CHAPTER 8
Vector-Borne Diseases

YORK REGION CLIMATE CHANGE AND HEALTH VULNERABILITY ASSESSMENT

8.0 Vector-Borne Diseases: Key Findings

Climate change projections and exposure pathways

- Temperature, rainfall and humidity play an important role in the spread of vector-borne diseases (VBDs). As a result of climate change, conditions are expected to become more favourable for disease vectors, which can increase the risk of VBDs in Ontario
- The number of West Nile virus (WNV) human cases are seasonal and vary based on weather trends for a given year, with the highest levels of human cases occurring in August. Specifically, temperature and precipitation have played an important role in the presence of WNV in York Region
- Factors contributing to the risk for WNV include favourable habitat conditions for vector population growth, increased urbanization and the presence of local bird populations
- Warmer winter temperatures play an important role in the survival rate of ticks. It is expected that ticks, such as the blacklegged tick (which can transmit Lyme disease), will continue to expand their habitat range north through temperate climate regions such as Ontario
- Recent surveillance has shown a substantial increase in blacklegged ticks in York Region. The majority of York Region is now considered an estimated risk area for Lyme disease

Population sensitivity

- Individuals spending substantial time outdoors are more vulnerable to exposure to vectors that can transmit WNV and Lyme disease
- Between 2000 and 2015 most cases (60% to 63%) of WNV and Lyme disease were women
- Travel to endemic areas outside of York Region has been an important exposure route for York Region residents

Adaptive capacity

- Current surveillance activities in York Region focus on WNV, Lyme disease and Eastern equine encephalitis virus (EEEV)
- York Region Public Health and the province are working proactively to prevent the risk of VBDs through surveillance activities, prevention measures and awareness campaigns
- York Region Public Health works with municipalities to address mosquito larviciding activities (such as with municipal catch basins and stormwater management ponds) and with York Region Forestry regarding preventing Lyme disease

Health impacts

- There is strong supportive evidence that VBDs are likely to increase in York Region as a result of climate change
- Climate change may impact emerging VBDs from ticks (babesiosis, Powassan encephalitis and *Borrelia miyamotoi)* and mosquitoes (EEEV, Jamestown Canyon virus and snowshoe hare virus)

Recent trends:

- The highest number of human cases of WNV in York Region occurred in 2002, followed by 2012 and 2017. Lower number of human cases and positive mosquito pools found between 2012 and 2017 were likely due to temperature and drought conditions
- Ontario has seen a large increase in the number of Lyme disease cases since 2010. The number of confirmed and probable Lyme disease cases has also substantially increased in York Region in recent years

VBDs are transmitted by the bite of arthropod species, namely mosquitoes and ticks that are infected with disease pathogens. They also spread from human-to-human and animal-to-human contact by vectors that carry the disease. Multiple factors can influence the risk and presence of VBDs, including habitat for vectors and animal reservoirs[r], human populations with increased risk of contact or proximity to vectors and agricultural practices that can affect suitable habitat for vectors/animal reservoirs and climate conditions.[142] While vectors may currently exist, the number and proportion of vectors that carry infectious disease pathogens vary, making it difficult to estimate future changes in human cases.

Conditions are expected to become more favourable for disease vectors, which can increase the risk of VBDs in Ontario, including in York Region. Increases in temperature will create favourable conditions for vectors and expand their habitat range. Specifically, rising temperatures are expected to increase the ability of tropical and sub-tropical vector populations to survive in warming temperate regions.[142] Longer and warmer summer periods with more intense rainfall events and fewer extreme cold events will also support the survival and growth of vector populations in existing habitat ranges.[142]

The following sections focus on West Nile virus (WNV) and Lyme disease, two vector-borne diseases (VBDs) that are the focus of York Region Public Health's comprehensive and collaborative VBD program. York Region Public Health currently conducts surveillance programs focused on Lyme disease and WNV. Eastern equine encephalitis virus (EEEV) is also monitored as part of the surveillance/testing program for WNV in Ontario. Recent trends from vector surveillance and reported human cases provide an overview of the current status of VBDs in York Region. Recent research on climate change and VBDs are discussed to provide more context on future VBD risks in York Region. This report also provides an overview of York Region's program and policies related to VBDs to explain existing and future adaptive capacity.

8.1 WEST NILE VIRUS

WNV arrived in North America in 1999 and was first detected in Ontario in September 2001.[143] Dipteran mosquito species are the main vector that transmits disease to humans. In Ontario, *Culex pipiens/restuans* are the main species of mosquitoes responsible for transmitting WNV. Avian populations act as a reservoir for the disease and are an important factor in the risk of WNV infections in humans from vector populations.

Southern Ontario has been identified as a hot spot area for WNV activity due to the large number of residents, land type factors (e.g., urban areas, grasslands and wetlands) combined with favourable climate conditions (e.g., temperature and precipitation) resulting in increased vector activity.[143,144] The average temperature was shown to be an important indicator of seasonal activity of the vector for southern Ontario health units, including York Region.

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[r] A reservoir refers to a living (e.g., animal, human, insect, or plant) or non-living (water, soil) entity where the pathogen carrying organism can survive and multiply. Reservoirs can support the survival and expansion of the pathogens, but are not directly responsible for transmission to human populations.

Since WNV was first detected in Canada in 2001, there have been more than 5,000 confirmed human cases. However, many cases go unreported as most individuals with WNV are asymptomatic. According to the Public Health Agency of Canada, there have likely been 18,000 to 27,000 human WNV cases that have gone unreported.[143] The first known human case in Ontario was reported in 2002, and WNV has been a reportable disease in Ontario since 2003. Positive WNV results from blood donation testing are also reported to Public Health by Canadian Blood Services.

Health effects of WNV

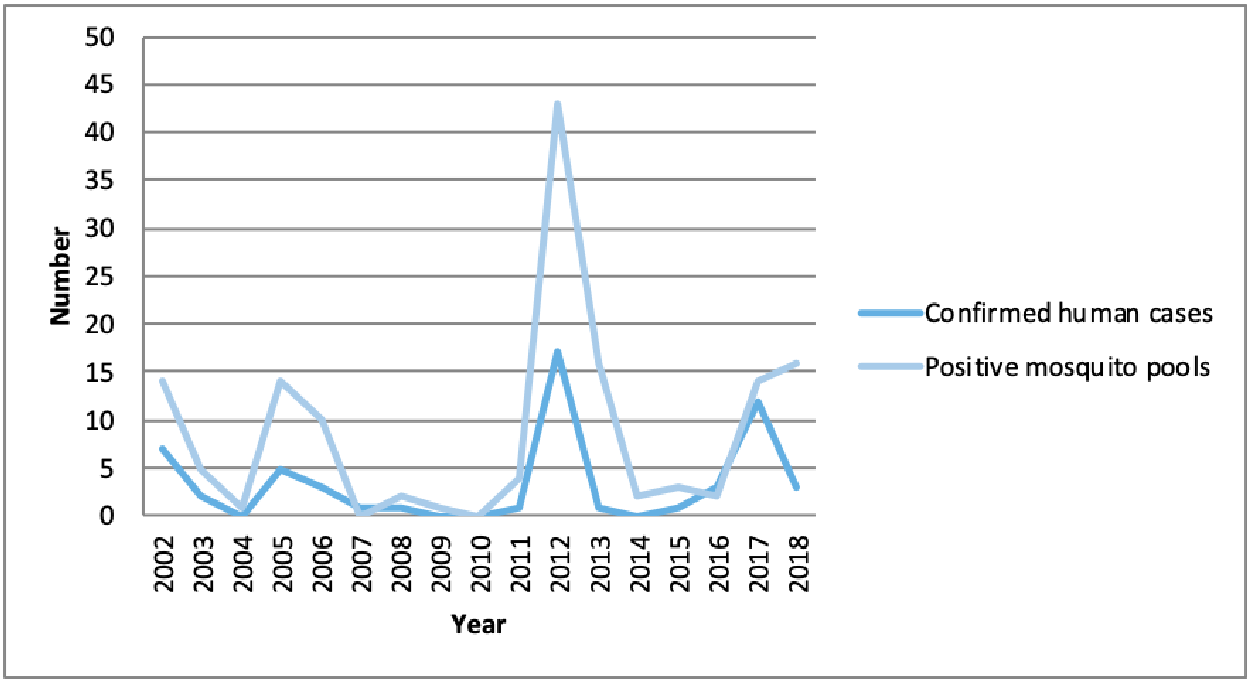
There are three clinical manifestations of WNV: Asymptomatic, non-neurological and neurological. Although up to 80% of WNV cases show no symptoms, approximately 20% develop mild, non-neurological symptoms ("WNV Fever") typically lasting a few days, which can include fever, headache, body aches, swollen lymph nodes and skin rash among other symptoms. Serious neurological infections impacting the central nervous system (e.g. encephalitis, meningitis) occur in less than 1% of infected people.[145] In rare cases, WNV can result in death.[145]

Recent trends in York Region

As mosquito populations are sensitive to weather conditions, the number of WNV human cases and positive mosquito pools vary based on weather trends for a given year. As WNV depends on favourable weather conditions, most cases show a seasonal trend peaking in August. Figure 8.1 provides an overview of the number of confirmed human cases and positive mosquito pools of WNV in York Region from 2002 to 2018.

The highest number of confirmed cases of WNV in York Region occurred in 2002, when it was first introduced to York Region, followed by 2012 and 2017. In other years, there was a median of one case reported per year.[146] The lower number of human cases and positive mosquito pools found between 2012 and 2017 were likely due to temperature and drought conditions.

Figure 8.1. West Nile virus surveillance activity in York Region between 2002 and 2018.



Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario: West Nile Virus [data file]. Toronto: Queen's Printer for Ontario; 2019.

Vulnerable populations and WNV

See Chapter 4 for more information on vulnerable populations. Individuals most vulnerable to WNV are those who spend substantial time outdoors in the summer period and may be more exposed to WNV-carrying mosquitoes. Additionally, individuals may be more susceptible to serious complications when infected. These populations can include:

- Individuals who are active or work outdoors
- Individuals experiencing homelessness (sleeping outdoors increases the risk of exposure to WNV, as *Culex* species carrier mosquitoes are most active at dusk and dawn)[31]
- Individuals 55 years of age and older and those with compromised immune systems (these groups are at a higher risk of developing meningoencephalitis if infected with WNV)[31]
- Women, as approximately 60% of reported human cases of WNV in York Region between 2000 and 2015 occurred in females, with the majority reported in women 50 to 54 years of age.[146] Pregnant women may also be particularly vulnerable to VBD due to changes to immune function as a result of pregnancy[147]
- Individuals who travel to WNV-endemic areas

Climate factors and risk for WNV

Temperature, rainfall and humidity conditions play an important role in the spread of WNV. With the rapid reproduction rate and short life cycle of mosquito populations, short-term changes in weather can significantly influence the growth and survival of mosquito populations. These impacts can also occur within a few weeks of specific weather events. Research has found links between how the following weather patterns play an important role in mosquito vector populations:

- **Temperature:** In low to medium temperatures, mosquitoes can have a shorter life cycle, increased activity and faster development. When temperatures are too high, mosquito activity can be reduced and mortality can be increased.[142] However, York Region surveillance data has revealed that an increase in the number of positive traps and human cases are associated with high temperatures. This increase was likely attributed to additional factors (e.g. warmer winter temperatures and an earlier spring) and highlights the importance of considering multiple weather variables
- **Humidity:** Dry conditions limits the available breeding habitat for mosquitoes and increases their need to return to water to rehydrate. In contrast, higher humidity can increase activity and indirectly reduce mosquito mortality[142]
- **Rainfall events:** Heavy rainfall can also cause an increase in *Culex pipiens* populations if temperatures are also suitable. However, heavy and sustained rainfall can also control mosquito populations by flushing larvae out of the catch basins. In contrast, *Culex pipiens* can respond to droughts in urban areas by reproducing in stagnant pools[142]

The higher number of human cases and positive mosquito pools observed in York Region in 2012 and 2017 were attributed to temperature and precipitation. In 2012 and 2017, warmer winter temperatures increased the chances of mosquito survival through winter and amplified mosquito populations during the summer season. The earlier start of spring and higher temperatures created favourable conditions for mosquitoes in 2012. By contrast, 2017 had cooler temperatures but greater precipitation, resulting in conditions suitable for mosquito breeding.

Figure 8.2. depicts positive mosquito pools and positive human WNV cases by week in 2012 along with accumulated degree days (ADD).[s] The first positive mosquito pools were detected during the third week of July at around 100 ADD, and the first human cases started to occur around 200 ADD. The 2012 mosquito season lasted a few weeks longer than typically seen in Ontario. Human cases were detected at the beginning of August, which was earlier than previously detected in other years. Warmer temperatures likely contributed to amplified virus replication in bridge vectors, which led to a greater risk to human health.

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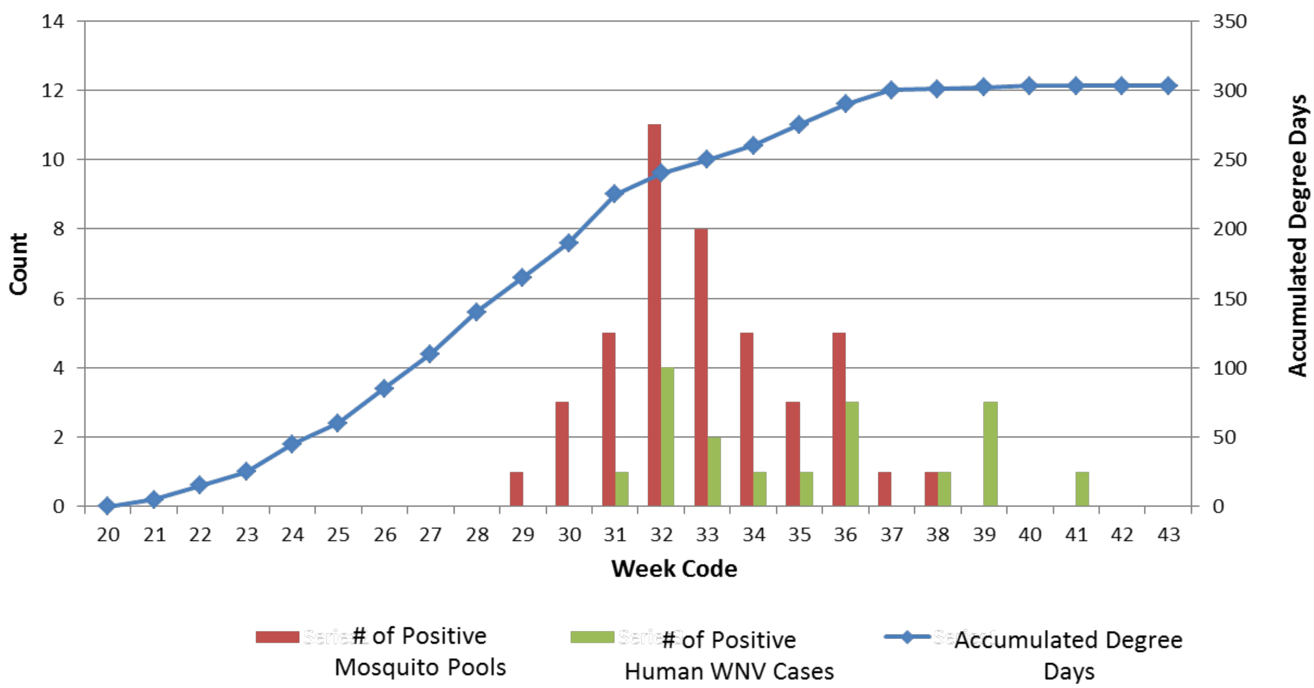
[s] Degree days is a measure of the quantity of heat needed for organisms such as mosquitoes to develop within certain life stages. For *Cx. pipiens/restuans* mosquitoes in Ontario, a degree day is 1˚C above 18.3˚C. For example, an average daily temperature of 20.3˚C would count as 2 degree days. Accumulated degree days (ADD) is the addition of consecutive degree days, which can help provide an indication for the start and intensity of a vector seasons. In general, the first positive mosquito pools tend to occur around 100 ADD, and there is a higher risk for WNV transmission to humans around 200 ADD.

Figure 8.2. York Region West Nile virus activity and accumulated degree days in 2012.

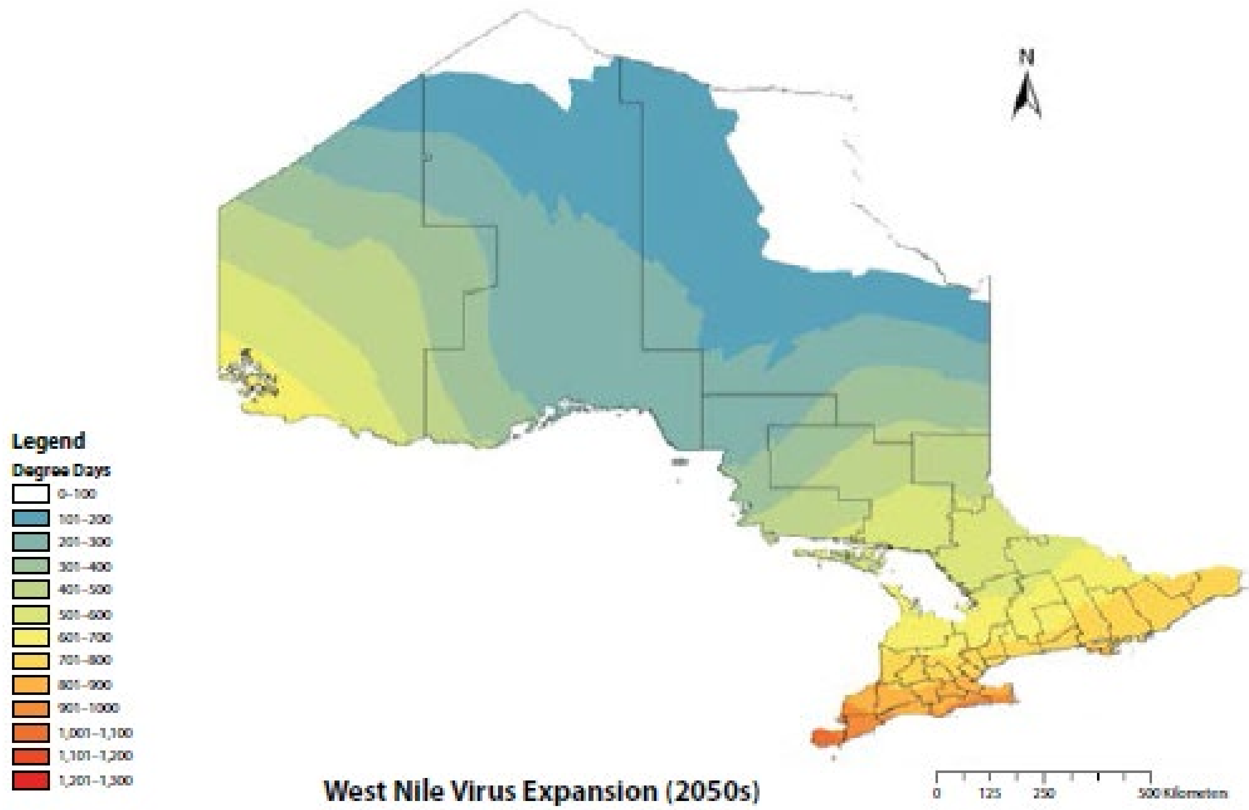


Source: Regional Municipality of York. West Nile active surveillance program. Newmarket: Regional Municipality of York; 2012.

Recent research has also looked at how weather variables during the transmission season (May to October) and the preceding winter can affect the risk of WNV in a given locality. When evaluating past surveillance activities in Ontario and potential links to weather variables, Mallya et al.[144] noted warmer temperatures in February played an important role in predicting the risk of WNV during the transmission season in Ontario.

Figure 8.3 highlights the expansion of WNV using degree days. This indicates when vectors may start reproducing and becoming more prevalent across Ontario. Accumulated degree days are expected to increase in York Region from 200 to 400 up to 600 to 800 by the 2050s. However, it should be noted that the definition of a degree day for this projection (minimum daily temperature threshold of 14˚C) differed from what is used by York Region.

Figure 8.3. Expansion of WNV in 2050 in Ontario. Increase in the number of degree days for *Cx. pipiens/restuans* (the degree day is defined by daily minimum and maximum temperatures between 14˚C and 35˚C).



Source: Ministry of Health and Long-Term Care. Ontario climate change and health modelling study [Internet]. Toronto (ON): Queen's Printer for Ontario; 2016. Fig 12 WNV. Favourable climatic conditions for the 2050s; p. 18. Available from: http://www.health.gov.on.ca/en/common/ministry/publications/reports/climate_change_toolkit/climate_change_health_modelling_study.pdf. Reproduced under the terms of this license: https://www.ontario.ca/page/copyright-information-c-queens-printer-ontario?_ga=1.192891053.642029082.1453497246. Reproduced with permission from the copyright holder.

Climate change is expected to increase the migration of other mosquito species from the United States into Canada.[148] As mosquitoes are more responsive to short-term climate conditions, it is difficult to predict how climate change will impact the risk of WNV over the longer term. However, as temperatures become warmer in higher latitude regions, the geographical range favourable for mosquito survival and reproduction will also increase.

Increased urbanization in York Region may provide more favourable conditions for mosquito population growth and risk of WNV transmission. Urban areas can create microclimates with more favourable conditions for mosquito populations to thrive. In urban and suburban communities, stagnant pools within catch basins can occur, creating urban heat islands that support mosquito population growth. Additionally, WNV mosquitoes can survive through the winter months in the sewer system where temperatures remain above freezing. While existing research illustrates the future impact climate change may have on the risk of WNV transmission, there are other factors to consider. Favourable habitat conditions are needed for mosquito populations to be active and grow in population size. Additionally, the presence of local bird populations contributes to the risk of WNV during the transmission season.

Adaptive capacity

York Region Public Health activities addressing WNV

Since the first cases of WNV emerged in North America, York Region Public Health has been actively engaged in monitoring and controlling the risk of WNV transmission.

York Region Public Health's VBD program takes a comprehensive approach that includes surveillance, investigations, and protection measures. Activities include testing of mosquito pools across the Region, identification and monitoring of mosquito species, educational activities on the risks of WNV transmission, larviciding to control for mosquito populations and investigating standing water complaints to reduce mosquito breeding grounds (Table 8.2).

For much of these activities, provincial agencies play an important role in helping to address WNV in Ontario, particularly for surveillance and supporting public outreach. For example, local public health units, such as York Region Public Health, and Public Health Ontario (PHO) work together to ensure all relevant surveillance information is shared when assessing current WNV risk. York Region Public Health collects data on probable and confirmed human cases of WNV, which is shared with PHO. Active surveillance of mosquito populations is conducted through the weekly testing of mosquito traps. Information on cases and VBD surveillance data are shared with the province to support broader provincial surveillance activities and trend analysis.

Larviciding is conducted with local municipalities to support mosquito control in areas such as municipal catch basins, park basins, stormwater management ponds, roadside ditches and sewage lagoons. For larviciding, York Region Public Health uses methoprene and biopesticides (*Bacillus thuringinsis* and *Bacillus sphaericus*). It should be noted that UVB wavelengths inhibit the *Bacillus* bacterium. Increases in ultraviolet radiation due to climate change could reduce the effectiveness of larviciding in the future without changes in pesticides.[149]

York Region also provides WNV educational activities, supported by the province, to educate local communities on how to reduce their risk of WNV transmission. Resources target a wide population range and materials are distributed to schools and communities through tactics such as newspaper ads and social media.

8.2 LYME DISEASE

Lyme disease is a tick-borne illness spread by the bite of blacklegged ticks infected with the bacteria *Borrelia burgdorferi*. Since its emergence in North America in the 1970s, Lyme disease has become one of the most frequently reported VBDs in North America. The suitable habitat range for ticks has expanded from the United States into parts of Canada, with the range of some tick species increasing faster than predicted. There is now a significant risk of infection for Lyme disease in southern Ontario.[142,150,151]

Blacklegged ticks depend on animal hosts for their dispersal and reproduction rate. Within Ontario, white-tailed deer and white-footed mice are the main animal reservoir populations. In an assessment of tick populations in the Thousand Islands, an area with a higher presence of blacklegged ticks, the study found the abundance of white-footed mice and greater diversity in animal species were related to the presence of blacklegged ticks.[152]

Blacklegged ticks have a long life cycle that can last from months to years.[142] The blacklegged tick in the nymph life cycle stage has a higher risk of Lyme disease transmission to human populations. Blacklegged ticks in this life cycle are difficult to see, making it easier to attach to the human host unnoticed and feed for more than 24 hours, thereby increasing the risk of infection.[t]

In Canada, the number of Lyme disease cases reported increased from 144 in 2009 (when it became reportable) to 992 cases in 2016.[153] This represented an increase in the incidence of 0.4 to 2.7 per 100 000 population over the same time period.[153] The Centers for Disease Control and Prevention (CDC) estimates the number of people with Lyme disease in the United States to be approximately 10 times higher than actually reported.[154]

Health effects of Lyme disease

The symptoms of Lyme disease differ from person to person and there is a range of clinical manifestations Lyme disease typically presents in stages: Early localized, early disseminated and late disseminated. Symptoms of early localized infection typically include a rash (sometimes shaped like a “bull’s eye”) called Erythema migrans, and can include fever, chills, headache, fatigue, muscle and joint aches and swollen lymph nodes. If infection is untreated, the bacteria can spread in the body, causing more severe symptoms and disease to develop over time, which can last from months to years. These can include severe headaches, additional Erythema migrans rashes, facial paralysis, cardiac disorders, neurological disorders, intermittent body aches and arthritis (often in larger joints like the knees). In rare cases, Lyme disease can lead to death, usually related to complications involving infection of the heart.[153]

Recent trends in York Region

York Region Public Health uses active and passive surveillance methods to measure the local distribution and incidence of ticks in York Region. Table 8.1. provides a summary of surveillance activities for local blacklegged ticks in York Region from 2012 to 2018.

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[t] A tick must be attached for a minimum of 24 hours (irrespective of life cycle) for transmission of the bacteria that causes Lyme disease.

Table 8.1. Lyme disease surveillance activity in York Region from 2012 to 2018.

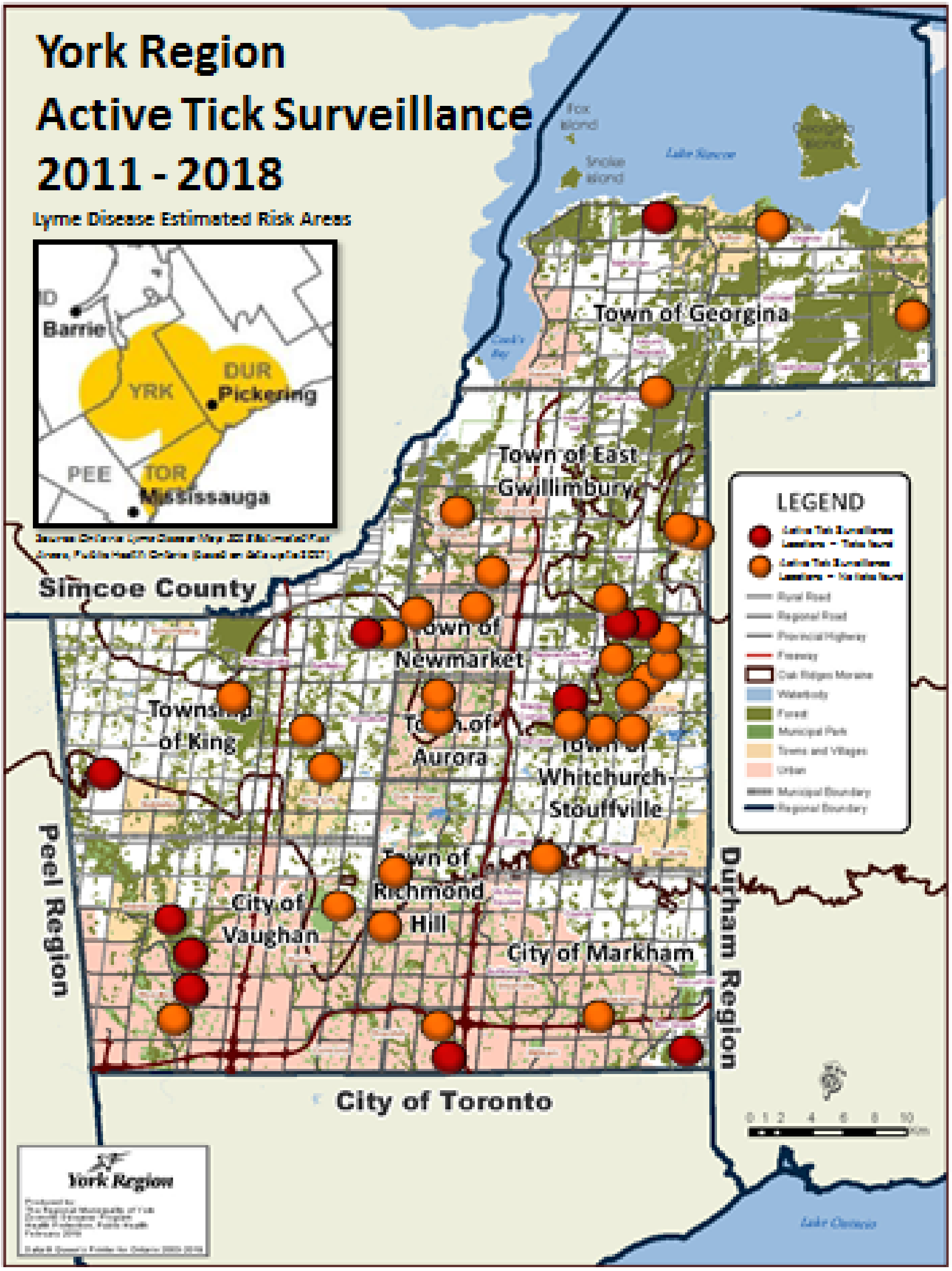
	2012	2013	2014	2015	2016	2017	2018
Local blacklegged ticks - passive tick surveillance	1	4	7	11	15	35	37
Local blacklegged ticks - active tick surveillance	0	0	2	4	0	10	28
Positive *Borrelia burgdorferi* local blacklegged ticks	0	0	1	0	1	2	1

Source: Regional Municipality of York. Lyme disease surveillance program. Newmarket: Regional Municipality of York; 2012.

- **Passive tick surveillance:** Residents can submit ticks to York Region Public Health for identification.[u] In 2017, 35 of the 113 passive tick submissions were locally acquired in York Region and identified as blacklegged ticks. One tick tested positive for the bacterium that causes Lyme disease.[155] The majority of submissions from residents reported travel to woodland habitats.
- **Active tick surveillance:** Ticks are collected from their habitat by dragging white cloth sheets over and around vegetation where ticks wait for a passing host. Locations for active surveillance are facilitated by information gathered during passive surveillance. Figure 8.4 summarizes the results of active tick surveillance in York Region from 2011 to 2018. In 2017, two new Lyme disease risk areas were identified; in the vicinity of Joker's Hill in King Township and in the vicinity of the York Region Forest North Tract in the Town of Whitchurch-Stouffville.[155] In 2018, York Region Public Health conducted tick dragging at 35 locations in the Region throughout the spring and fall in natural, forested public spaces (e.g., parks, conservation areas, river valley systems). Twenty-eight blacklegged ticks were found at nine locations, with one blacklegged tick testing positive for *Borrelia burgdorferi*.[155] This was a substantial increase in the amount of blacklegged ticks found through active tick surveillance and is likely due to the expansion of blacklegged tick habitat in southern Ontario. One new risk area was also identified in 2018 in the Humber Valley near the Boyd and Kortright Conservation Areas.

[u] As of January 1, 2020 the National Microbiology Laboratory will no longer be conducting diagnostic testing of passive tick submissions.

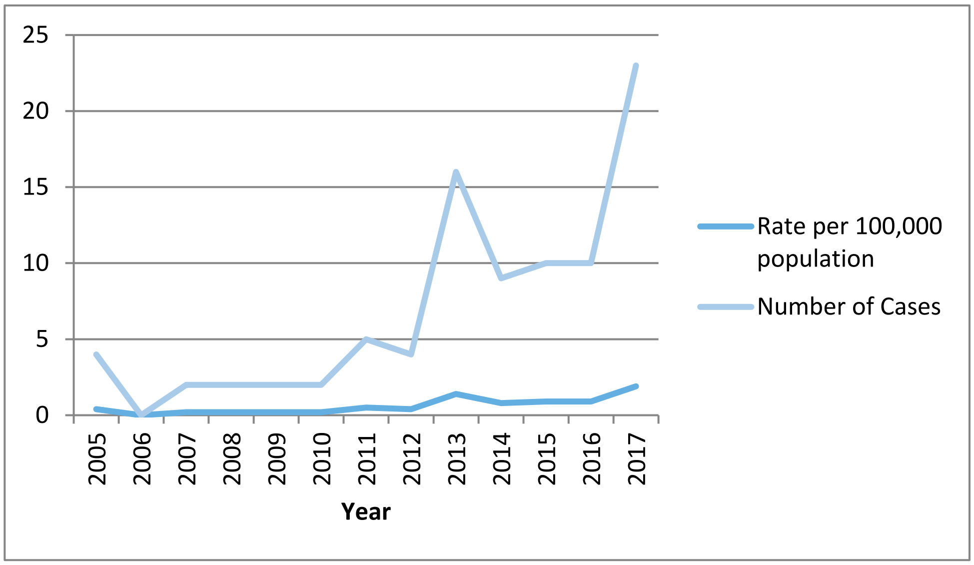
Figure 8.4. Summary of active tick surveillance from 2011 to 2018 in York Region.



The occurrence of blacklegged ticks and human cases of Lyme disease has increased in York Region. Reporting human cases of Lyme disease is integral to local and provincial surveillance programs. As a disease of public health significance, confirmed and probable human Lyme disease cases are reportable to York Region Public Health. Overall, the province has seen a rise in the number of cases of Lyme disease since 2010, particularly in eastern Ontario. Reported cases in York Region relate to potential local exposure but also to travel. Figure 8.5

shows the number of human cases of Lyme disease in York Region between 2005 and 2017. Notably, the number of probable and confirmed cases started increasing in 2011. In 2017 there were 18 confirmed and five probable cases of Lyme disease. The rates of Lyme disease in York Region have also increased from 0.2 to around 1 case per 100,000.

Figure 8.5. Number of human cases (probable and confirmed) and incidence rates of Lyme disease from 2005 to 2017 for York Region residents.



Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario).Infectious disease trends in Ontario [data file]. Lyme disease cases and rate. Toronto: Queen's Printer for Ontario; 2018.

Vulnerable populations

See Chapter 4 for more information on vulnerable populations in York Region. Similar to WNV, those spending substantial time outdoors in wooded or brushy areas, or travel to endemic areas are more vulnerable to Lyme disease. Between 2000 and 2015, 63% of Lyme disease cases in York Region occurred in females across most age groups, but rarely in seniors or children.[146] Part of this may be due to limited mobility and activity on trails among seniors. However, submission rates of ticks in Ontario have tended to be highest for children 0 to 9 years of age and adults 55 to 74 years of age.[156]

Individuals active on trails may be at a higher risk of exposure to blacklegged ticks in York Region. Currently, the York Regional Forest consists of approximately 2,400 hectares of land, providing around 150 km of free trails for the public. Recent surveys conducted in 2017 suggest there are approximately 1,623 visitors per day in York Regional Forest tracts, peaking during the fall.[35] This survey only covered York Region Forest tracts and does not include the wide range of public green spaces in York Region, such as, municipal and provincial parks. Most visits (63%) occur in four tracts: Eldred King (24%), Hollidge (17%), Bendor and Graves (11%) and Brown Hill (10%).[35] The most common activity was walking, with or without a dog. The tracts most favoured for use are near population centres and users' residences. Most visitors are from households living in close proximity to Regional Forest tracts (65%) and visitors driving in primarily from the closest local municipalities of Newmarket, Whitchurch-Stouffville, Markham and Georgina.[35]

Climate factors related to Lyme disease

Tick populations respond more to long-term trends in climate rather than short-term variability in weather. This is due to their longer life cycle, dependence on host populations, ability to withstand weather changes and use of soil/soil litter as refuge.[142,157] Public Health Ontario has noted that the expansion of blacklegged ticks into Ontario is largely driven by climate change and the increase in the mean annual degree days above 0°C.[157] Recent surveillance assessments have highlighted how recent changes in climate have played a factor in the spread of Lyme disease in Ontario. Cheng et al.[158] illustrated how warming temperatures from 1979 to 2013 have created more favourable habitat and host conditions for blacklegged ticks, particularly for southern and eastern Ontario.

Temperature, precipitation and humidity play an important role in the presence of ticks. An earlier seasonal occurrence of Lyme disease has been linked to warmer temperatures in previous seasons in the United States.[159] Similarly, changes in precipitation can impact ticks by creating more humid conditions in soil and litter, which provide refuge from changes in weather. However, heavy precipitation leading to persistent and deep flooding likely decreases tick survival rates.[142] During drought conditions, ticks will be able to return to humid soil and litter for protection. However, this will likely limit their spread into new territories.[142]

The climate in York Region is expected to result in longer and warmer summer periods with more intense rainfall events and fewer extreme cold events. Therefore, there is the potential for blacklegged tick populations to be present in greater numbers due to more favourable weather conditions.

As a result of warming temperatures and an increase in precipitation, it is expected ticks will continue to expand their geographic range north in temperate regions and have an earlier start and longer season of activity. Blacklegged ticks are active in the spring and fall when temperatures are above 0˚C and there is no snow. The reproductive rate is commonly looked at as an indicator of the expanding range of blacklegged ticks. Blacklegged ticks are expected to increase their reproductive rate by 2.2 to 4.6 times more from 2051 to 2065 when compared to historical reproductive rates (1970 to 2000), which is expected to contribute to the expanding range.[151]

Adaptive capacity

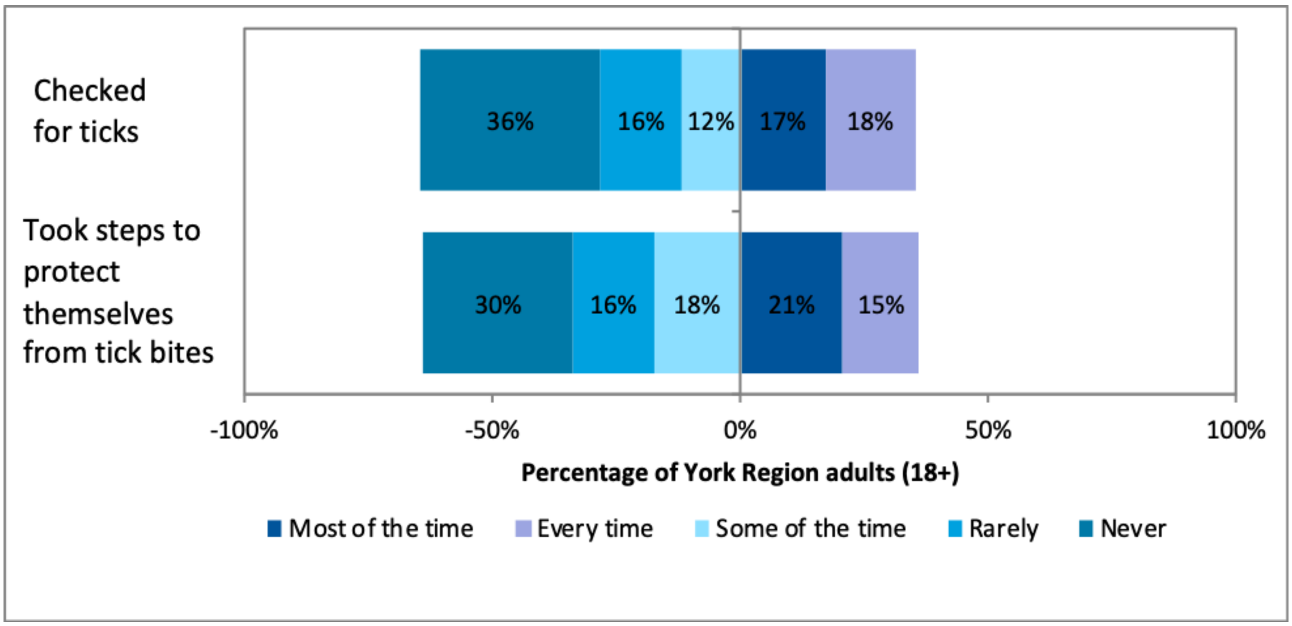
York Region Public Health activities addressing Lyme disease

As part of provincial requirements for Lyme disease, York Region Public Health will continue surveillance activities for Lyme disease and blacklegged ticks.

While surveillance activities are essential to help address current and future Lyme disease risk, educating stakeholders and the public on the health risks and encouraging positive and protective behaviours are vital to reducing risk and decreasing exposure. Current educational activities include promotional campaigns such as **Fight the Bite** (this includes messaging about personal protective measures and signage on Lyme disease at trails where blacklegged ticks were found), educational materials at community events and schools, social media messages and news releases.

However, results from the 2017 Rapid Risk Factor Surveillance System telephone survey suggest approximately one-third of York Region adults have not adopted behaviours to protect themselves against Lyme disease.[16] Approximately 30% of residents reported they never take steps to protect themselves from tick bites and 36% of residents reported they never check themselves for ticks after spending time outdoors (Figure 8.6).[16]

Figure 8.6. How often York Region residents reported taking steps to reduce their exposure to Lyme disease.



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

Additional activities include working with Regional partners such as Forestry staff as part of their public outreach activities and informing the Forest Management Plan and Greening Strategy.

8.3 EMERGING VECTOR-BORNE DISEASES

Climate change and other factors could lead to an emergence of other VBDs that could pose serious health challenges to York Region communities.

Due to projected temperature and precipitation increases, there is the potential for the introduction of new vector species. Current York Region climates ensure exotic VBDs such as malaria and dengue are not established locally. However, the risk of disease establishment is expected to change as a result of climate change. Climate change may support the migration of vectors, reservoirs into current temperate climate zones. This would affect the introduction of exotic mosquitoes and other mosquito-borne diseases into Canada.[160]

Mosquitoes found in Canada (e.g., *Aedes albopictus*) may be able to support the transport and transfer of pathogens currently not endemic to Canada.[160] Malaria is of particular concern, as vectors (*Anopheles species*) responsible for spreading the illness are common in Canada.[160] Of the 41 *Anopheles* species that transmit malaria, the two principal vectors are established in Canada (*Anopheles freeborni and Anopheles quadrimaculatus*).[160] Surveillance of species in positive pools of mosquitoes from 2002 to 2013 have shown *Culex pipiens/restuans* is the most prevalent species (87% of positive pools) followed by *Aedes vexans* (6.2%).[143]

Two mosquito species that can spread the Zika virus, *Aedes albopictus* and *Aedes aegypti*, have been observed in Windsor. These mosquitoes can also spread other diseases such as chikungunya, dengue and yellow fever. Currently, *Aedes aegypti* is not an established species in Ontario due to the relatively cooler temperatures, whereas *Aedes albopictus* is considered established in the Windsor area.

As a result of climate change, other mosquito-borne diseases, such as EEEV and two California serogroup viruses (Jamestown Canyon virus and snowshoe hare virus) may increase, particularly in rural areas.[161] EEEV has a high mortality rate and there has never been a human case in York Region. There has only ever been one human case reported in southeastern Ontario. To date, EEEV has not been detected in vectors through York Region Public Health's mosquito surveillance program.

There are currently no national surveillance programs that monitor other endemic mosquito-borne diseases, such as EEEV and California serogroup viruses in mosquitoes, reservoirs or human populations.[161] Surveillance and research activities need to be enhanced, and are critical to ensure timely and accurate evaluation of other endemic mosquito-borne disease risks to public health.[161]

The research also identifies other tick-borne diseases, namely babesiosis, anaplasmosis, Powassan encephalitis, human granulocytic anaplasmosis and Borrelia miyamotoi disease. Ticks infected with *Babesia microti* (the protozoa that causes babesiosis), and *Anaplasma phagocytophilum* (the bacteria that causes human granulocytic anaplasmosis, Powassan virus and Borrelia miyamotoi disease) have been found in Canada and are expected to increase as a result of climate change.[150,162] Increasing temperatures are expected to expand the number, activity and geographic area of ticks' animal hosts, resulting in increased tick abundance.[162] Additionally, other vectors may spread into Canada such as Amblyomma americanum (also known as the lone-star tick) and Dermacentor species vectors of Rocky Mountain spotted fever, known for their endemic transmission within Ontario, but likely not abundant in York Region.[162]

8.4 CONCLUSION

Weather conditions play an important role in the spread of vectors and VBD. Certain vectors are expected to extend their range and be more prevalent in areas such as Ontario due to climate change.

The two main VBDs of concern in recent years for York Region are WNV and Lyme disease. While most WNV cases show a seasonal trend peaking in August, it is more dependent on local weather conditions in a given year. Rates of Lyme disease and the presence of blacklegged ticks in York Region have shown a rise in recent years due to climate factors, such as temperature, precipitation and humidity.

While research shows climate change will increase the risk of VBDs, various social and environmental factors are also changing that can influence this risk. Expected land-use changes, including more urban and suburban communities, may impact the presence of vectors. While urban corridors are expected to grow, a substantial portion of York Region will remain agricultural or woodland areas (as part of the Greenbelt and Oak Ridges Moraine), which are known to support the presence of ticks and reservoir species.

To help address existing and future VBD issues, York Region Public Health and the province are working proactively to better understand and prevent the risk of VBDs through surveillance, prevention measures and awareness campaigns.

With municipalities, including York Region, working to develop climate change action plans, there are opportunities to incorporate VBD considerations into existing activities. Currently, York Region Public Health works with local municipalities on issues such as stormwater management ponds and WNV risks, and active tick surveillance of municipal parks. Maintaining collaborative relationships with local municipalities will continue to be important as the population continues to grow and communities urbanize across York Region.

York Region Public Health will continue to assess potential VBD risks to inform future adaptation planning. Table 8.2 provides a summary of completed/ongoing activities and opportunities for future planning. While research is relatively strong on climate change and VBDs, it is still important to better understand local factors that can increase risks in York Region.

Table 8.2. Summary of vector-borne disease related activities and adaptation planning opportunities.

	Ongoing and Completed Activities	Opportunities
Population Health Assessment and Surveillance	**Health Surveillance:** Reporting of WNV cases (confirmed and probable). Reporting of Lyme disease cases (confirmed and probable).	Consulting province on ensuring new and emerging VBD diseases that could be introduced to York Region from climate change are considered and monitored as needed.
	Vector Surveillance: Mosquito vectors Active surveillance through mosquito traps set weekly during the WNV and EEEV season. Tick vectors Active surveillance of ticks through annual tick dragging. Passive surveillance of ticks. • Additional tick dragging conducted based on tick submission results.	Explore datasets from other York Region Departments on stagnant water bodies. Explore urban flood risk maps when available to inform surveillance activities in urban and suburban communities. Explore datasets relating to reservoir populations, such as white-tailed deer and white-footed mice. Assess forest corridors and forest cover data that can impact wildlife movement and VBD risk. Consulting province on expanding surveillance and reporting of other mosquito and tick species (e.g., lone star tick) as needed.
	Completion of RRFSS modules for mosquito and Lyme disease personal protection (2014, 2017, 2018).	
Program and Policy	Investigation of standing water complaints to reduce mosquito breeding habitats. Larviciding conducted on municipal catch basins, stormwater management ponds with confirmed mosquito larvae, and sewage lagoons in summer months. **Health Equity:** Larviciding activities conducted near areas with potentially vulnerable populations such as long-term care homes.	Evaluate the effectiveness of biopesticides during longer and warmer summers with more high ultraviolet radiation days.

Health Promotion	Promotional activities include • Media releases and interviews of protection measures and surveillance findings • Social media and YouTube educational videos on Lyme disease, blacklegged ticks and personal protection • Posted ads in York Region Media Group publications, multicultural newspapers and municipal recycling calendars • Provided pamphlets and/or posters to municipal and Regional offices, libraries, community and recreation centres, municipal parks, garden centres, golf courses, Sibbald Point Provincial Park and conservation areas • Posted permanent "Fight the Bite!" tick signs in risk area trailheads **Health Equity:** Promotional messaging targeting children (storybooks and messaging for school board and child care guides), seniors (radio ads), trail users (trail Guide) and immigrants (multicultural newspapers).	Continue education efforts to reach the target groups (active seniors or adults 50 years of age and older). **Health Equity:** Ensure outreach and educational programs target other vulnerable groups (e.g., homeless populations, children through summer day camps and school boards). Advocacy to recommend areas for research and/or review by PHO such as assessing green infrastructure developments for WNV habitats such as bioswales. Educate health care providers on local risks for VBDs, including Lyme disease and testing for Lyme bacteria (two-step process).
Other Stakeholder Activities (outside of Public Health)	Surveillance and public health assessments conducted by PHO and PHAC. Land use planning measures to reduce urban flooding and stagnant pool conditions. Forestry department supporting sign postings and tick surveillance activities of trail areas in York Regional Forests.	Consult with researchers on appropriate weather variables to inform vector surveillance in a season, particularly mosquitoes. Explore best practices that minimize the risk of stagnant pools in green infrastructure developments (e.g., bioswales and rain gardens).