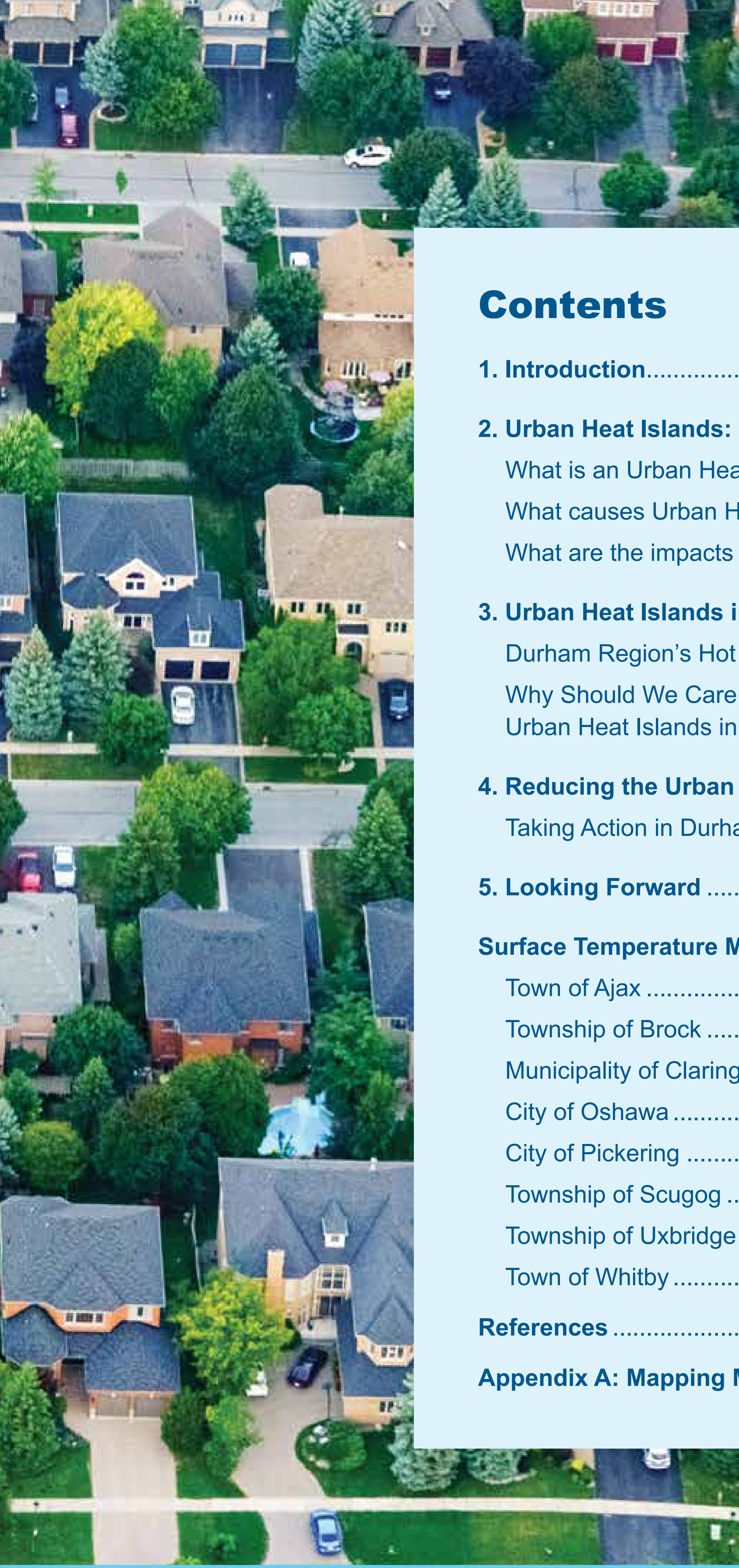
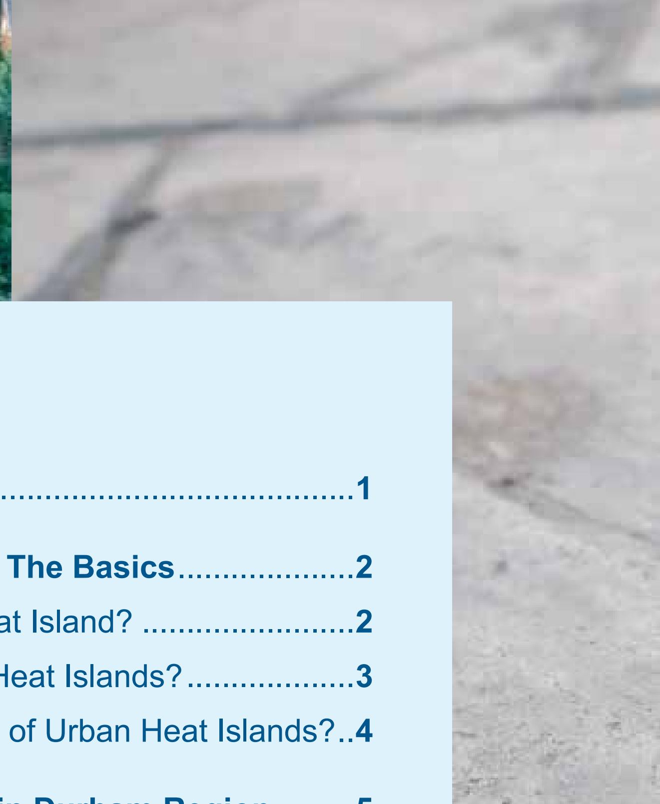
KEEPING OUR COOL

Managing Urban Heat Islands in Durham Region

2018

DURHAM REGION





Contents

1 Introduction

In 2016, 83 per cent of Canada's population lived in urban areas, reflecting an increased shift from rural to urban living over time (Statistics Canada, 2017). Urban spaces provide a rich diversity of social, recreational, and economic opportunities. However, Durham Region's urban areas are also hotter than we think.

Urban Heat Island describes the higher temperature experienced in urban areas compared to rural areas. Urban heat islands have health, social, economic, and environmental impacts. Vulnerable community members are especially at risk. Urban heat island effects are intensified by land use and development decisions, and by climate change, which is projected to make Durham Region hotter, wetter, and wilder by the 2040s (SENES, 2014).

This report takes a closer look at urban heat islands in the context of risks and concerns for Durham Region. The first half of the report provides an overview including definitions, causes, impacts, and measures that can lessen urban heat island effects.

The second half of the report contains a set of surface temperature maps for each of the eight local area municipalities in Durham Region. The maps show areas with high surface temperatures – locations most at risk to the impacts of urban heat islands. Each map includes relevant facts and observations of interest.

2 Urban Heat Islands: The Basics

What is an Urban Heat Island?

Urban heat island is the term used to describe the higher temperature difference between urban and rural areas. The term can refer to surface temperatures, air temperatures, or a combination of both:

> **Surface Urban Heat Island** – occurs when surface temperatures are higher in urban than rural areas. On hot sunny days, dark coloured roofs and pavements can reach temperatures 27C° to 50C° hotter than the surrounding air (EPA, 2008). The effects are most intense in the summer, with variation throughout the day and night. It is measured by mapping temperature data collected by satellites, typically using a snapshot of a selected high temperature day.
>
> **Atmospheric Urban Heat Island** – occurs when air temperatures are higher in urban than rural areas. Effects are the most intense at night due to the slow release of heat from urban structures. Air temperature differences in large North American cities can be 1C° to 3C° warmer than rural areas on a sunny day, and up to 12C° higher at night (EPA, 2008). It is measured by mapping or graphing data collected from fixed weather stations.

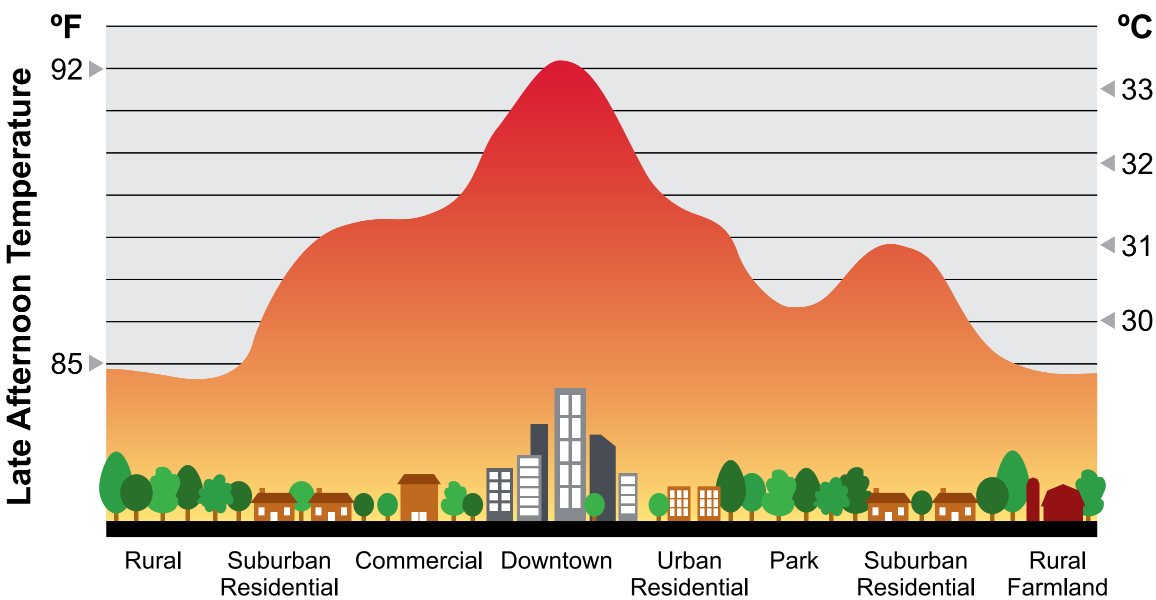


Figure 1: Varying temperatures across rural, commercial, urban and other landscape features (adapted from EPA, 2008).

What causes Urban Heat Islands?

Urban heat islands are created by land use practices and human activities and typically happen alongside urban growth and development. Specific factors that contribute to urban heat islands include (EPA, 2008):

Removal of vegetation – bare soil absorbs and holds onto more of the sun's heat than vegetated landscapes. Trees provide shade and stop the absorption of solar energy below the canopy, resulting in cooler surface and air temperatures. Cooler air temperatures also occur when heat is absorbed as plants transpire water, and as water evaporates from permeable ground surfaces such as soil and grass.

Dark surface materials – surface materials vary in the amount of solar energy they absorb and the rate at which they radiate heat back into the air. The dark-coloured materials typically used in roofs, roads, parking lots, and sidewalks absorb and hold onto more solar energy compared to lighter-coloured materials. Building materials such as steel and stone can absorb and store twice as much heat compared to rural landscapes. These surfaces then release heat into the air, raising air temperatures in urban areas, especially at night.

Urban form – the way an urban space is arranged can affect wind flow and the amount of heat that can be removed from urban areas through natural processes. Tall buildings close together can trap more heat within urban areas. Urban areas with large amounts of asphalt and concrete and flat roofs reflect less and absorb more of the sun's energy.

Waste heat – heat is the waste product of many machines such as air conditioners and ventilation, cooling and refrigeration appliances, vehicles, and those used in certain industrial activities. The heat released from these activities contributes to warmer air in urban areas.

Urban heat islands are also influenced by weather conditions and geography. Calm winds and clear skies provide more opportunity for urban areas to absorb solar energy. On cloudy days more of the sun's energy is reflected off clouds back into the upper atmosphere. Wind and climate is also moderated in urban areas located close to large bodies of water or mountain ranges.

Urban heat islands and climate change. Canada's climate is getting warmer. The national average temperature in 2016 was 2C° above average, the fourth warmest year observed since recording began in 1949 (ECCC, 2016). This warmer weather brings increased health risks, risks which are intensified by urban heat islands as they absorb and retain more heat than rural landscapes.

What are the impacts of Urban Heat Islands?

Health

The impact of urban heat islands on health are particularly concerning as they intensify the effects of extreme heat and humidity – also known as heat waves. Heat-related impacts can include skin rashes, cramps, dehydration, fainting, exhaustion, heat stroke, and death (Health Canada, n.d.). Toronto Public Health estimates that heat contributes to an average of 120 deaths in the city each year that would not have occurred without the extreme heat (Toronto Medical Officer of Health, 2013).

Social

Community members who are particularly vulnerable to the effects of extreme heat and humidity include the elderly, young children, and individuals with pre-existing chronic lung, heart, and kidney conditions (Toronto Medical Officer of Health, 2013). People who are socially isolated, homeless, or low income, and newcomers who are unfamiliar with the area are also vulnerable to extreme heat (Toronto Medical Officer of Health, 2013). For example, people living in substandard housing may not have access to air conditioning and are more likely to live in built up areas that trap more heat through the heat island effect. As the solar heat absorbed by dark surface areas and structures is released slowly at night, there is little relief from heat in the evenings.

Economic

Higher temperatures mean increased demand and costs for cooling through air conditioners and refrigeration. Peak urban electricity demand goes up by 1.5 to 2 per cent for every 0.6C° increase in summer temperature (EPA, 2008). Extreme heat events worsened by heat absorbed and retained in urban heat islands can overload the electricity grid resulting in potential blackouts – with large economic costs.

Environmental

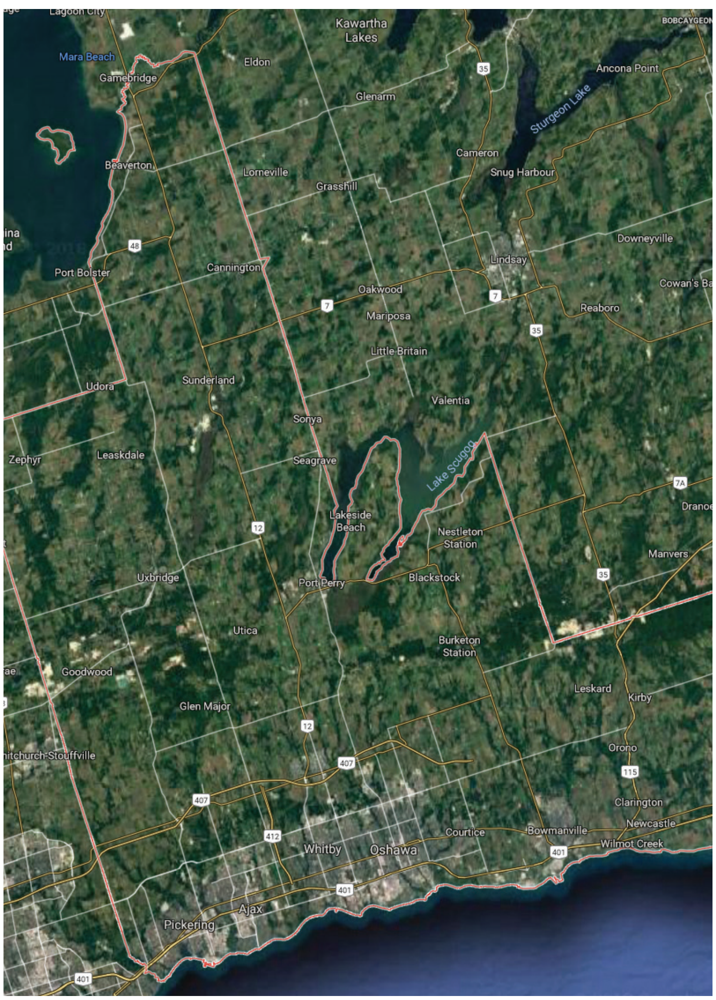
Increased energy use for cooling produces more greenhouse gas emissions and air pollutants. Urban heat islands can also affect local ecosystems. The higher surface temperature of dark-coloured materials in urban areas is transferred to stormwater running over these surfaces. When this warmer runoff joins rivers and creeks it raises the water temperature, negatively affecting aquatic life which are adapted to particular temperature ranges for reproduction, development, and survival (EPA, 2008).

3 Urban Heat Islands In Durham Region

Durham Region’s Hot Spots

There is evidence that urban cores in Durham Region are hotter than surrounding rural areas. Figure 2 is a surface temperature map of Durham Region (see Appendix A for methods); detailed maps for each municipality are in Section 2. The map was created using data from September 21, 2017, a day selected for its particularly high temperature that month. Surface temperature maps help identify hot spots within a community, helping to focus interventions where they are needed most.

On the map in Figure 2 on the adjacent page, dark red areas represent the hottest land surfaces in the Region, while the dark blue represent the coolest areas of the Region. The map shows that the urban cores of Pickering, Ajax, Whitby, and Oshawa are hotter than the more rural and forested areas in the northern and eastern portions of the Region[1]. These areas are therefore most at risk of the impacts of urban heat islands.



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1 In Figure 2 on the adjacent page, the red areas in North Durham are likely due to various agricultural practices and time of year. For example, bare land recently cleared of a crop would absorb more heat than if the crop was still on the land.

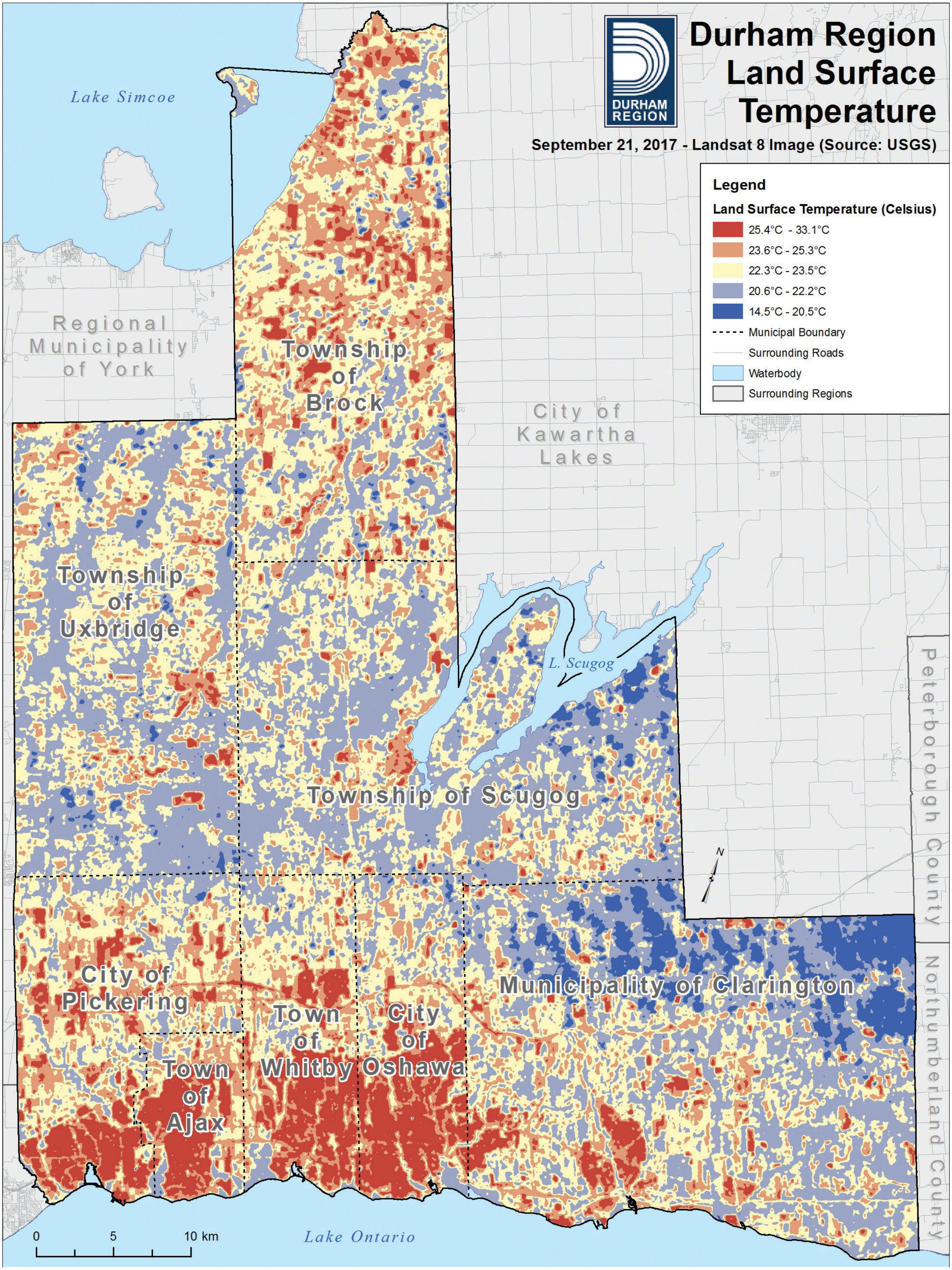


Figure 2: Surface Temperature Map of Durham Region

Why Should We Care about Urban Heat Islands in Durham Region?

We know that…

Urban heat islands intensify the impacts of extreme heat days, which are on the rise with climate change.

This is of concern in Durham Region because…

Durham's future climate is predicted to be warmer with higher humidity by the 2040s (SENES, 2014). The number of extreme heat days per year, or days with a temperature above 30°C, is expected to increase by 5 to 23 days depending on the municipality (SENES, 2014) (see Figure 3). For example, in Whitby, there were an average of 2 days a year above 30°C between 2000 and 2009 – this is estimated to increase to an average of 17 days a year by the 2040s (SENES, 2014).

Humidex levels – the index which combines values for temperature and humidity to estimate how hot it feels – is also projected to rise. Using the Whitby example again, the average number of days per year that feel like they are over 40°C due to humidity will increase from 3 to 19 in the same time period (SENES, 2014).

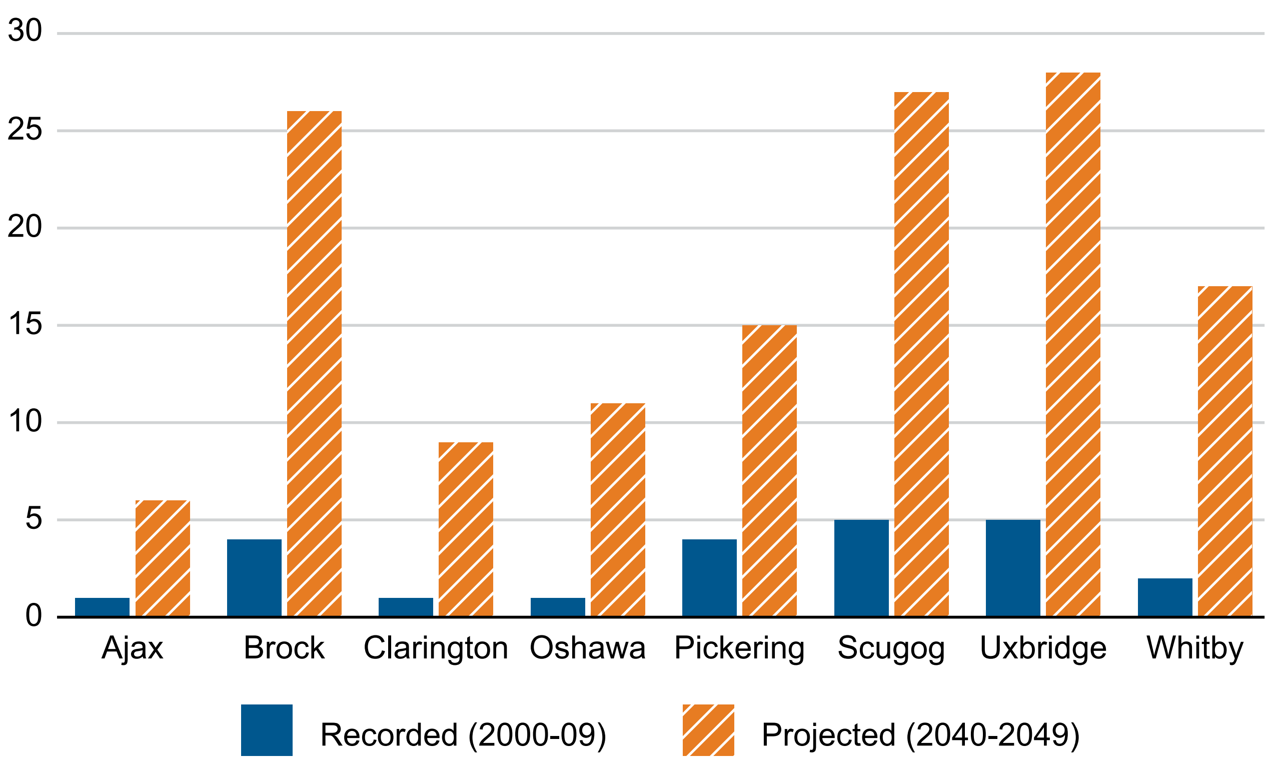
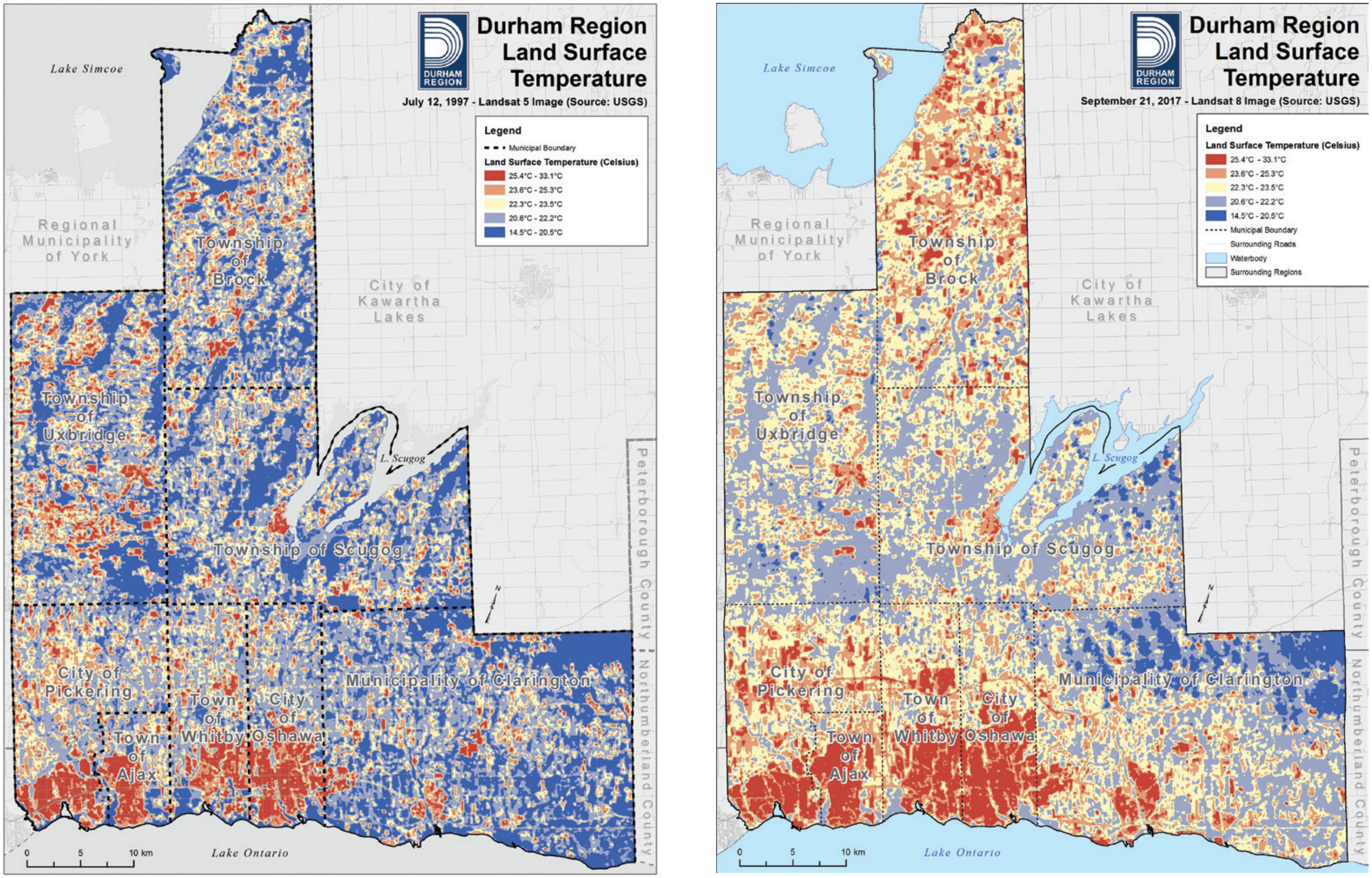


Figure 3: Average number of extreme heat days (above 30°C) per year for Durham Region municipalities.

We know that…	This is of concern in Durham Region because…
Vulnerable populations such as the poor, the elderly, and those with pre-existing illnesses, are most at risk from the impacts of extreme heat and humidity. 	Durham Region's population is aging, increasing the size of population vulnerable to extreme heat and humidity. Public Health Ontario estimates that 24 per cent of the population will be 65 years or older by 2036, compared to 8.3 per cent in 1971 (Public Health Ontario, 2015). The rates of asthma and lung disease prevalence are higher in Durham Region than the Ontario average (Durham Region, 2017). These individuals are particularly vulnerable to extreme heat and humidity. Increased temperatures are linked with higher levels of ground ozone, or smog, a respiratory irritant particularly affecting those with asthma (EPA, 2008). Durham Region Health Department has identified seven priority neighbourhoods across Durham Region, based on health and wellness indicators. In these seven neighbourhoods, hospital Emergency visit rates for children with asthma and cardiovascular disease in adults aged 45 to 64 are higher than the other 43 neighbourhoods in Durham (Durham Region Health Department, 2015). These seven neighbourhoods are particularly vulnerable to the effects of extreme heat and urban heat islands.
Urban heat islands are associated with increased development and urbanization. 	The 2017 Growth Plan for the Greater Golden Horseshoe forecasts that Durham Region's population will double to 1.19 million by 2041 (Government of Ontario, 2017). Housing and infrastructure will be required to support that population, which could mean more conversion of "cool" vegetated landscapes to "hot" areas with pavement, roads, and dark roofs. Figure 4 illustrates the increase in land surface temperatures that have accompanied Durham Region's growth over the past 20 years. The number of households in Durham has increased by 6.6 per cent between 2006 and 2011; faster than the population increase of 6.2 per cent in the same time period (Regional Municipality of Durham, 2017). This is consistent with the trend of fewer people living in each household. This means more housing units are needed to shelter the same number of people, increasing the amount of pavement, roads and dark roofs.



Durham Region 1997

Durham Region 2017

Figure 4: Extent of hotter land surface temperatures (red on map) that has followed growth in Durham Region in the last 20 years.

4 Reducing The Urban Heat Island Effect

Municipalities can take action now to reduce the effect of existing and future urban heat islands. General measures include (Health Canada, 2015; Carolis, 2012; EPA, 2008):

Planting trees and urban greening – increasing vegetation in urban areas through planting trees and expanding greenspace provides cooling through shade and evapotranspiration. Examples include expanding urban forests, conserving natural areas, and naturalizing public properties.

"Cool" roofs and "green" roofs – cool roofs are built with materials that absorb less and radiate out more of the sun's energy. They have been shown to reduce surface temperatures by 29 to 33C° and reduce temperatures in the top floors of buildings (EPA, 2008). Green roofs planted with vegetation or gardens contribute to cooling while also assisting with stormwater management, improved air quality, and energy efficiency of buildings.

Reflective surfaces – light-coloured surface materials for roads, sidewalks, and other infrastructure surfaces reflect rather than absorb a high proportion of solar energy. Other surface materials are continually being developed in a range of colours that also reflect more solar energy.

Energy efficiency – increasing energy efficiency in appliances, vehicles, and equipment can help reduce waste heat that contributes to warmer air in urban centres.

Heat alert and protection planning – ensuring community members have advanced warning of extreme heat events and access to cooling locations that provide heat relief is essential for minimizing the impact of urban heat islands. This includes plans for addressing extreme heat such as checking in on neighbours and helping pets.

Oshawa Centre white roof. Photo courtesy of Oshawa Centre, 100 per cent owned and operated by Ivanhoé Cambridge.

University of Ontario Institute of Technology green roof. Photo courtesy of Kalvin Taylor/UOIT

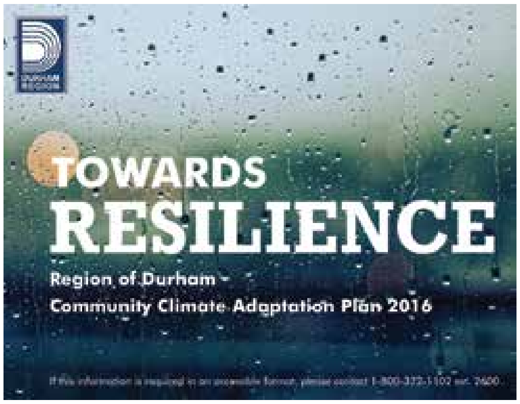
Many actions to lessen the impact of urban heat islands also benefit other economic, social, and environmental goals (Figure 5). For example, a roof-top vegetable garden can also provide habitat for urban bees (enhancing local biodiversity), provide access to local fresh food, improve air quality, absorb rainwater, and reduce energy consumption in the top floors of the building.

Figure 5: Co-benefits of measures to address urban heat islands (adapted from Health Canada, 2015)

The Role of Urban Forests in Mediating Urban Heat Islands, Kingston, Ontario

Kingston has increased efforts to grow its urban forest as one way to adapt to extreme heat events. An urban tree canopy target of 30 per cent was included in the city's official plan when it was renewed in 2010, following Environment Canada's recommendations. The City estimates that the 28,000 trees that now make up their urban forest provide $1.87 million in benefits including reduced building energy use, improving air quality, and carbon storage, in addition to moderating the urban heat island effect.

Source: Guilbault, Kovacs, Berry, and Richardson (2016)



Taking Action in Durham Region

Towards Resilience: Durham Community Climate Adaptation Plan 2016 (Durham Region, 2016) outlines 18 programs that respond to climate change risks to Durham Region's infrastructure, health and welfare, economy, and natural environment.

The foremost program addressing urban heat islands in this Plan is the **"Cool Durham" Heat Reduction Program (HH3)**. The goal of this program is to lower ambient temperatures in urbanized areas during summer heat waves, when extreme temperatures and humidex levels cause increased health risks. The program promotes the adoption of cooling measures in municipalities across Durham including:

Reflective roofs ("white roofs")

Vegetated flat roofs ("green roofs")

Urban tree cover

Shading structures in parks and public spaces

Light coloured pavement and buildings

Energy efficiency in buildings and passive cooling design

Water features in landscaping, such as rain gardens

Additional programs in Towards Resilience to help reduce urban heat island impacts include:

HH1: Extreme Weather Alert and Response System (EWAR) – a mechanism to alert Durham residents to extreme heat and to provide access to increased protection such as pop-up cooling centres, free public swims, and community outreach.

HH2: Property Standards By-law for Maximum Temperature Allowed in Apartments – to reduce health risks to tenants due to extreme heat and heat waves.

CS1: Protect Our Outside Workers – promoting measures to protect outdoor workers from extreme heat, humidity and infectious diseases.

R1: Resilient Asphalt Program – practices to reduce the absorption of heat and increase heat tolerance of asphalt, including use of light coloured material.

NE1: Achieving Climate Change Resilience in the Natural Environment – supporting green infrastructure such as backyard habitat, green roofs, and rain gardens to enhance the health and resilience of natural environments and communities.

Other initiatives in Durham Region can also contribute to reducing heat island effects. Durham Region's Age-Friendly Strategy and Action Plan (2017) includes actions that will help reduce impacts on the elderly through activities that promote affordable, accessible, age-friendly housing, and activities that encourage social inclusion.

Research is also being conducted on heat reduction standards for roofs and roofing materials, reflective pavement and pavement materials, and maximum allowable temperatures in rental units. Recommendations are forthcoming from this research and include suggestions such as including data on amount of pavement surfaces, potential cool and green roof candidates, and apartment buildings without air conditioning on land surface temperature maps to further identify hot spots and areas of high vulnerability.

Mandatory cool roofs to mitigate Urban Heat Islands in Quebec

The community of Rosemont-La Petite-Patrie in East Montreal was the first in Canada to develop comprehensive white and green roof regulations. Zoning by-laws were amended specifying that property owners wishing to replace or build a new roof must install a green roof, a white roof, a highly reflective roof, or a combination thereof. Approximately 2,000 roofs have been retrofitted since the implementation of the by-law, or about 10 per cent of the flat roofs in the municipality. Homeowners who have installed the roofs have reported a decrease in temperature inside their homes combined with a reduction in energy use. While there was initial concern that the white roofs would cause higher heating demands in the winter, this impact was not experienced in the winter months.

Source: Guilbault, Kovacs, Berry, and Richardson (2016)

5 Looking Forward

Urban heat islands are not exclusive to large urban centres such as Toronto. Urban centres across Durham Region are already showing higher temperatures than rural areas. These areas are at risk from the health, social, economic, and environmental impacts of urban heat islands, especially combined with increasing risks of extreme heat and humidity.

Many actions are already underway by government departments, environmental organizations, and residents across Durham that will help lessen the effects of urban heat islands. More can be done to both better understand the risks and reduce the impacts.

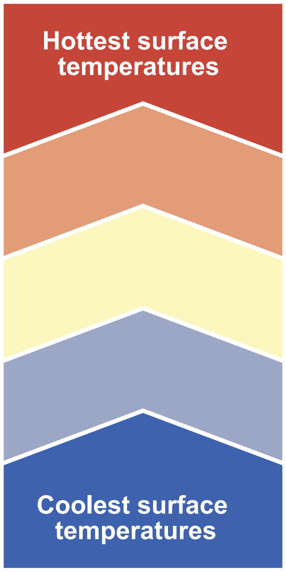
Durham Region's population is forecasted to double by 2041. Now is the time to integrate measures that mitigate urban heat islands into new development to address the effects of urban heat islands before they become unmanageable. These measures will not only lessen the effects of extreme heat in our urban centres, but will also help us build and maintain sustainable and resilient communities for years to come.

New GO Rail Maintenance Facility in Whitby. Notice the white roofs and white walls.
Photo courtesy of Town of Whitby and Metrolinx.

Surface Temperature Maps

This section includes a set of surface-temperature maps, one for each of the eight local municipalities in Durham Region. The maps were created from Landsat 8 images, taken by the United States Geological Survey on September 21, 2017. The maps indicate hotspots in Durham Region, areas that are at the highest risk of impacts from heat and heat island effects. Details on the methodology can be found in Appendix A.

Each map includes landmarks associated with community members who are particularly vulnerable to extreme heat, including seniors' residences, childcare centres, social housing, and hospitals. Also marked on the map are areas where people can go to get cool, including pools and splash pads, public libraries, shopping malls, community or recreation facilities, and evacuation centres. The maps therefore help to identify priority areas for shade and cooling efforts.



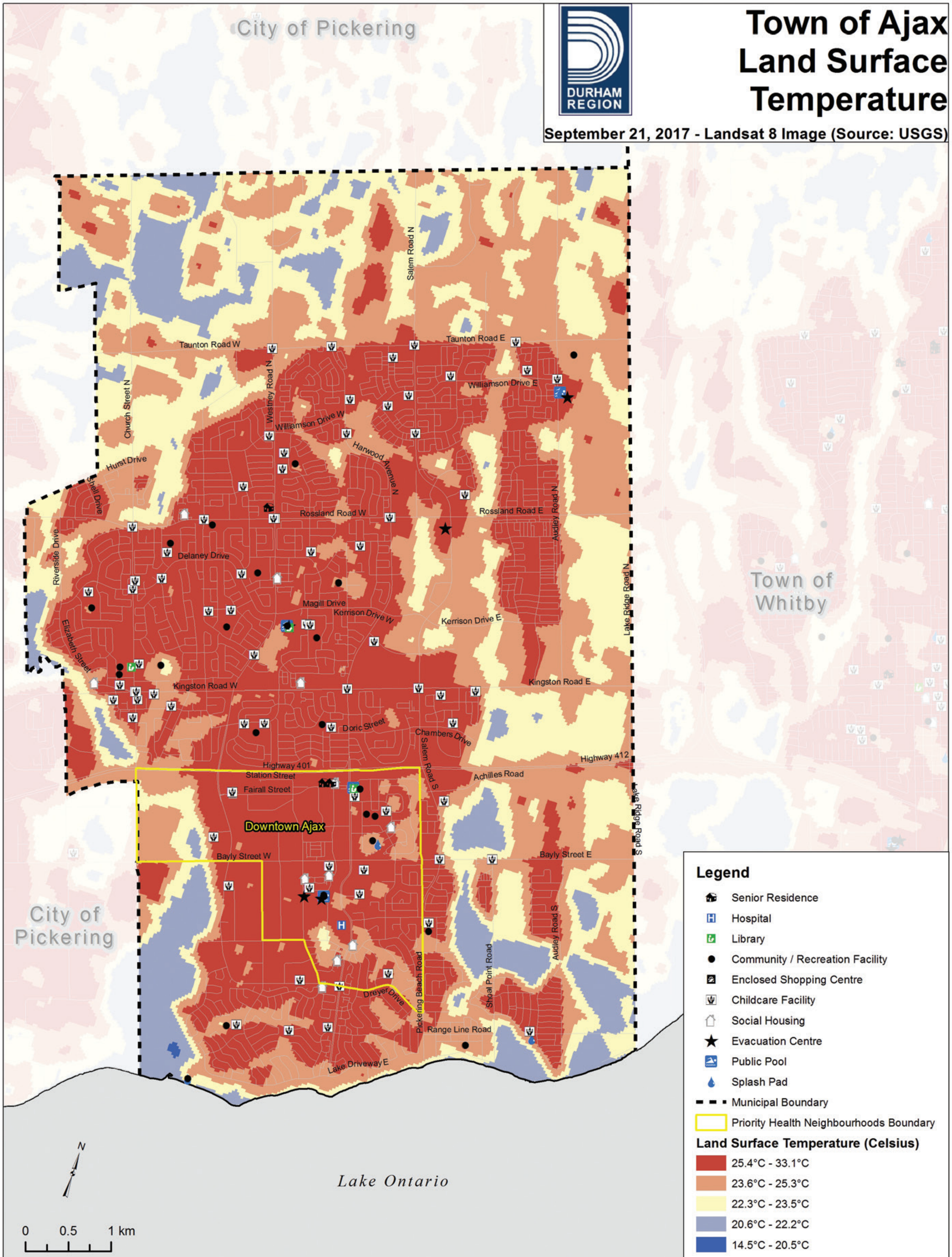
The page next to each municipal map includes relevant statistics about that municipality and specific observations of interest from the maps. Statistics include recent population trends[2] and future projections[3], information regarding Priority Neighbourhoods[4], and climate projections for that municipality.[5]

[2] Commissioner of Planning and Economic Development. 2016 Census Population – Population and Dwelling Counts Release. The Regional Municipality of Durham Information Report. Retrieved from: https://www.durham.ca/en/living-here/resources/Documents/EnvironmentalStability/2017-INFO-40-2016-Census-of-Population---Population-and-Dwelling-Counts-Release.pdf

[3] Durham Region. 2017. Durham Regional Official Plan Consolidation 2017. Retrieved from: https://www.durham.ca/en/doing-business/resources/Documents/PlanningandDevelopment/Official-Plan/2017-Durham-Regional-Official-Plan-Consolidation.pdf

[4] Durham Region Health Department. 2015. Building on Health in Priority Neighbourhoods. The Regional Municipality of Durham. Retrieved from: https://www.durham.ca/en/health-and-wellness/resources/Documents/HealthInformationServices/HealthNeighbourhoods/buildingOnHealth.pdf

[5] SENES Consultants. (2014). Durham Region's Future Climate (2040-2049) – Summary. Retrieved on January 16th, 2018, from: https://www.durham.ca/en/living-here/resources/Documents/EnvironmentalStability/DurhamsFutureClimateStudy_Executive-Summary.pdf


Town of Ajax
Land Surface
Temperature
September 21, 2017 - Landsat 8 Image (Source: USGS)
DURHAM REGION
City of Pickering
Town of Whitby
Lake Ontario
Downtown Ajax
Taunton Road W
Taunton Road E
Williamson Drive W
Williamson Drive E
Westney Road N
Church Street N
Salem Road N
Harwood Avenue N
Hurst Drive
Shell Drive
Rossland Road W
Rossland Road E
Audley Road N
Riverside Drive
Delaney Drive
Magill Drive
Kerrison Drive W
Kerrison Drive E
Lake Ridge Road N
Elizabeth Street
Kingston Road W
Kingston Road E
Doric Street
Chambers Drive
Salem Road S
Highway 401
Highway 412
Station Street
Fairall Street
Achilles Road
Lake Ridge Road S
Bayly Street W
Bayly Street E
Audley Road S
Shoal Point Road
Pickering Beach Road
Dreyer Drive
Range Line Road
Lake Driveway E
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C
N
0 0.5 1 km

Town of Ajax

Demographics

Population (2016):	Projected population 2031:	Number of households (2016):
119,677	**137,670**	**37,549**

Population increase 2011 to 2016:

9.2%

Increase in number of households 2011 to 2016:

7.2%

Priority Neighbourhoods

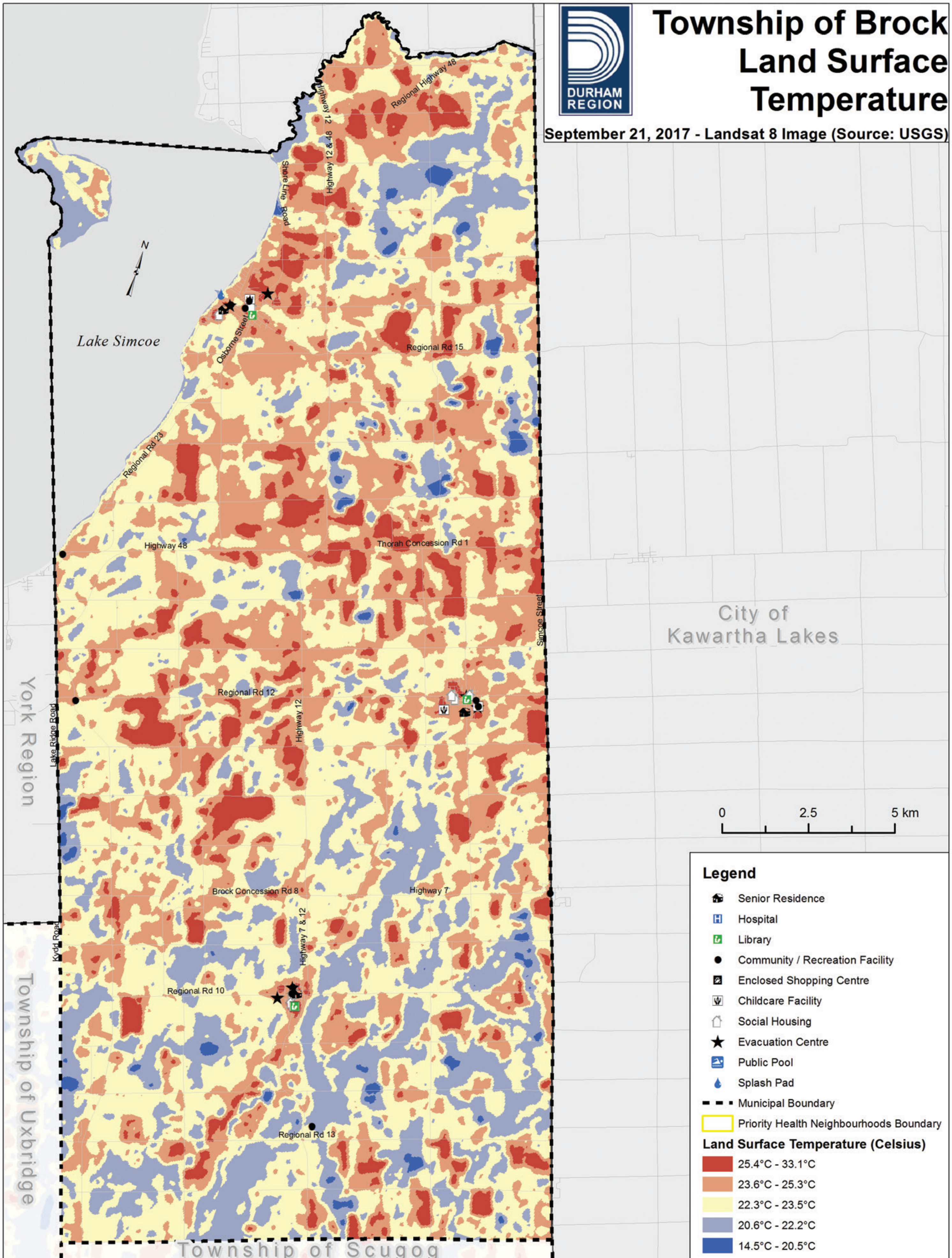
Number of Priority Neighbourhoods identified by Durham Region Health Department: **1** (Downtown Ajax)

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	24ºC	26ºC
Extreme maximum temperature	31ºC	40ºC
Number of days per year over 30ºC	1	6
Maximum Humidex	43ºC	48ºC
Number of days per year over 40ºC with Humidex	1	6

Points of Interest on Map

- Downtown and residential areas to the north and south of Highway 401 show high land surface temperatures (red on map).
- The valley of Duffins Creek in the southwest portion of Ajax has a low land surface temperature (grey on map) due to cooling effects of trees and vegetation.
- The wooded area in the southeast part of Ajax around and to the north of the Ajax Waterfront Lakeside Park has a low land surface temperature (grey on map).
- The commercial centre to the north of Highway 2 at Salem Road shows a high land surface temperature (red on map). The surface temperature in the fields adjacent and to the north are cooler (yellow on map).



Township of Brock Land Surface Temperature
September 21, 2017 - Landsat 8 Image (Source: USGS)
DURHAM REGION
Lake Simcoe
City of Kawartha Lakes
York Region
Township of Uxbridge
Township of Scugog
Regional Highway 48
Highway 12 & 48
Shore Line Road
Osborne Street
Regional Rd 15
Regional Rd 23
Highway 48
Thorah Concession Rd 1
Simcoe Street
Regional Rd 12
Highway 12
Lake Ridge Road
Brock Concession Rd 8
Highway 7
Highway 7 & 12
Kydd Rd
Regional Rd 10
Regional Rd 13
N
0
2.5
5 km
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

Township of Brock

Demographics

Population (2016):
11,642

Projected population 2031:
14,015

Number of households (2016):
4,543

Population increase 2011 to 2016:
2.7%

Increase in number of households 2011 to 2016:
4.8%

Priority Neighbourhoods

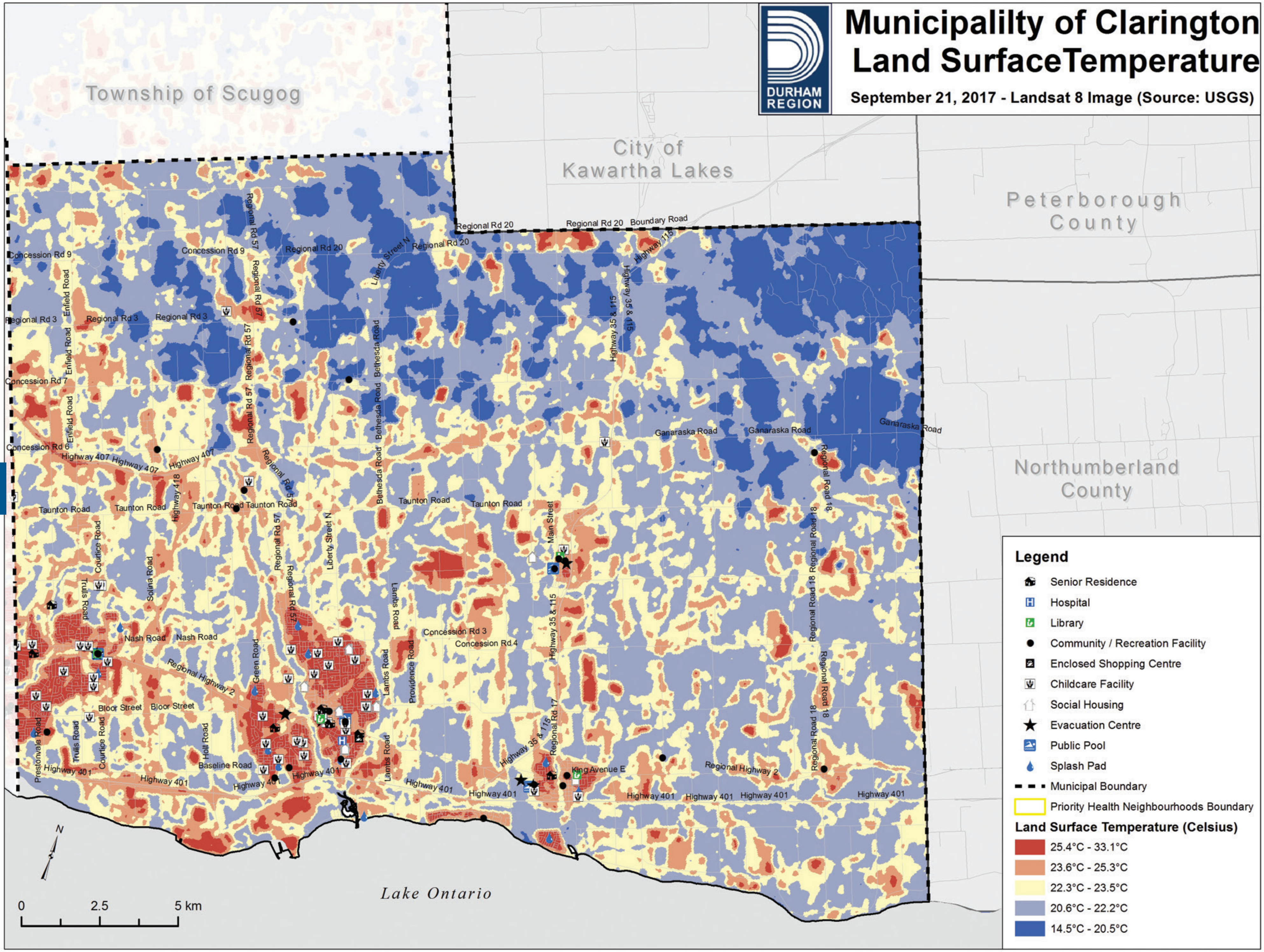
Number of Priority Neighbourhoods identified by Durham Region Health Department: **0**

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	24ºC	29ºC
Extreme maximum temperature	33ºC	40ºC
Number of days per year over 30ºC	4	26
Maximum Humidex	45ºC	54ºC
Number of days per year over 40ºC with Humidex	4	25

Points of Interest on Map

- There are extensive areas with cool (grey on map) to average (yellow on map) surface temperatures, consistent with vegetated rural areas.
- The hot areas (red on map) throughout the agricultural areas are likely exposed soil from cleared cropland or other agricultural practices. Exposed dry soil absorbs a high amount of solar radiation. This increases the surface temperature on clear sunny days such as the day from which data was drawn to create the maps.
- Sunderland, Cannington and Beaverton do not yet have extensive areas with high surface temperatures (red on map). This is in part due to the small size and low density of the communities.


Municipalilty of Clarington
Land SurfaceTemperature
September 21, 2017 - Landsat 8 Image (Source: USGS)
DURHAM REGION
Township of Scugog
City of Kawartha Lakes
Peterborough County
Northumberland County
Lake Ontario
Regional Rd 20
Boundary Road
Highway 115
Highway 35 & 115
Liberty Street N
Concession Rd 9
Regional Rd 57
Regional Rd 3
Enfield Road
Concession Rd 7
Concession Rd 6
Highway 407
Highway 418
Bethesda Road
Ganaraska Road
Regional Road 18
Taunton Road
Main Street
Courtice Road
Trulls Road
Solina Road
Nash Road
Regional Highway 2
Green Road
Lambs Road
Providence Road
Concession Rd 3
Concession Rd 4
Regional Rd 17
King Avenue E
Bloor Street
Holt Road
Baseline Road
Prestonvale Road
Highway 401
N
0
2.5
5 km
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

Municipality of Clarington

Demographics

Population (2016): **92,013**

Projected population 2031: **140,340**

Number of households (2016): **32,838**

Population increase 2011 to 2016: **8.8%**

Increase in number of households 2011 to 2016: **9.9%**

Priority Neighbourhoods

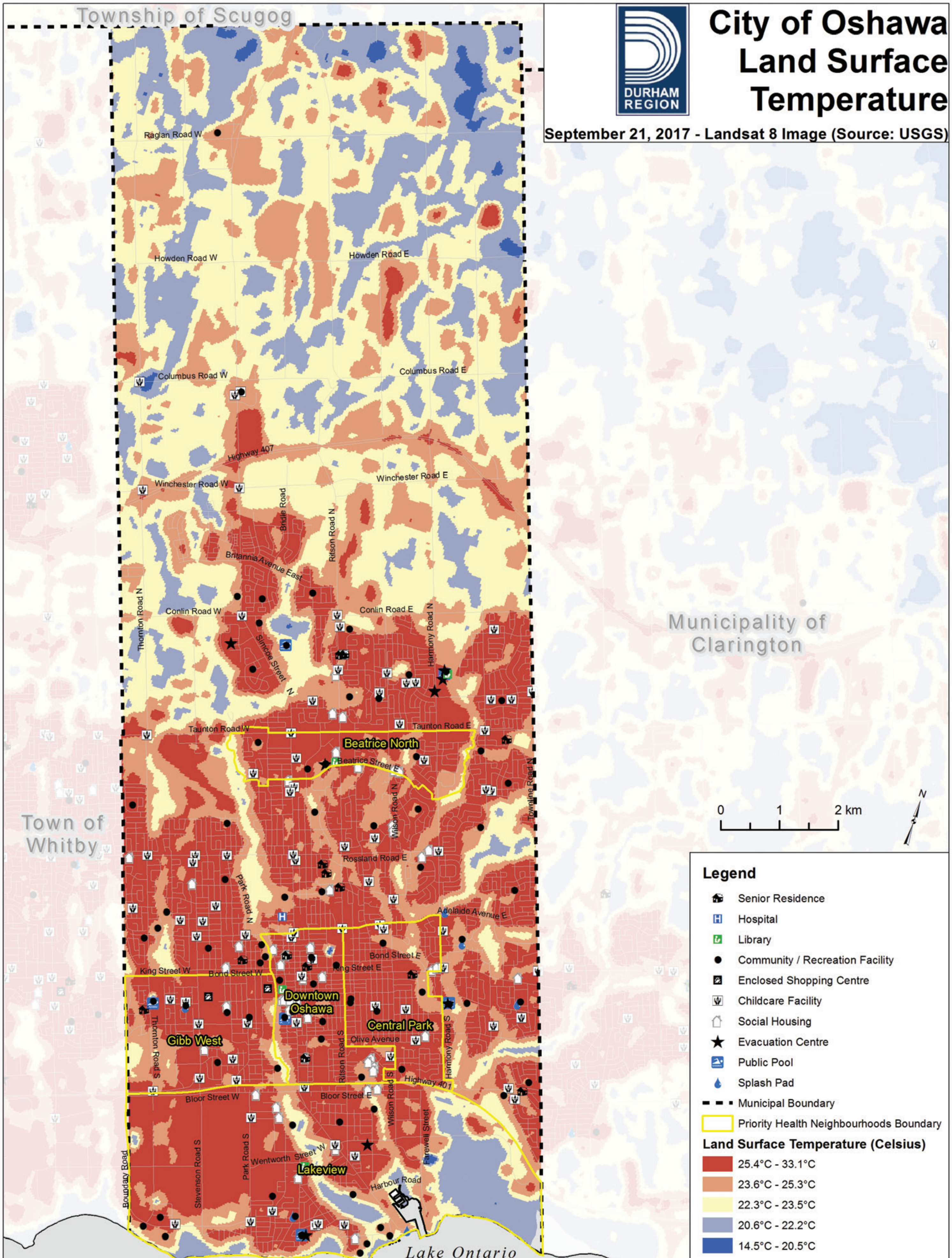
Number of Priority Neighbourhoods identified by Durham Region Health Department: **0**

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	24ºC	27ºC
Extreme maximum temperature	32ºC	40ºC
Number of days per year over 30ºC	1	9
Maximum Humidex	45ºC	48ºC
Number of days per year over 40ºC with Humidex	2	13

Points of Interest on Map

- Bowmanville and Newcastle have the hottest surface area temperatures in the municipality (red on map).
- The industrial facility south of the 401 in Bowmanville has a high surface area temperature (red on map), indicating an area bare of vegetation.
- The majority of north Clarington has cool surface temperatures (dark blue on map) correlating with the largely forested areas of Durham East Cross Forest Conservation area, the Long Sault Conservation Area, and part of the Ganaraska Forest.



City of Oshawa Land Surface Temperature
DURHAM REGION
September 21, 2017 - Landsat 8 Image (Source: USGS)
Township of Scugog
Municipality of Clarington
Town of Whitby
Lake Ontario
Raglan Road W
Howden Road W
Howden Road E
Columbus Road W
Columbus Road E
Highway 407
Winchester Road W
Winchester Road E
Bridle Road
Ritson Road N
Britannia Avenue East
Conlin Road W
Conlin Road E
Thornton Road N
Simcoe Street N
Harmony Road N
Taunton Road W
Taunton Road E
Beatrice North
Beatrice Street E
Wilson Road N
Townline Road N
Rossland Road E
Park Road N
Adelaide Avenue E
Bond Street E
King Street W
Bond Street W
King Street E
Downtown Oshawa
Central Park
Gibb West
Thornton Road S
Ritson Road S
Olive Avenue
Harmony Road S
Highway 401
Bloor Street W
Bloor Street E
Wilson Road S
Farewell Street
Boundary Road
Stevenson Road S
Park Road S
Wentworth Street W
Lakeview
Harbour Road
0
1
2 km
N
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

City of Oshawa

Demographics

Population (2016):
159,458

Projected population 2031:
197,000

Number of households (2016):
62,595

Population increase 2011 to 2016:
6.6%

Increase in number of households 2011 to 2016:
6.5%

Priority Neighbourhoods

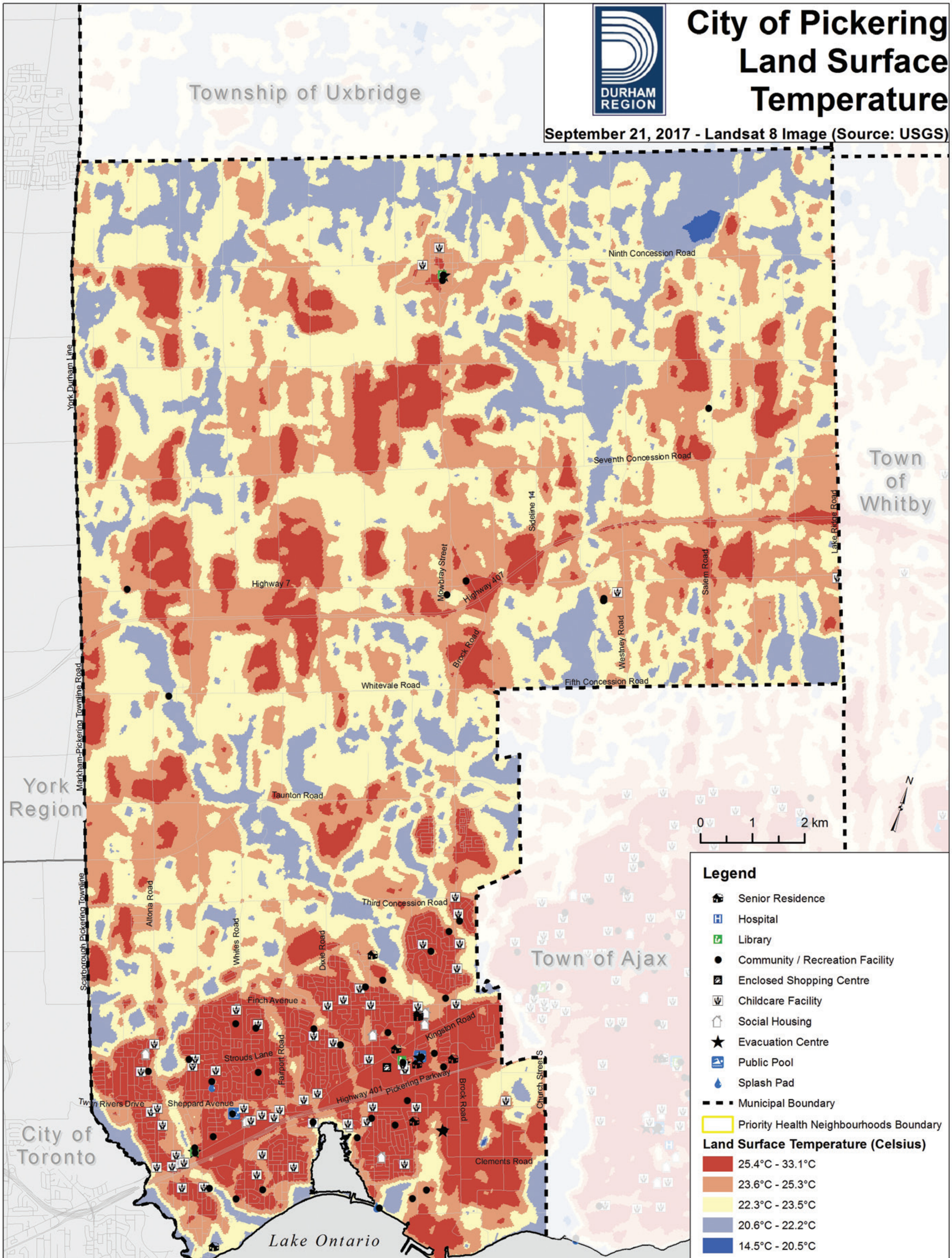
Number of Priority Neighbourhoods identified by Durham Region Health Department: **5** (Lakeview, Gibb West, Downtown Oshawa, Central Park, Beatrice North)

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	24ºC	28ºC
Extreme maximum temperature	32ºC	40ºC
Number of days per year over 30ºC	1	11
Maximum Humidex	46ºC	50ºC
Number of days per year over 40ºC with Humidex	3	16

Points of Interest on Map

- The residential and commercial areas to the north of Highway 401, and residential area to the south of 401, show high land surface temperatures (red on map).
- The industrial park in the southwest corner of Oshawa near the Lake Ontario shoreline shows high land surface area (red on map).
- The new residential areas near UOIT show high land surface area (red on map) and are currently surrounded by vegetated land with lower land surface temperatures (yellow and grey on map).
- Oshawa Valleylands Conservation Area and Second Marsh in the southeast corner of Oshawa have low land surface temperature on account of the high amount of vegetation (grey and yellow on map).



City of Pickering Land Surface Temperature
DURHAM REGION
September 21, 2017 - Landsat 8 Image (Source: USGS)
Township of Uxbridge
Town of Whitby
York Region
Town of Ajax
City of Toronto
Lake Ontario
Ninth Concession Road
Seventh Concession Road
Fifth Concession Road
Third Concession Road
Highway 7
Highway 407
Highway 401
Whitevale Road
Taunton Road
Finch Avenue
Strouds Lane
Sheppard Avenue
Twyn Rivers Drive
Kingston Road
Pickering Parkway
Clements Road
York Durham Line
Markham-Pickering Townline Road
Scarborough Pickering Townline
Altona Road
Whites Road
Dixie Road
Fairport Road
Brock Road
Mowbray Street
Sideline 14
Westney Road
Salem Road
Lake Ridge Road
Church Street S
0 1 2 km
N
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

City of Pickering

Demographics

Population (2016):
91,771

Projected population 2031:
225,670

Number of households (2016):
30,919

Population increase 2011 to 2016:
3.4%

Increase in number of households 2011 to 2016:
5.4%

Priority Neighbourhoods

Number of Priority Neighbourhoods identified by Durham Region Health Department: **0**

Climate Projections (Summer Air Temperatures)

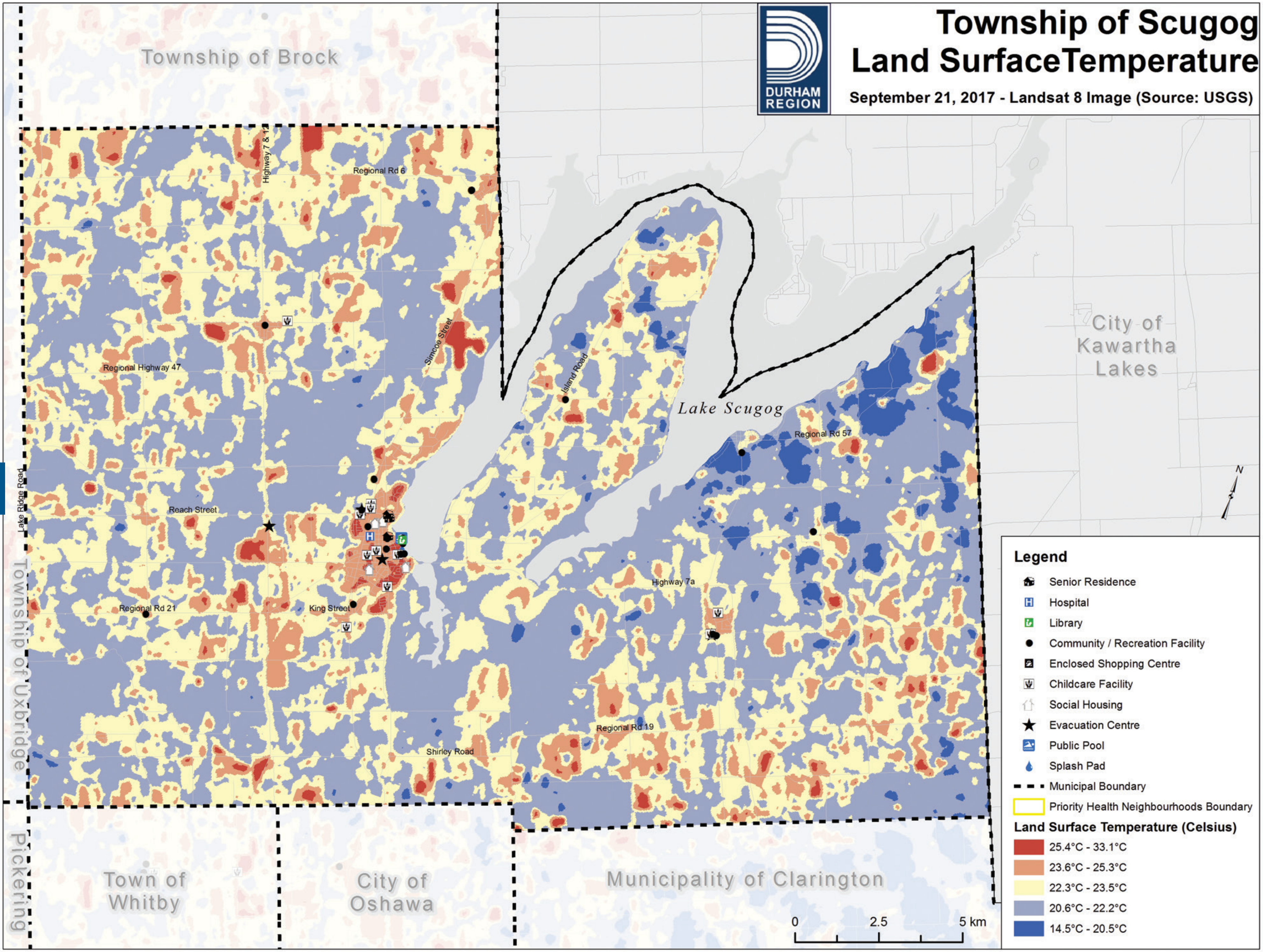
Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	25°C	28°C
Extreme maximum temperature	35°C	43°C
Number of days per year over 30°C	4	15
Maximum Humidex	48°C	53°C
Number of days per year over 40°C with Humidex	4	17

Points of Interest on Map

- Commercial and residential areas to the north and south of Highway 401 show high land surface temperatures (red on map).
- The valley of Petticoat Creek in the southwest portion of Pickering has a low land surface temperature (grey and yellow on map).
- The new housing development near Highway 407 and Brock Road has a high surface area (red on map) and is surrounded by vegetated areas with a low land surface temperature (yellow and grey on map).
- The red areas with high surface temperature in the far north of Pickering may be bare soil due to crop harvest or other agricultural practices.

Township of Scugog Land SurfaceTemperature

September 21, 2017 - Landsat 8 Image (Source: USGS)



Township of Scugog

Demographics

Population (2016):
21,617

Projected population 2031:
25,390

Number of households (2016):
8,218

Population increase 2011 to 2016:
0.2%

Increase in number of households 2011 to 2016:
2.7%

Priority Neighbourhoods

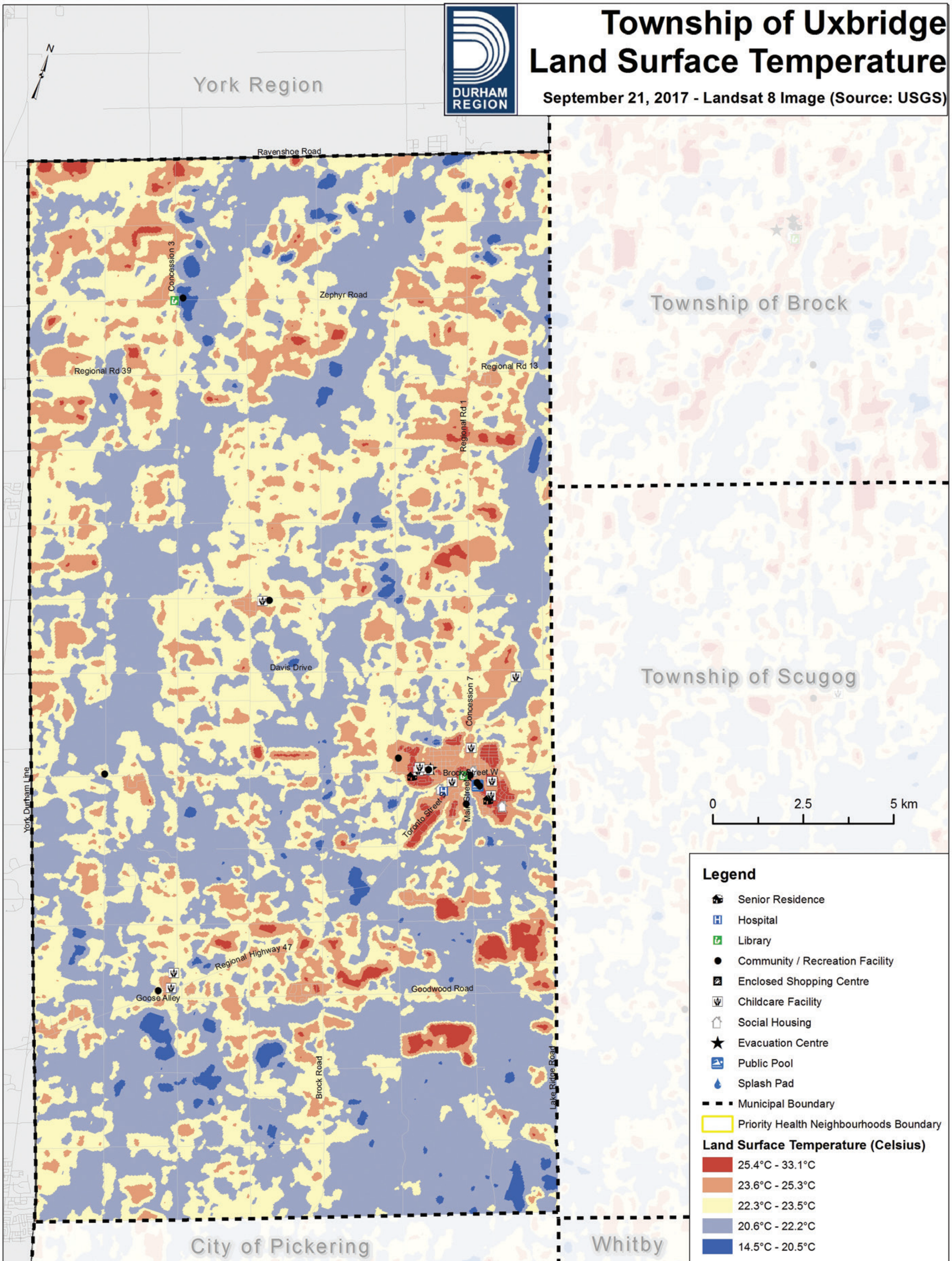
Number of Priority Neighbourhoods identified by Durham Region Health Department: **0**

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	25ºC	29ºC
Extreme maximum temperature	35ºC	44ºC
Number of days per year over 30ºC	5	27
Maximum Humidex	46ºC	54ºC
Number of days per year over 40ºC with Humidex	4	25

Points of Interest on Map

- Port Perry stands out on the map as an area with higher surface temperatures (red and orange on map) than surrounding areas.
- The majority of the municipality shows cooler temperatures (yellow and grey).
- Areas of high surface temperature (red on map) in rural and agricultural areas are likely due to bare soil from cleared crops or other agricultural practices.


Township of Uxbridge
Land Surface Temperature
September 21, 2017 - Landsat 8 Image (Source: USGS)
DURHAM REGION
N
York Region
Township of Brock
Township of Scugog
City of Pickering
Whitby
Ravenshoe Road
Concession 3
Zephyr Road
Regional Rd 39
Regional Rd 13
Regional Rd 1
Davis Drive
Concession 7
Brock Street W
Toronto Street
Main Street
York Durham Line
Regional Highway 47
Goose Alley
Goodwood Road
Brock Road
Lake Ridge Road
0
2.5
5 km
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

Township of Uxbridge

Demographics

Population (2016):	Projected population 2031:	Number of households (2016):
21,176	**26,965**	**7,663**

Population increase 2011 to 2016:

2.7%

Increase in number of households 2011 to 2016:

4.3%

Priority Neighbourhoods

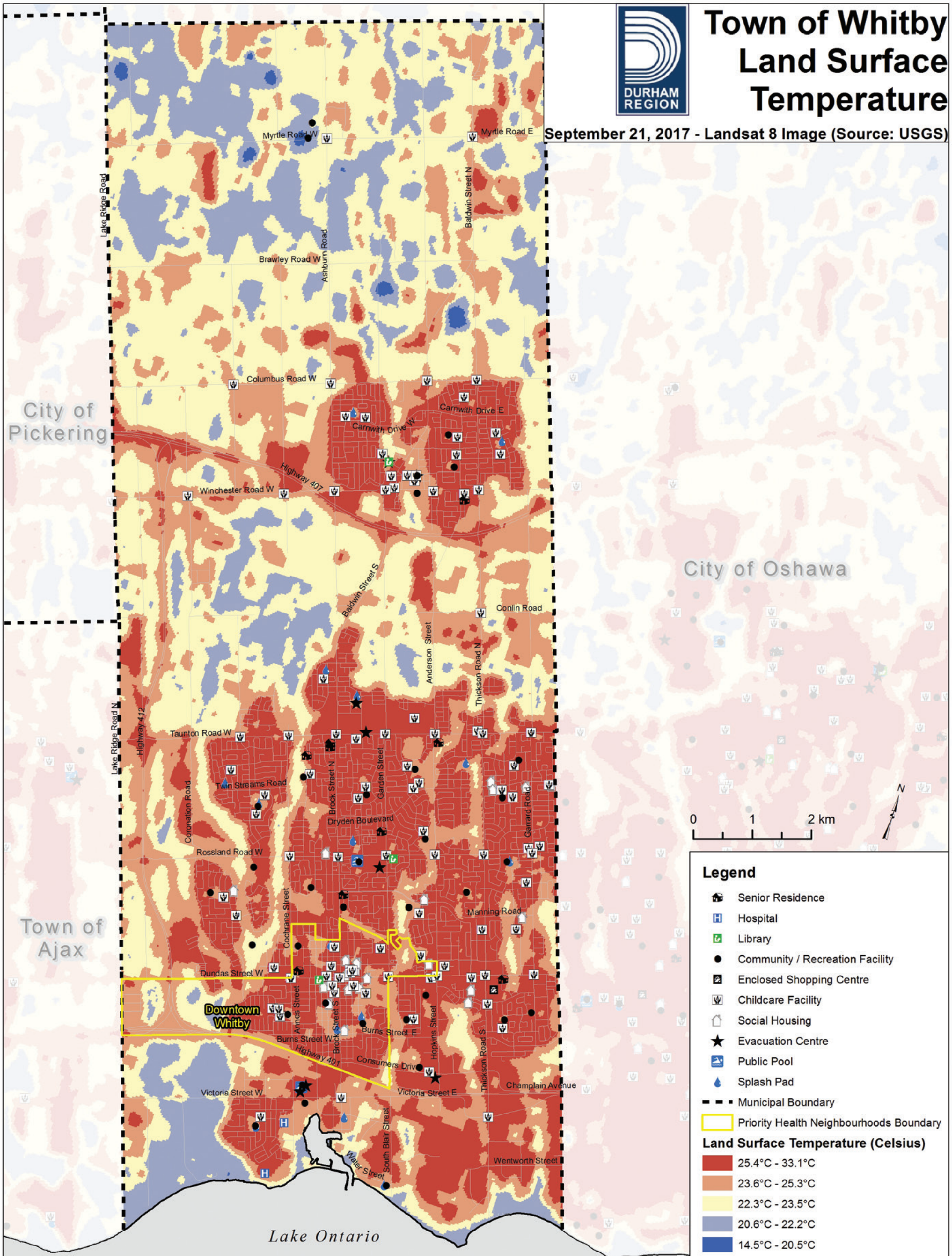
Number of Priority Neighbourhoods identified by Durham Region Health Department: **0**

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	25ºC	29ºC
Extreme maximum temperature	37ºC	43ºC
Number of days per year over 30ºC	5	28
Maximum Humidex	45ºC	54ºC
Number of days per year over 40ºC with Humidex	3	24

Points of Interest on Map

- The Town of Uxbridge stands out on the map as an area with higher surface temperatures (red and orange on map) than surrounding areas.
- The majority of the municipality shows cooler temperatures (yellow and grey).
- Areas of high surface temperature (red on map) in rural and agricultural areas are likely due to bare soil from cleared crops or other agricultural or industrial practices.


Town of Whitby
Land Surface
Temperature
DURHAM REGION
September 21, 2017 - Landsat 8 Image (Source: USGS)
City of Pickering
Town of Ajax
City of Oshawa
Lake Ontario
Downtown Whitby
Myrtle Road W
Myrtle Road E
Lake Ridge Road
Baldwin Street N
Brawley Road W
Ashburn Road
Columbus Road W
Carnwith Drive E
Carnwith Drive W
Highway 407
Winchester Road W
Baldwin Street S
Conlin Road
Anderson Street
Thickson Road N
Taunton Road W
Lake Ridge Road N
Highway 412
Twin Streams Road
Brock Street N
Garden Street
Coronation Road
Dryden Boulevard
Garrard Road
Rossland Road W
Cochrane Street
Manning Road
Dundas Street W
Ames Street
Brock Street S
Burns Street W
Burns Street E
Hopkins Street
Thickson Road S
Highway 401
Consumers Drive
Victoria Street W
Victoria Street E
Champlain Avenue
South Blair Street
Water Street
Wentworth Street
0
1
2 km
N
Legend
Senior Residence
Hospital
Library
Community / Recreation Facility
Enclosed Shopping Centre
Childcare Facility
Social Housing
Evacuation Centre
Public Pool
Splash Pad
Municipal Boundary
Priority Health Neighbourhoods Boundary
Land Surface Temperature (Celsius)
25.4°C - 33.1°C
23.6°C - 25.3°C
22.3°C - 23.5°C
20.6°C - 22.2°C
14.5°C - 20.5°C

Town of Whitby

Demographics

Population (2016):
128,377

Projected population 2031:
192,860

Number of households (2016):
43,529

Population increase 2011 to 2016:
19.9%

Increase in number of households 2011 to 2016:
6.1%

Priority Neighbourhoods

Number of Priority Neighbourhoods identified by Durham Region Health Department: **1** (Downtown Whitby)

Climate Projections (Summer Air Temperatures)

Climate Indicator	2000-2009	2040-2049
Average daily maximum temperature	25ºC	28ºC
Extreme maximum temperature	33ºC	40ºC
Number of days per year over 30ºC	2	17
Maximum Humidex	47ºC	51ºC
Number of days per year over 40ºC with Humidex	3	19

Points of Interest on Map

- The residential and commercial areas between Highway 401 and Taunton Road show high land surface temperatures (red on map).
- The community of Brooklin, north of Highway 7, shows high land surface temperatures (red on map) and is currently surrounded by vegetated land with lower land surface temperatures (yellow on map).
- The valley of Lynde Creek in the southwest portion of Whitby has a low land surface temperature (grey and yellow on map).
- The industrial park south of Highway 401 to the Lake Ontario shoreline shows high land surface temperatures (red on map).

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Appendix A: Mapping Methods

The land surface temperature maps were developed as a tool to visualize areas at greatest risk of the impacts of urban heat islands. The technology used to create surface temperature maps provides better geographic coverage than that used to measure air temperature. Limitations are that the data can only be collected in clear weather conditions when a satellite passes over the city or region.

The Durham Region and municipal maps were created with thermal data from Landsat 8 satellite imagery. The warmest dates in September 2017 were reviewed through a search of Environment Canada weather and temperature data. September 21, 2017 was selected due to warm temperatures and available cloud free satellite imagery. Data was collect at 15:57:47 GMT, almost noon in Durham Region. A Landsat 8 image from this date was identified (in fact two images reprocessed into one), downloaded, and processed.

Processing of the Landsat 8 image involved multiple steps. The combined image was analyzed with ENVI FX software, a remote sensing application that has many tools and functions to process satellite and orthophoto data. The data was radiometrically corrected using a built-in model, a process that reduces or corrects errors in the digital numbers of images. This process converted the thermal bands of Landsat 8 into a file with cells in degrees Kelvin. This data was imported into the mapping software ArcGIS, where the data in degrees Kelvin was converted into degrees Celsius. The map was converted from a pixels format (raster) to a structured visually fluid format (vector), a format that is more flexible and easy to use. A colour scheme was then applied to temperature categories to aid in visual recognition of temperature differences.

The weather data in the text box was taken from the Oshawa weather station on September 21, 2017.[1] Note that these readings are for air temperatures, not surface temperatures.

- Highest air temperature recorded: 25.9°C
- Lowest air temperature recorded: 15.3°C
- Relative humidity range: 53% to 93%
- Highest humidex reached: 30
- Wind speed range: 4 to 15 km/h
- Wind direction at maximum temperature: 160° (SE)

The previous day, September 20, was a similarly warm day, with a high of 25.5°C and a maximum Humidex of 33. Data on precipitation and other weather conditions on the days leading up to September 21 is not available.

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[1] Environment and Climate Change Canada. Hourly data report for September 21, 2017, Oshawa, Ontario. http://bit.ly/2CESuC3

More information:

For background information on the Durham Community Climate Adaptation Plan and its development, please visit: www.durham.ca/climatechange

Please direct any questions or comments to:

climatechange@durham.ca

1-800-372-1102 ext. 2600
905-668-7711 ext. 2600

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Whitby, Ontario, L1N 6A3

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If this information is required in an accessible format, please contact 1-800-372-1102 ext. 2600.