Harper Creek Management Plan

FINAL Report
February 2013

Prepared for the
City of Peterborough by:

OTONABEE
CONSERVATION

Report Outline

The Harper Creek Management Plan is the sixth in a series of Urban Watercourse Management Plans, prepared by the Otonabee Region Conservation Authority (ORCA) in partnership with the City of Peterborough. This plan is intended to assist Public Works staff with the maintenance of urban watercourses in the City of Peterborough, without compromising their form, function or natural features. To date, management plans have been completed for Bears, Riverview, Curtis, Thompson and Byersville Creeks.

This Plan is intended to simplify watercourse management for landowners and the City of Peterborough, and provide an easily transferable watercourse management strategy and maintenance schedule.

The Harper Creek watershed includes one of the only large, naturally vegetated and heavily treed areas in the City of Peterborough (Harper Creek Wetland and the associated Harper Park). This wetland is the source of numerous seeps and springs that discharge clean, cool groundwater to the Creek. In the context of its urban setting, the woodland, wetland and cold water stream habitat of the area make this watershed ecologically important to the City. The Harper Creek watershed is unique in that it is an urban cold water stream system that supports a variety of cold water species including Brook Trout (*Salvelinus fontinalis*).

The Harper Creek watershed is approximately 1.92 km^2 and encompasses approximately 0.19km^2 of the Harper Creek Wetland. Harper Creek is approximately 3.19 km long and discharges to Byersville Creek and ultimately to the Otonabee River. The main headwaters are located in Stenson Park in the west portion of the watershed between Brealey and Spillsbury Drives. Water flows east from this area through the Harper Creek Wetland, under Harper Road, and continues northeast along the west embankment of a CPR line, finally discharging into Byersville Creek, west of The Parkway. The northern branch of Harper Creek originates in a second headwaters area northeast of the Harper Creek Wetland. The north branch flows south to and east along the north side of Rye Street, south under the road at Webber Avenue, and continues south to Byersville Creek, west of the Parkway.

Detailed structures inventories including culverts and bridges, and of areas of concern such as stream banks subject to erosion are included in this Plan. The Plan also includes recommendations for annual, immediate, short-term and long-term maintenance activities, and site specific information on permits and/or approvals that may be required to complete these activities. To further assist City staff in their implementation of a creek management strategy for Harper Creek, restoration, recreation and land acquisition opportunities are also identified.

To ensure the natural features of Harper Creek are considered when maintenance and management activities are planned/undertaken, this Plan provides a reach-by-reach description of stream characteristics of Harper Creek. Information about the water quality, natural heritage and the thermal regime of the watercourse is summarized in this report, rendering it a one-window document for current information on the state of the watercourse.

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1.0 Introduction

The Harper Creek Management Plan was developed by the Otonabee Region Conservation Authority (ORCA) to assist City of Peterborough Public Works staff in the management of urban watercourses. It is the sixth Management Plan in a series, created to provide an effective management strategy for all watercourses within the City.

In response to severe flooding events in 2002 and 2004, a Flood Reduction Master Plan (FRMP) was developed for the City of Peterborough by UMA/AECOM in 2005. The FRMP recommended a number of priority actions including the completion of a detailed flood-reduction study for each watercourse in the City, including Harper Creek. The Byersville/Harper Creek Detailed Flood Reduction Study (BHCDFRS) was initiated in 2006 by XCG for the City of Peterborough and was completed in 2009. A series of recommendations were included in the BHCDFRS and preferred options were identified, but as of July 2012, no works have been undertaken. The recommendations in the Harper Creek Management Plan are intended to assist municipal staff in the maintenance of urban drainage and watercourse management, but do not specifically reference works identified in the BHCDFRS.

To ensure that maintenance activities do not have a negative impact on the environmental integrity and overall health of the watercourse, it is important to have an understanding of the form, function and characteristics of the entire watershed. This document is intended to act as a one-window document for current information on the state of the watercourse, including an inventory of existing structures, areas of concern, areas requiring restoration and a natural heritage inventory. This information was used to develop recommendations for maintenance activity scheduling.

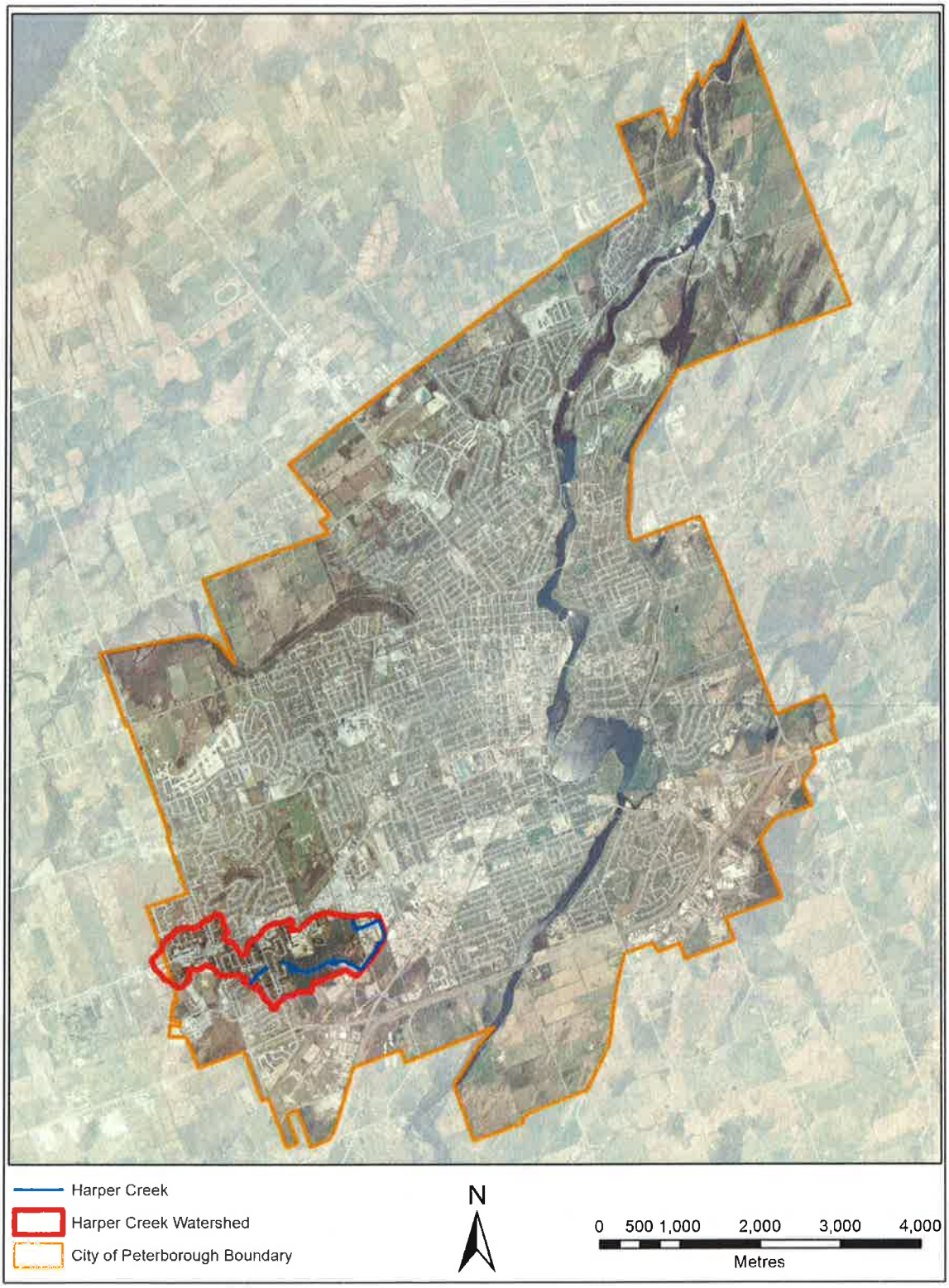
1.1 Project Goals and Deliverables

- To simplify watercourse management for landowners and the City of Peterborough by streamlining the approvals process.
- To create an inventory of structures that includes detailed information about location, age, maintenance requirements, stream characteristics, permit requirements and timing windows in the form of an Access database.
- To identify areas of concern and provide potential management strategies.
- To provide recommendations on annual, immediate, short-term and long-term maintenance activities to inform City of Peterborough Public Works staff of maintenance schedules.
- To suggest areas for land acquisition and recreational opportunities that would help to enhance the long term health, maintenance and enjoyment of the creek system.
- To report on the health of the creek system by synthesizing existing water quality and natural heritage information as well as including observations from field assessments.

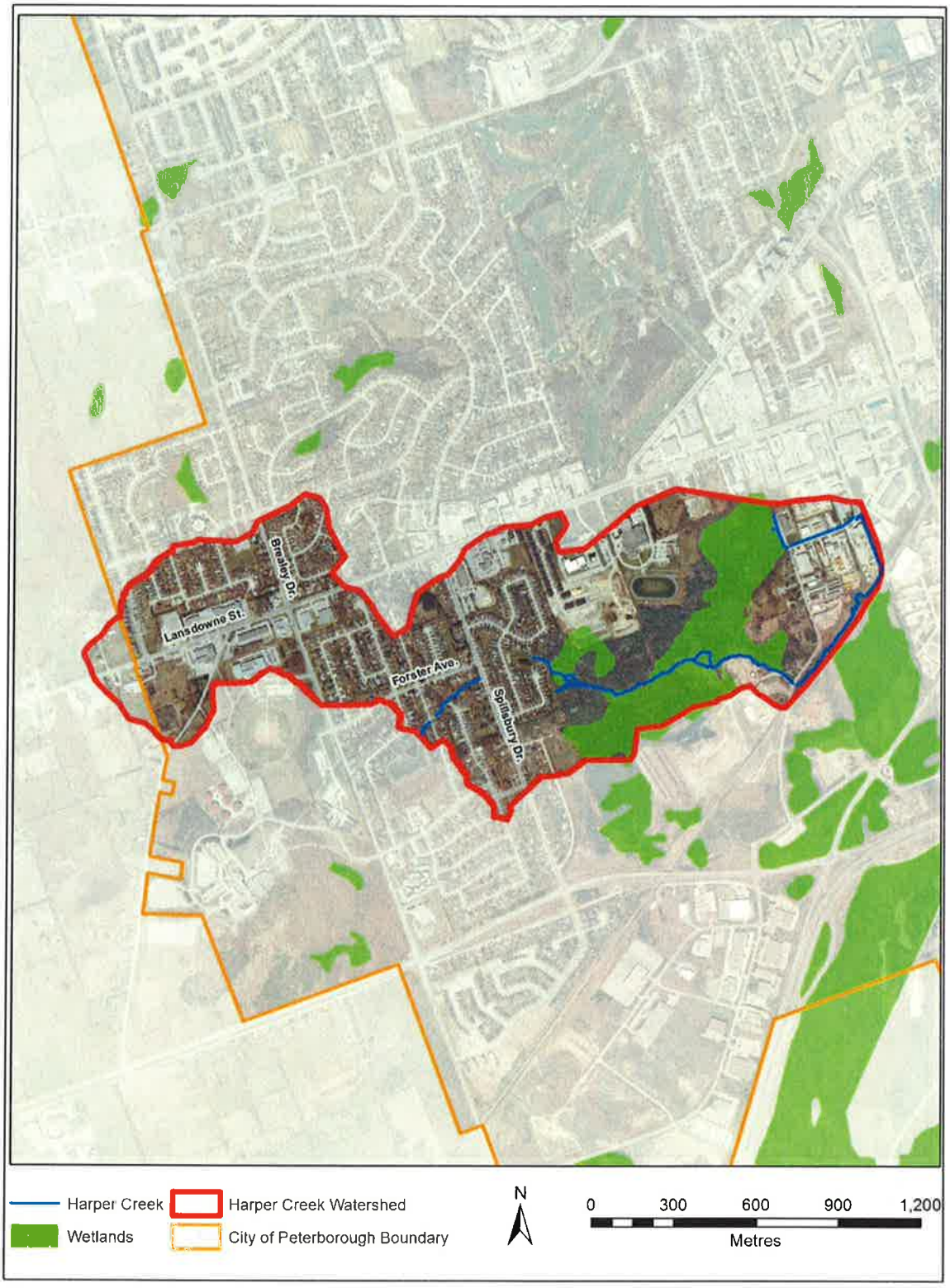
1.2 Study Area

Harper Creek is located in the City of Peterborough in the Harper Creek Watershed and encompasses a drainage area of approximately 2.65 km^2 (Maps 1 and 2). The main channel of the creek drains an area of approximately 2.35 km^2 and a tributary located north of Rye Street, referred to as the North Tributary, drains an additional area of approximately 0.30 km^2. Harper Creek is approximately 2.66 km long and discharges to Byersville Creek and ultimately, the Otonabee River. The North tributary drains to Byersville Creek at the same confluence point as Harper Creek.

This urban watershed supports a variety of residential, commercial and industrial land uses and includes one of the only large, naturally vegetated and heavily treed areas in the City of Peterborough, Harper Creek Wetland. The City owned Harper Park is encompassed by this wetland and includes documented cold water fisheries resources and a significant area of contiguous vegetative cover. The wetland is the source of numerous seeps and springs that discharge clean, cool groundwater to the watercourse. Harper Creek is unique in that it is an urban cold water stream system that supports a variety of warm, cool and most notably, cold water fish species including Brook Trout (*Salvelinus fontinalis*).



Map 1: Study Area Location



Map 2: Harper Creek Watershed

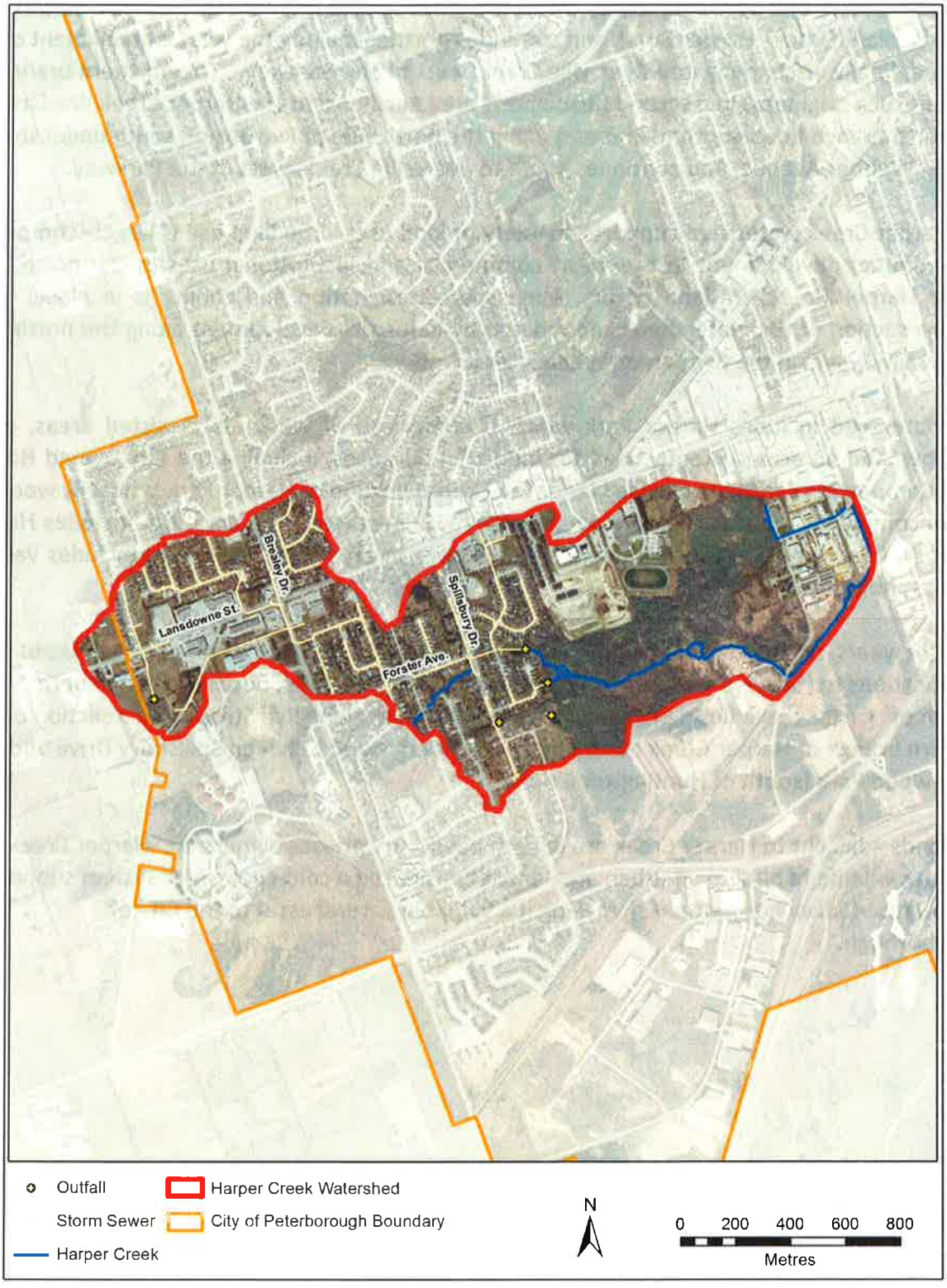
The main headwaters are located in Stenson Park in the west portion of the watershed between Brealey and Spillsbury Drives. Water flows east from this area through the Harper Creek Wetland, under Harper Road, and continues northeast along the west embankment of a CPR line, finally discharging into Byersville Creek, west of The Parkway. The northern branch of Harper Creek originates in a second headwaters area northeast of the Harper Creek Wetland. The north branch flows south to and east along the north side of Rye Street, south under the road at Webber Avenue, and continues south to Byersville Creek, west of the Parkway.

The Harper Creek watershed supports a variety of land uses. The land use is largely comprised of residential development in the west, commercial and institutional uses in the north, and where Harper Creek Wetland occurs, open space designation and zoning is in place. The eastern section of the watershed is dominated by industrial development along the north side of the railway line in the Rye Street/Webber area.

The watershed includes Harper Park which is comprised of wetlands, forested areas, open meadow, and an area currently used for industrial purposes, including the City owned Harper Road Composting Facility and leased land. The central portion of Harper Park is heavily wooded, and encompasses an area of approximately fifty (50) hectares. The area also includes Harper Creek Wetland which is approximately 17.8 hectares in area (GLL, 1996) and includes various seeps, springs and tributaries.

Over the years, residential and commercial/industrial land uses have resulted in significant modifications to Harper Creek and its flow patterns (Map 3). Most notably, the northern branch of Harper Creek flows primarily in a roadside ditch along Rye Street, and a section of the western branch of Harper Creek has been piped underground between Spillsbury Drive and Bridlewood Park (south of Huntington Close).

The lands adjacent to Harper Creek are in both public and private ownership. Harper Creek provides wildlife habitat in an urban area and is considered a cold-cool water system supporting Brook Trout (*Salvelinus fontinalis*), making it a valuable natural asset to the City of Peterborough.



Map 3: Surface and Underground Drainage Patterns of Harper Creek

1.1 Methodology

A four-step methodology was used to produce this report: desktop review, field observations, data compilation and analysis, and reporting. The tasks associated with the four steps are as follows:

1.1.1 Step One - Desktop Review of Available Background Information Including:

- Aerial photos and Ontario Base Map (OBM) topographic maps
- ORCA Engineered Floodlines
- Areas regulated under Ontario Regulation 167/06
- Peterborough Natural Areas Strategy
- Other related data from ORCA
- Review of relevant planning documents, including the Provincial Policy Statement and the City of Peterborough Official Plan.

1.1.2 Step Two – Field Observations

During 2010, Otonabee Region Conservation Authority staff conducted detailed field investigations of Harper Creek and adjacent lands to complete an inventory of all structures and Areas of Concern. ORCA staff subsequently confirmed the Areas of Concern through site visits conducted 2012. A natural environment inventory of riparian vegetation and adjacent upland species was also completed. The information collected includes:

Identification and inventory all structures:

- Culvert size, age and condition
- Bridges and outlet pipes
- Photo documentation

Identification, inventory and photo documentation of all areas of concern including:

- Flood prone lands
- Erosion
- Unstable soils

Inventory of natural environment and natural heritage features including:

- Vegetation identification
- Stream, riparian zone and fisheries habitat assessments using a rapid assessment technique based on The Stream Assessment Protocol for Southern Ontario developed by the Ontario Ministry of Natural Resources
- Resident wildlife and wildlife habitat identification
- Water quality using chemistry and benthic macroinvertebrates
- Photo documentation

1.1.3 Step Three – Data Compilation and Analysis

Based on the results of the background research and fieldwork, Harper Creek was divided into nine (9) reaches to facilitate identification, and a detailed summary of the existing stream conditions in each reach was prepared. A table of recommendations for annual, immediate, short and long-term maintenance was developed both for structures and areas of concern. Opportunities for future land acquisition, and potential recreation opportunities were also identified. Additional information including planning and regulations issues, permits, species lists and contact information was also compiled.

1.1.4 Step Four - Reporting

The main deliverable of this project is a final report, which includes the mapping and information referred to above. Current site conditions, impacts from development and current management techniques have been documented. This information will be available for use by City staff to manage Harper Creek and other urban watercourses more effectively. Data is provided to the City of Peterborough Public Works Department.

2.0 Structure Inventory

An assessment of Harper Creek was undertaken during the summer of 2010 and resulted in the identification of areas of concern (ACs). All storm sewer outfalls, bridges and culverts were identified, photographed and located using a hand held global positioning system (GPS).

A database was used to facilitate the management of information related to all structures on Harper Creek. The information contained in Appendix 1 of this report was created using the database and provides specific information for each structure. For each structure, the following information is provided:

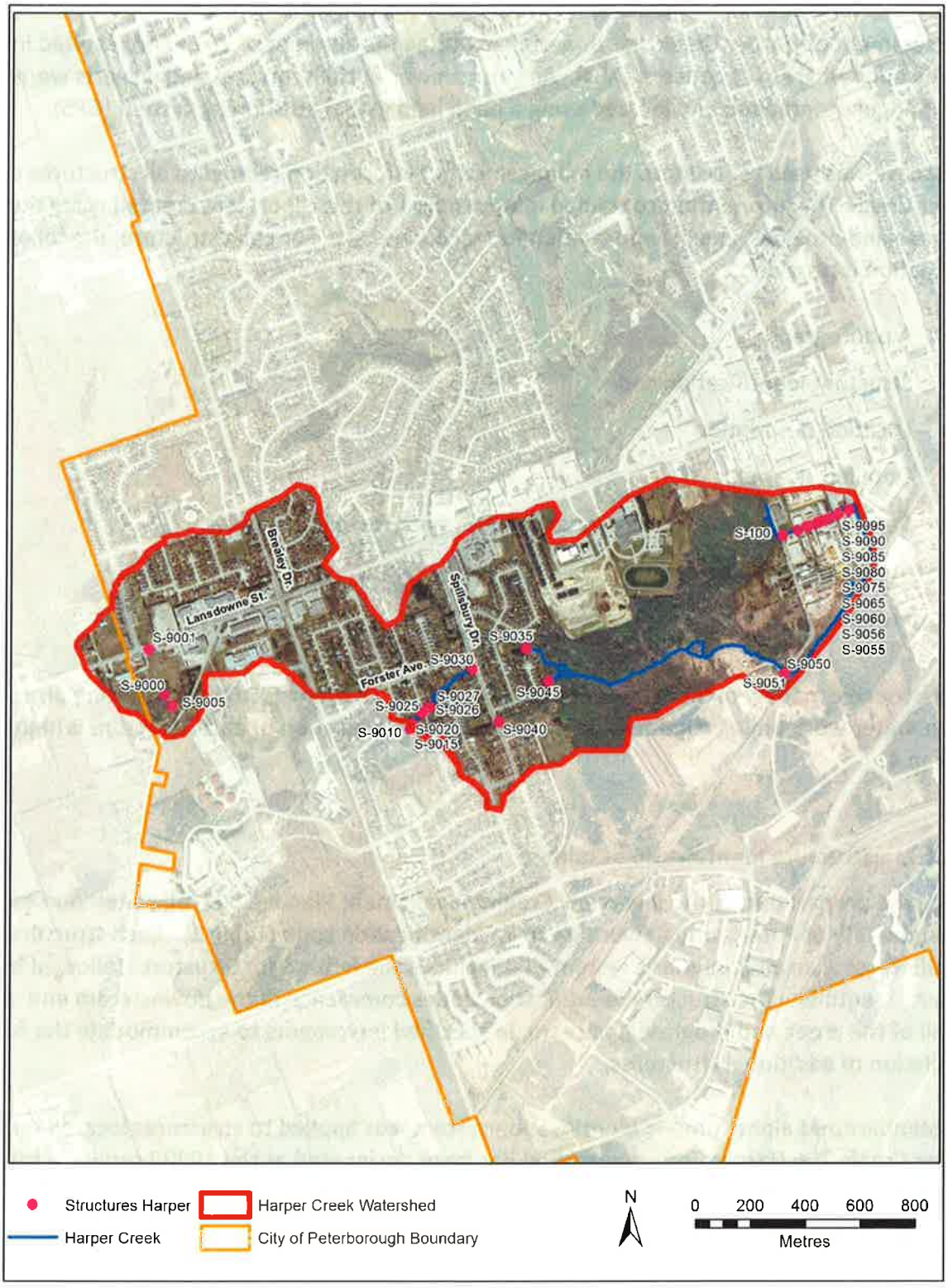
- A photograph
- Structure identification code
- Location description
- Detailed site map
- Structure specifications (rise, span, length, type, installation date)
- Structure condition
- Fish presence

Where specific management actions are recommended, references to the permitting procedure and in-water work timing windows are also included. The location of each structure is identified on Map 4.

2.1 Structure Identification Codes

During the preparation of the Riverview Creek Management Plan in 2002, all watercourses within the City of Peterborough were given an identification code (Table 1). Each structure is identified using an alphanumeric system that includes the letter S for Structure, followed by a numeric identifier. The structure identification codes commence at the downstream end or outfall of the creek and progress upstream, in specified increments to accommodate the future installation of additional structures.

This standardized alphanumeric identification system was applied to structures located on Harper Creek. The Harper Creek watershed has been designated as the S9000 series. A total of 26 structures were identified along Harper Creek, and are outlined in the following section.



Map 4: Structures within Harper Creek Watershed

Table 1: Structure Identification Code Key for City of Peterborough Watercourses

Watershed	Structure Identification Code
Riverview Creek	S1000
Bears Creek	S2000
Thompson Creek	S3000
Curtis Creek	S4000
Jackson Creek	S5000
North Meade Creek	S6000
South Meade Creek	S7000
Byersville Creek	S8000
Harper Creek	S9000

2.2 Recommended Maintenance Activity Schedule

A summary list of structures and identified problems and a recommended maintenance schedule for each is provided below in Table 2. Maintenance schedule recommendations are relatively generic and works should be evaluated by Public Works staff prior to final maintenance scheduling. Table 2 should be read in conjunction with Map 4, identifying the location of each structure within the watershed. Generally, the following maintenance scheduling recommendations apply to works along Harper Creek based on the structure inventory.

Recommendations for Immediate Action (0 to 2 Years)
Sediment loadings to storm sewers and receiving watercourses should be reduced to minimize flooding, reduce maintenance, preserve structures and improve water quality through the implementation of best management practices and enforcement of by-laws.

- Regular preventative maintenance will reduce the probability of flooding, preserve structures and improve water quality.
- Visual inspections of debris grates, sediment and debris accumulations and culvert condition should be performed annually for all structures.
    - Harper Creek is a cold-cool water system and in-water work is permitted from June 1 to September 30 only).
    - Permits and approvals must be obtained prior to commencing work.
- Review Protocol for Emergency Works within Regulated Areas (Section 6.8 of this report) with all work crews.

Recommendations for Short Term Action (2 to 5 Years)

- Undertake shoreline stabilization projects using bioengineering whenever possible.
    - Bioengineering combines natural and engineered solutions for bank stabilization.
    - Natural vegetation with fascines or logs can address problems of erosion and improve water quality.
- Plants should be permitted to establish along both sides of the creek to form vegetated buffer strips.
- Areas of erosion can be enhanced by planting native species of vegetation. ORCA staff can assist with determining the most appropriate native species based on specific site conditions.
- Improve existing structures such as gabion baskets and armour stone to address erosion concerns while enhancing habitat.

Recommendations for Long Term Action (>5 Years)

- Continue to complete projects incorporating shoreline stabilization and naturalization.
- Replace perched culverts.
- Monitor erosion prone areas.
- Complete major structure repairs if required.

  Note: Major repairs may be included in the immediate action category if there is a concern regarding imminent failure or negative impact to the watercourse.

Table 2: Summary List of Structures, Identified Issues and Recommended Maintenance Codes

Structure Number	Structure Type	Structure Condition	Easting	Northing	Description	Maintenance Code
S-9000	Concrete Culvert	New	709306	4905783	No issues.	n/a
S-9001	Concrete Culvert	Good	709266	4906167	No issues.	n/a
S-9005	Concrete Box Culvert	Good	709334	4905445	No issues.	n/a
S-9010	Concrete Culvert	Good	710203	4905359	No issues.	n/a
S-9015	Concrete Culvert	Good	710214	4905370	No issues.	n/a
S-9020	Concrete Culvert	Good	710211	4905375	No issues.	n/a
S-9025	Concrete Box Culvert	Good	710246	4905417	Capacity limited due to culvert height.	n/a
S-9026	PVC	Good	710245	4905420	No issues.	n/a
S-9027	PVC	Good	710273	4905440	No issues.	n/a
S-9030	Concrete Culvert	Good	710423	4905576	No issues.	n/a
S-9035	Concrete Culvert	Good	710627	4905654	No issues.	n/a
S-9040	Concrete Culvert	Good	710527	4905386	No issues.	n/a
S-9045	Concrete Culvert	Good	710709	4905333	No issues.	n/a
S-9050	CSP	Failing	711572	4905563	Culvert rusted and collapsing.	Immediate
S-9051	CSP	Good	711571	4905561	No issues.	n/a
S-9055	CSP	Adequate	711804	4906164	Sediment build up.	Short Term
S-9056	CSP	Good	711803	4906161	No issues.	n/a
S-9060	CSP	Good	711763	4906145	No issues.	n/a
S-9065	CSP	Good	711731	4906129	No issues.	n/a
S-9070	CSP	Good	711716	4906124	No issues.	n/a
S-9075	CSP	Good	711699	4906119	No issues.	n/a
S-9080	CSP	Good	711688	4906115	No issues.	n/a
S-9085	CSP	Good	711658	4906103	No issues.	n/a
S-9090	CSP	Good	711649	4906100	No issues.	n/a
S-9095	CSP	Failing	711617	4906087	Holes in corroded culvert.	Immediate
S-9100	CSP	Good	711562	4906068	No issues.	n/a

3.0 Areas of Concern Inventory

A complete inventory of the Areas of Concern (ACs) was undertaken during the summer of 2010 survey period. ACs include locations which pose management challenges such as erosion, ice and debris jams, as well as opportunities for restoration activity. All ACs were identified, photographed, and located using a hand held GPS. The exact location of each AC is identified on each data form and on Map 5.

A database was created to facilitate the management of information related to all ACs on Harper Creek. The information contained in Appendix 2 of this report was created using the database and provides specific information for each AC:

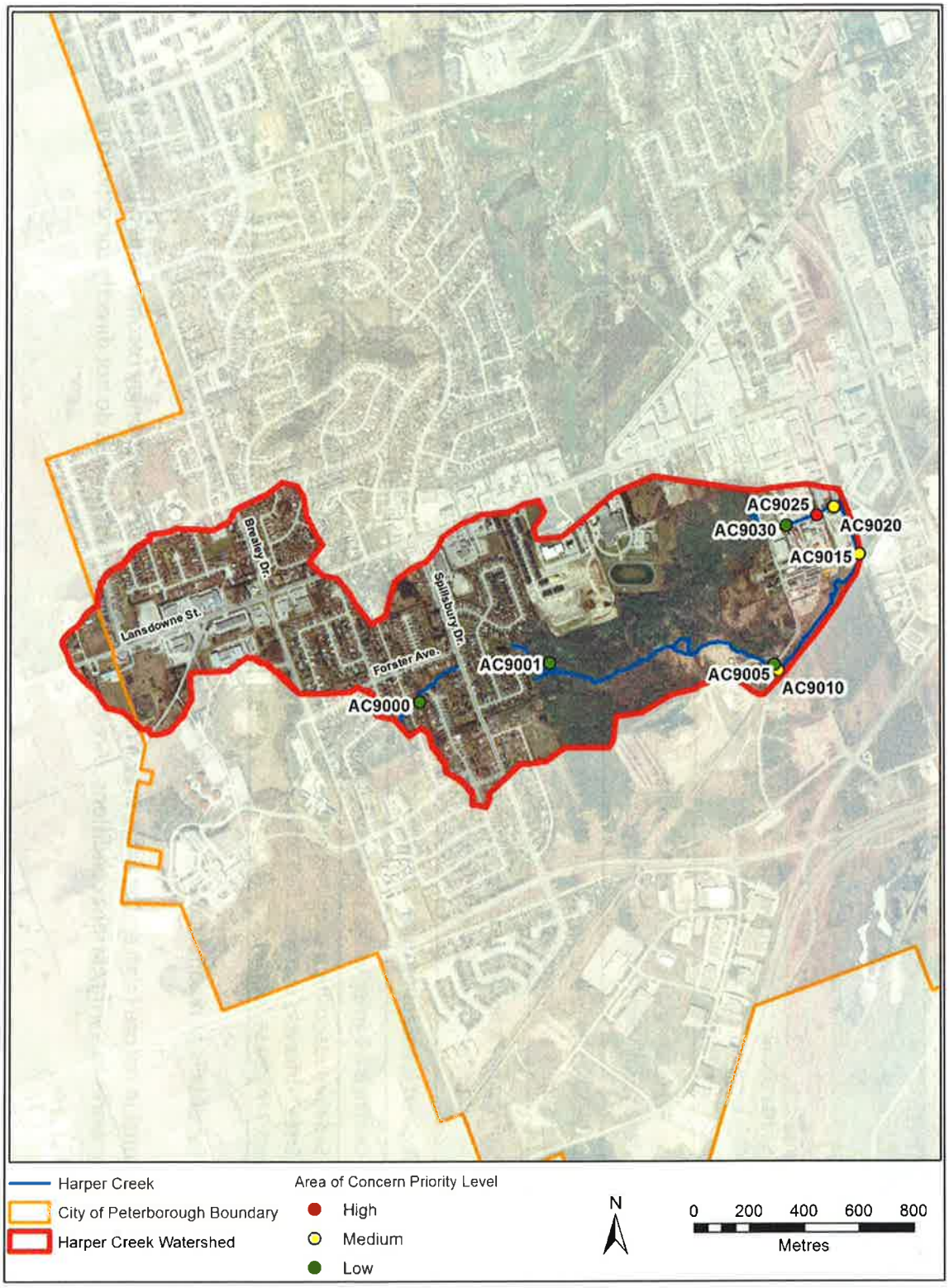
- Photograph
- Area of Concern Identification code
- Stream type
- Location description
- Detailed site map
- Area of Concern specifications
- Maintenance/management issues including suggestions for remediation and references to permitting and timing

3.1 Area of Concern Identification Codes

A standardized numbering system similar to that used to identify structures was used to identify Areas of Concern (AC) located on Harper Creek. In keeping with the structure alphanumeric system, the Harper Creek watershed has been designated as the AC 9000 series. Numbering codes commence at the downstream end or outfall of the creek and progress upstream, in increments to accommodate the future identification of additional Areas of Concern. Map 5 identifies the location of each of the 8 Areas of Concern codes located within the Harper Creek watershed.

3.2 Areas of Concern: Restoration and Implementation

To inform maintenance activities, ACs were prioritized along Harper Creek. Generally, erosion issues (or activities that could result in erosion) were considered high priority, culvert and fish passage concerns were rated as medium priority, and areas of debris build up were ranked as low priority. The recommended priorities recognize that some high priority areas may not be quick-fixes, and that although activities such as culvert clean-outs are lower priority, they can be easily and quickly implemented. Table 3 identifies the ACS, their priority levels and recommended implementation order. Priority levels are also identified on Map 5.



Map 5: Areas of Concern within the Harper Creek Watershed

Table 3: Prioritized List of Areas of Concern

Priority Level	Area of Concern No.	Details	Implementation Timeline
High	AC9025*	Erosion and lack of shade over Harper Creek along the north side of Rye Street	Short Term (2-5 yrs)
Low	AC9000	Sand buildup on the downstream side of Pinewood Drive is widening and slowing the creek in this location. Slower and shallower water velocities and a lack of shading are resulting in the growth of algae at this location.	Short Term (2-5 yrs)
	AC9001	An old fence across the creek has collapsed into the channel and has created a dam of woody debris and cobble stones. This has resulted in a deep pool downstream of the dam.	Immediate (1-2 yrs)
	AC9005	A debris build up has resulted in the creation of a pool upstream of the debris. The debris build up is approximately 7 meters in width and is impeding water flow.	Immediate (1-2 yrs)
	AC9030	Culvert has a few holes in the inside and therefore water flows through the holes which may result in erosion of the driveway or road.	Short Term (2-5 yrs)
Medium	AC9010	Culvert is collapsing under shoulder of the road.	Short Term (2-5 yrs)
	AC9015*	Outfall is a barrier to fish passage as it has a very steep slope.	Long Term (>5 yrs)
	AC9020*	Sediment deposition at culvert outfall has restricted flow and resulted in flooding at 740 Rye Street driveway entrance. Bell service box being undermined. Reorienting this culvert may prevent these concerns.	Short Term (2-5 yrs)

* Refer to Appendix 2 for details of recommended restoration activities.

Debris build up is seasonal in nature (high spring flows may flush debris). Site visits are strongly recommended prior to the commencement of any works to verify current conditions. Area of Concern Priority Levels do not directly correspond to structure maintenance schedules.

4.0 Public Lands

The City of Peterborough owns a significant portion of the land in the Harper Creek watershed, including Harper Park in the Harper Creek Wetland. Properties under public ownership are identified on Map 6.

Where possible, it is recommended that the City acquire land or land easements for lands adjacent to the creek to provide access for maintenance activities. It is recommended that hazard land such as floodplains be zone accordingly.

City land ownership should focus on establishing a linked system of maintenance access points on publicly owned land extending a *minimum* of 10 m from the high water mark on *at least* one side of the creek.

From an ecological perspective, creek side buffers should extend 30 m from either side of a watercourse and this width should be present along 75% of the length of a creek. Regardless of width, all publicly owned lands adjacent to Harper Creek should be managed by the City and riparian buffers comprised of native tree and shrub species be established or enhanced where possible. Shorelines should not be mown to the water's edge as this may result in erosion and provides little habitat.

Lands owned by the City represent good opportunities to implement and highlight stream restoration techniques and the value of this unique cold- cool water stream system in Peterborough. A continuously or near-continuously linked access to the creek could be accomplished as circumstances arise and provide recreational opportunities, as outlined in Section 5.0.

4.1 Management of Privately Owned Lands Adjacent to Harper Creek

Where the land adjacent to Harper Creek is privately owned, coordination of erosion control works and restoration will require an innovative approach. Several privately owned properties adjacent to the Creek have been identified as ACs that requires erosion control, naturalization, debris clean-out, or other maintenance work. These landowners should be contacted to discuss the potential options for addressing identified issues on their property and to gain permission to access their property.

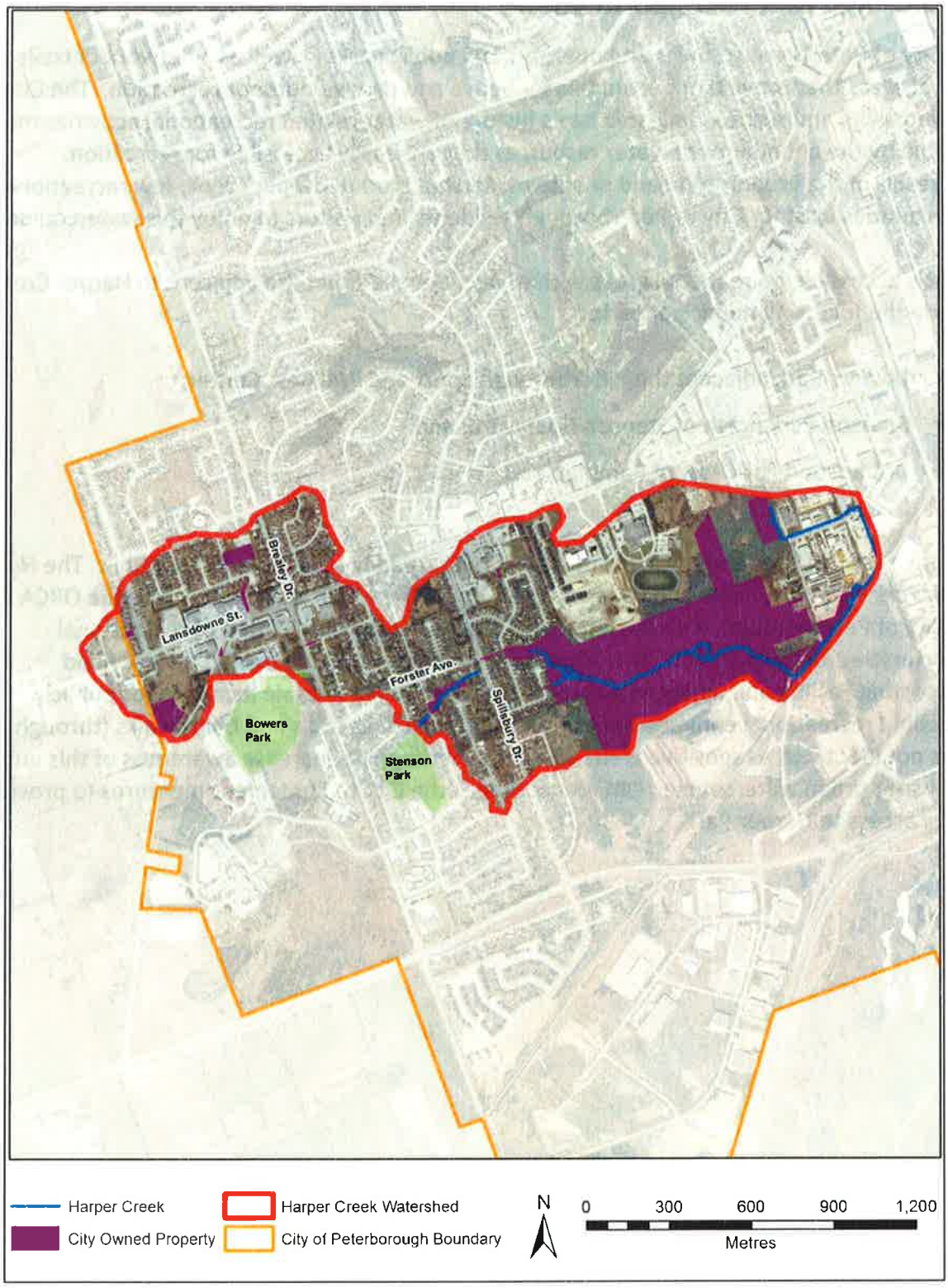
Where ACs coincide with locations identified as targets for easements, it is recommended that the City consider establishing a conservation easement with applicable landowners, where one does not already exist.

A conservation easement is a voluntary agreement entered into between the grantor of the (private landowner) and the holder of the easement (City) that:

A. Grants rights and privileges to the holder of the conservation easement respecting land

that relate to the purposes for which the conservation easement is granted

B. May impose obligations, either positive or negative, on the holder of the conservation easement, the grantor of the conservation easement or any subsequent owner of the land, related to the purposes for which the conservation easement is granted.



Map 6: City Owned property in the vicinity of Harper Creek

5.0 Recreational Opportunities

The City of Peterborough owns and operates 105 public parks as well as a network of trails and natural areas that provide opportunities for active and passive outdoor recreation. The City of Peterborough and surrounding area has a history of water related recreational activities made possible by the abundance of water resources that are easily accessible for recreation.
As a result of the urbanization and private ownership around Harper Creek, few recreational opportunities exist for City of Peterborough residents and visitors to enjoy this watercourse.

Publicly accessible recreational areas within the watershed that are adjacent to Harper Creek include the following municipal parks:

- Bowers Park adjacent the Peterborough Sport and Wellness Center;
- Stenson Park north of Stenson Boulevard; and
- Bridlewood Park east of Ramblewood Drive.

Although Harper Park is municipally owned, it is not readily accessible to the public. The *Harper Creek Park – Opportunities and Constraints Study* (2004) which was prepared by the ORCA for the City of Peterborough, includes a detailed analysis and identification of recreational opportunities for Harper Park. This 2004 study highlights the City owned Harper Road Composting Facility and adjacent leased land as potentially suitable locations for publicly accessible recreational enhancement opportunities such as trails and boardwalks (through areas not identified as sensitive wetland natural heritage) to increase awareness of this unique cold water urban watercourse. ORCA encourages the City to implement measures to provide public access to Harper Park.

6.0 Legislation, Regulations and Studies

Several pieces of legislation (federal, provincial, local) and associated regulations govern actions that may influence management of the watercourse and adjacent lands along Harper Creek. A summary of the legislation and regulations is provided below.

6.1 Planning

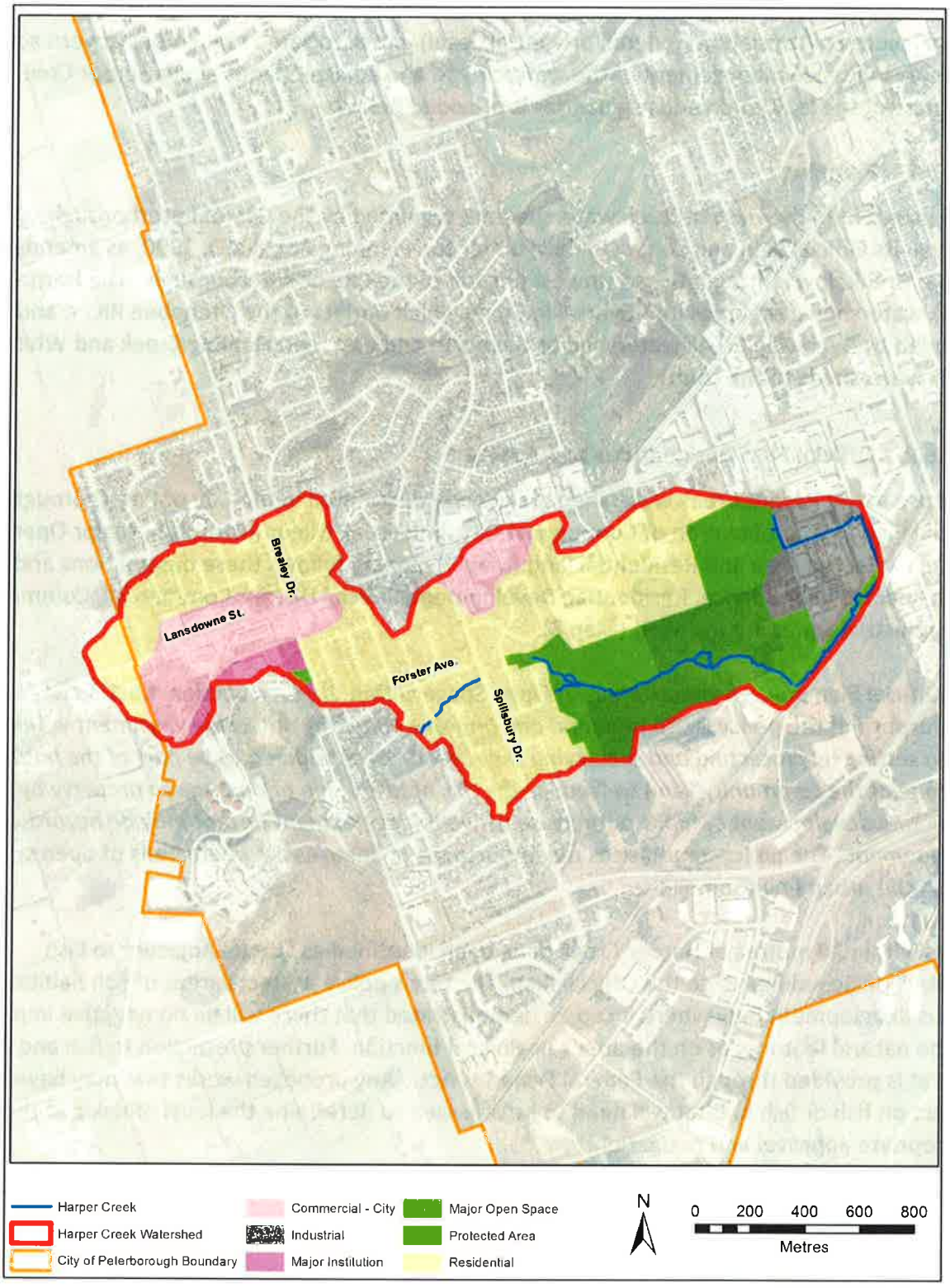
Land uses within the Harper Creek watershed are regulated by the City of Peterborough, through its Official Plan and Zoning By-law, under the Planning Act, R.S.O. 1990, as amended. Harper Creek flows through the southwest portion of the City of Peterborough. The Harper Creek watershed discharges into Byersville Creek which outlets to the Otonabee River, and is bounded by Byersville Creek watershed to the north and east, and Fleming Creek and Whitfield Creek watersheds to the south.

6.2 Official Plan Designations and Zoning

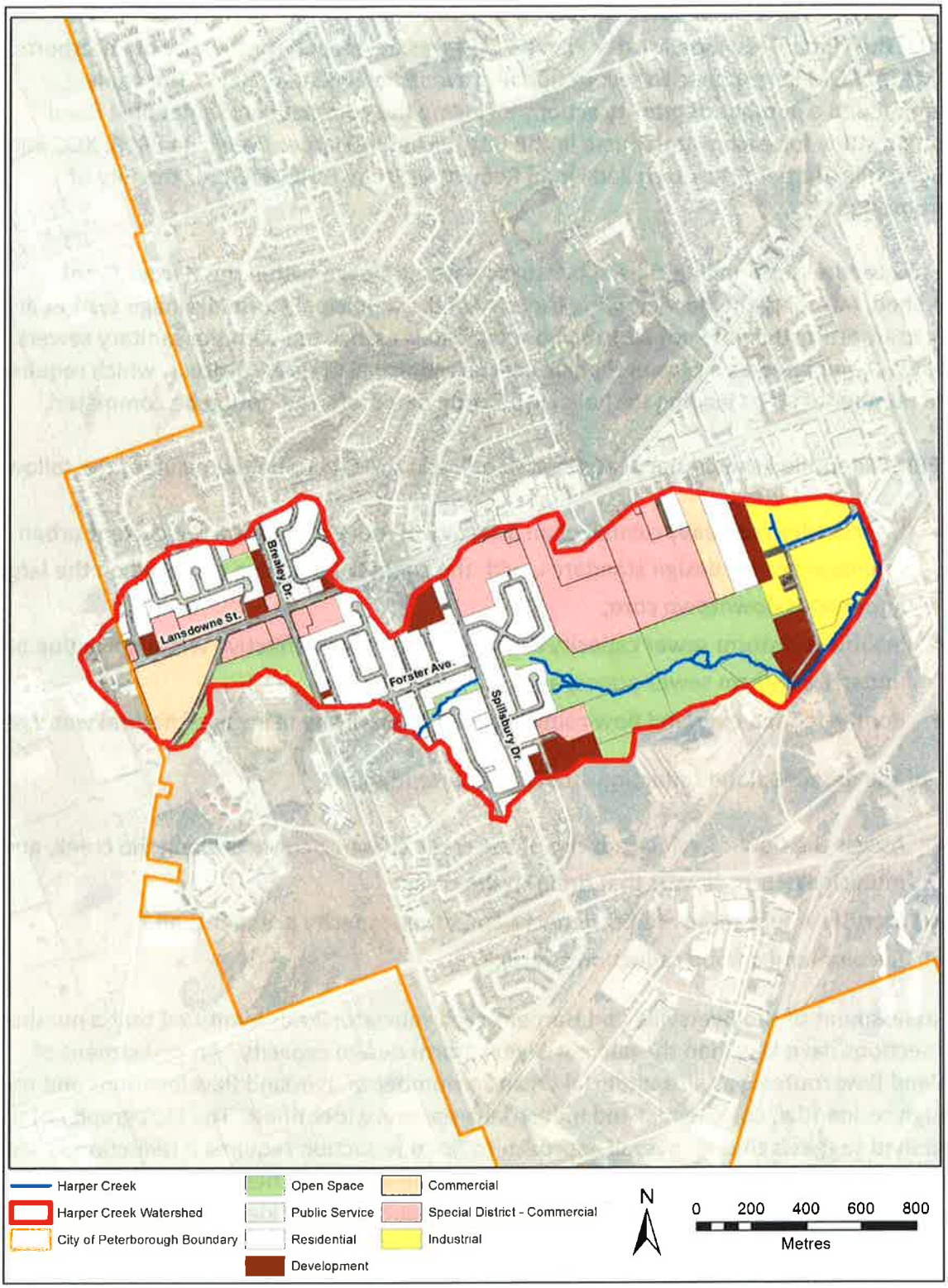
Land use in the Harper Creek watershed is currently designated in the City of Peterborough Official Plan as a combination of Commercial-City, Industrial, Major Institution, Major Open Space, Protected Area and Residential land (Map 7). Zoning follows these designations and Open Space, Public Service, Residential, Development, Special District-Commercial, Commercial and Industrial zones are included (Map 8).

The Official Plan policy protects areas of Open Space within the City. Section 4.5.1.3 states that the purpose of the policy is *"To maintain and improve a healthy natural environment within an urban setting by protecting and preserving those features considered to be part of the natural heritage of the community"* and to *"reduce the risk of loss of life or damage to property by restricting development of lands or areas sensitive to development or that may be hazardous to development"* The policy emphasizes the importance of linkages between areas of open space within the urban environment.

Lands within 30 metres of Harper Creek have been identified as "Lands Adjacent to Fish Habitat" on Schedule "C" to the Official Plan. The City's policy protects areas of fish habitat, and allows development only where it can be demonstrated that there will be no negative impact on the natural features or on the area's ecological function. Further protection to fish and fish habitat is provided through the Federal Fisheries Act. Any proposed works that may have an impact on fish or fish habitat will need to be assessed to determine the level of risk and the appropriate approval and mitigation.



Map 7: City of Peterborough Official Plan Designations within the Harper Creek Watershed



Map 8: Zoning of Land within the Harper Creek Watershed

6.3 Flood Reduction Master Plan and Detailed Flood Reduction Studies

In 2005, the Flood Reduction Master Plan (FRMP) was developed for the City of Peterborough by UMA/AECOM in response to severe flooding events in 2002 and 2004. The study recommended a number of priority actions including the completion of a detailed flood-reduction study for each watercourse in the City, including Harper Creek. In 2006, XCG initiated the Byersville/Harper Creek Detailed Flood Reduction Study (BHCDFRS) for the City of Peterborough.

The study addresses flooding caused by storm water drainage within the Harper Creek watershed, including the flow-carrying capacity of the municipal storm drainage system and the creek itself. This study did not address flooding issues associated with the sanitary sewers. The study was completed as a Master Plan under the Municipal Class EA process, which requires that a number of steps leading to the identification of a preferred option be completed.

The FRMP identified the primary causes of flooding in the City to be the result of the following:

- Unprecedented heavy rainfall of an intensity of more than twice the current urban drainage-system design standards, with the event having been centered on the largely impervious downtown core;
- Insufficient storm sewer capacity caused primarily by ineffective water collection and undersized storm sewer popes; and,
- Poorly defined overland flow routes caused primarily by filling in of natural waterways

Each of the detailed flood reduction studies was intended to:

- Assess the flow-carrying capacity of the creek channel, culverts along the creek, and municipal storm sewers that drain to the creek;
- Identify where there are bottlenecks and other capacity problems; and
- Recommend a flood reduction strategy.

The assessment of the Byersville and Harper Creek subwatersheds identified that a number of pipe sections have less than the current 5-year storm design capacity. An assessment of overland flow routes was also undertaken and a number of overland flow locations and routes through residential, commercial and industrial areas were identified. The topography of the watershed suggests that an overall approach to flood reduction requires a reduction in the rate of flow coming from the upper reaches, to protect the lower reaches from the risk of flooding. As a result, a number of areas that are at risk from flooding were identified and mapped.

A series of recommendations were included in the report and at the time of publication no works had been undertaken, but preferred options had been identified. The recommendations in the Harper Creek Management Plan are in keeping with the BHCDFRS, but do not specifically reference works identified in the study.

6.4 *The Fisheries Act* – Section 35

Through a Fish Habitat Partnership Agreement with the DFO, the ORCA is involved in assessing risks to fish and fish habitat as per Section 35 of the Federal *Fisheries Act*. On behalf of the DFO, ORCA reviews project proposals for activities in or near water that may affect fish and fish habitat within the Otonabee Region Watershed (including Harper Creek), with the exception of areas within the jurisdiction of the Trent Severn Waterway.

Under the *Fisheries Act*, fisheries habitat is defined as "spawning grounds and nursery, rearing, food supply, migration and any other areas on which fish depend directly or indirectly in order to carry out their life processes".

Maintenance activities which could result in a negative impact on fisheries or fish habitat include the following (Stoneman et al. 1997):

A. Alterations to the Channel Shape or Cross Section

- Can occur with culvert replacement or extension.
- Machinery in the water can alter the channel shape by compacting the bottom or collapsing the banks and may result in changes in velocity and in the pattern of erosion and deposition within the system.

B. Changes to Bank or Bottom Materials

- Can be changed intentionally, by the introduction of rip-rap, or by crushing caused by heavy machinery.
- Can lead to changes in channel shape or cross-section.

C. Mobilization of sediment

- Can result from stirring up sediment on the stream bottom or from works on bridge decks, as well as erosion due to bank de-stabilization.

D. Alteration of Bank or Buffer Vegetation

- Reduction of riparian (stream bank) can decrease shading of stream and can de-stabilize the shoreline.
- Removal of buffer vegetation reduces opportunity for sediment to be trapped before it enters the stream.

E. Disruption of Flow

- Coffer dams and diversions can strand fish and other organisms and can block migration and spawning routes.
- Sudden release of water held behind dams can cause erosion and can introduce sediment which had accumulated behind the dam.

F. Changes to Groundwater Flows

- Groundwater seeps help to maintain stable flows and water temperature regimes.
- Brook trout spawn on groundwater seeps and the loss of these seeps can quickly destroy trout populations in local watercourses.

G. Introduction of Toxic Materials

- Chemicals introduced through pesticide spraying, paving, and dust suppression activities can poison waters and kill fish immediately or over time.

H. Fish Kills

- Blasting and quick release of water may kill fish, affecting food supplies and reproductive cycles.

I. Blockage of Fish Passage

- Dams and culverts can block upstream movements of fish, including spawning and foraging for food.

The ORCA Watershed Biologist undertakes reviews of proposals affecting watercourses in order to determine whether the proposed works will cause an impact on fish or fish habitat via the Fisheries Act. Mitigative measures, such as limiting the use of heavy machinery or minimizing the duration of works being undertaken can often alleviate the negative impacts of the activities, and this advice is provided to proponents by ORCA staff. Higher risk projects requiring Fisheries Act authorization and/ or assessment under the Canadian Environmental Assessment Act are forwarded by ORCA to DFO.

An ORCA review under the Fisheries Act will result in the application of the Risk Management Framework, which places a project in one of the following categories:

A. Low Risk Projects

- Development proposals that are characterized as Low Risk are not likely to result in HADD, providing appropriate mitigation measures are applied. Where an adverse impact is anticipated and can be mitigated or the design altered to avoid impacts, a Letter of Advice is issued by ORCA. This letter typically will follow discussions with the project proponent in which changes are made to the project design, or additional mitigation measures are included in the project scope. Any variance from the works described could result in an adverse impact to fish or fish habitat, leading to charges laid by DFO Enforcement Officers under the Fisheries Act, against the City and any others involved in the works.

- Development proposals where the effects are well understood and readily mitigated using standard measures may be able to be conducted following the advice of a DFO Operational Statement (Appendix 3). When a project can be completed within the guidelines set out in an Operational Statement the Conservation Authority will advise that a Letter of Advice is not required.

B. Moderate Risk Projects

- Development proposals characterized as Medium Risk are likely to result in HADD, and a Fisheries Act authorization will be required. The purpose of the Medium Risk category is to recognize that some activities result in HADDs that are small-scale and/or temporary in duration, and have predictable outcomes with a low level of uncertainty surrounding potential negative effects.

- Where it is determined that the works proposed are expected to result in HADD the application will be reviewed by ORCA in conjunction with DFO. DFO staff may provide an Authorization to complete the work, typically involving compensation for the HADD to ensure no net loss of fish habitat.

C. High Risk Projects

- Proposed developments that are High Risk will result in HADD over a long period of time and/or a broad geographic extent, and/or will take place in areas ranked high on the Sensitivity of Fish and Fish Habitat scale. Such development proposals will require a site-specific review and authorization under subsection 35(2) of the *Fisheries Act*.

- Where it is determined that the works proposed are expected to result in HADD the application will be reviewed by ORCA in conjunction with DFO. DFO staff may provide an Authorization to complete the work, typically involving compensation for the HADD to ensure no net loss of fish habitat.

Acting in a capacity as a One-Window service provider to the City of Peterborough, staff at ORCA will oversee the preparation of all submissions to the DFO and will assist City staff in the preparation of proposals for mitigation or compensation required for maintenance works.

6.5 Ministry of Natural Resources Timing Windows for In-Stream Works

The Ministry of Natural Resources determines timing windows for in-stream works. The timing windows limit periods during which in-stream works can be undertaken to protect native fish species from the negative impacts of development during sensitive periods in their lifecycle. For example, Brook Trout, which live in cold and cold-cool water streams, spawn in the fall and their eggs incubate through the winter. Sediment can bury and suffocate the eggs and developing fry, thereby killing future generations of these species. For this reason, in-water work in Harper Creek can only occur between June 1 and September 30.

ORCA staff will assist City staff in the design of projects which respect these limitations.

6.6 Lakes and Rivers Improvement Act

The Ministry of Natural Resources no longer administers the Lakes and Rivers Improvement Act and the Lakes and Rivers Improvement Act Regulation (Ontario Regulation 454/96) within the Province of Ontario (with the exception of work related to dams).

The ORCA will assist the Department of Public Works in determining whether proposed works are subject to the Lakes and Rivers Improvement Act. Where the Act is applicable, Otonabee Conservation staff will assist in the development and filing of applications on behalf of the City.

6.7 Conservation Authorities Act - Ontario Regulation 167/06

Under Ontario Regulation 167/06 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses), permission is required for alterations to a watercourse. A watercourse refers to rivers, streams, creeks or other depressions in the ground where water regularly or continuously flows. This includes seasonal and ephemeral streams. A brochure with additional information on Ontario Regulation 167/06 and working around water is provided in Appendix 4.

The Watershed Planning and Regulation Policy Manual, Approved in May 2012 articulates the specific policies that relate to alterations to watercourses in Section 9. Interference or Alterations to a watercourse will not be permitted, except in accordance with the policies contained in this section.

What are watercourses and why is ORCA concerned with watercourses?

Watercourses are dynamic, living systems with complex processes that are constantly undergoing change. The structure and function of *watercourses* are influenced by channel morphology, sediment characteristics (soil type, bedrock, and substrate characteristics) and the nature of riparian vegetation both on the bank and rooted in the bed of the *watercourse*. Any changes to one of these influences can have significant impacts on other parts of the system and in turn, impair the function of the *watercourse*. One of the key influences on the structure and function of the *watercourse* is related to the hydrology of the *stream* and its normal hydrograph – changes in the volume, peaks and timing of flows can significantly impact the channel morphology, sediment transport and even the riparian vegetation.

The *riparian zone* not only provides habitat for a wide range of flora and fauna, it also filters surface run-off before it reaches open waterways. As run-off passes through, the *riparian zone* retains excess nutrients, some pollutants and reduces the sediment flow. A healthy zone can also keep *stream* flow going even during the dry seasons, by holding and releasing groundwater back into the *stream*. This interface between terrestrial and aquatic environments acts as a sponge for storing water, which in turn helps to reduce flooding and shelters the banks against shoreline erosion.

Why is ORCA concerned about alterations to watercourses?

Alterations to the channel or shoreline of a *watercourse* can negatively impact the *hydrologic function* of the watercourse and ultimately, the control of flooding and erosion. For example, changes to channel morphology reduce the ability of the *watercourse* to process sediment, causing erosion, and may change the amount or size of bed load being moved. Loss of riparian vegetation can result in more pollutants and run-off being transported from the land to the water, impacting water quality and flooding downstream reaches.

What is ORCA's position with respect to the alteration or interference with the channel or shoreline of a river creek, stream or watercourse?

In general, ORCA discourages altering or interfering with the channel or shoreline of a *river*, *creek*, *stream* or *watercourse*. We recognize that some uses by their nature must locate within or adjacent to *river*, *creek*, *streams* or *watercourses*. Furthermore, it is recognized that channel or shoreline alterations may facilitate existing agricultural uses (e.g., watercourse crossing for farm equipment or livestock). Any alteration to the channel or shoreline of a *river*, *creek*, *stream* or *watercourse* requires permission from ORCA. This includes activities such as, but not limited to, culvert placement or *replacement*, bridge construction, installation of bed level crossings, enclosure of *watercourses*, installation or maintenance of pipeline crossings, cable crossings, maintenance of by-pass, connected or online ponds, straightening and diversions as well as any work on the bed or the banks of the *watercourse* such as dredging or bank protection projects.

Note: Applicants and their agents should be advised that where any in water or near water works are being proposed, there may be restrictions relating to the timing of activities (e.g. seasonal restrictions) that may be required by MNR and/or Fisheries and Oceans Canada.

Permits may also be required from the MNR through the Lakes & Rivers Improvement Act and/or the Public Lands Act.

ORCA staff will work with applicants, including municipal staff to ensure that applications for works within regulated areas comply with the policies of the Conservation Authority. Permits are issued for approved works and may be monitored to ensure compliance.

6.8 Emergency Works within Regulated Areas

Ontario Regulation 167/06, the Authority's "Development, Interference with Wetlands and Alteration to Shorelines and Watercourses" Regulation makes no provisions for exemptions from the permitting process to recognize emergency works undertaken within a regulated area. However, ORCA recognizes that emergency situations occur and require an immediate response by the municipality. In order to facllitate approval of these works, policy 4.1.2(2) has been developed and is copied below. ORCA staff will determine, in consultation with municipal staff, whether the proposed works constitute emergency measures and qualify for emergency status.

The complete Watershed Planning and Regulation Policy Manual can be viewed or downloaded at www.otonabee.com.

EMERGENCY WORKS

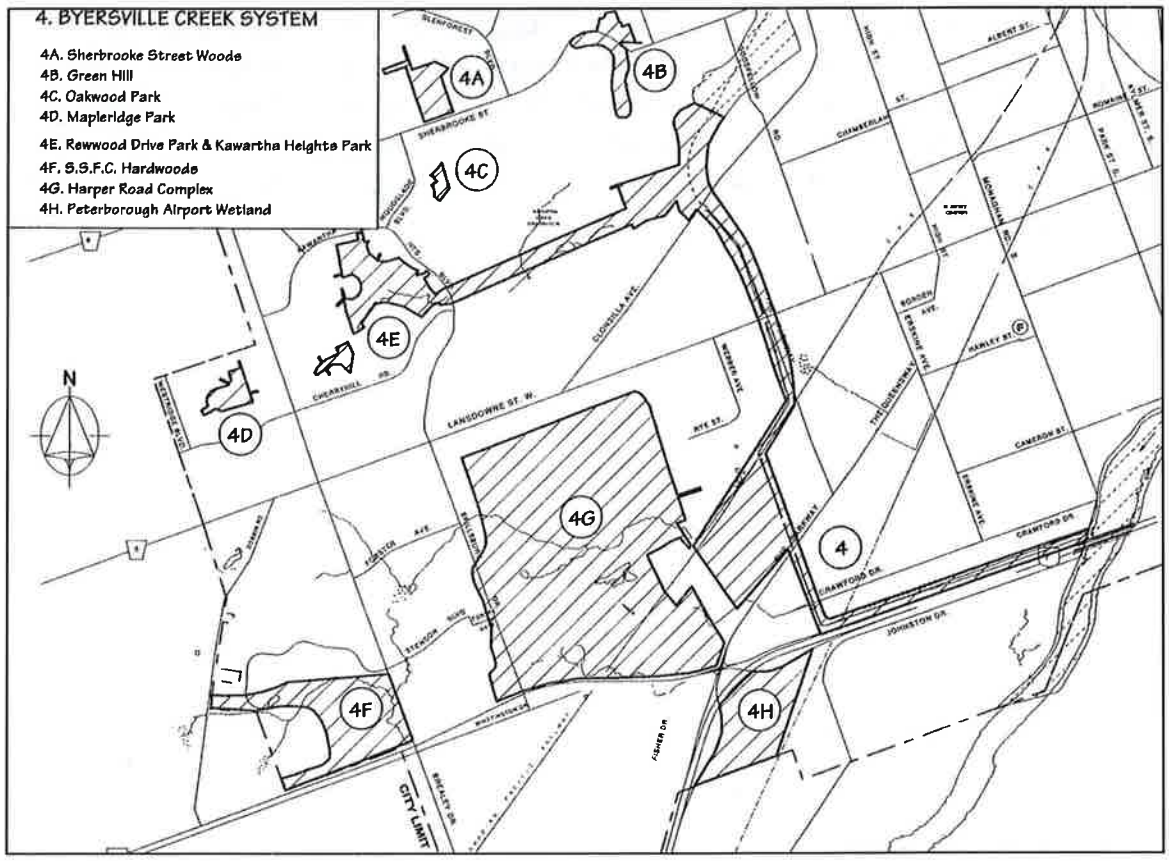
4.1.2(2) Permission will be granted by ORCA in the form of a Letter of Permission to municipalities and other agencies for *emergency works* to repair existing infrastructure within a *regulated area* that is at immediate risk of failure or other public safety concerns provided that ORCA is notified prior to conducting remediation works, and where appropriate or possible given the opportunity to review, provide technical guidance related to the control of flooding, *pollution* and/or the *conservation of land*, and supervise. Municipalities shall provide a description of the emergency works or 'as built' information upon the completion of emergency works.

7.0 Terrestrial Natural Resources Identification

The natural environment associated with Harper Creek includes the stream itself, the riparian zone along the edge of the stream, and adjacent upland areas. This section of the Harper Creek Management Plan focuses on the natural heritage values of the creek, with a latter section delving into detailed water quality characteristics.

The Harper Creek watershed is a subwatershed of the Byersville Creek watershed and includes the Harper Creek Wetland. According to the Peterborough Natural Areas Strategy which provides an ecological overview of the City, the Harper Creek Wetland and other terrestrial natural heritage features including the Harper Road Wooded Fen, the Parkway Woods and the Crawford Drive Woods, are all part of the Harper Road Complex (Area 4G highlighted below (Peterborough Natural Areas Strategy, 1996; Map 9).

This area is an ecologically important natural area in the city and contains a variety of features that warrant protection. Harper Park is one of the largest naturally vegetated areas in the City. It consists of not only a unique diversity of plant species but also provides the groundwater seepage and upwellings that support the cold water fisheries of Harper Creek.



Map 9: Natural Areas of Significance within the Byersville Creek System, Peterborough Natural Areas Strategy (Fisher 1996)

7.1 Identification of Creek Reaches

To facilitate data collection and reporting, ORCA staff divided Harper Creek within the study area into nine reaches, identified as follows:

Reach 1: Dobbin Road Storm Water Management Pond

Reach 2: Stenson Park SWMP to Bridlewood Park

Reach 3: Spillsbury Drive to Kingdon Avenue

Reach 4: Creekwood Drive to Confluence with Harper Creek main channel

Reach 5: Bridlewood Park to Reach 4 confluence

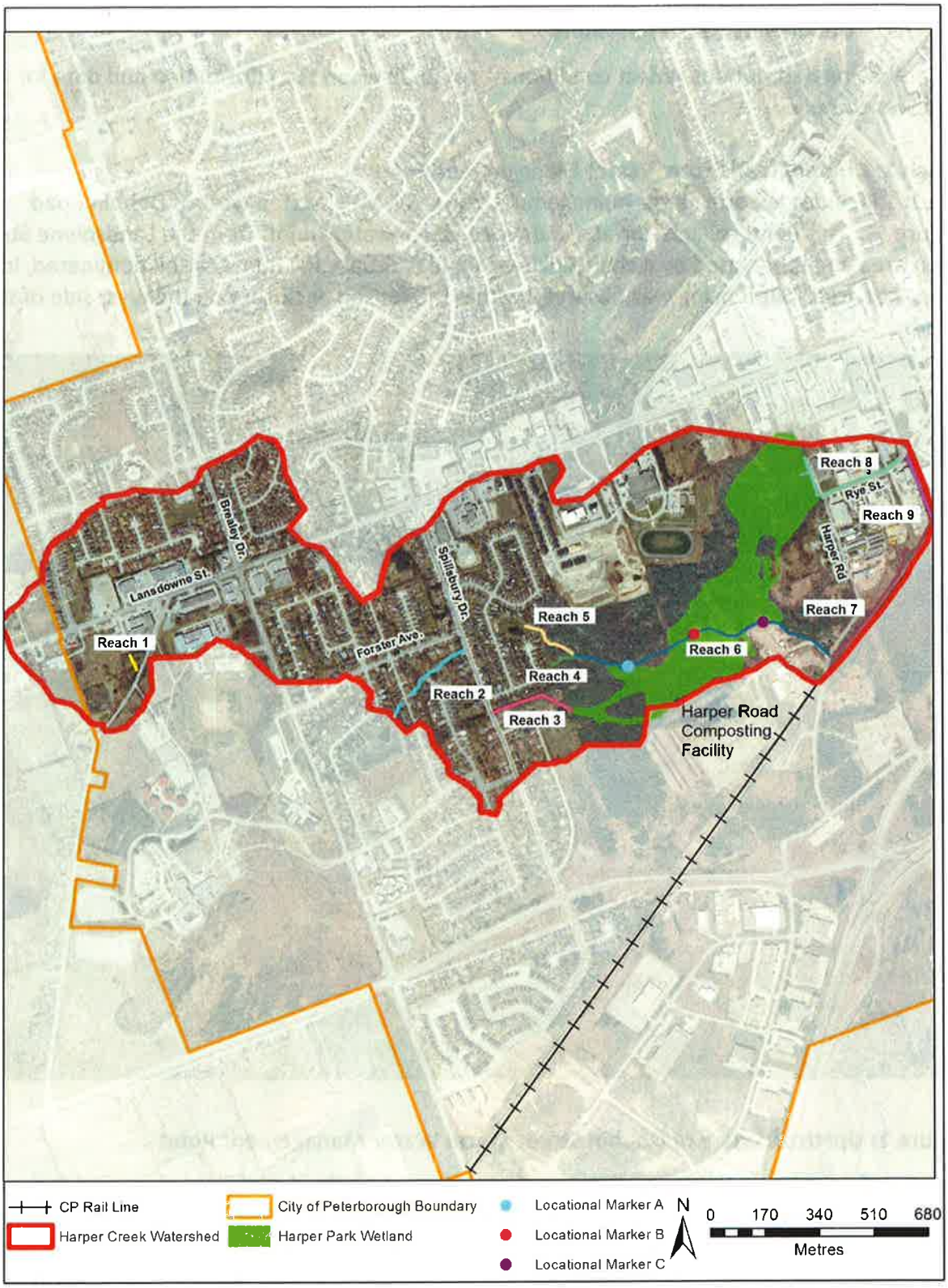
Reach 6: Harper Park through to Harper Road

Reach 7: Harper Road to Byersville Creek

Reach 8: Northern Tributary / Rye Street watercourse

Reach 9: Rye/Webber Avenue to Byersville Creek

In 2010, ORCA staff conducted field investigations of Harper Creek and recorded general observations on the riparian vegetation and channel morphology of each reach. ORCA staff confirmed these observations during 2012 site visits. The following section includes detailed information about the characteristics of the creek and adjacent riparian areas (Map 10). Please note that reach location information below may not be continuous as portions of Harper Creek are subterranean.



Map 10: Harper Creek Stream Reaches

7.2 Detailed Reach Descriptions

The following descriptions reflect conditions as of 2009 when the information and data for this Plan was compiled.

Reach 1: Dobbin Road Storm Water Management Pond

Reach 1 includes a storm water management pond (SWMP) located west of Dobbin Road (Figure 1). This Pond collects surface and piped storm water runoff from the Landsowne Street West area and is enclosed by a chain link fence and is situated within a cattail dominated, low-lying, wet area. Silt fencing was observed within the fenced enclosure on the west side of the pond.

Figure 1: Upstream view of Dobbin Street Storm Water Management Pond

Vegetation species in the immediate area were characteristic of disturbed areas and includes Red Osier Dogwood (*Cornus stolonifera*), Wild Grape (*Vitis spp.*), Milkweed (*Asclepias spp.*), Birdsfoot Trefoil (*Lotus corniculatus*), Tufted Vetch (*Vicia cracca*), Canada Goldenrod (*Solidago canadensis*) and various Asters (*Symphyotrichum spp.*) and Grasses (*Agrostis spp.*). A rip-rap covered pipe at the south end of the SWMP conveys flow to the storm sewer system which drains southeast to the SWMP in Stenson Park.

Reach 2: Stenson Storm Water Management Pond to Bridlewood Park

The Stenson Park SWMP is surrounded by single family residences and conveys flow east through a concrete headwall into a rip-rap lined open water channel to Spillsbury Drive. Cup Plant (*Silphium perforliatum) is* a rare species (ranked S-2 by the Natural Heritage Information Centre of the Ministry of Natural Resources) dominated the SWMP riparian area and was not observed elsewhere along the watercourse. A chain link fence downstream of the outlet headwall appears to delineate property limits and has an approximate three foot vertical clearance from the Creek.

The initial section of Reach 2 between the SWMP outlet and Pinewood Drive is well vegetated with mature White Elm (*Ulmus laevis*), Basswood (*Tilia americana)*, Manitoba Maple (*Acer negundo*) and willow species (*Salix spp.*) that provide up to 75% canopy cover (Figure 2). Other riparian vegetation includes Wild Grape, Jewelweed, Larger Bur Marigold (*Bidens laevis*) and Cup Plant. The stream morphology in this Reach is comprised of steps and pools with an approximate 2m wetted width and depth of 0.2 m. Aquatic vegetation includes Duckweed (*Lemna spp.*), Cattails (*Typha spp.*) and Watercress (*Nasturtium officinale*).

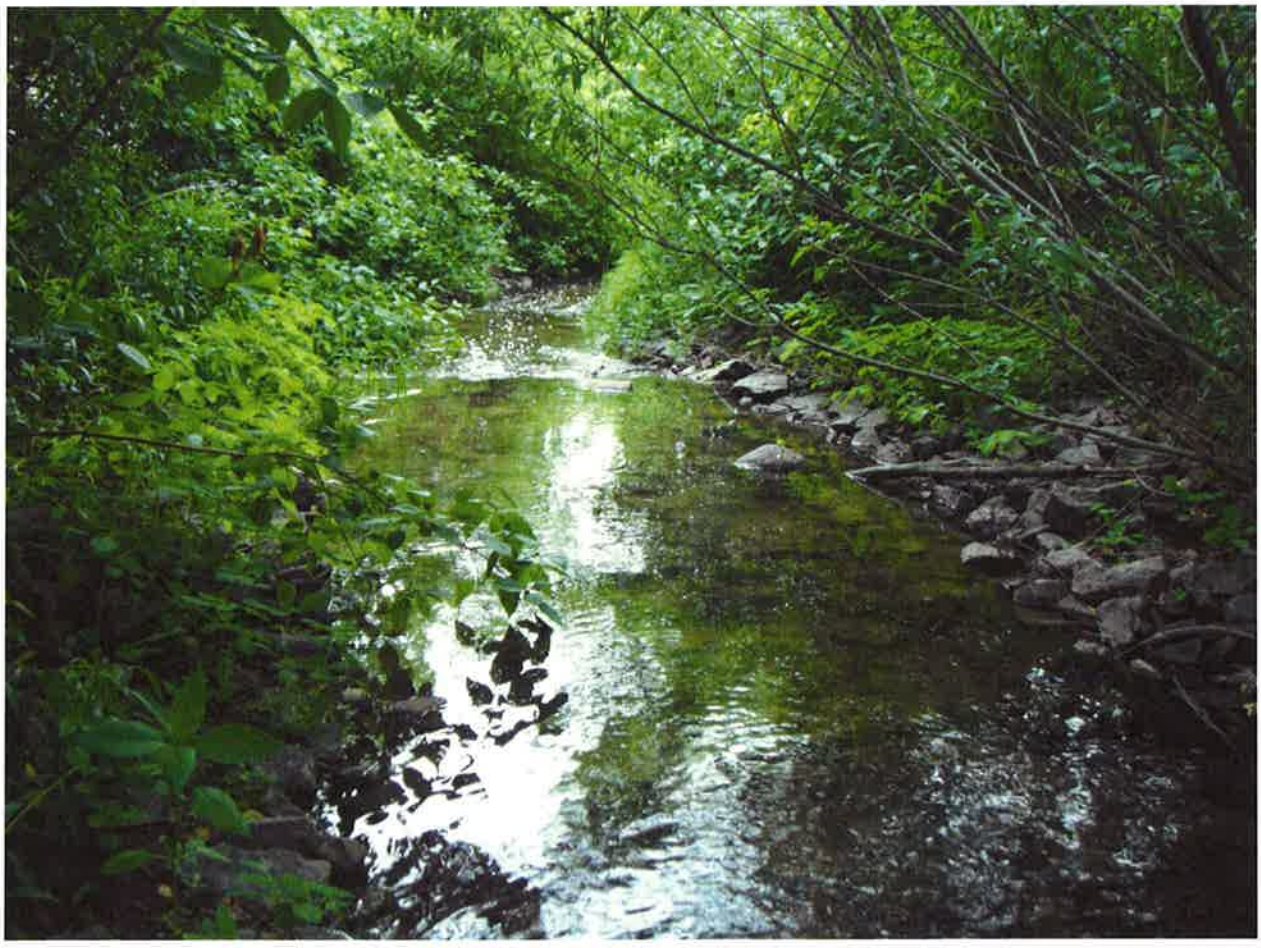


Figure 2: Downstream view from Stenson Storm Water Management Pond

Flow is conveyed under Pinewood Drive via a concrete box culvert which marks the beginning of the mid-section of this Reach (Figure 3). Surface water runoff from the west side of Pinewood Drive, north of the Creek, also flows under the road via this box culvert. Pinewood Drive is asphalt paved and has no curbs.

Figure 3: Downstream view of box culvert under Pinewood Road

The Creek flows through an open water channel east of Pinewood Drive to Spillsbury Drive, meandering through a naturalized area where wetted widths vary from approximately 1.5 m to 3 m. Tree cover in the riparian zone includes Manitoba Maple, Largetooth Aspen (*Populus grandidentata*), Basswood and Common Buckthorn (*Rhamnus cathartica*). Vegetation species along the banks include Wild Mint (*Menthe arvensis*), Watercress, Cattails, Goldenrod (*Solidago spp.*), Common elderberry (*Sambucus Canadensis*), Dogwood (Cornus spp.), Horsetail (*Equisetum spp.*), Jewelweed (*Impatiens capensis*), and Common milkweed (*Asclepias syriaca*).

Immediately east of Pinewood Drive, filamentous algae was observed in the watercourse. This algae was identified in an area where substantial sand deposition appears to be widening the creek channel and reducing flow depths. This area could benefit from riparian plantings and restoration to re-establish natural creek processes and reduce further sedimentation.

At the downstream end of Reach 2, flow is conveyed through an armour-stone lined section where Cattails, Goldenrod, Jewelweed and invasive Dame's Rocket (*Hesperis matronalis)* are

growing in areas of sand deposition within the channel (Figure 4). Flow is conveyed under Spillsbury Drive at which point it is piped underground to the concrete headwall located east of Bridlewood Park.

Figure 4: Upstream view of armour-stone lined channel, west of Spillsbury Drive

Reach 3: Spillsbury Drive to Kingdon Avenue

Reach 3 is represented by an open channel that extends east of Spillsbury through a low-lying area between the rear lot lines of the residential dwellings located on the south side of Creekwood Drive and north side of Kingdon Avenue. Immediately east of Spillsbury Drive, the channel is reinforced with gabion baskets. Surface flows are conveyed east of the road and through private property into Harper Park and the Harper Creek Wetland via a series of diffuse channels. The section of the reach west of Harper Park is well-shaded with canopy trees species including Manitoba Maple, Eastern White Cedar (*Thuja occidentalis*), Black Locust (*Robinia pseudoacacia*), Norway Maple (*Acer platanoides*) and Trembling Aspen.

Reach 4: Creekwood Drive to Confluence with Harper Creek main channel

Between 155 and 151 Creekwood Drive a storm water outfall conveys water through a concrete

headwall into a channel with a sand substrate and rip rap lined banks (Figure 5). The creek in this area was approximately 0.1 m deep with a 0.5 to 1 m wetted width. Riparian vegetation in the open area between 155 and 151 Creekwood Drive includes a non-native White Mulberry tree (*Morus alba*), Willow, White Spruce (*Picea glauca*) and White Ash (*Fraxinus Americana*), while the ground-level vegetation consisted of Coltsfoot (*Tussilago farfara*), Watercress, Common Buckthorn, Jewelweed and Forget-me-not (*Myosotis Sylvatica*) and mown grass.

Figure 5: Upstream view of structure where Harper Creek daylights, east of Creekwood Drive

Beyond the manicured areas and rip rap lined channel, the Creek exhibits natural stream meanders, rounded cobble, boulder and gravel substrates and step/pool morphology (Figure 6). Clearings are characterized by Sensitive Fern (*Onoclea sensibillis L.*) and Horsetail, and treed areas are dominated by Eastern White Cedar. As this reach approaches the main channel, several braids are apparent, all of which exhibit undercut banks, coarse woody debris and deep pools of approximately 0.5 m.

Figure 6: Downstream view of Harper Creek, east of Creekwood Drive

Reach 5: Bridlewood Park to Reach 4 confluence

Reach 5 flows through the concrete wingwall/headwall structure on the east side of Bridlewood Park to the confluence with open water channel that originates east of Creekwood Drive and is identified as Reach 4. Water flows through a storm sewer outlet over a concrete flow dissipater and into a rounded river rock channel. Riparian vegetation in this open area is characterized by Goldenrod, Jewelweed, Coltsfoot, Green Amaranth (*Amaranthus viridis*), Watercress, Asters and Staghorn Sumac (*Rhus typhina*). As water flows east, it enters the Harper Creek Wetland where vegetative cover primarily consists of Eastern White Cedar, with Basswood and Sugar Maple (*Acer saccharum*) present. Ground cover includes Sensitive Fern, Spinulose Wood Fern (*Dryopteris carthusiana*), Beaked Sedge (*Carex utriculata*) and Jack-in-the-Pulpit (*Arisaema triphyllum*) (Figure 7). Reach 5 has an approximate wetted width of 2m and depth of 0.15 m.

Figure 7: Downstream view of Reach 5

Reach 6: Harper Park through to Harper Road

Reach 6 flows through the City owned Harper Park and much of the Harper Creek Wetland. It exhibits a natural meandering flow and with wetted widths ranging from 1 m to 3m and has an approximate average depth of 0.2 m. The channel was incised and had undercut banks in some areas, abundant coarse wood debris and substrates composed of cobble, gravel and boulder.

This long reach flows through a natural area that lacks the anthropogenic markers that are prevalent in other sections of the watercourse (i.e. streets). For ease of identification, three locational markers were added to the Harper Creek Stream Reaches Map (Map 10) to assist in the spatial characterization of the variability in terrestrial and aquatic habitats. These markers are noted as "A", "B" and "C" on the map.

Reach 6 initially flows through a cedar-dominated forest with some White Birch (*Betula papyrifera*) and Sugar Maple. Ground vegetation is limited in this area and includes Zig Zag Goldenrod (*Solidago flexicaulis*), Marsh Bedstraw (*Galium palustre*), Jack-in-the-Pulpit. Openings in the overstory in the western section of Reach 6 has encouraged the growth of

Bracken Fern (*Pteridium aquilinum*), Poison Ivy (*Rhus radicans*), Common Buckthorn, Coltsfoot, Horsetail, Hog-peanut (*Alisma plantago-aquatica*) and Bittersweet Nightshade (*Solanum dulcamara*).

At "A", the creek is braided, with most of the flow being directed along the northerly main channel in habitat similar to that described above (Figure 8).

Figure 8: Downstream view of Reach 6 at location marker *1 as shown on Map 10

At "B", the riparian habitat opens to a deciduous woodland with tall Ostrich Ferns (*Matteuccia struthiopteris*) lining the banks. Basswood, Trembling Aspen, Black Ash (*Fraxinus nigra*), Manitoba Maple and Common Buckthorn formed the tree cover. From this point east to Harper Road, the Creek substrates become dominated by sand and silt as opposed to the cobbles and boulders typically observed in the upstream reaches (Figure 9).

At "C", riparian habitat transitioned to an open meadow marsh with Goldenrod species, Milkweed, Asters, Boneset (*Eupatorium perfoliatum L.*), Sensitive Fern, Cattails, Spotted Joe Pye Weed (*Eupatorium maculatum L.),* Canada Anemone (*Anemone Canadensis*) and Dogwood present. Average cover in this area was 0% to 25% though it may have been higher historically

based on the abundant presence of standing dead trees.The channel wetted width averaged 1.5 m and natural meanders with riffles and pools were observed. Aquatic plant species along this section of the Reach include Watercress and Arrowhead (*Sagittaria spp.*) (Figure 10). This open meadow marsh riparian habitat persisted as the Creek flowed north of the City materials recycling yard. A small seep was apparent to the north of the main channel, west of the recycling yard where groundwater flowed through a very narrow channel that was indistinguishable in some areas.

Figure 9: Downstream view of Harper Creek at Marker *2 as shown on Map 10

Immediately adjacent to the recycling yard, invasive and non-native species are more prevalent than in upstream reaches and included Dame's Rocket, Japanese Knotweed (*Polygonum cuspidatum*), Mullein (*Verbascum Thapsus*) and Field Cress (*Barbarea verna*).

The final 100 m of this Reach west of Harper Road changes from an open meadow habitat to one of virtually 100% tree cover consisting of Trembling Aspen, Balsam Poplar (*Populus balsamifera*) and Basswood. The Creek in this area appears to have had sufficient flow velocities to have flushed some of the sand and silt substrates through such that it exhibits the gravel and cobble substrate more characteristic of upstream reaches.

Figure 10: Upstream view of meadow marsh area, downstream of Marker *3 of Map 10

Reach 7: Harper Road to Byersville Creek

East of Harper Road, young-of-the-year Brook Trout have been observed in Harper Creek and the stream morphology meanders before being constrained by the railway embankment upstream of the confluence with Byersville Creek (Figure 11). The approximate wetted width and depth are 1.0 m and 0.5 m, respectively. The substrate in Reach 7 generally consists of sand and cobble. A stepped structure to facilitate fish passage, live stakes and erosion control blanket was observed at the downstream end of Reach 7, where Harper Creek discharges into Byersville Creek.

Riparian vegetation observed along Reach 7 includes Eastern White Cedar, Staghorn Sumac, Purple Loosestrife (*Lythrum salicaria L.*), Common Buckthorn, Tufted Vetch (*Vicia cracca L.*), Red Osier Dogwood (*Cornus stolonifera*), Canada Thistle (*Cirsium arvense*), Birdsfoot Trefoil, Green Amaranth (*Amaranthus viridis*), Nannyberry (*Viburnum lentago*), Common Elderberry, and Virginia Creeper (*Parthenocissus quinquefolia*). Wild Grape and Dog Strangling Vine (*Cynanchum rossicum*) were the dominant species along the railway embankment, and non-native species dominated the riparian area. Native species planting would enhance this area.

Figure 11: Downstream view of Reach 7

Reach 8: North Tributary/ Rye Street watercourse

Reach 8 is located west and northwest of 687 Rye Street. The initial section of this Reach has 75% to 100% cover comprised of Balsam Poplar, Tamarack (*Larix laricina*), Willow species, White Birch, Basswood and Trembling Aspen. From the northwest corner of the parking lot for 687 Rye Street the Creek flows south to Rye Street in an incised channel that appears to have been historically straightened so that it flows parallel to the west limit of the parking lot. Vegetative cover along this clear, fast flowing section diminishes to approximately 15% and includes Cattails, Red- Osier Dogwood and Purple Loosestrife and mown grass.

Upstream wetted widths in this section were approximately 0.45 m, widening to 1 m as it approaches to Rye Street. Gravel and cobble substrate was observed, with increasing amounts of sand closer to Rye Street. At Rye Street, the creek is redirected at a right angle and flows east along the north side of the road to Webber Avenue through a constructed channel that has gravel and sand substrates where cover varies from 0% to 50% (Figure 12).

Figure 12: Downstream view of Harper Creek along north side of Rye Street

At Webber Avenue, the watercourse is directed south under Rye Street through a culvert that forces the watercourse to take a 90 degree turn. Re-orienting this culvert may reduce sedimentation, erosion and flooding at the intersection of Webber and Rye Streets. Brook Trout have been noted in this section of Harper Creek. Rye Street is asphalt paved and has no curbs. The average wetted width and depth in this section of the Reach is approximately 1 m and de 0.3 m, respectively. Riparian vegetation along this Rye Street section includes Birdsfoot Trefoil, Queen Anne's Lace (*Daucus carota*), Coltsfoot, Purple Loosestrife, Swamp Milkweed (*Asclepias incarnate*), Canada Thistle, Canada Rush (*Juncus canadensis*), and Reed Canary Grass (*Phalaris arundinacea*), and mown grass and provides little to no shade to the watercourse.

Reach 9: Rye/Webber Avenue to Byersville Creek

This reach begins at the downstream outlet of the culvert at 740 Rye Street which conveys flow south under Rye Street, west of Webber Avenue. The Creek flows east parallel to the road, to the east limit of 740 Rye Street at which point significant sediment deposition was observed in the channel. A realignment of the culvert under Rye Street may improve the flow pattern in

this area, reduce flooding potential, erosion and sedimentation. This sediment build-up appears to inhibit surface water flows the road/ditch drainage area and has been identified. Flows appeared to be scouring the substrate at the base of a Bell telephone service box that is located adjacent to the road, east of the driveway for 740 Rye Street. Although this equipment in all likelihood installed outside of the watercourse, its' base is now at least intermittently in the flowing channel. Despite these physical challenges, the creek supports Brook Trout in this location and young-of-year and adult fish have been observed in this reach. The substrate was sandy with cobbles and the average width of the creek in this reach was 1.0 m with a depth of 0.3 m. At the east limit of 740 Rye Street, the creek turns sharply south and flows parallel to the east lot line to its outfall into Byersville Creek, south of 740 Rye Street, at the railway embankment.

Riparian vegetation in Reach 9 was minimal in the vicinity of Rye Street and consisted of manicured grass and Dandelion (*Taraxacum officinale*). Further downstream along this reach, upstream of its confluence with Byersville Creek, riparian vegetation provides up to 100% cover and includes Common Buckthorn, Slender Williow (*Salix exigua*), White Ash, Eastern White Cedar, Basswood, Trembling Aspen, Tickle Grass (*Agrostis hyemalis*), Swamp Milkweed, Canada Goldenrod, Wild Grape, and Poison Ivy (*Toxicodendron radicans*) (Figure 13).

Figure 13: Downstream view of Reach 9

Reaches 8 and 9 are physically isolated from Byersville Creek due to a very steep section of creek to the southeast of Rapid Lift's operations. This fish barrier has been identified by ORCA and the City of Peterborough as a restoration opportunity (and Area of Concern) because it leaves the upstream population of Brook Trout at high risk should a negative impact affect the watercourse.

7.3 Terrestrial Natural Cover

The Harper Creek watershed covers an area of 1.92 km^2. Of this area, 22.78% is forested, which is below the threshold of 30% considered necessary to support a full suite of forest-breeding bird species (Environment Canada, 2004). Forest cover forms part of the riparian cover of the creek and helps shade water, maintaining the cold/cool water regime. Riparian cover along Harper Creek, while extensive within Harper Park, accounts for only 1.13 km of the creek's total length of *3.19 km*. The 43% of channel length that is vegetated is below the guidelines set by Environment Canada, which recommend that 75% of a stream's length should be naturally vegetated. Easy gains here could be made along Rye Street, in particular, which is a good location to direct restoration efforts. Despite not meeting the Environment Canada guidelines,

for a watercourse in an urban setting, Harper Creek does have a good deal of riparian cover. For comparison, Byersville Creek is only naturally vegetated along 19% of its length. Harper Creek watershed benefits immensely from the protections afforded to Harper Park by the ownership of the City of Peterborough and the park and wetland designation.

In addition, 42% of the watershed is covered in impervious surfaces. This has a role in influencing the quality of runoff waters. Imperviousness also contributes to the 'flashiness' of a watercourse. This means precipitation flows rapidly from impervious surfaces into surface water systems instead of infiltrating and percolating more slowly through the soil into the groundwater.

7.4 Species at Risk

Species at Risk and their habitat need to be considered prior to conducting any work that will alter current habitat conditions. A search of the Natural Heritage Information Center (NHIC) database revealed that there are currently two publicly accessible plus one restricted access species at risk occurrences listed within the Harper Creek watershed. These species and their associated provincial and federal status* are listed in Table 4.

The species listed within an individual NHIC mapping tile as well as the status and the habitat management directives prescribed for those species are subject to change and as such it is imperative to conduct a NHIC search prior to commencing any works such as might be undertaken pursuant to the recommendations for creek maintenance provided in this Plan.

Table 4: Species at Risk in the Harper Creek Watershed

Common Name	Scientific Name	Provincial (SARO) Status*	Federal (COSEWIC) Status*
Butternut Tree	*Juglans cinerea*	Endangered	Endangered
Common Five-lined Skink	*Plestiodon fasciatus*	Special Concern	Special Concern
Sensitive Species	(Square 17QK10, last observed in 1964)	n/a	n/a

** current as of November 2012*

8.0 Aquatic Resources Assessment

8.1 Water Quality

Water quality affects both human and environmental health and can affect local property values and the economy of the region. Problems such as erosion or point sources of contamination may be discovered and mitigated through the analysis of water quality. The water quality of Harper Creek has been influenced by alterations of the watercourse, and urban development adjacent to the creek. To assess the water quality of Harper Creek, chemical, physical and biological parameters were investigated.

All water quality data and information analysed in this report was obtained from the ORCA Watershed Health Monitoring Program from 2001 to 2010 and the 2009 Harper Creek Temperature Study that was completed by the ORCA.

8.1.1 Water Quality Methodology

8.1.1.1 Water Chemistry

Water samples were analysed from a single site located immediately upstream of Harper Road on six dates from 2001 to 2010 (Map 11). Surface water samples were measured for physical and water chemistry parameters in the field using the YSI 650 MDS Multi-Meter probe. This meter was calibrated before sampling according to the MOE Protocol and the manufacturers recommended procedures for the following parameters:

- Total Dissolved Solids
- Conductivity
- pH
- Salinity
- Dissolved Oxygen
- Temperature

Parameters were evaluated in comparison to the Provincial Water Quality Objectives (PWQO) established by the MOE. These objectives represent levels of various surface water quality parameters that "are protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water" (Ontario MOE 1999). In those instances where a given parameter did not have an associated PWQO, it was evaluated in comparison to the Canadian Water Quality Guidelines (CCME 2005) for the Protection of Aquatic Life which are "meant to protect all forms of aquatic life and all aspects of the aquatic life cycles, including the most sensitive life stage of the most sensitive species over the long term", or where available, local guidelines established by the ORCA. Table 5 lists the surface water quality parameters analyzed in this report and the guideline or objective to which they were compared.

Table 5: Water Quality Parameters and Guidelines or Objectives

Parameter	Guideline/ Objective	Source
Total Dissolved Solids	300 mg/L	Provincial Water Quality Objective
Conductivity	400 µs/cm	Otonabee Region Conservation Authority
pH	6.5-8.5	Provincial Water Quality Objective
Salinity	0.4 %	Otonabee Region Conservation Authority
Dissolved Oxygen	6.5 mg/L	Canadian Water Quality Guideline for cold water biota
Total Suspended Solids	5 mg/L	Otonabee Region Conservation Authority

8.1.1.2 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates are often considered to be a better representation of aquatic health than fish, primarily due to the ability of fish to quickly relocate to more suitable habitats. Benthic macroinvertebrates are the "bugs" that live in the bottom of watercourses and wetlands. Since their distribution in aquatic systems is dependent on environmental conditions, they are frequently used as water quality indicators. Different species of benthic macroinvertebrates have different levels of tolerance to pollution making them an excellent water quality assessment tool. The presence or absence, and relative abundance of benthic macroinvertebrates at a point location are a good indicator of aquatic ecosystem health. For example, worms and leeches are much more tolerant of pollution than stonefly nymphs. Habitat type may also influence community composition due to individual species requirements.

Samples were collected at one location in Harper Creek at Harper Road on six dates between 2001 and 2010 (Map 12, Table 6). Benthic sampling was undertaken using the travelling kick and sweep method, with benthos collected in a hand-held D-net with 500 µm mesh. Generally, three replicate samples were collected at each site during each sampling event.

Table 6: Benthic Data for Harper Creek at Harper Road

Year	Season
2001	Spring
2002	Spring
2003	Spring
2008	Spring
2008	Fall
2009	Fall
2010	Fall

Sampling was performed for approximately 10 minutes per replicate or until it was certain that over 100 bugs were collected. Habitat information and water chemistry were recorded for each site and benthic macroinvertebrates were identified to a coarse 27 group level.

Benthic macroinvertebrate data was analysed using two common metrics: the Hilsenhoff Index and Simpson's Diversity Index (Appendix 5). The Hilsenhoff Index measures the likelihood of organic pollution in water on a scale of 0 – 10 as detailed by Table 7. The Simpson's Diversity Index assesses species richness and abundance ranging from 0.0 (low species diversity) to 1.0 (high species diversity).

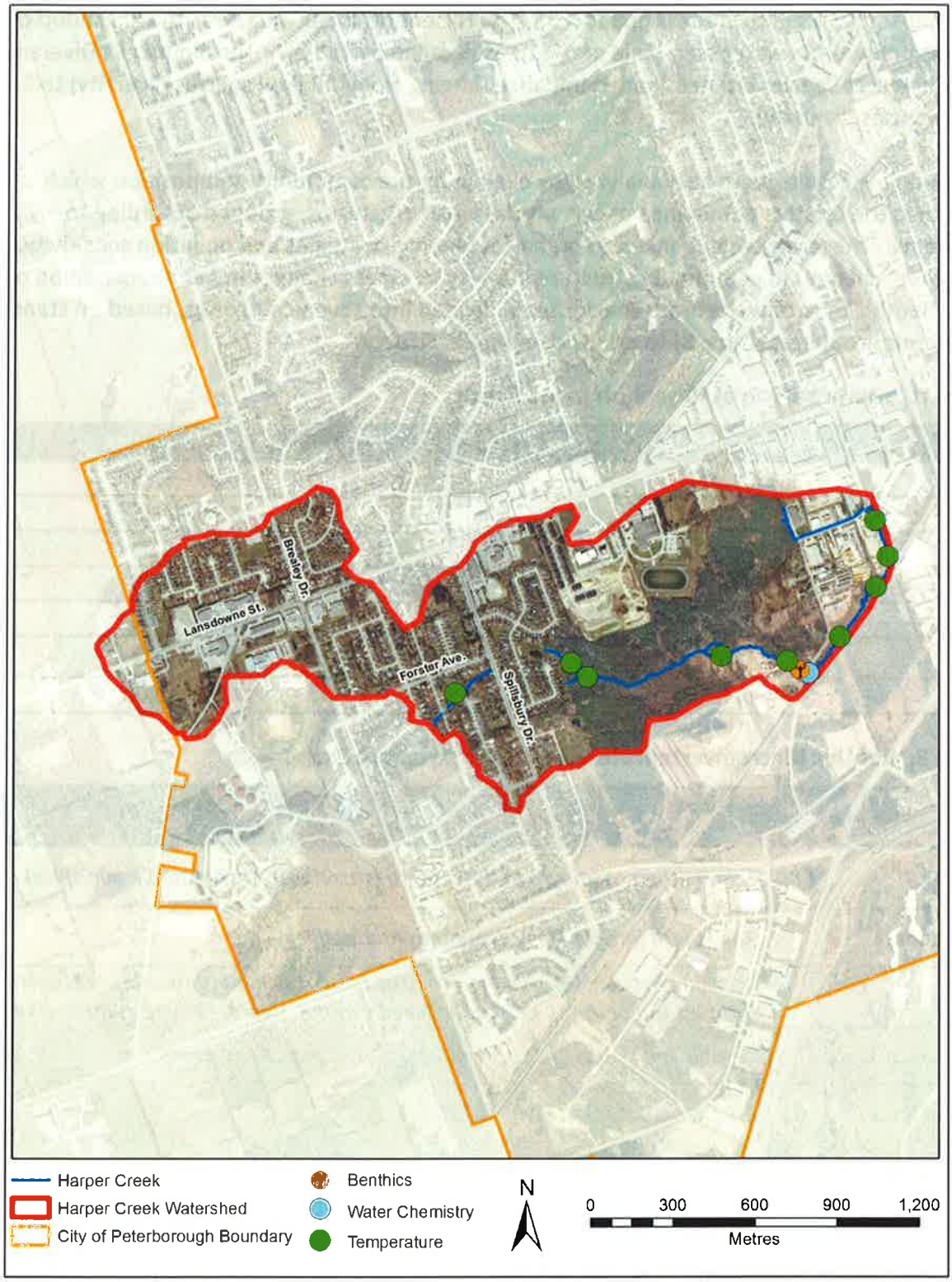
The sampling results were also analyzed by examining the community composition which illustrates the relative dominance of certain classes of organisms, grouped according to taxonomy. These classes are linked to organism feeding strategies and pollution sensitivities. Examining changes in community structure is a way to assess changes in habitat condition over time. Benthic macroinvertebrate species were divided into seven categories, based on standard taxonomic groupings (Table 8) to assess community structure.

Table 7: Interpretation of Hilsenhoff Index Results

Water Quality	Hilsenhoff Index
Excellent	0.00 – 3.75
Very Good	3.76 – 4.25
Good	4.26 – 5.00
Fair	5.01 – 5.75
Fairly Poor	5.76 – 6.50
Poor	6.51 – 7.25
Very Poor	7.26 – 10.00

Table 8: Benthic Macroinvertebrate Community Structure Classes

Community Structure Ratio	Taxonomic Groups Included
% EPT	*Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)*
% Odonata	*Anisoptera (dragonflies), Zygoptera (damselflies)*
% Other	*Acarina (water mites), Hemiptera (true bugs), Coleoptera (beetles), Megaloptera (fishflies & alderflies), Ostracoda (seed shrimp), Hydra, Platyhelminthes (flatworms)*
% Malacostraca	*Amphipoda (scuds), Isopoda (sowbugs), Decapoda (crayfish)*
% Mollusca	*Gastropoda (snails), Bivalvia (clams)*
% Worms	*Oligochaeta (aquatic earthworms), Nematoda (round worms), Hirudinea (leeches)*
% Diptera	*Chironomidae (non-biting midges), Simuliidae (black flies), Tipulidae (crane flies), Culicidae (mosquitoes), Ceratopogonidae (biting midges), Other Diptera*



Map 11: Monitoring Locations in Harper Creek

8.1.2 Water Quality Results and Discussion

Tables 10 shows the results of surface water monitoring from 2002 to 2010 at a single site along Harper Creek, upstream of Harper Road. Highlighted cells represent exceedences of the water quality objective.

Table 9: Surface Water Sampling Data Harper Creek at Harper Drive

Date	Temperature (°C)	DO (mg/L)	Conductivity (µS/cm)	TDS (mg/L)	pH	Salinity
Guideline/ Objective	**n/a**	**5 mg/L**	**400**	**300**	**6.5 - 8.5**	**0.40**
21-Oct-10	9.32	9.28	437	406	7.24	0.30
15-Oct-09	6.65	13.50	410	407	7.71	0.31
02-Oct-08	10.54	13.54	654	425	7.97	0.32
15-May-08	11.06	12.85	589	383	7.49	0.29
23-Apr-03	9.67	14.91	621	n/a	8.14	0.30
11-Apr-02	6.50	11.89	670	312	7.50	0.30

Temperature

Water temperatures in Harper Creek upstream of Harper Road range from 6.5°C to 11.06°C when recorded in conjunction with water chemistry sampling undertaken from 2002 to 2010. In 2010, the ORCA completed the Harper Creek Water Temperature Study to assess the thermal classification of Harper Creek. Refer to Section 8.2 of this report for details of this study.

Dissolved Oxygen

Dissolved oxygen (DO) is essential to the respiratory metabolism of most aquatic organisms. It affects the solubility and availability of nutrients, which can impact the productivity of aquatic ecosystems. Low DO levels facilitate the release of nutrients from the sediments. DO is important for aquatic life, and the amount of DO in surface water is a widely used indicator of overall aquatic ecosystem health. The Canadian Water Quality Guideline (CWQG) for DO for cold water biota is 6.5 mg/L (CCME 1999). Unlike the other water quality parameters discussed in this report, this guideline is the *minimum* acceptable level, rather than the maximum.

DO levels consistently met the guideline averaging of 12.67 mg/L.

Conductivity

Conductivity may be used to estimate the total ion concentration of the water and is often used as an alternative measure of TDS. High levels of conductivity can indicate water quality impairment, but further investigation of other parameters is necessary to determine causes. ORCA uses a local guideline of 400 µs/cm.

Although the two lowest conductivity levels were recorded in the most recent sampling years, 2009 and 2010, all samples exceeded the guideline, ranging from 410 µs/cm to 670 µs/cm.

Total Dissolved Solids

Total dissolved solids (TDS) is a measure of the amount of dissolved solids in the water column. High levels of TDS limit the suitability of water as a drinking source and irrigation supply and may interfere with the clarity, colour, and taste of manufactured products. ORCA uses a local guideline of 300 mg/L.

TDS levels exceeded the guideline consistently and averaged 387 mg/L.

pH

High pH values in water tend to facilitate the solubility of ammonia, heavy metals and salts. Low pH levels tend to increase carbon dioxide and carbonic acid concentrations. Lethal effects of pH on aquatic life occur below pH 4.5 and above pH 9.5. Acid precipitation and industrial discharges are the main causes of extreme pH levels. The Provincial Water Quality Objective for pH is 6.5 to 8.5.

Levels of pH have all been within the acceptable range.

Salinity

Salinity is a measure of the amount of dissolved salts such as chloride, sodium, magnesium, calcium, and potassium within the water. High salinity levels may have a negative impact on aquatic biota. Typical sources of salinity include road salt and naturally occurring salts. Levels of salinity between 0.10% and 0.25 % are typical for surface waters in the ORCA watershed, and levels above 0.40% are considered elevated.

Salinity levels have varied minimally and have consistently met the guideline.

8.1.3 Water Chemistry Summary

The main water quality issues identified within Harper Creek appear to be sediment loading as evidenced by the associated elevated levels of Conductivity and TDS which are likely the result of urbanization and development within the watershed. Sources of conductivity and TDS include erosion, minerals, and pesticides which tend to occur more frequently with overland flows in urbanized areas.

Sedimentation has the potential to negatively impact aquatic habitat, smother fish eggs, damage fish gills, impede the growth of aquatic vegetation due to reduced light penetration, bury groundwater upwellings and spawning gravels, and alter water temperatures as a result of changed flow parameters.

Urban development including residential, commercial and industrial land uses, parking lots and

road crossings can contribute sediment to the creek. Maintaining and establishing healthy riparian areas comprised of native vegetation can protect the watercourse by stabilizing banks, reducing erosion and filtering contaminants from urban runoff before they enter the creek.

8.1.4 Benthic Macroinvertebrate Results and Discussion

From 2001 to 2010 benthic macroinvertebrate samples were collected from a single location along Harper Creek, upstream of Harper Road (Map 11). Summaries of calculated index values and % community composition are documented in Table 10 for each of the seven sampling events.

Table 10: Benthic Data for Harper Creek, 2001 to 2010

Year	Season	Hilsenhoff Index	Simpson's Index	Community %						
				Diptera	Malacostraca	Mollusca	EPT	Odonata	Worms	Other
2001	Spring	5.00	0.68	46.4	12.2	0.4	40.5	0.0	0.0	0.4
2002	Spring	5.83	0.76	15.0	36.1	0.5	48.4	0.0	0.0	0.0
2003	Spring	6.62	0.63	58.8	23.5	2.0	14.3	0.0	1.5	0.0
2008	Spring	5.75	0.59	14.8	62.7	0.0	16.9	0.0	2.7	3.0
2008	Fall	5.95	0.46	2.9	80.6	0.0	14.6	0.0	1.0	0.9
2009	Fall	6.07	0.60	9.4	70.8	4.8	13.2	0.0	0.6	1.2
2010	Fall	5.22	0.70	9.6	38.2	0.0	39.9	0.0	5.3	7.0

Results of a single sampling event are representative of the benthic community at a given location and time, and are not necessarily indicative of conditions throughout the watercourse. Benthic community composition also varies seasonally, with some organisms being more abundant at certain times of the year.

Hilsenhoff Index values ranged from 5.00 (indicating "good" water quality) in 2001 to 6.62 (indicating "poor" water quality) in 2003. This range suggests that "some" to "very substantial" organic pollution is likely.

The Simpson's Diversity Index ranged from 0.46 in 2008 to 0.76 in 2002. Excluding 2008 (two lowest index values), the index ranged from 0.60 to 0.76, which is indicative of relatively high species diversity, a characteristic that is often associated with a healthy ecosystem.
The benthic community composition in the spring varied from year to year (Figure 14). *Diptera* (i.e. mosquitos, blackflies) and *Malacostraca* (i.e. scuds, crayfish) are typically pollution tolerant taxa, and combined, they represented the majority of the community each sample year. In

2003 and 2008, the proportion of pollution tolerant taxa was noticeably greater than in 2001 and 2002. Conversely, 2001 and 2002 samples contained a higher level of pollution sensitive *EPT* (caddisflies, stoneflies and mayflies) than in 2003 and 2008.

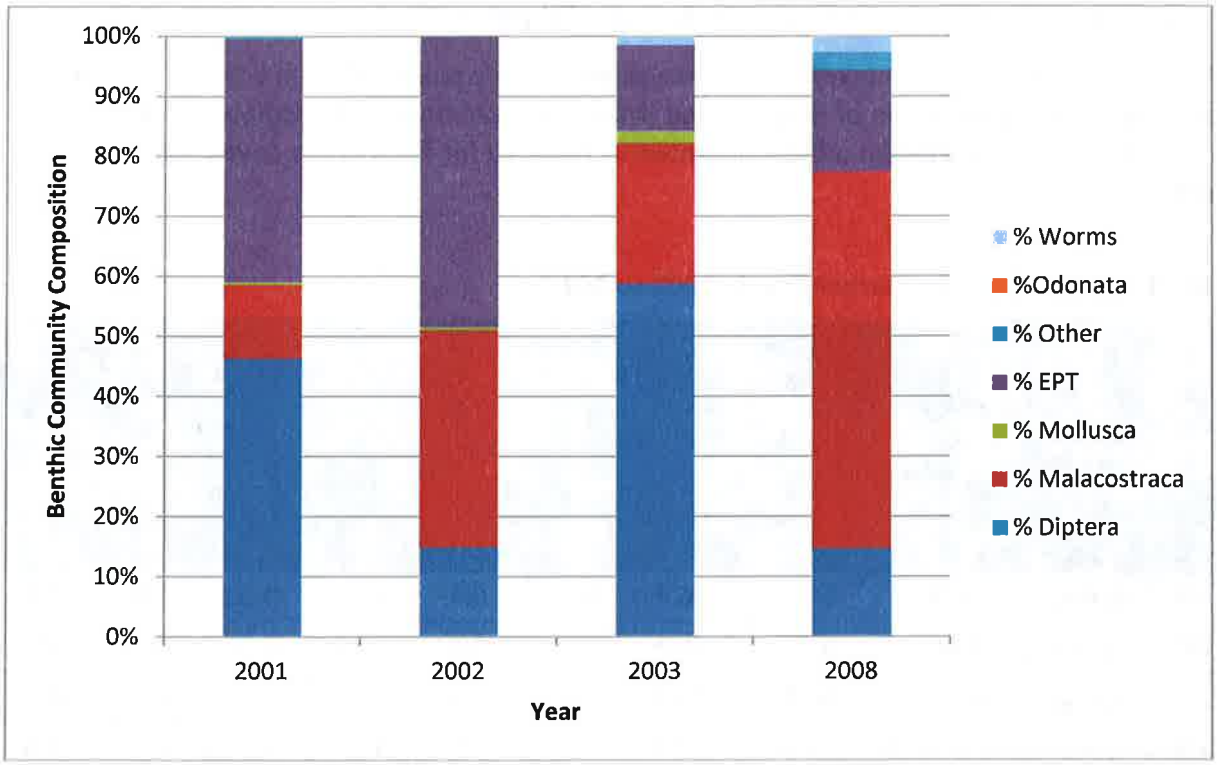


Figure 14: Spring Benthic Community Structure in Harper Creek upstream of Harper Road

The Fall benthic community composition demonstrated annual variation (Figure 15). Pollution tolerant *Malacostraca* dominated the community in 2008 and 2009, comprising 80.6 and 70.8%, respectively. During the same years, pollution sensitive *EPT* taxa made up no more than 15% of the benthic community. However, in 2010, the percentage of *Malacostraca* dropped to 38.2% and the percentage of EPT increased to almost 40% of the benthic community.

8.2 Thermal Classification

The temperature of water affects the solubility of many chemical compounds and can therefore influence the effect of pollutants on aquatic life. Increased temperatures elevate the metabolic oxygen demand, which in conjunction with reduced oxygen solubility, impacts many species. Temperature can be affected by development, agricultural use, industrial discharges and the alteration of flow patterns. Water temperature and air temperature data can be used to classify fish habitat and assess the habitat suitability of an area to support specific aquatic species. Water temperature was monitored in Harper Creek to ensure that existing water temperatures were documented as a basis for comparison in the future.

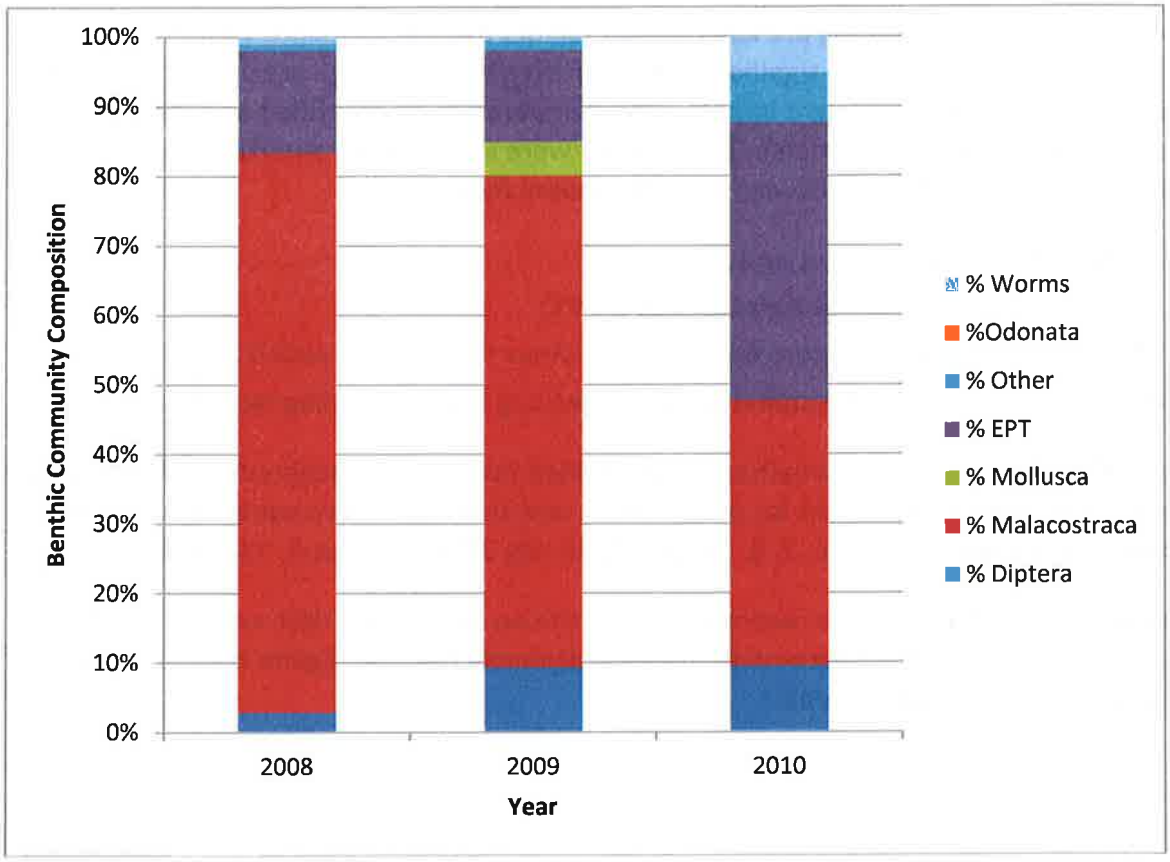


Figure 2: Fall Benthic Community Structure in Harper Creek upstream of Harper Road

The water temperature data, discussion and results that are presented in this report are based on the 2009 Harper Creek Temperature Study completed by the ORCA. A copy of this report accompanies the 2009 Harper Creek Management Plan. The Study was undertaken to classify the thermal regime of the creek.

8.2.1 Thermal Monitoring Methodology

The 2010 Harper Creek Temperature Study was completed by the ORCA to investigate and classify the thermal regime of the watercourse. On June 30, 2010, HOBO Water Temp Pro temperature loggers were installed at nine locations along Harper Creek, each placed beyond any apparent direct influencers such as groundwater inputs or storm water inputs and secured in place using a steel pin anchored into the substrate (Map 13). These loggers have an accuracy of +/- 0.20°C at 25.0°C and were programmed to record daily water temperature every half hour between 16:00 and 18:00 hours, the time of day that typically represents the maximum daily water temperature (Chu et al, 2009).

All nine temperature loggers were successfully retrieved in October 21, 2010, and the water temperature data that each recorded was downloaded for analysis (Map 12).

Air temperature and precipitation are key weather factors that can influence water temperature. It is important that significant weather events such as high precipitation or major swings in air temperature that might impact water temperature be identified and removed from the analysis of thermal regime(s). Target dates were identified by analyzing the data to identify those dates where the following conditions were met:

1. Data collected between July 1 and August 31;
2. Daily maximum air temperature exceeded 24.4°C;
3. Daily maximum air temperature on each of previous two days exceeded 24.4°C; and
4. Base flow conditions (no precipitation on a given day or on preceding two days).

Analysis of Environment Canada weather data identified five dates throughout the study period for which the prescribed conditions for precipitation and air temperature were met. These 2010 target dates were July 4, 5, 6, 7, 8, 13, 14, 15, 16, 26, 27 and August 3, 13, 14, and 30.

The maximum water temperature recorded at each site on each target date was plotted on nomogram (Chu et al, 2009) to determine the most probable thermal regime classification at each logger location in Harper Creek.

Map 12: Location of Temperature Loggers in Harper Creek

8.2.2 Thermal Monitoring Results

Harper Creek demonstrates a typical stream thermal gradient throughout its midsection, with water temperatures generally increasing. Overall, water temperatures decreased from the headwaters area to its outlet at Byersville Creek. The atypically warm water temperatures identified in the headwaters area may be attributed to the thermal impacts associated with the surrounding urban and residential development. As the creek flows eastward through the relatively pristine, naturally vegetated area of Harper Park, water temperatures were observed to decrease.

Ground water inputs contribute to the predominantly cold and cool water temperatures observed throughout Harper Creek. The dense canopy found throughout much of Harper Park also shades the watercourse and contributes to the maintenance of the relatively cooler temperatures. Together, these natural features buffer the thermal impacts associated with urban development, particularly where such land use is adjacent to the Creek.

Harper Creek demonstrates a typical stream thermal gradient from Site 4 through to Site 7 with water temperatures generally increasing (Figure 15, Map 13). The atypically relatively warm water temperatures identified in the headwater area (Sites 1, 2, and 3) may be attributed to the thermal impacts associated with the surrounding and upstream urban and residential development. There is often variability from one location to another along a watercourse due to factors that include the influence of groundwater inputs, inflows from tributaries, changes to riparian vegetation that alter shade conditions, surface runoff, and surrounding land use(s). Ground water inputs contribute to the predominantly cold-cold-cool water temperatures observed throughout the Creek, without which the thermal regimes would be more significantly impacted by conditions resulting from adjacent land use activities.

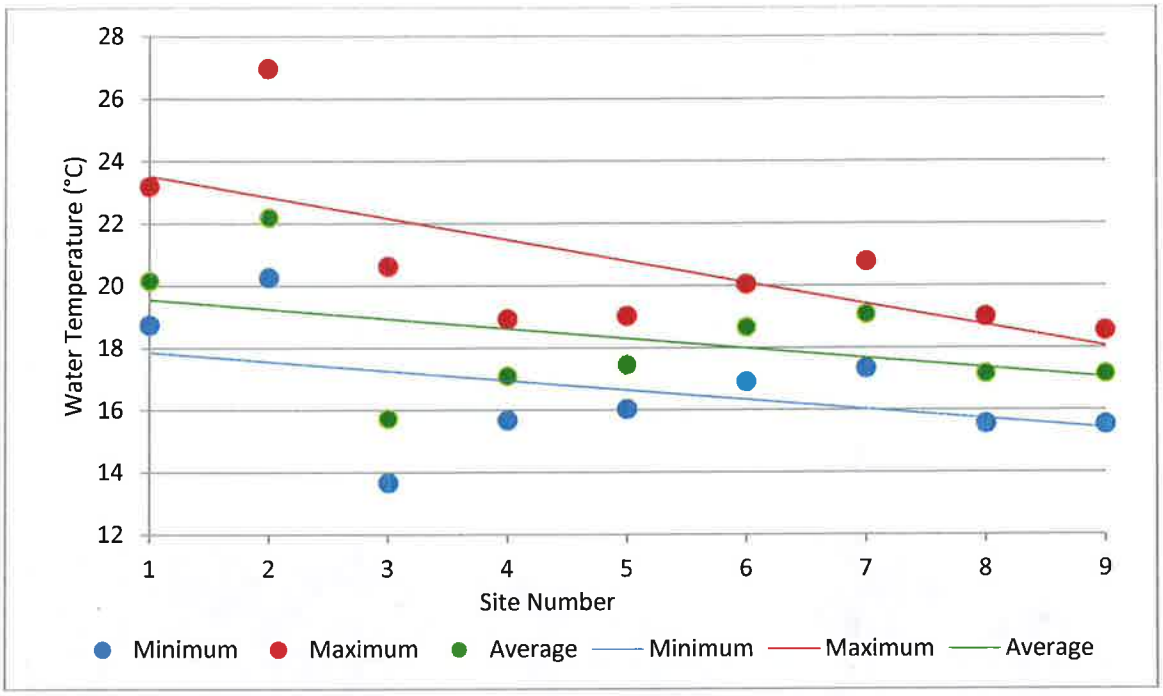
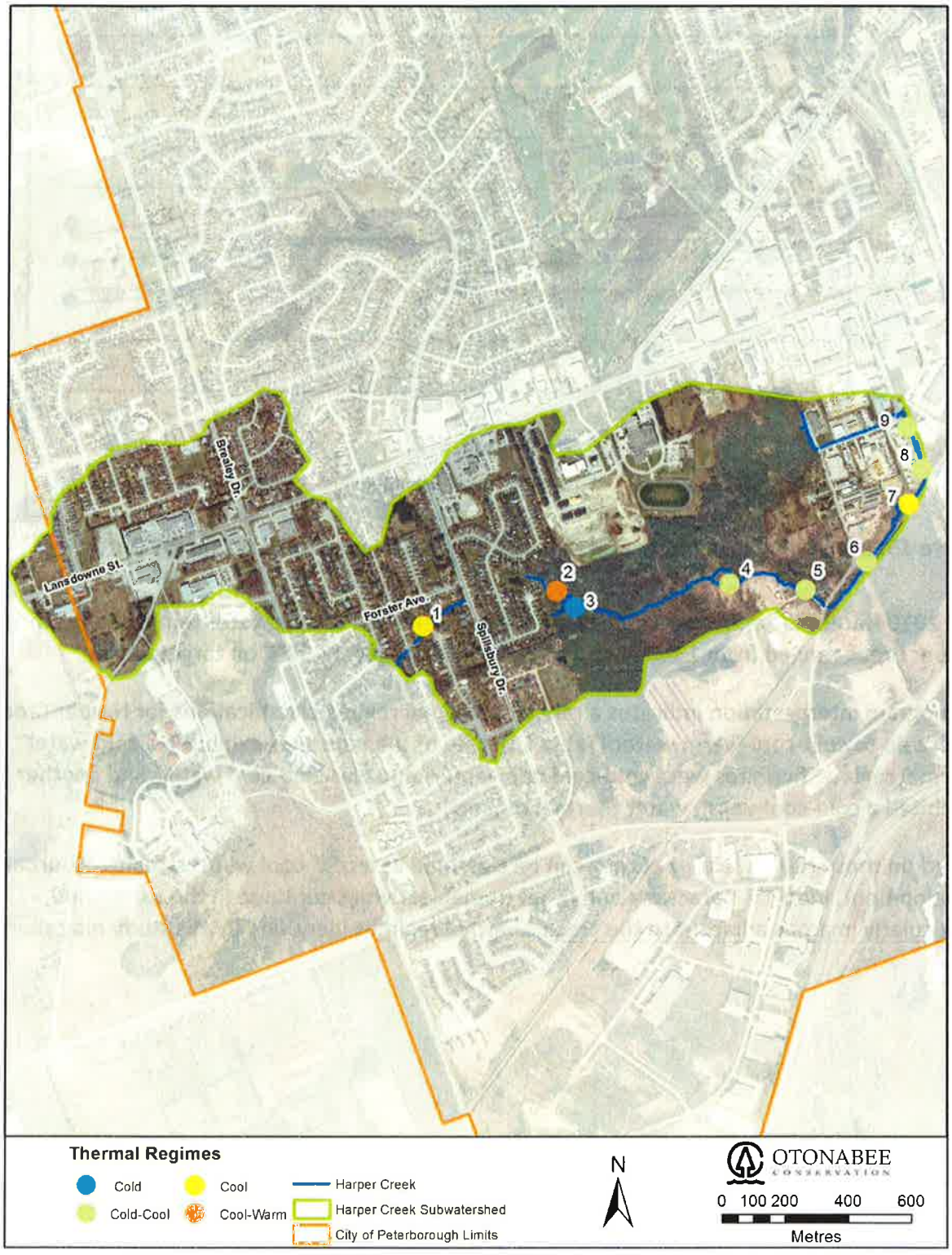


Figure 15: Minimum, Maximum, and Average Water Temperatures on Target Dates

The 2010 Harper Creek Water Temperature Study determined that water temperatures in Harper Creek ranged from 13.67°C to 26.97°C and averaged 18.30°C on target dates.

Nomogram interpretation indicates a range of thermal regime classifications for Harper Creek from cold to cold-cool-warm water (Table 11). One of the nine sites exhibited a cold water thermal regime, five sites were cold-cold-cool water, one was cold-cool water, and another site exhibited a cold-cool-warm water thermal regime.

Based on these results, Harper Creek can be classified as a cold-cool water stream. As urban development, industrial practices and other human activities continue in the watershed, particularly in areas adjacent to the creek, thermal regimes identified in this study may change.



Map 13: Thermal Regimes of Harper Creek

Table 11: Summary of Thermal Regimes

Site	Cold	Cold-cold-cool	Cold-cool	Cold-cool-warm
1			•	
2				•
3	•			
4		•		
5		•		
6		•		
7			•	
8		•		
9		•		

8.3 Fisheries

Based on the findings of the 2010 Harper Creek Temperature Study (ORCA, 2010), Harper Creek is capable of supporting cold and warm water fish species.

Fish data from 1991 to 2009, including incidental observations by ORCA staff, indicates that cold water fish species are present in Harper Creek. Table 12 lists the fish species that have been historically identified in Harper Creek by the Ontario Ministry of Natural Resources, along with the thermal regime and preferred water temperature for each species.

Table 12: Harper Creek Fish Inventory

Harper Creek Fish Data, 1991-2009 (ORCA)			
Fish Species	**Scientific Name**	***Thermal Regime**	***Preferred Temperature (°C)**
Slimy Sculpin	*Cottus cognatus*	Cold	11.5
Brook Trout	*Salvelinus fontinalis*	Cold	16.0
Mottled Sculpin	*Cottus bairdii*	Cold	16.6
Rock Bass	*Ambloplites rupestris*	Cold-cool	20.5
Blacknose Dace	*Rhinichthys atratulus*	Cool	24.6
Pumpkinseed	Lepomis gibbosus	Warm	26.0

(*Coker et al. 2001)

Water temperature plays a critical part in determining spawning locations for cold water fish species. Site specific habitat characteristics that enable cold water fish species to inhabit Harper Creek include the amount and type of riparian vegetation, presence of groundwater

seepages, stream substrate, barriers to movement, length of watercourse, surficial geology and surrounding land uses. The presence of riparian vegetation, groundwater, gravely substrates and few barriers contribute to Harper Creek's suitability for cold water fish species including Brook Trout, Slimy Sculpin, and Mottled Sculpin.

The majority of the water temperatures recorded by the 2009 Harper Creek Water Temperature Study were within the range characterized by cold-cold-cool water streams (Chu et al. 2009). Fisheries data confirms that while Harper Creek generally exhibits the characteristics of a cold-cool water stream, it also supports warm water fish species, which is an indication that Harper Creek is experiencing thermal stress.

8.4 Aquatic Resources Assessment Summary

Overall analysis of water chemistry and benthic macroinvertebrate data indicates that urban development and land use activities may be impacting water quality and associated aquatic habitat within Harper Creek.

Water chemistry results are indicative of Harper Creeks' urban setting. Observed exceedences of conductivity and TDS suggest that overland runoff may be carrying anthropogenic compounds into the watercourse. The most recent benthic sampling indicates a level of organic pollution, with the most recent samples indicating "fair" to "fairly poor" water quality based on community composition. Benthic species diversity indicates a healthy ecosystem.

Similar to Peterborough's other cold water creek, Byersville, much of the headwater areas of Harper Creek have been altered. Significant portions of the western headwaters have been piped underground through storm sewers and the northern tributary has been conveyed via open ditching along the edge of a curbless urban road through an industrially developed area.

Despite the urban pressures exerted on Harper Creek, a significant portion of it has been protected as a result of the Harper Creek Wetland designation and the City-held ownership of Harper Park. Substantial groundwater upwellings are apparent throughout the Harper Creek Wetland and Harper Park and contribute to the cold-cool water thermal classifications for this creek. These features also help to perpetuate the suitability of the creek for Brook Trout and other cold water fish species.

9.0 Conclusions

Harper Creek has a total of twenty six structures and eight Areas of Concern. Harper Creek exhibits a range of terrestrial and aquatic characteristics as it flows through the City of Peterborough from its headwaters proximate to commercial/residential development, through residential and open space areas and finally flowing through an industrial/commercial area where it outlets to Byersville Creek.

This cold-cool water creek system supports endangered species in its riparian areas (e.g. Butternut trees) and native Brook Trout. Riparian vegetation is largely composed of native species although some invasive species are present (e.g. Dame's Rocket).

As a direct result of its urban setting, the watercourse has been subject to various alterations to facilitate infrastructure works including the construction of storm water management ponds, channel riprap, underground piping and the installation of culverts to accommodate urban transportation needs (i.e. roads).

It is anticipated that Harper Creek will increasingly be subjected to the impacts associated with urban expansion such additional storm water discharge points and increased areas of impervious surface. Efforts should be made to ensure the downstream impacts are mitigated/ minimized and that the cold water thermal characteristics of Harper Creek are maintained.

It is recommended that the City undertake efforts to protect this unique urban cold water stream, particularly where development exists/is undertaken adjacent to the watercourse, headwater areas and the Harper Creek Wetland, through the restoration of identified Areas of Concern and the naturalization and enhancement of riparian areas. Recommended maintenance activities focus on the clean-out of areas of heavy sediment or debris build-up and riparian enhancement.

Habitat enhancements opportunities include improving the quality of storm water inputs and runoff by planting wide, vegetated buffers comprised of native species that will filter runoff, limit sedimentation, stabilize banks, and reduce erosion. Areas that would most benefit from significant riparian planting include Reaches 7 and 8 and the initial section of Reach 9.

Downstream of Harper Park (Reaches 7, 8 and 9), the watercourse is located within industrially zoned areas in the City of Peterborough and is highly constrained by the railway embankment and roadways. Enhancements to the watercourse in this area using natural channel design would enhance habitat significantly. Eliminating the present barriers to fish passage in Reach 9 will assist in alleviating pressure on the isolated Brook Trout population known to inhabit Reaches 8.

Opportunities to increase maintenance access and provide recreational areas along the Harper Creek will increase public awareness of an appreciation for this unique cold water watercourse and contributed improved water quality and habitat.

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11.0 Glossary of Terms

Cold Water Stream: Temperature of 5 - 18 degrees Celsius; fish species indicators include sculpins and trout, benthic indicators include stoneflies.

Cold-cool Water Stream: Temperature of 18 - 25 degrees Celsius, combinations of warm and cold water fish species and benthic indicators.

Debris: Foreign material which does not improve the quality of the stream such as litter, as well as natural debris including stumps, logs, and detritus which can provide habitat.

In water work: Any activity that occurs within the bankfull channel.

Riparian: Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water.

Watercourse: A channel that carries water from an area to a receiving water body. These watercourses may be either perennial or intermittent in nature. Roadside ditches that receive runoff only from adjacent road and sheet flow from adjacent land are not considered to be watercourse.

Wetland or Wetland area: "Any low lying area land which may serve a reservoir function and be, for hydrological purposes, a wetland." (L. Kamerman, Mining and Lands Commissioner, Donald Bye vs Otonabee Region Conservation Authority, November 19, 1993 - unreported). Such areas may or may not be wetlands identified by the Ministry of Natural Resources. Where a wetland is identified by the Ministry of Natural Resources that fact will be considered in decision-making.

Appendix 1: Harper Creek Structures Inventory

Harper Creek Structures Inventory

Structure Number S-9000 **Easting** 709306 **Northing** 4905783 **Stream Type** Cold

Stream Name Harper Creek **Location** Harper Creek at 453 Dobbin Road

Structure	Length	Year Built	Fish Observed	Public Land	
Concrete Culvert	Unknown	Unknown	No	Private Land	☐

Culvert 1 Rise 0.70m **Structure Condition** New

Culvert 1 Span 0.70m **Problem Description** Structure in good condition, no issues.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Storm sewer outfall culvert into stormwater management pond

Record 1 of 26

Harper Creek Structures Inventory

Structure Number S-9001 **Easting** 709266 **Northing** 4906167 **Stream Type** Cold

Stream Name Harper Creek **Location** Adjacent to 1931 Lansdowne Street West

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Culvert	Unknown	Unknown	No	☑	☐

Culvert 1 Rise 0.30m **Structure Condition** Good

Culvert 1 Span 0.45m **Problem Description** Structure in good condition, no issues.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Road drainage inlet

Record 2 of 26

Harper Creek Structures Inventory

Structure Number	S-9005	**Easting**	709334	**Northing**	4905445	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Harper Creek at 453 Dobbin Road				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Box Culvert	Unknown	Unknown	No	☑	☐

Culvert 1 Rise	2.30m	**Structure Condition**	Good		
Culvert 1 Span	2.10m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Storm sewer inlet from stormwater management pond

Record 3 of 26

Harper Creek Structures Inventory

Structure Number	S-9010	**Easting**	710203	**Northing**	4905359	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Stenson Park located off Waddell Avenue				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Culvert	Unknown	Unknown	No	☑	☐

Culvert 1 Rise	1.60m	**Structure Condition**	Good		
Culvert 1 Span	1.40m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Storm sewer outfall into stormwater management pond

Record 4 of 26

Harper Creek Structures Inventory

Structure Number	S-9015	**Easting**	710214	**Northing**	4905370	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Stenson Park located off Waddell Avenue				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	**Private Land**
Concrete Culvert	Unknown	Unknown	No	☑	☐

Culvert 1 Rise	1.00m	**Structure Condition**	Good
Culvert 1 Span	1.00m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Stormwater management pond inlet

Record 5 of 26

Harper Creek Structures Inventory

Structure Number	S-9020	**Easting**	710211	**Northing**	4905375	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Stenson Park located off Waddell Avenue				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	☑
Concrete Culvert	Unknown	Unknown	No	**Private Land**	☐

Culvert 1 Rise	1.20m	**Structure Condition**	Good		
Culvert 1 Span	1.30m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Storm sewer outfall

Record 6 of 26

Harper Creek Structures Inventory

Structure Number S-9025 **Easting** 710246 **Northing** 4905417 **Stream Type** Cold

Stream Name Harper Creek **Location** Between 699 and 691 Pinewood Drive

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Box Culvert	31.10m	Unknown	Yes	☑	☐

Culvert 1 Rise 0.40m **Structure Condition** Good

Culvert 1 Span 1.78m **Problem Description** Structure in good condition. Capacity limited due to height of culvert.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Looking downstream at culvert

Record 7 of 26

Harper Creek Structures Inventory

Structure Number	S-9026	**Easting**	710245	**Northing**	4905420	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	699 Pinewood Drive				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	
PVC	11.20m	Unknown	Yes	**Private Land**	☑

Culvert 1 Rise	0.30m	**Structure Condition**	Good
Culvert 1 Span	0.30m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Driveway ditch drainage into Harper Creek

Record 8 of 26

Harper Creek Structures Inventory

Structure Number	S-9027	**Easting**	710273	**Northing**	4905440	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Paved walking path that links Fortye Drive and Pinewood Drive (698 Pinewood Drive)				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	**Private Land**
PVC	10.50m	Unknown	Yes	☑	☐

Culvert 1 Rise	0.35m	**Structure Condition**	Good
Culvert 1 Span	0.35m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Pavement drainage into Harper Creek

Record 9 of 26

Harper Creek Structures Inventory

Structure Number	S-9030	**Easting**	710423	**Northing**	4905576	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Harper Creek adjacent to 717 Spillsbury Drive				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Culvert	Unknown	Unknown	Yes	☑	☐

Culvert 1 Rise	0.77m	**Structure Condition**	Good
Culvert 1 Span	0.90m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Culvert inlet

Record 10 of 26

Harper Creek Structures Inventory

Structure Number	S-9035	**Easting**	710627	**Northing**	4905654	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Bridle Park located off Ramblewood Drive				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	**Private Land**
Concrete Culvert	Unknown	Unknown	Yes	☑	☐

Culvert 1 Rise	1.80m	**Structure Condition**	Good
Culvert 1 Span	1.80m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Culvert outfall

Record 11 of 26

Harper Creek Structures Inventory

Structure Number	S-9040	**Easting**	710527	**Northing**	4905386	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Adjacent to 662 Spillsbury Drive				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
Concrete Culvert	Unknown	Unknown	No	☑	☐

Culvert 1 Rise	0.60m	**Structure Condition**	Good		
Culvert 1 Span	0.60m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Storm sewer outfall

Record 12 of 26

Harper Creek Structures Inventory

Structure Number	S-9045	**Easting**	710709	**Northing**	4905333	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Between 151 and 155 Creekwood Drive				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	**Private Land**
Concrete Culvert	Unknown	Unknown	Yes	☑	☐

Culvert 1 Rise	0.50m	**Structure Condition**	Good
Culvert 1 Span	0.55m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Culvert outfall

Record 13 of 26

Harper Creek Structures Inventory

Structure Number S-9050 **Easting** 711572 **Northing** 4905563 **Stream Type** Cold

Stream Name Harper Creek **Location** Under Harper Raod

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	12.30m	Unknown	Yes	☑	☐

Culvert 1 Rise 0.90m **Structure Condition** Failing

Culvert 1 Span 0.90m **Problem Description** Culvert rusted and collapsing under Harper Rd.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Culvert under Harper Road

Record 14 of 26

Harper Creek Structures Inventory

Structure Number	S-9051	**Easting**	711571	**Northing**	4905561	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Driveway to City recycling yard and composting facility				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	**Private Land**
CSP	15.10m	Unknown	No	☑	☐

Culvert 1 Rise	0.34m	**Structure Condition**	Good
Culvert 1 Span	0.40m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Ditch drainage culvert

Record 15 of 26

Harper Creek Structures Inventory

Structure Number	S-9055	**Easting**	711804	**Northing**	4906164	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	Adjacent to 740 Rye Street (Rapid Lift)				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	12.80m	Unknown	Yes	☑	☐

Culvert 1 Rise	0.40m	**Structure Condition**	Adequate
Culvert 1 Span	1.00m	**Problem Description**	Culvert has high sediment build up. Clean out required.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Culvert under Rye Street

Record 16 of 26

Harper Creek Structures Inventory

Structure Number	S-9056	**Easting**	711803	**Northing**	4906161	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	740 Rye Street (Rapid Lift)				

Structure	Length	Year Built	Fish Observed	Public Land	
CSP	17.30m	Unknown	No	Private Land	☑

Culvert 1 Rise	0.30m	**Structure Condition**	Good
Culvert 1 Span	0.30m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Driveway ditch culvert

Record 17 of 26

Harper Creek Structures Inventory

Structure Number S-9060 **Easting** 711763 **Northing** 4906145 **Stream Type** Cold

Stream Name Harper Creek **Location** 771 Webber Avenue (rear driveway entrance for National Sanitation and Supply Compnay Limited)

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	9.90m	Unknown	Yes	☑	☐

Culvert 1 Rise 0.60m **Structure Condition** Good

Culvert 1 Span 1.00m **Problem Description** Structure in good condition, no issues.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Driveway ditch culvert

Record 18 of 26

Harper Creek Structures Inventory

Structure Number	S-9065	**Easting**	711731	**Northing**	4906129	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	731 Rye Street (entrance to Norm's Cash and Carry)				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	☑
CSP	9.10m	Unknown	Yes	**Private Land**	☐

Culvert 1 Rise	0.60m	**Structure Condition**	Good		
Culvert 1 Span	0.60m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Driveway ditch culvert

Record 19 of 26

Harper Creek Structures Inventory

Structure Number	S-9070	**Easting**	711716	**Northing**	4906124	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	721 Rye Street				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	☑
CSP	6.80m	Unknown	Yes	**Private Land**	☐

Culvert 1 Rise	0.50m	**Structure Condition**	Good		
Culvert 1 Span	0.65m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Driveway ditch culvert

Record 20 of 26

Harper Creek Structures Inventory

Structure Number	S-9075	**Easting**	711699	**Northing**	4906119	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	721 Rye Street				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	6.90m	Unknown	Yes	☑	☐

Culvert 1 Rise	0.65m	**Structure Condition**	Good		
Culvert 1 Span	0.65m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Driveway ditch culvert

Record 21 of 26

Harper Creek Structures Inventory

Structure Number S-9080 **Easting** 711688 **Northing** 4906115 **Stream Type** Cold

Stream Name Harper Creek **Location** 711 Rye Street

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	8.50m	Unknown	Yes	☑	☐

Culvert 1 Rise 0.65m
Culvert 1 Span 0.65m
Culvert 2 Rise none
Culvert 2 Span none

Structure Condition Good

Problem Description Structure in good condition, no issues.

Work Permitted June 1st - September 30th

Permit Required Yes

Photo Description Driveway ditch culvert

Record 22 of 26

Harper Creek Structures Inventory

Structure Number	S-9085	**Easting**	711658	**Northing**	4906103	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	711 Rye Street				

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	6.90m	Unknown	Yes	☑	☐

Culvert 1 Rise	0.65m	**Structure Condition**	Good		
Culvert 1 Span	0.65m	**Problem Description**	Structure in good condition, no issues.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Driveway ditch culvert

Record 23 of 26

Harper Creek Structures Inventory

Structure Number	S-9090	**Easting**	711649	**Northing**	4906100	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	705 Rye Street				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	☑
CSP	8.05m	Unknown	Yes	**Private Land**	☐

Culvert 1 Rise	0.65m	**Structure Condition**	Good
Culvert 1 Span	0.65m	**Problem Description**	Structure in good condition, no issues.
Culvert 2 Rise	none		
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th
		Permit Required	Yes

Photo Description Driveway ditch culvert

Record 24 of 26

Harper Creek Structures Inventory

Structure Number	S-9095	**Easting**	711617	**Northing**	4906087	**Stream Type**	Cold
Stream Name	Harper Creek	**Location**	705 Rye Street				

Structure	**Length**	**Year Built**	**Fish Observed**	**Public Land**	☑
CSP	7.10m	Unknown	Yes	**Private Land**	☐

Culvert 1 Rise	0.60m	**Structure Condition**	Failing		
Culvert 1 Span	0.60m	**Problem Description**	Holes present in corroded culvert.		
Culvert 2 Rise	none				
Culvert 2 Span	none	**Work Permitted**	June 1st - September 30th	**Permit Required**	Yes

Photo Description Driveway ditch culvert

Record 25 of 26

Harper Creek Structures Inventory

Structure Number S-9100 **Easting** 711562 **Northing** 4906068 **Stream Type** Cold

Stream Name Harper Creek **Location** 687 Rye Street

Structure	Length	Year Built	Fish Observed	Public Land	Private Land
CSP	13.90m	Unknown	Yes	☑	☐

Culvert 1 Rise 0.65m **Structure Condition** Good

Culvert 1 Span 0.65m **Problem Description** Structure in good condition, no issues.

Culvert 2 Rise none

Culvert 2 Span none **Work Permitted** June 1st - September 30th **Permit Required** Yes

Photo Description Driveway ditch culvert

Record 26 of 26

Appendix 2: Harper Creek Areas of Concern

Harper Creek Areas of Concern

Reach Number 2 AC9000 | Stream Name Harper Creek | Stream Type Cold | Priority Level Low

Site Harper Creek downstream of Pinewood Drive ☐ Private land ☑ Public land

Location Description | Easting 710272 | Northing 4905445

This area of concern occurs east of Pinewood Drive and describes sediment accumulation along the creek banks.

Issues

Sand buildup on the downstream side of Pinewood Drive is widening and slowing the creek in this location. Slower and shallower water velocities and a lack of shading are resulting in the growth of algae at this location.

Recommendations

Plantings along the side of the creek will help to direct flows into the main channel and maintain velocity, flushing sediments downstream rather than allowing it to accumulate. This is City owned property (706 Pinewood Dr) and a good location for stream bank naturalization.

Work Permitted June 1st - September 30th | Permit Required Yes | Fish Observed Yes

Please contact ORCA prior to commencing any in water work

Photo

Sediment buildup downstream of Pinewood Drive June 2012

Harper Creek Areas of Concern

Reach Number 5 AC9001 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: Low

Site: Harper Creek east of Ramblewood Drive ☑ Private land ☑ Public land

Location Description | Easting: 710690 | Northing: 4905376

This area of concern is located east of Ramblewood Drive at Bridlewood Park. Walking along the creek, this AoC occurs in the forested area east of the storm sewer outfall.

Issues

An old fence has collapsed across the creek and has created a dam of wood debris in the channel resulting in a deep pool downstream of the obstruction.

Recommendations

Manual cleanout and removal of old fence.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Woody debris and boulder build up. July 2010

Harper Creek Areas of Concern

Reach Number 7 AC9005 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: Low

Site: Harper Creek at Harper Road ☑ Private land ☑ Public land

Location Description | Easting: 711576 | Northing: 4905348

This is area of concern is located east of Harper Road after the creek passes beneath Harper Road.

Issues

A debris build up has resulted in the creation of a pool upstream of the debris. The debris build up is approximately 7 meters wide and is impeding water flow.

Recommendations

Manual cleanout required.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Debris build up. July 2010

Harper Creek Areas of Concern

Reach Number 6 AC9010 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: Medium

Site: Harper Creek at Harper Road ☐ Private land ☑ Public land

Location Description | Easting: 711589 | Northing: 4905566

This area of concern is located at the culvert where Harper Creek passes under Harper Road.

Issues

The culvert is collapsing on the upstream (west) side of Harper Road.

Recommendations

Replace culvert and ensure new culvert has open footing to permit groundwater upwellings to enter the creek flow.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Downstream end of damaged culvert. July 2010

Harper Creek Areas of Concern

Reach Number 9 AC9015 | Stream Name Harper Creek | Stream Type Cold | Priority Level Medium

Site Harper Creek at outfall into Byersville Creek ☐ Private land ☑ Public land

Location Description Easting 711895 Northing 4905988

This area of concern is located adjacent to 740 Rye Street (Rapid Lift) where the north tributary of Harper Creek outlets into Byersville Creek.

Issues

The steep slope at the outfall represents a barrier to fish passage. Isolated fish populations upstream of this location face increased risk in the event that there is a negative localized impact.

Recommendations

The ORCA has prepared a restoration plan to remove the fish barrier which currently isolates the north channel brook trout poulation from the main channels of Harper and Byersville Creeks. This restoration plan has been prepared as compensation for fish habitat impacts elsewhere in the City. Upstream natural channel deisgn could further enhance Harper Creek north of the barrier and along Harper Road.

Work Permitted June 1st - September 30th Permit Required Yes Fish Observed Yes

Please contact ORCA prior to commencing any in water work.

Photo

Outlet of Harper Creek into Byersville Creek. July 2010

Harper Creek Areas of Concern

Reach Number 8 AC9020 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: Medium

Site: Harper Creek at 740 Rye Street (Rapid Lift) ☐ Private land ☑ Public land

Location Description | Easting: 711802 | Northing: 4906162

This area of concern is located at 740 Rye Street driveway entrance from Rye Street.

Issues

The culvert configuration under Rye Street forces the creek to take a 90 degree turn and flow south. Flooding on the upstream side and sedimentation on the downstream side of this culvert have occurred due to unnatural flow patterns. In addition, a Bell Service box east of the driveway, is being undermined by

Recommendations

Re-orienting the culvert to allow for more natural flow patterns may reduce concerns at this location. Natural channel design and bioengineering could re-orient flows to prevent erosion downstream of the culvert and enhance shading and fish habitat conditions along this section of Harper Creek. Replacing the Harper Road and Webber Avenue culvert with an open-bottom culvert would provide natural substrates and allow groundwater flows to reach the creek channel.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Sediment build in ditch. July 2010

Harper Creek Areas of Concern

Reach Number 8 AC9025 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: High

Site: Harper Creek parallel with Rye Street | ☐ Private land ☑ Public land

Location Description | Easting: 711739 | Northing: 4906131

This area of concern stretches the length of channel along the north side of Rye Street.

Issues

Erosion has occurred on some of the banks along this sectin of the Creek which is highly urbanized and historically altered from its natural morphology.

Recommendations

At a minimum, riparian vegetation and/or bioengineering (erosion control blanketing, live stakes) should be put iinstalled to stabilize and reinforce the stream banks. Natural channel design and restoration practices should be implemented as opportunities arise. While riparian plantings along all of the watercouses in the study area would enhance fish habitat and improve terrestrial species diversity, they are especially critical along the north side of Harper Rd, the north side of Crawford Dr west of the Visitor Centre (Byersville Creek), and select areas along the Harper Creek main channel.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Stream bank erosion. July 2010

Harper Creek Areas of Concern

Reach Number 8 AC9030 | Stream Name: Harper Creek | Stream Type: Cold | Priority Level: Low

Site: Harper Creek adjacent to 705 Rye Street ☐ Private land ☑ Public land

Location Description | Easting: 711619 | Northing: 4906087

This area of concern is located at the driveway entrance to 705 Rye Street.

Issues

There are holes in the culvert which allow water to flow through create conditions for erosion of the driveway or shoulder of the road.

Recommendations

Replace culvert.

Work Permitted: June 1st - September 30th | Permit Required: Yes | Fish Observed: Yes

Please contact ORCA prior to commencing any in water work.

Photo

Holes in culvert. July 2010

Appendix 3: DFO Operational Statements

List of DFO Operational Statements

1. Notification Form
2. Timing Windows
3. Beaver Dam Removal
4. Culvert Maintenance
5. Maintenance of Riparian Vegetation in Existing Rights-of-Way
6. Routine Maintenance Dredging
7. Submerged Log Salvage
8. Temporary Stream Crossing

These DFO Operation Statements listed above may be found at:

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/index-eng.htm

Appendix 4: Working Around Water Brochure

Appendix 5: Benthic Macroinvertebrate Indicies

The Hilsenhoff Index (H)

The Hilsenhoff Index indicates the quality of water and the likelihood of organic pollution using the abundance and diversity of pollution tolerant and pollution sensitive species. Index values range from 0.00, indicating excellent water quality and that organic pollution is unlikely, to 10.00, indicating very poor water quality and that severe organic pollution is likely. The Hilsenhoff Index is calculated as follows:

$$H = \frac{\text{sum}[(Tv)(n)]}{N}$$

Where:
n =the percent of an individual species in the sample
TV = tolerance value for each species
N = the total number of individuals in the collection

The Simpson's Diversity Index (D)

Represents the probability that two individuals randomly selected from a sample will belong to different species or, in this case, different taxonomic groups. The results range between 0.0 (low species diversity) and 1.0 (high species diversity). The Simpson's Diversity Index is calculated as follows:

$$D = 1 - (\Sigma(n(n-1))/N(N-1))$$

Where:

N = the total number of organisms in the sample
n = the total number of organisms of a particular species