

Petticoat Creek Watershed Action Plan

August 2012

Toronto and Region Conservation for The Living City

Rouge Park

This action plan is available to view or download at *www.trca.on.ca*.

Foreword

Petticoat Creek has long been in the shadow of neighbouring better known, and larger watersheds. As a result, it has received limited attention and action in watershed management. The time to change that is now.

Due to its natural physiography with limited groundwater discharge, Petticoat Creek was never a permanently flowing coldwater stream. While the watershed has lost a significant amount of forest cover, it retains unique features such as Altona Forest. Today, Petticoat Creek is an urbanizing, warmwater watershed dominated by agricultural uses, generally in "fair" condition. Its ecological function is altered, but well-positioned to respond favourably to remediation efforts, and it certainly deserves more attention than it has received. Current actions are inadequate to maintain the health of this watershed.

This watershed action plan serves as a wake-up call. Without new efforts and resources, Petticoat Creek will become yet another degraded watershed. There is an opportunity now to implement a coordinated approach to maintain and enhance the ecological function of Petticoat Creek into the future, while advancing the concepts of urban sustainability. Experience has shown that having an approved watershed plan in place is often a catalyst for action and a proven, critical step to securing the resources necessary for effective watershed management.

Acknowledgements

Thanks to the Regional Municipality of Durham, Regional Municipality of York, City of Pickering, and City of Markham, who each contributed special project funding, and to their staff for their knowledge and assistance to develop this plan.

Thanks to Rouge Park staff who contributed in-kind support.

Thanks to the many TRCA staff who contributed their time and expertise, given limited resources, to develop this plan.

Special appreciation to the Credit Valley Conservation-Toronto and Region Conservation-Central Lake Ontario Conservation (CTC) Source Protection Committee for sharing information collected as part of characterization work, assessment, reports, and mapping support. Maps for this plan have been designed to conform with Source Water Protection study standards.

Map Source Data

Data to support this document and the longer-term development of a plan for Petticoat Creek watershed were made available through a broad network of monitoring partnerships which have evolved over time. In 2001, TRCA developed a Regional Watershed Monitoring Program, to further a network approach amongst agencies collecting watershed environmental data in the Toronto Region, and to enhance data integrity and shareability through detailed relational databases. TRCA continues to work with provincial ministries including the Ministry of Natural Resources, Ministry of the Environment, Ministry of Municipal Affairs and Housing and the Ministry of Northern Development & Mines, as well as Rouge Park, municipal partners and neighbouring conservation authorities to ensure that we have comprehensive and integrated datasets available to characterize our watersheds.

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1.0 Introduction

Petticoat Creek is one of nine watersheds in the Toronto and Region Conservation Authority (TRCA) jurisdiction (Figure 1). TRCA integrates watershed planning and management into planning and policy decision-making across its jurisdiction, working with government and other partners to minimize negative impacts from human activities on the multiple, inter-connected watershed components. This watershed plan is a tool to guide restoration of the watershed, seek strategic resources to support this restoration, and to inform and guide TRCA, Rouge Park, municipalities, provincial and federal governments, businesses, developers, non-government organizations, and private landowners to incorporate watershed management into their policy-making and practices.

The former Rouge-Duffins-Highland-Petticoat Conservation Authority created a watershed plan in 1956 for these four watersheds jointly, which was the last comprehensive watershed management planning effort undertaken for Petticoat Creek. Once these watersheds became the responsibility of TRCA, watershed plans were developed or revised for the Rouge, Duffins and Highland watersheds, and areas of the Rouge River watershed which became Rouge Park in 1995 have been the subject of a variety of management plans.

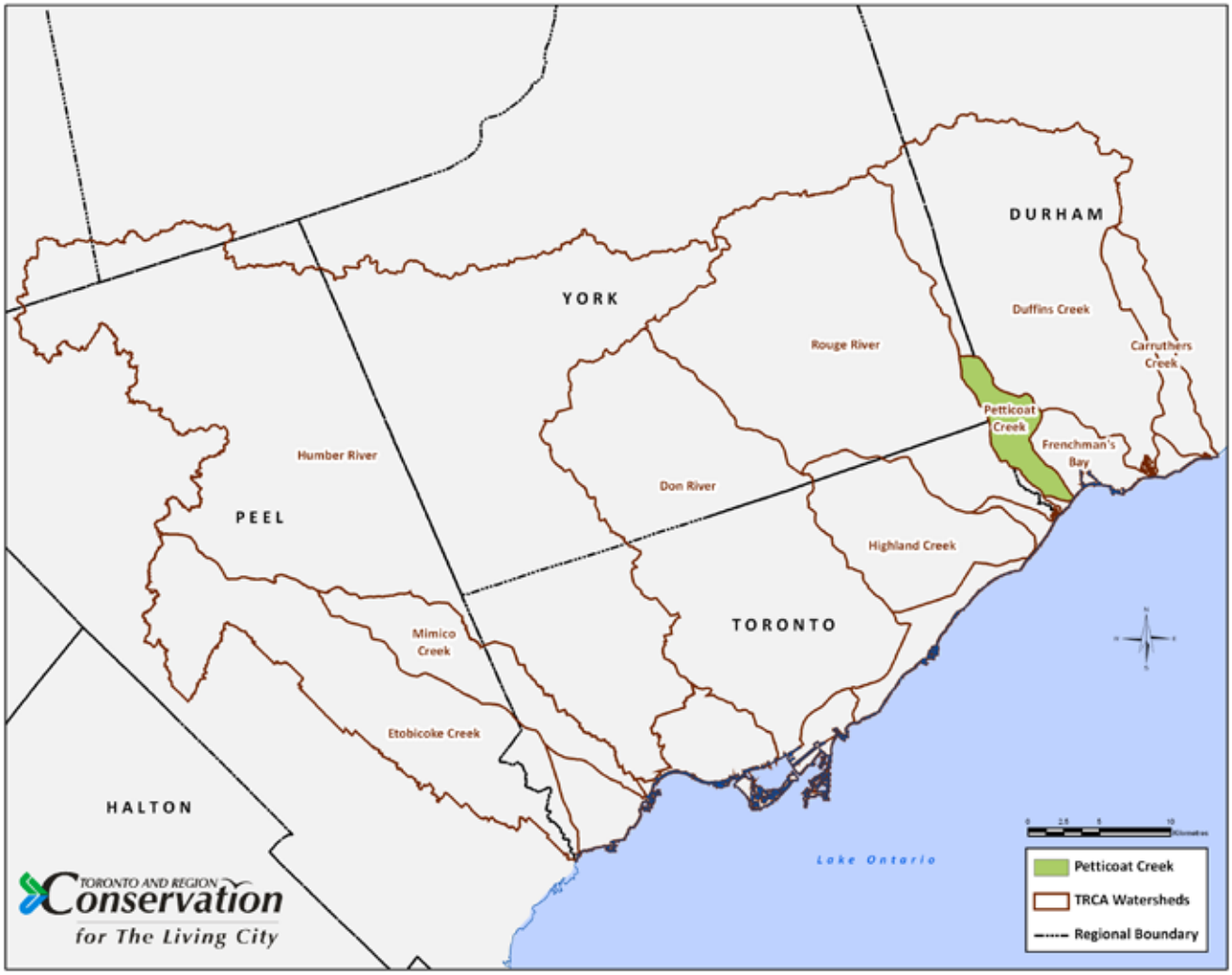


Figure 1: *TRCA Jurisdiction*

In 2007, Councillors from Pickering and Markham requested that TRCA complete a watershed plan for Petticoat Creek. While TRCA, Rouge Park, and local and regional municipalities completed a number of studies which include this watershed, and have been actively engaged in restoration and other forms of management in the area, as part of on-going conservation and water management responsibilities, these initiatives were primarily focused on immediate issues or opportunities and were not guided by an overarching plan.

Extensive environmental information about Petticoat Creek watershed was gathered as part of the *City of Pickering's Growth Management Study* (2003) and the Central Pickering Development Plan (2006). A review of these studies and reports identified sufficient water quality, groundwater, surface hydrology, terrestrial natural heritage, fisheries, erosion, stormwater and public use information and data to start the planning exercise. Advanced watershed studies in neighbouring watersheds also provide an extensive knowledge base on general watershed issues and cost-effective management actions which can be applied to Petticoat Creek watershed.

Given the availability of existing information and the high level of protection afforded the watershed through the Greenbelt Plan (2005), it was determined that a comprehensive watershed planning process was not warranted at this time and available resources were sufficient to develop a strategic action plan. Therefore, this planning study has focussed on the compilation of available information, interpretation of this information to improve our understanding of current watershed system functions and health, and preparing strategic management recommendations to guide future decisions.

TRCA, Rouge Park, and City of Pickering staff worked in partnership to prepare this plan, in consultation with the City of Markham, Durham Region, other watershed partners, and the public, to review issues and seek feedback on the planning process and recommendations. A public open house was held in June 2009, to share findings and gather input early in the process. Notices about the open house were placed in local newspapers to invite the public and community groups. The session:

- Introduced the study team
- Described the study process and expected outcomes
- Summarized existing physical conditions of the watershed including hydrology, terrestrial natural heritage, stormwater management, existing land use, aquatic habitat, water quantity and quality, and the watershed's role in the larger regional planning context, as well as its significance as part of Rouge Park and a link in regional trail and recreation networks.
- Sought public input on the plan and proposed next steps.

A notice was also sent out to ENGOs by the Pickering Regional Councillor involved with the plan to notify them of the open house and planning process. A presentation was made to the Altona Forest Stewardship Council in January 2008, as an important local community stakeholder group. Our municipal partners were kept informed throughout the process, with presentations to City of Pickering Council in June 2009, and to the City of Markham Planning Committee, a standing committee reporting to City of Markham's Council, in October 2009.

This plan is part of a broader planning framework for Petticoat Creek watershed which includes other plans and studies relevant to this watershed and related plans which provide additional recommendations and regional direction:

- Duffins Creek and Carruthers Creek Watershed Plan (2003)
- Greenbelt Plan (2005)
- *Moving Toward The Living City* (2006)
- Central Pickering Development Plan (2006)
- Rouge River Watershed Plan (2007)
- The Living City Report Card (2011)
- *City of Pickering Environment and Countryside Conformity OPA (2011, in progress)*
- Regional and local municipal official plans
- Rouge Park Management Plan (1994)
- Rouge North Management Plan (2001)
- *Little Rouge Corridor Management Plan* (2007)

As part of its *Official Plan* review, the City of Pickering is developing an environment and countryside conformity amendment which will address implementation of the Greenbelt Plan and the Central Pickering Development Plan in the upper reaches of Petticoat Creek watershed, as well as appropriate elements of other watershed plans and conservation strategies.

Without new resources to improve and enhance Petticoat Creek, it will become yet another degraded urban watershed, which will be costly to remediate in the future—prevention and protection are important now.

Vision

Petticoat Creek watershed is part of a larger natural system in the Greater Toronto Area, the Lake Ontario drainage basin, where many of the watersheds are under particular pressure due to urbanization. TRCA recognized that a new approach was needed to address these pressures in the nine watersheds in its jurisdiction and developed "The Living City", a vision for a new kind of community where human settlement can flourish forever as part of nature's beauty and diversity. TRCA is committed to community partnerships with all sectors of society to encourage environmental stewardship and to build on innovative thinking about environmental health, social responsibility, and sustainable economies. TRCA's vision of a Living City Region has four objectives:

- *Healthy Rivers and Shorelines*
  To restore the integrity and health of the region's rivers and waters from the headwaters in the Oak Ridges Moraine, throughout each of the nine watersheds in TRCA's jurisdiction, to the Toronto waterfront on Lake Ontario.
- *Regional Biodiversity*
  To protect and restore a regional system of natural areas that provide habitat for plant and animal species, improve air quality and provide opportunities for the enjoyment of nature.
- *Sustainable Communities*
  To facilitate broad community understanding, dialogue and action toward integrated approaches to sustainable living and city building that improves the quality of life for residents, businesses and nature.
- *Business Excellence*
  To produce continuous improvement in the development and delivery of all programs through creative partnerships, diverse funding sources and careful auditing of outcomes and effectiveness.

The Living City sets a general vision for the region which may then be refined into a goal for Petticoat Creek watershed itself:

Petticoat Creek will be a healthy, dynamic and sustainable watershed which continues to have clean, safe water. The watershed will have functioning wetlands and be diverse with self-sustaining communities of native plants, fish and wildlife, where natural and human heritage features are protected and valued. Residents will recognize the watershed as an essential community resource that enhances their quality of life. All stakeholders will participate in the stewardship of the watershed, and growth and development will reflect this vision and the importance of protecting and enhancing this priceless legacy.

This goal can be achieved through the protection, restoration and enhancement of the watershed, by following the management actions laid out in this plan.

2.0 Current Conditions and Issues

The Petticoat Creek river system has a total length of 49 kilometres and drains an area of approximately 27 square kilometres, with portions in the City of Pickering, City of Markham, and City of Toronto. Over 70% of this small watershed is designated as "Protected Countryside" by the provincial Greenbelt Plan (2005). The western third of the watershed is protected in Rouge Park, and the northern half falls within the Province of Ontario's Central Pickering Development Plan (2006) area. Agriculture dominates the northern portion of the watershed, interspersed with a number of large, provincially significant wooded swamps. The southern half is largely developed, with the notable exception of Altona Forest, and Petticoat Creek Conservation Area at the creek mouth. While there may be pressure for intensified development in the southern portion, provincial legislation precludes new development in the northern and western portions of the watershed (Figure 3).

In contrast with many of the watersheds in the Greater Toronto Area (GTA), Petticoat Creek does not originate on the Oak Ridges Moraine, its headwaters, or upper reaches, are located south of the Oak Ridges Moraine, between the larger Rouge River and Duffins Creek watersheds. Petticoat Creek flows south and empties into Lake Ontario at Petticoat Creek Conservation Area. Water moves through the watershed across a variety of landscapes and conditions, over farm fields and subdivisions, roads and ditches, forested valleys and meadows, and finally reaches Lake Ontario, the source of drinking water for millions of Ontarians. The most effective way to ensure that this drinking water remains safe is to protect water quality and quantity at the source: the watershed. Efforts to improve the health of small watersheds such as Petticoat Creek have downstream water quality benefits in Lake Ontario and the St Lawrence River.

Petticoat Creek watershed has not experienced the wide-spread urbanization which has occurred in most other GTA watersheds however the density and type of development have had significant impacts, including changes in hydrological patterns and the reduction and fragmentation of natural systems. In addition, our changing climate will impact all watersheds in the GTA as changing weather patterns affect stream flows, flora and fauna, the types of vegetation which can adapt in ecological restoration efforts, and the demand for water from agriculture and other large scale users. Climate change will also result in greater duration, intensity and frequency of heavy rain events, and a shift in the seasonal timing of high precipitation to more rain events occurring when the ground is already saturated or frozen. Development must be carefully planned in consideration of these changes in order to avoid increased risk of flooding to downstream residents, as well as erosion, both of which undermine infrastructure including sewers and bridges.

While a majority of Petticoat Creek watershed's natural and agricultural resources are protected by the Greenbelt Plan (2005) and Central Pickering Development Plan (2006), there is still a need to improve the sustainability of urbanized areas, and to protect and restore the remaining natural systems.

2.1 Watershed Perspective

The health of a watershed is dependent on a complex system of interrelated forms and functions. Climate and geology provide the foundation of a watershed's aquatic and terrestrial systems. Human activities, such as agriculture and urbanization, can impact these systems by reducing and fragmenting habitat, altering hydrological patterns, and degrading water quality.

Today, Petticoat Creek watershed represents a continuum between natural, rural and urban land uses and is best described as an urbanizing, warm-water system. Natural and rural areas of the watershed, comprising roughly 75% of the land base, are protected under selected provincial initiatives, explained below. The long history of agriculture in this area has not resulted in significant degradation of the northern portion of the watershed. The agricultural community has generally been a good steward of this land.

The southern portion of the watershed is primarily urbanized, where the density, timing and type of development have impacted watershed health negatively. This earlier urban development employed stormwater management methods which, though accepted practice at the time, have proven to be ineffective for stormwater control, and have resulted in the uncontrolled transport of sediment and contaminants directly into watercourses. Development constructed during the past two decades has improved significantly in managing stormwater to minimize or mitigate its negative ecological impacts. Today's standards strive for even greater levels of control which address objectives for overall water balance.

This summary of current conditions is based on a variety of planning and Environmental Assessment studies undertaken in the watershed between 2003 and 2009, and supplemented with data collected by TRCA on an ongoing basis through the Regional Watershed Monitoring Network. For more detailed information, please refer to the References section of this Plan. Resources of particular relevance are:

- York Durham Sewer System Environmental Assessment
- *Credit Valley Conservation – Toronto and Region Conservation – Central Lake Ontario Conservation Source Protection Region Watershed Characterization Report*
- Regional Watershed Monitoring Network reports
- Various plans for neighbouring watersheds: Rouge River, Duffins Creek and Carruthers Creek

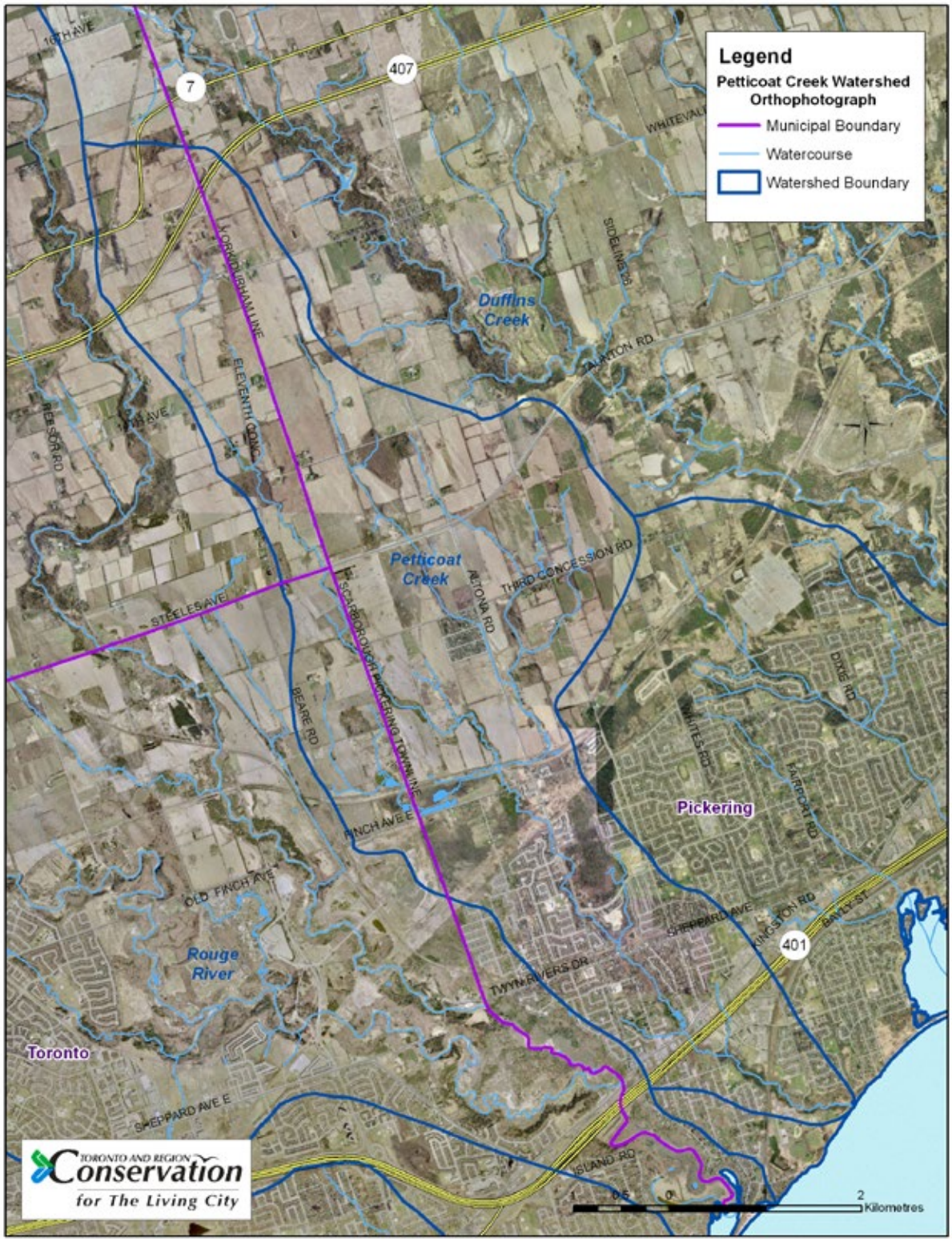


Figure 2: *Orthophotograph of Petticoat Creek Watershed*

2.1.1 Provincial, Regional and Municipal Planning

Petticoat Creek watershed has a unique planning framework of provincial, regional and municipal plans to guide the implementation of future development and conservation in the watershed (Figure 4). The headwaters of Petticoat Creek are in the Duffins-Rouge Agricultural Preserve, which is protected in the provincial Greenbelt for agricultural and natural heritage use. There is also a considerable amount of protected area in the watershed from TRCA lands, provincial lands, Rouge Park, and private lands under Conservation Easement (Figure 4).

The Central Pickering Development Plan (2006) establishes a comprehensive vision for land use and development in an area which includes the planned community of Seaton and the Duffins-Rouge Agricultural Preserve. The Central Pickering Development Plan is a provincial initiative which outlines specific objectives and policies for future land use activities such as residential development, employment lands, agriculture and natural heritage restoration.

The area of Petticoat Creek watershed south of the CP rail line and north of Kingston Road is experiencing the most rapid change in the watershed, with new low- and medium-density suburban communities under construction. The Rouge-Duffins Wildlife Corridor is adjacent to that area, between the CP rail line and the hydro corridor. It is recognized in the City of Pickering Official Plan Edition 6 (2010) as a significant vegetated connector providing for species migration between the Rouge and Duffins watersheds. A number of properties in the wildlife corridor are owned by the Province, including some with natural heritage features and values. TRCA is working in consultation with Infrastructure Ontario to develop a management agreement for areas with high conservation value, as outlined in TRCA's *Greenlands Acquisition Project for 2011-2015* (2010).

South of Kingston Road, low density residential and commercial suburban development began in the 1960s. Continued growth in this area will primarily involve the redevelopment of residential properties, infill, and intensification of the Kingston Road corridor to transition it from suburban to urban. Land use planning is directed through the Official Plans of Durham Region and the City of Pickering. A key natural feature in this area is the Petticoat Creek valley system which bisects the southwestern portion of Pickering, north and south of Kingston Road, and creates a well-vegetated corridor through Petticoat Creek Conservation Area to Lake Ontario.

Environmental Assessments

TRCA has a number of roles and responsibilities in the planning process, including the review of development proposals which affect our watersheds, and the regulation of development in valley and stream corridors, wetlands, and along the Lake Ontario shoreline. TRCA staff are responsible for providing technical clearance on applications made under the Environmental Assessment Act, R.S.O. 1990 and recommendations to TRCA's Executive Committee regarding any permit applications reviewed under the Conservation Authorities Act - Ontario Regulation 166/06. Staff comments and recommendations are based on TRCA's commitment to integrating the principles of sustainable planning into city building. Examples of Environmental Assessment applications in which TRCA has recently been involved in Petticoat Creek watershed include the York-Durham Sewer System Southeast Collector, York-Durham Line road widening, Central Pickering Development Plan Transportation and Water/Waste Water plans, and Altona Road widening.

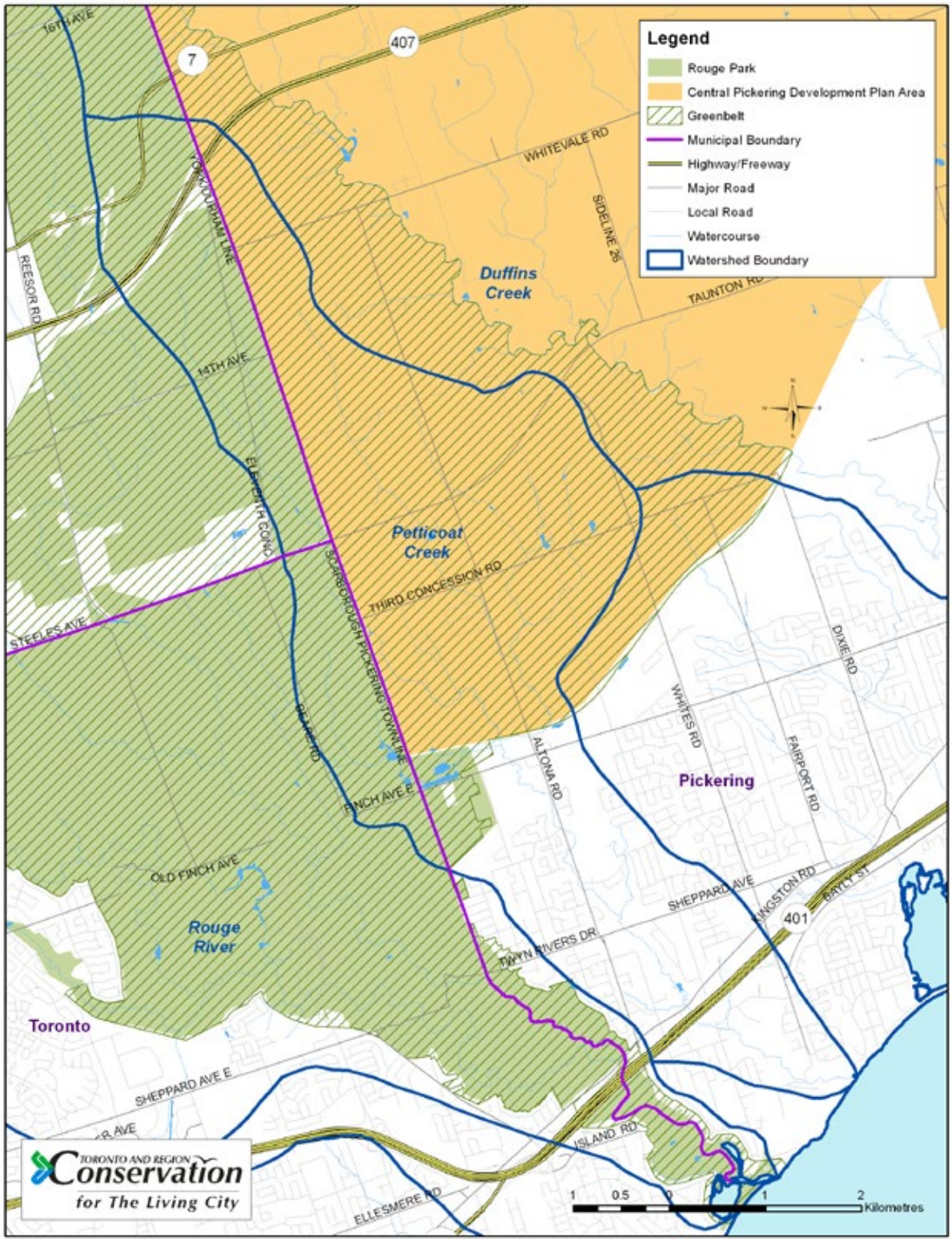


Figure 3: *Natural and Rural Land Protection Initiatives*

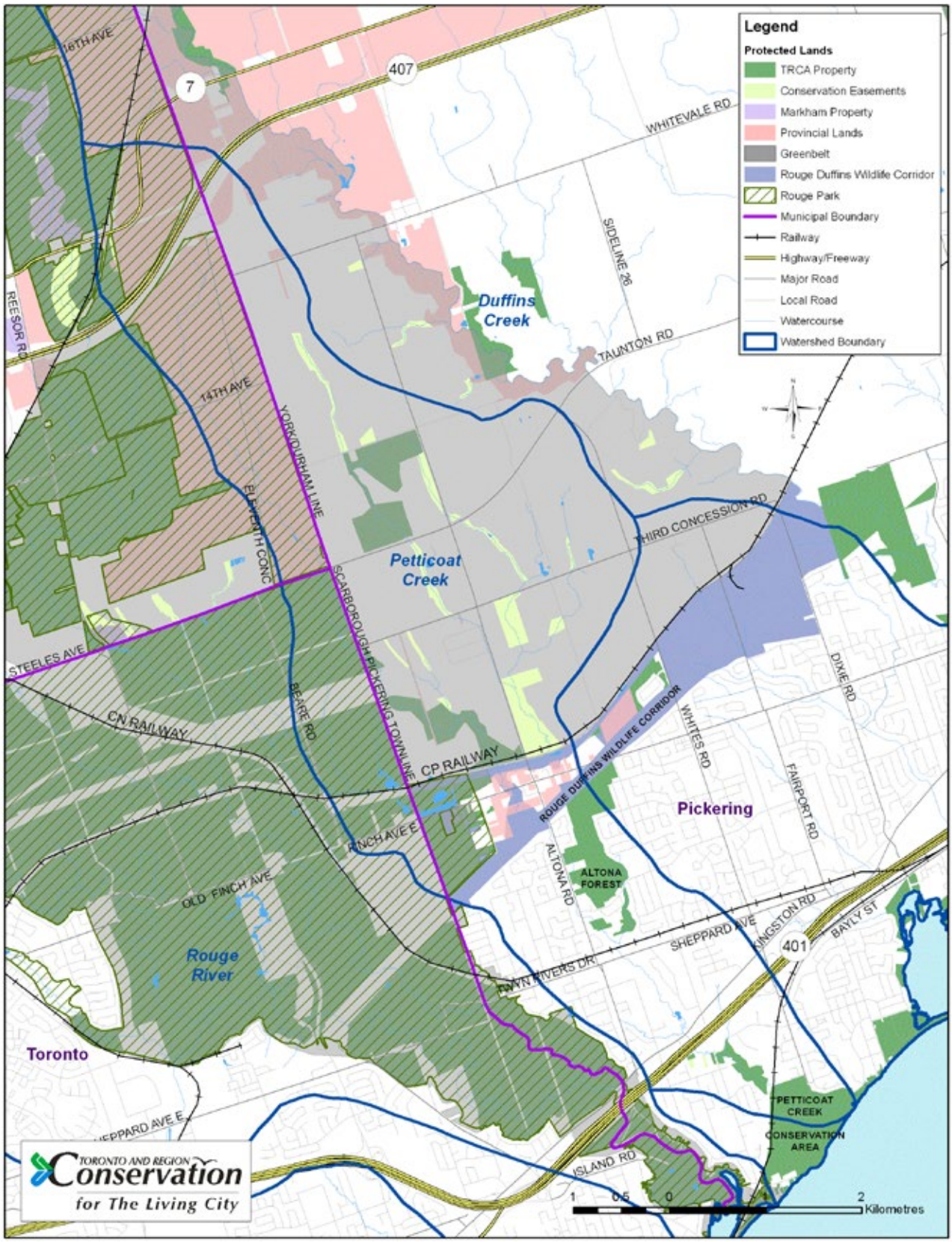


Figure 4: *Land Use Protection Categories*

2.2 Regional Watershed Monitoring Network

TRCA initiated the Regional Watershed Monitoring Network (RWMN) to develop a comprehensive, integrated and coordinated approach to environmental monitoring across the GTA. The RWMN focuses on long-term monitoring of aquatic and terrestrial ecosystems at the subwatershed and watershed scale using a series of indicators to measure environmental change and assess the health of the regional environment. The resulting data is used by RWMN partners to help guide environmental management decisions. Indicators focus on six primary areas: aquatic habitat and species, fluvial geomorphology, terrestrial natural heritage, surface water quality, flow and precipitation, and ground water. In Petticoat Creek watershed, there are stations for monitoring terrestrial natural heritage, aquatic habitat and species, provincial water quality, water temperature, benthic macroinvertebrates, West Nile Virus, stream flow, precipitation, and baseflow (Figure 5).

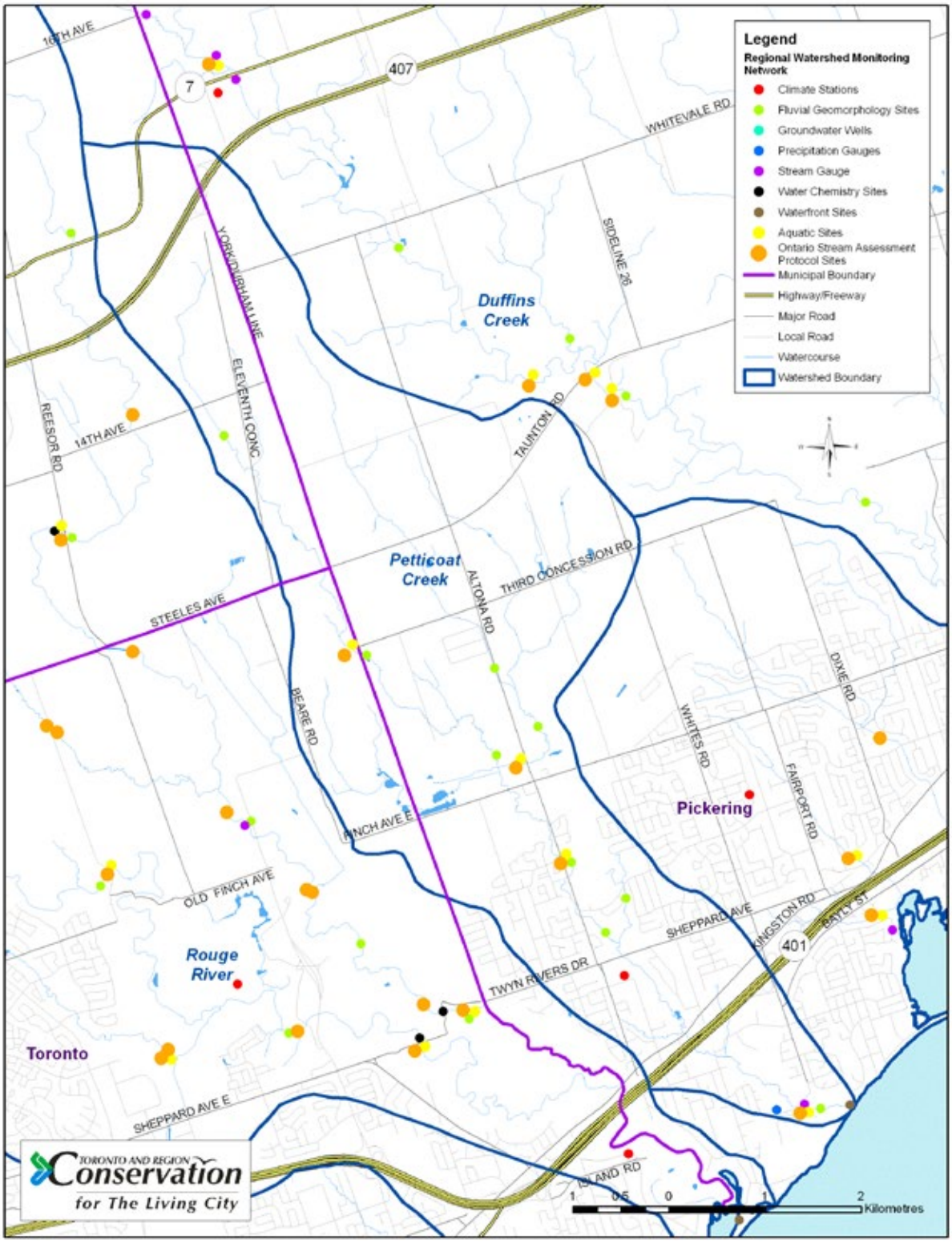


Figure 5: *Petticoat Creek Watershed in Regional Watershed Monitoring Network*

2.3 Hydrogeology

A healthy, sustainable groundwater flow system is an important component of a watershed's terrestrial and aquatic ecology. Over the past decade, hydrogeological studies that included the Petticoat Creek watershed have been led by the University of Toronto Geology Department (Boyce *et al*., 1995; Gerber and Howard, 2002), York-Peel-Durham-Toronto-Conservation Authority Oak Ridges Moraine Hydrogeology Program (Earthfx, 2006), Ontario Geologic Survey (Karrow, 1967; Barnett, 1992), Geologic Survey of Canada (Brennand *et al*., 1997; Russell *et al*., 2002a,b; Sharpe *et al*., 1997; Sharpe *et al*., 2002a,b), York-Durham Southeast Collector Environmental Assessment (CRA, 2009), and the Credit Valley Conservation-Toronto and Region Conservation-Central Lake Ontario Conservation Authority (CTC) Source Protection Region. Also, numerous landfill siting investigations have contributed to the hydrogeologic knowledge base for the area (M.M. Dillon Limited, 1990; IWA, 1994a-e). The results of these investigations have provided sufficient understanding of local water budgets, geologic settings and groundwater flow paths to develop this Action Plan. Figure 6 shows the locations of boreholes and monitoring wells installed for many of these historical investigations, the red line shows the location of the stream profile in Figure 10.

Petticoat Creek watershed differs from the adjacent Rouge River and Duffins Creek watersheds in that the Oak Ridges Moraine landform is absent. Instead, the watershed is dominated by the South Slope physiographic region, a smooth, faintly drumlinized till plain (Figure 7; Figure 8). The lower reaches of the watershed near Lake Ontario are dominated by lacustrine deposits laid down in glacial Lake Iroquois, or ancestral Lake Ontario. The southern part of the watershed along the Lake Ontario shore is mainly urban (City of Pickering) with large tracts of agricultural land to the north of the urban boundary. Much of the developed area is situated south of the Lake Iroquois shoreline.

The lower permeability soils of the South Slope generally provide less than 100 millimetres per year of recharge to the groundwater flow system in the headwater areas. Estimated recharge within the watershed ranges from 0 to 175 millimetres per year (TRCA, 2010). Little, if any, recharge occurs in groundwater discharge areas along some stream reaches and along the glacial Lake Iroquois shoreline where vertical hydraulic gradients are upwards. A small but significant zone of higher recharge is associated with the beach and nearshore sands deposited by glacial Lake Iroquois along the current remnant shoreline. These higher permeability deposits in the lower reaches of the watershed raise the overall average annual watershed recharge to approximately 108 millimetres per year (Figure 9).

Precipitation and snow melt that have infiltrated to form groundwater recharge then moves through the various geologic deposits within the subsurface. Figure 10 illustrates an interpretation of the geologic deposits in a cross section along the main stream reach of Petticoat Creek. Further details regarding this geologic interpretation can be found in Earthfx (2006). The geologic deposits that occur above bedrock are interpreted to have been deposited over the last approximately 135,000 years, and indicate an alternating sequence of glacial (till) and interglacial units (silt, sand and gravel). The till deposits form aquitards, while three aquifer complexes occur within the interglacial deposits. The shallow aquifer occurs locally within sands and gravels deposited during the Mackinaw Interstadial (MIS) period, which is considered equivalent in time to depositional processes forming the Oak Ridges Moraine, and includes the Oak Ridges aquifer complex (ORAC). This aquifer is referred to as the MIS/ORAC on Figure 10. The deeper aquifers occur within higher permeability deposits (sand and gravel) of the Thorncliffe and Scarborough Formations which were deposited more than 20,000 years ago. Groundwater flow within all three aquifer complexes is generally from north to south toward Lake Ontario, with local deflections where groundwater discharges to stream reaches. Horizontal hydraulic gradients generally range from 0.01 to 0.001.

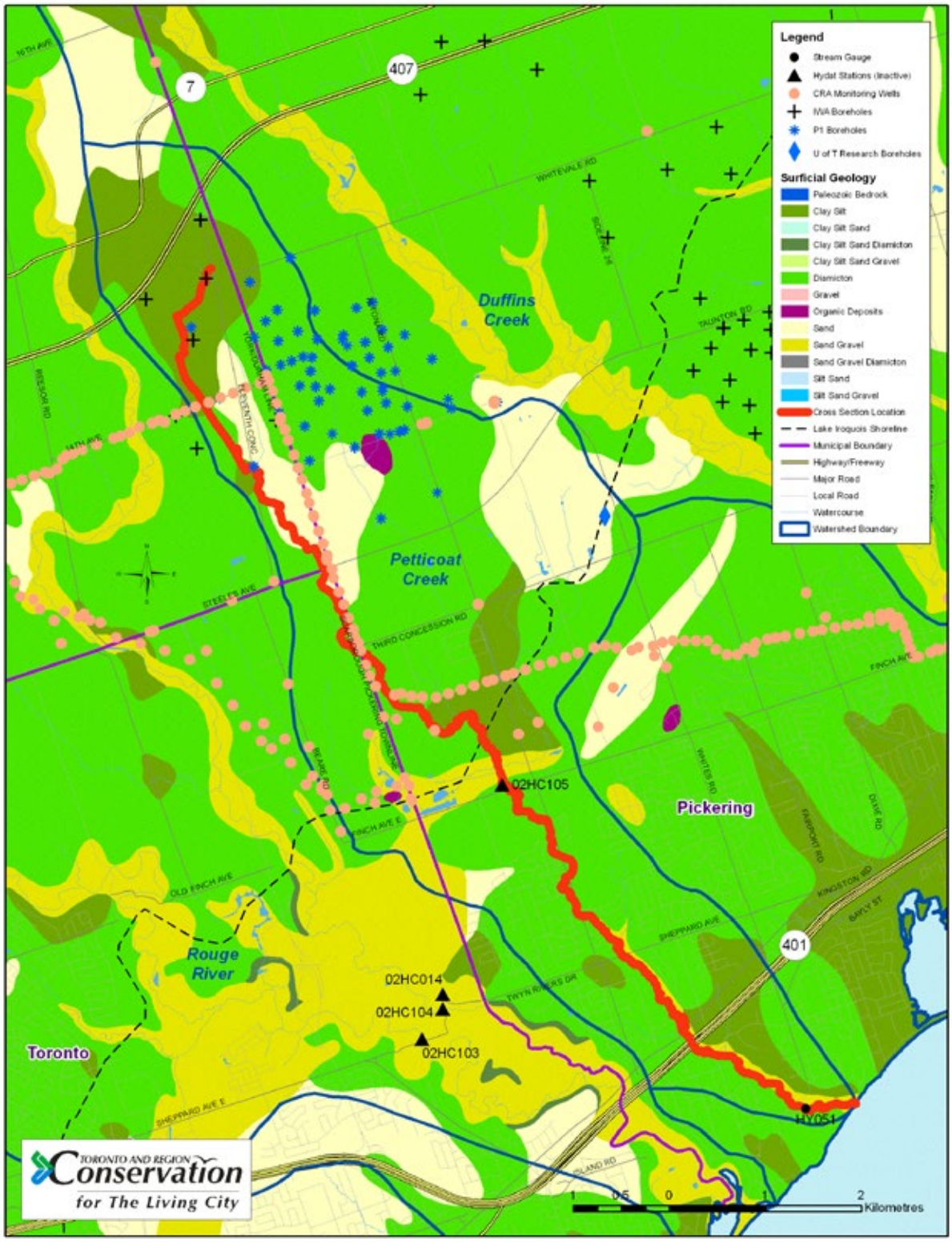


Figure 6: *Hydrogeology Study Locations*

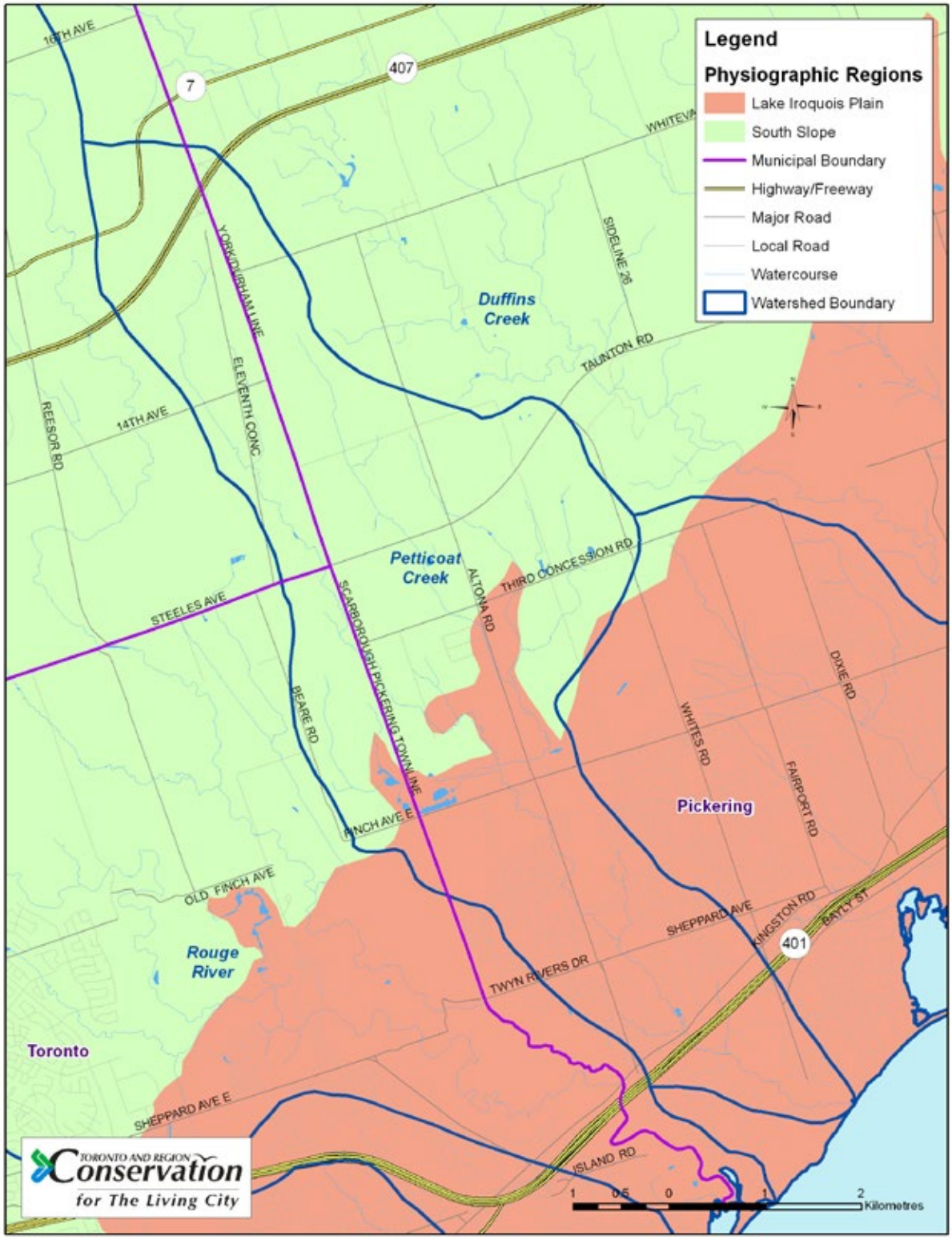


Figure 7: *Physiography*

Source: Chapman and Putnam, 1984

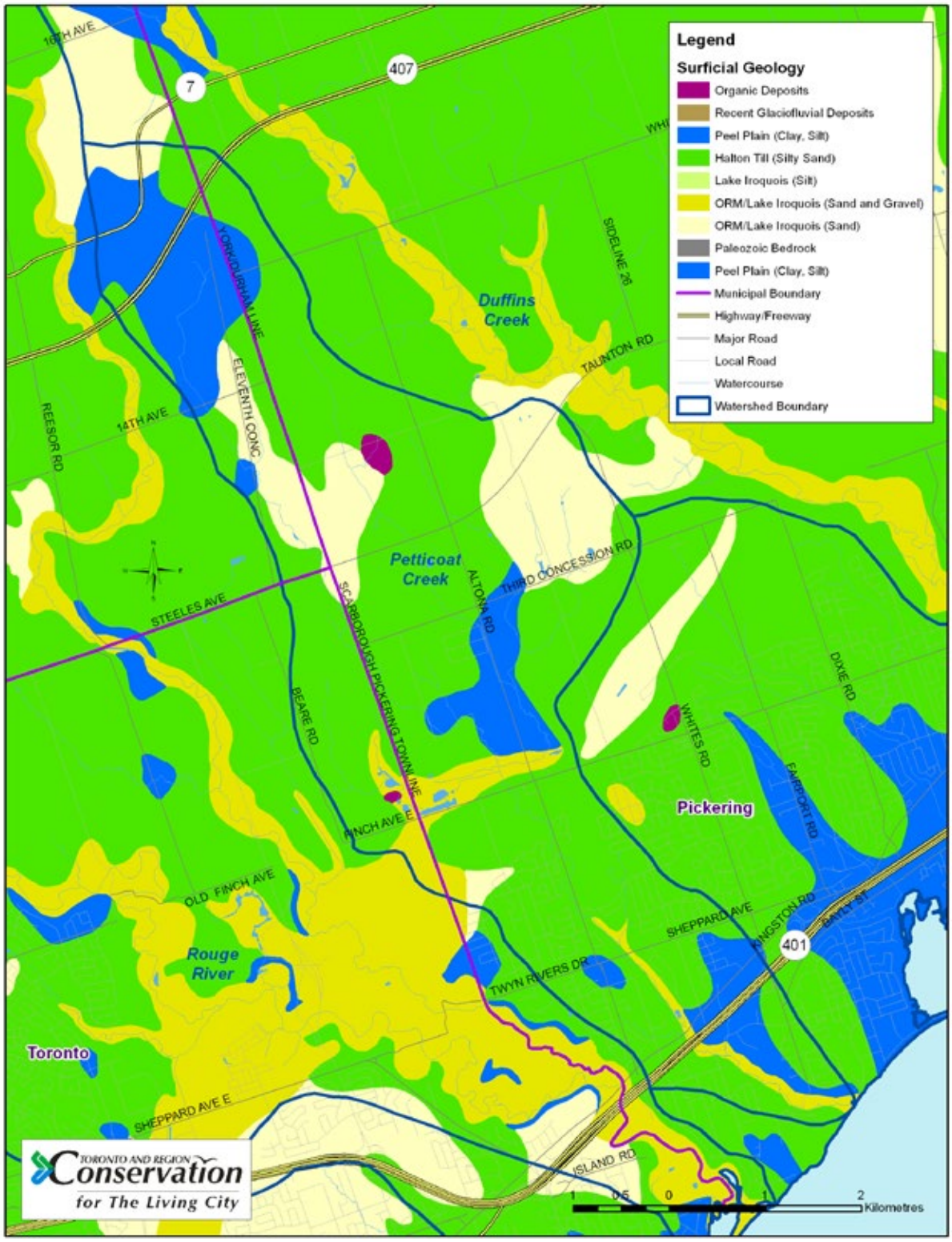


Figure 8: *Surficial Geology*

Source: Ontario Geological Survey, 2003

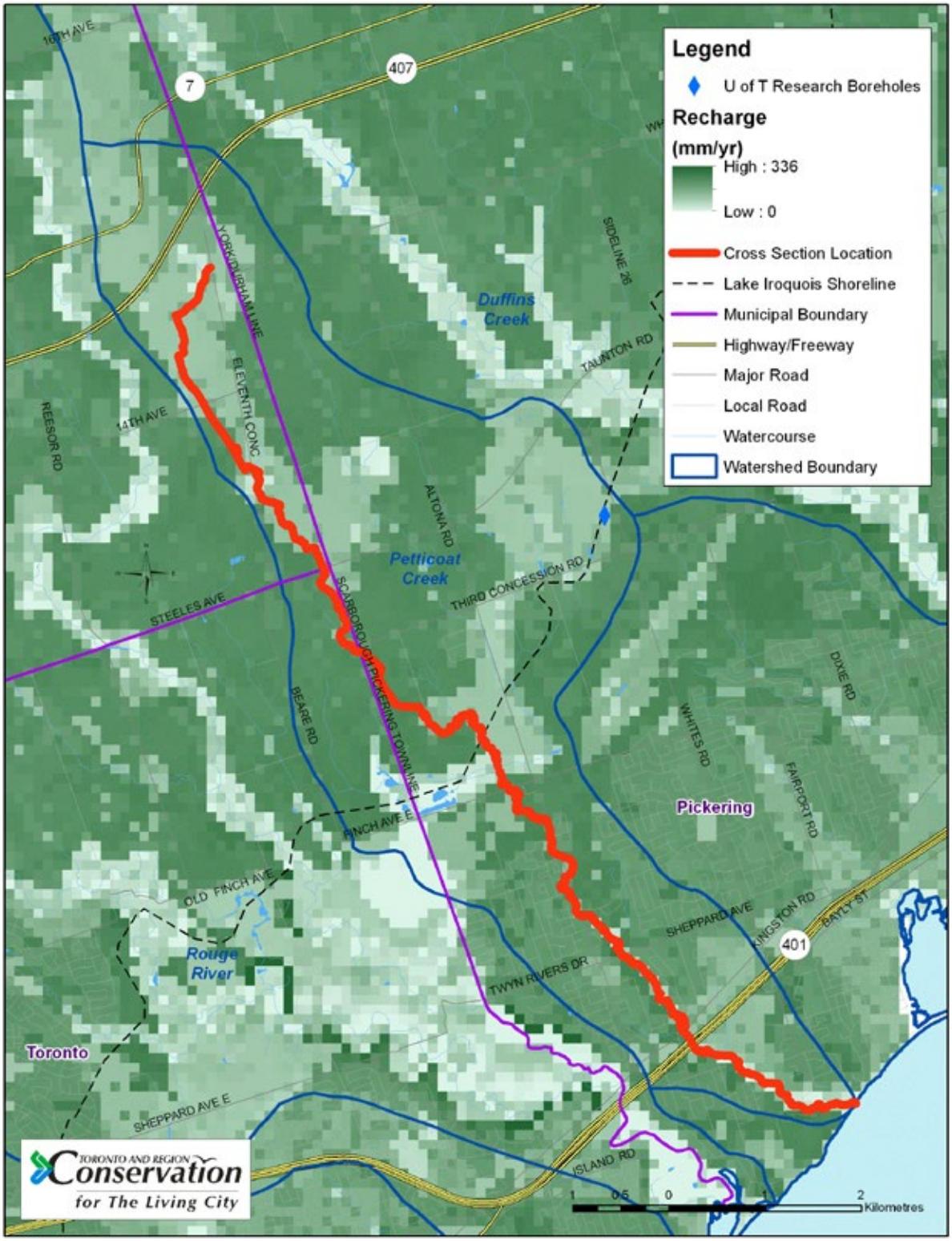


Figure 9: *Estimated Recharge for Petticoat Creek Watershed*

Note: Recharge estimates from TRCA, 2010

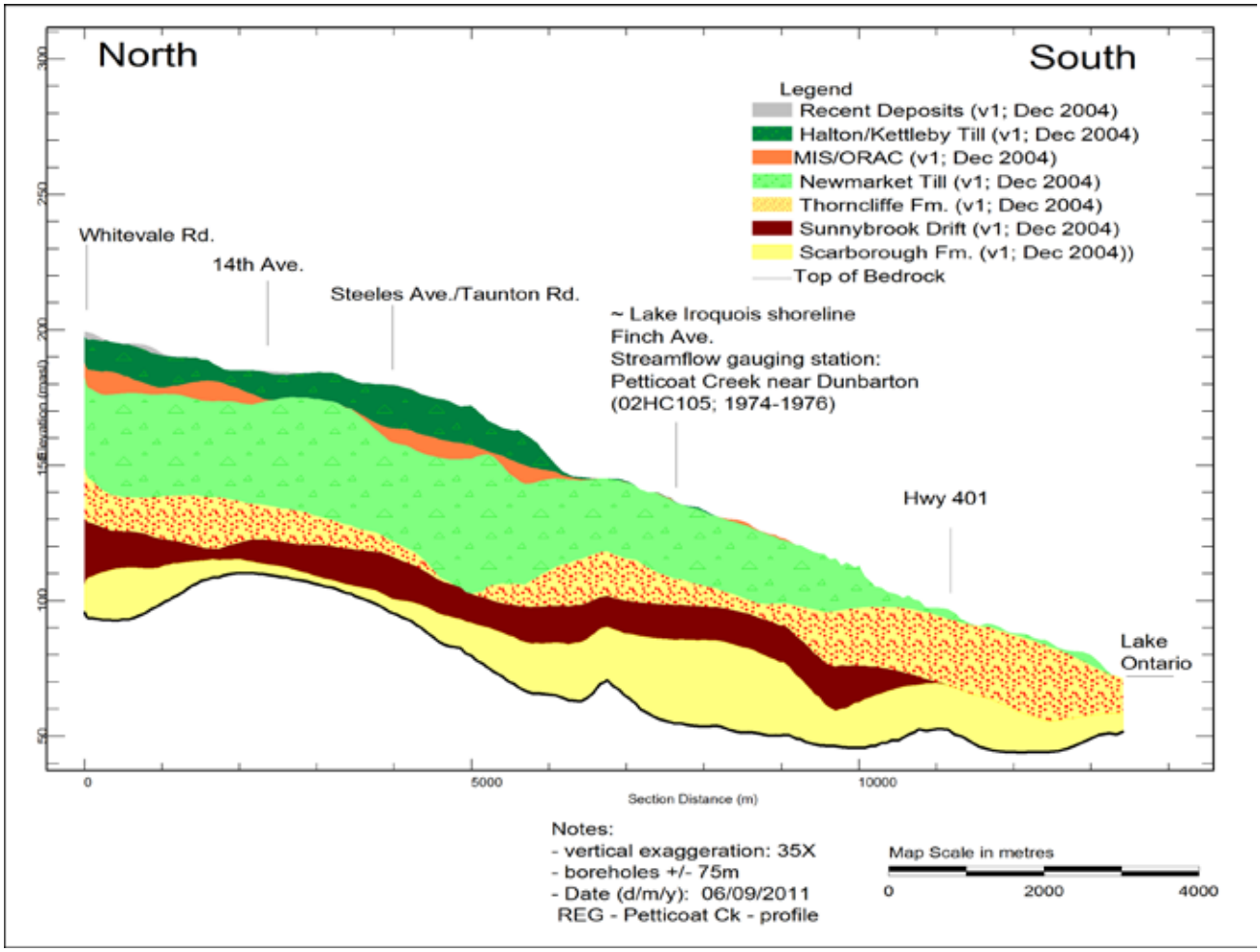


Figure 10: *North-South Stream Profile Along Petticoat Creek*

Note: *See profile location in Figure 6.*

Groundwater which re-emerges to the ground surface is known as groundwater discharge. In the Petticoat Creek watershed groundwater discharge occurs in the headwater areas, and also along and south of the glacial Lake Iroquois shoreline. Discharge in the headwater areas is provided from the water table and shallow aquifer complex (MIS/ORAC) while discharge along and south of the Lake Iroquois shoreline is provided from the glacial Lake Iroquois beach deposits and from deeper aquifers (Thorncliffe Formation and Scarborough Formation). Much of the southward groundwater flow within all three aquifers occurring north of the watershed boundary is generally intercepted by the deep valleys of Little Rouge Creek and the West Branch of Duffins Creek before reaching the headwaters of Petticoat Creek. As a result of this interception and the relatively low rates of recharge on the South Slope, there is minimal stream flow in Petticoat Creek during dry weather periods. The small, intermittent nature of the Petticoat Creek headwaters reaches are not a sign of stream degradation, but rather a reflection of the natural hydrogeology of the system. Stream flows within the lower reaches of the watershed are higher, reflecting local recharge and discharge from the Lake Iroquois deposits, and groundwater discharge from the middle and lower aquifer complexes.

Two streamflow gauges have been operated on Petticoat Creek. An initial gauge was established by the Water Survey of Canada and operated from March 1974 to December 1976. The only full year of daily streamflow measurements is from 1976. This gauge (02HC105) is located near the Lake Iroquois shoreline and would only receive groundwater discharge from part of the watershed (Figure 6). The lack of a long-term streamflow gauge near the mouth of the creek makes water budget estimation and model calibration difficult. The limited data that does exist for Petticoat Creek (1974-1976) was collected near the centre of the watershed and it is expected that a significant amount of groundwater discharge may occur south of this gauge. The total annual average streamflow measured for 1976 is 0.244 cubic metres per second, or 320 millimetres per year over the estimated 24 square kilometre drainage area at gauging station 02HC105. The groundwater discharge component of this total streamflow is estimated at 0.06 cubic metres per second or approximately 80 millimetres per year, representing approximately 25% of the total streamflow. These values can be compared to average annual precipitation measured at three local Environment Canada climate stations including Toronto Buttonville Airport (615HMAK), Frenchman's Bay (6152605) and Stouffville Water Pollution Control Plant (6158084), which range from 826 to 864 millimetres per year. The difference between total annual precipitation and total streamflow would represent an estimate of the amount of water that evapotranspires annually. The second historical streamflow gauge (HY051) on Petticoat Creek was established in June of 2001 by TRCA at a location just south of Highway 401 (Figure 6). This gauging station is still active and recent data are provided in Section 2.5.

The spatial distribution of groundwater discharge can be determined by low flow streamflow surveys where total streamflow is measured at various locations along a stream reach during periods outside of precipitation or snow melt events. Coldwater fisheries mapping also illustrates locations of groundwater discharge. Both types of surveys have been conducted by TRCA, and indicate that no significant groundwater discharge areas exist in Petticoat Creek watershed, consistent with the fact described above, that regional southward groundwater flow emanating from north of the watershed is intercepted by the Little Rouge Creek and West Duffins Creek valleys.

Groundwater levels in all three aquifer complexes have been measured at numerous locations outside the watershed boundaries (Gerber, 1999; Ostry, 1979; Sibul *et al.*, 1977), including Provincial Groundwater Monitoring Network locations operated by TRCA and the Ontario Ministry of the Environment. The annual fluctuation of groundwater levels in both the shallow (MIS/ORAC) and deep aquifer systems have been monitored at Site 1/94 (RG-194; Figure 11) since 1994. These annual fluctuations are interpreted to represent natural fluctuations unaffected by anthropogenic activities. The annual fluctuation of the water table in till is up to 4 metres, similar to the annual fluctuation in the Upper aquifer within Mackinaw Interstadial deposits. The natural annual fluctuation of groundwater levels in the Thorncliffe Aquifer Complex is generally less than 1 metre. Note that groundwater levels are highest during the winter and spring melt periods when most of the groundwater recharge occurs, and lowest during late summer and fall due to decreased recharge largely caused by increased evapotranspiration during the growth season. In terms of water taking, there are no municipal wells in the watershed and only a small number of private wells. Locations of private wells are shown in Figure 12, which also shows that for more than half of the watershed water supply is obtained from Lake Ontario.

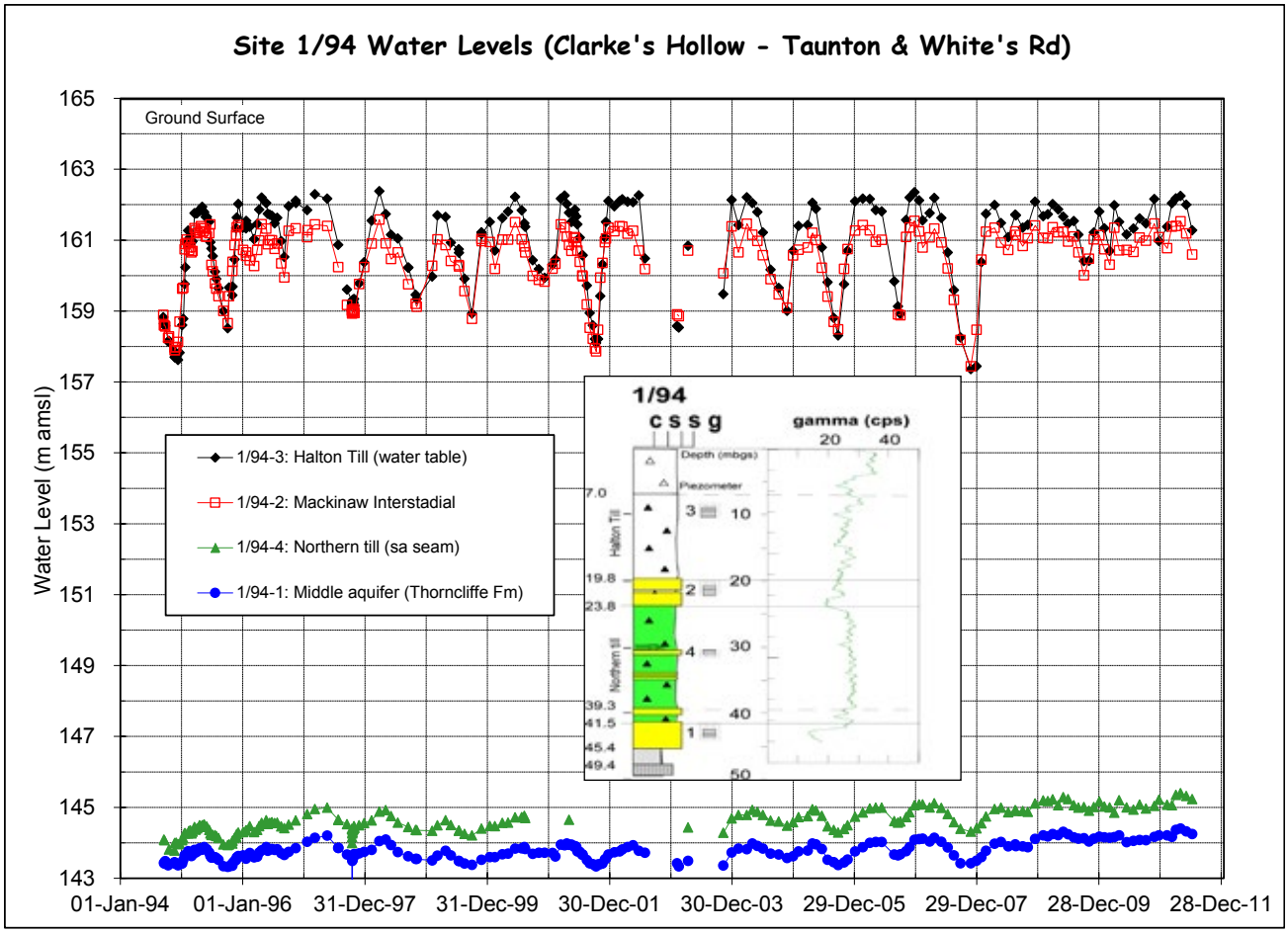


Figure 11: *Monthly Water Levels at Site 1/94*

Source: Data from R.E. Gerber

2.4 Surface Water Quality

Maintaining the quality of surface water is important for healthy ecosystems in a watershed. Surface water quality has been monitored in recent years under three different initiatives: York Region's baseline environmental work for the York-Durham Southeast Collector study, provincial Source Water Protection studies, and the Regional Watershed Monitoring Network.

York Region collects water samples in the headwaters of Petticoat Creek each year in the spring and fall, when there is sufficient flow in the streams. Preliminary examination of these results suggests that nutrient (phosphorus and nitrogen) and chloride levels are slightly elevated whenever Petticoat Creek receives surface runoff from the surrounding land. With the exception of total phosphorus, aluminum, iron and zinc, the water samples collected generally had concentrations which met the Ontario Ministry of the Environment Provincial Water Quality Objectives and Guidelines. Details can be found in the Southeast Collector Trunk Sewer Environmental Assessment Report.

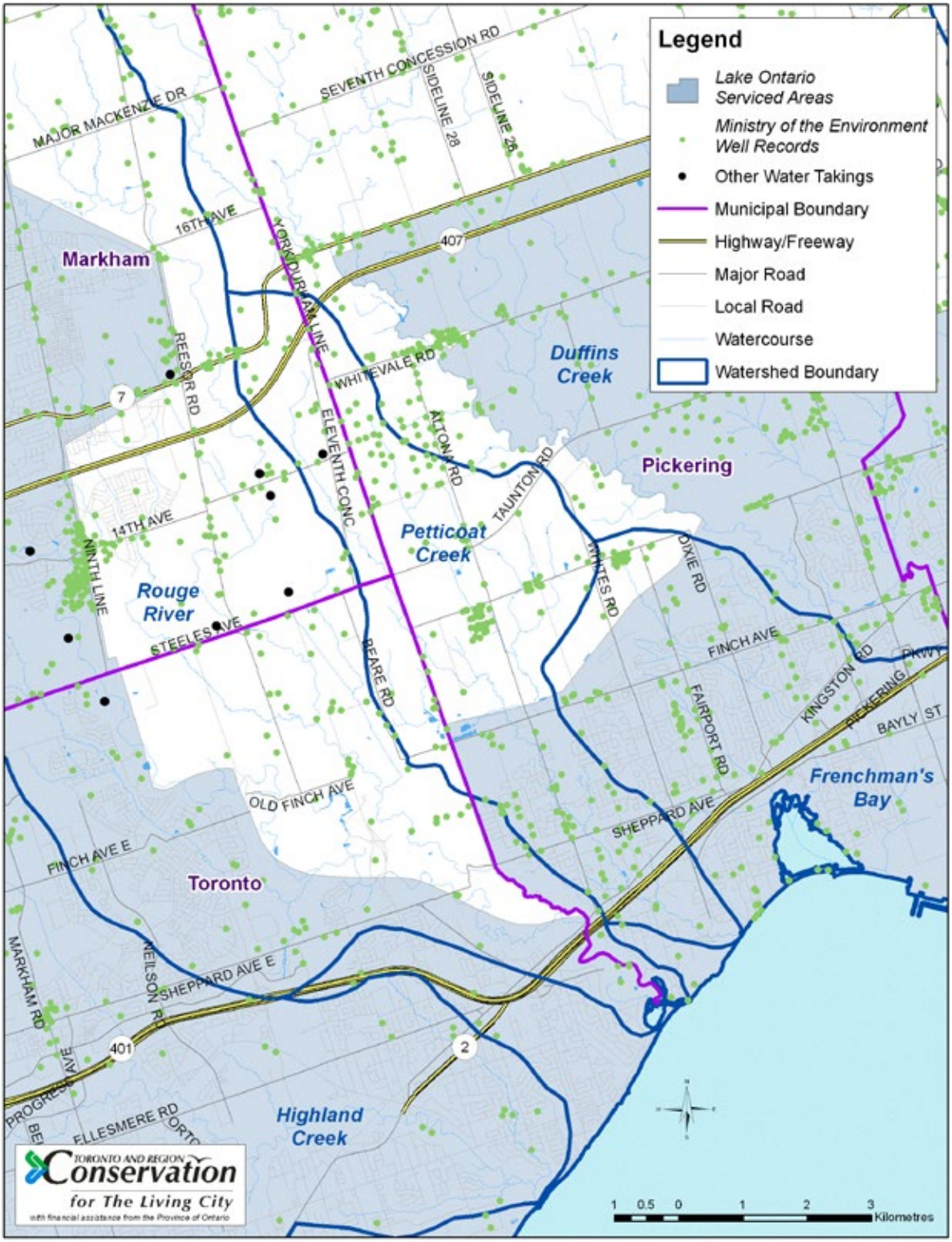


Figure 12: *Location of Known Water Taking and Drinking Water Supply from Lake Ontario*

While detailed wet weather sampling has not been completed, hydrologic conditions suggest that Petticoat Creek will have poorer water quality following major rainstorms and snowmelt, and in the urbanized areas of the watershed. High amounts of surface runoff from the surrounding land over short periods of time, such as during a heavy rain event, also contribute to poor water quality through in-stream erosion. Erosion of the existing stream banks and channel bottom result in large amounts of sediment travelling downstream, which adversely affects water quality and the aquatic habitat of the watercourse. In-stream erosion is also one of the most expensive capital issues facing municipalities since it has negative impacts on private property, infrastructure and human safety. Prevention by maintaining and improving watercourse health is key to minimizing risk.

As part of the 2008 International Year of Study of Lake Ontario, water quality studies were undertaken in nearshore areas of Durham Region, including parts of the shoreline near the mouth of Petticoat Creek. Information gathered from this study extends lake-wide, in support of Source Protection studies for Lake Ontario drinking water intakes under direction of the CTC Source Protection Committee, and relates to the Great Lakes Water Quality Agreement. Scientists from the United States, Environment Canada, Ontario Ministry of Environment, and TRCA are collaborating to update studies on the level of nutrients discharged from watersheds, water pollution control plants, and the upper Great Lakes via the Niagara River. Results from these studies will inform ongoing discussions leading to the renewal of the Great Lakes Water Quality Agreement and the Canada Ontario Agreement Respecting the Great Lakes.

In 2009, TRCA's Regional Watershed Monitoring Network initiated water quality monitoring on Petticoat Creek upstream from the lakeshore, in Petticoat Creek Conservation Area. Figures 13, 14 and 15 illustrate observed trends in total phosphorus, suspended solids, and turbidity, respectively during the first two years of monitoring. During periods of snowmelt and heavy rainfall, water quality conditions were poor. When Petticoat Creek watershed is not under the influence of precipitation or snow melt events, water quality conditions are fairly good and meet current provincial water quality objectives. Bacterial monitoring during this two year period revealed elevated *E.coli* counts (Figure 16) well above swimming objectives. Only during extreme flow conditions, such as in November 2009, will trace metals such as copper exceed provincial water quality objectives (Figure 17). The high levels are naturally-occurring and increase due to soil erosion, not anthropogenic causes. Trends in water quality in Petticoat Creek watershed will be tracked and reported at regular intervals through TRCA's Regional Watershed Monitoring program.

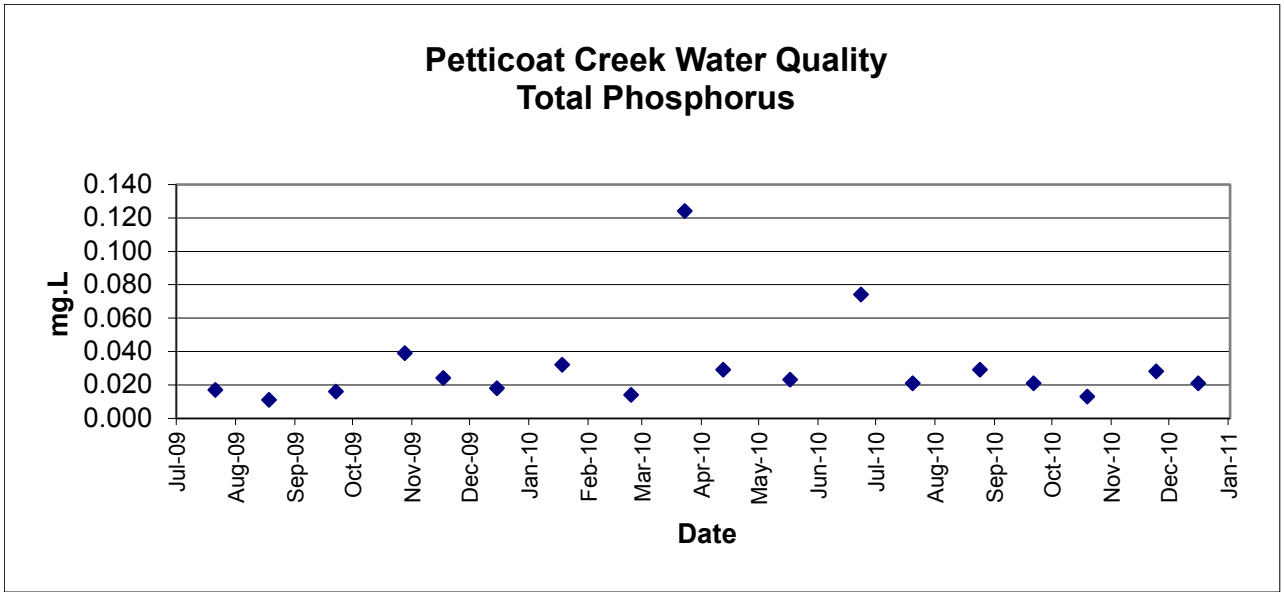


Figure 13: *Petticoat Creek Water Quality Total Phosphorus*

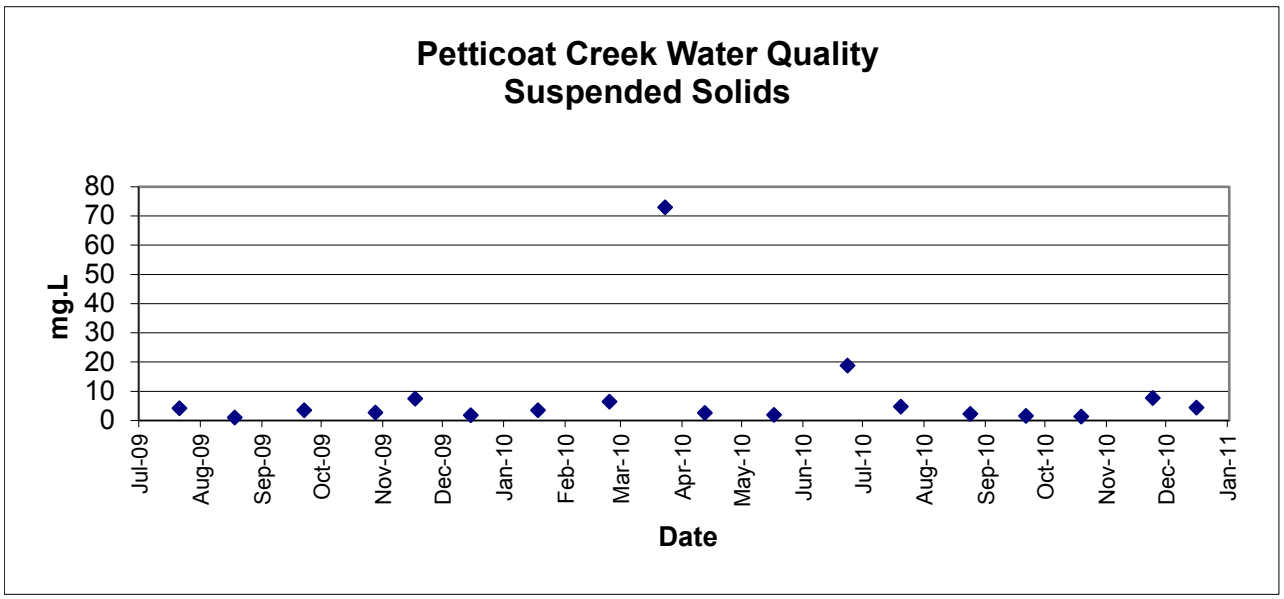


Figure 14: *Petticoat Creek Water Quality Suspended Solids*

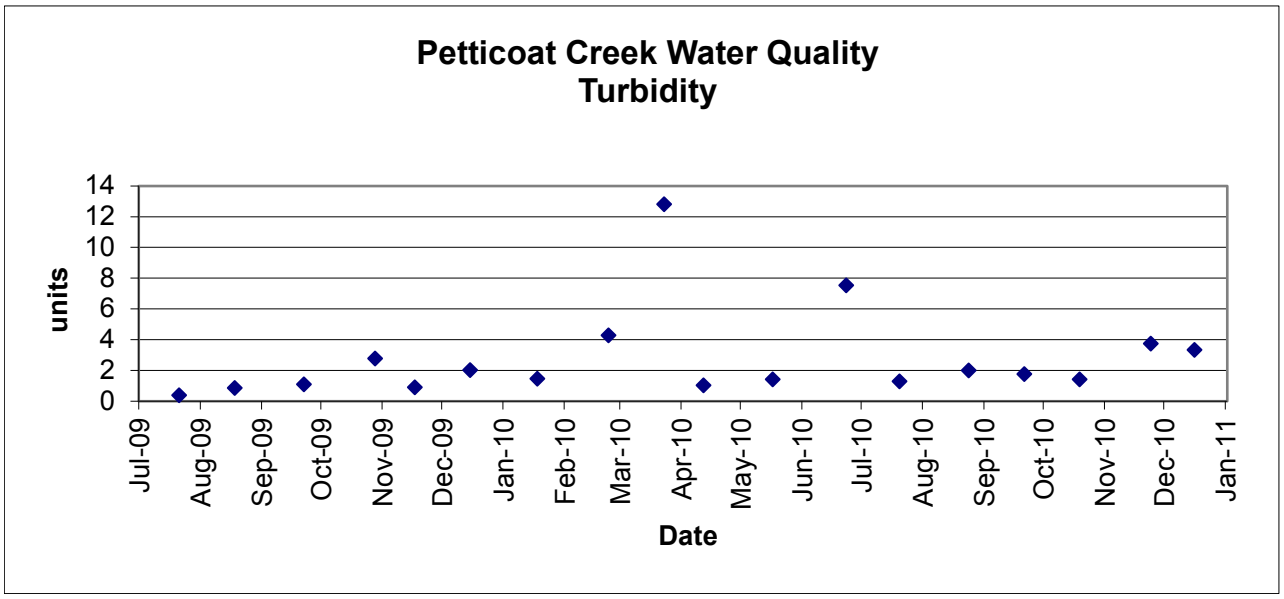


Figure 15: *Petticoat Creek Water Quality Turbidity*

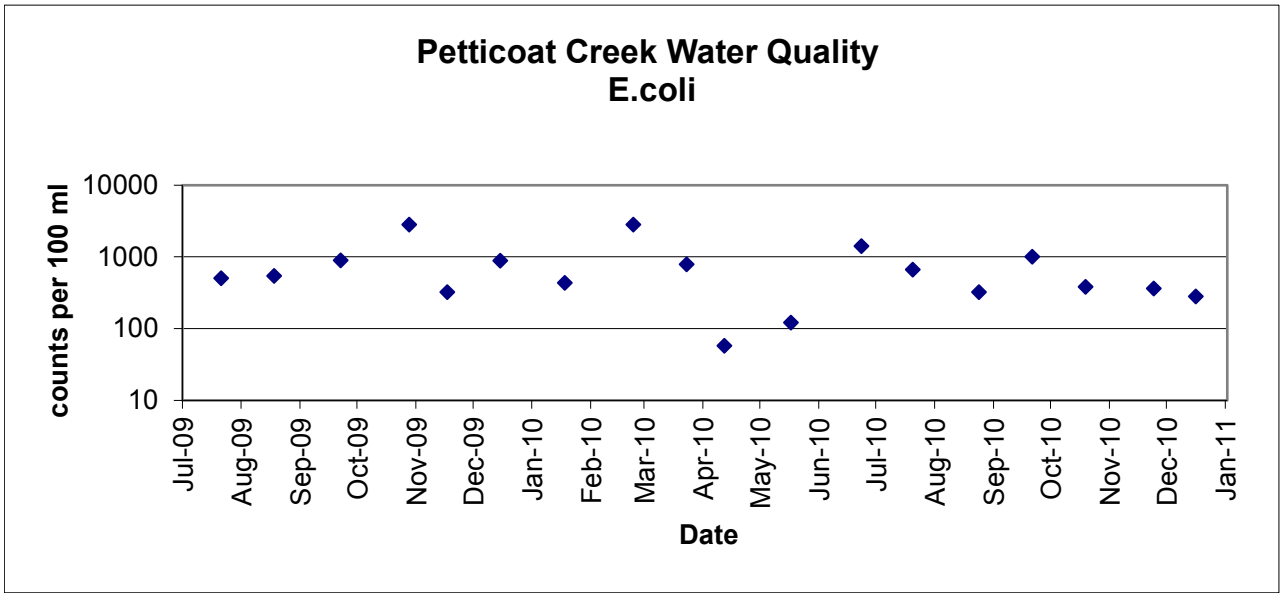


Figure 16: *Petticoat Creek Water Quality E. coli Counts*

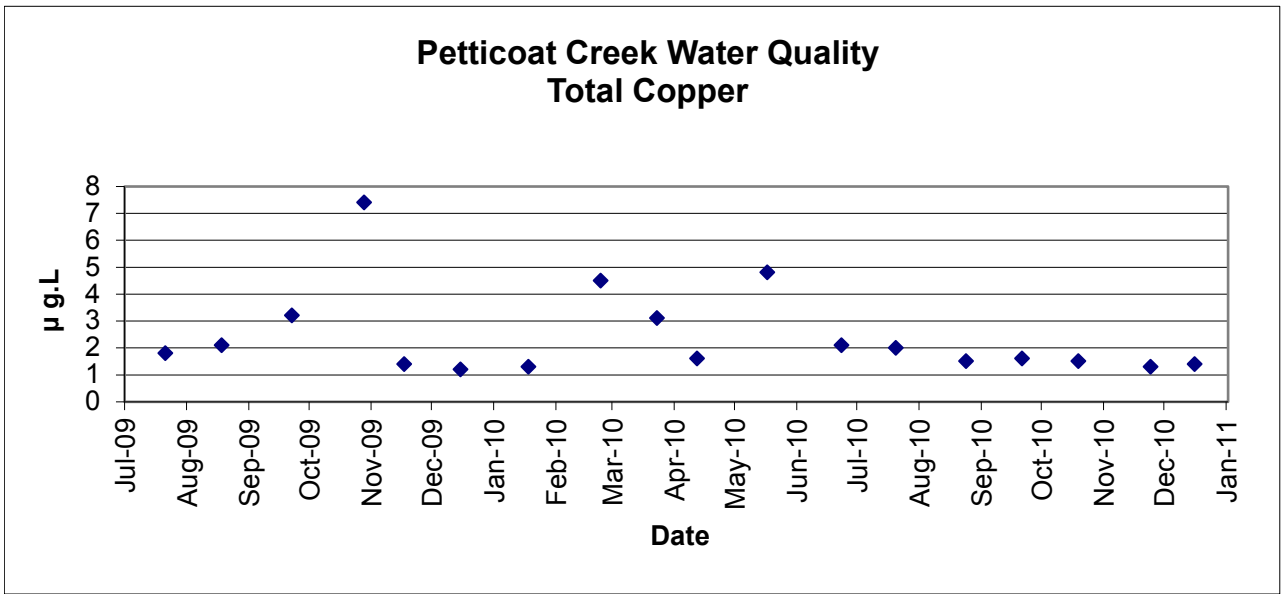


Figure 17: *Petticoat Creek Water Quality Total Copper*

2.5 Surface Water Quantity

The hydrology of Petticoat Creek watershed is a reflection of the watershed's geology and climate. Unlike neighbouring Rouge River and Duffins Creek, the hydrology of this watershed is not dominated by permeable soils and groundwater discharge from the Oak Ridges Moraine. As a result, stream flow in Petticoat Creek responds rapidly to precipitation and snow melt events. The headwaters are frequently dry in summer and fall in response to low groundwater infiltration rates on the till deposits and a downward flow gradient. Lower reaches of the creek, below the Lake Iroquois shoreline, benefit from the regional groundwater flow system as evident from baseflow surveys. While precipitation amounts are evenly distributed throughout the year, stream runoff is reduced during the summer months due to evaporation.

TRCA's stream gauge on Petticoat Creek shows that the majority of the stream flow occurs over the winter and spring months, with significantly lower average flows during summer months (Figure 18). On an annual basis, the average daily flows in Petticoat Creek reflect the watershed's runoff response to variations in evapotranspiration and precipitation. Daily precipitation patterns over a six year period indicate that 2001, 2002, and 2007 were very dry years with little flow in the creek over most of the year. During this period there were only four events where the daily flows exceeded 10 cubic metres per second (Figure 19, 20).

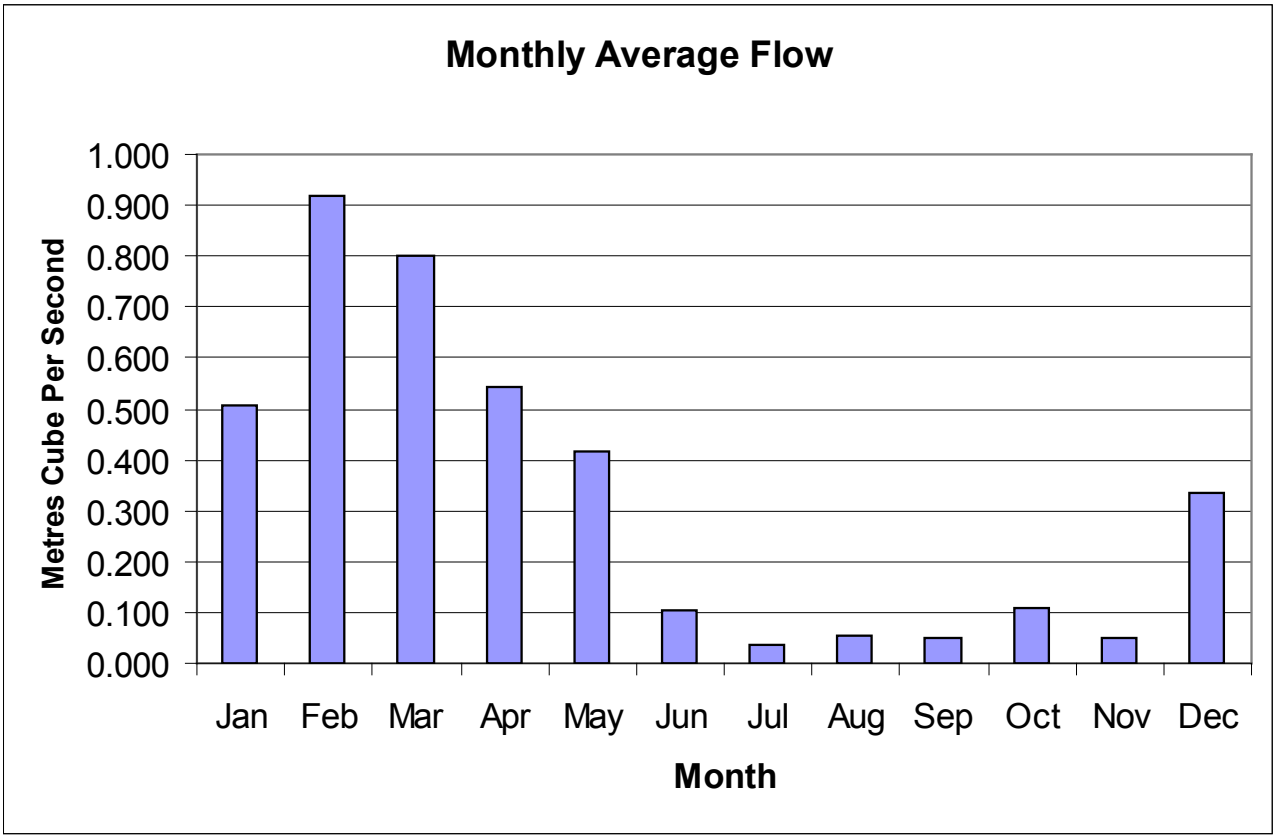


Figure 18: *Petticoat Creek Watershed Average Monthly Flow*

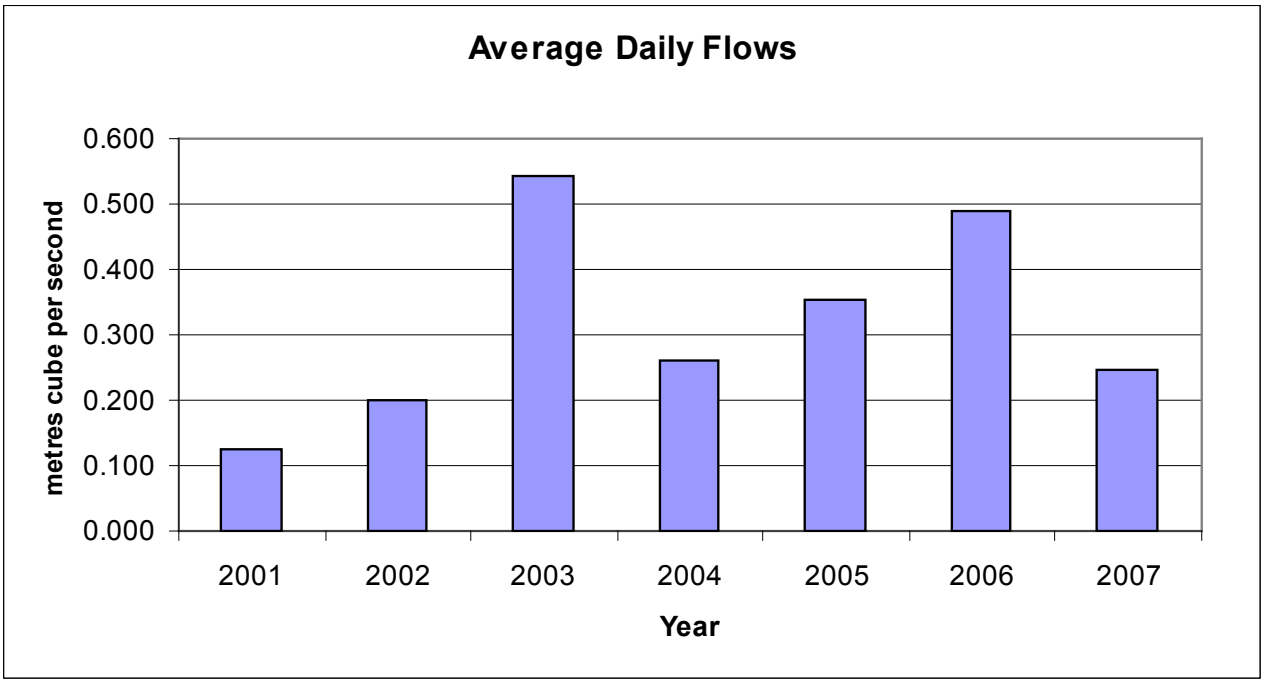


Figure 19: *Petticoat Creek Watershed Average Daily Flows*

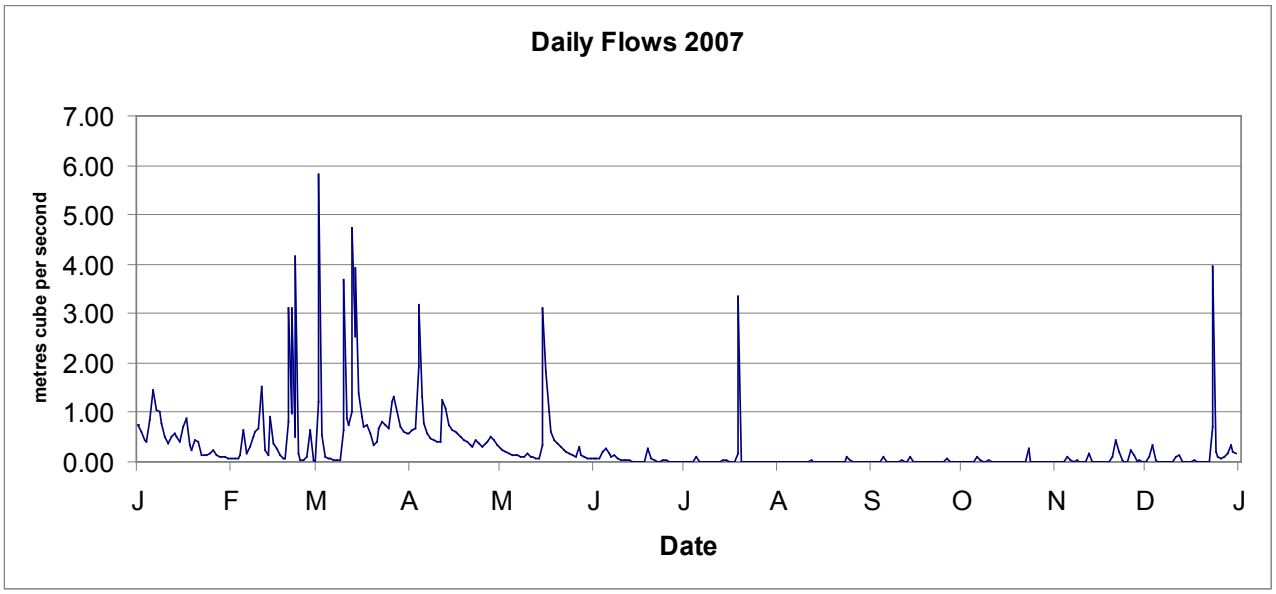


Figure 20: *Petticoat Creek Watershed Daily Flows*

2.6 Stormwater Management

The most significant change to the natural environment during the process of urbanization is the conversion of pervious surfaces (forests, meadows, agricultural fields) to impervious surfaces (roads, parking lots, rooftops), which prevent water from infiltrating the soil, and change the amount of water that evapotranspires. As a result, the volume of stormwater runoff from urban areas is many times greater than from rural ones. Historically, drainage management has focused exclusively on conveying this excess stormwater runoff from urban lands to local watercourses as quickly and efficiently as possible. Past practices often led to increased flooding downstream and higher erosion rates with a resulting decline in the health of the aquatic ecosystem, changes in terrestrial and aquatic habitat, and degraded water quality.

Retention ponds and wetlands for stormwater management originated several decades ago as attempts to mitigate flooding, erosion, and water quality impacts. These approaches were not always successful. Today, state-of-the-art stormwater management practices provide a higher level of protection for the environment, property, and residents, by trying to mimic natural hydrology through a combination of lot-level and conveyance measures, instead of end-of-pipe controls alone. Low Impact Development measures focus on infiltrating and evaporating excess runoff volume at the source, where precipitation falls.

Existing development in Petticoat Creek watershed is almost exclusively in the older, southwest portion of Pickering. There are five stormwater management ponds in the watershed: Stroud's Pond, Bramalea-Highbush Pond, Silverlane Estates Pond, Crystal Forest Pond, and Altona Pond (Figure 21). Due to accepted practice at the time of construction, much of the area was developed without the use of at-source, conveyance (lot-level) and stormwater management pond measures. Therefore the runoff flows directly into the stream, carrying sediment and contaminants with it.

While widespread flooding in developed areas of Petticoat Creek watershed is not a concern, four areas are recognized as susceptible to flooding during a large scale rain event, like Hurricane Hazel. These flood-prone areas tend to be associated with undersized infrastructure such as bridges and culverts. The areas are:

- Highway 401 corridor
- Sheppard Avenue/CN Railway corridor
- Finch Avenue Corridor (West of Woodview Avenue)
- Heska/Davidson/Altona Corridor

Flood remediation for these areas may be achieved through increased conveyance systems such as bridges, culvert spans, and modifications to the stream channel. This type of work may be completed as part of road reconstruction or drainage system maintenance projects which typically require the municipality, regional government or Ontario Ministry of Transportation to complete Environmental Assessments, with mitigation measures resulting from the review process.

Effective stormwater management strategies make use of a variety of techniques to reduce runoff volume, such as increasing infiltration and evaporation. It is more effective to implement these at the time development occurs since it is generally more difficult to construct, or retrofit, stormwater management measures into existing development. Additionally, post-development stormwater management is typically the responsibility of the local municipality and funding opportunities are generally limited.

Lot-level and at-source conveyance stormwater retrofits can contribute greatly to the effective restoration of a natural flow regime and improvement of water quality. Rainwater harvesting and re-use for outdoor water consumption, even at the individual residential lot level, is effective in conserving treated municipal water and in reducing runoff. Small-scale technologies requiring minimal financial investment, such as rain barrels and downspout attachments, are often all that is required to achieve significant results, especially when an aggressive educational campaign is part of the program.

Stormwater management retrofit studies are one mechanism by which opportunities for improvement are identified in an area where limited stormwater management controls are present. TRCA, in partnership with the City of Pickering, initiated the *City of Pickering Stormwater Retrofit Study* (2003) as the framework for a long-term strategy to implement erosion controls in ponds and wetlands in the existing urbanized area. While this study did not identify any potential new stormwater management ponds in Petticoat Creek watershed, it did identify Stroud's Pond as a potential retrofit site where water quality treatment could be added. Implementation of this study is currently underway.

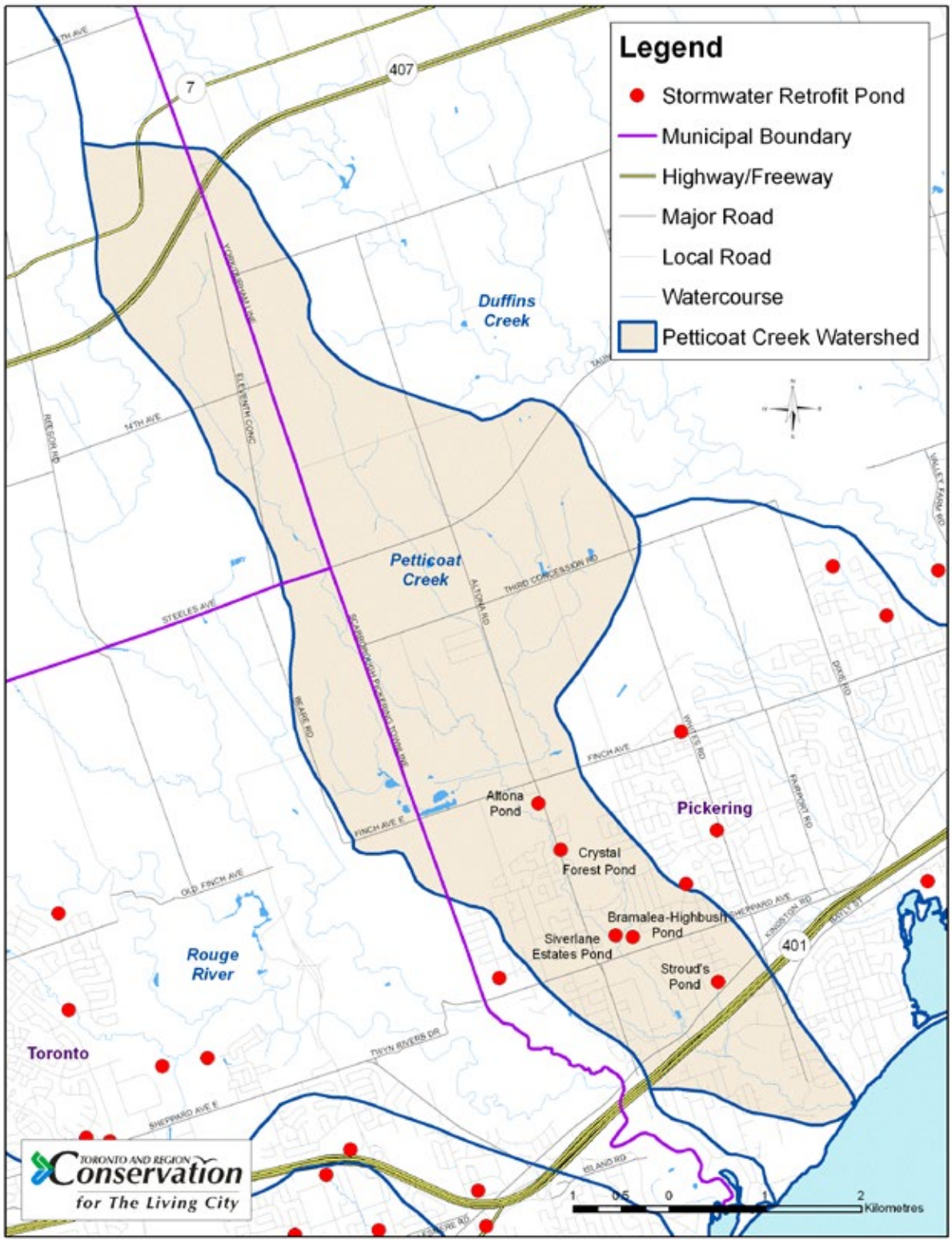


Figure 21: *Petticoat Creek Stormwater Management Ponds*

2.7 Aquatic System

Petticoat Creek watershed is characterized as a warm water system, with its headwaters originating south of the Oak Ridges Moraine on the South Slope. Due to the limited recharge potential of the South Slope and the thick layer of till soils underlying the stream channel, little groundwater enters the system and the baseflow is mainly supported by surface water drainage. Data from recent studies suggest that during dry summers, flow through much of the system may be intermittent or ephemeral.

Although the physical components of the aquatic habitat contain a good mixture of substrate and habitat types such as pools, riffles and runs, the quality of the habitat is influenced by the intermittent nature of the flow. Additionally, the fish community is segregated by in-stream barriers (primarily perched culverts) which have differences in height between the downstream end of the culvert and the stream channel below ranging from several centimetres to approximately 0.5 metre.

Based on the fish species currently inhabiting this watershed, it is best classified as a warm water baitfish community. Over the last 25 years, various field studies have been carried out by agencies, researchers and consultants to document the aquatic habitat and fish communities in Petticoat Creek watershed (Figure 18).

The area of the watershed between the CP rail line to the south and Highway 407 to the north is drained by a network of small tributaries which primarily flow through agricultural lands. Most of these small channels have healthy riparian zones with grass and shrub vegetation communities. Water depth is shallow and there are numerous pools, often located at the downstream end of culverts. Channel substrates are a mixture of cobble, gravel and fine sediments. Habitat cover is moderate and comprised of woody material, aquatic vegetation, rocks and undercut banks. The channel banks are generally well-vegetated and protected from erosion. There is evidence of groundwater upwelling into the stream at a small number of sites. Generally, the flow in these tributaries is largely dependent on surface water drainage. During dry summers, many of these tributaries have intermittent or ephemeral flow and fish are only present seasonally. The deeper pools have large schools of small fish including creek chub, fathead minnow, white sucker, common shiner, blacknose dace, longnose dace, Johnny darter and brook stickleback.

Moving downstream, the area of the watershed south of the CP rail line to the Lake Ontario shoreline contains a main stem stream channel formed by the confluence of three tributaries. The surficial geology at this confluence, and at the adjacent Townline Swamp Wetland Complex, is comprised of Lake Iroquois sands and gravels. Baseflow is increased via groundwater discharge in these porous soils, however, there is insufficient volume to create coldwater habitat. The substrate includes a mixture of cobbles and gravel with some zones of exposed clay. In-stream habitat in this channel is generally diverse, with greater water depths and a good mixture of pools, riffles and runs, and abundant cover composed of aquatic vegetation, woody material and rocks. Stream banks are generally well vegetated and protected from erosion, and the stream flows through a defined valley feature with associated mature forest.

This zone has a warmwater fish community predominantly composed of baitfish species similar to the northern reaches of the watershed, with creek chub, fathead minnow, white sucker, common shiner, blacknose dace, longnose dace, Johnny darter and brook stickleback. In addition, small numbers of adult migratory coldwater fish have been observed seasonally in the lower sections of the watershed, such as rainbow trout in the spring and chinook salmon in the fall. However, these salmonids are likely strays from adjacent watersheds and there is no evidence of a self-sustaining population of these species. Historic records indicate that smallmouth bass, largemouth bass, rock bass, pumpkinseed, spotfin shiner, northern redbelly dace, northern hog sucker and stonecat have also been captured.

Figure 22 presents information on stream sensitivity in various portions of the Petticoat Creek watershed. Stream sensitivity is defined as "the stream's ability to withstand both natural and/or anthropogenic factors which result in environmental change" (Wichert, 1994). The data to support this classification system was collected during the field work to prepare the Natural Environment Baseline Conditions Report for the York-Durham Southeast Collector Trunk Sewer Environmental Assessment (EA). Stream sensitivity was determined to be one of three categories:

1. highly sensitive (dark brown)
2. moderately sensitive (orange)
3. low sensitivity (light yellow)

Sensitivity was based on the community of fish species present at sites which were surveyed for the EA. The various fish communities were assigned a score based on their degree of intolerance to reductions of water quality.

Figure 22 indicates that the Petticoat Creek watershed generally contains moderate- and low-sensitivity stream habitat compared to the adjacent Rouge River and Duffins Creek watersheds which contain high- and moderately-sensitive stream habitat.

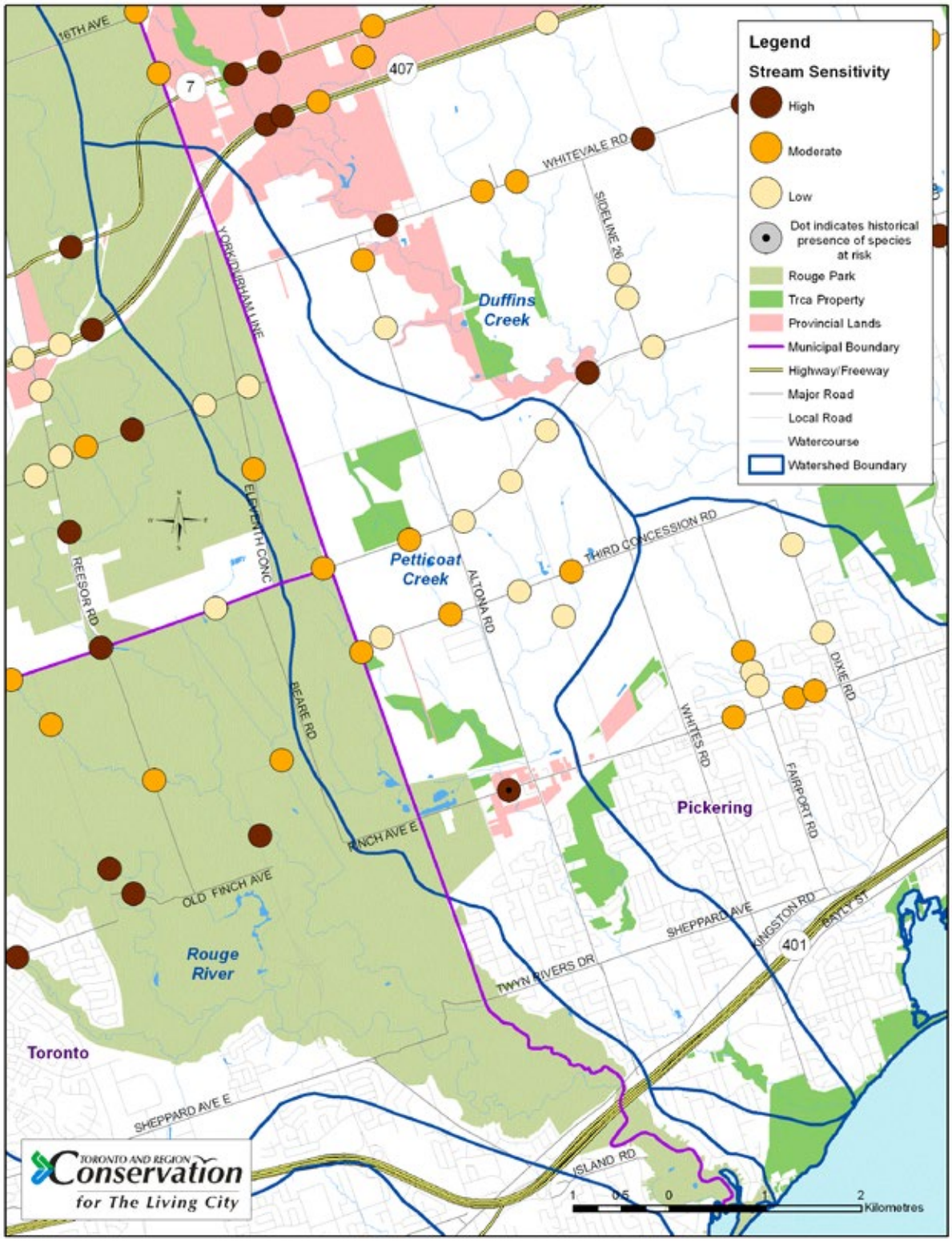


Figure 22: *Petticoat Creek Watershed Stream Sensitivity*

2.8 Terrestrial System

Petticoat Creek watershed is located along the boundary between the Carolinian and Great Lakes-St Lawrence Mixed Forest zones. It provides important ecological linkages between the neighbouring Rouge River and Duffins Creek watersheds, and between the Oak Ridges Moraine and Lake Ontario. Historically, the watershed would have been predominantly covered in forest and wetlands. Over time this natural cover, along with its environmental benefits, was diminished by human activity to what is now considered below the desired level. Today, natural cover in the form of forests, wetlands and meadows is concentrated in public greenspace areas:

- Altona Forest
- Townline Swamp Wetland Complex (Provincially Significant Wetland)
- Petticoat Creek Forest, an Environmentally Significant Area comprised of a valley system linking Altona Forest to Lake Ontario
- Eastern areas of Rouge Park
- The hydro corridor

Petticoat Creek Wetland is an Environmentally Significant Area located northwest of York-Durham Line and Steeles Avenue East. Also notable is Cherrywood Swamp, which is Locally Significant and supports a Regionally Significant great blue heron colony.

An important physiographic feature is the Lake Iroquois shoreline which is an historic, glacial lakeshore running east-west across the watershed, north of Finch Avenue. This sandy plain is highly sensitive due to the presence of wetlands and remains relatively well-forested. The central portion of the watershed is also part of the Rouge-Duffins Wildlife Corridor (Figure 23), which is recognized in the City of Pickering's *Official Plan* as a protected area intended to function as a natural linkage between the Rouge River and Duffins Creek valleys, providing passage for various species to broaden their habitat, leading to greater species survival. While this corridor provides significant natural habitat, it is under stress from human activities such as littering, vandalism, encroachment, trampling of flora and compacting soils, and invasive species.

There are three initiatives relevant to protecting natural features in Petticoat Creek watershed. The first is the provincial Central Pickering Development Plan (2006), which applies in the Pickering portion of the watershed. The Central Pickering Development Plan (CPDP) is comprised of the Duffins-Rouge Agricultural Preserve, employment and residential development parcels which will become the planned community of Seaton. It also includes a Natural Heritage System designated by the Ontario Ministry of Natural Resources (Figure 23) through the identification of existing natural features and their critical interrelationships and dependencies, links between features in and outside of the planning area, and buffers around each feature, based on more than 30 years of fieldwork. This system includes:

- All wetlands
- All significant woodlands
- All streams/watercourses
- Lake Iroquois shoreline
- All valley systems to stable top-of-bank
- All Environmentally Significant Areas
- All locations of species at risk
- Groundwater seepage/discharge areas
- Linkage corridors
- Buffer zones

As the Central Pickering Development Plan is implemented, the Natural Heritage System will be designated, maintaining a Primary Designation on publicly-owned lands (*i.e.*, Seaton), an Overlay Designation on privately-owned lands (*i.e.*, the Duffins-Rouge Agricultural Preserve), and include both significant natural heritage features and other lands which provide the required linkage, corridor, and buffer functions (Figure 23). This Natural Heritage System is similar in size, extent, function and services to TRCA's Target Terrestrial Natural Heritage System, and has the additional benefit of support from provincial policy.

The second initiative to consider is Rouge Park, specifically the management plan created by the Province in 1994 which delineated the park boundary and designated park zoning, including "Nature Reserve" and "Restoration" zones (Figure 23). The Nature Reserve zone encompasses Areas of Natural and Scientific Interest, other primary natural areas in the park such as river and stream corridors, upland woodlots, wetlands and critical linkage areas which were identified in background studies leading to the establishment of the park. Rouge Park incorporates TRCA's Target Terrestrial Natural Heritage System approach in its system planning. The Rouge North Management Plan developed by the park in 2001 is also relevant, with unique management principles and recommendations which apply to the northern reaches of Petticoat Creek watershed. A management plan for the Rouge Park East Lands in Markham is under development and will be informed by the recommendations in this watershed action plan.

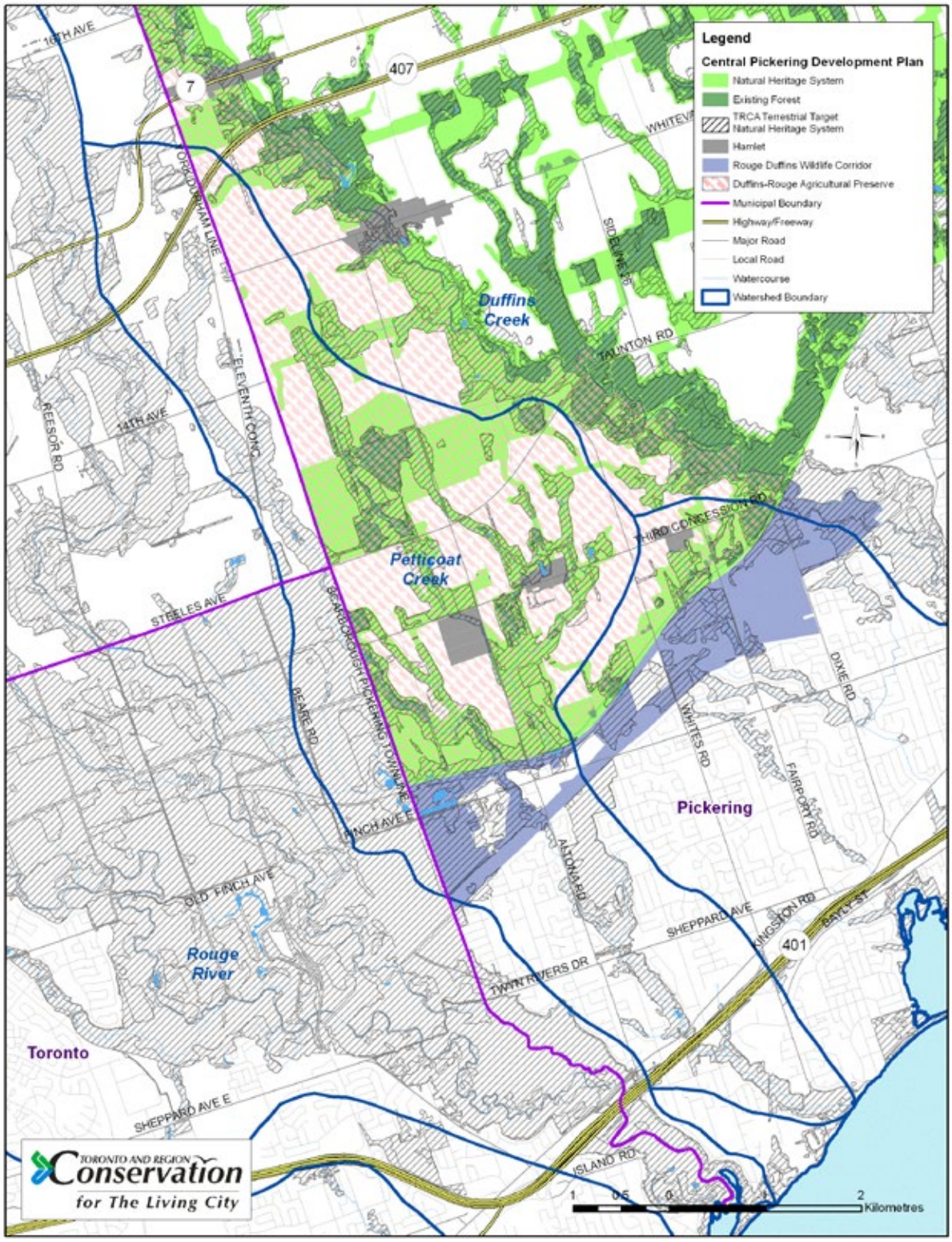


Figure 23: *Central Pickering Development Plan Natural Heritage System and TRCA Target Terrestrial Natural Heritage System*

The third initiative relevant to Petticoat Creek watershed is the Terrestrial Natural Heritage System Strategy (TNHSS) developed by TRCA in 2007 for the nine watersheds in its jurisdiction in response to the continued loss of habitat and biodiversity in the GTA (Figure 23). This strategy provides direction at the regional scale for the protection and restoration of a natural system. It is based on local knowledge and current landscape ecology principles. The TNHSS uses a strategic approach to protect and restore natural cover, with detailed rankings of species and vegetation communities.

2.8.1 Natural Cover Quantity

As part of the TNHSS, TRCA developed a "target system" to encompass existing natural cover, and identify areas of potential natural cover where forests and wetlands should be created to encourage sustainability of the ecosystem and regain some of the original environmental benefits. The concept of protecting a target system which includes the sum of existing and potential natural cover is relatively new in land use planning; at present, individual areas are designated as environmentally significant, not entire systems. The target system is significant in terms of ecological function and ecosystem services and guides ecological restoration planning on public lands in TRCA jurisdiction. It has been modeled at the regional scale and can be refined at the watershed scale, a level of protection which should be a priority direction in the near future.

2.8.2 Natural Cover Quality

The overall quality of natural cover is determined by evaluating the size, shape, and matrix influence (surrounding land uses) of habitat patches, determined through remote sensing as a surrogate for habitat quality. This gives an idea of the entire watershed's existing natural cover quality, including areas where field investigation could not be conducted. The 16% of the watershed which is categorized as existing natural cover in forests and wetlands is well-distributed, with a noticeable concentration in the central part of the watershed. Based on studying and modelling conditions in all TRCA watersheds, TRCA ecosystem managers used maps of patch score categories to assign an overall character of "Fair" to Petticoat Creek watershed, in terms of patch size, shape and matrix influence (Table 1).

Natural Cover	Hectares	Area of Watershed
Existing	435	16%
Potential	609	23%
Target System (Existing + Potential)	1044	39%

Table 1: *Petticoat Creek Watershed Target System*

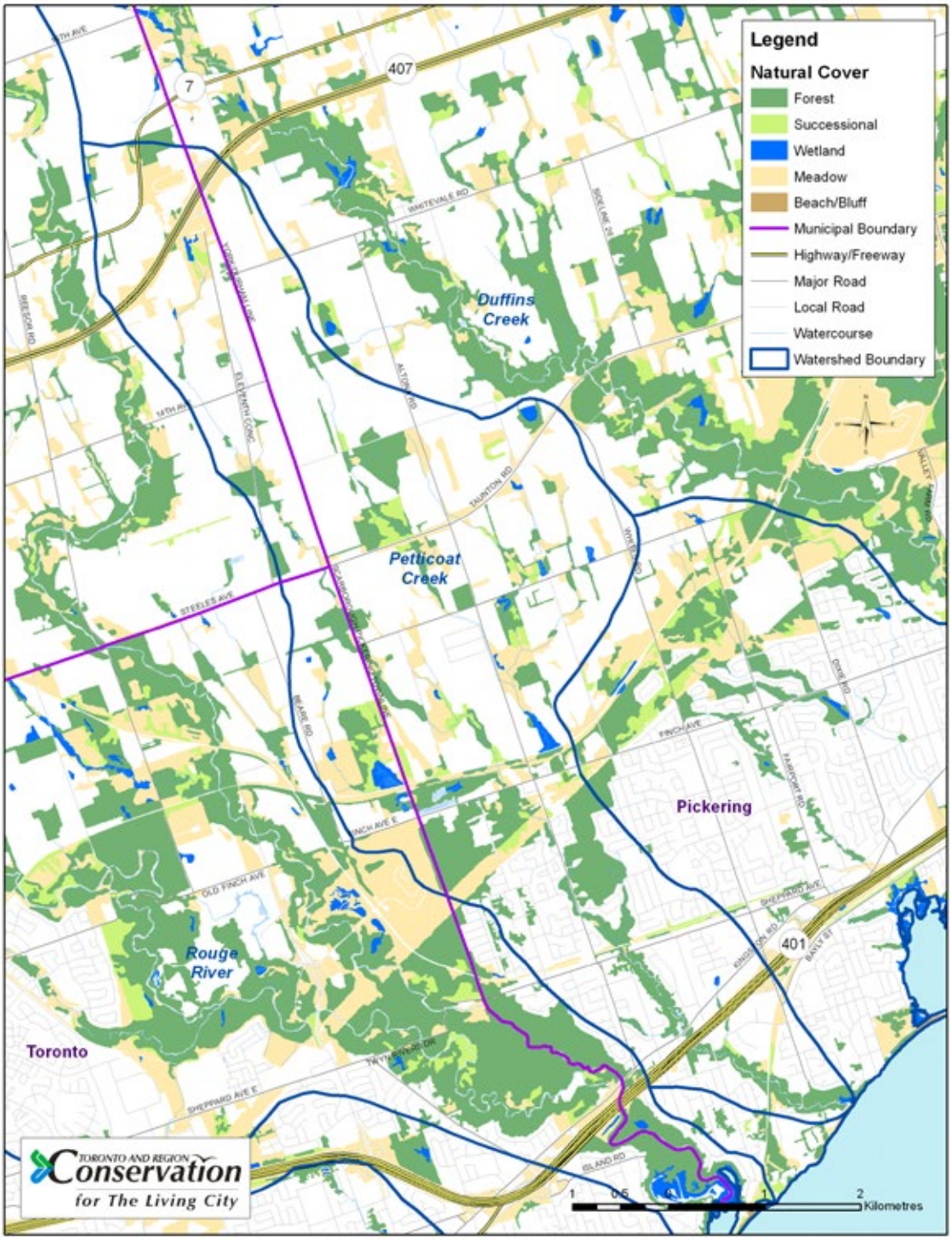


Figure 24: *Petticoat Creek Watershed Natural Cover*

Quality Determinant	Range	Natural System Character
Patch Size	Poor to Good	Fair(Score 3)
Patch Shape	Poor to Excellent	Fair(Score 3)
Patch Matrix Influence	Poor to Good	Good (Score 4)
Overall (combined, weighted)	Poor to Good	Fair (L3)

Table 2: *Petticoat Creek Watershed Existing Patch Size, Shape and Matrix*

However, this does not mean that the system is resilient, since "fair" is the threshold below which many species tend to disappear. If the watershed undergoes further urbanization, thereby increasing the negative matrix influence, the overall patch rank will drop to L4, or "Poor", and many species will disappear. Any change in one parameter should be met with an improvement in the other two parameters; for example, the target system mentioned above represents a vision of improvements to patch size and shape to build up the natural system's resilience in light of potential changes in matrix influence in the future (Table 2).

Ecosystem managers often look at the combination of forest patch size and shape to obtain a measure of "interior forest", referring to forest habitat located more than 100 metres from adjacent agriculture, houses, roads, and other development. Interior forest is an important measure of the quality of natural cover because many species rely on habitat that is buffered from human disturbance for successful breeding and to maintain healthy populations. While the patch size of forest cover is relatively low in this watershed (Fair), there are three separate habitat patches containing interior forest (Figure 25):

- Altona Forest area, at Altona Road and Finch Avenue East
- Petticoat Forest area, at Altona Road and Sheppard Avenue East
- Rouge Park, at York-Durham Line and Finch Avenue East

In terms of matrix influence, 52% of the watershed is currently in agricultural use, which has far less impact on the natural system, and offers more opportunities for restoration, than does urban land cover. The watershed is also positively influenced by the natural matrix of the neighbouring Rouge River and Duffins Creek watersheds, especially from the extensive, protected natural habitats in Rouge Park. There may be opportunities to increase the positive matrix influence by increasing the amount of trees, especially in the urban areas. Urban forest cover is valuable not only in creating positive matrix influence, but also in providing many benefits to water quality, climate change mitigation, aesthetics and the quality of life for urban residents. The City of Pickering has completed an urban forest study to be used for developing detailed urban forest management plans.

Invasive species lower the quality of natural cover by threatening, or in some cases diminishing, the biodiversity of natural areas. Generally, Petticoat Creek watershed is in the late stage of infestation by invasive plant species, such as buckthorn and dog strangling vine, which are present throughout the watershed, including in Altona Forest and Petticoat Creek Conservation Area. TRCA is managing the following invasive plant species in Altona Forest:

- Dog Strangling Vine: mechanical control by cutting, and chemical pesticide applications
- Buckthorn: mechanical control by cutting tree and covering stump, and/or chemical pesticide applications
- Garlic Mustard: mechanical control through hand removal

At this time no biological control methods have been tried by TRCA in Petticoat Creek watershed.

2.8.3 Species and Vegetation Community

Ranks

The list of species and vegetation communities in TRCA watersheds is so extensive, with over 1100 native flora and fauna species in total, that staff determined the need for a ranking system ("L ranks" or local ranks) to help evaluate the condition of a study area and make management decisions (Figure 27). The ranks range from 1 to 5, with L1 being more sensitive and L5 more resilient:

Rank	Designation	Description
L1	Regional Concern	Of concern in entire TRCA jurisdiction due to stringent habitat needs, threat to habitat and/or rarity.
L2	Regional Concern	Typically occurs in high-quality natural areas and under highly specific site conditions; probably at risk in the Toronto area.
L3	Regional Concern	Restricted in occurrence and/or requires specific site conditions; generally occurs in natural rather than cultural areas.
L4	Urban Concern	Widespread and generally secure in rural matrix but of conservation concern in the urban matrix; frequently occur in relatively intact urban sites but vulnerable to long-term declines.
L5	Generally Secure	Resilient; may be a conservation concern in a few specific situations. L5 vegetation communities contribute to natural cover.

Table 3: *Species Local Ranks*

Communities or species of *regional concern* (L1 to L3) and of *urban concern* (L4) now replace the idea of *rare* communities or species, making it possible to recognize communities or species of concern before they become rare, and hopefully therefore maintain their abundance. The value of *secure* species and communities is in their contribution to natural cover and ecosystem services.

Although as a society we tend to assign more value to rare or special aspects of ecosystems, it is impossible to have a healthy watershed without valuing the communities and species that both characterize (*the common*) and accentuate (*the special*) the landscape.

Habitat patches (interior forests, wetlands and meadows) were also given L ranks from 1 to 5 based on their size, shape and surrounding matrix influence, as follows: excellent (L1), good (L2), fair (L3), poor (L4) and very poor (L5). The species and vegetation community ranks roughly correspond to the habitat patch ranks; for example, L4 species may be expected in L4 to L1 patches (poor to excellent patches). Since the patch character in Petticoat Creek watershed is "fair", or L3, it can be expected that many L3 species will be found throughout the watershed. As the natural heritage system is implemented, improvement from "fair" to "good" is anticipated, with more L4 species expected to occur in the future.

Common Species and Communities

The most dominant vegetation communities make up the general character of a landscape. The natural cover of Petticoat Creek watershed is characterized by Poplar Forest, Native Deciduous Cultural Woodland/Savannah, Reed Canary Grass Meadow Marsh, Ash Swamp and Lowland Forest, Old Field Meadow and Treed Hedgerow.

A number of plant and animal species are prevalent enough to make up the general character of the watershed. They include forest edge and thicket species such as American woodcock, grey catbird and indigo bunting; meadow species such as eastern meadowlark; forest species such as eastern wood-pewee, great-crested flycatcher, hairy woodpecker, red squirrel, red-breasted nuthatch, red-eyed vireo and wood thrush; and wetland species such as common grey treefrog, northern waterthrush and swamp sparrow.

Special Species and Communities

A number of vegetation communities and species accentuate the character of Petticoat watershed because they indicate some areas of increased ecological function or special natural character. Among the wetlands which accentuate the character of the watershed are organic wetlands (e.g. Buttonbush Organic Thicket Swamp and Bur-reed Organic Shallow Marsh), most being ranked L2. Numerous plant species in the watershed are generally associated with these communities, including royal fern (L2), and naturally-occurring balsam fir, tamarack and white spruce (L3).

Some of the sand from areas upstream is deposited at the mouth of Petticoat Creek where it meets the waves of Lake Ontario. Such Great Lakes coastal, highly dynamic conditions are ideal for Switchgrass-Beachgrass Open Sand Dune (L1), with its own Great Lakes-specialized species. One such species, beachgrass (or marram grass) (L2), is found at the Petticoat mouth, and bushy cinquefoil was found in the past (1999). Others, such as seaside spurge, sea rocket, and perhaps beach pea may come in the future from seed sources on neighbouring dynamic beaches such as Frenchman's Bay to the east and Rouge Beach to the west, depending on future site conditions.

Various black ash, maple and coniferous swamps are ranked L3 and also help to diversify the character of the watershed. A number of interesting plant species are associated with upland and lowland forest types such as Dry-Fresh Beech Deciduous Forest (L3) and Fresh-Moist White Cedar-Coniferous Forest (L4). Such plants include broad-leaved spring beauty (L3), bunchberry (L2), goldthread (L2), partridgeberry (L3), squirrel-corn (L3), and star-flower (L3). Canada plum (L3) and several interesting hawthorn species are found in the hedgerows.

Some fauna species in Petticoat watershed are ranked L2. Common snapping turtle, blue-winged teal and ruffed grouse nest on the ground and therefore indicate areas where there may be less access and fewer disturbances by people and pets. The river otter, a medium-size mammal, is slowly returning to TRCA watersheds and is only seen occasionally. Grey treefrog and wood frog are found only where good wetlands and water quality exist.

A number of species are ranked L3, including bobolink in meadows; hooded merganser, northern harrier, northern leopard frog and Virginia rail in wetlands; pileated woodpecker, redback salamander, scarlet tanager, sharp-shinned hawk and veery in forests; and yellow-billed cuckoo in forest edge.

As the natural heritage system improves, more species may be added to the list, and more of each may be found in the watershed. As L1 to L4 species and communities increase in abundance and distribution, so will air and water quality, urban climate regulation, flood attenuation, and natural aesthetics in the landscape.

2.9 Ecological Restoration

Terrestrial natural heritage strategies are the foundation for planning ecological restoration. For example, by increasing the quantity of natural cover we can improve the quality of habitat by enhancing patch size and shape, and reducing the negative impact of surrounding land use.

The terrestrial natural heritage components of the Central Pickering Development Plan (2006) are the Seaton Natural Heritage System which will remain in public ownership, and the Duffins-Rouge Agricultural Preserve comprised of privately-owned lands which will remain protected for agricultural and conservation uses. The Seaton Natural Heritage System can facilitate protection and restoration by identifying priority areas on public lands and areas with Conservation Easements. Restoration on lands which are under private ownership will rely on investment and cooperation from the landowner.

Resources for implementation of any ecological restoration work are limited and likely to go to higher priority, neighbouring watersheds, however there may be opportunities for work to be completed as part of remediation, compensation and/or enhancement work through Environmental Assessment requirements for infrastructure projects in the watershed, or through special project funding.

Areas with the most active restoration in Petticoat Creek watershed are in Rouge Park. Through park planning exercises, a total of 77 hectares in Petticoat Creek watershed in the Toronto portion of the park were zoned "Restoration", indicating their high potential for ecological restoration (Figure 28). Restoration has been completed on almost 50% of these lands, or 37 hectares.

TRCA completed a Restoration Opportunities Plan (ROP) for Petticoat Creek watershed in addition to Rouge Park (Figure 29). Watershed-wide restoration objectives were used to develop a more detailed, targeted, site-level implementation strategy for the ROP. The ROP was generated from desktop and field assessments, and contains a database of potential terrestrial restoration sites which are linked to geographic information system (GIS) data layers with general site descriptions, existing habitat, potential habitat opportunities, and priority ranking.

Wetland and riparian opportunities were then identified by TRCA based on the ROP, to guide staff in restoration planning. These were developed using GIS desktop assessment techniques, and ground-truthing, which determine landscape characteristics based on elevation and drainage. For example, using tools such as ArcHydro (a GIS application), a drainage line is derived from the Digital Elevation Model. Staff then pinpoint the flow of water across the landscape in more detail than aerial photography interpretation would determine. This enables the identification of permanent watercourses, intermittent streams, and depressions which may be suitable for riparian or wetland restoration projects. In addition, this work can complement other initiatives such as source water protection, species recovery planning, and Atlantic salmon reintroduction. Given that wetland and riparian habitat have been identified as critical indicators of watershed health, and are important for a variety of valuable watershed ecosystem components, these tools are particularly useful in restoring the hydrologic function of our natural systems.

In addition to identifying surficial flow and topography, these tools can be used to delineate subwatershed catchments, which characterize the watershed's natural cover features. Wetland and riparian opportunities can be prioritized based on catchments which have low natural cover. This process is particularly helpful for areas where physical access to the property by staff is limited. Figure 28 shows sites for wetland or riparian implementation opportunities identified through this planning process, as well as suggested locations for Best Management Practices (BMPs) related to rural land uses, such as installing fencing to prevent livestock access to a stream, or increasing vegetative buffers around wetlands and watercourses.

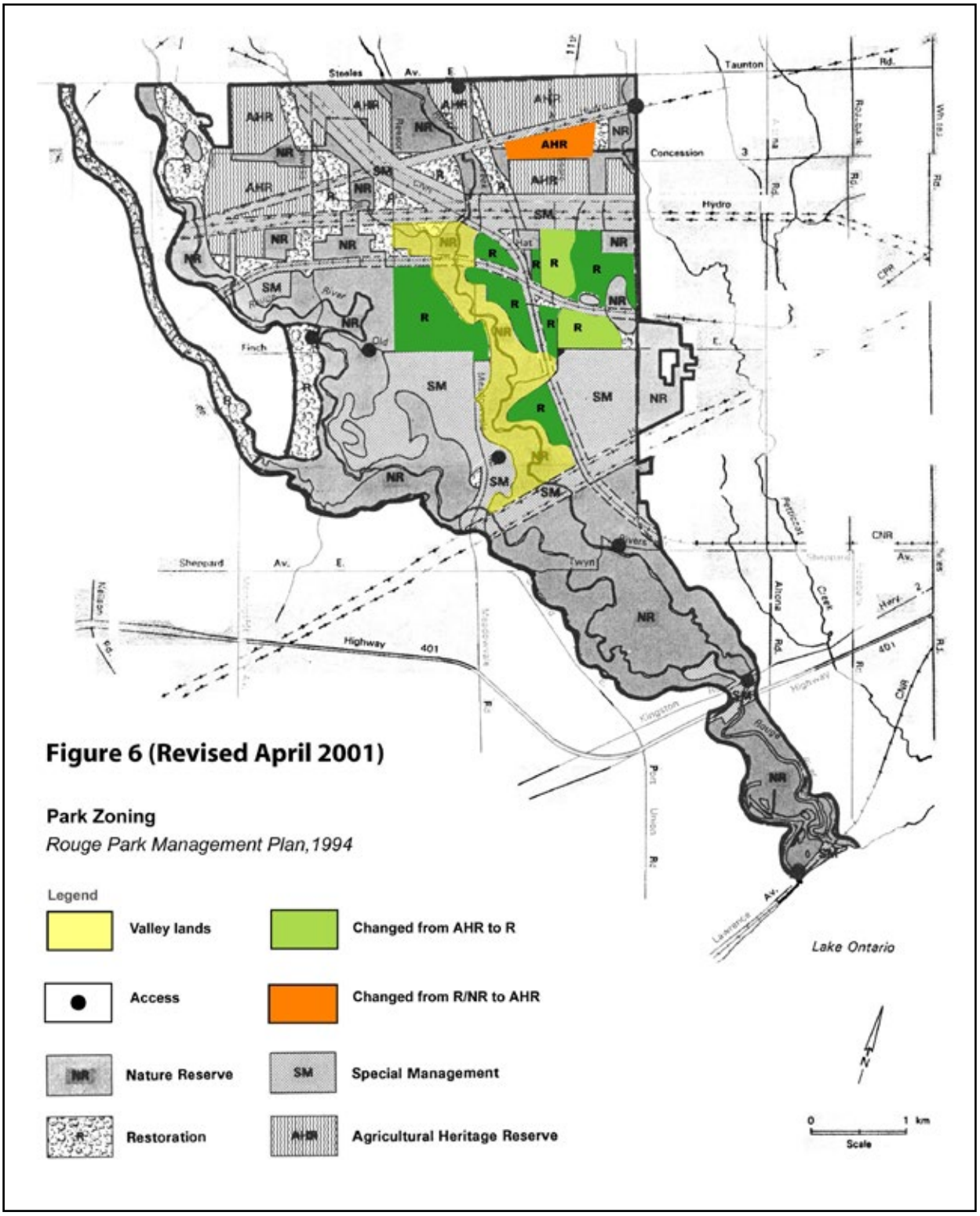


Figure 25: *Rouge Park Zoning*

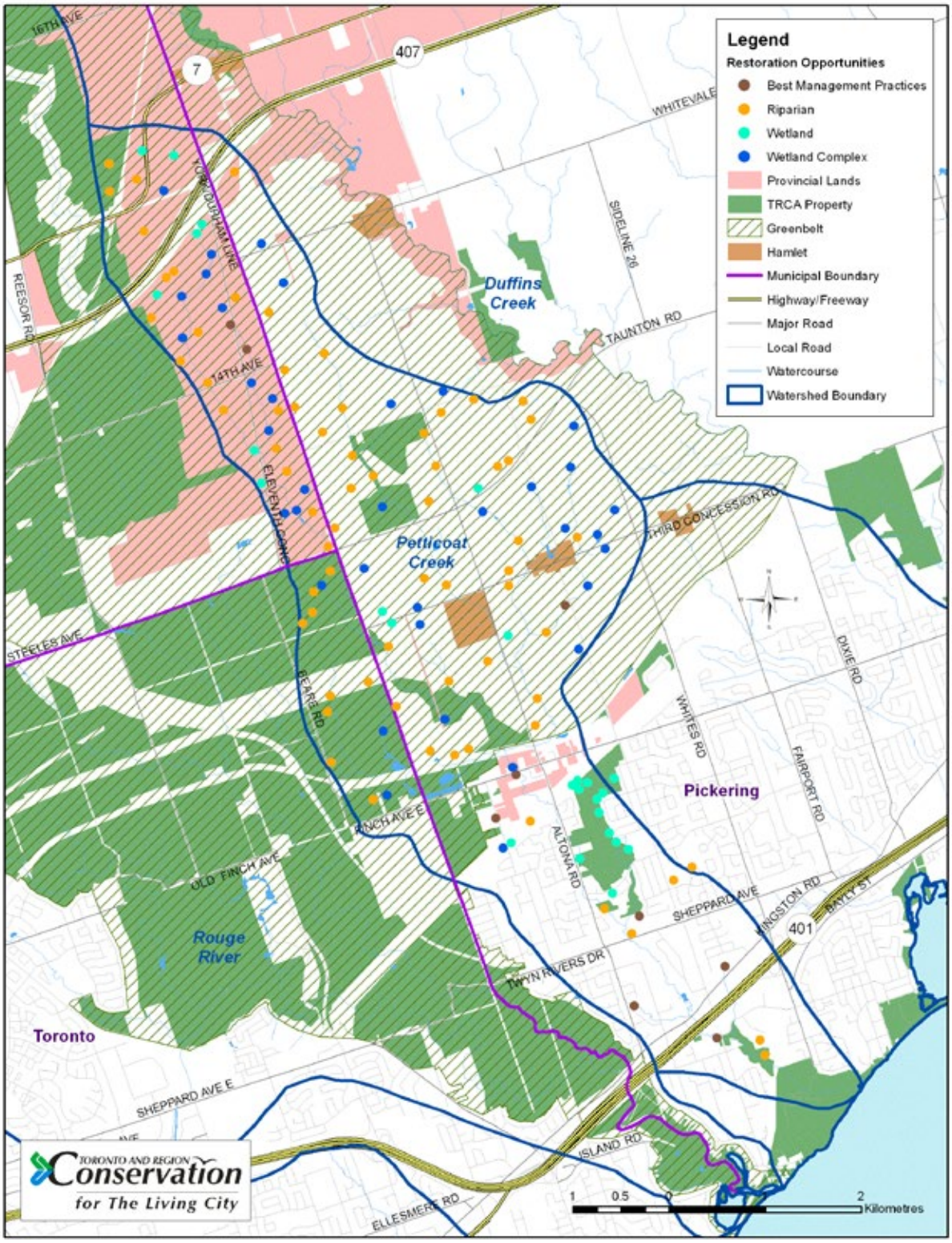


Figure 26: *Petticoat Creek Watershed Ecological Restoration Opportunities*

Ecological restoration will initially be implemented on lands under public ownership (TRCA, provincial lands, Rouge Park) or private lands with Conservation Easements, which are a voluntary, legal agreement between a landowner and conservation organization that permanently limits uses of the land in order to protect its conservation values. Figure 4 shows the land parcels owned by the Province, TRCA, and lands under Conservation Easement.

Opportunities for protecting and restoring terrestrial systems in the watershed have also been identified by Rouge Park in various management plans which have been developed for the majority of the park lands, identifying areas for natural heritage restoration, public use, and agricultural preservation, including areas of Petticoat Creek watershed. The Park has begun creating a management plan for its latest addition of new properties, the Rouge Park East Lands in Markham, which also includes areas of Petticoat Creek watershed, however the plan is not yet complete.

2.10 Land Use

Petticoat Creek watershed is primarily located in the City of Pickering, with small areas in the northwest located in the City of Markham and the City of Toronto, respectively. The 27 square kilometre watershed is characterized by three principal land uses: agriculture (52%), urban development (21%), and public and private greenspace (27%) (Figure 30). According to the 2006 census, the watershed is home to approximately 25,000 urban and rural residents.

Agriculture

More than half of the land in Petticoat Creek watershed is used for agricultural purposes. Near-urban agriculture contributes many economic, social and environmental values to the GTA. Most of the land in the northern portion of the watershed (north of the CP Rail line) is protected for agriculture and natural heritage through various land use plans and policies. This area, known as the Duffins-Rouge Agricultural Preserve, provides an important natural heritage corridor between the Rouge River and Duffins Creek watersheds. While the majority of the lands in the preserve are privately owned, a suite of planning initiatives including the Greenbelt Plan (2005) and the Central Pickering Development Plan (2006) determine land use policies and maintain the long-term protection of the land for agricultural use. Other significant land uses in the preserve include the rural hamlet of Cherrywood and the Highway 407 corridor.

Urban Development

Urban development is focused in the southern portion of the watershed in the western part of Pickering, the area is predominantly low density residential, with a corridor of commercial and industrial development along Kingston Road and west of Whites Road. These neighbourhoods include Rouge Park, Highbush, Rougemount, Rosebank and parts of Amberlea, Woodlands and West Shore (Figure 31). Substantial growth occurred in these neighbourhoods for almost forty years, primarily in the suburban area north of Sheppard Avenue, when environmental protection standards and designs, particularly for stormwater management, were much less stringent than they are today. The result is negative impacts on the lake due to the sediment, pollutants and bacteria loads in the stormwater which are carried directly to the Lake without sufficient intervention.

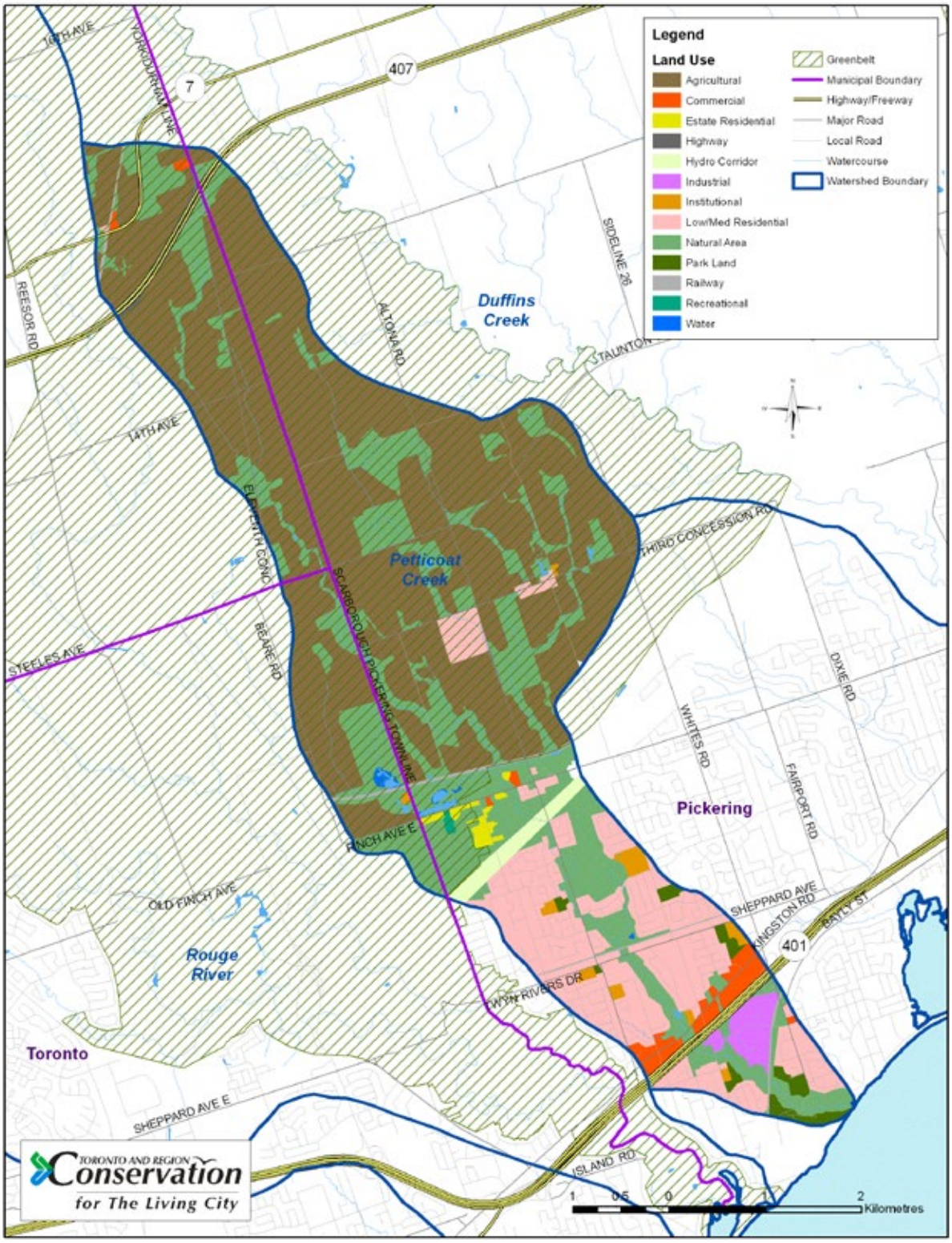
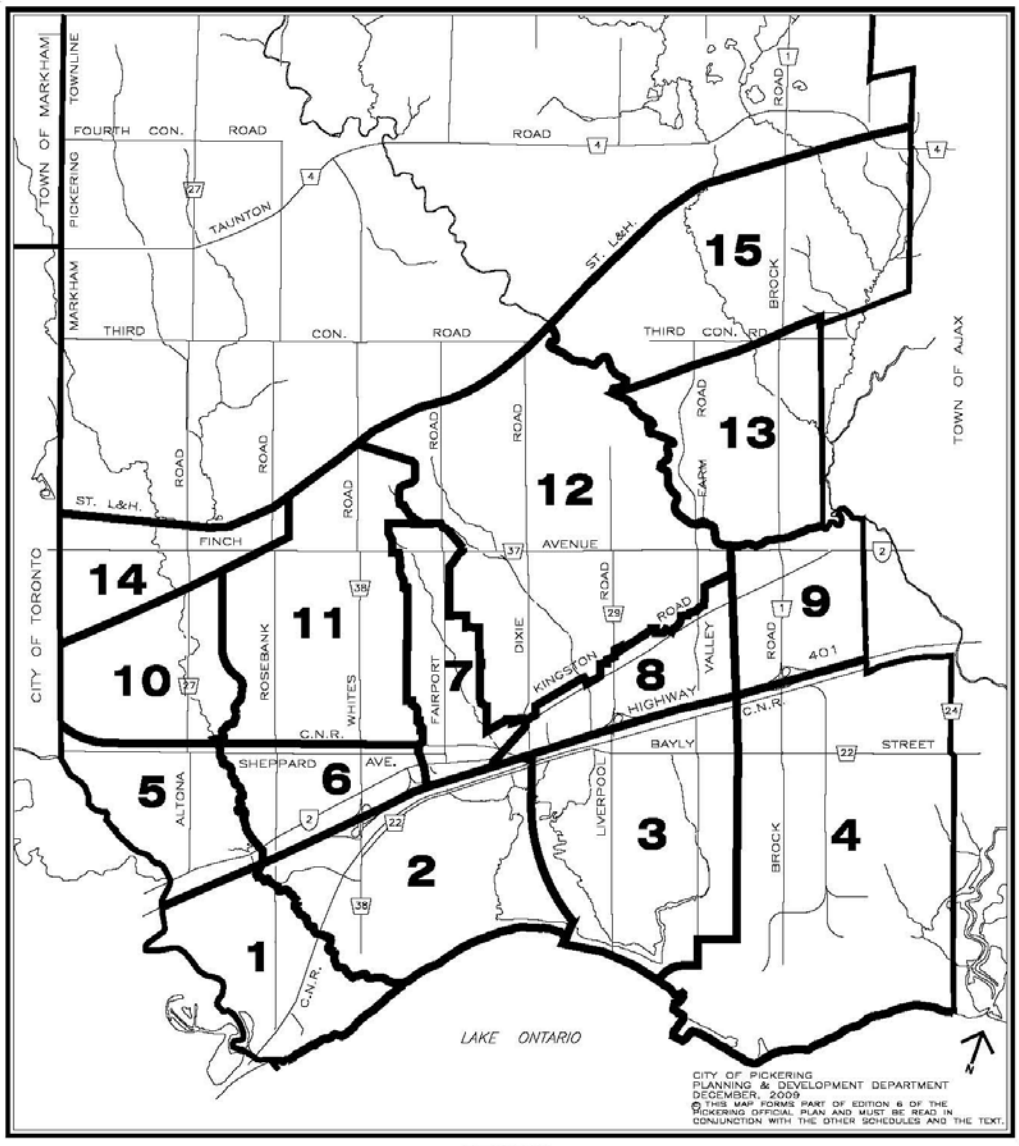


Figure 27: *Petticoat Creek Watershed Land Use*

MAP 9

SOUTH PICKERING
URBAN AREA NEIGHBOURHOODS



LEGEND

1. Rosebank	**6. Woodlands**	**11. Amberlea**
2. West Shore	**7. Dunbarton**	**12. Liverpool**
3. Bay Ridges	**8. Town Centre**	**13. Brock Ridge**
4. Brock Industrial	**9. Village East**	**14. Rouge Park**
5. Rougemount	**10. Highbush**	**15. Duffin Heights**

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Figure 28: *South Pickering Urban Area Neighbourhoods*

The table below (Table 4) summarizes the building permits issued for subdivisions in these neighbourhoods over the last 35 years. Future development will likely include the completion of the suburban neighbourhoods south of Finch Avenue, the intensification of the Kingston Road corridor, as well as infill and re-development in the older, urban area south of Highway 401.

Neighbourhood	1974-1979	1980-1989	1990-1999	2000-2007
Amberlea	686	1907	1483	225
Highbush	n/a	154	1247	237
Rosebank	12	319	101	28
Rouge Park	n/a	n/a	n/a	197
Rougemount	6	511	101	28
West Shore	607	226	25	n/a
Woodland	n/a	206	n/a	n/a
Total	1311	3323	2957	715

Table 4: *Summary of Residential Building Permits by Neighbourhood, 1974-2007*

There is significant existing and proposed infrastructure in the northern portion of the watershed. Highway 407 bisects the northern headwaters, there is a planned expansion of the York-Durham Line roadway, and development of new roads to service the Seaton community are outlined in the Central Pickering Development Plan (2006). The York-Durham Southeast Collector Trunk Sewer will run through the watershed as well.

Major infrastructure in the lower reaches of the watershed includes Highway 401 and the hydro corridor. The hydro corridor provides a potential natural corridor between the Rouge River and Duffins Creek watersheds in the southern half of the watershed, and is part of the larger, but fragmented, Rouge-Duffins Wildlife Corridor. Petticoat Creek flows through two substantial areas of public greenspace in the urban area, Altona Forest and the Petticoat Creek Conservation Area. These two areas are connected by the forested Petticoat Creek valley system in a designated Environmentally Significant Area.

Greenspace

Approximately one-third of the Petticoat Creek watershed is greenspace, including natural cover (forests, wetlands, meadows), active public recreation areas and utility corridors. These areas provide both important natural heritage features and recreational open spaces. Greenspace in Petticoat Creek watershed is both publicly and privately owned and includes the eastern portion of Rouge Park (in Toronto and Markham, and parts of Pickering), hydro corridors, the City of Pickering's *Parks/Trails and Open Space System* (2010), and TRCA conservation lands and parks.

Pickering's open space system includes city parks and other publicly-owned lands. The City of Pickering Official Plan, Edition 6 (2010) identifies all natural core areas, shorelines and stream corridors. Core areas identified in Petticoat Creek watershed include Cherrywood Swamp, Rouge Park, Altona Forest, Townline Swamp Wetland Complex, and Petticoat Creek Conservation Area.

Additional habitat corridors and core areas are located in the Petticoat Creek valley lands and the Rouge-Duffins Wildlife Corridor.

2.11 Rouge Park

Rouge Park, as it exists today, is one of North America's largest urban parks, spanning 47 square kilometres in the eastern Greater Toronto Area. Located in the heart of Canada's largest and most diverse metropolitan area, the park owes its existence, dating back to the late1980s, to the foresight, dedication and engagement of a diversity of local visionaries and stewards.

The park is a complex assembly of natural, cultural, agricultural and recreational lands with a boundary that overlaps private properties, and municipal and provincial infrastructure corridors, in Toronto, Markham and Pickering. It has a rich diversity of natural and cultural heritage resources, including: a rare Carolinian forest, numerous species at risk, national historic sites, geological outcrops from the interglacial age of international significance, and in-situ evidence of human history dating back over 10,000 years, including some of Canada's oldest known Aboriginal historic sites and villages.

Over the past 15 years, Rouge Park developed various plans to outline management strategies within its planning areas. These plans include the Rouge Park Management Plan (1994), the Rouge North Management Plan (2001), and the *Little Rouge Corridor Management Plan* (2007) and the *Bob Hunter Memorial Park Master Plan* (2007). The park is developing a management plan for the Rouge Park East Lands, which include Petticoat Creek, and provide an essential ecological link between the Rouge, Duffins and Petticoat watersheds. This management plan will seek a balance between natural heritage, agriculture, and recreation.

In 2010, a review of the park's governance, organization and finance concluded that a new model was required which led to the recommendation to create a national urban park. A public opinion poll was commissioned resulting in an overwhelming 88% of respondents supporting the concept of establishing Rouge Park as Canada's first national urban park.

The Government of Canada announced in the 2011 Speech from the Throne its commitment to work towards the creation of a national urban park in the Rouge Valley. The opportunity to establish Rouge Park under the stewardship of Parks Canada, as the first national urban park, builds on the success of the Agency's past efforts and is well aligned with its current priority to engage Canada's increasingly diverse urban population. Since its inception 100 years ago, Parks Canada has played, and continues to play, a vital role in preserving and presenting heritage areas representative of Canada's vast natural landscapes and rich history.

The Rouge National Urban Park is a unique concept in Canada. There are currently no comparable places, and this park will require an innovative conservation and management approach to respond to the park's unique urban context. Parks Canada will work with provincial, regional, municipal, Aboriginal and community partners to develop a common purpose and the broad elements for the implementation of Canada's first national urban park.

2.12 Nature-based Recreation

Recreation Areas

Rouge Park, Altona Forest, and Petticoat Creek Conservation Area are the largest recreational greenspaces in Petticoat Creek watershed (Figure 4). Rouge Park is developing public use areas and trails in the Park, including areas along the western edges of Petticoat Creek watershed. Altona Forest and Petticoat Creek Conservation Area are owned and managed by TRCA, providing very different recreational experiences for the public. Altona Forest is conservation land in the Rouge-Duffins Wildlife Corridor where hiking and wildlife viewing are the primary activities. Petticoat Creek Conservation Area is an active conservation park located at the mouth of Petticoat Creek, with

water play features, picnic areas, and numerous trails, including the Waterfront Trail, which runs along the Lake Ontario shoreline.

Trails

Trails can provide a sustainable alternative to car travel and a convenient and affordable way to exercise and enjoy greenspace. Petticoat Creek watershed is close to major regional trail systems running from east to west, such as the Oak Ridges Trail to the north, and the Waterfront Trail in the south. Opportunities exist to create north-south connections for these trail systems through Rouge Park and the Transport Canada Greenspace lands, with the Seaton Trail, and in future trails as outlined in the Central Pickering Development Plan (2006) for the Seaton portion, which includes provisions for bike paths/lanes on arterial and collector roads.

The City of Pickering's *Trails and Bikeway Master Plan* (1996) also identified a north-south trail corridor along the Petticoat Creek valley system running through central and southern Pickering. East-west connections across Petticoat Creek watershed linking the neighbouring Rouge and Duffins watersheds are proposed in Durham's *Regional Cycling Plan Study* (2008), the City of Markham's Pathways and Trails Master Plan (2008), York Region's Pedestrian and Cycling Master Plan (2008) and in the Seaton Natural Heritage System Management Plan and Master Trails Plan (2008) for the Seaton portion. Key connections are the Rouge-Duffins Wildlife Corridor, as well as rail and hydro corridors.

2.13 Cultural Heritage

Understanding our cultural heritage helps to define our sense of place and provides insights into today's landscapes and environmental conditions. For the purposes of this plan, cultural heritage includes not only archaeological resources, built heritage resources and cultural heritage landscapes, but also the stories associated with these resources, along with current cultural pursuits such as art, performing arts, literature, and gardening, which are means of expressing our relationships with our environment. Together these comprise our shared cultural heritage.

Petticoat Creek watershed is home to historic hamlets like Cherrywood, which were established during early European settlement, and rural vistas which retain some of the character of this part of Ontario prior to urban development. The name "Petticoat" itself is a clue to the human heritage of the area. The City of Pickering notes that it is a variation on the term "Petite Côte", which was used by French settlers in the 1600s in reference to the creek mouth where one bank is quite high, and the other side low and flat. The watercourse itself likely had many other previous names given its history of aboriginal settlement, known to have occurred over at least the past 4000 years by nations such as the Huron and the Iroquois.

There has been much work done in Petticoat Creek's two neighbouring watersheds which share similar human history and settlement patterns, focussed mainly on heritage building conservation. Amendments to the Ontario Heritage Act (2005) give the Province and municipalities new powers to stop demolition of heritage sites. They also increase the ability of the Province to identify and designate sites of provincial heritage significance and to set clear standards and guidelines for preservation. The Planning Act and Provincial Policy Statement (2005) enable municipalities to adopt policies and procedures to protect cultural heritage such as demolition control by-laws and requirements for heritage impact assessments and conservation plans. The Ontario Ministry of Culture has published an on-line guide, Heritage Resources in the Land Use Planning Process and maintains a public database of heritage properties across the province, the Ontario Heritage Properties Database which is in the process of being updated.

Locally, the City of Toronto's Heritage Property Search is an on-line searchable database and interactive map of heritage properties. The City of Pickering also has an inventory of properties available online, the Municipal Heritage Register. The City of Markham also has an on-line searchable database of heritage properties, the Markham Register of Properties of Cultural Heritage Value or Interest. TRCA and consultants continue to undertake

archaeological surveys, update heritage inventories and assess properties for archaeological resources prior to making any site alterations.

Previous plans and studies relevant to this small watershed which contain more information on the cultural heritage resources of the area include Section 4.2 of the Central Pickering Development Plan *(2006)*, the City of Pickering Official Plan, Edition 6 *(2010),* and various cultural heritage plans and inventories developed by Rouge Park.

3.0 Management Strategies and Actions

Although Petticoat Creek watershed has not experienced the wide-spread urbanization which has occurred in other GTA watersheds, the density and manner of development have had significant impacts, such as changes in hydrological patterns, and the reduction and fragmentation of natural systems. With a projected population growth of 4.5 million people in the GTA over the next 20 years (Hemson, 2005), this small watershed will continue to experience increased impacts from surrounding growth, such as transportation and infrastructure corridors, urban intensification and infill development. In addition, our changing climate will impact all watersheds in the GTA as weather patterns affect stream flows, existing flora and fauna habitat, the types of vegetation which will be suitable for ecological restoration efforts, and demands for water from agriculture and other large scale users. While much of the watershed's natural and agricultural resources are protected by the provincial Greenbelt and in the Natural Heritage System of the Central Pickering Development Plan (2006), there is still a need to improve the sustainability of the urbanized areas, and to protect and restore the remaining natural systems. Petticoat Creek watershed is in overall "fair" condition, with good potential to respond to regeneration efforts.

New resources are required for regeneration efforts to ensure that the health and function of Petticoat Creek watershed is maintained and enhanced in the future. The watershed's protection under provincial initiatives such as the Central Pickering Development Plan and the Greenbelt means that there will not be significant planning triggers as with other watersheds, only compliance monitoring through regional reporting. The watershed is well-positioned to respond favourably to even modest investment in regeneration at this time:

- There is a high level of protection for the northern reaches of the watershed through the Central Pickering Development Plan and the Greenbelt.
- It is favourably located between the Rouge River and Duffins Creek watersheds which both have high biodiversity and large amounts of protected natural land.
- It is a system heavily reliant on surface water, and would therefore be responsive to improved stormwater management in southern portions of the watershed.
- The watershed has overall "fair" condition. Land and water stewardship activities could maintain, protect and enhance conditions with significant results over a short term.
- Implementation action can be adjusted to work with resources coming from a variety of sources to meet the needs of the watershed while fulfilling the objectives of the funder.

The various partners should continue to build on the momentum gained through the past decade's planning, protection and restoration efforts and expand on these initial accomplishments for longer-term success. This plan draws on the understanding gained through the development of comprehensive plans in neighbouring watersheds and knowledge gained through recent planning and infrastructure studies which included Petticoat Creek watershed, to recommend management strategies and actions to guide land acquisition, new infrastructure, infrastructure retrofits, urban development and re-development, and ecological restoration.

3.1 Strategic Recommendations

Key recommendations will benefit many aspects of the watershed simultaneously, such as water quality, and terrestrial and aquatic systems, and are integral to the overall health of the watershed. These recommendations should be integrated into future decisions by all partners.

- Encourage the Province to support the implementation of actions which will achieve provincial planning objectives such as the Greenbelt Plan (2005) and the Central Pickering Development Plan (CPDP) (2006).
- Implement rural best management practices in partnership with the agricultural community.
- Bring lands with high conservation value into public ownership (i.e. along the Lake Iroquois shoreline) through the development review process and as outlined in the TRCA *Greenlands Acquisition Project* 2011-2015.
- Ensure that new development, redevelopment, and retrofits of existing development incorporate best management practices in water management and the protection and enhancement of the natural heritage system.
- Maintain and improve natural (green) infrastructure, such as Pickering urban forest initiatives.
- Implement stormwater management retrofit initiatives and community stewardship projects such as lot-level stormwater management and backyard naturalization. In addition to lot-level measures, ensure that new and retrofit development, including infrastructure, investigates opportunities to mitigate flood risk within the watershed.
- Seek out opportunities to implement the CPDP, and the TRCA terrestrial natural heritage systems across the other areas of watershed.
- Work with municipal partners and non-government organizations to engage and educate the community on sustainable actions and behaviours.
- Protect cultural heritage resources and integrate nature-based recreation opportunities with larger regional systems.
- Integrate all existing and new monitoring and information into the TRCA Envirodatabase, share information with TRCA watershed planning report card initiative (in progress, 2012).

3.2 Management Actions

The following management actions build on knowledge and understanding gained in the development of the Duffins Creek, Rouge River and Don River watershed plans, as well as the Frenchman's Bay Stormwater Management Master Plan. The recommendations provide general direction and may be adapted and refined as new information, opportunities and resources are made available.

3.2.1 Water

Water balance and natural drainage patterns are crucial to the health and functioning of the entire watershed. A healthy, sustainable watershed requires an adequate annual and seasonal water balance and flow pattern, and a certain level of quality of groundwater and surface water, all of which require maintenance and enhancement in the face of ongoing impacts from human activities. Improvements to the water balance and flow patterns will benefit water quality, stream bank erosion, flooding, and habitat conditions.

Groundwater

- Increase understanding:
  - Track progress of the York-Peel-Durham-Toronto Conservation Authorities Moraine Coalition (CAMC) Groundwater Study, the Credit Valley Conservation-Toronto and Region Conservation-Central Lake Ontario Conservation Authority (CTC) Source Protection Region studies, York Region Southeast Collector Environmental Assessment.
  - Encourage academic institutions, including the University of Toronto Scarborough Campus, and professionals with the Ontario Geographic Survey and the Geologic Survey of Canada, to continue their studies of the geology and hydrogeology of Petticoat Creek watershed, as well as neighbouring Rouge River and Duffins Creek watersheds.
- Implement recommendations and management actions identified by ongoing and new groundwater studies and apply the knowledge gained from current research in the implementation of restoration initiatives to most effectively benefit groundwater.
- Continue to monitor and model the groundwater flow system and groundwater quality in the watershed through multiple partners, including but not limited to: the Regional Watershed Monitoring Network, York-Peel-Durham-Toronto CAMC Groundwater Study, and CTC Source Protection Region.

Surface Water Quality

- Integrate water quality data from the station in Petticoat Creek Conservation Area for the Regional Watershed Monitoring Network, and from the York-Durham Southeast Collector Study Environmental Assessment into the TRCA Envirodatabase.
- Identify nutrient and pathogen loading in nearshore areas of Lake Ontario and develop targets and options for lake-wide reductions/improvements as part of the Cladophora study led by the Ontario Ministry of Environment, the Lake Ontario Collaborative drinking water study, and the updated Great Lakes Water Quality Agreement.
- Work with the City of Pickering to implement current requirements for source, conveyance and end-of-pipe stormwater management (retrofit and new) and maintain and improve existing stormwater management facilities, or introduce new ones where opportunities arise.
- Secure funding and implement stewardship programs such as TRCA's Rural Clean Water Program in consultation with the agricultural community in the rural areas of York and Durham Regions.
- Continue to develop partnerships and implement stewardship activities such as the Healthy Yards and Yellow Fish Road programs, targeting residents in urbanized areas of Pickering.
- Restore wetlands, woodlands and riparian corridors identified in the Central Pickering Development Plan *(*2006) natural heritage system, Rouge Park management plans, and TRCA's Terrestrial Natural Heritage System Strategy as directed in TRCA's Restoration Opportunities Plan (draft, 2008) as a means of improving water quality.

Surface Water Quantity

- Invest in improved flood forecasting and warning tools, such as real-time gauging. Promote public awareness of the risks due to flooding in the watershed.
- Continue current floodplain management activities to reduce risks from flooding. Identify mechanisms to provide flood remediation to known areas of flooding and continue implementation of state-of-the-art stormwater management practices.
- Work with the City of Pickering to implement source, conveyance and end-of-pipe stormwater management (retrofit and new) and maintain existing stormwater management facilities.
- Recommend comprehensive stormwater management facilities for new transportation corridors identified in the Central Pickering Development Plan (2006), and where possible on existing roadways.
- Apply the knowledge gained for the entire jurisdiction from modeling tools developed as part of the TRCA Terrestrial Natural Heritage System Strategy to evaluate the effectiveness of beneficial management practices and ecological restoration activities.
- Monitor stream flows and undertake periodic baseflow surveys as part of the work done by the Regional Watershed Monitoring Network. Petticoat Creek watershed has a unique recharge function which is not affected by the Oak Ridges Moraine, TRCA should explore relationships between runoff patterns and the health of aquatic communities using data from the Network.

3.2.2 Nature

Nature includes both the aquatic and terrestrial systems. The aquatic system is comprised of the physical and chemical conditions and the communities of fish, invertebrates and other animals and plants that live in Petticoat Creek watershed. The health of the aquatic system depends on the status of other elements of the watershed, especially the water cycle and natural cover. The terrestrial system includes forests, meadows, wetlands, beaches and urban vegetation, and the plants and animals that inhabit them. These natural systems provide many benefits which are critical to the health of the watershed: they maintain hydrology and stream stability, protect aquatic ecosystems, provide wildlife habitat, moderate climate, absorb air pollution, improve aesthetics, provide recreational opportunities, and generally improve the quality of life for watershed residents.

Aquatic System

- Review monitoring data collected through the Environmental Assessment process, such as the York-Durham Southeast Collector and Altona Road widening studies, to refine management actions, modify mitigation work and track responses.
- Establish a minimum vegetated riparian zone of 30 metres wide on all watercourses wherever possible, in accordance with the applicable provincial or municipal planning policy direction.
- Identify key in-stream barriers which fragment habitat and mitigate or remove them, where possible.
- Restore vegetation to roadside ditches and improve sediment management during road construction and maintenance.
- Monitor in-stream conditions by installing temperature loggers at key locations and taking spot flow measurements during baseflow.

- Continue to monitor aquatic species, including invasive species, as part of the Regional Watershed Monitoring Network.
- Monitor ecological restoration projects completed as part of Environmental Assessment mitigation requirements to ensure that the compensation work, such as a restoration planting, is functioning as proposed and that infrastructure projects contribute to a continuum of improvement.
- Coordinate TRCA staff and volunteers to track migratory fish movements to determine potential of local, self-sustaining populations, and improved population health over time in relation to restoration activities.
- Utilize the Petticoat Restoration Opportunities Plan (draft) to identify wetland, forest and riparian opportunities and implement the high priority projects.

Terrestrial System

Experience in other watersheds has demonstrated that achieving biodiversity objectives is best undertaken using a system design approach. The Province and TRCA together defined a comprehensive natural heritage system (NHS) for Petticoat Creek watershed, using a combination of the Province's Natural Heritage System and TRCA's Terrestrial Natural Heritage System Strategy. The approaches and opportunities for implementing this NHS vary throughout the watershed, depending on field conditions and policies.

- Implement TRCA's *Restoration Opportunities Plan* (draft) to meet the objectives of a target NHS, identifying and prioritizing specific restoration (forest, wetland) projects, including the Lake Ontario shoreline in Petticoat Creek Conservation Area.
- Work with private landowners to gain access to lands under Conservation Easement to implement the *Restoration Opportunities Plan* (draft).
- Explore opportunities to expand areas under Conservation Easement.
- Work with the City of Pickering to implement urban forest recommendations from the City of Pickering Urban Forest Study (2012), and from an urban forestry management plan, upon its completion.
- Work with the City of Pickering, local businesses, community groups and residents to explore opportunities for naturalizing landscaped areas on public lands such as parks, private lands including backyards, and commercial/ industrial property.
- Undertake a natural heritage survey/inventory in the developed portion of watershed and implement long-term monitoring throughout the watershed through the Regional Watershed Monitoring Network.
- Expand efforts to manage invasive species.
- Monitor restoration projects completed as part of Environmental Assessment mitigation requirements to ensure that compensation work, such as restoration plantings, are functioning as proposed and that infrastructure projects contribute to a continuum of improvement.
- Protect natural heritage systems (CPDP, TRCA TNHS, Rouge Park Nature Reserve zones), including existing and potential natural cover, to maintain ecological function and optimize ecosystem services at a regional and a watershed scale.

3.2.3 Community

A healthy watershed is the foundation of a healthy community. With approximately 25,000 residents (2006 Census), most living within five kilometers of Lake Ontario, Petticoat Creek has a relatively small population, but a growing one. The Petticoat Creek community is quite diverse and includes new Canadians, multi-generation family farms, urban condominiums and rural estate homes. The sustainability of the watershed is dependent on how we plan future development and redevelopment. Equally important is how watershed residents' actions and behaviours impact the health of the water, air and land in their community.

Land and Resource Use

- Continue to develop and implement education and outreach activities initiated through local, partnership-driven stewardship initiatives such as Altona Forest Stewardship Committee and Environmental Stewardship Pickering, including greenspace stewardship, residential property naturalization, pollution prevention and reducing urban runoff.
- Engage the rural and agricultural community in private land stewardship programs such as the Rural Clean Water Program and Environmental Farm Plan to identify restoration opportunities and implement beneficial management practices.
- Encourage the Province of Ontario, the Region of Durham and the City of Pickering to support and implement the policies outlined in the Greenbelt Plan (2005) and Central Pickering Development Plan (2006).
- Assist municipalities in their efforts to incorporate watershed plan strategies into their Official Plan policies.
- Support sustainable development measures such as those outlined in the *Low Impact Development Stormwater Management Planning and Design Guide* (2010).
- Strengthen partnerships with local champions such as the Altona Forest Stewardship Committee, and engage new partners in stewardship initiatives. These may include schools, faith communities, seniors, new Canadians, businesses, and large lot landowners.
- Work with partners like Rouge Park to communicate the importance of watershed management to a broader audience through websites and social media, newsletters, local newspapers, radio, and television.
- Develop and install watercourse identification signs at all road crossings to further local residents' recognition of the watershed in which they live.

Nature-based Recreation

- Develop hiking and cycling trails utilizing the Rouge-Duffins Wildlife Corridor, Central Pickering Development Plan (2006) natural heritage system and transportation corridors, City of Pickering Open Space system, Durham's *Regional Cycling Plan* (2008), York Region and Markham trails plans, and evolving Rouge Park public use plans.
- Foster inter-municipal trail corridors between the Oak Ridges Moraine, Rouge Park, Seaton Trail, Trans Canada Trail, Waterfront Trail, emerging trails systems on the Transport Canada Greenspace lands, York Region and Markham trails, and proposed trail systems in lower reaches of the watershed.
- Continue greenspace restoration and interpretive public events with Rouge Park, City of Pickering, City of Toronto, City of Markham, corporate partners, Altona Forest Stewardship Committee, and other partners where opportunities arise.

- Explore wildlife viewing and cultural interpretive opportunities in the watershed.
- Encourage fishing opportunities at Petticoat Creek Conservation Area.
- Work with governments at all levels to promote and enhance public use of Rouge Park, Petticoat Creek Conservation Area and Altona Forest, including infrastructure investments.

Cultural Heritage

- Work with Rouge Park and local municipalities, Municipal Heritage Committees, and other groups such as local historical societies to maintain a current inventory of cultural heritage resources in the watershed.
- Support and implement the policies outlined in the Cultural Heritage section of the Central Pickering Development Plan (2006) and the City of Pickering Official Plan, Edition 6 (2010) and the City of Pickering *Official Plan* review.
- Support and implement cultural heritage management strategies and recommended actions in Rouge Park Management Plans.

4.0 Implementation

Various stakeholders, including the provincial government, local and regional municipalities, TRCA, non-government organizations, the private sector, and citizens, all have a role to play in the implementation of this plan through specific management actions, many of these partners already have policies and programs in place to assist their role. This plan is intended to guide municipalities, provincial and federal governments, TRCA, and Rouge Park as they update their policies and programs for environmental protection, conservation, and restoration. The action plan also provides direction to local non-government organizations and private landowners with regard to best management practices and opportunities for environmental stewardship.

Implementation of these strategies will be most effective if the various partners coordinate their efforts, make creative use of existing tools, and prepare specific proposals to take advantage of new funding opportunities as they arise. Achieving the strategies outlined in this plan is challenging since resources are often directed to larger, higher profile watersheds and landscapes. Significant greenspaces such as Rouge Park and Altona Forest are important assets for increasing awareness of the Petticoat Creek watershed. Increased awareness must be complemented with rigorous and coordinated enforcement, which also requires additional resources, since current enforcement capacity is severely limited.

When setting priorities for implementation of this action plan, consideration needs to be given to the likelihood of a specific action achieving multiple benefits to maximize impact. For example, the restoration of riparian vegetation enhances the aesthetics of the watershed, improves water quality, and provides wildlife corridors. An important first step is to ensure that maximum benefits are being achieved from the use of current resources and that activities by the various partners are strategic and coordinated.

A strategic plan of action is often an important pre-cursor to accessing sustainable, capacity-building resources. Implementation of this plan will require new investment. Current efforts are inadequate to protect Petticoat Creek watershed and a lack of action will result in a slow decline in watershed health over time.

4.1 Municipal Policies and Programs

TRCA works closely with our municipal partners to implement watershed plan recommendations and actions. Work related to land and resource management, and nature-based recreation planning done by municipalities in any given watershed is taken into consideration when TRCA develops watershed plans. Selected municipal policies and plans have informed the development of this watershed action plan, including:

- Regional Municipality of Durham Recommended Durham Regional Trails Network (2006)
- Regional Municipality of Durham *Regional Tree Bylaw* (2008)
- City of Markham Pathways and Trails Master Plan (2008)
- City of Pickering *Stormwater Retrofit Study* (2003)
- City of Pickering *Growth Management Study: Phase 1 Environmental Systems Analysis Report and Phase 1 Summary* (2003)
- City of Pickering *Summary of Major Residential Applications and Building Permits* (2009)
- City of Pickering *Urban Forest Study (2012)*

Future updates to the above plans should now take the Petticoat Creek Watershed Action Plan into consideration. York, Durham, Pickering, Toronto and Markham are well-positioned to update and amend their policies and programs in relation to Petticoat Creek watershed with direction from this plan, through:

- Incorporation of strategies and recommendations in this watershed action plan to municipal and Regional official plans through plan reviews, and official plan amendments.
- Related planning exercises done in partnership with Rouge Park, especially for the new Rouge Park East Lands.
- Local stewardship group activities, such as those of Environmental Stewardship Pickering.

4.2 Provincial Initiatives

Provincial initiatives such as the Greenbelt Plan (2005), *Growth Plan for the Greater Golden Horseshoe* (2006), Central Pickering Development Plan (2006), and the *Provincial Policy Statement* (2005), direct land use planning and the protection of natural heritage. For Petticoat Creek watershed, the City of Pickering and Region of Durham must conform to these plans when developing and amending their respective Official Plans. The *Provincial Policy Statement* provides direction on various aspects of land use planning which relate to Petticoat Creek watershed, including the protection of natural heritage, agriculture, cultural heritage and water resources. The northern part of Petticoat watershed is designated "Protected Countryside" in the Greenbelt Plan, which is intended to protect agricultural and natural systems. Population growth and urban intensification targets in the *Growth Plan* apply to the established urban neighbourhoods in Petticoat Creek watershed, where downtown Pickering is designated as an "Urban Growth Centre". The Central Pickering Development Plan (2006) also provides specific policies for the management of land and natural heritage resources in the northern part of Petticoat Creek watershed. Its policy related to natural heritage protection is explained in more detail in section 2.8 of this plan.

While the *Clean Water Act* (2006) does not directly impact Petticoat Creek watershed, it is relevant in that it sets direction for the preparation of drinking water Source Protection Plans within each source water protection planning region in Ontario. The Credit Valley Conservation, Toronto and Region Conservation and

Central Lake Ontario Conservation Authority (CTC) Source Protection Region is one of 19 source protection regions in Ontario as described in O. Reg. 284/07 under the Clean Water Act . While there are no municipal wells in Petticoat Creek watershed, this Plan has benefited from shared information about broader watershed functions. For additional information, see the CTC Source Protection Region website: http://www.ctcswp.ca/ .

4.3 Stewardship, Outreach Education and Restoration

Many of the strategies outlined in this plan can be achieved through the improved stewardship and restoration of public and private lands. Restoration of public or private lands includes in-the-ground works that address the following objectives:

- Water quality and quantity management
- Aquatic and terrestrial habitat enhancement
- Trail development and infrastructure support for nature-based recreation

Restoration planning is underway for Petticoat Creek watershed through initiatives such as the Central Pickering Development Plan (2006) natural heritage system, TRCA's Terrestrial Natural Heritage System Strategy and *Restoration Opportunities Plan* (draft), and the City of Pickering's urban forest strategy. The implementation of these natural heritage initiatives will involve both public and private lands. Early efforts by TRCA, Rouge Park and the City of Pickering will focus on lands currently in public ownership so that successes on these lands will encourage enhanced efforts on private lands. Coordination amongst the various partners is essential for the successful implementation of restoration initiatives.

A recurring theme in this watershed action plan is the need for initiatives to increase awareness and provide more information about ways for individuals, businesses, and governments to contribute to restoring a healthy, sustainable watershed. The long-term value of education and awareness cannot be underestimated. Areas like Altona Forest, Petticoat Creek Conservation Area and Rouge Park provide an invaluable opportunity for promoting watershed-wide interest and creating a community that supports restoration initiatives. This plan also highlights the urgency of a shift to sustainable behaviour, not just to reduce our present impact on the watershed, but to create a receptive market for innovative community designs which will be the basis for redeveloping more sustainable communities as population density continues to increase. How our neighbourhoods and lots are redeveloped and renovated will determine the watershed's long term health.

TRCA's Stewardship and Outreach Education team implements various programs which support the shift to sustainable behaviours, including:

- In-class school programming, such as Watershed on Wheels, Yellow Fish Road and Aquatic Plants.
- Community stewardship involving family nature events, hands-on volunteer regeneration, habitat creation, maintenance and monitoring (e.g. Environmental Stewardship Pickering, Altona Forest Stewardship Committee).
- Private land stewardship, such as the Rural Clean Water Program which facilitates the adoption of beneficial management practices to protect water quality, and Healthy Yards programs for small lot owners to learn about natural lawn and garden care and reducing urban runoff.

- Multicultural environmental stewardship programs, including adult English-as-a-Second-Language (ESL) presentations about climate change and the Great Lakes, and subsidized visits for ESL classes to Petticoat Creek Conservation Area to introduce newcomers to local greenspaces and encourage return visits with their families.

4.4 Rouge Park

Detailed and comprehensive restoration plans are produced for all lands in Rouge Park, with restoration work accomplished through partnerships with groups such as TRCA, the City of Toronto, Region of York, Ontario Streams, Friends of the Rouge Watershed, 10,000 Trees for the Rouge Valley, and many others. Rouge Park has dedicated funding to support restoration work, and supplements this with contributions from partner agencies for specific projects. Given the success of ecological restoration implementation in the park to date, these partnerships should continue as important mechanisms for implementation.

Rouge Park also has its own stewardship program, with the goal of park users becoming leading stewards of the land. The program works to build and maintain partnerships with agencies, groups and volunteers to carry out and create a stewardship program that both educates and engages the local community. The stewardship program focuses on monitoring, educational programs and activities, and outreach, allowing a variety of participants, from families with small children to conservation professionals, to become involved in the Park. The program has grown every year with new and exciting events, from over 300 volunteers in 2009, to almost 1500 in 2011.

Monitoring programs include: Winter Bird Count, Breeding Bird Survey, Bird Box Monitoring, Frog Watch, Adopt a Salamander Grid Program, Deer Browse Project, and Bee Monitoring.

Educational programs include: Tree Planting, Native Plant Demonstration Gardens, Invasive Species Removal, Litter Cleanups, Birdhouse Building and Installation, Amphibian and Reptile Awareness Day, Rouge Park Hoot and Howl, and Discovery Workshop: Insects.

Outreach programs include: Interpretive and specialized hikes for schools, naturalist groups and others, the Rouge Park booth at local community events, presentations for summer camps, and guided hikes with guest experts to share ideas and information on conservation.

4.5 Operations and Maintenance

Property managers responsible for operations and maintenance of public property such as roads, parks and infrastructure, as well as for private property, should consider ways to incorporate this plan's directions into their ongoing practices and programs. For example, naturalization schemes can be adopted as part of landscaping practices, thereby contributing to improved lot-level water management and the achievement of Terrestrial Natural Heritage System Strategy goals.

Life cycle planning should be undertaken for all infrastructure – stormwater, wastewater, drinking water systems, roads and bridges, trail systems, and green infrastructure (e.g., terrestrial natural heritage, parks and greenspace). Long term planning and capital budgeting for operations, maintenance, repair and replacement is essential to meet watershed management objectives.

Significant opportunities to implement restoration activities exist through mitigation measures required under the Environmental Assessment process and planning approval process for both transportation and infrastructure initiatives. These opportunities will be evaluated on an individual basis and priority areas targeted for restoration.

4.6 Monitoring and Further Study

Ongoing monitoring will be essential to identify whether the management strategies in this watershed plan are effective, and to adapt them if necessary. For example:

- Are the management measures performing as designed?
- How are environmental conditions responding?
- Do we need to change our strategies, and if so, how?

The Regional Watershed Monitoring Network, led by TRCA in partnership with its member municipalities and other monitoring groups, provided a substantial information base for this watershed plan. The RWMN was developed based on regional and watershed scales, and to the extent possible at the subwatershed scale. On-going monitoring of the health of Petticoat Creek watershed will be undertaken through the Network, which allows for comparison between adjacent and similar watersheds.

During the development of this plan, the need for additional information, at the watershed and subwatershed scales, in order to fully understand systems in Petticoat Creek watershed was identified. New and existing information should be integrated into a consolidated, dynamic database or report. Additional detail about recommendations for modifications to regional monitoring, and other suggestions for further monitoring and study can be found in Section 3.2 of this plan. An adaptive management approach is recommended, whereby feedback from monitoring activities is used to make adjustments to implementing the recommendations in this plan.

In addition, The Living City Report Card 2011 compares the Petticoat Creek watershed to the other eight watersheds in TRCA's jurisdiction, with targets and measures for atmospheric carbon production, air quality, water quality, waste production and storage, land use, and biodiversity. It provides a comprehensive assessment of the state of various ecological systems and functions.

5.0 Conclusion

To ensure that the health of Petticoat Creek watershed is maintained and enhanced, an increase in effort and resources is required. Petticoat Creek has not received the attention that larger watersheds and landscapes such as the Rouge River, Duffins Creek and Oak Ridges Moraine have attracted. The watershed has benefited from the protection afforded to it by the Greenbelt, the Central Pickering Development Plan, and Rouge Park, but these designations do not necessarily lead to improvement over the short term. It is time for a pro-active approach to developing and retrofitting our communities, to restoring our aquatic and terrestrial landscapes, and to engaging and educating our residents and visitors.

This plan has outlined a series of management strategies and actions which provide a comprehensive approach for preventing a decline in ecological function of the watershed. Our primary challenge is to increase awareness of Petticoat Creek watershed and secure the resources required to put this plan into motion. Effective communication amongst the various partners is essential to ensure that future efforts are undertaken using a coordinated approach so that limited resources achieve the greatest benefits.

Petticoat Creek is an opportunity to work collectively to restore habitat and protect agricultural land in the *Greenbelt*, to work with the urban and rural communities to reduce their impact on water quality through agricultural beneficial management practices and lot-level stormwater management, to design new neighbourhoods and retrofit existing ones using sustainable technologies, to protect and enhance our urban forest, and to mitigate and adapt to a changing climate. With a combined effort, Petticoat Creek can serve as a model for the achievement of biodiversity objectives and as a watershed in transition towards urban sustainability.

6.0 Next Steps

New resources are needed for implementation, these may arise from a number of opportunities including:

- Environmental Assessment work required for infrastructure under the Central Pickering Development Plan.
- Rouge Park restoration work and new planning and projects from Parks Canada for the anticipated Rouge National Park.
- Restoration on TRCA lands such as Altona Forest, to contribute to developing the Target Terrestrial Natural Heritage System.
- Public acquisition of land, through the development approval process, in and adjacent to the Petticoat Creek valley between Highway 401 and Sheppard Avenue (the urbanized area of Pickering).

Figure 29: *Pickering Urban Area Potential Natural Linkage*

7.0 References

All web links current as of August 2012.

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