2015	27 (2.3)	1,859 (164.6)
2016	39 (3.5)	1,875 (164.5)
2017	48 (4.1)	1,863 (161.9)
Total	249	22,045

Case counts (rate per 100,000 population)
Data Source: Ambulatory Visits & Population Estimates, 2007-2017, IntelliHealth Ontario. Extracted May 2, 2019.
**** Rate too unstable to report***
[1] Any diagnostic code
[2]Age-standardized rate per 100,000

Source: Ambulatory Visits & Population Estimates, 2007-2017, Ontario Ministry of Health and Long Term Care, IntelliHealth Ontario. May 2019.

As expected, seasonal trends for allergies were observed that corresponded with pollen seasons. The rates were highest during the months of May and June (tree and grass pollen peak period) and September (ragweed peak) (Figure 7.1). Some years had lower rates, which may be reflective of differences in pollen levels over a year or differences in the number of people seeking medical attention. Overall, age standardized rates of seasonal allergies has increased in recent years (Figure 7.2).

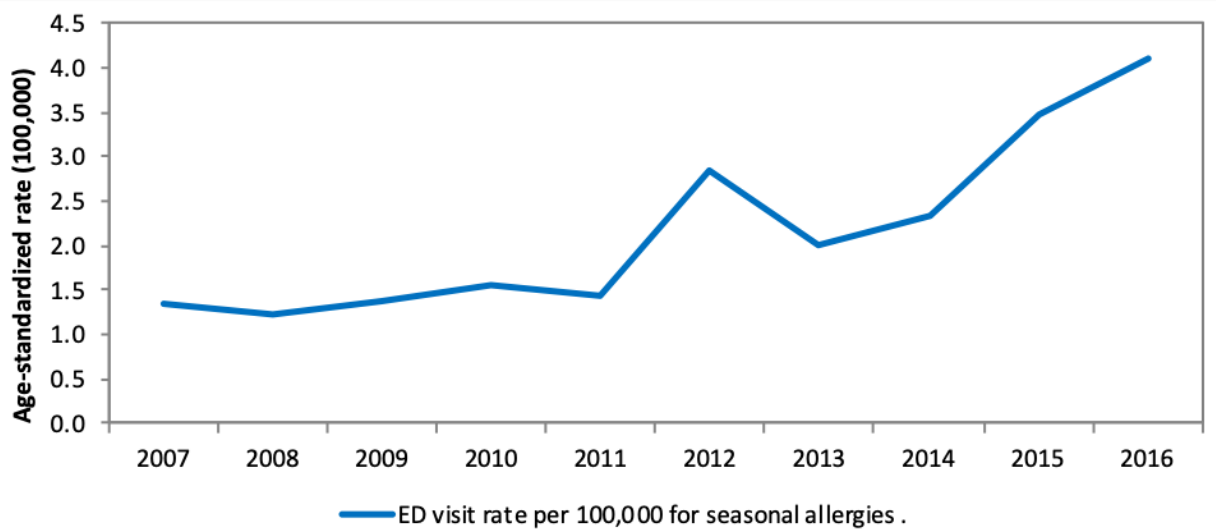
Figure 7.1. Monthly trends in emergency department visit rates for seasonal allergies between 2007 and 2017 in York Region.



[1] Rate of emergency department visits for seasonal allergies per 100,000 population.
Data Source: Ambulatory Visits & Population Estimates, 2007-2017, IntelliHealth Ontario. Extracted May 2, 2019. Seasonal allergies defined as any unscheduled emergency visit using ICD-10 CA codes J30.1 and J30.2.

Source: Seasonal allergies visits. Ambulatory Visits & Population Estimates, 2007-2017, Ontario Ministry of Health and Long Term Care, IntelliHealth Ontario. May 2019.

Figure 7.2. Emergency department visit rates for seasonal allergies between 2007 and 2017 in York Region.



Data Source: Ambulatory Visits & Population Estimates, 2007-2017, IntelliHealth Ontario. Extracted May 2, 2019. Seasonal allergies defined as any unscheduled emergency department (ED) visit using ICD-10 CA codes J30.1 and J30.2. Rates were indirectly age-standardized using the 2011 Ontario Population Estimates by Age, from Statistics Canada, catalogue # 17-10-0005-01.

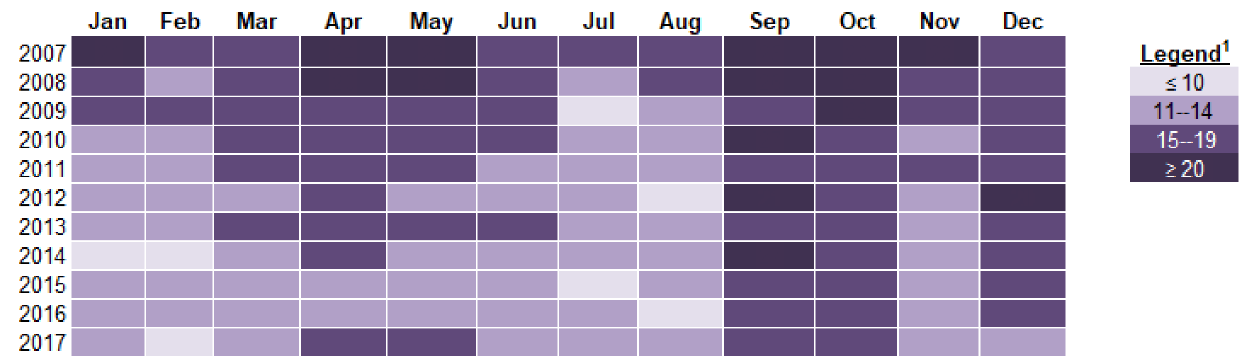
Source: Emergency department visits for seasonal allergies. Ambulatory Visits & Population Estimates, 2007-2017, Ontario Ministry of Health and Long Term Care, IntelliHealth Ontario. May 2019.

The observed asthma rates indicate a seasonal relationship and year-to-year variability (Figure 7.3). For example, asthma ED visit rates were generally high for 2007, but lower for 2015 and 2016. This may relate to generally poorer air quality in a given year, as 2007 had 11 smog advisories lasting 29 days in York and Durham Region, mostly in the summer months.[133] However, other years with high rates such as 2008, only had five advisories lasting nine days.[133]

A trend is observable for higher asthma-related ED visit rates in September and October. Higher rates of ED visits relating to asthma were also noted in the spring and in the month of December.

Since asthma conditions can be aggravated by a wide range of issues, it is not possible to attribute the role of air quality conditions on ED visit rates. Additionally, recent research suggests that effects on health may be taking place below thresholds for air quality advisories.

Figure 7.3. Monthly trends in emergency department visit rates for asthma between 2007 and 2017 in York Region.



[1]Age-standardized emergency department visit rates for asthma per 100,000 population.

Data Source: Ambulatory Visits & Population Estimates, 2007-2017. Intellihealth Ontario. Extracted, May 2, 2019.
Asthma cases defined the most likely diagnosis for any unscheduled emergency visit, based on ICD-10 CA code J45.
Rates were age-standardized using the 2011 Candian Census Total Population by Age, from Statistics Canada, catelogue #98-311-XCB2011018.

7.3 RECENT AIR QUALITY TRENDS IN YORK REGION

7.3.1 Previous levels of O_3 and $PM_{2.5}$ in York Region

The main sources of air pollution in York Region include traffic-related air pollutants, industrial and residential emissions, and transboundary pollutants from neighbouring municipalities, and the United States. Overall, air quality in York Region has improved in the past few decades due to increased regulations and lower emissions in the United States and Canada.

The Ontario Ministry of the Environment, Conservation and Parks (MECP) monitors air pollutants across Ontario. There is one air quality monitor located in Newmarket, as well as a monitor located in North York that is used as a reference for southern York Region.[q] There has been an overall

[q] North York Station changed location on January 1, 2017, to 4905 Dufferin St., North York from the previous location at Hendon Ave and Yonge St., North York.

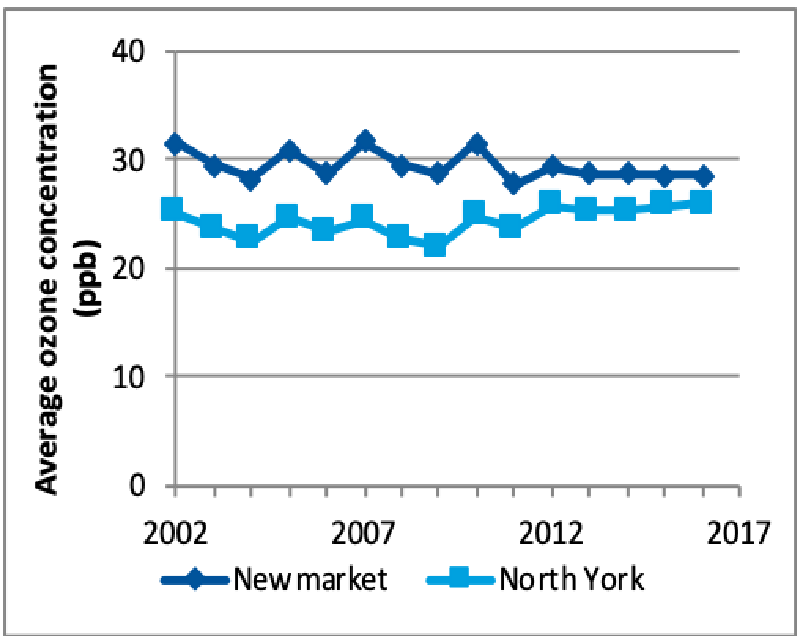
decreasing trend in the annual frequency of smog advisories and poor air quality days for the province since 2007.[123]

Since 2002 annual mean O_3 concentrations have remained relatively stable in York Region. While most pollutant concentrations have decreased in Ontario, O_3 has tended to remain relatively similar in recent years. From 2007 to 2016 annual mean concentrations for O_3 have decreased by 8% for the Newmarket station, but increased by 12% for the Toronto North station.[123]

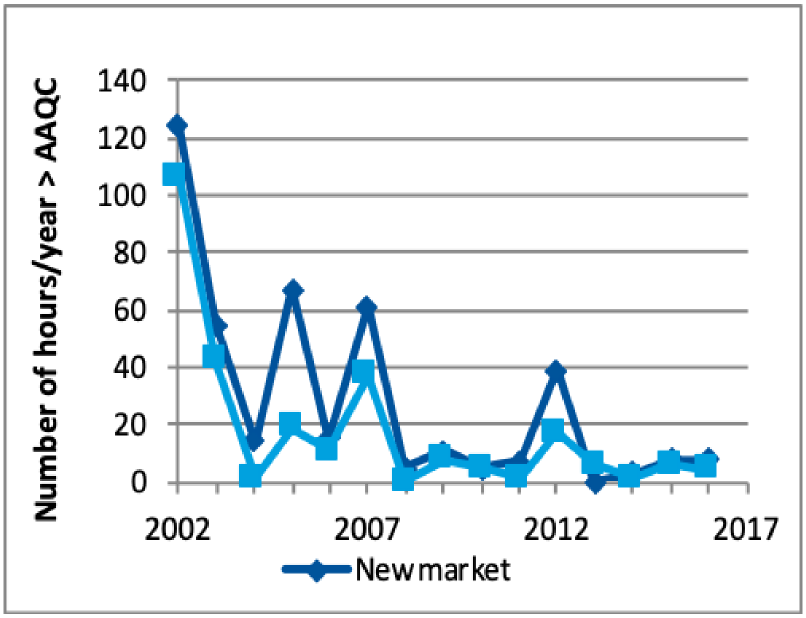
Additionally, there has been a decrease in the number of hours per year where the O_3 concentration exceeded the Ontario Ambient Air Quality Criteria (AAQC) of 80 parts per billion (ppb). For example, in Newmarket, the 1-hour AAQC for O_3 was exceeded for 124 hours in 2002 compared to eight hours in 2016 and no exceedances in 2013. The North York station showed similar results; the AAQC was exceeded for 106 hours in 2002, compared to four hours is 2016 (Figure 7.4).

Figure 7.4. Ground-level ozone data from the Newmarket and North York air quality monitoring stations from 2002 to 2016. A: Average annual concentration. B: Number of hours per year exceeding the AAQC (1 hour) (80 ppb for O_3).

A. Average O_3 concentrations in York Region from 2002 to 2016.

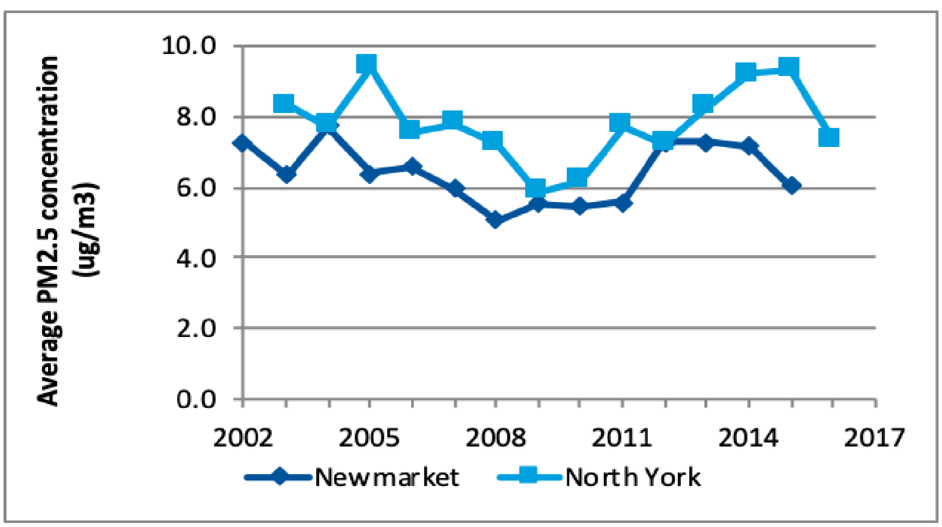


B. Number of hours/year exceeding ambient air quality criteria for O_3 from 2002 to 2016.



Overall levels of $PM_{2.5}$ have slowly declined in York Region, with levels varying slightly from year to year. Annual average $PM_{2.5}$ levels from 2002 and 2016 tend to vary between 5 to 10 µg/m^3 (Figure 7.5). It should be noted that the MECP upgraded its $PM_{2.5}$ monitoring network in 2013. As a result, the monitors were able to detect additional components of $PM_{2.5}$, especially during cold weather. This may have resulted in higher reported $PM_{2.5}$ concentrations due to more accurate measurements, but it does not necessarily reflect changing air quality. When correcting for the change in monitoring equipment, the annual mean concentration of $PM_{2.5}$ is estimated to have decreased by approximately 12% from 2007 to 2016 in Ontario.[123]

Figure 7.5. Average $PM_{2.5}$ concentrations in York Region from 2002 to 2016.

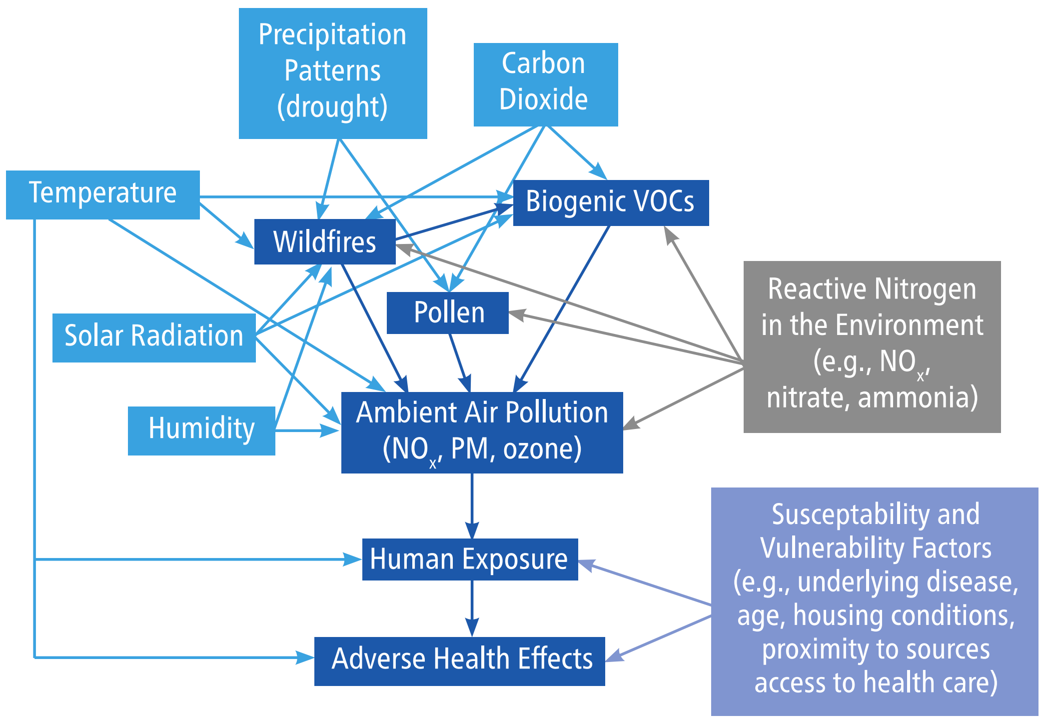


Data Source: Ontario Ministry of the Environment, Conservation and Parks. Air Pollutant data from 2002 to 2016 for ground-level ozone from Newmarket and North York monitoring stations. Toronto:Queen's Printer for Ontario; 2017.

7.4 CLIMATE CHANGE IMPACTS RELATED TO AIR QUALITY

Assessing the impacts of climate change on local air quality is challenging due to a multitude of factors. Figure 7.6 highlights some of the climate change and air quality factors that can interact to impact human health.[134]

Figure 7.6. Climate conditions and their impact on air quality.



Source: Peel JL, Haeuber R, Garcia V, Armistead G, Russle LN. Impact of nitrogen and climate change interactions on ambient air pollution and human health. Biogeochemistry [serial online]. 2013 114(1-3):121-134. Fig 1; Interactions of factors likely to change due to global climate change; p. 122. Available from: https://link.springer.com/article/10.1007/s10533-012-9782-4. Reproduced with permission from the copyright holder.

7.4.1 Climate change impacts on poor air quality days

Despite gains in air quality, future O_3 concentrations are expected to increase due to climate change. Across Canada, there is an increasing trend of moderate, moist and mild air masses and a decrease of dry, cold air masses. Moist tropical air masses with hot and humid air are expected to increase in the summer, which may contribute to poor air quality episodes in Canada.[125] The research suggests that nitrogen compounds such as NO_x will play an important role in the formation of ground-level O_3 during heat waves and stagnant air mass events.[134]

Cheng et al.[135] modelled future air pollutant days for four Canadian cities (Montreal, Ottawa, Toronto and Windsor) using data from 1981 to 2000, assuming pollutant emissions remained at the same level as at the end of the twentieth century. As this study is more than 10 years old, projections may need to be updated using more current data and updated models. The study found the number of days with high O_3 levels (1-hour maximum concentration $\geq$ 81 ppb) could increase by 51% by the 2050s and 109% by the 2080s.[135] In addition, the number of days within the low O_3 level category (1-h maximum $\leq$50 ppb) could decrease from 1981 to 2000 levels by 6% by the 2050s and 9% by the 2080s.[135] Based on these predictions, daily mean O_3 concentrations could increase above 1990s levels by 2.7 ppb in the warm season (April to September) by the 2050s, and 4.0 ppb by the 2080s. Furthermore, Yue et al.[136] predict increases in forest fires in Canada could lead to a mean increase of 3 ppb of summertime O_3.

Between 1971 and 2000, York Region experienced an average of eight days per year with O_3 concentrations above 80 parts per billion (ppb). The Ministry of Health[11] predicts this number will remain the same into the 2050s, increasing by only one day per year by the 2080s. These changes were predicted based on temperature alone and do not take into account the potentially larger effects of transborder O_3 transport and precursors.

As noted previously the impacts of climate change on $PM_{2.5}$ are not clear, particularly related to seasonal trends and poor air quality episodes. Climate change is expected to increase concentrations of particulate matter in the air by increasing drought, leading to more intense and frequent wildfires and increasing air pollution levels. Wood smoke contains more than 100 atmospheric pollutants, including $PM_{2.5}$, greenhouse gases and precursors to O_3.[137]

7.4.2 Future projected health impacts from climate change on air pollutant exposure

Few studies have estimated the future health impacts from climate change relating to air pollutant exposure in Ontario. Cheng et al.[79] predicted air pollution-related mortality in Toronto would increase between 15% to 20% by the 2050s and between 20% to 30% by the 2080s, largely driven by O_3 concentrations. Similarly, Health Canada[4] examined climate change impacts across Canada and found future health impacts would primarily be due to increases in O_3 as particulate matter was expected to decrease.

It is important to note that future health projections are highly dependent on the assumptions made in the models used, and for the chosen emission scenarios. With existing progress to reduce air pollutant emissions from vehicles and other sources, emissions may be lower than current model assumptions. Additionally, changes in population structure and demographic factors can also play an important role in predicting future climate change impacts on air quality and health, especially with respect to the local level.

7.4.3 Climate change impacts on aeroallergens

Allergens can play a major role on the health outcomes of individuals with asthma and existing allergies. Sources of aeroallergens in the environment such as pollen, mould and fungal spores may be influenced by climate change.

Climate change may exacerbate the onset, duration and intensity of the pollen season along with the prevalence of mould and fungal spores.[5] There are three distinct pollen seasons in the floristic zone of southwestern Ontario: Tree pollen in the spring, grass pollen in spring and early summer, and ragweed pollen in the fall.[130]

A longer, warmer growing season may increase the duration of the pollen season, lengthening exposure to aeroallergens and exacerbating allergies and respiratory conditions.[129] Other important climate variables to consider are thunderstorms and heavy rainfall events that have been associated with higher pollen counts. In a recent Toronto study, aeroallergens were investigated to better understand the impacts of various allergens on respiratory health conditions.[130] The study suggests climate change will be associated with increased asthma, allergic rhinitis and bronchitis encounters in Toronto.[130] These health impacts are expected to increase due to climate change increasing maximum daily temperature, pollen counts and levels of O_3 and CO_2.

As pollen spores can travel substantial distances - over hundreds of kilometres - sources of pollen outside of York Region are important considerations for local aeroallergen concentrations.[130]

In recent decades, the length and timing for pollen season has shifted in North America and Europe. An analysis of 11 different plant taxa over a 21-year period found that 71% of taxa flowered earlier each year.[138] Allergenic plants may also shift their ranges northward due to warmer temperatures.[127]

While changes in pollen seasons have already been observed in North America, an extended growing season will likely increase the risk of public exposure to pollen from allergenic species. The growing season in York Region is predicted to increase by 30 days by 2050s.[10] The current growing season takes place from approximately May 17 to October 15 but could extend from early April to November.

The allergenicity of pollen will likely be affected by climate change. Ziska et al.[139] evaluated ragweed grown across an existing temperature/carbon dioxide (CO_2) gradient between urban and rural areas. They found CO_2 and temperatures at the urban site were 30% to 31% and 1.8 ^oC to 2.0^oC higher respectively than the rural site.[140] This resulted in ragweed that grew faster, flowered earlier and produced significantly higher above-ground biomass and pollen. Plants such as ragweed, grown in conditions with elevated temperatures and CO_2 produced larger amounts of pollen that were more allergenic.[138] Atmospheric pollen records worldwide have shown an increasing trend of pollen concentrations for allergens, including birch and alder, suggesting climate change is already having an impact.[138]

While there are many limitations in predicting the future impacts of climate change on aeroallergens in Toronto, Brubacher et al.[130] expect climate change to decrease weed pollen and increase tree pollen, grass pollen and certain fungi spores by the 2080s. Similar impacts may be possible in York Region, particularly in the southern municipalities closest to Toronto. However, the composition of species, differences in landscape, and differences in vulnerable population exposure that exists in York Region make it challenging to extrapolate to York Region.

7.5 ADAPTING TO FUTURE IMPACTS IN AIR QUALITY

7.5.1 Monitoring air quality in York Region

In Canada, multiple monitoring systems provide information on air quality conditions relevant to local stakeholders and the public, including those living in York Region. These include wildfire, pollen and air pollutant monitoring.

Adverse air quality conditions relating to air pollutant concentrations are monitored and forecasted at the provincial and federal level, and incorporate the Air Quality Health Index (AQHI) as part of public and stakeholder notifications. In the case of wildfire events, ECCC has integrated wildfire smoke into air quality forecasts that can be used to predict the movement of smoke plumes across the country. This tool can be valuable for determining wildfire risks that require emergency response measures and can highlight potential impacts to air quality from wildfires occurring in other regions.

There is limited monitoring data available for pollen. The closest monitoring stations to York Region are located in Brampton and Toronto. Pollen monitoring involves the daily collection of pollen samples that are analyzed through a microscope. This monitoring approach is not real-time, and may not be a relevant measure of levels found in York Region. With emerging research looking at the relationship between pollen and weather, synergistic effects with air pollution, and the spatial variability of pollen in communities, there may be more opportunities to consider how local public health activities could incorporate pollen monitoring.

7.5.2 Air Quality Health Index and air alerts

The AQHI was launched in 2015 to help the public make decisions about their health and activity levels based on outdoor air quality. Since the implementation of the AQHI in 2015, there has not been any high risk air quality warning in York Region.

The AQHI is also used for air quality alerts at the provincial level. Depending on the severity, MECP can issue a Special Air Quality Statement or Smog and Health Advisory. York Region Public Health currently monitors for such alerts and provides information to the public through social media platforms.

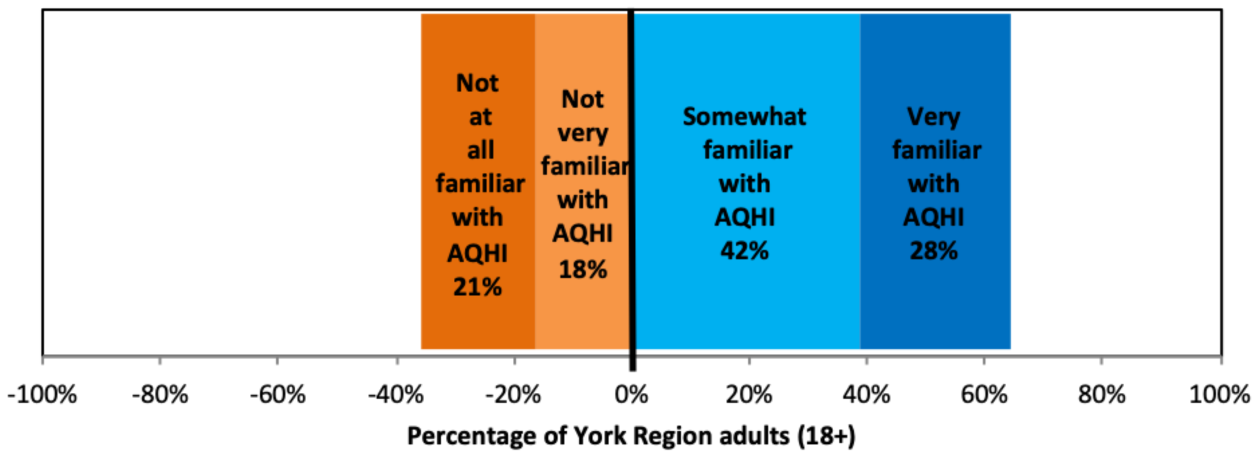
7.5.3 Adaptive capacity of local stakeholders and residents: Use of AQHI

The AQHI is a valuable tool that can be utilized by the general public and local stakeholders who work with vulnerable populations.

Certain stakeholders engaged with vulnerable populations have plans for poor outdoor air quality. In a 2016 survey of long-term care homes in York Region, 25 of 28 homes noted having a plan or policy in place to address days with poor outdoor air quality. Such programs by local stakeholders will play an important role in increasing adaptive capacity for vulnerable populations.

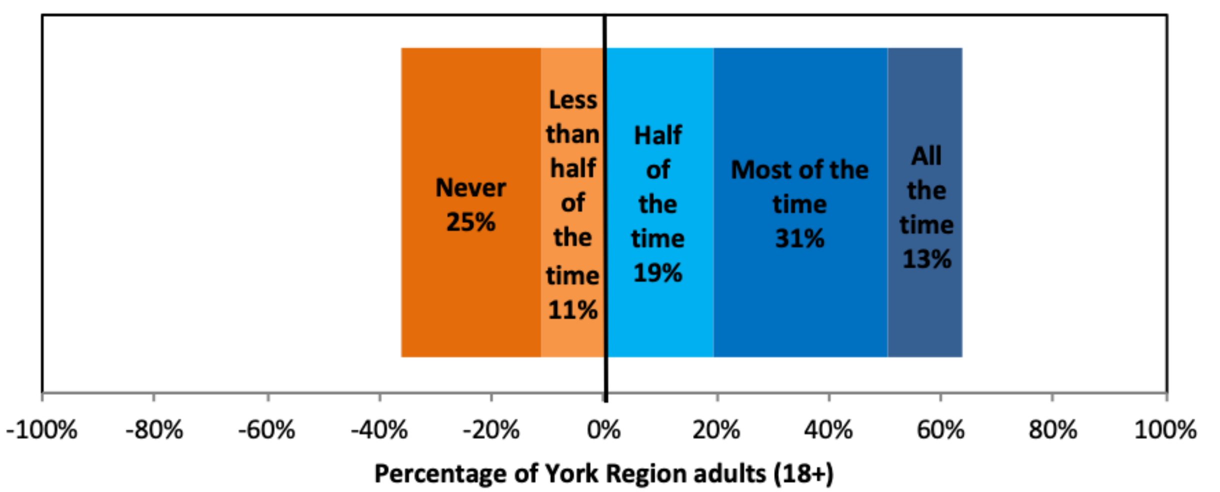
York Region residents are familiar with the AQHI. Approximately 70% of York Region adults reported they were somewhat or very familiar with the AQHI (Figure 7.7).[16] Only 25% of adults familiar with the AQHI reported checking the AQHI daily. Additionally, 36% of York Region adults familiar with the AQHI reported to never, or less than half the time change their outdoor activities based on the AQHI (Figures 7.8).[16,69]

Figure 7.7. Familiarity of York Region adults with the AQHI.



Data source: Rapid Risk Factor Surveillance System (RRFSS), 2016-2017, Regional Municipality of York, Community and Health Services.

Figure 7.8. York Region adults familiar with the AQHI who report changing their activities based on the AQHI.



Data source: Rapid Risk Factor Surveillance System (RRFSS), 2016-2017, Regional Municipality of York, Community and Health Services.

Raising awareness of the AQHI in York Region

In 2018, York Region Public Health partnered with the Ontario Lung Association and Health Canada to develop and implement a public education campaign on the AQHI across York Region. The campaign goal was to increase awareness about outdoor air quality and the AQHI, and encourage York Region residents to regularly use the AQHI tool when planning their outdoor activities. A needs assessment and follow up workshop was conducted with more than 20 local stakeholders from school boards, health care, paramedic services, child care centres and long-term care homes. Some of the key recommendations identified by stakeholders to reach residents included effectively reaching vulnerable populations and the promotion of the AQHI App.

Various communication tactics were used to reach the target populations including social media, news media, transit and billboard ads, promotional videos and community events. Results of the campaign evaluation indicate there was an increase in awareness based on overall social media impressions, extensive reach and news media viewership, app downloads, engagement at public events, survey data from in-person outreach and level of key stakeholder engagement. Stakeholders reported that they found the engagement valuable and they intended to share and use the tools created as part of the campaign.

7.6 CONCLUSION

While there are significant linkages between climate change and air quality, more research is needed to better understand the impacts that climate change will have on air quality, and ultimately human health. Levels of O_3 are influenced by various climatic factors such as warming temperatures, stagnant air masses and greater emission of biogenic precursor pollutants due to changing temperatures. Longer summer seasons may also increase average O_3 levels. However, research is still limited in understanding how climate change may contribute to future levels of $PM_{2.5}$. Impacts may include increases in ambient $PM_{2.5}$ levels through other pathways such as from wildfire events.

There is insufficient information to assess the health impacts of air quality and related weather factors in York Region. Current work assessing the burden of illness from environmental hazards in Ontario may provide a better understanding of how many cases are attributed to air quality. Analyzing existing climate and air quality data related to health will be essential to inform future surveillance needs, and inform appropriate interventions.

While research has shown strong evidence of air pollutants' spatial and temporal distribution in urban communities, there is still limited information to assess potential exposures in York Region. There are limited monitoring stations in York Region and spatial variation in pollutant levels will likely differ between municipalities and areas, such as urban, suburban and rural communities. Information on pollen in York Region is currently limited, but emerging research may provide a better understanding of pollen risks in terms of spatial distribution and the additive effects of pollen with air pollutants.

Program activities, such as monitoring air quality conditions and communicating air quality notifications to the public, play an important role for public health and adaptive capacity. There is an opportunity to expand monitoring to different air quality issues such as wildfire and pollen issues, and to ensure notifications reach those most vulnerable to air quality impacts such as children and seniors. Health outcome surveillance programs and a better understanding of the linkages between weather variables and air pollutant levels will help inform the criteria for notifications.

Addressing air quality offers multiple co-benefits that can support climate change mitigation and improvements to air quality. Certain GHGs, such as black carbon and O_3, are short-lived climate pollutants that contribute to climate change and reducing air quality. While addressing these impacts on climate change, important improvements in air quality can be achieved to help reduce the impacts on human health.

Nevertheless, air quality is an important consideration for future climate change adaptation planning. Existing traffic-related air pollutants and industrial emissions contribute to local air pollution and to greenhouse gas emissions. During morning peak hours the number of trips in York Region is expected to increase from around 300,000 to 500,000 trips between 2011 and 2041, the majority of which are automobiles.[141] Additionally, efforts to reduce vehicle traffic can also support health benefits such as greater physical activity. Work should continue to develop a healthy built environment in order to encourage active transportation, increase physical activity and decrease exposure to traffic-related air pollutants. Table 7.2 provides an overview of existing activities and adaptation planning opportunities.

Table 7.2. Summary of air quality related activities and adaptation planning opportunities.

	Ongoing and Completed Activities	Opportunities
Public Health Assessment and Surveillance	**Environmental monitoring:** Monitoring of AQHI levels in York Region based on two monitoring stations (Newmarket and Toronto North). Monitoring air quality alerts issued by MECP and ECCC.	Explore additional datasets related to pollen levels in York Region. Consider assessing the spatial distribution of air quality impacts across York Region, including $PM_{2.5}$ and O_3.
	Health surveillance: Monitoring health outcomes relating to air quality.	Consider further analysis of health outcome data relationship with air quality (pollutants and pollen) and weather variables to better understand impacts in York Region. After assessing health outcome data related to air quality, consider developing a syndromic surveillance plan for air quality related impacts.
	Population and stakeholder surveys: Completed RRFSS (2016, 2017) modules on the AQHI. **Health Equity:** Completed survey of long-term care homes in York Region (2016).	Consider surveillance plan to monitor the population and environmental related risk factors. **Health Equity:** Consider the analysis of responses related to demographic factors to better understand risk factors for vulnerable populations. Consider modules related to allergies and asthma to better understand vulnerable populations.
Program and Policy	Recommending and supporting policies and programs that promote active transportation, access to green space, healthy built environments, and local emission reductions. Reviewing relevant research to inform policy and programs.	Engage with York Region Forestry, community groups and homeowners regarding planting non-allergenic plants and trees. Consider recommendations for personal air monitoring or air purifier equipment that can be used by local residents.
	Public notification of poor air quality episodes.	**Health Equity:** Consider notification options that target vulnerable populations (e.g., seniors, children and individuals with certain pre-existing conditions).

Health Promotion	Social media messaging and webpage content relating to the AQHI and air quality alerts. Webpage content on outdoor air quality and AQHI. 2018 AQHI Awareness Campaign in York Region. Initiatives included multiple media platforms (e.g., radio, bus and newspaper ads, etc.) to inform the public and physicians on AQHI.	**Health Equity:** Consider targeting vulnerable populations as part of future health promotion activities. Incorporate climate change messaging into air quality health promotion resources where relevant. Consider additional key messaging to the general public for issues relating to pollen and wildfires. Consider educational opportunities for local medical professionals regarding climate change and health including air quality.
Key Stakeholder Activities (outside of Public Health)	ECCC monitoring and forecasting wildfires, including smoke plumes. MECP monitoring of air quality through local air monitoring stations and weather conditions.	Consult ECCC regarding aeroallergen monitoring opportunities and available data. **Emergency Preparedness and Response***:* Incorporate consideration of smoke impacts from wildfires into emergency plans.
	Organizations supporting individuals with respiratory conditions (e.g., Asthma Canada, Ontario Lung Association, local asthma and allergy support programs).	**Health Equity:** Explore opportunities to understand existing support services for vulnerable populations to inform public health programs and promotion activities. Consider surveying other stakeholders engaged with vulnerable populations on plans relating to poor air quality events.
	Research on air quality impacts in Ontario from PHO and Health Canada.	Consult PHO and Health Canada regarding assessment opportunities and data limitations for assessing impacts within York Region.