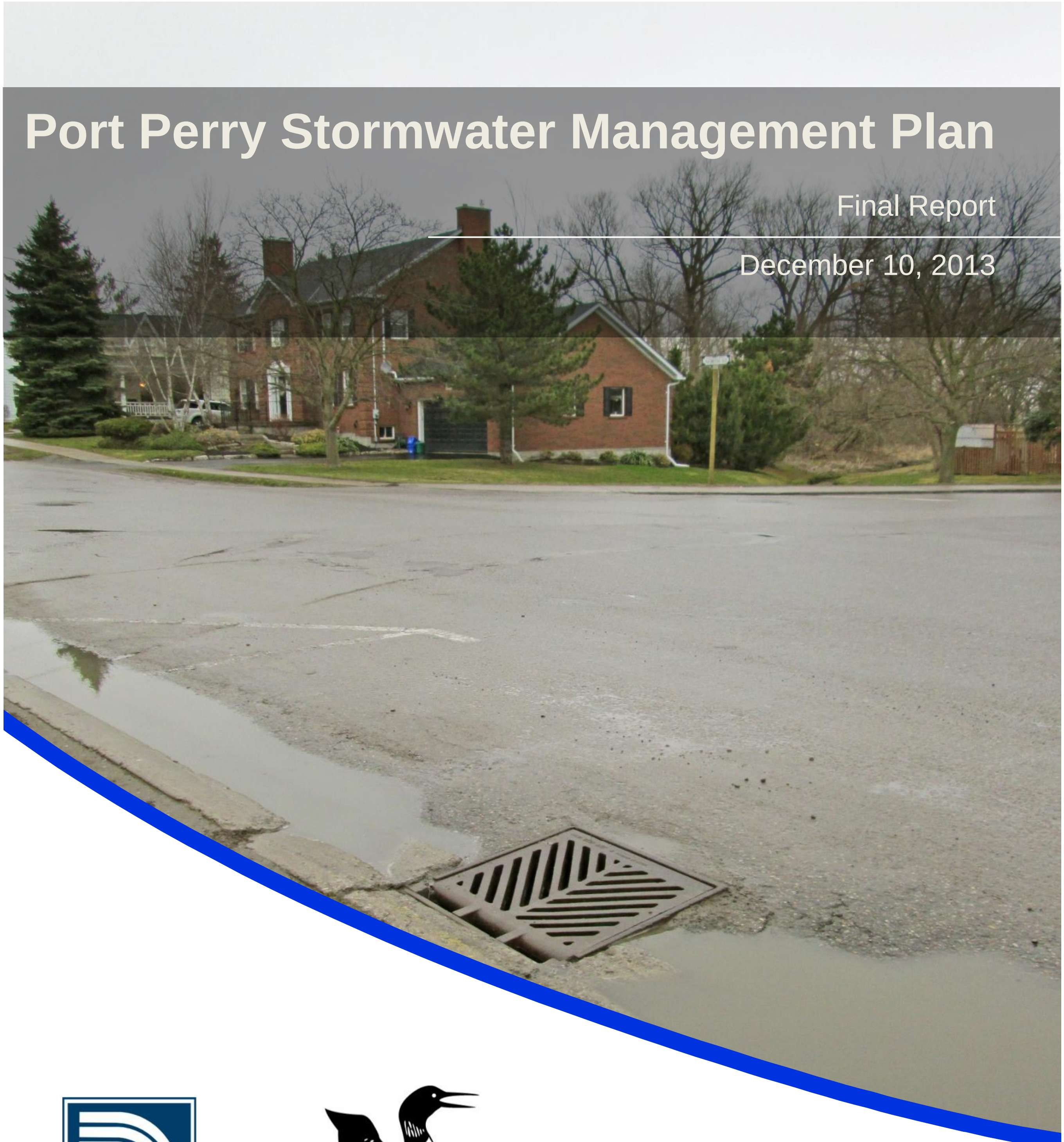
Port Perry Stormwater Management Plan

Final Report

December 10, 2013



DURHAM REGION

KAWARTHA CONSERVATION

TOWNSHIP OF Scugog

ABOUT KAWARTHA CONSERVATION

A plentiful supply of clean water is a key component of our natural infrastructure. Our surface and groundwater resources supply our drinking water, maintain property values, sustain an agricultural industry and support tourism.

Kawartha Conservation is the local environmental agency through which we can protect our water and other natural resources. Our mandate is to ensure the conservation, restoration and responsible management of water, land and natural habitats through programs and services that balance human, environmental and economic needs.

We are a non-profit environmental organization, established in 1979 under the Ontario Conservation Authorities Act (1946). We are governed by the municipalities that overlap the natural boundaries of our watershed and voted to form the Kawartha Region Conservation Authority. These municipalities include the City of Kawartha Lakes, Township of Scugog (Region of Durham), Township of Brock (Region of Durham), the Municipality of Clarington (Region of Durham), Township of Cavan Monaghan, and Township of Trent Lakes.

Kawartha Conservation

T: 705.328.2271

F: 705.328.2286

277 Kenrei Road, Lindsay ON, K9V 4R1

geninfo@kawarthaconservation.com

www.kawarthaconservation.com

EXECUTIVE SUMMARY

Port Perry's Stormwater Network and Lake Scugog

The stormwater network in the town of Port Perry is designed to collect and transport stormwater from the urban area as quickly as possible to the closest water body. Although this is effective in keeping roads and sidewalks clear of water and preventing flooding, it deteriorates water quality in natural water bodies and interrupts the natural hydrologic cycle. More effective stormwater management facilities such as wet ponds and wetlands do exist in some of the newer subdivision developments; however the majority of stormwater runoff from the town is entering Lake Scugog and local watercourses untreated.

The stormwater network currently consists primarily of ditches, curb and gutter and storm sewers. Residential areas primarily drain overland through ditch networks, whereas higher traffic areas such as the downtown commercial district drain through curb and gutter and storm sewers. Some areas of town combine the two with ditches that drain into a storm sewer network.

Stormwater from the Port Perry urban area is directed into five water bodies. These are Lake Scugog, Osler Marsh, Cawkers Creek, Williams Creek, and the Nonquon River. Of Port Perry's 1368 ha, 402 ha drains to Cawkers Creek, 89 ha drains to Williams Creek, 391 ha drains to the Nonquon River, 120 ha drains to Osler Marsh, and 366 ha is draining directly into Lake Scugog. It is important to note however that whether drained directly or indirectly, Lake Scugog ultimately receives all stormwater runoff from the town.

One of the major concerns regarding stormwater runoff is the contribution of nutrients and sediments into Lake Scugog that accelerate the rate of eutrophication. Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive sediments and excess nutrients from surrounding lands, with these nutrients stimulating increased plant growth. Although this is a natural process, accelerating it can have serious environmental, social, and economic impacts such as a decrease in property value, decreased fish populations and angler hours, and the potential growth of toxic algae blooms.

This lake is an important natural resource for the Region of Durham, the City of Kawartha Lakes and the province as a whole. Situated within 60 minutes of Canada's largest population centre, Lake Scugog is a major driver of the local economy. Our estimates indicate that municipalities within its watershed receive approximately 10-15 million dollars annually from tourism and recreational activities concentrated around the lake. In addition, the multiple shoreline residences and small lakeside communities support many local businesses e.g. landscaping, home renovation, property management as well as commercial enterprises in the Port Perry and Lindsay areas.

The lake and its contributing watershed are significant on a landscape basis. Lake Scugog is situated primarily within the Township of Scugog (the Region of Durham) and the City of Kawartha Lakes, with portions of the Township of Brock and the Municipality of Clarington within its watershed. It is an important headwater lake for Sturgeon Lake, the entire Kawartha Lakes system and the Trent-Severn Waterway, with its waters eventually emptying into Lake Ontario. Water flowing from Lake Scugog, via the Scugog River, is a primary source of drinking water for the residents of the Town of Lindsay.

Although historical documentation exists that indicates abundant aquatic vegetation has been a concern from its earliest years, the Lake Scugog Environmental Management Plan (LSEMP) shows that long time lake users perceive greater problems and significant changes in their lifetime. Many are concerned about the symptoms of accelerated eutrophication and other human caused impacts such as: sedimentation and excessive aquatic vegetation growth, the potential for toxic algae blooms, certain types of habitat loss and degradation, a wave of invasive species (aquatic plants, fish and invertebrates), and the potential effects of climate change. Others are concerned about the decline of key game fish population, such as walleye, and the replacement with other species.

The LSEMP recommends that urgent actions be taken to drastically reduce the input of sediment and nutrients and thus the rate of eutrophication. Such actions would maintain the lake's ecosystem health and water quality for future generations. The western basin, particularly the portion immediately offshore from the Port Perry urban area, was identified as one of the areas in greatest need of remedial activities.

Data collected for the LSEMP show that on average 630 kg of phosphorus is exported annually into Scugog Lake from the developed areas of Port Perry (5.16 km^2) excluding the Nonquon River and Cawkers Creek watersheds. According to the LSEMP targets, phosphorus load from Port Perry should be decreased by 320-350 kg (Kawartha Conservation, 2010).

The Port Perry Stormwater Management Plan

To address urban stormwater runoff, Scugog Township and the Region of Durham funded Kawartha Conservation to initiate the Port Perry Urban Drainage Study in the spring of 2008. The study's purpose was to determine drainage areas in the urban area, investigate the level of stormwater control in each sewershed and determine high priority areas for retrofit opportunities. The study also took inventory of existing stormwater management facilities, culverts, and catch basins as part of delineating the storm sewer network. The Port Perry Stormwater Management Plan began in June 2009 as a follow up to the Urban Drainage Study, and is being conducted in accordance with the Schedule B guidelines of the Municipal Class Environmental Assessment (MCEA). The objectives of the plan are as follows:

- Identify existing stormwater infrastructure through field investigation and review of municipal engineering drawings, implement the water quality monitoring, provide calculations, models, and develop the recommendations;
- Identify the existing stormwater infrastructure, determine runoff volumes and contaminant loadings from high priority drainage areas within the town of Port Perry;
- Recommend specific measures to improve the stormwater quality and decrease contaminant loading into Lake Scugog in accordance with the Lake Scugog Environmental Management Plan recommendations and targets; and
- Calculate storm sewer flow, with specific capital investments recommended for areas identified within the Port Perry Urban Drainage Study as high priority.

The Port Perry Stormwater Management Plan does not specifically identify water quantity issues, nor does it deal in any significant way with riparian or aquatic habitats. However, implementation of plan recommendations will have a positive effect on Lake Scugog and its tributaries in the Port Perry

Urban Area by reducing sediment and nutrient loading responsible for accelerated eutrophication. The study encompasses the Port Perry urban boundary as identified in the Township of Scugog's Official Plan and focuses efforts on high priority areas identified in the downtown core.

Key Findings

High priority areas for the stormwater management plan were identified in the downtown core of Port Perry. These areas are fully developed and drain directly into Lake Scugog and consist of seven sewersheds. Calculations and modeling for these sewersheds show that an opportunity exists for improving the quality of stormwater runoff from the downtown core. Analysis of the water quality monitoring data combined with existing data from previous studies such as the LSEMP was used to determine contaminant loadings from these areas (26.7 ha). On average, 49 kg of phosphorus, 500 kg of nitrogen, 691 kg of metals and 34,700 kg of sediments enter Lake Scugog either directly or via Williams Creek on an annual basis. More than two-thirds of that phosphorus and 30% of the nitrogen remain in the lake. A majority of the sediment settles and remains in the lake, filling in low spots and contributing to the decreased depth of the lake, especially around stormwater outlets. It is estimated that upon implementation of the stormwater management plan phosphorus load from high priority areas can be decreased by 75-80% and an estimated decrease of sediment load can be as high as 90% from the current levels. Metal loadings can be decreased by 70-80% as well. Looking at the Port Perry urban area overall, it can be estimated that phosphorus loading from developed areas can be decreased by 50%.

Calculations also revealed sections of storm sewer that are improperly sized and could result in surcharging and/or flooding.

Investigations into existing stormwater controls and facilities, both private and municipally owned show that cleanouts and maintenance are required in most facilities to ensure maximum operating efficiency. Further, there is a need for surveys and closed circuit television (CCTV) work in storm sewer pipes to fill in data gaps and determine the overall condition of the storm sewer network.

Key Recommendations

Based on the data obtained during the research phase of the program, this document; the Port Perry Stormwater Management Plan, has been prepared and includes a set of recommendations. These recommendations range from the implementation of specific capital items in a specific drainage area, to general items such as by-law amendments that apply to the entire urban area. The general recommendations are as follows:

I. Construction of selected capital alternatives;
II. Amendments to by-laws;
III. Amendments to engineering design standards;
IV. Amendments to municipal operations;
V. Cleaning and maintenance of existing stormwater management facilities; and
VI. Education, outreach and other stewardship activities.

I. Construction of selected capital alternatives

Construction of the following stormwater controls at the following locations is recommended. Listed in order from high to low priority, bracketed numbers indicate outlet ID:

RECOMMENDATION	PRIORITY	IMPLEMENTATION COST
OIL GRIT SEPARATOR AT CASIMIR STREET OUTLET (11)	1	$38,000
PARKINGLOT BIORETENTION IN MARY STREET LOT TO COMPLIMENT OGS AT CASIMIR STREET OUTLET (11)	2	$25,750
OIL GRIT SEPARATOR AND BIOSWALE AT NEW WATER STREET OUTLET TO LAKE (28)**	3	Implemented
OIL GRIT SEPARATOR AND BIOSWALE AT OUTLET TO WILLIAMS CREEK (29)	4	$11,250
PARKING LOT BIORETENTION BEHIND MUNICIPAL BUILDING TO COMPLIMENT OGS AND BIOSWALE AT OUTLET (29)	5	$20,600
OIL GRIT SEPARATOR AT JOHN STREET OUTLET TO WILLIAMS CREEK (18)	6	$17,500
OIL GRIT SEPARATOR AT QUEEN STREET WEST OUTLET TO WILLIAMS CREEK (17)	7	$25,300
OIL GRIT SEPARATOR AT PERRY STREET OUTLET TO WILLIAMS CREEK (27)	8	$9,000
OIL GRIT SEPARATOR AT QUEEN STREET EAST OUTLET TO WILLIAMS CREEK (17)	9	$4,800
ROADSIDE BIORETENTION ON PERRY STREET TO COMPLIMENT OGS AT OUTLET TO WILLIAMS CREEK (27)	10	$31,200
TOTAL		**$183,400**

** This option represents the existing controls implemented at the Water Street outlet. An oil grit separator in combination with a bioswale was constructed at this outlet in conjunction with redevelopment of the waterfront area in 2009 while this study was being conducted.

II. Amendments to By-laws

By-laws and amendments will impact the entire Port Perry urban area and potentially the Township of Scugog as a whole.

Create the following By-laws:

- Stormwater controls/Best Management Practice (BMP) maintenance by-law:
  This will ensure that any new/existing controls and BMP's on both public and private property are properly maintained.
- Storm sewer discharge by-law:
  This will regulate what can be flushed down storm sewers

Amendments to the following existing By-law:

- Site Alteration By-law:
  To ensure that construction projects observe proper sediment control on site to prevent sediment from being flushed into the storm sewers.

III. Amendments to engineering design standards

Amendments to the engineering design standards will impact the entire Port Perry urban area and the Township of Scugog as a whole.

Amendments to the following existing standards:

- Amendment to C5.06: Aerators/fountains in stormwater management facilities:
  To prevent aerators/fountains from being installed in facility forebays where they can potentially re-suspend sediment.

IV. Amendments to municipal operations

Amendments to municipal operations will impact the entire Port Perry urban area and the Township of Scugog as a whole. It is recommended that the following municipal operation practices be implemented:

- Provision of erosion/sedimentation controls downstream of ditch cleaning activities:
  This will ensure that sediment is prevented from being flushed into storm sewers and water bodies.

- Regular Closed Circuit TV work in storm sewers:
  This can be used to ensure the structural integrity of the storm sewer system as well as to identify which areas are in need of cleaning or maintenance.

- Regular maintenance hole, catch basin and pipe cleaning:
  A regular cleaning and maintenance schedule of the storm sewer system will improve stormwater quality and decrease the frequency of cleaning of facilities and controls.

- Regular inspection, cleaning and maintenance of stormwater facilities and controls:
  This will improve the operating efficiency of facilities and controls and thus improve stormwater quality. Proper maintenance can also prolong the lifespan of controls and can identify potential problems before they start.

V. Cleaning and maintenance of existing stormwater management facilities

This involves the immediate cleaning and maintenance of existing municipally owned stormwater management facilities. The following is a prioritized list of facilities in need of cleaning or maintenance based on sediment buildup and maintenance issues observed at this time:

- Victorian Village Pond
- Baagwating Park Stormwater Channel
- Perryview Estates South West Pond
- Honey Harbour Heights North Pond
- Honey Harbour Heights South Pond
- Canterbury Commons North Pond
- Canterbury Commons South Pond

Other facilities should be cleaned and maintained as needed, determined through a regular inspection schedule. All facilities should be inspected prior to assumption by the Township.

There are 11 centralized stormwater management facilities proposed in watershed studies across Port Perry. It is recommended that these ponds be considered for development when the impervious area in the catchment exceeds 10% (roads, buildings and other hard surfaces). Any proposed stormwater management facility should service a catchment area equal to or greater than 20 hectares to minimize the number of facilities that the Township may need to assume in the future.

VI. Education, Outreach and Other Stewardship Activities

An opportunity exists to inform urban landowners in their role for reducing the burden on the urban stormwater network. Scugog Connections provides an opportunity for residents in Port Perry to be engaged in a direct manner. An urban stewardship project targeting landowners in the urban area is recommended to raise awareness and meet municipal goal to reduce nutrient loading in the lake. Specific items that could be included in education and outreach programming are best management practices such as rainfall gardens, animal waste pick-up and activities to reduce water consumption and nutrient loading. Informing other persons who can also have a bearing on stormwater quality would be of additional benefit, such as public works staff, and visitors and tourists to the town of Port Perry.

VII. New Technologies

Low Impact Development/Green Infrastructure design techniques, standards or BMP's as described in Appendix F should be encouraged for use and adoption both for new and existing developments.

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LIST OF ACRONYMS

BMP: Best Management Practice
CB: Catch Basin
CCTV: Closed Circuit Television
IDF: Intensity-Duration-Frequency
LSEMP: Lake Scugog Environmental Management Plan
KRCA: Kawartha Conservation
masl: Meters above sea level
MCEA: Municipal Class Environmental Assessment
MEA: Municipal Engineers Association
MH: Maintenance Hole
MOE: Ministry of the Environment
OCP: Organochlorinated Pesticides
OGS: Oil Grit Separator
ORM: Oak Ridges Moraine
PCB: Polychlorinated Biphenyls
PSW: Provincially Significant Wetland
PWQO: Provincial Water Quality Objectives
SWMF: Stormwater Management Facility
TN: Total Nitrogen
TP: Total Phosphorus
VO_2: Visual OttHymo (**Hy**drologic **Mo**del developed by the University of **Ott**awa) Ver. 2
PCSWMM: A Storm Water Management Model for Personal Computers

1.0 INTRODUCTION

1.1 BACKGROUND

Urban areas greatly impact the hydrologic cycle and are major contributors of contaminants to water systems. A significant proportion of these contaminants can be attributed to stormwater runoff. Urban stormwater can be defined as rainfall and snowmelt that runs overland into storm sewers, streams or lakes. It may also include runoff from activities such as watering lawns, washing cars and draining pools.

Due to the large amount of impermeable surface found in urban areas, the natural transfer of water within the hydrologic cycle is interrupted. Stormwater often flows overland until it enters storm sewer pipes, swales and ditches, to be drained into lakes and rivers. As the stormwater flows over surface routes like parking lots and roads it picks up contaminants, which are subsequently flushed into the sewer system and, eventually, end up in rivers and lakes. Examples of contaminants include oil and oil byproducts, metals, sediments, chlorides, nitrates and phosphorus.

In the past, stormwater was drained to lakes and rivers directly. Now, however, upon knowing the implications of this practice, a standard engineering approach is to treat stormwater before it enters the lake and river systems, through management controls such as filter systems, infiltration trenches and stormwater quality and quantity control devices.

Our understanding of stormwater management has expanded beyond traditional engineering approaches. Good planning approaches, construction methods and lot level practices all have important links to managing stormwater.Concepts such as water conservation and conservation ethics help to round out effective means of addressing urban runoff.

1.2 STUDY AREA

The Town of Port Perry is located on the shores of Lake Scugog with a population of approximately 9,500 people and covers an area of 1,368 hectares, making it the largest urban centre within the Township of Scugog. The population of the Township of Scugog was 21,439 as of the 2006 census (Meridian, 2007) and is projected to grow by 110 residential units per annum, primarily in the urban areas, to the year 2031 (Township of Scugog, 2009).

The study area encompasses the urban area of Port Perry as outlined in the Township Official Plan as can be seen in Figure 1.1. Land within the urban boundary includes residential, commercial, industrial, municipal, transportation, undeveloped, environmentally protected and rural land.

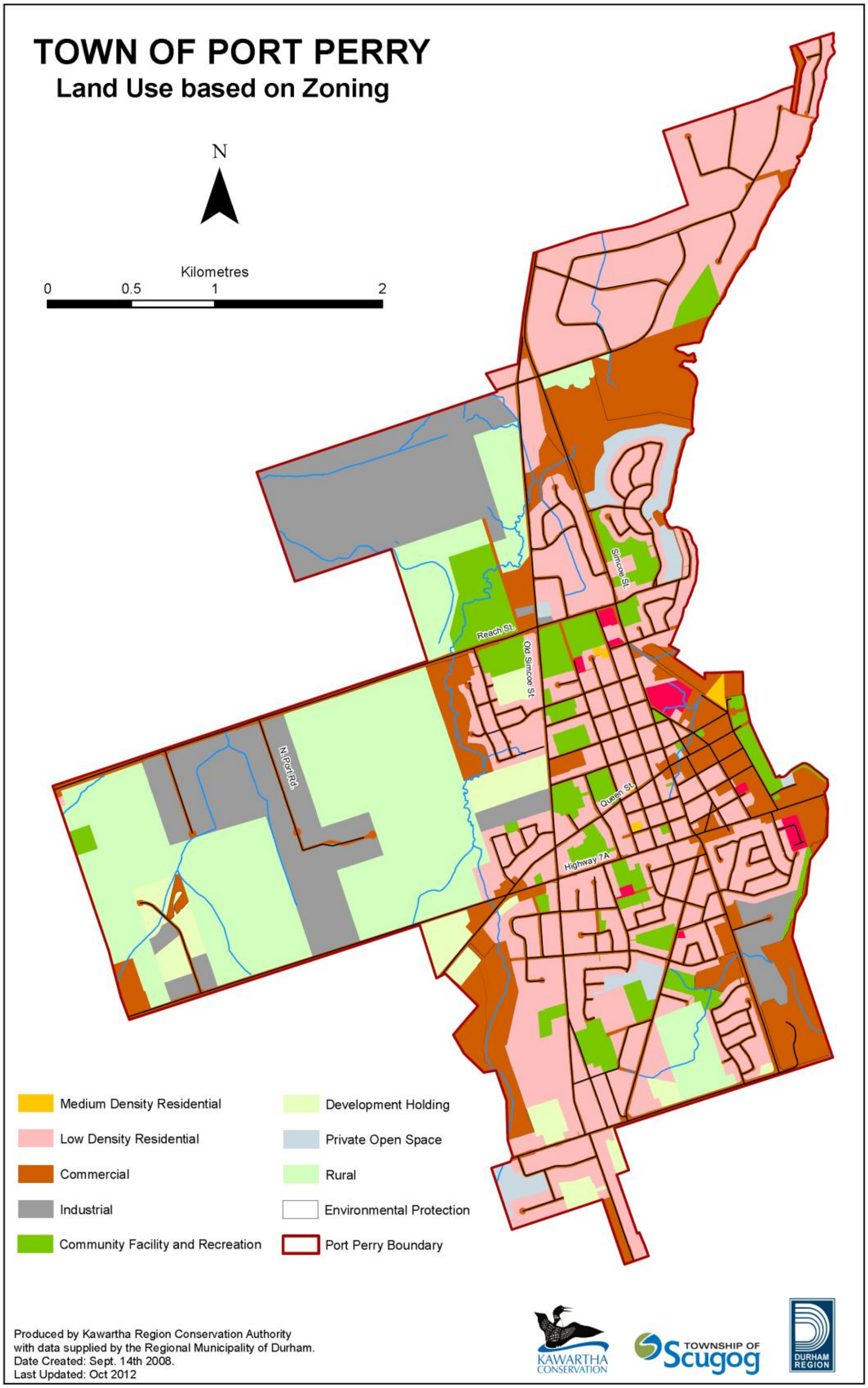


FIGURE 1.1: PORT PERRY URBAN AREA AND ASSOCIATED LAND USE

The Port Perry urban boundary also encompasses five separate watersheds (Figure 1.2), four of which are areas that discharge into the lake (Cawkers Creek, Williams Creek, Nonquon Tributaries and Osler Marsh) and the fifth being the Lake Scugog watershed itself.

Due to their close proximity to Port Perry, a large quantity of urban stormwater is directed to these water systems, especially Cawkers Creek and Williams Creek, which flow through heavily developed portions of the urban area (Figure 1.3).

1.3 CLASS EA PROCESS

The Municipal Class Environmental Assessment (MCEA), Municipal Engineers Association (MEA), as amended in 2007, describes the process that municipalities must follow to meet Ontario's Environmental Assessment requirements.

Public and agency consultation is also an important and necessary component of the above process. The level of assessment depends on the type of project or Master Plan that a municipality is undertaking. The MEA's Class EA document classifies projects as Schedules A, A+, B or C depending on their level of environmental impact and public concern.

- **Schedule 'A'** projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved and may proceed to implementation without following the full Class EA planning process. Schedule A projects generally include normal or emergency operational and maintenance activities.

- **Schedule 'A+'** The purpose of these projects is to ensure some type of public notification for certain projects that are pre-approved under the Municipal Class EA, it is appropriate to inform the public of municipal infrastructure project(s) being constructed or implemented in their area. There, however, would be no ability for the public to request a Part II Order. If the public has any comments, they should be directed to the municipal council where they would be more appropriately addressed. The manner in which the public is advised is to be determined by the proponent.

- **Schedule 'B'** projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process (see Appendix B), involving mandatory contact with directly affected public and relevant review agencies, to ensure that they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation. Schedule B projects generally include improvements and minor expansions to existing facilities.

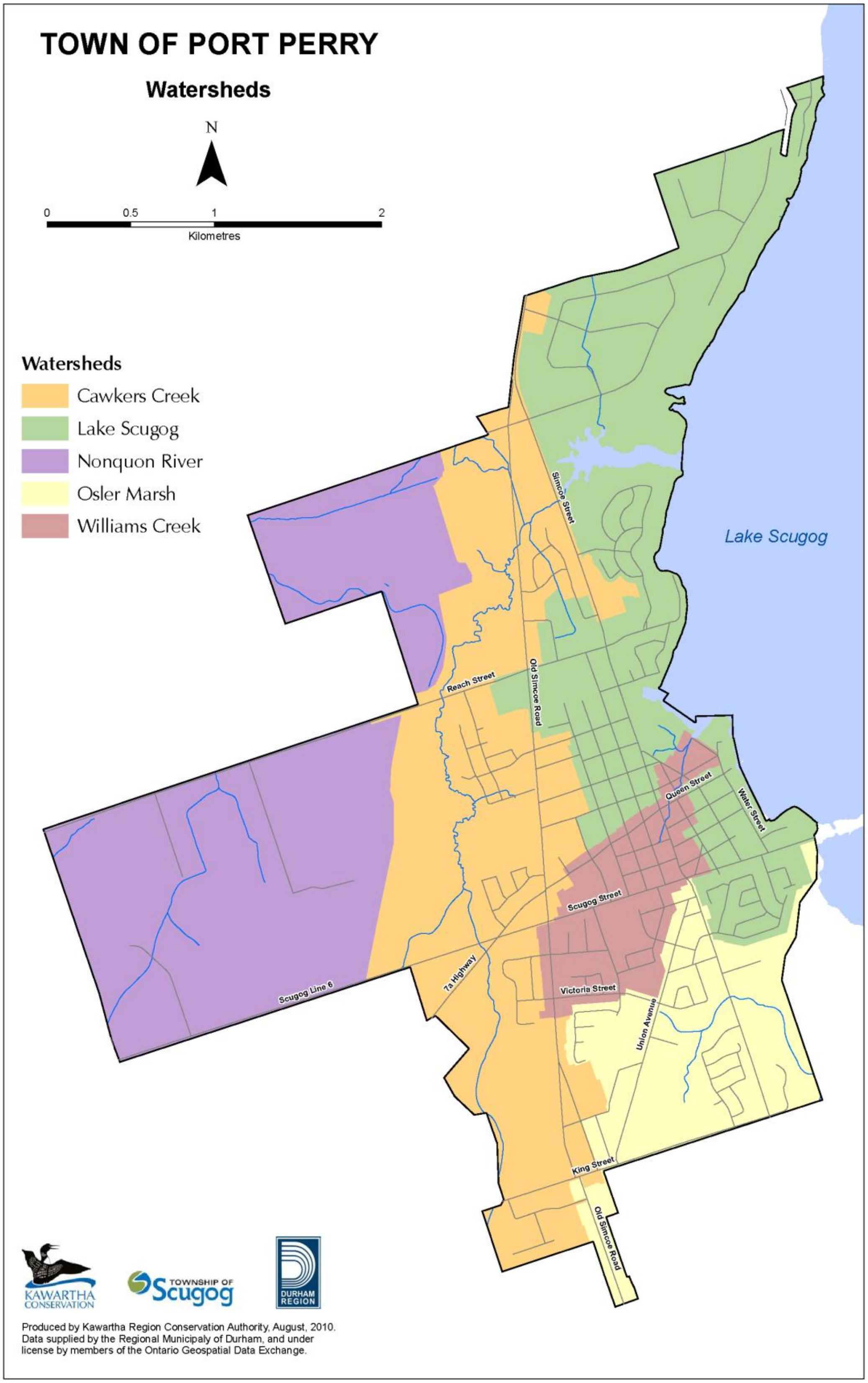


FIGURE 1.2: PORT PERRY URBAN AREA AND WATERSHED AREAS

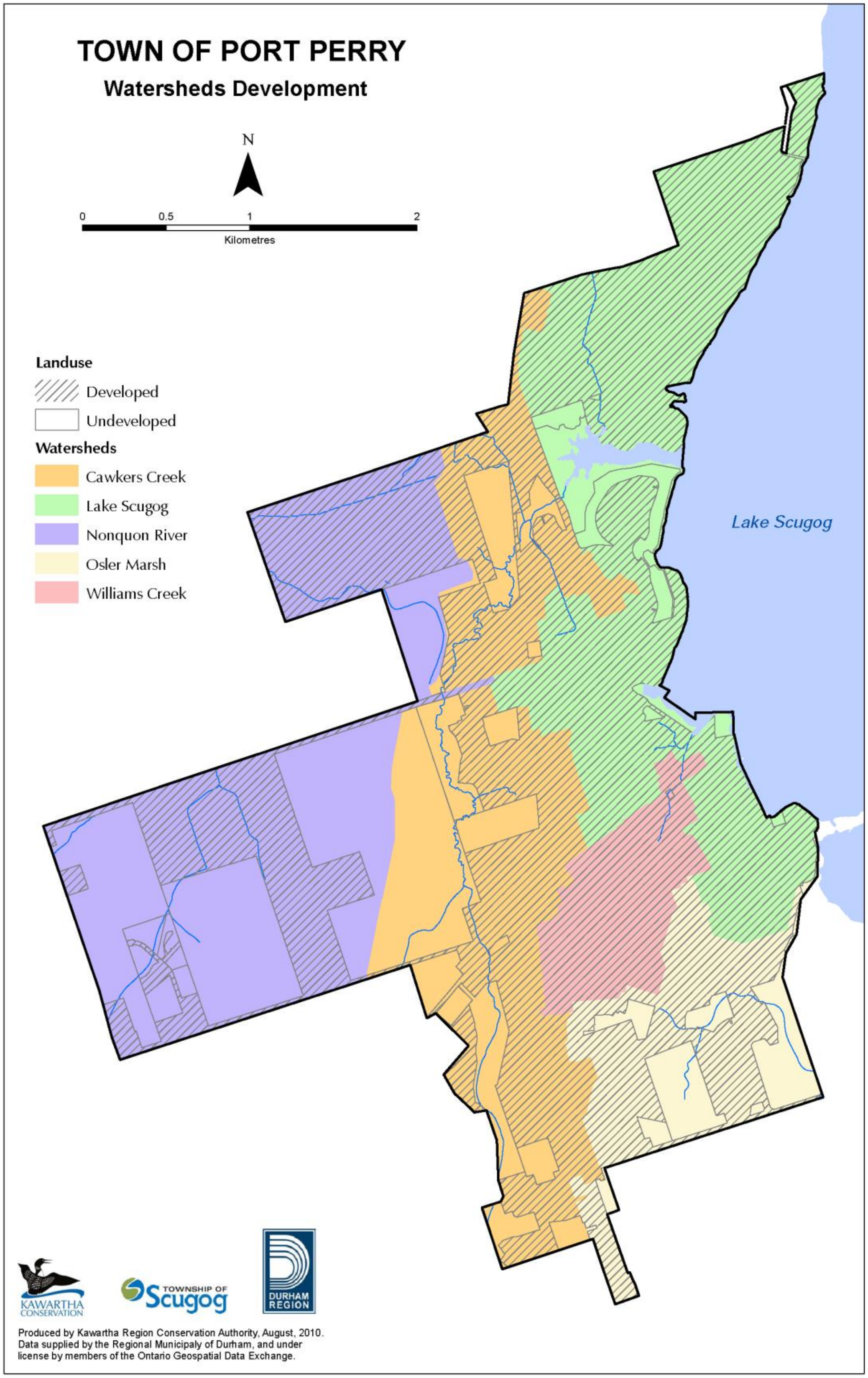


FIGURE 1.3 PORT PERRY URBAN AREA, DEVELOPED AREAS AND PRIMARY DRAINAGE BASINS

• **Schedule 'C'** projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in this Class EA document. Schedule C projects require that an environmental study report be prepared and filed for review by the public and review agencies. Schedule C projects generally include the construction of new facilities and major expansions to existing facilities.

1.3.1 SELECTED SCHEDULE AND DESCRIPTION OF PHASES

In accordance with the Terms of Reference, this project adheres to the Schedule B requirements of the Municipal Class Environmental Assessment (MCEA) whereby tasks are governed by the guidelines and provisions set out in the Municipal Engineers Association document: *Municipal Class Environmental Assessment*, June 2000.

Schedule B projects include improvements and minor expansions to existing facilities and where projects have the potential for some adverse environmental impacts, and also includes Master Planning processes which may lead to activities identified above. Schedule B projects have the option to adhere to Phase 1 and Phase 5 guidelines and are required to adhere to the Phase 2 guidelines as described in the MCEA document. Phase 3 and 4 guidelines involve alternative design concepts for the preferred solution and the creation of an environmental study report. However, these two phases are reserved for schedule C projects and were thus not looked at. A complete flow chart of the phases can be seen in Appendix B

Phase 1: Problem or Opportunity (Optional)

The first study phase involves identifying and describing the problem or opportunity. Earlier studies or reviews undertaken by the proponent may be available to assist in defining the problem which in this case is the Port Perry Urban Drainage Study. A notice of commencement was also issued at the beginning of the project.

Phase 2: Alternative Solutions (Mandatory)

The first step of Phase 2 is to identify alternative solutions to the problem. The appropriate EA schedule is then determined based on potential alternatives. The second step involves the preparation of a physical description of the area where the project is to occur and an inventory of the natural, social and economic environments. Step 3 involves the identification of the magnitude of the net positive and negative effects of each alternative and step 4 is the evaluation of all reasonable alternative solutions. Step five requires consultation with review agencies and the public to solicit comment and input and is the first mandatory point of contact with the public. The final step in Phase 2 is the selection or confirmation of the preferred solution.**Phase 3 & 4: Alternative Design Concepts for Preferred Solution and Environmental Study Report**

Not considered under this Class EA, a Schedule B project (applies to Schedule C projects only).

Phase 5: Implementation (Optional)

Phase 5 consists of the completion of contract drawings, construction and monitoring of the preferred alternative. This phase falls outside the scope of the Port Perry Stormwater Management Plan and was not included as part of the plan. As such, a Notice of Completion is to be issued at the end of Phase 2.

1.4 PUBLIC CONSULTATION

The Stormwater Management Plan, as presented, is consistent with the requirements of the Municipal Class Environmental Assessment process. The public consultation process, as summarized below, included meetings with Township staff and stakeholders, a public open house, as well a notice of commencement and notice of completion (See Appendix G for notice of commencement and open houses). These activities are required under the Municipal Class EA process and were conducted in accordance with the guidelines.

The following summarizes the consultation process which took place:

- First copy of notice of commencement issued, July 16, 2009, Scugog Standard newspaper
- Second copy of notice of commencement issued, July 23, 2009, Scugog Standard newspaper
- Initial meeting with Township staff, July 23, 2009, Port Perry Municipal Offices
- Open house for presentation of potential alternatives, December 10, 2009, Port Perry Community and Recreation Centre.
- Public opinion and input survey handed out during open house (see Appendix E)
- Open house for presentation of selected alternatives, December 12, 2012, Port Perry Community and Recreation Centre.
- Notice of completion to be issued upon submission of final report

Open House Comments and Feedback

Survey results from the open house show that people generally opt for the alternative with the highest removal of pollutants. Some concerns that were raised included the potential impact on businesses in the area; especially with regards to roadside bioretention located on Queen Street (see section 6.1.1). Other suggestions include the long term monitoring to determine the effectiveness of alternatives, and the creation of potential capital alternatives for all other areas of Port Perry.

2.0 STUDY GOALS AND OBJECTIVES

The Goals and Objectives of this project were developed from the vision and objectives identified in the Lake Scugog Environmental Management Plan (LSEMP). Consideration of municipal and community priorities were used to assist in the development of options and alternatives.

The Lake Scugog Environmental Management Plan (LSEMP) suggests that on average 630 kg of phosphorus is exported annually into Scugog Lake from the developed areas of Port Perry, excluding the Nonquon River and Cawkers Creek watersheds. The LSEMP target for reduction in phosphorus load from Port Perry is 320-350 kg (Kawartha Conservation, 2010). It is estimated that approximately 50% of the phosphorous loading could be decreased from urban areas, through a reduction in the availability of nutrients and containment of sediment.

Goals

1. To develop and recommend management guidelines for the maintenance of Port Perry's existing stormwater systems.

2. To develop and recommend appropriate alternatives in order to improve the quality of stormwater runoff from the Port Perry urban area.

Objectives

Water Quality

- Improve water quality in watercourses and major receiving waters including Lake Scugog, Osler Marsh, Cawkers Creek, Williams Creek and Nonquon River by reducing the amount of contaminants in urban stormwater runoff.

Sewer System

- Provide details on existing stormwater system in Port Perry
- Determine runoff, sediment and contaminant loading from high priority areas

3.0 STUDY AREA DESCRIPTION AND EXISTING CONDITIONS

This chapter looks at existing environmental conditions and the natural and cultural heritage of Port Perry and the Lake Scugog watershed in general. For the purpose of this report, the information provided in sections 3.1, 3.2 and 3.3 came primarily from the review of existing documents with a majority of the information coming from the Lake Scugog Environmental Management Plan.

3.1 PHYSIOGRAPHY AND HYDROLOGY

3.1.1 PHYSIOGRAPHY

The physiographic characteristics of the Port Perry area are the result of glacial activity during the Pleistocene Epoch (2.6 million to 12,000 years before present). The primary physiographic units represented in and around the Port Perry area are; the Oak Ridges Moraine located to the south the Peterborough Drumlin Field located north of the Moraine, west of Port Perry, and to the east of Lake Scugog toward Peterborough; and the Schomberg Clay Plain, which represents the Port Perry urban area and the areas around and to the north of Lake Scugog.

The Oak Ridges Moraine to the south of Port Perry is roughly 225 meters above Lake Ontario and has a surface of sand overlaying lacustrine silts and clays. The Oak Ridges Moraine is a significant geological feature and aquifer recharge area where many of the headwaters of local streams and rivers, including the Nonquon River and Osler Marsh, are located (Chapman & Putnam, 1984).

Drumlin fields located close to the Moraine, such as those found within the Port Perry watersheds, are often covered by shallow layers of silt and fine sand deposited by wind. These layers on top of the glacial till vary in thickness from a third of a meter to in excess of 2 meters in depth.

The Scugog and Port Perry urban area overlies the Schomberg Clay Plain and differs from the Drumlin fields to the west, having the appearance of a flat lake plain. The Schomberg sediments are varved clays with layers from two to four or more inches thick. The soils are well drained Schomberg silty clay loam, imperfectly drained Smithfield silty clay loam, and poorly drained Simcoe silty clay and silt loams (Chapman and Putnam, 1984)

The tributaries that flow through the Port Perry Urban area drain the drift covered Drumlin Fields to the South West of Port Perry, and the Schomberg Clay plains adjacent to Lake Scugog. These rivers flow in swampy valleys of low gradient. The most dominant physiographic feature of greater Port Perry area is the low drainage gradient that is evident from the northern edge of the Drumlin Fields and the Oak Ridges Moraine, where the

Schomberg Clay Plain begins and continues all the way to Sturgeon Lake. The fall from Lake Scugog to Sturgeon Lake is less than 2 meters, most of which is accounted for by the dam in Lindsay (Chapman and Putnam, 1984). The low gradient and sluggish flow of the tributaries, combined with sand, silt and clay soil types, contribute to sediment deposition in Lake Scugog in the Port Perry area.

Soil Characterization:

The dominant soil types found in the Port Perry Urban Area (Figure 3.1) are Brighton sandy loam, Dundonald sandy loam, Granby sandy loam, Bondhead sandy loam, and Schomberg clay loam. Sandy loam, loam, and clay loam all exhibit good drainage (Chapman and Putnam, 1984). These soil types are typical of glacial till plains and the rolling or topography of the region.

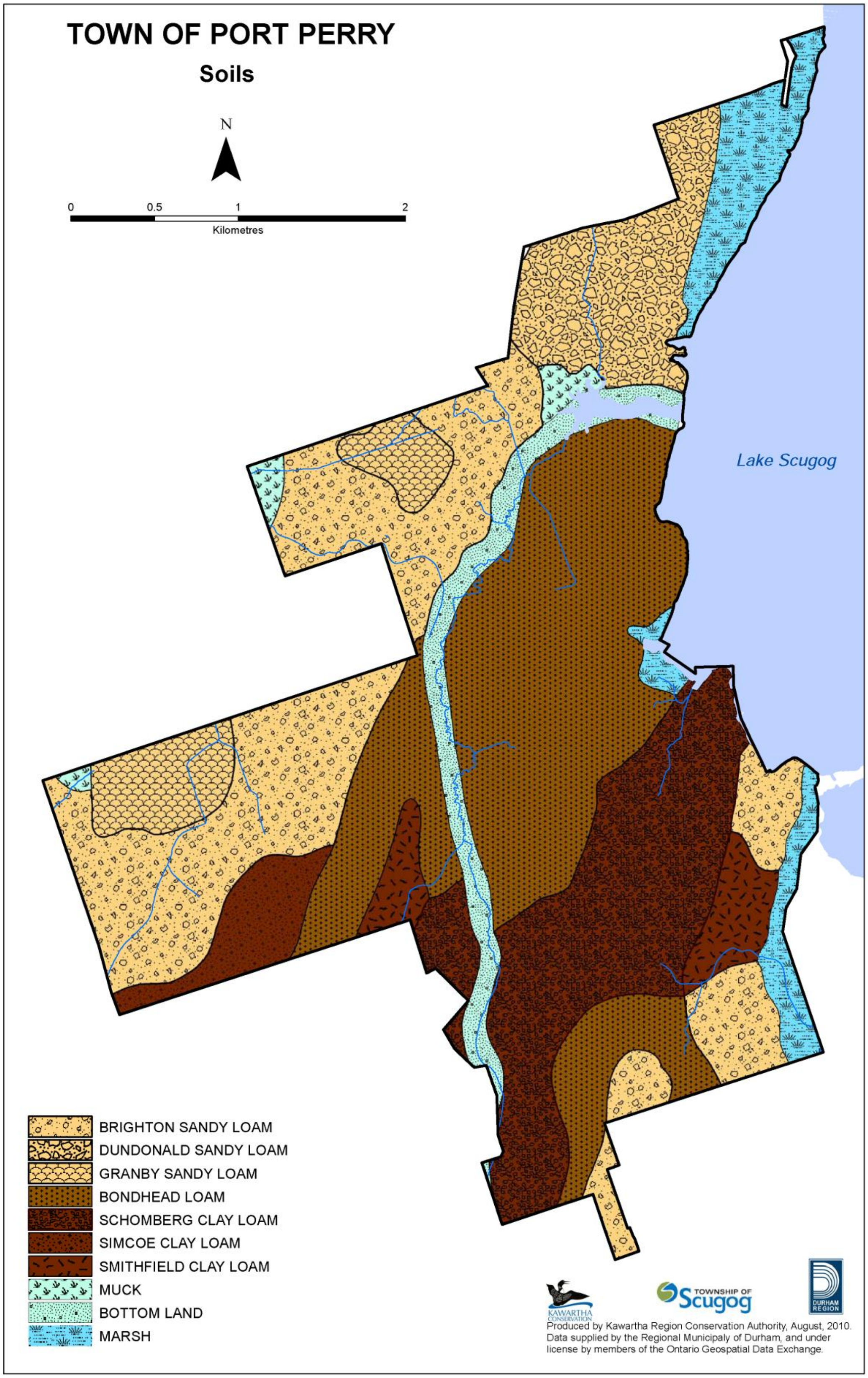


FIGURE 3.1 SOILS OF THE TOWN OF PORT PERRY

3.1.2 HYDROLOGY

There are five primary watersheds within the town of Port Perry (see Figure 1.2). Ultimately, all surface water runoff from Port Perry drains into Lake Scugog. Most surface runoff is deposited into Lake Scugog in the vicinity of Port Perry, with the exception of the employment lands to the west of the residential portion of Port Perry. These lands drain to the Nonquon River watershed, which empties into Lake Scugog approximately 10 km north along the shoreline of Lake Scugog. Portions of the urban area draining to these watersheds are depicted in Figure 3.2.

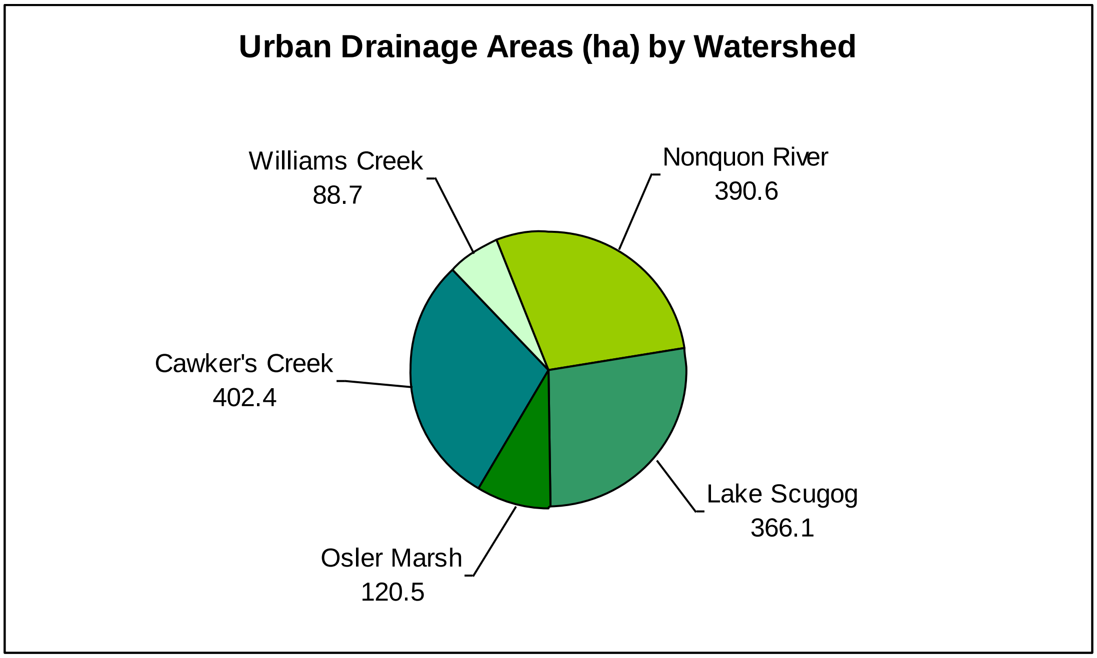


FIGURE 3.2 LAND AREAS DRAINING TO WATERSHED AREAS WITHIN PORT PERRY

Lake Scugog Watershed

The most prominent hydrological feature associated with Port Perry is Lake Scugog. The lake has a surface area of 68 km^2 and an average depth of 1.4 m. The deepest area of the lake has a depth of 7.6 m and is located in the eastern part of the lake near the community of Caesarea. The lake volume is approximately 9.57x107 m^3. Shoreline length of the lake is 175 km in total. Depth, area and volume of the lake are artificially maintained through the Lindsay Dam on the Scugog River, which was built more than 150 years ago. The average depth of the lake in the vicinity of Port Perry is approximately 1.4 m ranging from 0.6 m near shore to more than 2.5 m in the middle of the lake.

Seasonal water level fluctuations on the lake typically range between 20 and 50 cm and depend on the management of the Lindsay Dam by the Trent-Severn Waterway. Due to the consistent shallowness of the lake, it does not exhibit characteristics of seasonal thermal stratification.

The Lake Scugog watershed can be divided into several subwatersheds. The Nonquon River as well, many small watercourses, such as Cawker's Creek, and Williams Creek, empty into the lake (See Figure 1.2). As referred to in Figures 1.2 and 3.2, the Lake Scugog watershed refers to lands that directly run into Lake Scugog, separate from the subwatersheds described in more detail below. Five stormwater management ponds discharge directly into the lake accounting for 73 ha of the total 366 ha of land.

Nonquon River Watershed

Flowing through the western portion of the urban area is a small tributary of the Nonquon River. The Nonquon River is the largest tributary of Lake Scugog and is approximately 35% of the total Lake Scugog watershed area. The Nonquon River headwaters are located in the Oak Ridges Moraine at an elevation of 304.8 metres above sea level (masl) in the Township of Scugog, flowing northward to Lake Scugog. The majority of this watershed (80%) is located within the Peterborough Drumlin Field. Approximately 5% of this watershed lies within the ORM and 15% of the land area lies within the Schomberg Clay Plains. West of Port Perry, the Nonquon River has a wide floodplain and low gradient. Based on the Urban Drainage Study, 390.6 ha of the urban area drains to the Nonquon River, primarily from the industrial area and the lands surrounding the sewage lagoons.

Cawkers Creek

The Cawker's Creek watershed covers an area of 1,260 ha. The watershed is long and narrow and characterized by gently rolling terrain (Proctor and Redfern, 1996). Cawker's Creek has a main channel length of 7.86 km and a total length of 12.55 km when taking into account all streams. The creek generally marks the western border of development in the urban area with the exception of the Nonquon Industrial Area, and drains into Lake Scugog northwest of the Canterbury Commons subdivision. The creek originates to the south of town and flows through agricultural land and a golf course before entering the Port Perry Urban boundary at King Street, west of Old Simcoe Road. The average channel slope is approximately 0.4% to 0.6% and is consistent throughout the creek's entire length. According to the Port Perry Urban Drainage Study, 402.4 ha of land in the urban area drain into Cawkers Creek including discharge from three stormwater management ponds. From the headwaters to Highway 7A, the creek has been influenced by adjacent agricultural lands and it is obvious where portions of the creek have been re-aligned or straightened. Between Hwy 7A and Old Simcoe Road, the creek appears to be in a more natural state.

Williams Creek

Williams Creek has a main channel of approximately 1.1 km and flows from south to north and flows into Lake Scugog, next to the Port Perry public boat launch. The main channel of the creek was originally longer, however due to development; the portion south of Scugog Street has been buried and now runs through a storm sewer system originating at the stormwater facility in the Victorian Village subdivision. The creek is heavily influenced by surrounding development and a significant portion of its length is underground. The above ground sections flow through private properties that often have little or no riparian vegetation. Based on the Port Perry Urban Drainage Study, roughly 88.7 ha of developed land drains into Williams Creek via the storm sewer network or through overland routes.

3.2 AQUATIC RESOURCES

Lake Scugog is an important aquatic ecosystem that has a significant influence on the lives of Port Perry residents. The purpose of this section is to highlight aquatic features (mainly aquatic plants and fish habitat) within the lake that are often regarded as high management priorities and to touch on some emerging issues that may affect them.

3.2.1 AQUATIC PLANTS

In Lake Scugog, aquatic plants (macrophytes) play an integral role in supporting aquatic life. Macrophytes provide important habitat (e.g., food, reproductive, cover) for fish, invertebrates and wildlife and also produce oxygen, consume nutrients and absorb contaminates, stabilize the lake bottom and lessen shoreline erosion.

In Lake Scugog, aquatic plant growth is commonly perceived to be excessive. The lake can be classified as nutrient rich and conducive to increased aquatic plant and algal growth. This is due to a number of regional and local factors such as geology, physiography, climate and land use. In certain instances, excessive plant and algal growth in a lake can significantly reduce the amount of dissolved oxygen available for fish. This process can develop when large amounts of plant material decompose and oxygen-consuming microorganisms begin feeding on the decaying matter. This phenomenon can be accelerated by the formation of a thick layer of ice, preventing air to water oxygen exchange, as well as during periods of high water temperatures.

In many areas of the lake, increased macrophyte coverage results from the dispersal of Eurasian water milfoil, a non-native species. Eurasian water milfoil is an aggressive, submerged aquatic plant native to Europe, Asia and North Africa that has become one of the most widely distributed non-native aquatic plant species throughout North America. Areas of extensive milfoil growth consist of thick, dense beds of aquatic vegetation that can seriously impair the recreational uses of the lake, including swimming, boating and aesthetics. As a result, landowners and outdoor event operators often feel it necessary to actively reduce these aquatic plants in certain locations. Several site-specific plant control strategies exist including chemical (e.g., herbicide application), physical (e.g., harvesting equipment) and biological (e.g., milfoil weevil introduction). Some plant removal techniques have the potential to severely impact aquatic communities as most of the fishes in Lake Scugog rely, either directly or indirectly, on macrophytes to realize their life processes. Depending on the location, type and scale of control desired, work approval would likely be required from one or more approval agencies (i.e., DFO, TSW, MOE and/or Kawartha Conservation).

3.2.2 FISHERIES

Fish habitat is defined as “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes”. The Lake Scugog watershed provides all of these habitat features, which are important for supporting and maintaining healthy, naturally reproducing fish populations.

Fish species are an important ecological link in the food web and are also important indicators of water quality and ecosystem health. They serve as food for other fish, birds, reptiles and mammals, including humans. Water pollution threatens fish, and a fish kill or the disappearance of fish from a stream can alert people to water pollution concerns.

One of the most central organizing features of aquatic communities is water temperature. In streams and lakes, thermal habitat is influenced by a number of factors including: air temperature, precipitation, topography, latitude, land use, vegetation coverage, water depth, geology and soils. The fish community in Lake Scugog near Port Perry is similar to other Kawartha Lakes and is characterized by warm water fish species supported by natural reproduction (Kawartha Conservation, 2004). Warm water species (e.g., bass, muskellunge, walleye and common carp) occupy the entire lake as well as most sections of its tributaries. There are no coldwater fish species in the lake or any of the tributaries flowing through the Port Perry urban area.

3.2.3 EMERGING ISSUES

In order to maintain healthy aquatic ecosystems, resource managers must identify emerging threats and develop strategies to buffer any negative change. Most of the emerging threats and stresses identified as harmful to freshwater lakes in Ontario also apply to Lake Scugog and watercourses around Port Perry.

What takes place on land is often mirrored in the water. For example, a river or stream flowing through an agricultural area can pick up fertilizer, manure, and pesticides. Runoff passing through the Port Perry urban area gathers fertilizers that run off lawns, sediments from construction sites, and runoff from impervious surfaces like parking lots. Biological communities live in the receiving waters and as such their health and survival reflects the integrated effect of chemical, physical and biological influences exhibited by urban land use.

Much of the natural shoreline around Lake Scugog has been altered in some way from its original state by single dwelling developments or for waterfront access. Healthy riparian zones provide multiple benefits in terms of watershed health and ecology diversity, in addition to improving water quality. The lack of natural riparian areas often results in a reduced ability for natural nutrient and contaminant filtration, increased shoreline erosion, and loss of suitable aquatic habitat.

Invasive species are considered to be among the most severe agents of aquatic habitat alteration and degradation. Invasive species often work in conjunction with other stresses such as water quality impairment to degrade the health of aquatic environments. For instance, invasive species are commonly introduced into stormwater management ponds in urban areas by people, and have the ability to transfer into natural systems. Once established, they can be extremely difficult to eliminate.

3.3 WATER QUALITY

Water quality can be defined as an integrated index of chemical, physical and microbiological characteristics of natural water. Water quality is a function of natural processes and anthropogenic impacts. Anthropogenic influences on the quality of natural waters may severely damage environmental health of the aquatic systems and generally come from various sources. These include point sources of pollution such as municipal and industrial wastewater discharges, ruptured underground storage tanks, septic tanks and landfills. Non-point pollution may also heavily impact water quality, referring to diffuse sources such as agricultural drainage, urban runoff, land clearing and field application of waste.

The main objective of the water quality data analysis is to convert water quality observations into information for educational purposes and for effective decision-making by various levels of government that eventually will promote the development of programs and plans aimed to rehabilitate disturbed environmental systems. Water quality data collected for this plan is provided in Appendix C.

3.3.1 DESCRIPTION OF PARAMETERS

- **Total Phosphorus:**
  Phosphorus is a key nutrient in the growth of aquatic plants. 1 kg of phosphorus can contribute to the growth of 500 kg of aquatic plants. As such, an excessive amount of this nutrient is a significant cause of eutrophication. Phosphorus can enter the stormwater network as a result of fertilizer application, erosion, sediments, animal waste, soap products and improperly stored hazardous waste.

- **Total Nitrogen:**
  Total nitrogen includes both inorganic forms of nitrogen: ammonia (NH_3), nitrites (NO_2^-) and nitrates (NO_3^-) and organic forms: total Kjeldahl nitrogen (TKN) less ammonia. The nitrite values are usually combined with the nitrate concentrations, as a nitrite-ion is the transitional form of nitrogen from ammonia to nitrate-ion and eventually all nitrites in lake or river water will be transformed into nitrates in a very short time. As well, nitrites are usually present in surface water in very small concentrations, mainly in the range of 1-10 micrograms. The combined concentrations of nitrates and nitrites are usually called total nitrate and consist typically of 98.0-99.9% of nitrates and 0.1-2.0% of nitrites. Total Kjeldahl nitrogen is a measure of total organic nitrogen plus total ammonia and in some cases may be evidence of fresh organic pollution in a water object or may demonstrate amount of phytoplankton development in the water. Like phosphorus, nitrogen contributes to the growth of aquatic plants.

- **Total Suspended Sediment:**
  Suspended sediment refers to any solids that are suspended within the water column. They are more prevalent in turbulent or fast moving water due to its increased ability to transport material. As such, suspended sediment tends to settle in water with lower velocities. In the case of stormwater runoff, suspended sediment primarily consists of leaf and litter debris, sand from road de-icing and sand and earth resulting from erosion or construction activities. These sediments are flushed into the stormwater network during precipitation or snow melt where they eventually enter and settle in lakes or other water bodies, or remain trapped in the stormwater network at the bottom of catch basins, ditches and other infrastructure. Sediment can be harmful as other chemical pollutants such as phosphorus and trace metals can bind to sediment particles. Additionally when sediment settles, it can cause problems in aquatic ecosystems as water bodies become shallower and fish and vegetation habitat is altered or destroyed.

- **Metals:**
  In terms of water quality, metals are located within the water column as a result of natural or anthropogenic processes. In higher concentrations, metals, such as aluminum, copper, lead, zinc are toxic for aquatic organisms and humans. Metals can enter the stormwater network through erosion, industrial activities and as a result of residue from the operation of motor vehicles.

- **Artificial organic and inorganic pollutants:**
  Artificial organic and inorganic pollutants are a substantial threat to the health of aquatic ecosystems. Most of them are extremely toxic and dangerous to aquatic life as well as to human health if these contaminants reach drinking water sources. In many Canadian rivers and lakes, contaminated sediments are a widespread and serious problem. A number of compounds being investigated are very persistent, such as the organochlorinated pesticides (OCPs), polychlorinated biphenyls (PCBs) and some trace

metals, which may have been released into the environment years ago but continue to linger in the environment.

3.3.2 TRIBUTARIES

All watercourses flowing through the Port Perry urban area are under heavy pressure from human activities. As a result, streams usually have high conductivity, elevated levels of major ions (especially chloride, sodium and calcium), and very high concentrations of total phosphorus and nitrogen. Owing to the nature of physiography in the area, hardness is also high.

Results of water quality monitoring conducted under the Lake Scugog Environmental Management Plan have revealed several areas of concern in Cawker's Creek and the Nonquon River watersheds. Cawker's Creek exhibits extremely high phosphorus and nitrogen concentrations. The Nonquon River also shows evidence of eutrophication as a result of high nutrient levels.

William's Creek is an interesting example as the watershed is entirely urbanized. Water quality data for William's Creek were collected in 2007 as part of the Port Perry nutrient study. Total phosphorus concentrations in water of William's Creek consistently exceeded the PWQO limit (30 µg/L). Average TP concentration during the period of observation was 251 µg/L with a median of 142 µg/L. During the study, phosphorus concentration reached as high as 1,650 µg/L in November of 2007. The minimum concentration was 32 µg/L, recorded in June of 2007. As expected, the highest phosphorus levels have been observed after rain events when stormwater runoff is moving through the creek.

Total nitrogen and nitrate concentrations in the water of William's Creek have been considerably elevated as well. The maximum TN concentration was detected in November of 2007 and was as high as 5.89 mg/L, while maximum NO_3^- concentration was 2.57 mg/L in January of 2007. An analysis of collected data has shown that 76% nitrate concentrations exceeded 1.00 mg/L, which is often considered as the eutrophication benchmark (CAST, 1992). The average TN and NO_3^- concentrations for the period of observation were 2.85 mg/L and 1.44 mg/L respectively.

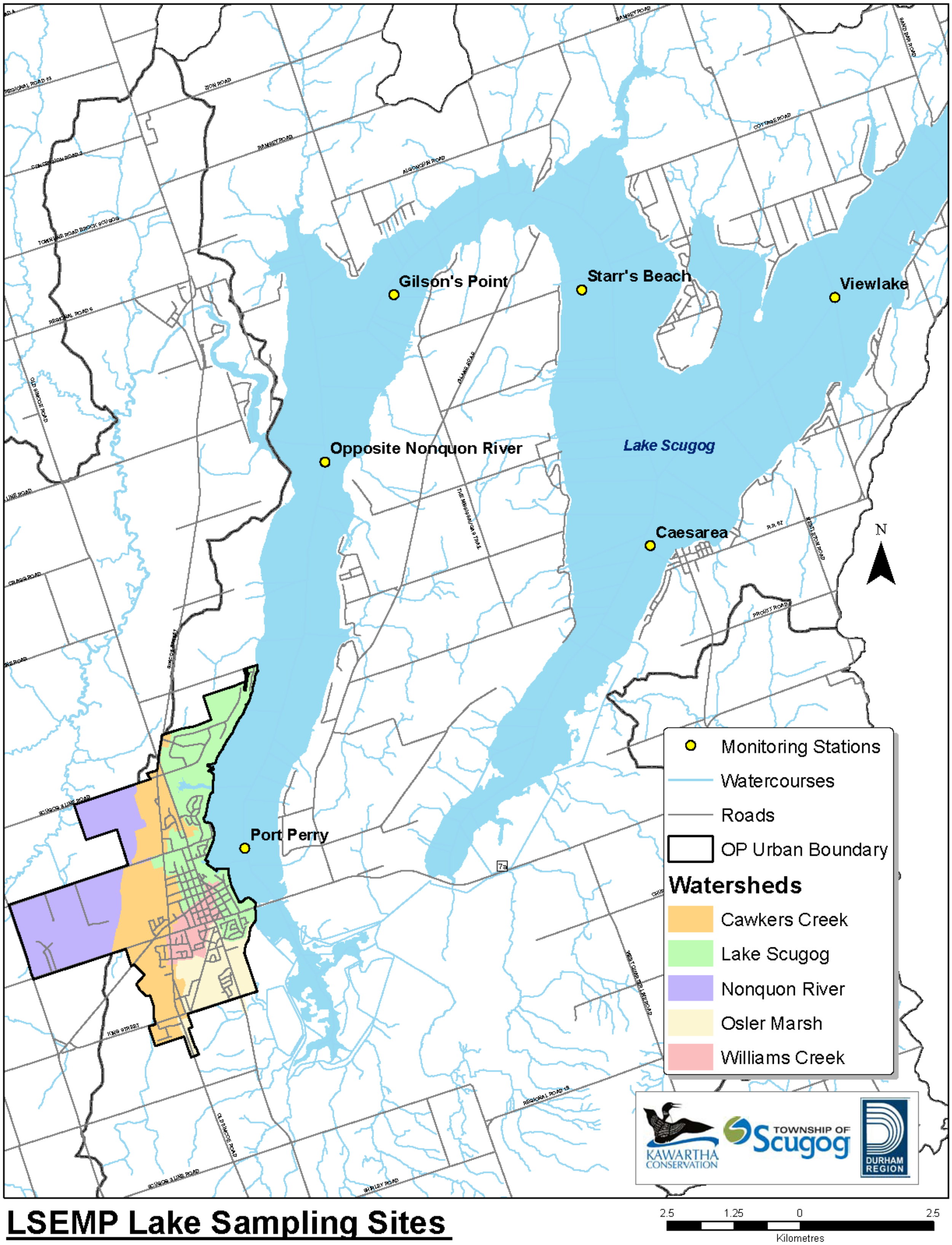
3.3.3 LAKE WATER QUALITY

Overall, Lake Scugog, based on the density of the aquatic vegetation and Secchi disk depth readings, can be characterized as a eutrophic water body. However, according to phosphorus levels in recent years, the lake can be placed into a mesotrophic category. According to the Canadian Council of Ministers of the Environment (CCME) classification, a lake can be defined as a mesotrophic water body if it has total phosphorus concentrations less than 20 µg/L (CCME, 2007). During the 2007 and 2008 monitoring seasons, phosphorus concentrations in Lake Scugog were below this limit.

Lake Scugog can be divided into two distinct sections: the western basin and the eastern basin. These two parts of the lake have very different features and hydrochemical regimes. These were determined by different water depths and, consequently, the amount of water, and abiotic anthropogenic factors including the urban area of Port Perry and a large influx of nutrients from the Nonquon River flowing into the western basin of the lake. Consequently, the western section of the lake is more eutrophic, consistently has higher phosphorus and nitrogen concentrations, and has remarkably more aquatic vegetation compared to the deep-water eastern basin. The shallowness of the western section and the considerable load of phosphorus, nitrogen and suspended sediments from the Port Perry urban area contribute to this condition. From the Port Perry urban area alone, approximately 630 kg of phosphorus and 6,480 kg of nitrogen enters the lake each year. Additionally, 250 kg of phosphorus and 12,900 kg of nitrogen enters the lake through Cawker's Creek flow.

Mean phosphorus concentrations at all three monitoring stations in the western basin (see Figure 3.3), namely Port Perry, the Nonquon River mouth and Gilson's Point, before 2007, were typically above the Provincial Water Quality Objective (PWQO) for lakes, which is set at 20 µg/L. In 2007, phosphorus levels dropped below the PWQO at all monitoring locations except Port Perry as can be seen in Figure 3.4. This tendency continued in 2008 when average TP concentrations in water of all monitoring stations in the western part of the lake reached their historical minimum. The average phosphorus concentration was 14.5 µg/L at Gilson's Point, 15.8 µg/L near the Nonquon River mouth and 17.3 µg/L in the vicinity of Port Perry. Throughout the summer period of 2007, the total phosphorus levels fluctuated from as low as 10 µg/L in the beginning of June to as high as 34 µg/L in the beginning of September. In 2008, the highest detected TP level was 23 µg/L recorded in the beginning of July in water at the Port Perry station. Total phosphorus levels are usually higher in the middle of summer (July- August).

Total nitrogen concentrations show the same decreasing trend in recent years as can be seen in Figure 3.3. In 2007, total nitrogen (TN) levels in the western basin of the lake ranged from 0.6 mg/L in June to as high as 1.00 mg/L in September. In 2008, nitrogen concentrations were lower, ranging from 0.59 mg/L to 0.92 mg/L. In the majority of cases, organic nitrogen constitutes most of the total nitrogen amount in the lake water ranging from 78% of TN in May to 99% during the summer and early autumn. Nitrate levels tend to be higher in the winter and early spring. The highest nitrate concentrations were between a low of 0.37 mg/L to a high of 2.55 mg/L detected in February of 2006. As well, slightly elevated nitrate levels (0.11-0.28 mg/L) are usually present in May although they are far below the Canadian Water Quality Guideline for the Protection of Aquatic Life (2.93 mg/L). For the remainder of summer and autumn, nitrate concentrations are typically under a laboratory detection limit (0.008-0.01 mg/L).



LSEMP Lake Sampling Sites

FIGURE 3.3: LAKE SCUGOG SAMPLING STATIONS

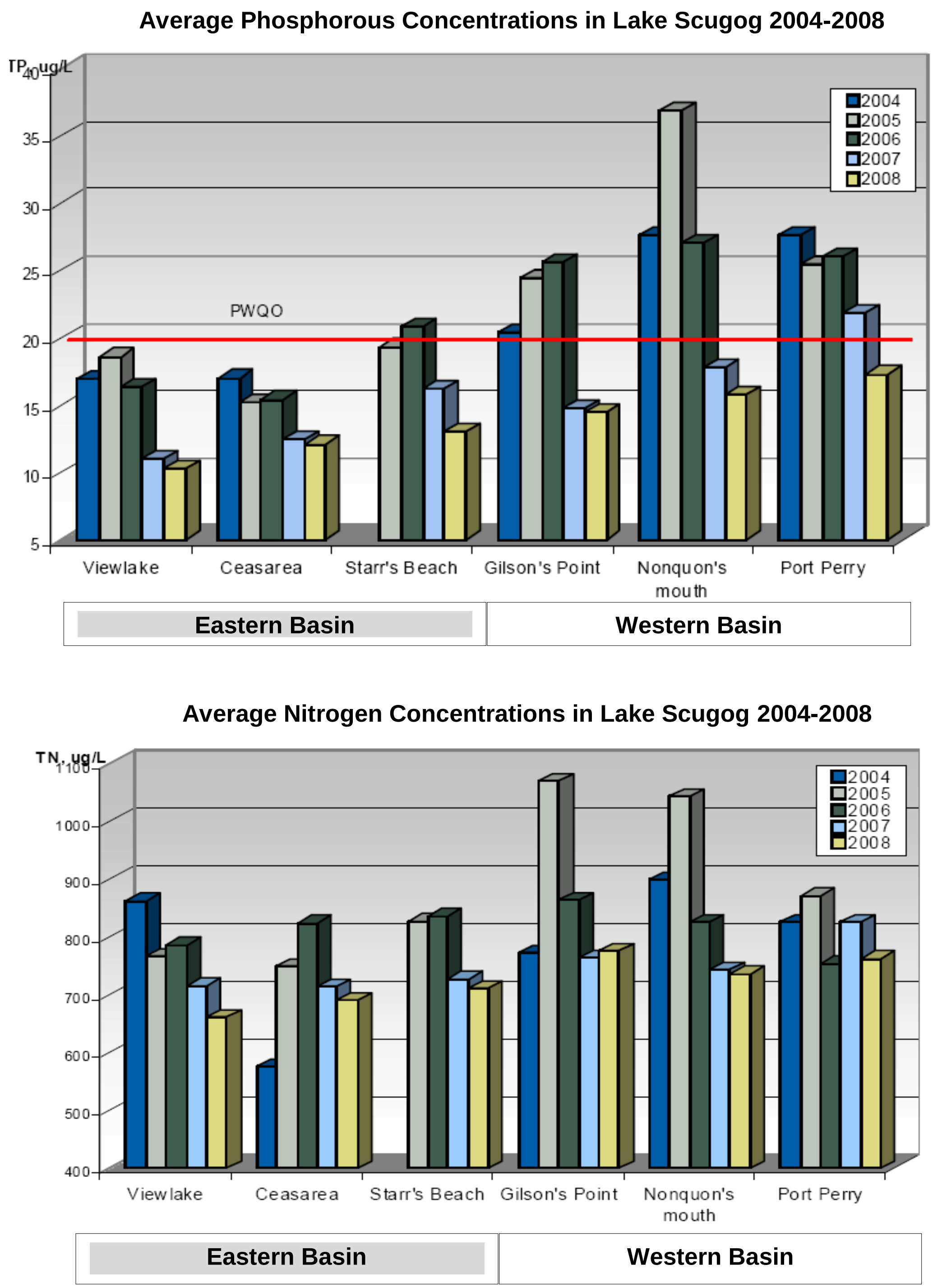


FIGURE 3.4: AVERAGE NITROGEN AND PHOSPHORUS CONCENTRATIONS IN LAKE SCUGOG 2004-2008

3.3.4 LAKE SEDIMENT QUALITY

As anthropogenic impacts on the Lake Scugog watershed increase, it is probable that metals and other toxic pollutants can accumulate in lake sediments. Their concentrations may increase to unacceptable levels and sediments may serve as a contaminant reservoir and source of pollution. Contaminated sediments can significantly impact the benthic environment and, as a result of bioaccumulation by benthics, some contaminants can work their way up the food chain.

Within the framework of the LSEMP, Kawartha Conservation initiated a sediment sampling program, which was aimed at studying possible contamination of bottom sediments in Lake Scugog in the vicinity of Port Perry. This study evaluated the condition of sediments with regard to the presence of selected organic and inorganic contaminants. Sediment samples were collected from 13 monitoring stations dispersed throughout the Port Perry Bay and Rowing Club Bay as can be seen in Figure 3.5. Sampling was conducted over a two-day period in June of 2007.

The positive finding is that no OCPs, PCBs, benzene, toluene, ethylbenzene and xylene (BTEX) have been detected in sediment samples from any monitoring station.

Polycyclic aromatic hydrocarbons (PAHs) have been detected in 13 of 15 samples, and in eight samples, at least one PAH compound exceeded the corresponding guideline. These compounds are known to be toxic to organisms, and are linked to carcinogenic effects. The highest concentration of total PAHs was detected in the sediment sample collected from SD1 station (13,163 µg/kg), located closest to the stormwater outlet. Concentrations of total PAHs at SD1 were approximately nineteen times higher than the next highest measured concentration found at SD4 (683 µg/kg), located in close proximity to another smaller culvert. Moreover, ten individual PAH parameters have been detected in the sample collected from station SD1 and all of these exceeded the corresponding guideline.

Petroleum Hydrocarbons (PHCs) have been detected in all sediment samples but only at station SD1 have they exceeded the corresponding guideline. Similar to PAHs, PHCs and the next set of parameters involving metals can degrade environmental quality and impact human health.

Metals have been detected in the majority of samples and in 13 sediment samples one or more metals exceeded the related guideline. Lead (Pb) was the prevailing parameter among this group of contaminants. It has been detected above the Ontario Sediment Quality Guidelines (OSeQGs) limit in samples from twelve stations. Especially high lead concentrations were found in sediments from stations SD12, SD11 and SD7. At station SD12, elevated concentrations of cadmium (Cd), copper (Cu), zinc (Zn) and PAHs also have been detected. At station SD7, in addition to lead, levels of cadmium, mercury, copper and

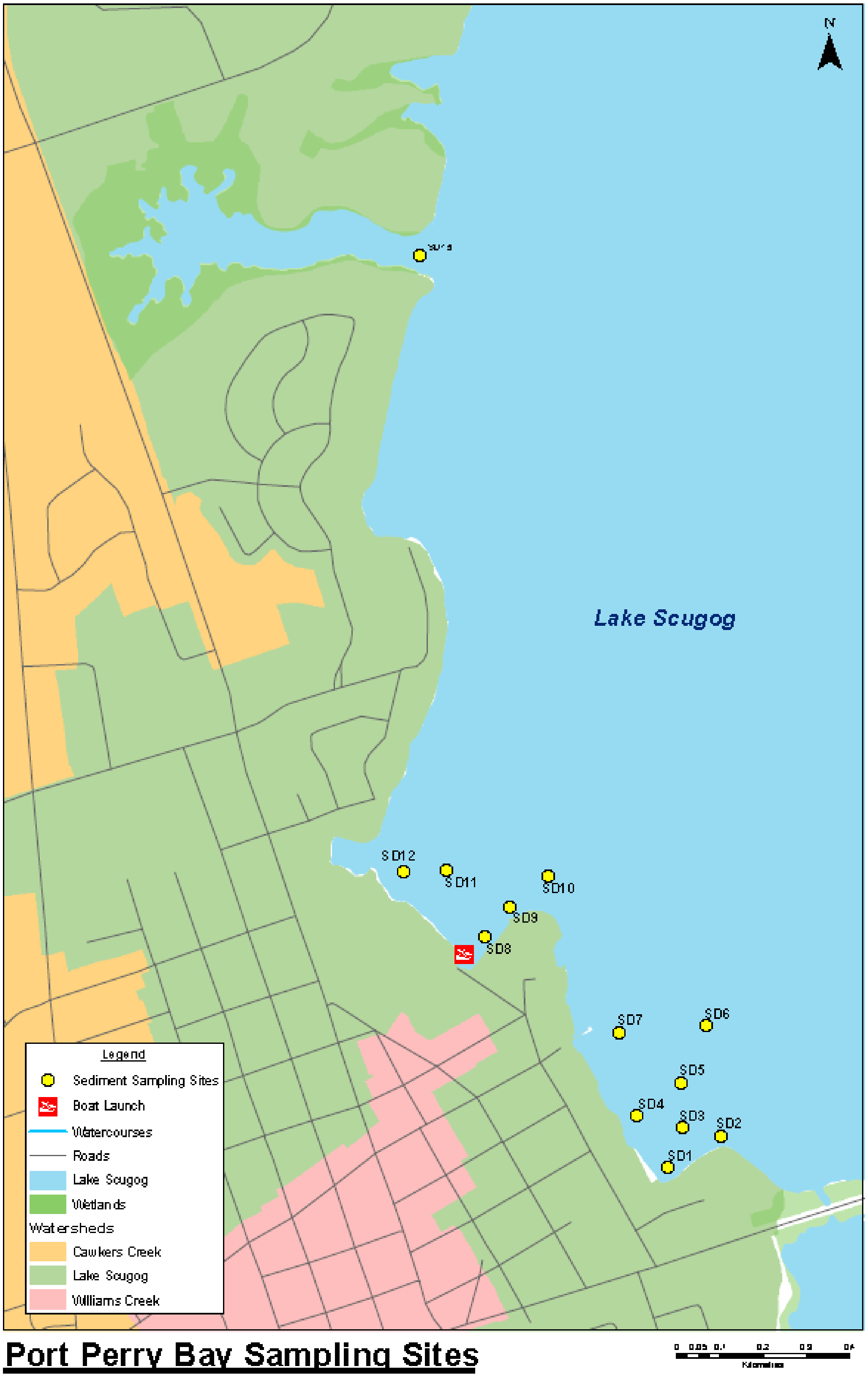


FIGURE 3.5: SEDIMENT SAMPLING SITES

phenanthrene exceeded corresponding guidelines. This station is located in close proximity to the pier, which is frequently used by private boats and the local cruise ship.

As well, sediment samples have been analyzed for TP, TKN, and total organic carbon (TOC). Most sediments have shown very high concentrations of phosphorus. The average phosphorus concentration in sediments from the southwestern portion of Lake Scugog is 948 mg/kg. Fortunately, most of that phosphorus amount is bound to sediment particles and is not available for consumption by aquatic plants when water is saturated with dissolved oxygen.

However, when an oxygen deficit occurs and pH values decline, the process of phosphorus desorption and, consequently, internal loading from sediments can be initiated. As well, reducing conditions at the water-sediment interface can lead to the mineral dissolution of iron-phosphorus, manganese-phosphorus and aluminum-iron-phosphorus minerals present in sediments. This produces elevated concentrations of both phosphorus and the above-mentioned metals in the bottom layer of water. The issue of possible internal loading of phosphorus and metals requires additional studies in the future.

3.3.5 URBAN STORMWATER QUALITY

Stormwater quality data was collected using an automatic sampler located at the sewer outlet in Baagwating pond from May until December of 2009. For the purpose of this project, samples were taken when water levels at the sewer outlet rose to an earlier determined level thus initiating automatic sampling activity required during a rain event. Collected samples were analyzed for total nitrogen, total phosphorus, total suspended sediments and total metals. In total, 65 samples were collected during 23 storm events over the monitoring period (See Appendix C for water quality results and Appendix D for water quantity results).

When looking at water level data, key points of the rain event and corresponding samples can be selected for analysis. For the purpose of this project, samples were taken at the first flush, at the point of highest concentrations of runoff contaminants and at the end of the rain event. The water level graph and corresponding samples for September 28, 2009 can be seen in Figure 3.6.

During the observation period, all samples had total phosphorus concentrations above the PWQO established at 0.03 mg/L for rivers. Concentrations during this period ranged from 0.041 mg/L to 0.705 mg/L. Obtained results indicate that phosphorus concentrations in urban runoff are at their highest during the initial stages of a rain storm in the first flush, with a gradual decreasing trend as the storm continues, even during periods of increased discharge. During the monitoring period, the average TP concentration in urban runoff was 0.282 mg/L, while in water of the first flush it was 0.439 mg/L (Table 3.1).

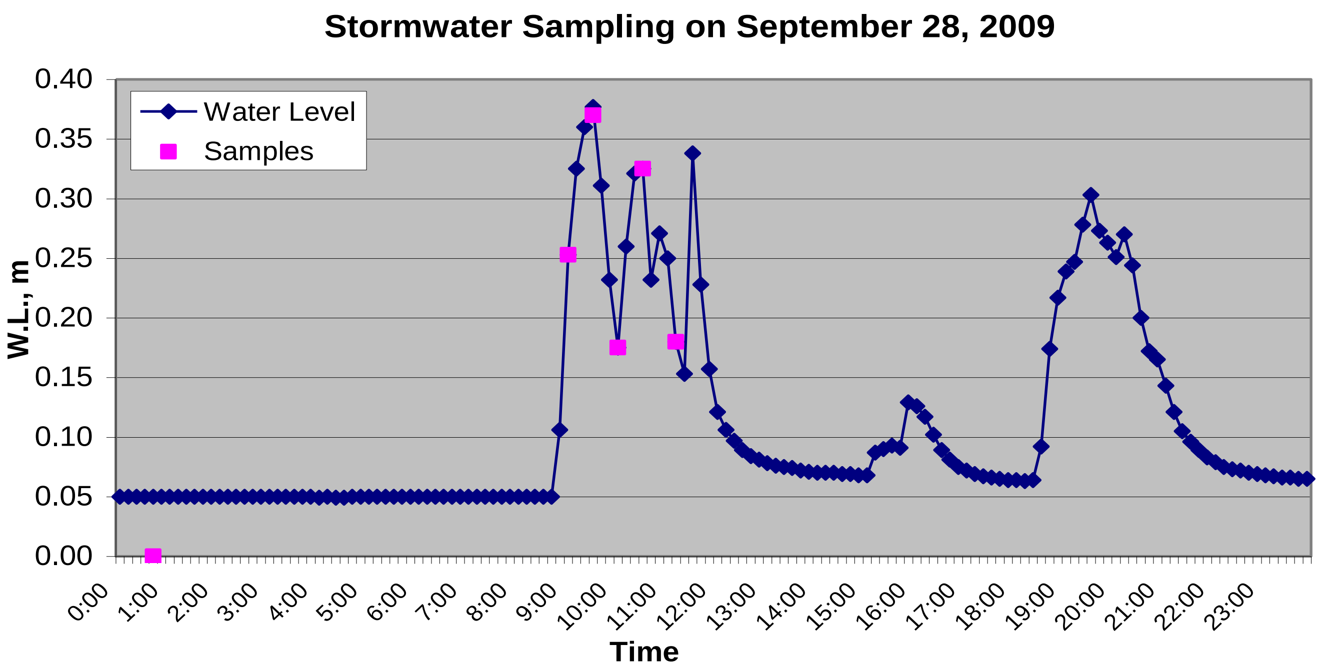


FIGURE 3.6: EXAMPLE OF AUTOSAMPLER SAMPLING DURING A STORM EVENT

Table 3.1. Concentration of Selected Contaminants in Stormwater of Port Perry

Sampling Criteria	Total Phosphorous mg/L	Total Nitrogen, mg/L	Total Suspended Solids, mg/L	Aluminum, mg/L	Copper, µg/L	Lead, µg/L	Zinc, µg/L	Metals as total, mg/L
First flush average	0.439	2.85	456	3.400	27.1	23.4	143.6	7.39
Peak/main flow average	0.266	1.88	200	1.973	15.2	11.2	74.5	4.37
Ending flow average	0.163	1.01	75	0.956	7.1	4.7	31.7	2.23
Total average	**0.282**	**1.90**	**213**	**1.909**	**14.8**	**11.6**	**74.3**	**4.24**
Corresponding PWQO or CWQG	0.03	--	30	0.100	5.0	5.0	20.0	--

Total nitrogen concentrations in stormwater runoff ranged from 0.45 to 5.53 mg/L. Like phosphorus, the highest total nitrogen concentrations were recorded during the first flush with a gradual decrease in concentrations as the rain continued. Samples taken closer to the end of the event had concentrations roughly 50% of the first flush levels. From May to December, the average concentration of total nitrogen was 1.90 mg/L

Total suspended solids concentrations ranged from 20 mg/L to 828 mg/L with an average concentration of 213 mg/L. The highest concentrations were recorded at the beginning of the precipitation events with a noticeable decreasing trend throughout the event. On average, samples taken during the initial flush had concentrations six times higher than those taken at the end of the storm event

The average concentration of the total sum of trace metals in urban runoff was 4.24 mg/L. Among metals of interest, aluminum and iron had the highest concentrations (Table 3.2). Recorded concentrations of copper, lead and zinc are usually far above the corresponding guideline (See Tables 3.1 and 3.2). The highest concentrations for all parameters were recorded at the beginning of rain events. As a result of stormwater contamination, a considerable load of various metals is entering the lake along with TSS, phosphorus and nitrogen.

Table 3.2. Results of Statistical Analysis of Several Contaminants in Port Perry Stormwater

Parameter	Min	25-%	Median	75-%	Max	PWQO or CWQG
Al, ug/L	85.4	704.5	1530	2520	7980	100
Cd, ug/L	0	0.1	0.1	0.2	1.5	0.5
Cr, ug/L	1	6	9	11	27	8.9
Co, ug/L	0.1	0.6	1.1	1.7	4.4	0.9
Cu, ug/L	3.1	7.4	11.1	20.5	39.7	5
Fe, ug/L	120	1055	2000	3410	9020	300
Ni, ug/L	0.7	2.1	3.1	5.6	11.6	25
Pb, ug/L	0.9	4.9	7.6	15.5	40.1	5
V, ug/L	0.7	2.6	4.1	6.3	16.9	6
Zn, ug/L	7	30	56	98	234	20
TP, ug/L	41	176	260	375	705	30
TN, mg/L	0.45	1.01	1.61	2.49	5.53	---
TSS, mg/L	20	81	124	281	828	30

Note: Highlighted cells are over the recommended guideline

Figure 3.7 displays an example of trends in contaminant concentrations during a rain event on September 28th, 2009. Water level (m) represents the change of water level at the storm sewer outlet as a result of rainfall intensity.

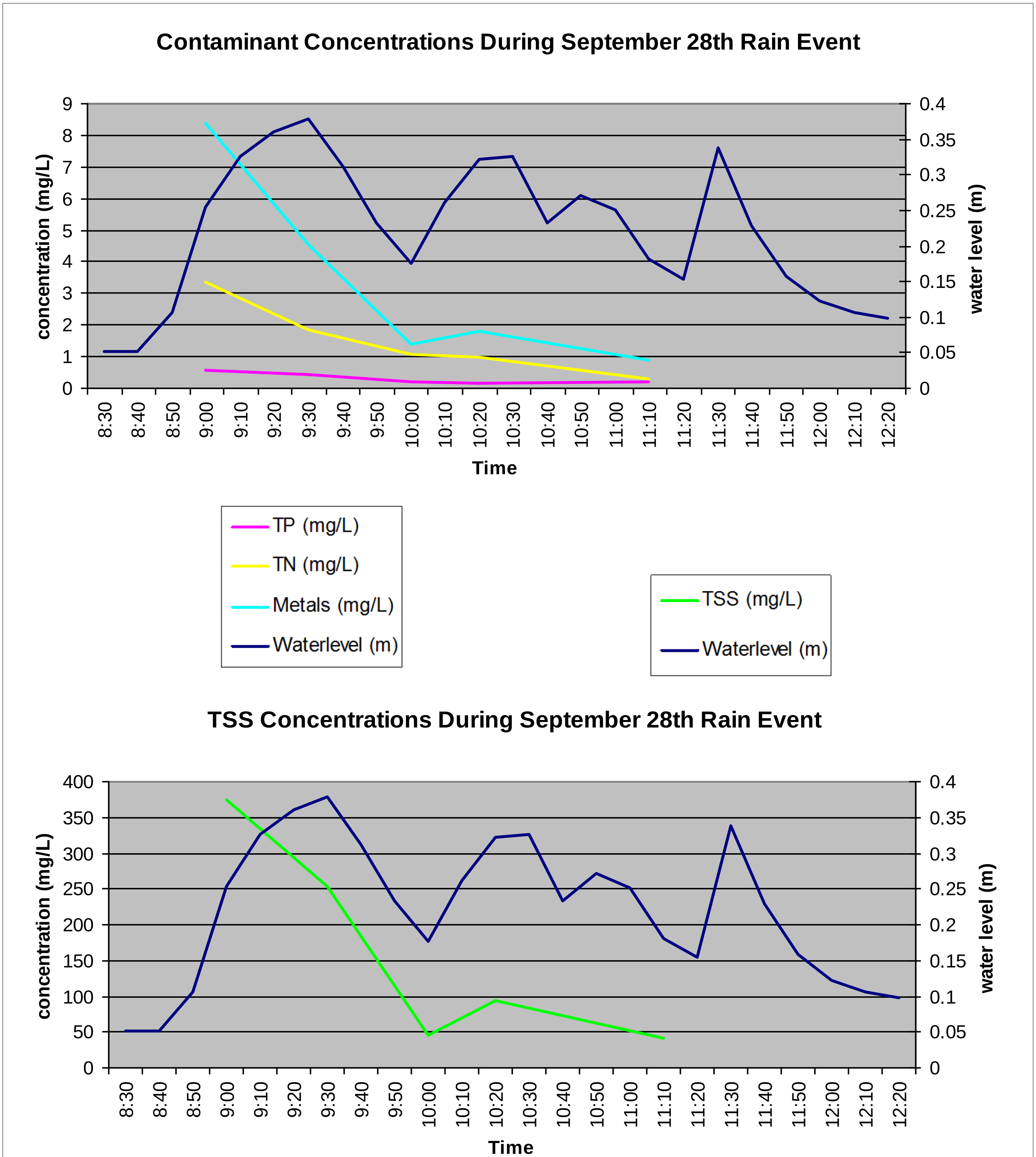


FIGURE 3.7: EXAMPLE OF CONTAMINANT CONCENTRATIONS DURING A RAIN EVENT

3.4 SOCIAL CHARACTERIZATION

The settlement of Port Perry was heavily influenced by the opportunities presented by Lake Scugog as a mode of transportation. When looking at settlement patterns one must go back to the years 1828-1830 when the dam in Lindsay was constructed by William Purdy. The effect of the dam was to increase the depth of the lake and expand the shoreline inland. “At the time these Townships were surveyed, the whole of what now constitutes the southern portion of Lake Scugog was dry land.” (Monteith, 1859). In 1844 Peter Perry of Whitby saw the area as an excellent site for a village, “where mills and stores might be erected, and to which might be easily conveyed the available lumber of the back country.” (Monteith, 1859) The town continued to grow and expand based on business and trade that was influenced by nearby Oshawa and surrounding agriculture that utilized Port Perry as a transportation hub with roads, rails and steamboat facilities being located there.

Port Perry has continued its growth into the twenty first century based on the proximity and dependence on the lake for economic development. Early settlement and continued expansion of the town of Port Perry along a changing shoreline has occurred over time. The current population of Scugog Township is 21,439 with roughly 9,500 persons residing in the Port Perry urban area. The population of Scugog Township grew steadily at a rate of 253 persons per year between 2001 and 2006. A significant trend in population growth in the Township is the steady increase in the number of urban dwellings. In 1995, 38.2% of the population was made up of urban dwellings, increasing to 42.1% by 2002 (Meridian, 2007). The Township of Scugog has accounted for this growth in their Official Plan and has projected a growth rate of 110 dwellings per year to the year 2031, primarily in urban areas (Township of Scugog, 2009).

As with most historic development, the urban drainage network was developed in response to urban expansion. As a result, there are opportunities to plan the storm sewer network such that it can more efficiently and effectively deal with overland runoff.

3.5 NATURAL HERITAGE

Lake Scugog was created by human processes, the creation of the dam in Lindsay flooding what was once a marsh. The result is a lake that is shallow with a thick layer of sediment on the bottom. The area to the south of Lake Scugog continues in this natural state as the Osler Marsh. Forests were once abundant throughout the Lake Scugog watershed; however, the dominant land use since the 1800's has shifted to agriculture, with only small areas of forest remaining.

Natural heritage features within the Port Perry urban area are limited amidst the existing 1368 hectares of developed areas. The total amount of natural space remaining in the urban area is 279 ha or 20%, of which 137 ha (10%) is wetland, 92 ha (7%) meadow and 49 ha (4%) forest (Figure 3.8). Valley areas associated with to Cawker's Creek stands out as the main terrestrial natural heritage feature with land adjacent to the creek being comprised of mainly forest and meadow. There remain two wetland areas within Port Perry; a portion of the 2,700 hectare Provincially Significant Osler Marsh (the largest in the Scugog watershed) and the 21.4 hectare Port Perry North wetland that Cawker's Creek drains into before entering Lake Scugog. There are also some remnant wetland areas in and adjacent to the Nonquon Industrial Area. The Osler marsh provides important breeding and migratory habitat for waterfowl (Hanna, 1984) as well as habitat for fish, supporting the vibrant sport fishing industry of Lake Scugog.

Although not a Provincially Significant Wetland, the Port Perry North Marsh provides biological attenuation of heavy metals and nutrients, and traps suspended solids and sediments. These wetlands potentially act as a significant water quality control for Lake Scugog as well as providing spawning habitat for fish and nesting habitat for birds (Proctor and Redfern, 1996).

The Cawker's Creek natural areas provide linkages to sections of the greenbelt to the west of Port Perry, which contains large areas of forest, wetland and the Nonquon River watershed. The natural areas around Cawker's creek also provide permeable surfaces for water infiltration and ground water recharge.

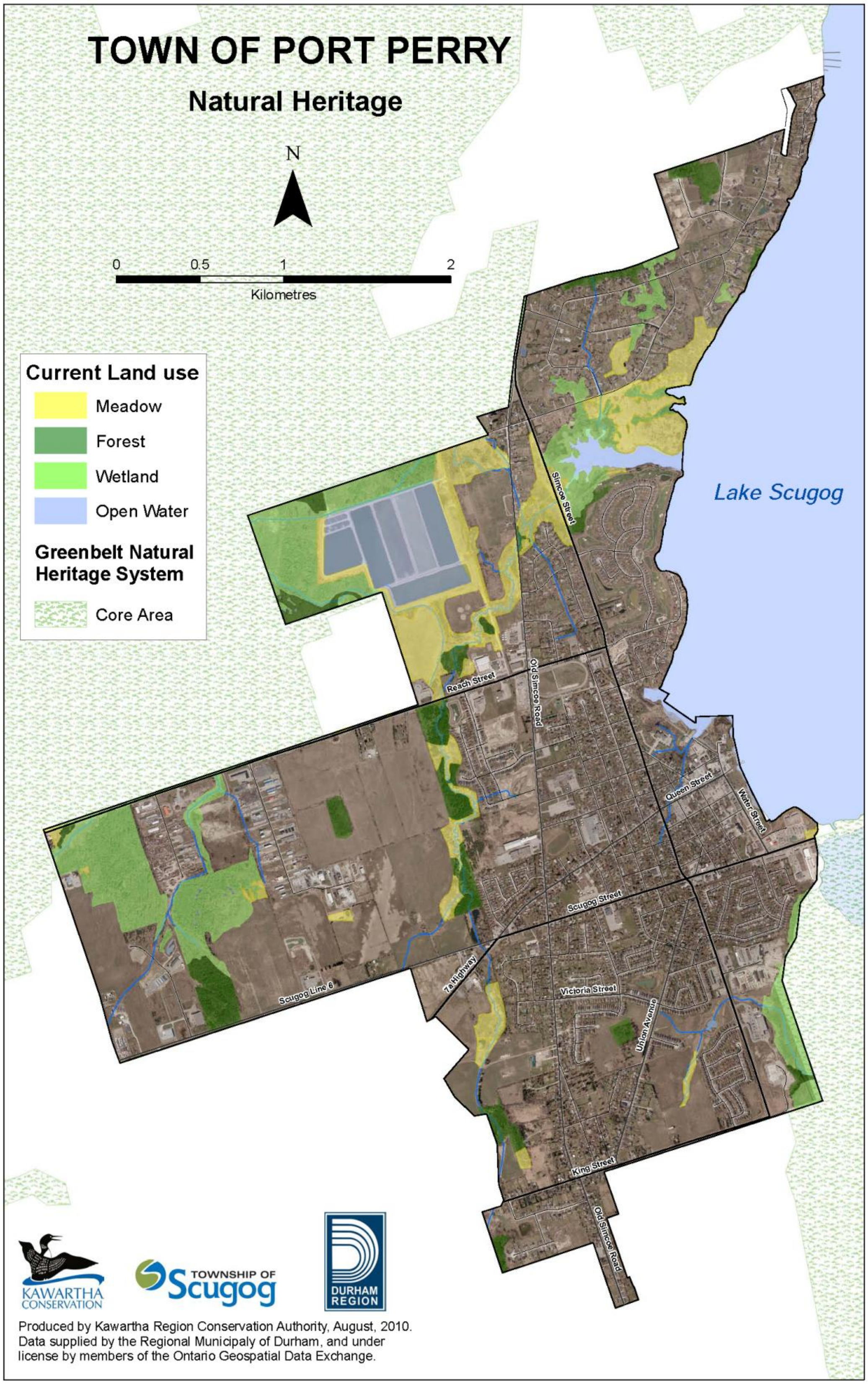


FIGURE 3.8: NATURAL HERITAGE FEATURES

3.6 MUNICIPAL STORMWATER INFRASTRUCTURE

The stormwater infrastructure that was considered in this plan includes the storm sewer system - ditches and swales, oil grit separators, catch basins, maintenance holes, culverts and stormwater management facilities.

This study draws from the conceptual stormwater drainage network and works to enhance the information contained in the Port Perry Urban Drainage Study (2009) (Figure 3.9). Wherever possible, as-built drawings, engineered plans and field work were utilized to refine the locations and flow gradients for the stormwater infrastructure. As-built drawings are critical for an accurate understanding of the urban stormwater network as they are a true reflection of development after they are constructed. These drawings, as well as engineered plans do not exist for the majority of the Town of Port Perry, therefore, much of the refined information relies on field observations. Figure 3.10 illustrates the general extent of the storm sewer infrastructure that was included as part of this plan. Figure 3.11 illustrates how as-built drawings can influence the understanding of the drainage network. This figure identifies the difference between the conceptual understanding of the drainage network and the as-built drawings obtained from an investigation of the connections in the sewer network.

Storm sewers in Port Perry are maintained by the Scugog Township Public Works Department. An exception to this are the sewers on Simcoe Street and Scugog Street which are regional and provincial roads respectively and thus under the jurisdiction of Durham Region and the Province of Ontario.

Stormwater management facilities provide important roles in water quality and water quantity control from developed areas. Approximately 16% (220 ha) of land in the urban area drains to these facilities. Stormwater management facilities on municipal property are maintained by the Township's Public Works Department. Other facilities located on private property are the responsibility of the property owners. Figure 3.12 illustrates the locations of the stormwater management facilities. Details of the stormwater management facilities can be seen in Table 3.3.

Undeveloped portions of the town will require stormwater facilities as the area is developed. Several watershed studies have identified locations for future stormwater management ponds within the urban area. These are discussed further in following sections.

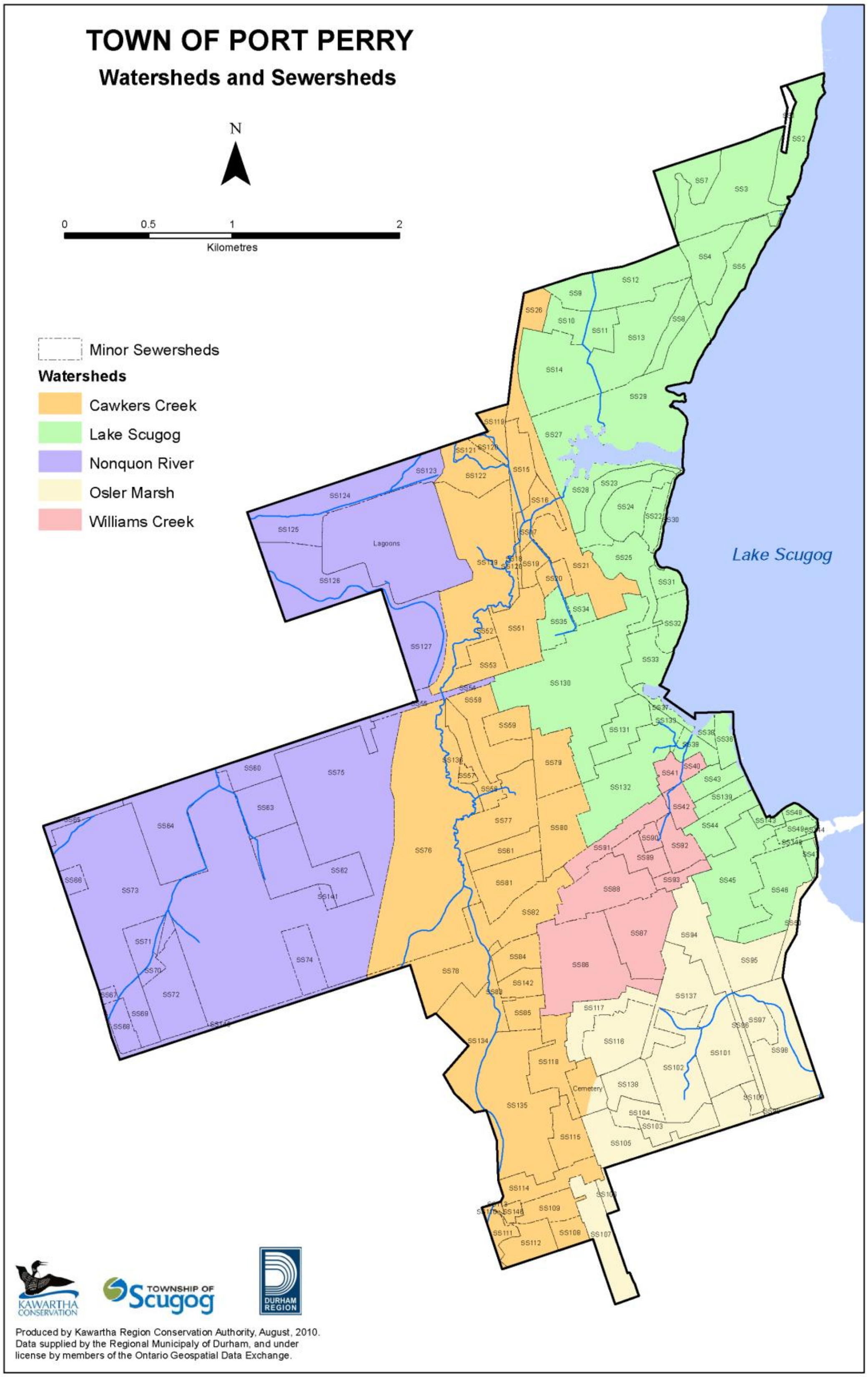


FIGURE 3.9: STORM SEWER NETWORKS AND WATERSHED DRAINAGE

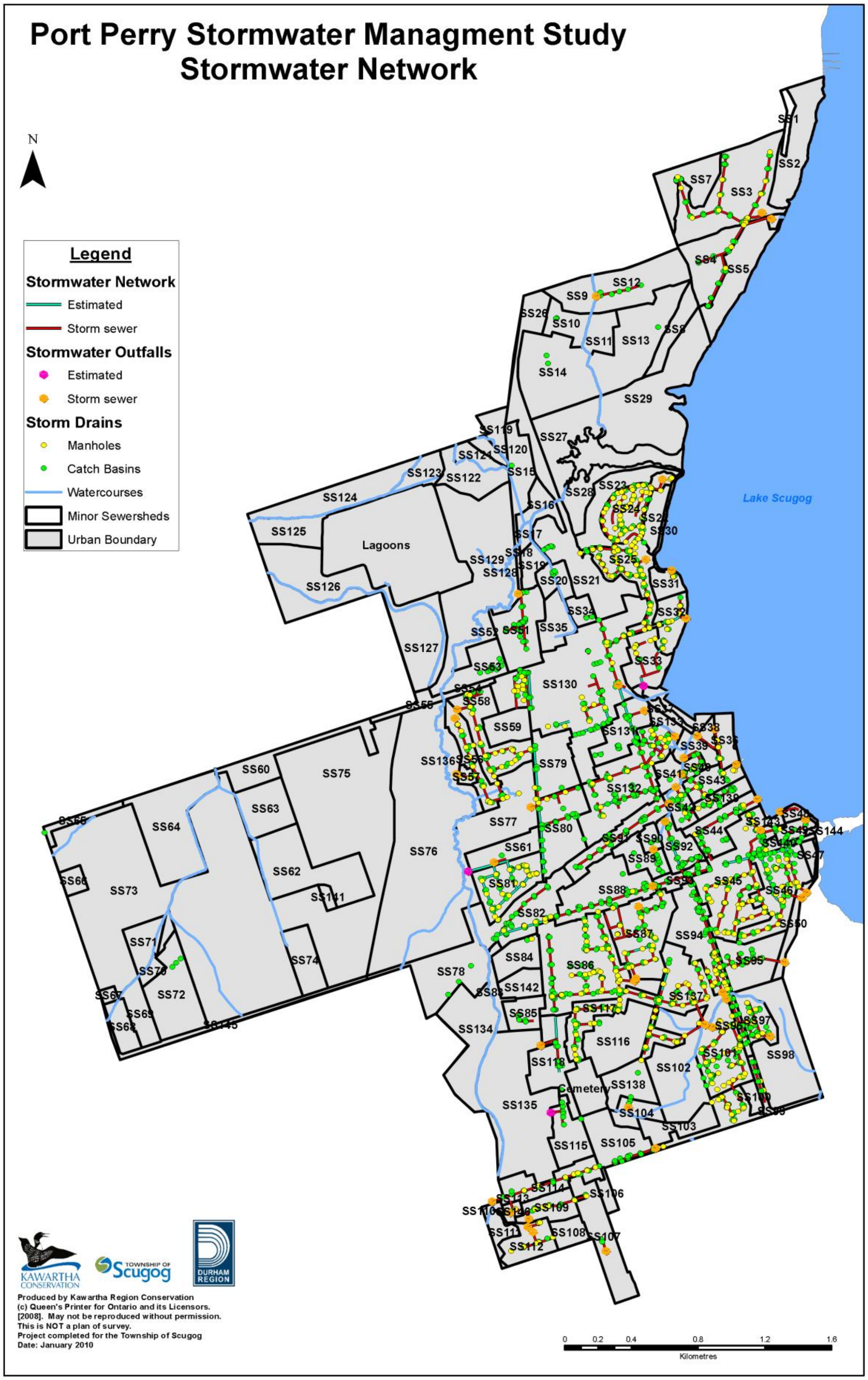
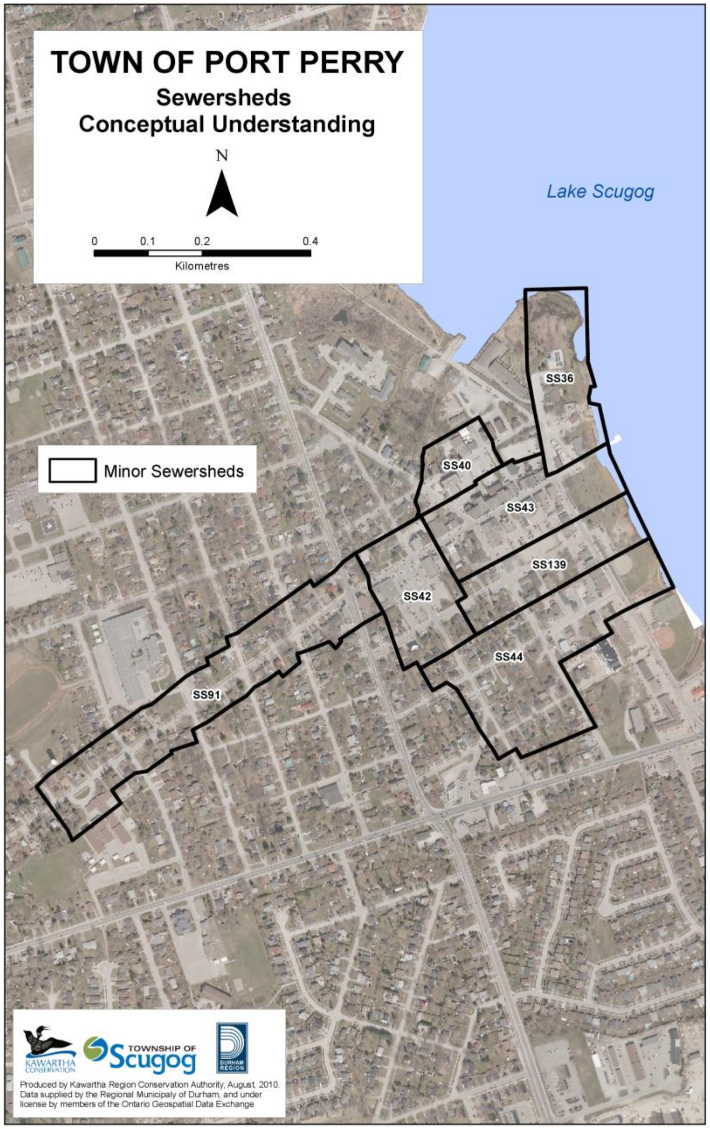


FIGURE 3.10: STORM SEWER NETWORKS AND INFRASTRUCTURE



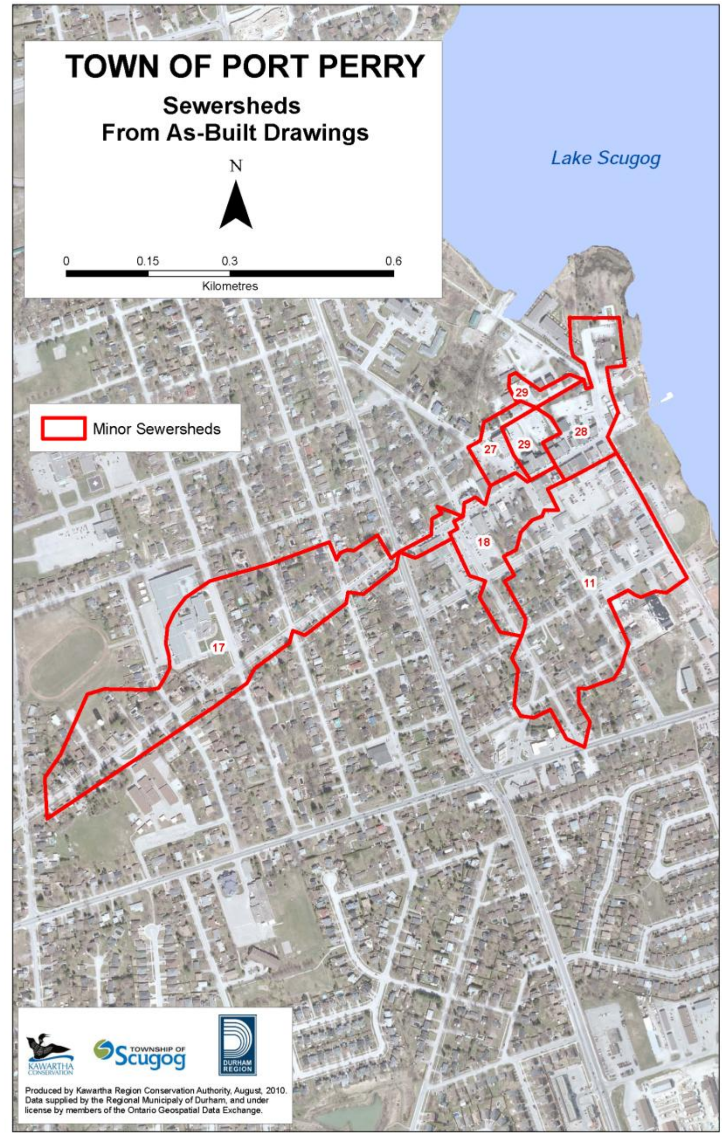


FIGURE 3.11: COMPARISON OF CONCEPTUAL VS AS-BUILT UNDERSTANDING OF STORM SEWER NETWORK FOR HIGH PRIORITY AREAS IN PORT PERRY

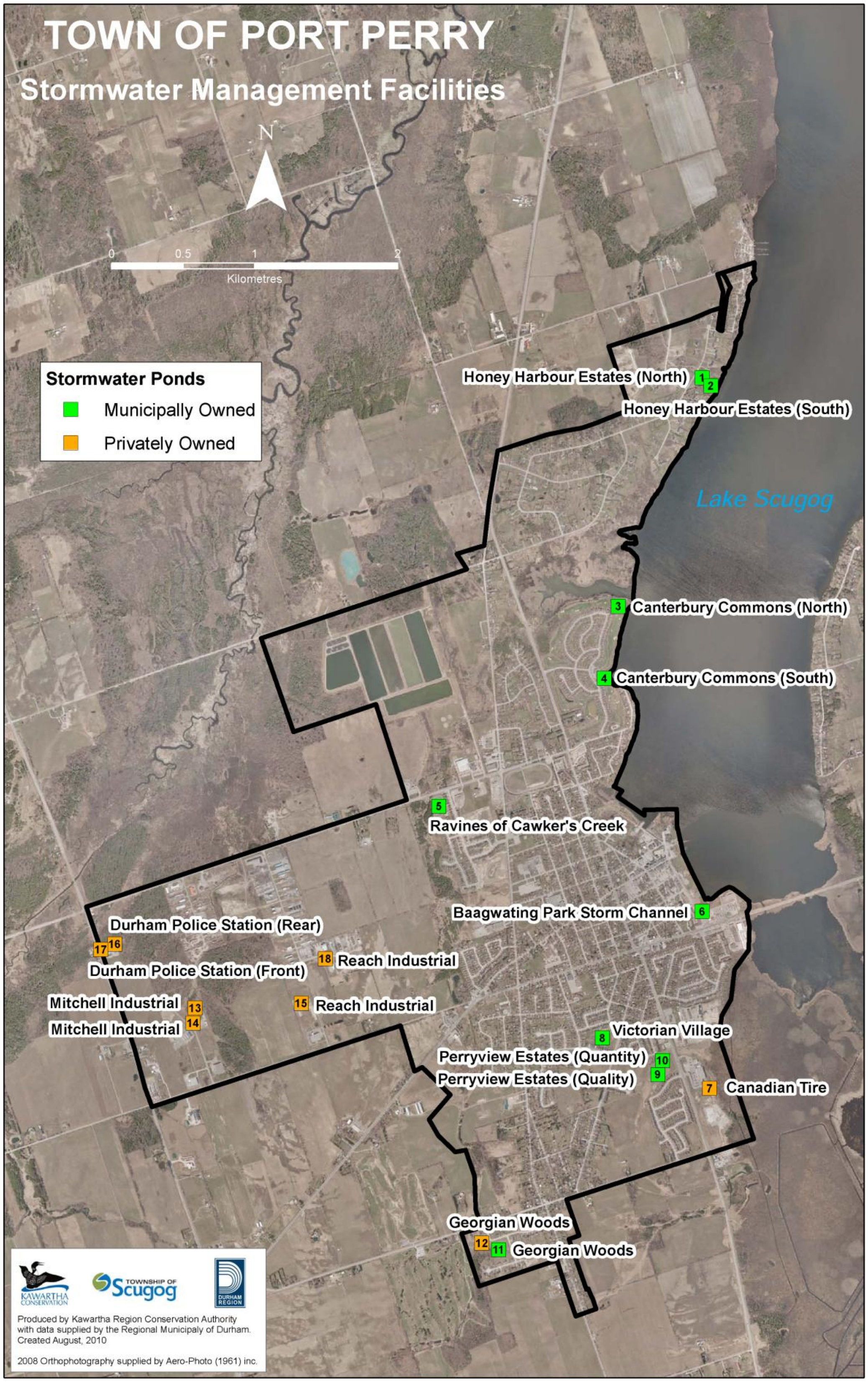


FIGURE 3.12: STORMWATER MANAGEMENT FACILITIES

Table 3.3: Stormwater Facility Details

ID	Facility Name	Type	Drainage Area (Ha)	% Imper-vious	Year of Construction	Assumed
1	**Honey Harbour Estates. (north pond)**	**wet pond**	**15.6**	**28%**	**2002**	**yes**
2	**Honey Harbour Estates (south pond)**	**dry pond**	**9.3**	**29%**	**1994**	**yes**
3	**Canterbury Commons (north)**	**wet pond**	**12.3**	**-**	**1997**	**yes**
4	**Canterbury Commons (south)**	**wet pond**	**7.9**	**43%**	**1995**	**yes**
5	**Ravines of Cawker's Creek**	**wet pond**	**37.0**	**55%**	**2004**	**yes**
6	**Baagwating Park Storm Channel**	**ditch**	**18.9**	**48%**	**2003**	**yes**
7	Canadian Tire	wetland	6.4	85%	2004	private
8	**Victorian Village**	**wetland**	**38.1**	**35%**	**1994**	**yes**
9	**Perryview Estates (quality)**	**wet pond**	**28.3**	**42%**	**1998**	**yes**
10	**Perryview Estates (quantity)**	**on-line dry pond**	**28.3**	**42%**	**1998**	**yes**
11	**Georgian Woods**	**wetland**	**15.1**	**35%**	**2000**	**yes**
12	Georgian Woods	0% swale	18.6	35%	N/A	N/A
13	Mitchell Industrial (Easy St)		12.2	60%	2000	no
14	Mitchell Industrial (Easy St)	fire pond	-	-	*N/A*	private
15	Reach Industrial (Adamson Systems)					private
16	Durham Police Sta. (rear)	dry pond			2000	private
17	Durham Police Sta. (front)	dry pond			2000	private
18	Reach Industrial (Taylor)					private

Note: Items identified in shaded bold are maintained by the Township of Scugog
There are many more, smaller private ponds in the Port Perry area

4.0 HIGH PRIORITY AREAS AND OPPORTUNITY IDENTIFICATION

Although the entire Port Perry urban area is being looked at as part of this plan, it was beyond the scope of the project to recommend specific capital project alternatives for such a large area. As such, recommendations for the urban area as a whole will be narrowed down to operations and policy amendments such as by-law and engineering design standard changes.

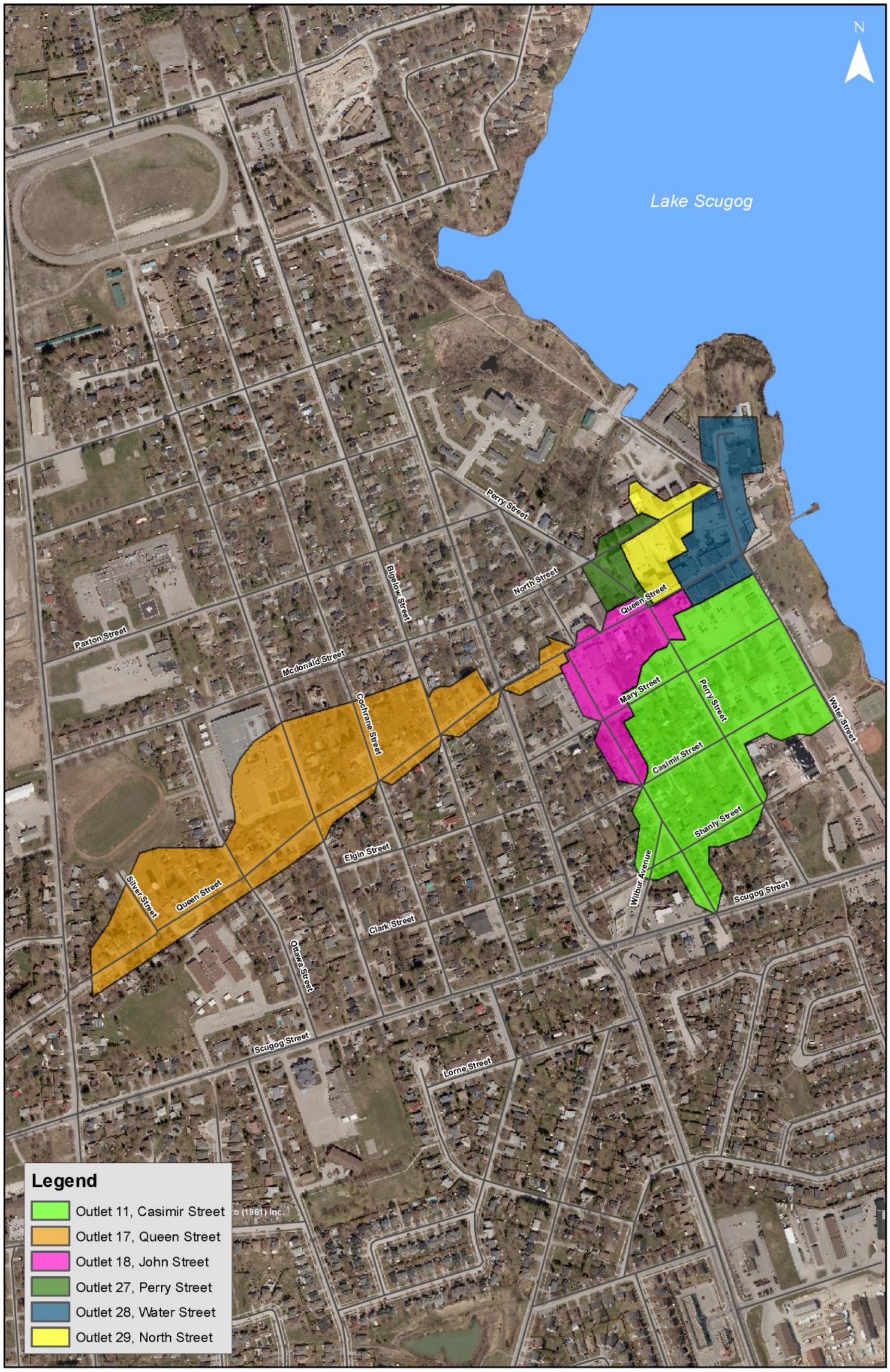
Specific capital project recommendations were made for those areas classified as high priority under the Port Perry Urban Drainage Study. Priority areas were determined based on existing stormwater controls and land use type. High priority areas consist of high traffic land use with high levels of impermeable surfaces such as commercial and industrial areas that are draining to surrounding water bodies with no quality control. For the purpose of this study, the high priority areas in the downtown core provided an opportunity for implementation of capital stormwater quality control infrastructure.

It is noteworthy that the Port Perry waterfront was undergoing a redevelopment phase during the course of this study. This has affected the recommendations for capital alternatives for the Water Street outlet (Outlet 28). As the capital alternatives will be completed, recommendations for the outlet are identified as an "implemented" alternative. The capital alternatives for this outlet, however, are included in charts and figures in this report to indicate the fact that this study straddled that of implementation works being undertaken by the Township of Scugog.

4.1 HIGH PRIORITY AREAS

The downtown core high priority area covers a total of 26.7 ha and is generally bounded by North Street to the north, Water Street to the East, Casimir and Shanly Streets to the South and John Street to the West. This area is highlighted in Figure 4.1. In total six separate drainage areas were delineated in this area based on topography and the existing storm sewer network. Detailed drainage area maps can be seen in Figures 4.2, 4.3, 4.4, 4.5, 4.6, and 4.7. Information for all six drainage areas can be seen in Tables 5.1 and 5.2.

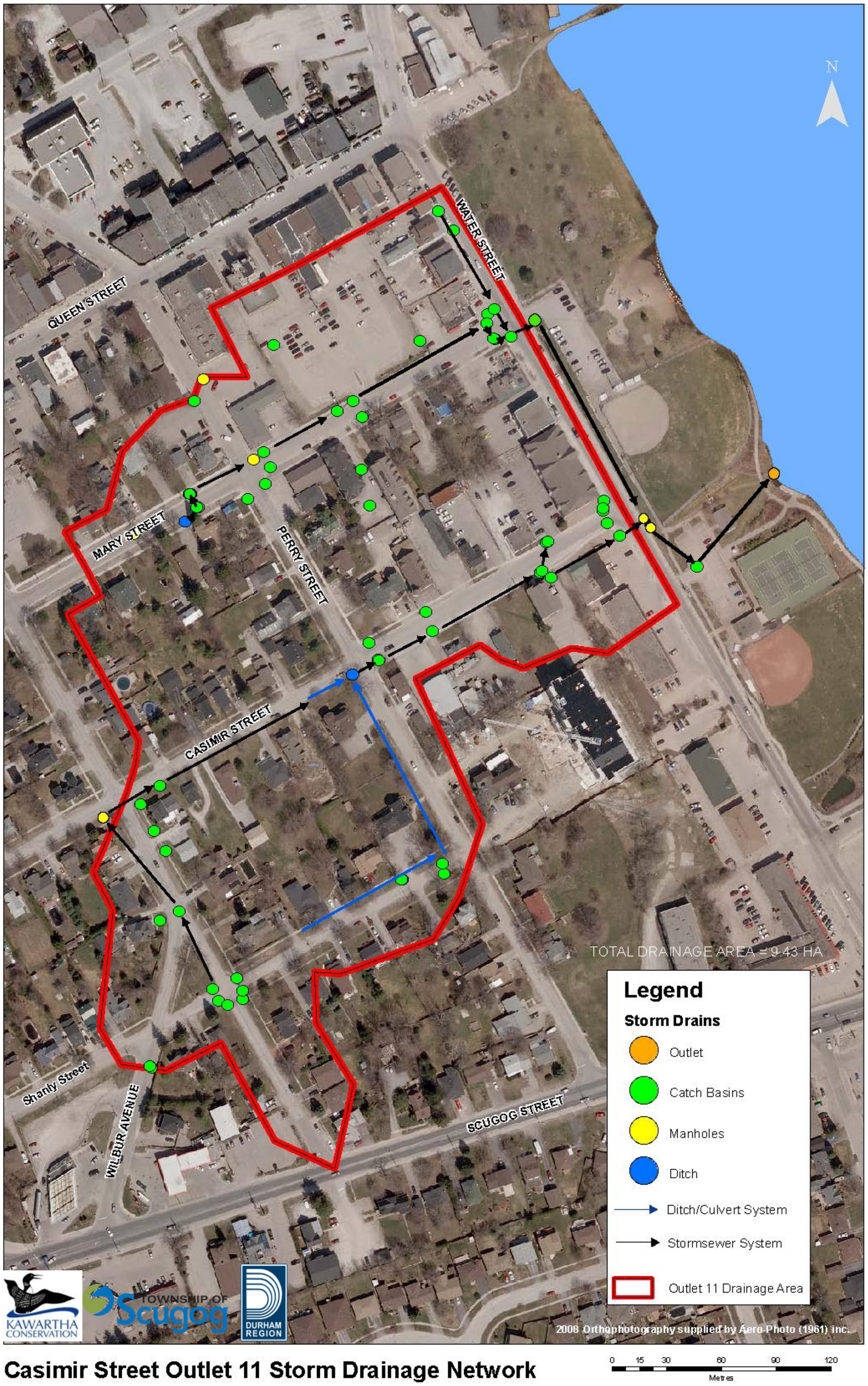
From these details, potential options were able to be selected and eventually narrowed down to a preferred option using a decision matrix scoring system, identified in chapters 6 and 7 of this report.



High Priority Drainage Areas

0 45 90 180 270 360
Metres

FIGURE 4.1: HIGH PRIORITY DRAINAGE AREAS



Casimir Street Outlet 11 Storm Drainage Network

FIGURE 4.2: HIGH PRIORITY DRAINAGE AREA, OUTLET 11 (CASIMIR STREET)

Queen Street Outlet 17 Storm Drainage Network

0 25 50 100 150 200
Metres

FIGURE 4.3: HIGH PRIORITY DRAINAGE AREA, OUTLET 17 (QUEEN STREET)

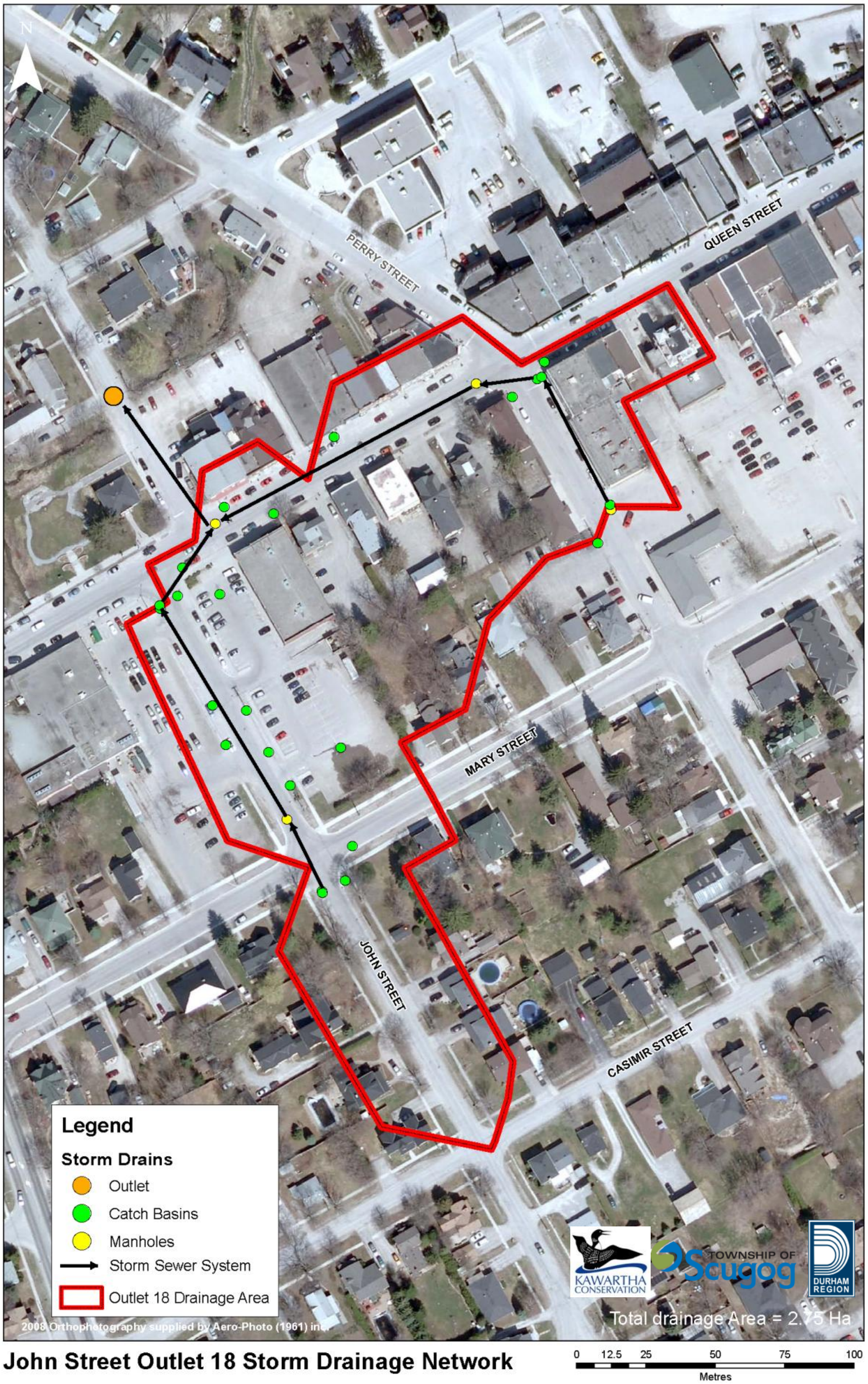


FIGURE 4.4: HIGH PRIORITY DRAINAGE AREA, OUTLET 18 (JOHN STREET)

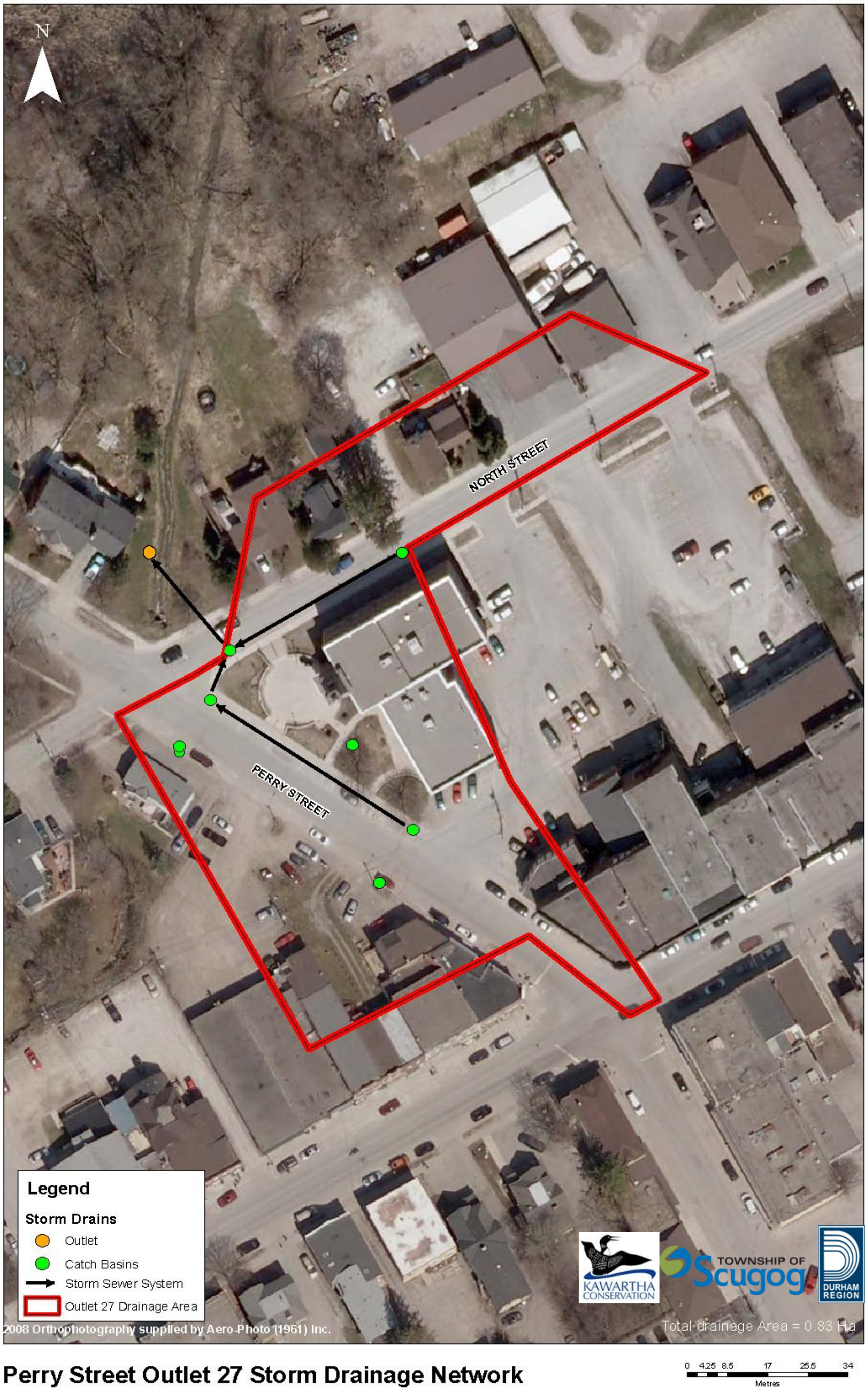


FIGURE 4.5: HIGH PRIORITY DRAINAGE AREA, OUTLET 27 (PERRY STREET)

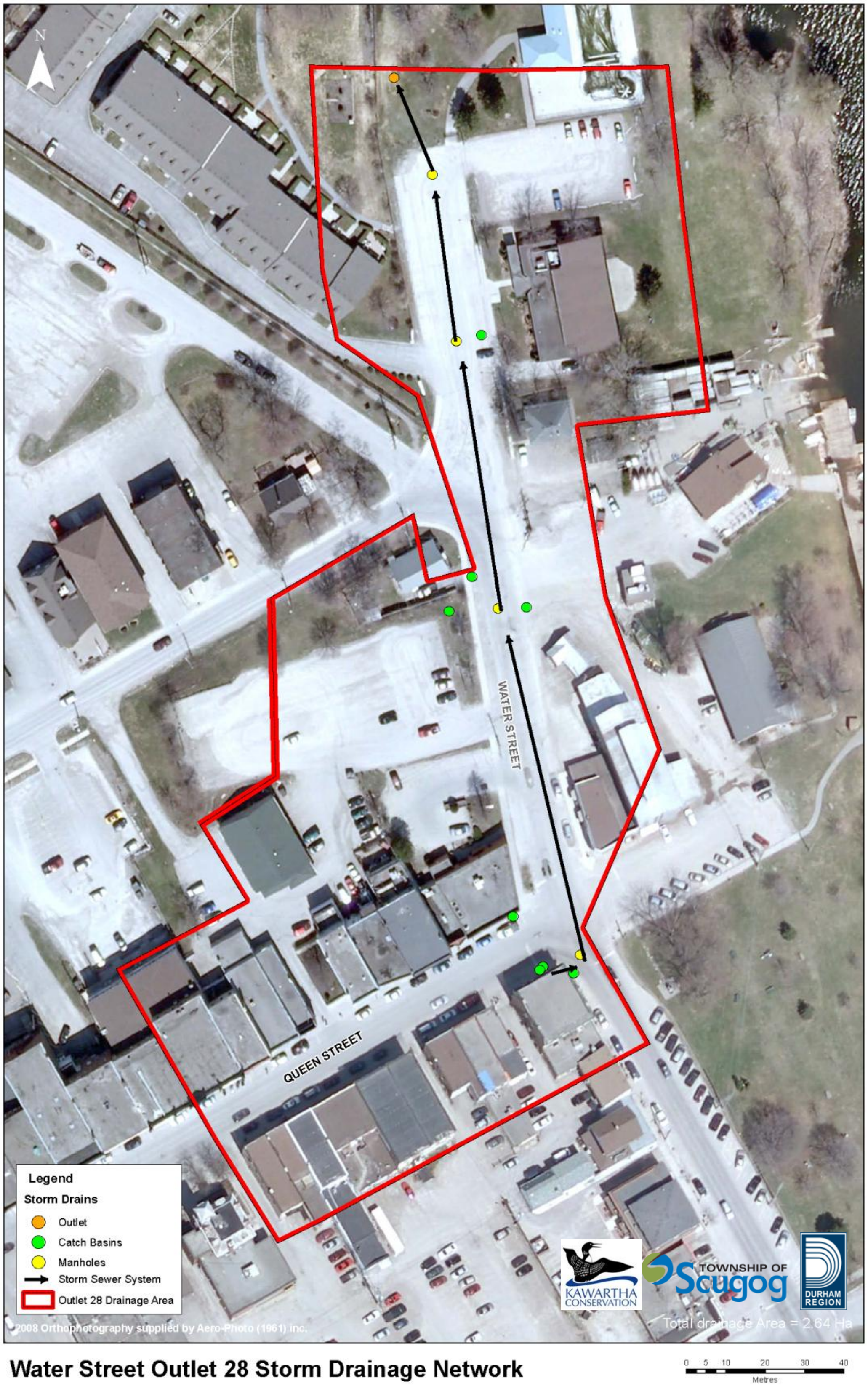


FIGURE 4.6: HIGH PRIORITY DRAINAGE AREA, OUTLET 28 (WATER STREET)

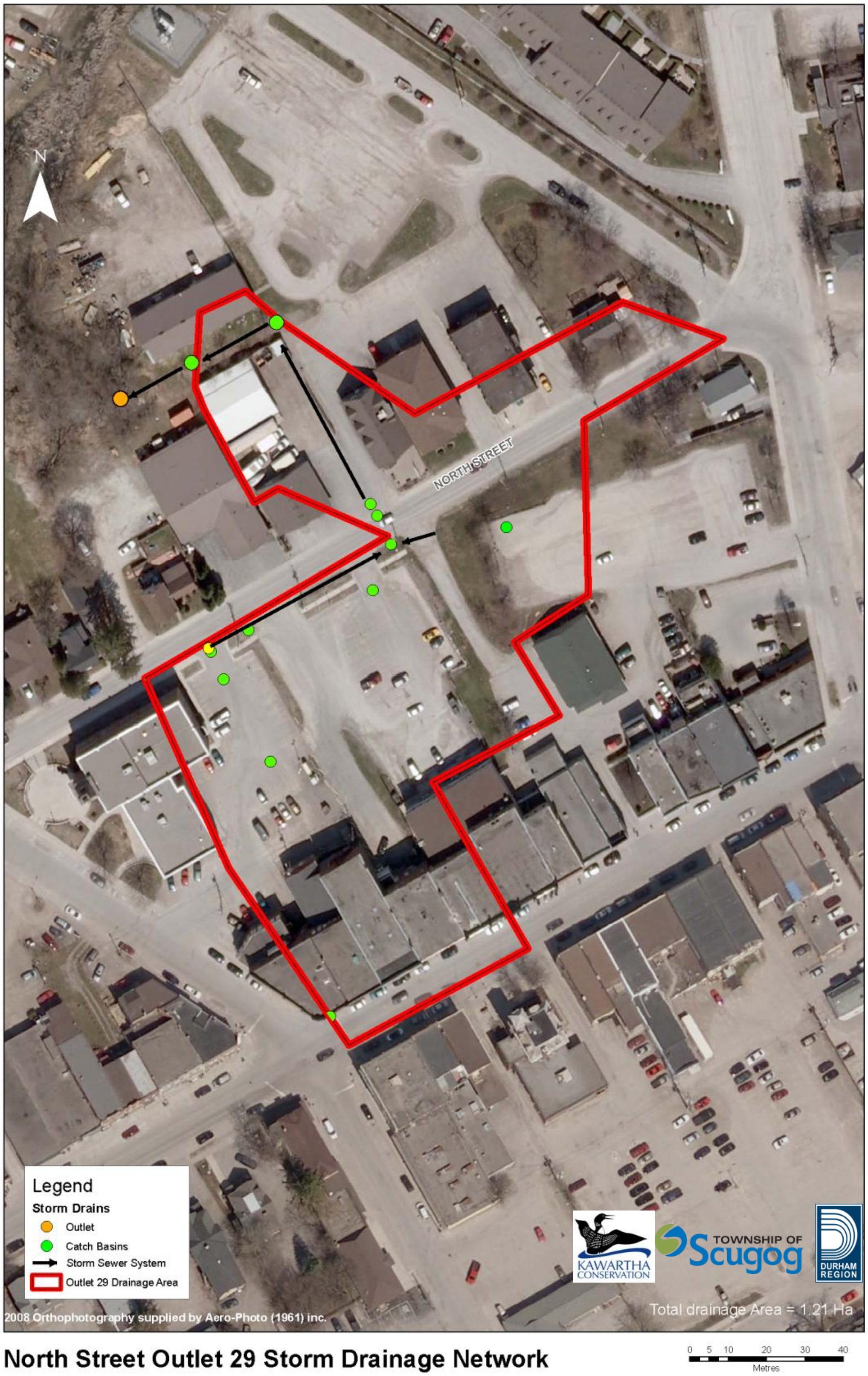


FIGURE 4.7: HIGH PRIORITY DRAINAGE AREA, OUTLET 29 (NORTH STREET)

Opportunities exist for improving operations, green technologies, policy amendments and stewardship throughout the entire Port Perry urban area, which will be discussed in future chapters. For the high priority areas however, a more specific approach was also taken. As the recommendations involve the installation of capital infrastructure, opportunities for improvement exist only on municipally owned lands. As such, any recommended infrastructure (Best Management Practice) must fit within the road allowance, park space and municipally owned parking lots and right of ways.

5.0 HIGH PRIORITY AREAS: CALCULATIONS AND MODELLING

In order to determine which controls and recommendations would be best suited for the area, the quantity of water that runs through the network must be determined. This was accomplished through the use of rational method spreadsheets, and through stormwater modeling using the Visual OTTHYMO (VO_2) program and PCSWMM for Oil Grit Separator (OGS) sizing.

5.1 STORMWATER MODELS

5.1.1 VO_2 MODEL

Visual OTTHYMO was used to calculate the required size of the capital infrastructure options sizing as well as contaminant loadings at the outlets and the areas where new stormwater quality controls could potentially be installed. The VO_2 models were generated using a one-year storm event (Appendix H). For the Port Perry area, a one-year storm is considered to be 25 mm over a four-hour period. When designing stormwater quality controls, a one-year storm is the standard that is used when determining control sizing and calculating pollutant removal. The VO_2 model takes into account impervious surfaces, drainage area, soil type, surface storage and many other factors when calculating discharge and runoff.

5.1.2 PCSWMM MODEL

PCSWMM is a modeling program provided by Imbrium Inc. for sizing of OGSs. This program calculates OGS sizes based on a user entered desired sediment removal, drainage area size, percent impervious surfaces, sediment particle size and rainfall.

5.2 STORM WATER CALCULATIONS

5.2.1 RATIONAL METHOD SEWER SYSTEM FLOWS

Rational method spreadsheets were used for calculating flow rates in storm sewers during a 5-year storm event (Appendix I). The 5-year storm values were derived from the intensity-duration-frequency (IDF) curves provided in the Township of Scugog Design Criteria and Standard Detail Drawings, 2003. The rational method can be used to calculate peak flows using rainfall intensity for time of concentration, catchment area, and runoff coefficients. This in turn helps in calculating pipe sizes, full flow velocity, how full the pipe is and discharge in different sections of sewer and as a total.

5.2.2 CALCULATING CONTAMINANT LOADING

Contaminant loading calculations are based on data derived from the Lake Scugog Environmental Management Plan urban stormwater data from 2007 and data that were collected at the sewer outlet in Baagwating stormwater pond in 2009 specifically for this project. An average concentration was calculated for each contaminant in stormwater runoff from the Port Perry urban area. These values were then applied to the applicable drainage areas of the sewersheds to determine annual contaminant loadings.

A summary of the modeling and calculation results for the 6 high priority drainage areas can be seen in Table 5.1 and Table 5.2.

Table 5.1: Background, Modelling and Calculation Results Summary

DRAINAGE AREA	BACKGROUND		RATIONAL METHOD		VO_2 RESULTS	
	Area (ha)	Impervious Surfaces (%)	Time of Concentration (minutes)	Total Discharge (L/s)	Peak Flow (m^3/s)	Runoff Volume (m^3)
Casimir Street Outlet (11)	9.43	63	20.6	1185	0.64	1273
Queen Street Outlet (17)	10.02	45	12.2	1380	0.54	1132
John Street Outlet (18)	2.75	79	12.2	542	0.25	454
Perry Street Outlet (27)	0.83	90	10.9	212	0.11	174
Water Street Outlet (28)	2.64	77	12.04	632	0.33	555
North Street Outlet (29)	0.99	90	12.48	239	0.13	254

Table 5.2: Contaminant Loading Calculations Summary

DRAINAGE AREA	CONTAMINANT LOADING (kg/year)							
	TP	TN	TSS	Alumi num	Coppe r	Lead	Zinc	Metals as total
Casimir Street Outlet (11)	17.5	178	12,393	111	0.86	0.67	4.32	247
Queen Street Outlet (17)	15.1	154	10,699	95.9	0.74	0.58	3.73	213
John Street Outlet (18)	5.96	60.8	4,235	38.0	0.29	0.23	1.48	84.3
Perry Street Outlet (27)	2.16	22.0	1,532	13.7	0.11	0.08	0.53	30.5
Water Street Outlet (28)	5.65	57.6	4,011	36.0	0.28	0.22	1.40	79.9
North Street Outlet (29)	2.58	26.3	1,830	16.4	0.13	0.10	0.64	36.4
Total Drainage Area	49.0	499	34,700	311	2.41	1.88	12.1	691

As identified in Table 5.2, Outlet 11, which represents the largest sewershed among six of them, also generates the largest amount of phosphorus (17.5 kg) as well as other contaminants, metals in particular (247 kg). This table is graphically represented in Figure 5.1.

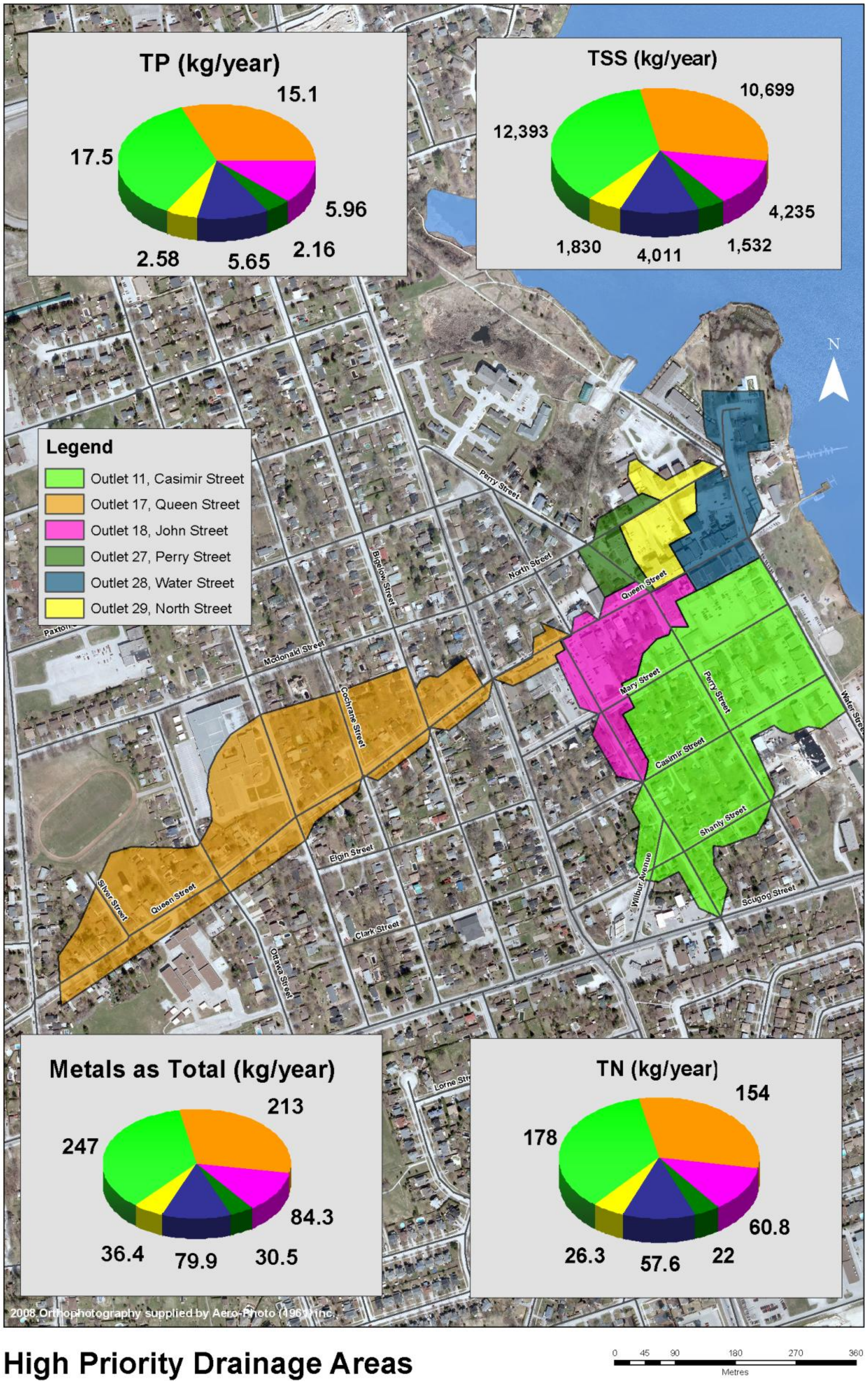


FIGURE 5.1: HIGH PRIORITY DRAINAGE AREAS AND RELATIVE LOADINGS OF CONTAMINANTS

6.0 High Priority Areas: Potential And Preferred Option Selection

6.1 DECISION MATRIX FOR POTENTIAL OPTIONS

The first step in identifying potential options was the development of a long list of alternatives. This list of alternatives was created based on information from the *Low Impact Stormwater Management Manual* developed by the Credit Valley Conservation Authority (draft November 2008) and the *Stormwater Technology Fact Sheet* released by the Environmental Protection Agency (1999).

For the selection of options, a basic decision matrix was created to get from the long list (Table A.1 Appendix A) to a short list, and a more complex matrix evaluating economic, social, environmental and technical details was used to derive potential options from the short list and determine the priority of implementation, which is discussed in chapter 6.2.

Short listed alternatives were required to satisfy these three questions:

- Is there available space?
- Are appropriate sizes available?
- Is the alternative desirable to the community?

Alternatives were discounted if the space was not available, if the option would not have a dramatic impact on improving water quality, and if the option would present a barrier to implementation based on community perspectives.

Using this method, the potential capital options that would be best suited for implementation in Port Perry high priority areas are oil grit separators (OGS) and bioretention areas used as standalone options or as part of a treatment train. Summary of these options are presented in Table 6.1. Dollar amounts represent the cost of materials only. Site-scale design details would increase the cost of alternative options presented in this report.

Table 6.1: Potential Capital Options Specifications

CAPITAL OPTION	COST ($)		POLLUTANTANT REMOVAL RATES (%)			
	Cost	Annual Maintenance	Total Phosphorus	Metals	Total Nitrogen	Suspended Sediment
Oil Grit Separator	\$5,500-\$71,000	\$750/unit	56	45	5	70
Lot Level Bioretention	\$51,500/ha of drainage area	\$7,700/ha of drainage area	75	95	75	90
Road Side Bioretention	\$51,500/ha of drainage area	\$7,700/ha of drainage area	75	95	75	90
Bioswale	\$20/m^2	\$8.50/m^2	60	55	30	75

6.1.1 POTENTIAL CAPITAL OPTIONS

Do Nothing

General Information

The do nothing alternative is used as a benchmark against which other alternatives may be measured. However, in some situations where existing controls are already in place, a do nothing alternative may be considered viable.

Under a do nothing alternative, no new infrastructure is created and no work is carried out anywhere on the stormwater network.

Unit Cost Estimates

$0

Maintenance Considerations

No additional maintenance

Maintenance Cost Estimates

$0 Annually

Pollutant Removal Rate

Total Phosphorus	0%
Metals	0%
Total Nitrogen	0%
Suspended Solids	0%

Oil Grit Separator

General Information

Oil grit separators are designed to remove sediment, debris and oil/grease from stormwater runoff. They allow for the settling of sediment and the phase separation of oil and grease within the unit. Oil grit separators are installed underground and are low profile making them ideal for locations where aesthetic appeal is important or where surface space is limited.

Unit Cost Estimates

From $5,500 to $71,000 depending on unit size

Maintenance Considerations

Units should be inspected post construction and prior to being put into service. Inspections are suggested every six months for the first year to determine the oil and sediment accumulation rate. In subsequent years, inspections can be based on first-year observations or local requirements. Cleaning is required once the sediment depth reaches 15% of storage capacity, (generally taking one year or longer). Local regulations for maintenance frequency may vary. An inspection should be conducted on the unit immediately after an oil, fuel or chemical spill. A licensed waste management company should remove oil and sediment and dispose of the waste appropriately.

Maintenance Cost Estimates

$750 per cleanout

Pollutant Removal Rate

Total Phosphorus	56%
Metals	45%
Total Nitrogen	5%
Suspended Solids	70%

Lot Level Bioretention

General Information

Bioretention areas are planted depressions that store and filter rainwater to enhance water quality. They are commonly located in parking lots as cells, where they are used to treat sheet flow from the impervious surroundings. Runoff is treated both mechanically by filter media such as sand, soil and/or organic material, as well biologically through vegetation growing within the cell before entering the existing storm sewer system. In order to prevent sediment build up in the cells, a gravel diaphragm is included around the perimeter of the cell as a method of pretreatment.

Unit Cost Estimates

$51,500/ha of drainage area

Maintenance Considerations

Bioretention requires seasonal landscaping maintenance in many cases, bioretention areas require intense maintenance initially to establish the plants, but less maintenance is required in the long term. Sediment buildup in the cells should be minimal with properly designed pre-treatment. Frequency of sediment removal from pre-treatment media can be determined through a regular inspection schedule.

Maintenance Cost Estimates

$7,700/ha of drainage area

Pollutant Removal Rate

Total Phosphorus	75%
Metals	95%
Total Nitrogen	75%
Suspended Solids	90%

Roadside Bioretention

General Information

Bioretention areas are planted depressions that store and filter rainwater to enhance water quality. The difference between lot level and road side bioretention is that lot level is traditionally designed to treat runoff from a smaller area such as a single property, by catching overland flow where as road side bioretention is designed to treat both overland flow and water already in the stormwater network. Runoff is treated both mechanically by filter media such as sand, soil and/or organic material, as well biologically through vegetation growing within the cell before entering the existing storm sewer system.

Unit Cost Estimates

$51,500/ha of drainage area treated.

Maintenance Considerations

Bioretention requires seasonal landscaping maintenance. In many cases, bioretention areas require intense maintenance initially to establish the plants, but less maintenance is required in the long term. Sediment buildup in the cells should be minimal with properly designed pre-treatment. The frequency of sediment removal from pre-treatment media can be determined through a regular inspection schedule.

Maintenance Cost Estimates

$7,700/ha of drainage area

Pollutant Removal Rate

Total Phosphorus	75%
Metals	95%
Total Nitrogen	75%
Suspended Solids	90%

Bioswale

General Information

Bioswales are landscape elements designed to remove sediment and pollution from surface runoff water. They consist of a swaled drainage course with gently sloped sides (less than six percent) and filled with vegetation, compost and/or riprap. The water's flow path, along the wide and shallow ditch, is designed to maximize the contact between swale bed and flowing water and the time the water spends in the swale, which aids in the trapping of pollutants and silt. Depending upon the geometry of land available, a bioswale may have a meandering or almost straight channel alignment.

Check dams may also be used to improve water quality treatment by temporarily detaining water within the swale.

Unit Cost Estimates

$20/m^2 of bioswale
Costs can reach $50/m^2 if clearing, leveling and filling are required

Maintenance Considerations

Maintenance includes inspecting for bank slumping and erosion. Replanting any bare patches where vegetation has been unsuccessful or removed and maintaining ideal vegetation heights by mowing may be required. Removal of sediment is necessary when build-up has accumulated to 25% of the original swale design volume.

Maintenance Cost Estimates

$8.50/m^2 of bioswale

Pollutant Removal Rate

Total Phosphorus	60%
Metals	55%
Total Nitrogen	30%
Suspended Solids	75%

6.2 HIGH PRIORITY AREAS: DECISION MATRIX FOR PREFERRED CAPITAL OPTIONS

The decision matrix used to identify the preferred capital options looks at different economic, social, environmental and technical details and weighs the alterative options (i.e. the short list) against them in each of the six high priority areas. The evaluation framework was similar to an evaluation model that was developed for the "Port Perry and Prince Albert Environmental Assessment Water Supply Study." The decision matrix was modified to represent the goals and considerations for this study and is presented in Table 6.2.

The decision matrix makes use of the following categories: Economic Environment, Natural Environment, Social Environment and Technical Environment. Specific criteria in each category were tailored to evaluate storm water technologies in the context of local community objectives and values.

The weighting assigned to each category was also modified to compliment local priorities and the goals of this study. For example, the natural environmental criterion has the highest consideration among the four major categories, with a weighting of 35% reflecting the goal of the plan and reflects the effectiveness of reducing specific water quality pollutants. The economic category, which for the most part pertains to the costs of construction, operation and maintenance was the next most important consideration and was assigned a weighting factor of 25%. The social and technical categories were each assigned an aggregate weight of 20%. Social criteria include such factors as aesthetics and the impact on existing social infra-structure. The technical category includes such considerations as life expectancy, ease of operation and available space.

From the comparison of alternative options in the high priority areas against this decision matrix, the top 10 options were selected as preferred capital options. Using this approach, the potential capital options that would be best suited for implementation in the high priority areas are oil grit separators (OGS) and bioretention areas used as standalone options or as part of a treatment train. The scores, priority and costs of the different options can be seen in Table 6.3. Numbers with brackets denote the outlet ID's as can be seen in Figures 6.1 to 6.7. These figures also have the preferred option identified for the location of capital options in each of the high priority areas.

Please note that the Water Street outlet (28) identifies an oil grit separator and bioswale in Figure 6.4 and Table 6.3, in recognition of recent works being undertaken with the Port Perry waterfront redevelopment project. For the purposes of this study, the alternatives have been evaluated as an "implemented" alternative as the works are complete.

Table 6.2: Preferred Capital Options Decision Matrix

ECONOMICS		25
CRITERIA	**DETAILS**	**WEIGHT**
Implementation Cost	Cost of construction/installation Cost of purchasing	10
Operations and Maintenance Cost	Annual cost of maintenance Maintenance Frequency Energy Cost New training/equipment required	10
Impacts on Adjacent Properties	Loss of parking availability in commercial areas	5

ENVIRONMENTAL		35
CRITERIA	**DETAILS**	**WEIGHT**
Pollutant Removal	Suspended Solids	15
Pollutant Removal	Nutrients	12.5
Pollutant Removal	Metals	5
Effects on Water Quantity	Reduction of Flooding	2.5

SOCIAL		20
CRITERIA	**DETAILS**	**WEIGHT**
Aesthetics	Visually appealing/low profile Fits in with vision for downtown core	7.5
Compliments Other Plans	Fits in with other strategic/environmental plans	5
Recreational and Open Space	Impacts on existing recreational and open space Creation of new recreational and open space	2.5
Public Health and Safety	Health, Safety and Security	5

TECHNICAL		20
CRITERIA	**DETAILS**	**WEIGHT**
Life Expectancy	Life expectancy of alternative	4
Ability to Expand	Ability of alternative to handle increased volumes Ability of alternative to be enlarged to handle increased volumes	2.5
Ease of Implementation	Complexity of construction/installation Property availability/permission constraints Disruptions during construction Ease of obtaining approvals	3.5
Ease of Operation	Ease of maintenance Disruptions during maintenance	3.5
Innovation	Use of new technology Potential for a demonstration project	2.5
Property Requirements	Surface area devoted to alternative	4

TOTAL	100

Table 6.3: Preferred Capital Options Summary

RECOMMENDATION	SCORE /100	PRIORITY	IMPLEMENTATION COST	ANNUAL MAINTENANCE COST
OIL GRIT SEPARATOR AT CASIMIR STREET OUTLET (11)	78	1	$38,000	$750**
PARKING LOT BIORETENTION IN MARY STREET LOT TO COMPLEMENT OGS AT CASIMIR STREET OUTLET (11)	77	2	$25,750	$3,850*
IMPLEMENTED OPTION (EXISTING CONTROLS) AT NEW WATER STREET OUTLET TO LAKE (28)***	71.5	3	$0	$0
OIL GRIT SEPARATOR AND BIOSWALE AT OUTLET TO WILLIAMS CREEK (29)	69	4	$11,250	$4,120*
OIL GRIT SEPARATOR AT JOHN STREET OUTLET TO WILLIAMS CREEK (18)	67.5	5	$17,500	$750**
OIL GRIT SEPARATOR AT QUEEN STREET WEST OUTLET TO WILLIAMS CREEK (17)	65	6	$25,300	$750**
OIL GRIT SEPARATOR AT PERRY STREET OUTLET TO WILLIAMS CREEK (27)	64.5	7	$9,000	$750**
PARKING LOT BIORETENTION BEHIND MUNICIPAL BUILDING TO COMPLEMENT OGS AND BIOSWALE AT OUTLET (29)	64.5	8	$20,600	$3,080*
OIL GRIT SEPARATOR AT QUEEN STREET EAST OUTLET TO WILLIAMS CREEK (17)	63	9	$4,800	$750**
ROADSIDE BIORETENTION ON PERRY STREET TO COMPLEMENT OGS AT OUTLET TO WILLIAMS CREEK (27)	54.5	10	$31,200	$9,750*
TOTAL			**$183,400**	**$24,550**

***** **Denotes maximum annual maintenance cost assuming major repair/replanting is necessary. On average, maintenance costs will only involve landscaping and trash removal costs.**

****** **Based on cleaning once per year.**

******* **This option represents the existing controls implemented at the Water Street outlet. An oil grit separator in combination with a bioswale was constructed at this outlet in conjunction with redevelopment of the waterfront area in 2009.**

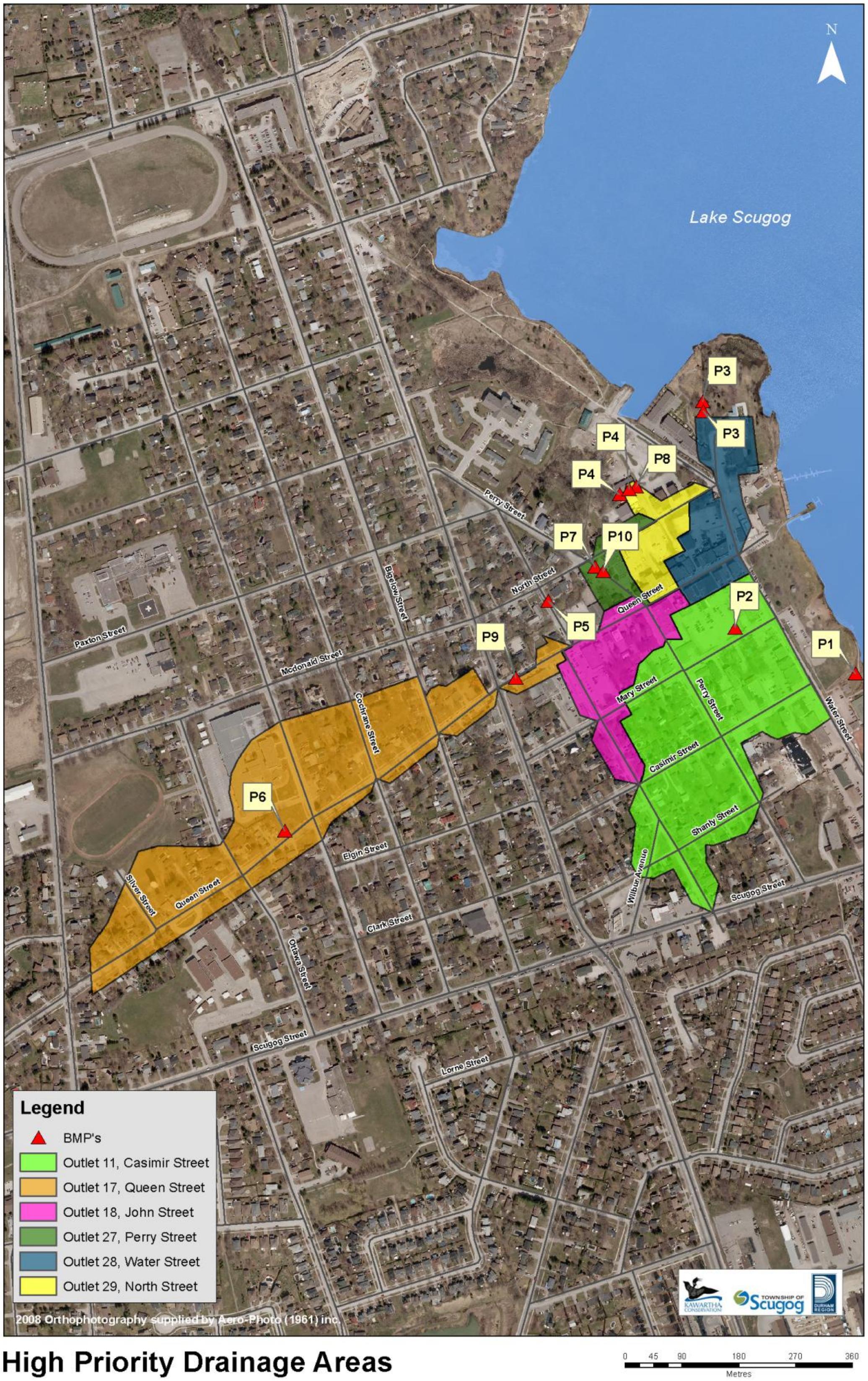
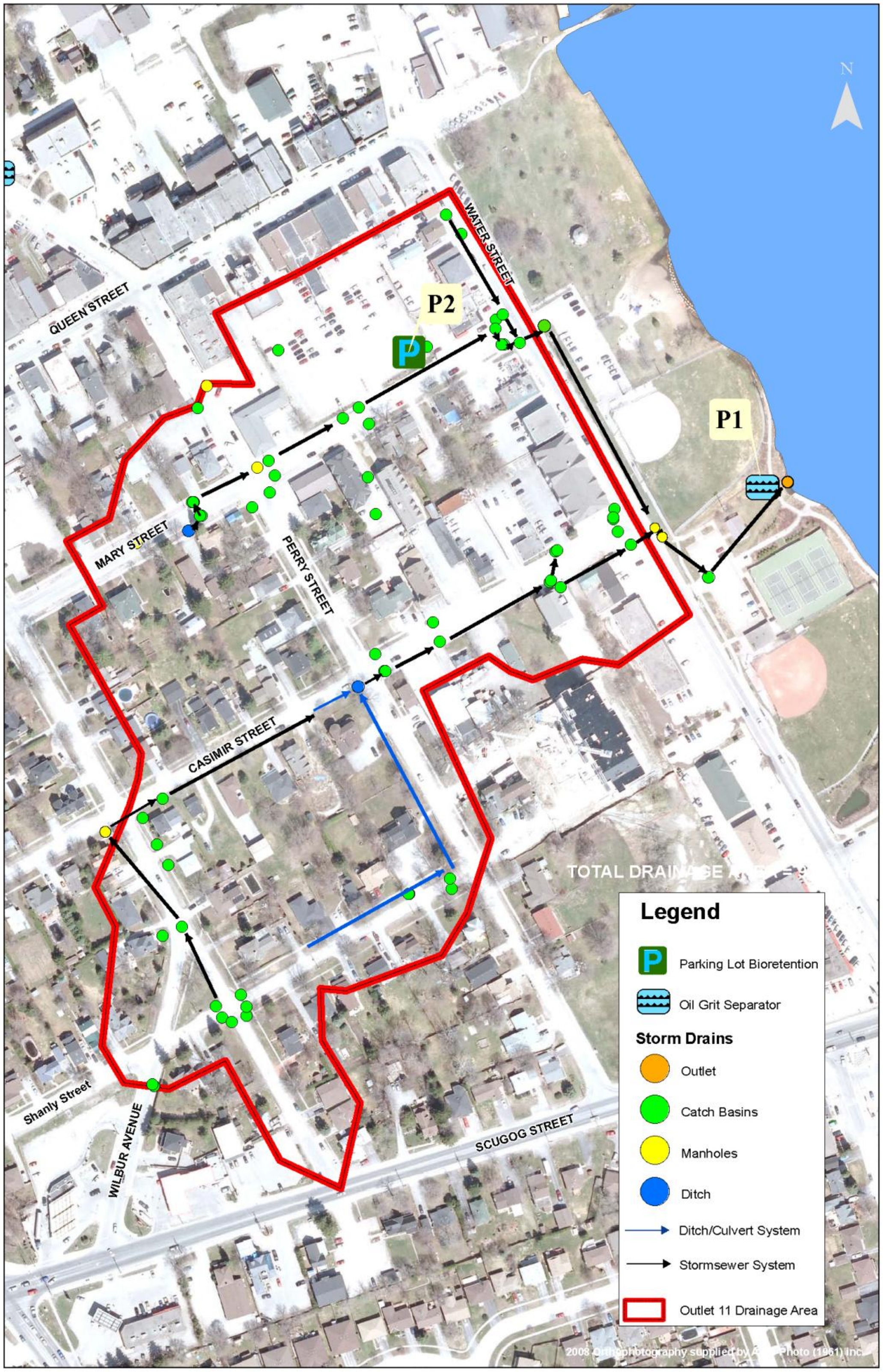


FIGURE 6.1: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS



Casimir Street Outlet 11 Storm Drainage Network

0 12.5 25 50 75 100
Metres

FIGURE 6.2: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 11 (CASIMIR STREET)

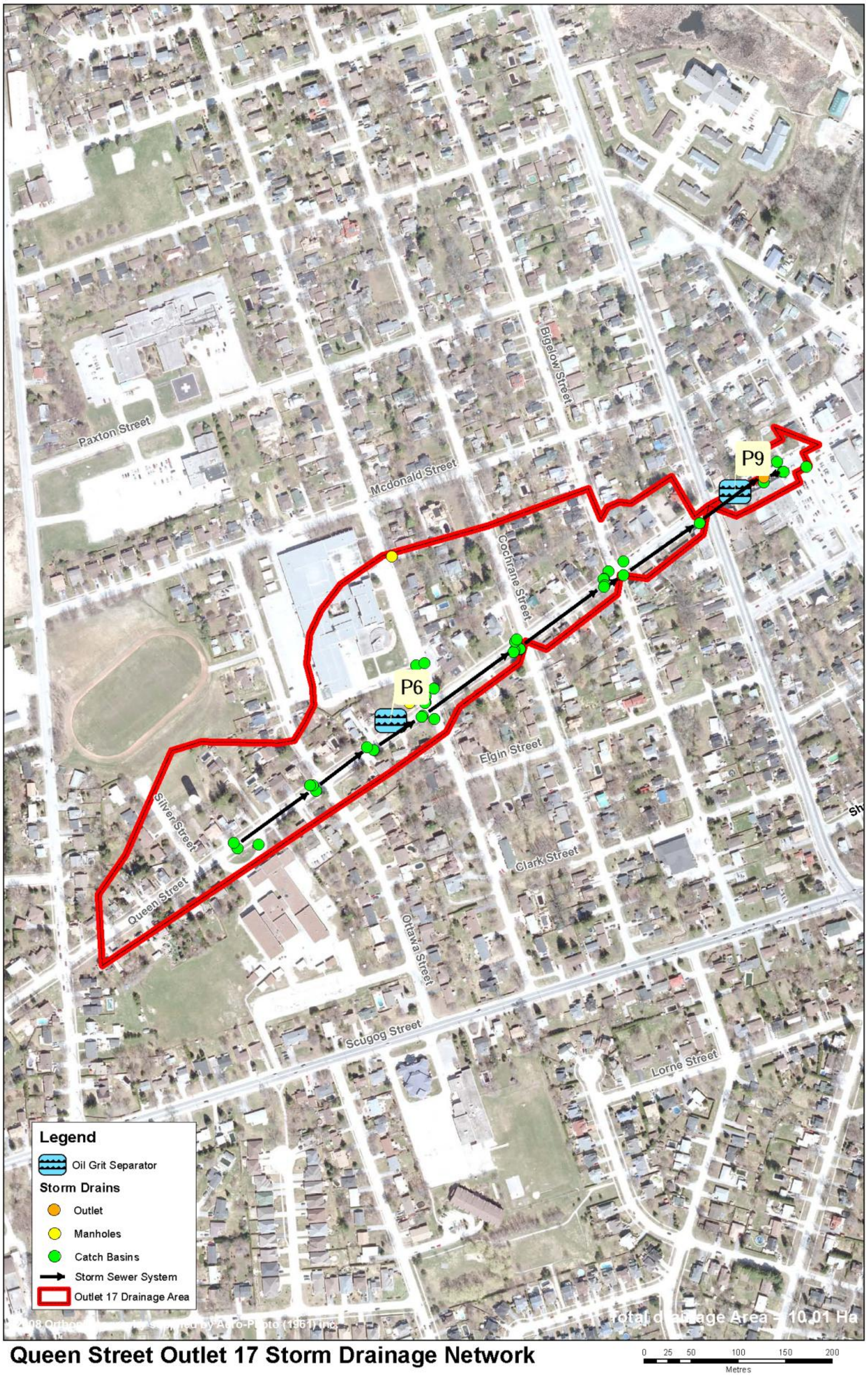


FIGURE 6.3: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 17 (QUEEN STREET)

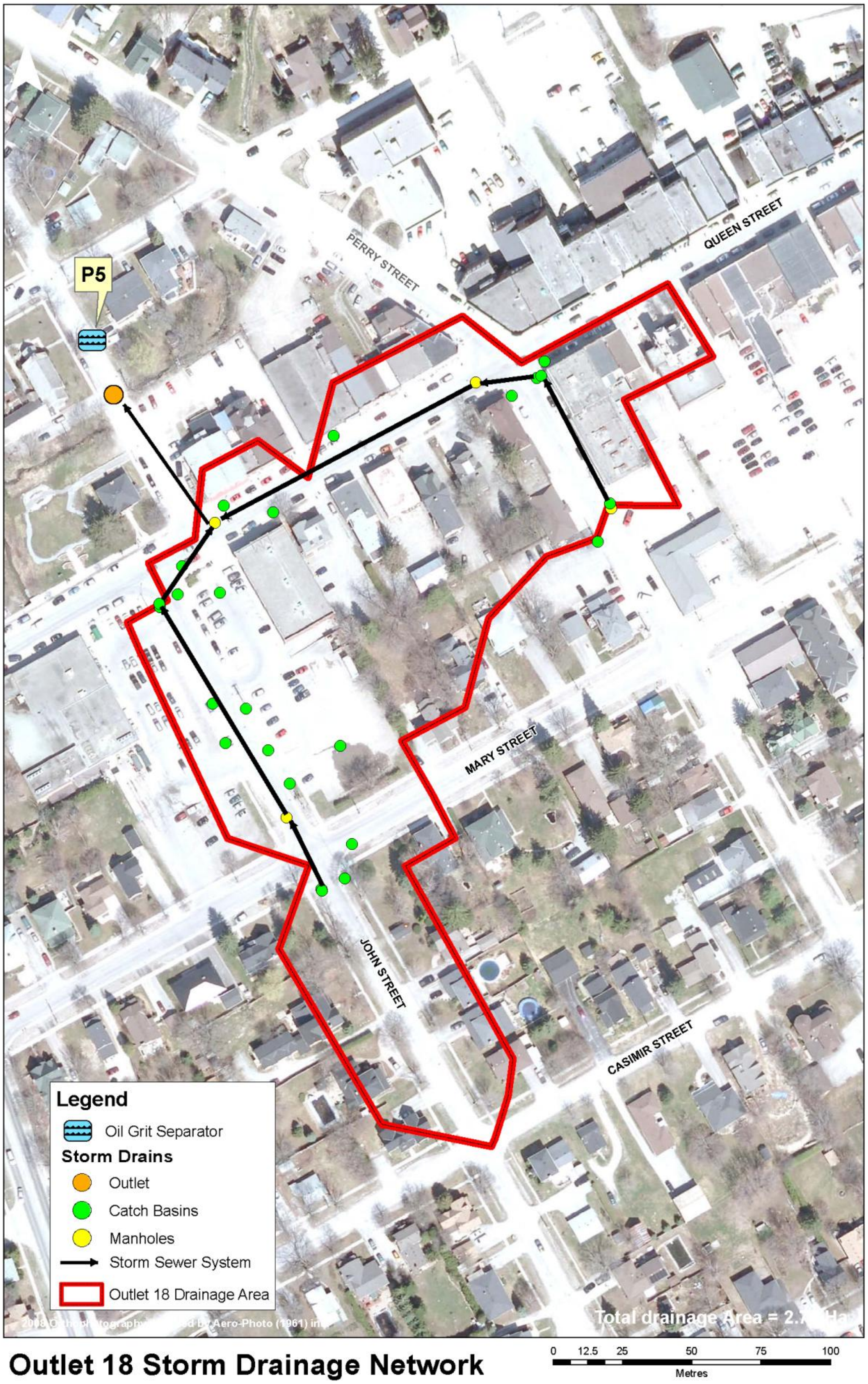


FIGURE 6.4: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 18 (JOHN STREET)

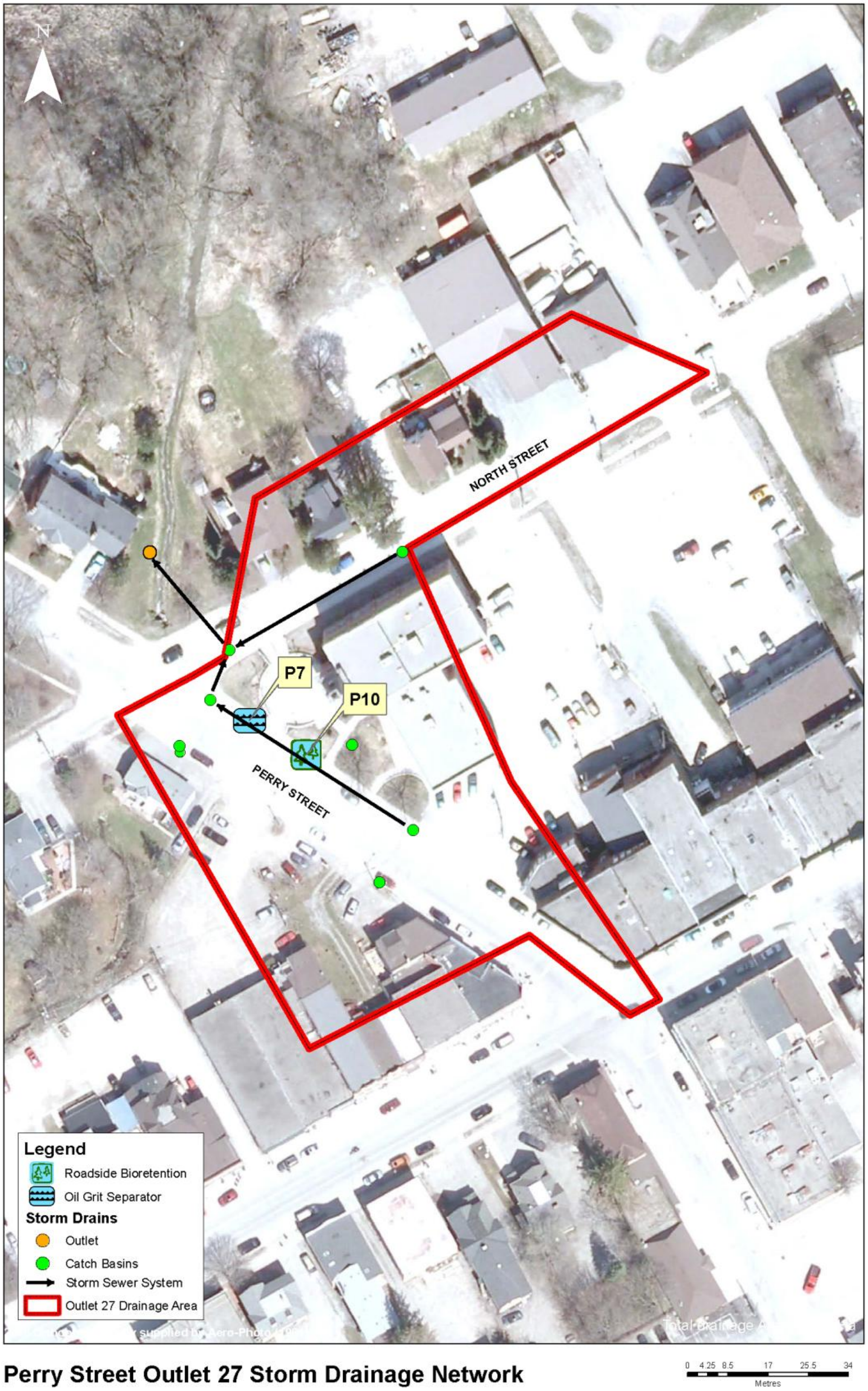
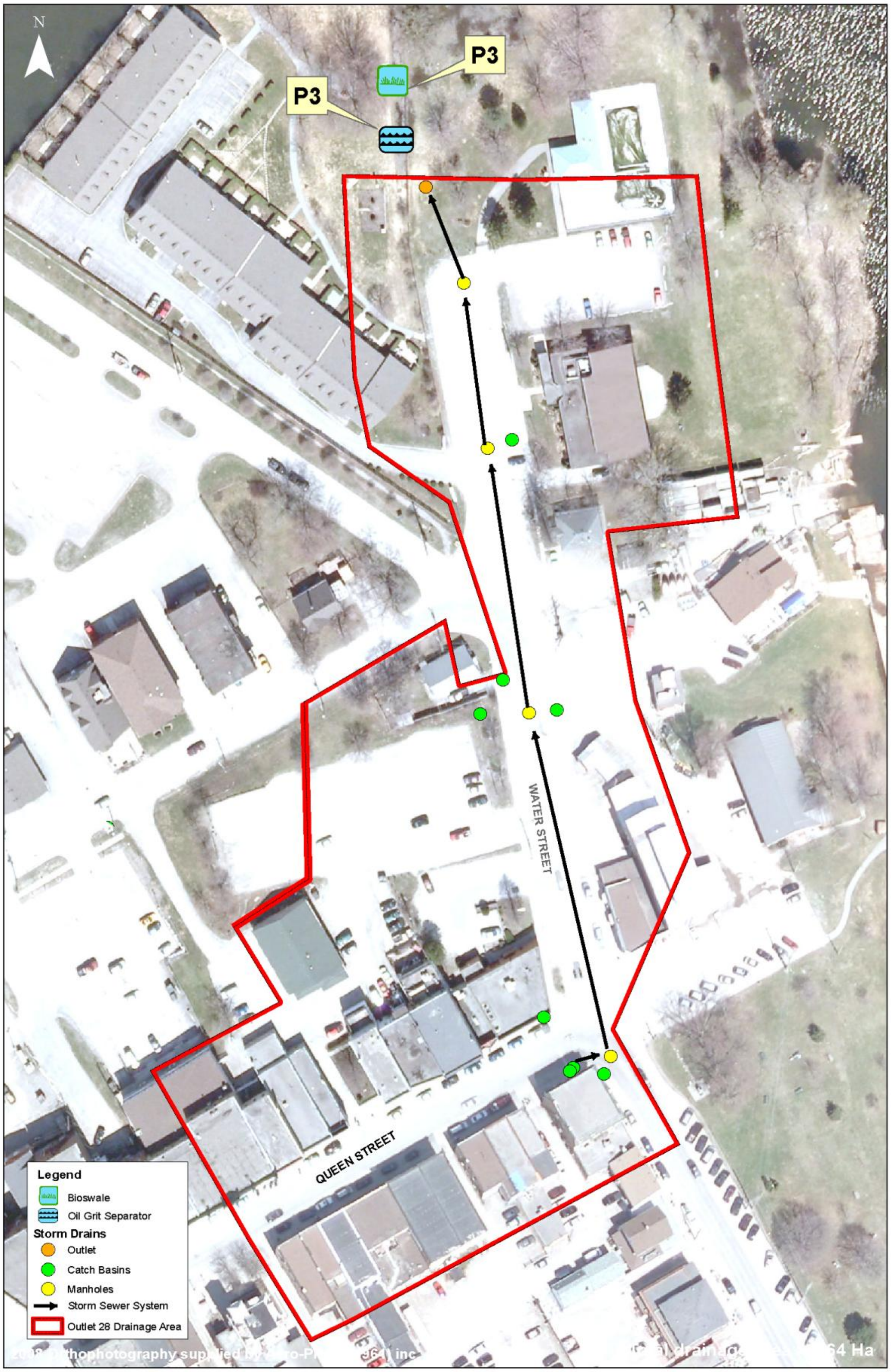


FIGURE 6.5: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 27 (PERRY STREET)



Water Street Outlet 28 Drainage Network

0 5 10 20 30 40
Metres

FIGURE 6.6: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 28 (WATER STREET)

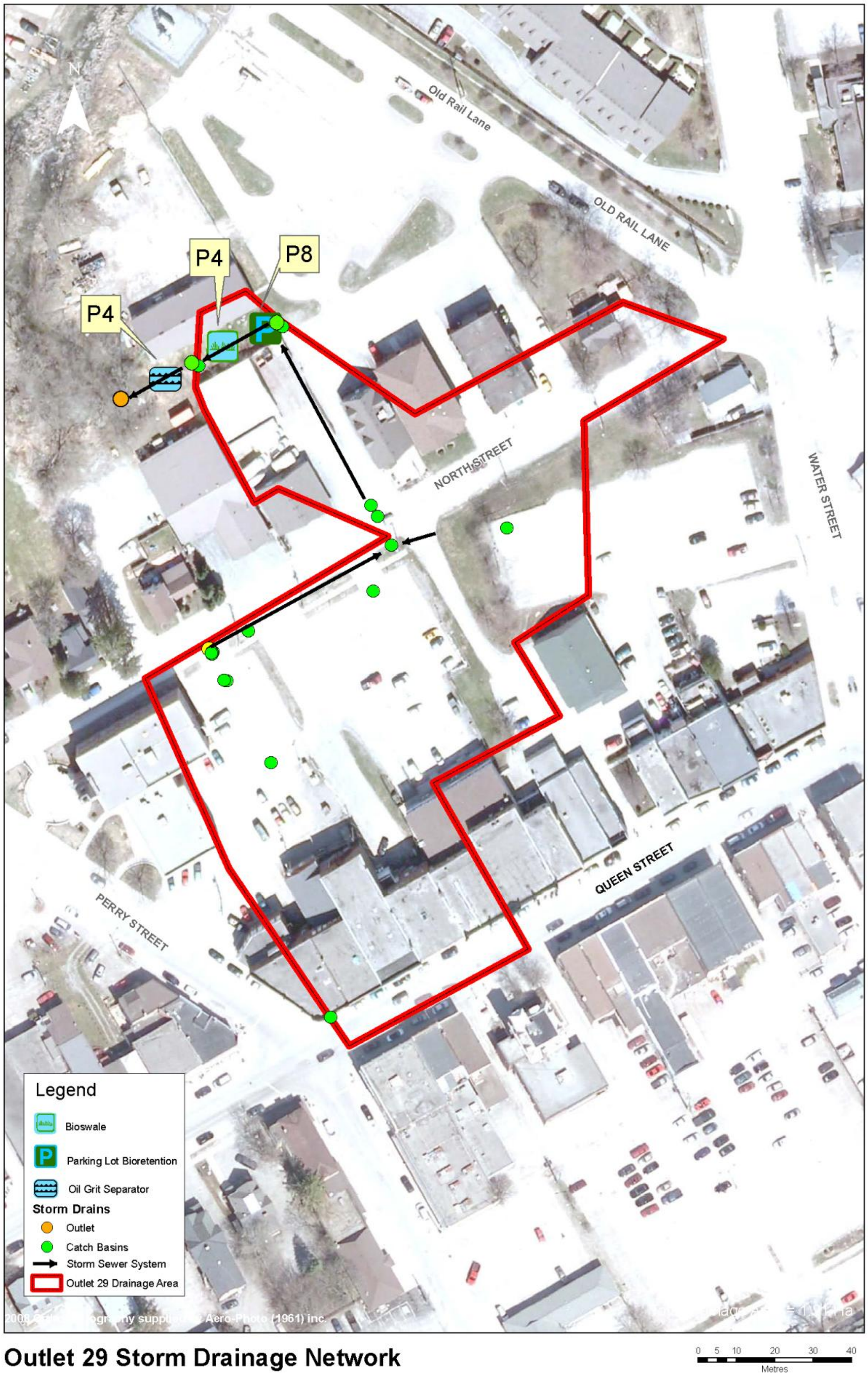


FIGURE 6.7: HIGH PRIORITY DRAINAGE AREAS AND LOCATION OF PREFERRED CAPITAL OPTIONS; OUTLET 29 (NORTH STREET)

7.0 PORT PERRY URBAN AREA: GENERAL OPTIONS

There are a number of options for consideration to improve runoff from urban areas, ranging from operations and maintenance enhancements and policy changes to education and stewardship promotion. These options are explored in the following sections. Options presented may support multiple objectives, such as supporting existing program delivery, planning delivery, Township and Regional objectives stated in official plans and meeting targets identified in strategic documents.

As identified in Table 7.1, most of the land within Port Perry has been developed. Only 32% of land is estimated to be undeveloped at this time, primarily located in the Cawker's Creek and Osler Marsh watershed located on the fringe of existing developed areas and in the Nonquon River watershed in the employment lands. Virtually all of Williams Creek watershed is developed at this time. Undeveloped areas represent opportunities for planning stormwater controls, while developed areas represent lands within which education, stewardship and retrofit opportunities need to be examined. Retrofit opportunities may present themselves as historic development is redeveloped or as plans for development are expanded.

Table 7.1 Watershed Areas: Development Area Statistics

Watershed	***Developed Area (ha)***	***Developed Area (%)***	***Undeveloped Area (ha)***	***Undeveloped Area (%)***
Cawker's Creek	*253*	*63*	*149*	*37*
Lake Scugog	*327*	*89*	*39*	*11*
Nonquon River	*194*	*50*	*197*	*50*
Osler Marsh	*72*	*60*	*48*	*40*
Williams Creek	*89*	*100*	*0*	*0*
Total	***935***	***68***	***433***	***32***

7.1. RECOMMENDATION FROM EXISTING WATERSHED STUDIES

There are three watershed studies that have provided recommendations for coordinated stormwater management in the Port Perry urban area. The Nonquon River Subwatershed Study contained what was identified as a "Detailed Area of Investigation", which determined stormwater management facilities for lands that drained to the Nonquon River wetland to the west of Port Perry. The Cawker's Creek Subwatershed Study identified a number of proposed locations for stormwater management ponds along the creek south of Reach Road. A final study identified a stormwater management facility for a small watercourse flowing into Osler

Marsh just north of Oyler Drive. Following is a summary of the recommendations and proposed locations of stormwater management facilities from three Subwatershed studies completed for the Port Perry urban areas. All of the studies identify that detailed design of these facilities would have to occur at the time of development.

7.1.1 NONQUON RIVER SUBWATERSHED STUDY AND NONQUON INDUSTRIAL TRIBUTARY AREA MASTER DRAINAGE PLAN (2005)

The proposed Master Drainage Plan (MDP) for the Nonquon Industrial Tributary Area (NITA) includes preliminary design details of a centralized stormwater management facility, located at Regional Road 8 (Reach Street) between the existing Northport and Reach subdivisions. The proposed Stormwater Management Facility (SWMF) will provide stormwater quantity and quality control for these two adjacent development areas and stormwater quality controls for a portion of the lands in the existing Mitchell subdivision.

This proposed facility would implement a modified on-line pond approach where a fish bypass channel would allow for continuous baseflow around the facility to facilitate the passage of identified fish species which have the potential to move between the designated Provincially Significant Wetland (downstream of Reach Street) and a tributary south of the proposed SWMF. A follow-up report has been generated to further outline the fisheries, soils, baseflow and water quality considerations for this centralized facility.

The recommended MDP also identifies possible locations and contributing areas for five additional stormwater management facilities, one of which currently exists within the Mitchell Subdivision, which would be constructed as the NITA lands become further developed in the future. Stormwater management facilities identified in the plan are illustrated in Figure 7.1.

Recommendations for the implementation of other structural and non-structural strategies to mitigate current nuisance flooding conditions within the NITA lands were addressed, including the installation of additional culverts under Reach Street to increase the conveyance of storm water toward Nonquon River through the Provincially Significant Wetland. The analysis presented in the study illustrates how storm water elevations will be reduced by implementation of the proposed SWM facilities and changes to culvert crossings.

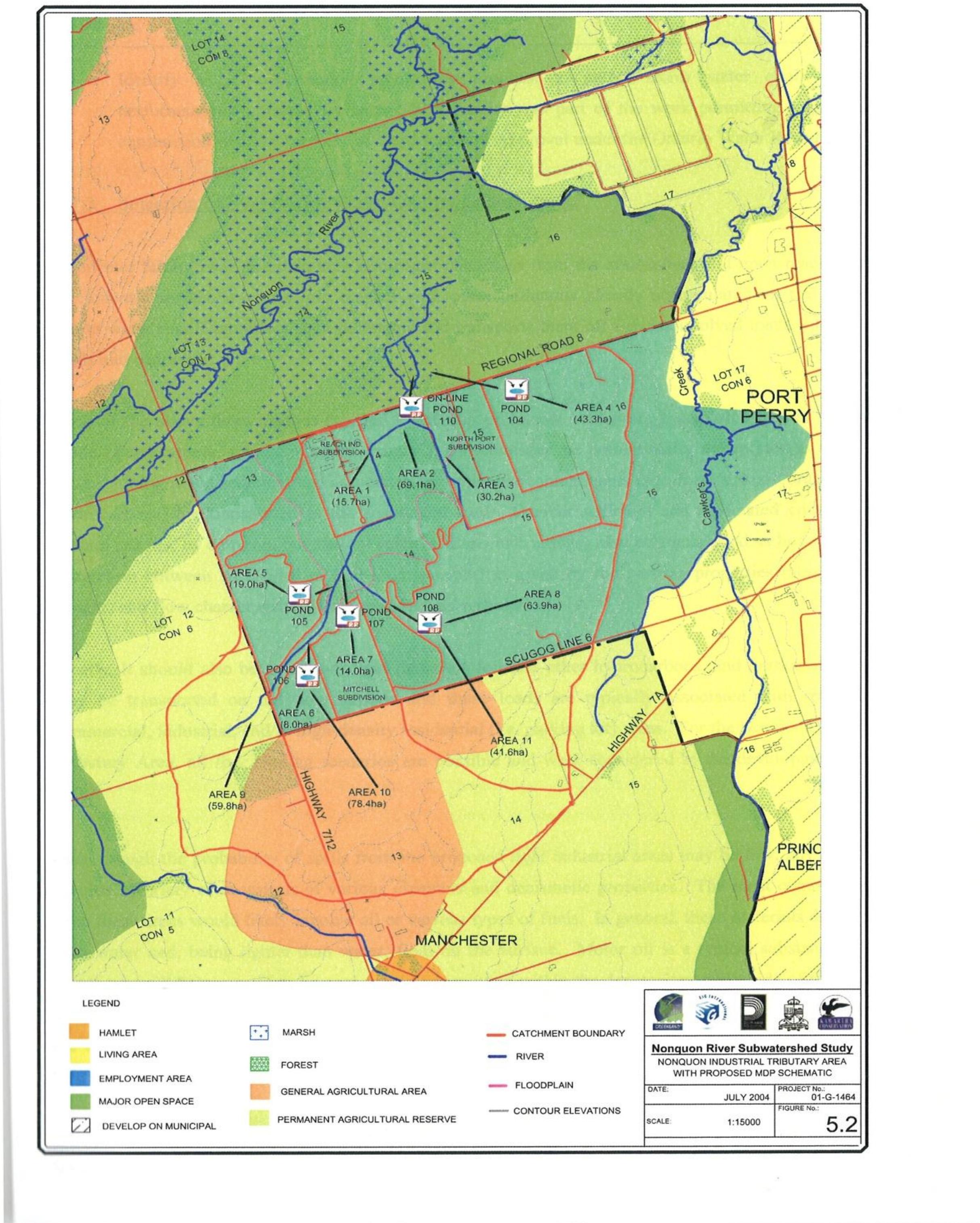


FIGURE 7.1: RECOMMENDED LOCATIONS OF SWM PONDS FOR NONQUON INDUSTRIAL TRIBUTARY AREA

7.1.2 CAWKER'S CREEK SUBWATERSHED STUDY, FINAL REPORT (1996)

A total of 7 quantity control ponds were recommended to be built adjacent to the creek corridor, outside of the floodplain and 15 m buffer strip. These ponds would limit flow rates to existing levels and are proposed to be constructed as part of the infrastructure associated with new development. Details on each of the proposed stormwater facilities are provided in Table 7.2 below and are illustrated in Figure 7.2. The proposed facility located at Reach Street to the east of Cawker's Creek (proposed SWMF #7) has been constructed.

The watershed study also recommended the enhancement of buffer strips along the creek channel and stabilization at erosion prone areas along the watercourse. The twinning of culverts under Regional Road 8 to eliminate potential upstream flooding was also suggested.

Table 7.2 Cawker's Creek: Proposed Stormwater Management Facilities

Proposed SWMF	Drainage Area No.	Drainage Area (ha)	Required Volumes (m^3)
1	201	22	7,200
2	301(b)	41	12,800
3	301(a)	15.4	6,700
4	401(a)	34	12,400
5	401(d)	19	6,800
6	401(b)	36	14,700
7	401(e)	37	10,300

Note: Required Volumes are for quantity control storage only

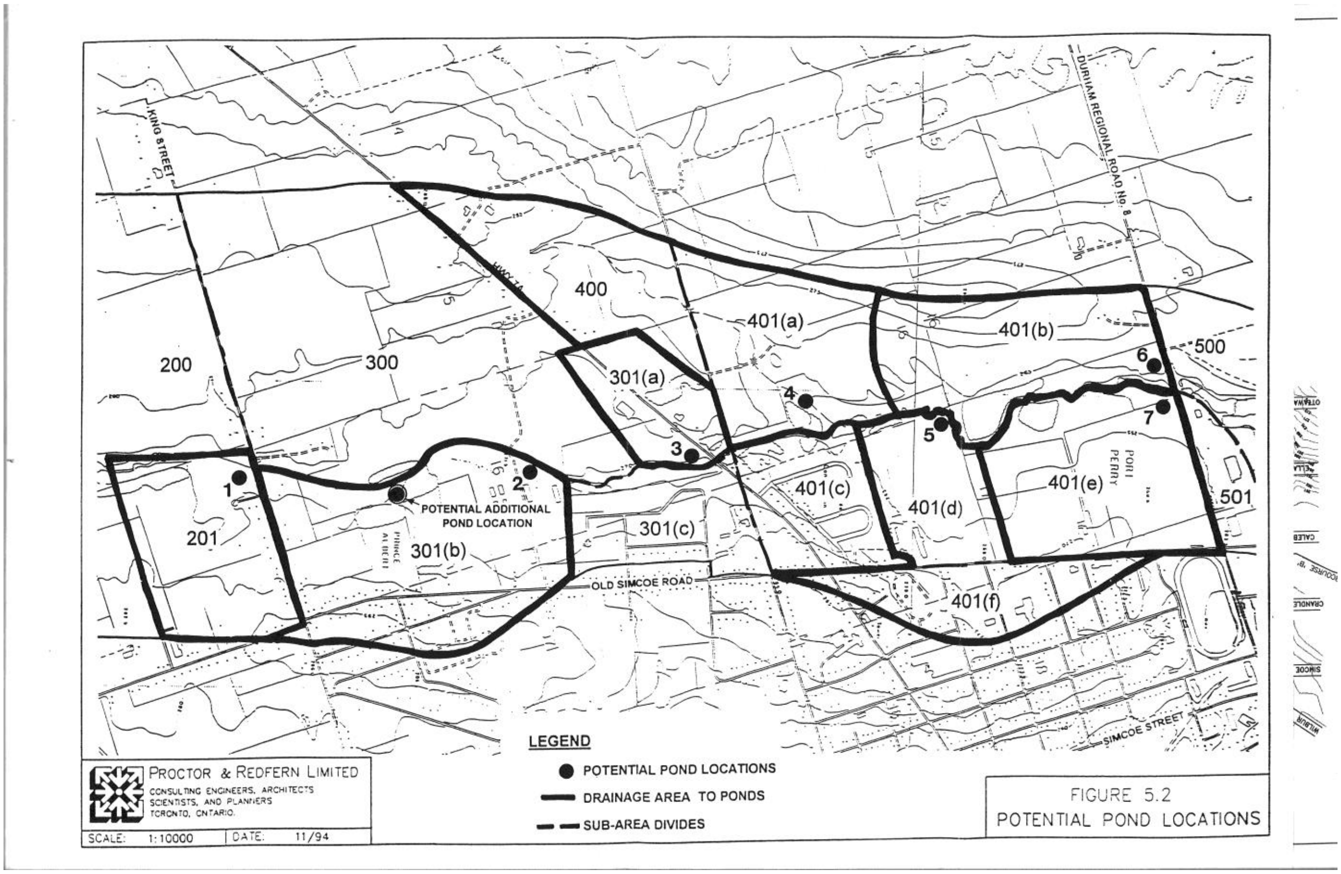


FIGURE 7.2: RECOMMENDED LOCATIONS OF SWM PONDS FOR CAWKER'S CREEK WATERSHED

7.1.3 SOUTH PORT PERRY SUBWATERSHED STUDY, FINAL REPORT (1995)

This study examined the requirements for stormwater management of a small watercourse flowing into Osler Marsh north of Oyler Drive in the southern boundaries of Port Perry. It was determined that stormwater quality controls were required via a 10,900 m^3 wet pond or 7,050 m^3 wetland located immediately west (upstream) of the Simcoe Street watercourse crossing, in addition to a 28,400 m^3 detention pond west of Simcoe street in order to reduce peak flows and velocities to ensure no impact to the Osler Marsh wetland downstream (See Figure 7.3). These ponds have been constructed.

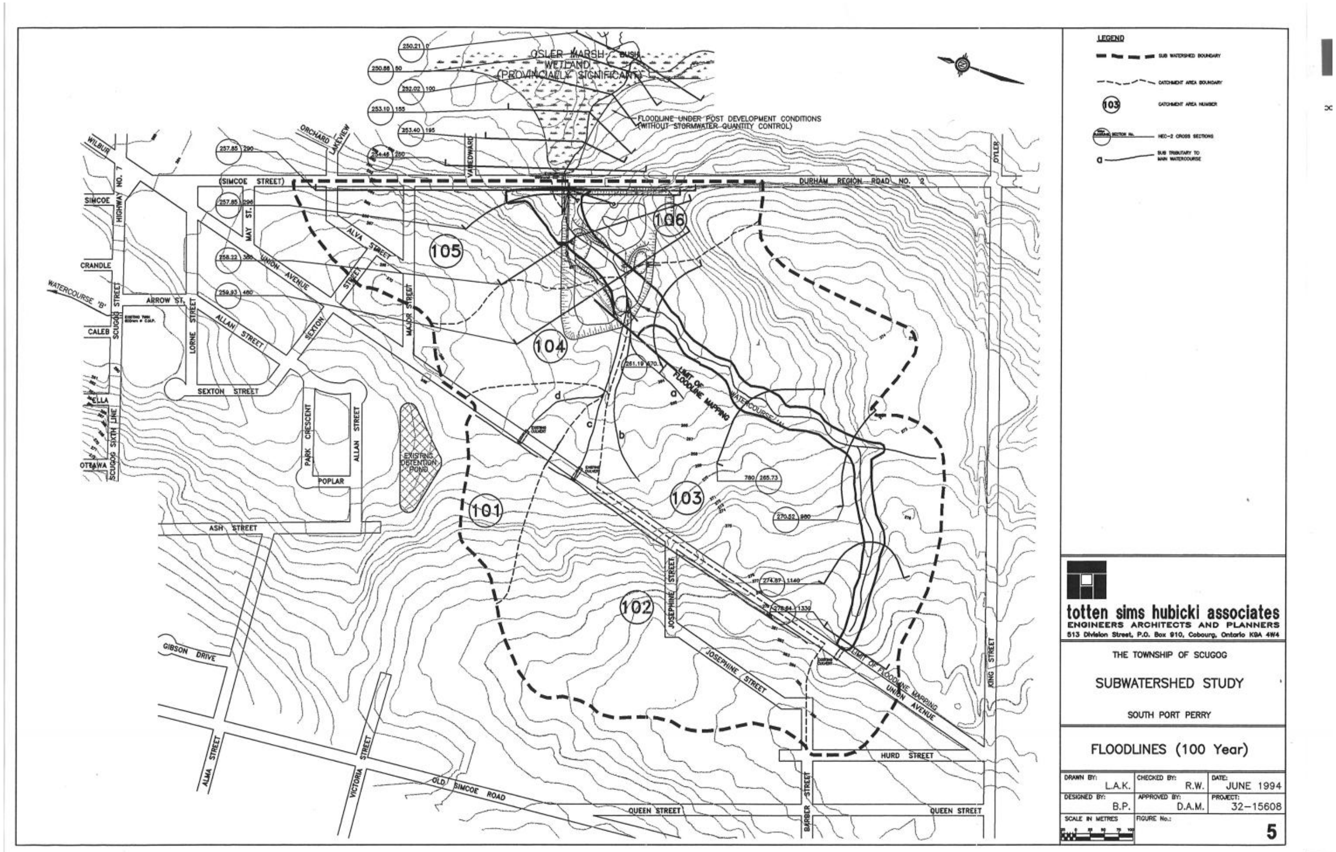


FIGURE 7.3: RECOMMENDED LOCATIONS OF STORMWATER MANAGEMENT FACILITIES FOR SOUTH PORT PERRY SUBWATERSHED.

7.1.4 SUMMARY

Stormwater management facilities proposed in the studies identified above are represented in Figure 7.4. It is apparent from this illustration that future development, as represented by undeveloped areas, can be approached in a coordinated manner as existing watershed plans cover the majority of areas where development will occur within the urban boundary. There are pockets of undeveloped land to the south and east of the Nonquon sewage lagoons, which can be accommodated through future development proposals.

As identified in Table 7.3, most of the planned stormwater facilities have 60% undeveloped lands in their conceptual catchment area. It will be important to ensure development has regard for these watershed studies as development moves forward. It would be prudent for the municipality to ensure future monies for the implementation of these facilities are collected through development charges. A threshold should be established to identify when a facility is constructed. It is suggested that when the impervious area exceeds 10% of the catchment area (including roads, buildings and other hard surfaces), that design considerations be undertaken and the pond developed. As noted in Table 7.3, there are four proposed stormwater management facilities that currently have developed lands that exceed these thresholds, based on an estimate of 30% imperviousness in existing developed areas. These stormwater management facilities include NR 106, CC 2, CC3 and CC 5. It may be difficult to implement the proposed Cawker's Creek #3 pond at this time.

Table 7.3: Proposed Stormwater Management Facilities: Area Statistics

Name	Serviced Area (ha)	Developed Area (ha)	Catchment Area (ha)	Developed Area (%)	Undeveloped Area (%)
NR 110	---	7.5	67.8	11	89
NR 104	---	2.3	50.9	5	95
NR 108 (Reach Industrial-Adamson)	**6.4**	**19.1**	**54.7**	**35**	**65**
NR 105	---	3.6	18.2	20	80
NR 106*	***---***	***3.7***	***8.0***	***46***	***54***
CC Null	see CC2				
CC 2	***---***	***24.4***	***59.3***	***41***	***59***
CC 3	***---***	***14.3***	***14.3***	***100***	***0***
CC 4	---	0.1	56.5	0	100
CC 5	***---***	***26.6***	***42.4***	***63***	***37***
CC 6	---	0.2	32	1	99
CC 7 (Cawker's Creek)	**17.9**	**18.9**	**37**	**66**	**34**
Perryview Estates (Quality)	**See Perryview Estates (Quantity)**				
Perryview Estates (Quantity)	**40.4**	**44.3**	**73.5**	**60**	**40**

Note: Information derived from an understanding of sewersheds in the Town of Port Perry, harmonized with information from the watershed studies.

Items identified in grey shaded bold text are existing facilities identified in subwatershed studies.

Items identified in yellow bold italics should be considered a priority.

*NR 106 exceeds the threshold for imperviousness within the urban boundary; however, the pond incorporates areas outside the urban boundary of Port Perry, which effectively reduces the impervious area calculation.

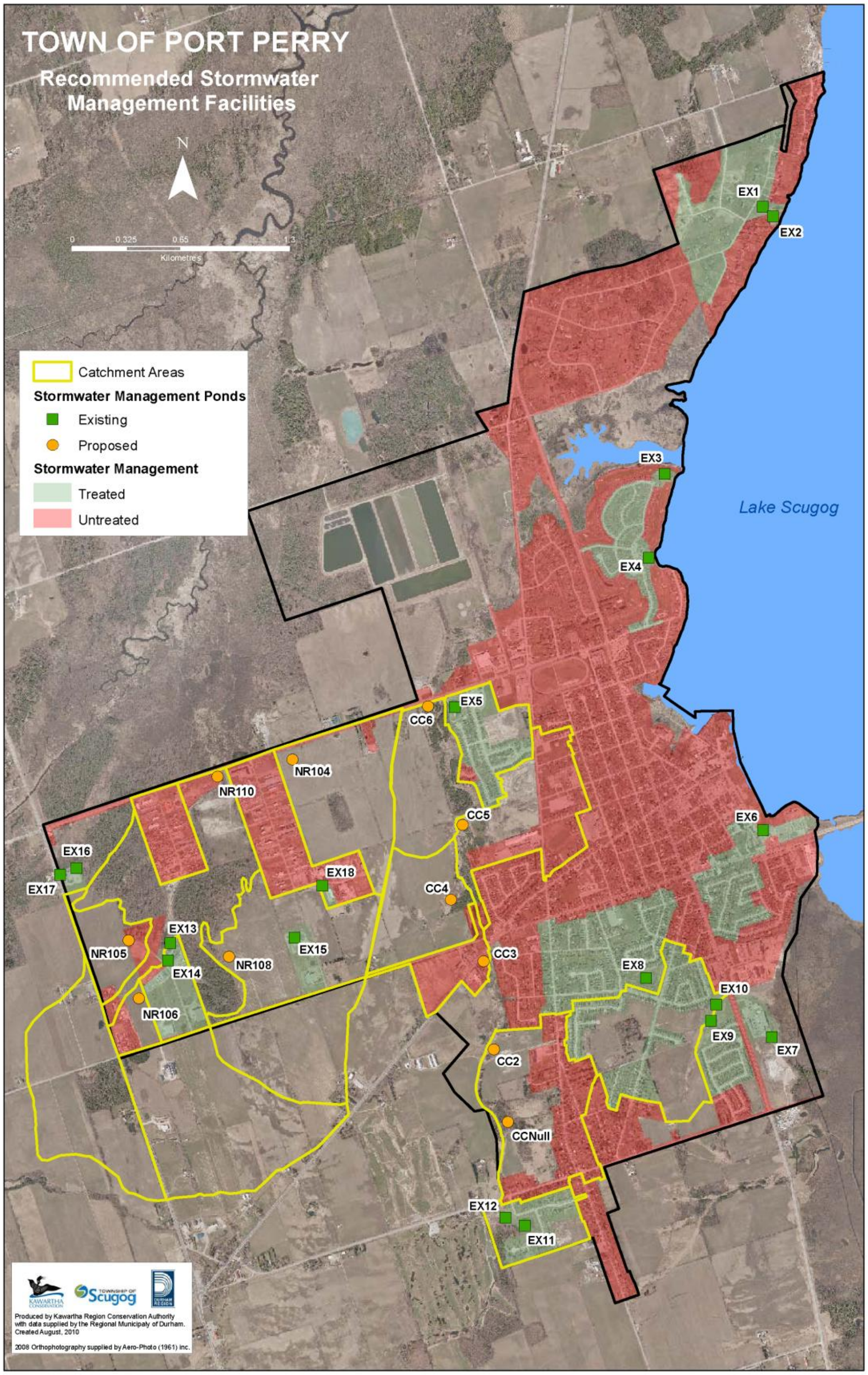


FIGURE 7.4 SUBWATERSHED STUDIES: PROPOSED STORMWATER MANAGEMENT FACILITIES

7.2 BY-LAW, ENGINEERING STANDARDS, AND MUNICIPAL OPERATIONS OPTIONS

7.2.1 BY-LAW ALTERNATIVES

Stormwater Controls By-Law

A stormwater control by-law allows the Township of Scugog to enforce the required cleaning and maintenance of existing controls/BMPs on private property. Properly maintained controls/BMPs improve the efficiency of quality treatment they provide. Improper maintenance can negate any benefits provided and potentially cause issues such as flooding upstream.

A By-law may include the following:

I. Property owners must maintain stormwater controls and/or best management practices on their property based on the manufacturer's maintenance recommendations to ensure maximum operating efficiency.

II. Property owners may delegate maintenance of stormwater controls and/or best management practices on their property to the Township for a fee to be determined based on the size and type of control/best management practice.

Controls/Best Management Practices include but are not limited to:

- Stormwater Management Facilities (Wet pond, Dry pond, Constructed wetland)
- Filter systems
- Oil grit separators
- Bioswales
- Bioretention
- Infiltration trenches/pits
- Permeable pavement
- Storage/Detention facilities
- Green roofs
- Catch basin inserts/defenders

Sewer Discharge By-Law

A storm sewer discharge bylaw will allow the Township of Scugog to prohibit what is being dumped or directed into the storm sewer system. This can prevent unwanted contaminants from entering the system and being subsequently released into surrounding water bodies.

By-law may include the following:

I. No person shall dump or direct polluted water or other pollutants into the storm drainage network through catch basins, maintenance holes, swales, storm sewers and ditches.

II. No person shall engage in an activity where polluted water or other pollutants may be directed into the storm drainage network through catch basins, maintenance holes, swales, storm sewers and ditches unless pretreatment is provided.

III. No person can interfere with or obstruct the proper operation of the storm water network.

Pollutants/polluted water include but are not limited to:

- Soap products
- Grease/oil
- Petroleum based products, including paints and thinners
- Sediments
- Pesticides/fertilizers
- Metals
- Chlorine/bromine (also covered under existing swimming pool by-law)
- Dyes/colouring material
- Acidic/basic substances
- Water mixed with any of the above
- Water with a temperature different than that of the receiving water body

Exceptions include:

- Sand/salt used for de-icing applications
- Pesticides/fertilizers used for agricultural applications
- Pollutants released during the normal operation of vehicles

Amendments to Site Alteration By-Law

Amendments to the building by-law will allow the Township of Scugog to enforce proper sediment control during site alteration projects. Sediment control such as silt fencing helps to keep sediment from construction sites and other areas of exposed earth from entering the storm water network and subsequently surrounding water bodies. This by-law will also give the Township the authority to prevent landowners from changing established drainage patterns. In addition, the Township can control the type of fill being brought into its boundaries.

Amendments may include the following:

I. Appropriate erosion and sedimentation controls shall be provided on site where any earth is to be exposed during construction or maintenance activities. These controls shall be regularly maintained by the party doing the work, to ensure maximum operating efficiency.

II. Exposed earth or other sediment shall not be stored on site without appropriate erosion/sedimentation control. These controls shall be regularly maintained by the property owner, or, in the case of temporary storage; the party doing the work, to ensure maximum operating efficiency.

Erosion/sedimentation controls include but are not limited to:

- Silt fencing
- Sedimentation pond/basin
- Maintenance hole/catch basin covers
- Maintenance hole/catch basin filters
- Straw bales
- Check dams
- Erosion preventing covers such as tarpaulins/mats

Exceptions include:

- Exposed earth in planted gardens/flower beds
- Exposed earth for agricultural purposes

7.2.2 ENGINEERING DESIGN STANDARD ALTERNATIVES

Intervention for Improving Quality of Stormwater Discharge

There are opportunities to utilize new technologies for stormwater management in the Port Perry urban area for improved management of stormwater for existing and future development. These include catchbasin inserts, rainwater harvesting, rain gardens and pervious pavements. Pervious pavements include concrete block pavers, concrete grid pavers**,** plastic grid pavers, pervious asphalt, pervious concrete**,** gravel pavers, and interlocking concrete paving blocks. These interventions can help both in stormwater quality and quantity controls. A detailed discussion of these technologies is provided in Appendix F.

Catchbasin inserts have applicability for all scenarios and would help to reduce the sedimentation into catchbasins. These inserts are attractive due to the lack of available space in urban areas. These can be used as a method of pretreatment rather than a gravel diaphragm or pretreatment cell and are reasonably priced between $50-$60 per insert.

Pervious pavements have more limited applicability as it is ideal to have well drained soils beneath which the permeable technology is placed. The use of pervious pavers including porous concrete and porous asphalt for sidewalks and parking lots could be considered whenever future improvements or developments are being undertaken. Figure 7.5 illustrates the areas in Port Perry where pervious technologies might be best placed, based on the hydrologic soil groupings associated with soil types. Well drained soils and moderately drained soils are identified as having potential for these technologies.

Inclusion of these types of technologies could be referenced in engineering standards, building bylaws and a manual produced identifying pervious pavement or low impact development alternatives.

Amendment to C5.06, Aerators/fountains in stormwater management facilities

Fountains and aerators can impact the operation of stormwater management facilities by preventing the settling of suspended sediment. Currently the standards make it mandatory to have a fountain/aerator installed in facilities by the developers. Making this optional, and ensuring that they are not installed in the sediment forebay can ensure the proper functioning of facilities.

Standards may include the following:

I. A fountain/aerator may be provided by the developer, at no cost to the Township of Scugog, in the main cell component of each stormwater management facility.

II. No fountain/aerator shall be installed at any time in the sediment forebay of a stormwater management facility.

Designs of stormwater management ponds should consider the active movement of pond surface water by wind or other applicable devices to minimize concerns for West Nile Virus. Design considerations should not impair the function of the stormwater management facility.

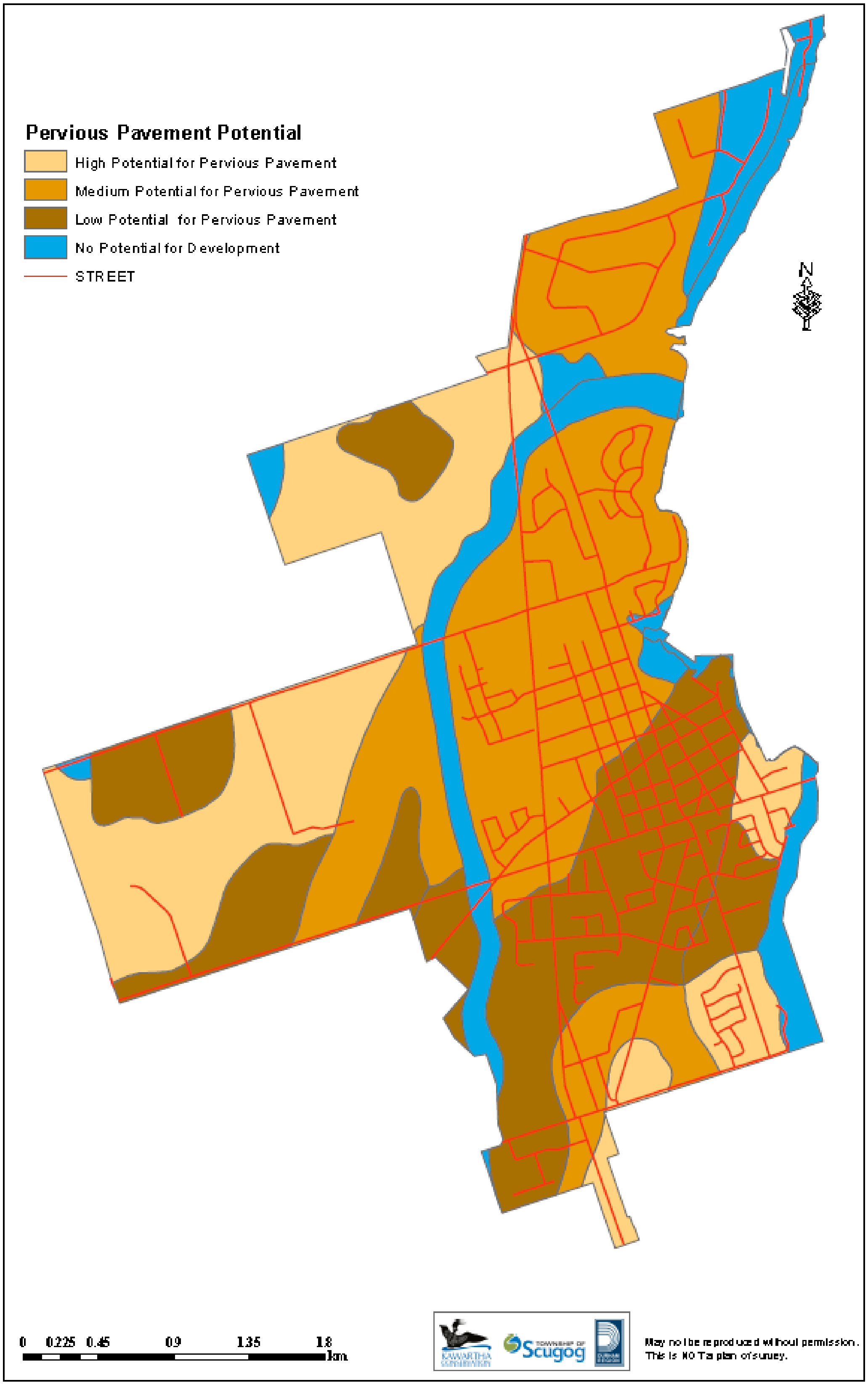


FIGURE 7.5: POTENTIAL FOR PERVIOUS PAVEMENTS TECHNOLOGY

Amendment to C9.03, Video record of stormwater infrastructure

Currently this standard only covers the video record of newly constructed storm sewers by Closed Circuit T.V. Amending this to cover all stormwater infrastructure will further verify the proper installation and operation of infrastructure. Additionally, the provision of as-built drawings along with the video record can help ensure that the Township of Scugog has the most up to date information in regard to its stormwater infrastructure.

Standards may include the following:

I. Closed Circuit T.V. videos of existing stormwater network within a subdivision must be provided to the Township prior to the assumption of that subdivision.

II. Before and after closed Circuit T.V. videos of the immediate section of a stormwater network must be provided when a site development ties into the existing network.

A permanent record in the form of as built drawings shall be supplied to the Township prior to the issuance of a "Certificate of Completion".

7.2.3 MUNICIPAL OPERATIONS ALTERNATIVES

Provision of erosion/sedimentation controls downstream of ditch cleaning activities

Construction and maintenance activities in ditches and swales can cause sediment to be flushed into the storm water network and surrounding water bodies. Because ditches and swales are designed to convey water, erosion and sedimentation in these systems can be substantially higher than in other areas. The provision of appropriate erosion/sedimentation controls can help alleviate this problem.

Operations may include the following:

I. The provision of appropriate erosion/sedimentation controls downstream of ditch cleaning and maintenance activities.

II. Re-vegetation or soil stabilization of cleaned ditches prior to the removal of erosion/sedimentation controls. Soil stabilization measures must remain in place until sufficient vegetation has grown to stabilize the soil.

Erosion/sedimentation controls include, but are not limited to:

- Maintenance hole/catch basin covers if present in the ditch
- Maintenance hole/catch basin filters if present in the ditch
- Straw bales
- Check dams

Closed circuit TV (CCTV) work in storm sewers

Including CCTV work as part of the standard storm sewer maintenance schedule can help ensure efficient operation of the sewer network and help determine when other maintenance items such as catch basin cleaning or sewer flushing may be required. This practice can also catch defects such as pipe collapse, pipe deflection and cross-connections.

Operations may include the following:

I. CCTV work to be conducted at a frequency such that the entire Port Perry storm sewer network is covered on a 5-year rotational basis.

Regular maintenance hole, catch basin and pipe cleaning

Proper storm sewer network maintenance can help improve its operational efficiency, as well as the quality of water being discharged from the system. Sediment and other pollutants build up in the storm sewer network as part of the normal operation. A regular maintenance schedule can remove the sediment and pollutants before they are discharged into a stormwater control or surrounding water body.

Operations may include the following:

I. A regular storm sewer maintenance schedule implemented at a frequency such that the entire Port Perry storm sewer network is covered on a 5-year rotational basis.

Regular stormwater management facility cleanout

The proper maintenance of a stormwater management facility will improve its operational efficiency. Facilities requiring sediment removal lack the volume to allow for the settling of new sediment. Additionally, during large rain events, existing sediment may become re-suspended thus negating any benefits provided by the facility.

Operations may include the following:

I. Municipally owned stormwater management facilities are to be cleaned out when the ability of the facility to remove suspended sediment decreases by 5%.

    - 75% suspended sediment removal for enhanced protection
    - 65% suspended sediment removal for normal protection
    - 55% suspended sediment removal for basic protection

II. Additional maintenance activities are to be determined based on a regular inspection schedule. A typical schedule involves inspecting each municipally owned facility after the spring thaw and before winter freeze up. Additional inspections may be required after heavy rainfalls.

Site-specific conditions may need to be considered when conducting cleanouts of stormwater management facilities. There may be a need to ensure frost has settled into the ground before cleaning out certain facilities.

Proper disposal of excavated material from stormwater ponds needs to be considered in the costing of a project. Sample material may need to be tested in a laboratory to ensure materials are not contaminated. If contaminated, the cost of disposal can increase significantly. Alternatively materials may be disposed of within a municipal roadway (see Victorian Village Stormwater Management Pond interim report for additional information).

Additional maintenance activities may include:

- Inspection
- Grass cutting
- Weed Control
- Upland vegetation replanting
- Shoreline Fringe and Flood Fringe vegetation replanting
- Aquatic vegetation replanting
- Outlet valve adjustment
- Pervious pipe flushing
- Trash removal

7.2.4 INFORMATION TRANSFER AND STEWARDSHIP

Effective stewardship represents a cost effective strategy to achieve nutrient reduction targets, particularly in urban areas where development has occurred and there may be limited retrofit opportunities. An understanding of the impact activities can have on a resource can make a difference. Activities and information packages can be geared toward achieving a reduction in stormwater nutrient and siltation loading.

Stewardship Activities described in further detail below can include the following:

- Establishment of riparian buffer demonstration sites (public and private lands) along tributaries within the sewersheds
- Multi-year Urban Stewardship Outreach Project
- Hosting Best Management Practices educational workshops in collaboration with the outreach programs and partners on the following topics:
    - Rain barrels, water diversion, water conservation
    - Minimizing ditch runoff
    - Rain garden creations
    - Shoreline naturalization and riparian buffers
    - Aquatic invasive species
    - Living in a watershed
- Yellow Fish Road and Adopt a Catch Basin programs
- Creation of a water efficient demonstration garden on municipal land (as seen at Durham Head Office, Whitby, ON)
- Collaborate with the Real Estate Council of Ontario to inform real estate agents on promoting shoreline and water quality protection as a component of homeownership
- Information transfer with local business associations to discuss beneficial management practices for business properties
- Production of information transfer resources specific to:
    - Organic lawn care
    - Stormwater runoff in an urban communities
    - Urban landowners guide to 'Living In Town'; promoting environmental protection in a urban setting
- Creating community stewardship volunteer opportunities for all ages through establishing demonstration sites, such as, riparian buffer creation and ditch naturalization

Restoration and development of riparian buffer zones:

A restoration program to expand riparian buffer zones on properties adjacent to urban watercourses would increase the filtration of sediments and facilitate nutrient uptake. Buffer areas can also serve as a permanent learning resource to urban residents to understand the function of riparian buffer vegetation. Demonstration sites can also highlight the aesthetics of riparian buffer zones and the ease of incorporating riparian buffer zones into existing landscaping.

Urban Stewardship Outreach

An urban stewardship outreach program has been developed by Kawartha Conservation in partnership with Scugog Connections as a multi-year project to promote best management practices (BMP) to urban homeowners within the targeted high priority areas. An ongoing resource or recurring program will serve to encourage residents to take action to improve the urban environment. Educational guides, such as “Living In Town,” provide realistic and easy BMP concepts to homeowners regarding their role in protecting water quality.

Yellow Fish Road:

This project works directly with a local school to stencil a yellow fish onto each catch basin. These symbols will serve as a reminder that materials dumped down catch basins drain directly into a waterbody, potentially having a negatively impact on water quality and fisheries in the Lake.

Adopt a Catch Basin Program:

Catch basins are designed to transport rainwater away from property and roads as quickly as possible to eliminate flooding during heavy rain storm episodes. This program could work directly with local schools to engage students of all ages to prevent leaves and litter from blocking catch basin covers

Information transfer to the urban community:

Giving people information is one of the most powerful ways to affect change. Information transfer and workshop forums organized at the scale most appropriate for urban landowners can achieve this goal. Emphasis upon water conservation and encouraging methods to minimize the amount of runoff from entering sanitary and storm sewers are examples of potential topics.

Opportunities exist to collaborate with organizations such as Scugog Connections, the Durham Land Stewardship Council and the Township of Scugog on workshop delivery, or to offer landowners access to additional technical expertise, resources and the possibility of developing grant programs to assist with urban projects. For example, Scugog Connections could provide rain gauges to interested landowners for the purpose of monitoring weekly rainfall to determine watering requirements for lawns and gardens.

The development of current information materials for businesses and private landowners in the form of fact sheets, pamphlets, and booklets is beneficial. Topics such as, addressing alternative property maintenance and landscaping techniques to reduce runoff from stormsewers, increase infiltration rates on properties, and establish and maintain riparian buffers are considerations.

Volunteer opportunities for demonstration sites on public lands:

Developing opportunities for community residents of all ages to participate in improvements to the character of the area they live is an important function. Demonstration sites, or implementation of a program to educate others such as the Yellow Fish Road or Adopt a Catchbasin program are examples of opportunities to engage the community. This allows community members to become more actively involved with the solutions to water quality issues, while providing greater awareness. In addition, these activities also promote a sense of community spirit and ownership for those involved. These projects will function to demonstrate these 'best management practices' which are feasible at an urban lot scale.

Incentive programs

An incentive program can promote best management practices such as the disconnection of downspouts, erosion protection and other beneficial measures. This is particularly helpful in an urban environment, where development may have proceeded according to best management practices at the time, but no longer conform to current practices and policies. A program could also encourage water conservation, purchase of rain barrels, establishment of rain gardens, water efficient fixtures for homes (shower heads, tap-sets, and low flush toilets) and outdoor watering equipment.

7.2.5 NATURAL HERITAGE CONSIDERATIONS

Maintaining or encouraging spaces which are treed or otherwise vegetated can perform several important functions in an urban environment. They can provide opportunities for reducing the stress on a storm sewer network by encouraging infiltration and reducing evaporation. These spaces also provide a link to natural heritage features outside of the urban area, provide linkages between park systems and support recreational opportunities for residents, tourists and other visitors.

Natural heritage features within the urban area are augmented by township properties, parkland, regional properties, lagoons and trails. These areas may act as both a linkage between the above mentioned natural heritage features and as permeable surfaces within the urban area.

The Cawkers Creek, Port Perry Marsh, Osler Marsh and the Lake Scugog shoreline offer good linkages in a north/south direction, whereas the east/west corridors through the urban area are dependent on municipally owned properties and parks to connect natural heritage features. Figure 7.6 shows municipally owned properties that can be used to enhance the natural heritage features within the urban area.

Each area on the map has been ranked based on its potential to be incorporated into a network of spaces and corridors that link to other natural heritage features within and beyond the urban area. High potential areas are large publically owned properties with no facilities and adjacent to existing natural areas. Medium Potential areas are publically owned properties that are large with facilities and adjacent to existing natural areas. Low potential areas are publically owned properties that are small, adjacent to existing natural areas, and have no facilities or large, isolated areas with facilities. Publically owned properties that are identified as No potential areas are small and isolated properties, with no facilities, or small properties with facilities.

The Cawkers Creek watershed, the Port Perry North Marsh, the Osler Marsh and the shoreline of Lake Scugog offer the best opportunities to enhance the natural heritage features that remain in the Port Perry urban area. Enhancement to the natural heritage system within the town of Port Perry is best directed to areas of high infiltration to alleviate pressure on the urban storm drainage network and in connection with other natural heritage features to allow for species movement to larger natural areas.

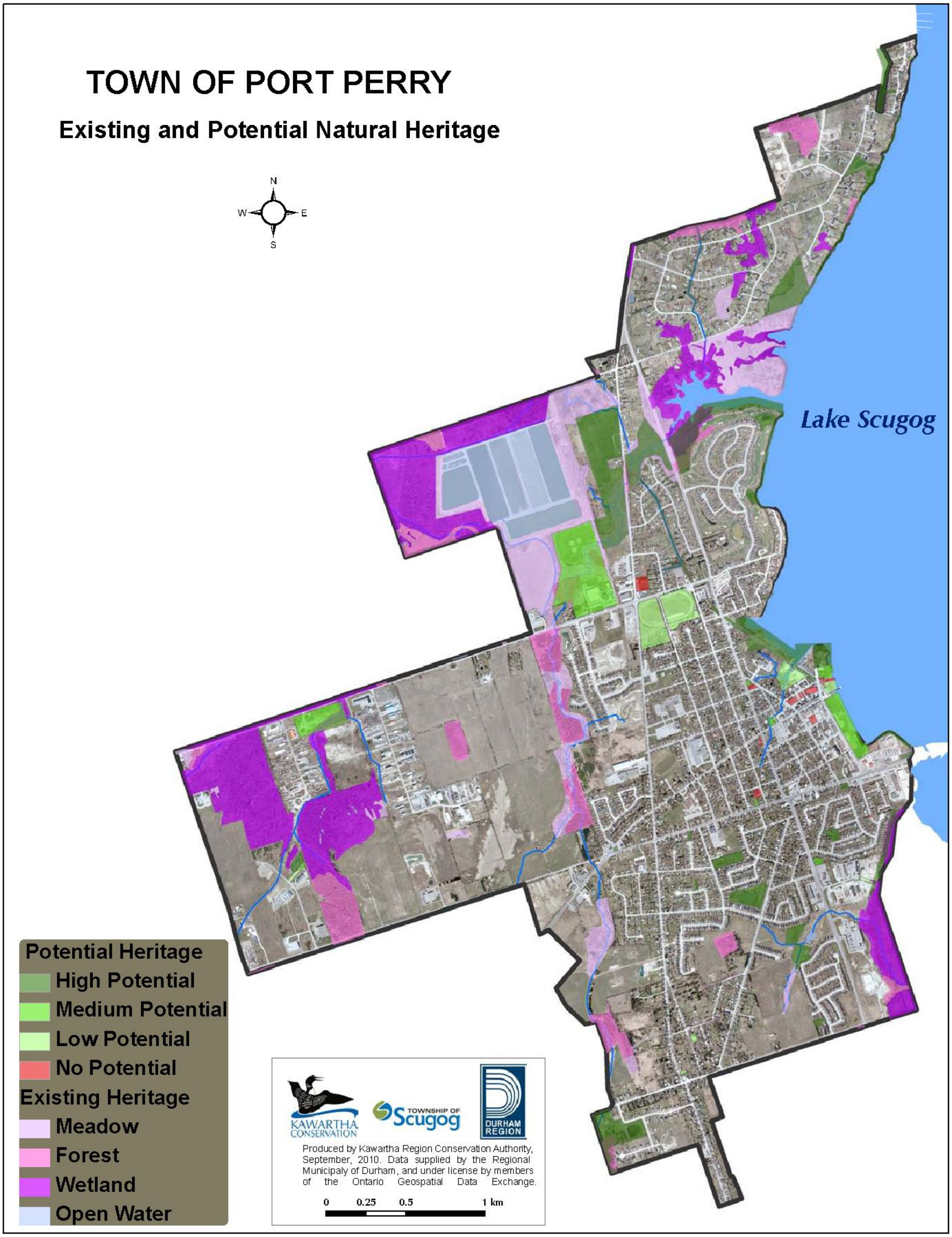


FIGURE 7.6: POTENTIAL NATURAL HERITAGE LINKAGES: MUNICIPALLY OWNED PROPERTIES

8.0 RECOMMENDATIONS

8.1 HIGH PRIORITY AREAS: PREFERRED OPTION RECOMMENDATIONS

It is recommended that the preferred options be constructed in order of priority as shown in Table 8.1.

Table 8.1: Capital Recommendations and Priority

RECOMMENDATION	PRIORITY
OIL GRIT SEPARATOR AT CASIMIR STREET OUTLET (11)	1
PARKING LOT BIORETENTION IN MARY STREET LOT TO COMPLIMENT OGS AT CASIMIR STREET OUTLET (11)	2
OIL GRIT SEPARATOR AND BIOSWALE AT NEW WATER STREET OUTLET TO LAKE (28) - **IMPLEMENTED**	3
OIL GRIT SEPARATOR AND BIOSWALE AT OUTLET TO WILLIAMS CREEK (29)	4
OIL GRIT SEPARATOR AT JOHN STREET OUTLET TO WILLIAMS CREEK (18)	5
OIL GRIT SEPARATOR AT QUEEN STREET WEST OUTLET TO WILLIAMS CREEK (17)	6
OIL GRIT SEPARATOR AT PERRY STREET OUTLET TO WILLIAMS CREEK (27)	7
PARKING LOT BIORETENTION BEHIND MUNICIPAL BUILDING TO COMPLIMENT OGS AND BIOSWALE AT OUTLET (29)	8
OIL GRIT SEPARATOR AT QUEEN STREET EAST OUTLET TO WILLIAMS CREEK (17)	9
ROADSIDE BIORETENTION ON PERRY STREET TO COMPLIMENT OGS AT OUTLET TO WILLIAMS CREEK (27)	10

** This option represents the existing controls implemented at the Water Street outlet. An oil grit separator in combination with a bioswale was constructed at this outlet in conjunction with redevelopment of the waterfront area in 2009 while this study was being conducted.

Additional details of each recommendation are provided in Chapter 6.2.

By implementing all of the above-mentioned stormwater controls, phosphorus loading from six high priority sewersheds can be decreased by as much as 75-80%, total suspended solids (TSS) by 90% and metals by 70-80%. These capital alternatives will need to be budgeted for as opportunities arise and as capital infrastructure is replaced.

8.2 PORT PERRY URBAN AREA: GENERAL RECOMMENDATIONS

The following provides recommendations that are applicable to the urban boundary of Port Perry.

8.2.1 BY-LAW, ENGINEERING STANDARDS, AND MUNICIPAL OPERATIONS RECOMMENDATIONS

It is recommended that the new By-Laws and the amendments to the By-Laws be reviewed and properly drafted and adopted by Council as soon as possible.

It is recommended that the new amendments to the Engineering Design Standards be adopted when the document is next scheduled for review.

It is recommended that the municipal operations options are included as part of the standard operating procedures of the Public Works Department. The most economical and efficient method of pipe cleaning is on a yearly rotational basis where one section of pipe is cleaned each year. The frequency can be determined by township staff; although a 5-year rotation is the standard used by some municipalities in Southern Ontario. Stormwater management pond maintenance schedules should be developed through a regular site inspection schedule. Existing ponds should be inspected prior to freezing in the winter, after the spring thaw and after any rain event greater than the 5-year storm. Newly constructed ponds should be inspected after every rain event during the first year to ensure proper operation.

8.2.2 STORMWATER MANAGEMENT FACILITIES

It is recommended that the following existing stormwater management facilities owned by the Township of Scugog be cleaned and maintained. Below is a list of facilities in need of cleaning or maintenance in order of priority, based on sediment buildup and maintenance issues such as high water.

1) Victorian Village Pond
2) Baagwating Park Stormwater Channel
3) Perryview Estates South West Pond
4) Honey Harbour Heights North Pond
5) Honey Harbour Heights South Pond
6) Canterbury Commons North Pond
7) Canterbury Commons South Pond

Other facilities should be cleaned and maintained as needed, determined through a regular inspection schedule. All facilities should be inspected prior to assumption by the Township.

Proposed Stormwater Management Facilities:

A total of 11 centralized stormwater management facilities are proposed within the urban boundary of Port Perry. It is recommended that a 10% threshold for impervious areas be set for the initiation of a stormwater management facility. As development is proposed, development charges should be apportioned appropriately to cover the implementation costs of these facilities. In order to reduce the number of small stormwater management facilities that the Township may assume, it is recommended that the minimum catchment area be 20 hectares or greater in size.

8.2.3 INFORMATION TRANSFER AND STEWARDSHIP:

Effective stewardship represents a cost effective strategy to achieve nutrient reduction targets. Recommended stewardship activities include the following:

- Establishment of riparian buffer demonstration sites (public and private lands) along tributaries within the sewersheds
- Multi-year Urban Stewardship Outreach Project
- Host Best Management Practices educational workshops in collaboration with partners
- Yellow Fish Road / Adopt a Catch Basin programs
- Creation of a water efficient demonstration garden
- Collaborate with Real Estate Council of Ontario to inform real estate agents on promoting shoreline and water quality protection as a component of homeownership
- Information transfer with local business associations to discuss BMP for business properties
- Production of information resources specific to stormwater runoff in an urban communities
- Creating community stewardship volunteer opportunities for all ages
- Explore opportunities for incentive programs to improve stormwater runoff quality

8.2.4 NATURAL HERITAGE

Examine areas where natural cover can be improved or restored to maintain linkages and corridors to features outside of the urban area. These actions also serve to mitigate urban storm water runoff by preserving and enhancing absorption and reducing evaporation.

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APPENDIX A – LONG LIST OF ALTERNATIVES

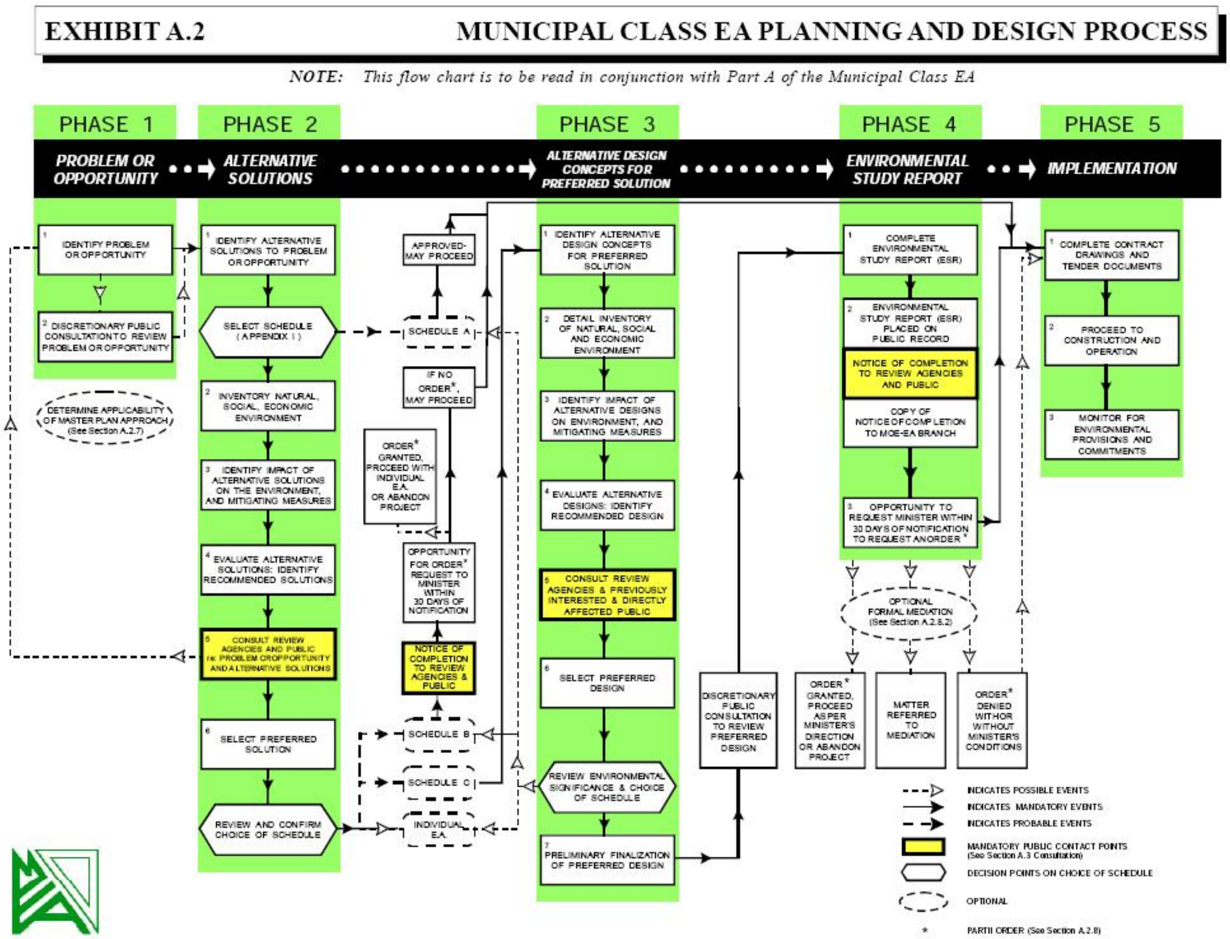
Table A.1

Long List of Potential Stormwater Management Options
Landscape-Based Stormwater Management Opportunities
Lot Level Controls
Depression Storage
Bioretention Areas
Rain Gardens
Soakaways
Permeable Pavement
Vegetated Filter Strips
Conveyance Controls
Grass Swales
Perforated Pipe Systems
Low Impact Development Practices For Stormwater Management
Rainwater Harvesting
Green Roofs
Roof Downspout Disconnection
Soakways, Infiltration Trenches and Chambers
Bioretention
Vegetated Filter Strips
Permeable Pavement
Enhanced Grass Swales
Dry Swales
Perforated Pipe Systems
Water Quality Inlet Oil and Grit Separator (OGS)
Stormwater Management Facilities
Wet Pond
Dry Pond
Wetland

Low Impact Development Storm Water Management Manual, 2009

Storm Water Quality Fact Sheet, 1999

APPENDIX B – MUNICIPAL CLASS EA PROCESS



APPENDIX C. STORMWATER QUALITY RESULTS

SGS Lakefield Research

Report No. **CA10235-AUG09**
Customer **Kawartha Conservation**
Attention **Alexander Shulyarenko**
Reference **PO#6077**
Title **Final Report**

Sample ID		Analysis	A1	A2	A3	A4	A5	A6
Sample Date/Time			10-Aug-09	10-Aug-09	10-Aug-09	20-Aug-09	20-Aug-09	20-Aug-09
Analysis	**Units**							
Temperature Upon	Receipt °C	---	15.0	15.0	15.0	15.0	15.0	15.0
TSS	mg/L	27-Aug-09	460	111	20	267	115	56
Hardness	mg/L	as 01-Sep-09	262	90.6	75.0	180	90.3	63.3
Ag	mg/L	01-Sep-09	0.00008	0.00002	0.00002	0.00003	0.00004	0.00002
Al	mg/L	01-Sep-09	3.61	1.86	0.446	2.36	1.44	0.848
As	mg/L	01-Sep-09	0.0042	0.0026	0.0013	0.0024	0.0016	0.0015
Ba	mg/L	01-Sep-09	0.0511	0.0272	0.0159	0.0414	0.0229	0.0171
Be	mg/L	01-Sep-09	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
B	mg/L	01-Sep-09	0.006	0.011	0.012	0.009	0.008	0.007
Ca	mg/L	01-Sep-09	96.3	32.7	26.8	66.4	33.1	23.0
Cd	mg/L	01-Sep-09	0.000228	0.000060	0.000028	0.000123	0.000090	0.000046
Cr	mg/L	01-Sep-09	0.014	0.011	0.008	0.010	0.008	0.010
Co	mg/L	01-Sep-09	0.00260	0.00113	0.000287	0.00170	0.00105	0.000596
Cu	mg/L	01-Sep-09	0.0234	0.0092	0.0058	0.0209	0.0111	0.0088
Fe	mg/L	01-Sep-09	5.20	2.39	0.55	3.56	2.00	1.13
K	mg/L	01-Sep-09	1.93	3.17	2.03	2.42	2.43	1.89
Mg	mg/L	01-Sep-09	5.19	2.19	1.96	3.60	1.88	1.41
Mn	mg/L	01-Sep-09	0.243	0.0839	0.0203	0.165	0.0922	0.0554
Mo	mg/L	01-Sep-09	0.00072	0.00042	0.00043	0.00067	0.00038	0.00045
Na	mg/L	01-Sep-09	2.47	4.86	8.09	5.16	3.22	5.13
Ni	mg/L	01-Sep-09	0.0071	0.0030	0.0013	0.0056	0.0030	0.0019
Pb	mg/L	01-Sep-09	0.0229	0.00659	0.00159	0.0162	0.00760	0.00475
Sb	mg/L	01-Sep-09	0.0010	0.0005	0.0005	0.0010	0.0006	0.0006
Se	mg/L	01-Sep-09	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sr	mg/L	01-Sep-09	0.169	0.0732	0.0742	0.125	0.0690	0.0590
Ti	mg/L	01-Sep-09	0.151	0.0772	0.0169	0.0982	0.0584	0.0323
Tl	mg/L	01-Sep-09	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
U	mg/L	01-Sep-09	0.000373	0.000160	0.000168	0.000205	0.000141	0.000102
V	mg/L	01-Sep-09	0.00903	0.00474	0.00201	0.00729	0.00406	0.00294
W	mg/L	01-Sep-09	0.00030	0.00009	0.00008	0.00032	0.00013	0.00010
Zn	mg/L	01-Sep-09	0.107	0.037	0.017	0.096	0.044	0.034
Zr	mg/L	01-Sep-09	0.00062	0.00045	0.00017	0.00062	0.00052	0.00040

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1, Lindsay
, K9V 4RI
Phone: 705-328-2271, Fax:705-328-2286, excel, pdf

August 7, 2009

Date Rec. : 28 July 2009
LR Report: **CA11272-JUL09**
Reference: PO#6077

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PWQO Limits	6: A1	7: A2	8: A3	9: A4
Sample Date & Time						27-Jul-09	27-Jul-09	27-Jul-09	27-Jul-09
Temperature Upon Receipt [°C]	---	---	---	---	---	8.0	8.0	8.0	8.0
Tot. Suspended Solids [mg/L]	28-Jul-09	15:17	29-Jul-09	15:06	---	52	75	113	80
Hardness [mg/L as CaCO3]	30-Jul-09	15:00	31-Jul-09	13:09	---	163	88.4	106	45.4
Silver [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.0001	0.00009	0.00004	0.00003	0.00001
Aluminum [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.015	0.706	1.66	1.19	0.264
Arsenic [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.005	0.0007	0.0008	0.0007	0.0005
Barium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	---	0.0453	0.0262	0.0323	0.0114
Beryllium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	0.011	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	0.2	0.006	< 0.002	< 0.002	< 0.002
Calcium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09		60.7	32.4	39.3	16.9
Cadmium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.0002	0.000124	0.000057	0.000048	0.000009
Chromium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	0.001	0.008	0.008	0.010	0.009
Cobalt [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.0009	0.000715	0.00109	0.000790	0.000165
Copper [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.001	0.0145	0.0076	0.0104	0.0031
Iron [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	0.3	1.33	2.17	1.67	0.30
Potassium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09		1.34	1.48	1.14	0.86
Magnesium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09		2.82	1.83	1.89	0.775
Manganese [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	---	0.0828	0.0904	0.0727	0.0131
Molybdenum [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.04	0.00095	0.00027	0.00040	0.00020
Sodium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09		9.35	4.18	5.04	2.82
Nickel [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.025	0.0049	0.0033	0.0031	0.0008
Lead [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.001	0.00772	0.00598	0.00622	0.00092
Antimony [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.02	0.0014	0.0004	0.0010	0.0003
Selenium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.1	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	30-Jul-09	15:00	31-Jul-09	13:09	---	0.153	0.0770	0.0932	0.0478
Titanium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	---	0.0302	0.0590	0.0440	0.0082
Thallium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.005	0.000214	0.000109	0.000113	0.000042
Vanadium [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.006	0.00311	0.00381	0.00336	0.00109
Tungsten [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.005	0.00014	0.00009	0.00010	0.00006
Zinc [mg/L]	05-Aug-09	13:30	06-Aug-09	15:24	0.02	0.095	0.030	0.048	0.007
Zirconium [mg/L]	05-Aug-09	13:30	07-Aug-09	09:03	0.004	0.00031	0.00050	0.00040	0.00017

OnLine LIMS

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Lakefield Research

Report No.	**CA11272-JUL09**
Customer	**Kawartha Conservation**
Attention	**Alexander Shulyarenko**
Reference	**PO#6077**
Works#	
Title	**Final Report**

Sample ID		Analysis	PWQO Limits	A1	A2	A3	A4
Sample Date/Time		Date		27-Jul-09	27-Jul-09	27-Jul-09	27-Jul-09
Analysis	**Units**						
Temperature Upon	Receipt °C	---	---	8.0	8.0	8.0	8.0
TSS	mg/L	28-Jul-09	---	52	75	113	80
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Ba	mg/L	30-Jul-09	---	0.0453	0.0262	0.0323	0.0114
Be	mg/L	30-Jul-09	0.011	< 0.0001	< 0.0001	< 0.0001	< 0.0001
B	mg/L	30-Jul-09	0.2	0.006	< 0.002	< 0.002	< 0.002
Ca	mg/L	30-Jul-09		60.7	32.4	39.3	16.9
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Fe	mg/L	30-Jul-09	0.3	1.33	2.17	1.67	0.30
K	mg/L	30-Jul-09		1.34	1.48	1.14	0.86
Mg	mg/L	30-Jul-09		2.82	1.83	1.89	0.775
Mn	mg/L	05-Aug-09	---	0.0828	0.0904	0.0727	0.0131
Mo	mg/L	05-Aug-09	0.04	0.00095	0.00027	0.00040	0.00020
Na	mg/L	30-Jul-09		9.35	4.18	5.04	2.82
Ni	mg/L	05-Aug-09	0.025	0.0049	0.0033	0.0031	0.0008
Pb	mg/L	05-Aug-09	0.001	0.00772	0.00598	0.00622	0.00092
Sb	mg/L	05-Aug-09	0.02	0.0014	0.0004	0.0010	0.0003
Se	mg/L	05-Aug-09	0.1	< 0.001	< 0.001	< 0.001	< 0.001
Sr	mg/L	30-Jul-09	---	0.153	0.0770	0.0932	0.0478
Ti	mg/L	05-Aug-09	---	0.0302	0.0590	0.0440	0.0082
Tl	mg/L	05-Aug-09	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002
U	mg/L	05-Aug-09	0.005	0.000214	0.000109	0.000113	0.000042
V	mg/L	05-Aug-09	0.006	0.00311	0.00381	0.00336	0.00109
W	mg/L	05-Aug-09	0.005	0.00014	0.00009	0.00010	0.00006
Zn	mg/L	05-Aug-09	0.02	0.095	0.030	0.048	0.007
Zr	mg/L	05-Aug-09	0.004	0.00031	0.00050	0.00040	0.00017

SGS
SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Hazard Mapping

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1
Lindsay, ON
K9V 4RI,

Phone: 705-328-2271
Fax:705-328-2286, excel, pdf

August 14, 2009

Date Rec. : 07 August 2009
LR Report: **CA12110-AUG09**
Reference: PO#6077

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PWQO Limits	6: A1	7: A2	8: A3	9: A4	10: A5
Sample Date & Time						29-Jul-09	29-Jul-09	29-Jul-09	29-Jul-09	31-Jul-09
Temperature Upon Receipt [°C]	---	---	---	---	---	12.0	12.0	12.0	12.0	12.0
Tot. Suspended Solids [mg/L]	11-Aug-09	12:41	13-Aug-09	08:49	---	202	181	113	50	480
Hardness [mg/L as CaCO3]	12-Aug-09	08:06	12-Aug-09	11:03	---	175	110	76.4	62.6	274
Silver [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.0001	0.00009	0.00005	0.00003	0.00003	0.00008
Aluminum [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.015	1.74	1.53	1.23	0.662	4.08
Arsenic [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.005	0.0013	0.0012	0.0009	0.0006	0.0023
Barium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	---	0.0433	0.0276	0.0195	0.0156	0.0643
Beryllium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	0.011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001
Boron [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	0.2	0.006	< 0.002	< 0.002	< 0.002	0.019
Calcium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03		62.6	40.5	28.1	23.0	99.5
Cadmium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.0002	0.000139	0.000071	0.000056	0.000086	0.000156
Chromium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	0.001	0.011	0.011	0.005	0.009	0.016
Cobalt [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.0009	0.00109	0.000894	0.000696	0.000375	0.00241
Copper [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.001	0.0160	0.0128	0.0085	0.0054	0.0219
Iron [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	0.3	2.30	1.87	1.44	0.73	4.90
Potassium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03		1.97	1.46	1.11	0.87	2.54
Magnesium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03		4.55	2.25	1.50	1.28	6.15

Page 1 of 2

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Hazard Mapping

LR Report : **CA12110-AUG09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PWQO Limits	6: A1	7: A2	8: A3	9: A4	10: A5
Manganese [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	---	0.108	0.0825	0.0723	0.0314	0.229
Molybdenum [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.04	0.00086	0.00054	0.00029	0.00028	0.00066
Sodium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03		15.5	6.70	3.30	4.12	19.9
Nickel [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.025	0.0041	0.0030	0.0023	0.0013	0.0073
Lead [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.001	0.00816	0.00628	0.00485	0.00275	0.0160
Antimony [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.02	0.0011	0.0009	0.0006	0.0005	0.0012
Selenium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	12-Aug-09	08:06	12-Aug-09	11:03	---	0.150	0.0972	0.0658	0.0650	0.213
Titanium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	---	0.0612	0.0512	0.0404	0.0209	0.150
Thallium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.005	0.000473	0.000149	0.000108	0.000104	0.000541
Vanadium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.006	0.00516	0.00436	0.00365	0.00228	0.00932
Tungsten [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.005	0.00021	0.00018	0.00010	0.00008	0.00040
Zinc [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.02	0.082	0.060	0.040	0.026	0.109
Zirconium [mg/L]	12-Aug-09	16:51	13-Aug-09	14:48	0.004	0.00050	0.00042	0.00029	0.00022	0.00068

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1
Lindsay, ON
K9V 4RI,

Phone: 705-328-2271
Fax:705-328-2286, excel, pdf

Wednesday, August 19, 2009

Date Rec. : 12 August 2009
LR Report: **CA10119-AUG09**
Reference: 6077

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A1	7: A2	8: A3	9: A4	10: A5
Sample Date & Time			11-Aug-09	11-Aug-09	11-Aug-09	11-Aug-09	11-Aug-09
Temperature Upon Receipt [°C]	---	---	8.0	8.0	8.0	8.0	8.0
Tot. Suspended Solids [mg/L]	18-Aug-09	14:54	591	286	101	61	64
Hardness [mg/L as CaCO3]	17-Aug-09	09:48	276	157	72.9	65.9	69.9
Silver [mg/L]	17-Aug-09	13:14	0.00008	0.00006	0.00004	0.00005	0.00004
Aluminum [mg/L]	17-Aug-09	13:14	4.01	2.54	1.46	1.61	1.35
Arsenic [mg/L]	17-Aug-09	13:14	0.0029	0.0024	0.0020	0.0020	0.0018
Barium [mg/L]	17-Aug-09	09:48	0.0552	0.0331	0.0200	0.0227	0.0245
Beryllium [mg/L]	17-Aug-09	09:48	0.0002	0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	17-Aug-09	09:48	0.007	< 0.002	< 0.002	0.003	0.007
Calcium [mg/L]	17-Aug-09	09:48	101	57.4	26.8	23.8	24.8
Cadmium [mg/L]	17-Aug-09	13:14	0.000201	0.000124	0.000064	0.000056	0.000051
Chromium [mg/L]	17-Aug-09	09:48	0.013	0.008	0.006	0.007	0.004
Cobalt [mg/L]	17-Aug-09	13:14	0.00283	0.00169	0.000923	0.000861	0.000760
Copper [mg/L]	17-Aug-09	13:14	0.0236	0.0157	0.0074	0.0073	0.0065
Iron [mg/L]	17-Aug-09	09:48	5.47	3.42	1.90	1.96	1.72
Potassium [mg/L]	17-Aug-09	09:48	2.04	1.47	1.51	2.17	2.45
Magnesium [mg/L]	17-Aug-09	09:48	5.57	3.24	1.48	1.60	1.93
Manganese [mg/L]	17-Aug-09	13:14	0.278	0.167	0.0942	0.0718	0.0615
Molybdenum [mg/L]	17-Aug-09	13:14	0.00039	0.00023	0.00017	0.00027	0.00035
Sodium [mg/L]	17-Aug-09	09:48	3.10	1.15	1.76	3.06	5.55
Nickel [mg/L]	17-Aug-09	13:14	0.0067	0.0042	0.0023	0.0023	0.0022
Lead [mg/L]	17-Aug-09	13:14	0.0214	0.0136	0.00649	0.00522	0.00462
Antimony [mg/L]	17-Aug-09	13:14	0.0008	0.0004	0.0003	0.0003	0.0003
Selenium [mg/L]	17-Aug-09	13:14	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	17-Aug-09	09:47	0.175	0.102	0.0532	0.0546	0.0633
Titanium [mg/L]	17-Aug-09	13:14	0.152	0.101	0.0566	0.0610	0.0507
Thallium [mg/L]	17-Aug-09	13:14	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	17-Aug-09	13:14	0.000345	0.000167	0.000092	0.000125	0.000151
Vanadium [mg/L]	17-Aug-09	13:14	0.00998	0.00587	0.00355	0.00394	0.00374
Tungsten [mg/L]	17-Aug-09	13:14	0.00024	0.00012	0.00008	0.00007	0.00005
Zinc [mg/L]	17-Aug-09	13:14	0.110	0.064	0.037	0.029	0.026
Zirconium [mg/L]	18-Aug-09	09:33	0.00062	0.00041	0.00029	0.00034	0.00043

OnLine LIMS

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: C01865 **REPORT No. B09-24668**

Report To:
Kawartha Conservation
277 Kenrei Road
Lindsay, Ontario, K9V 4R1
Attention: Alexander Shulyarenko

Caduceon Environmental Laboratories
160 Charlotte St. Suite 206
Peterborough, Ontario, K9J 2T8
Tel: 705-748-1506
Fax: 705-748-6514

DATE RECEIVED: 12-Aug-09
DATE REPORTED: 21-Aug-09
SAMPLE MATRIX: Surface Water

JOB/PROJECT NO.: LSEMP
P.O. NUMBER: 6076
WATERWORKS NO.

	Parameter:		Nitrite (N)	Nitrate (N)	Ammonia (N)-Total	Total Kjeldahl Nitrogen	Phosphorus-Total
	Units:		mg/L	mg/L	mg/L	mg/L	mg/L
	M.D.L.:		0.002	0.02	0.01	0.05	0.002
	Reference Method:		SM 4500	SM 4500	EPA 350.2	EPA 351.2	EPA 365.4
	Date/Site Analyzed:		13-Aug-09/P	14-Aug-09/P	18-Aug-09/O	20-Aug-09/O	20-Aug-09/O
Client I.D.	**Sample I.D.**	**Date Collected**					
A1	B09-24668-1	10-Aug-09	0.031	0.46	0.18	1.57	0.548
A2	B09-24668-2	10-Aug-09	0.024	0.46	0.14	0.72	0.310
A3	B09-24668-3	10-Aug-09	0.019	0.29	0.09	0.49	0.185
A4	B09-24668-4	10-Aug-09	0.023	0.45	0.09	0.62	0.220
A5	B09-24668-5	10-Aug-09	0.045	0.70	0.09	0.58	0.189

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,P-Peterborough,M-Moncton

Christine Wright
Lab Supervisor

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

Page 1 of 2.

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: C01864 **REPORT No. B09-26185**

Report To:
Kawartha Conservation
277 Kenrei Road
Lindsay, Ontario, K9V 4R1
Attention: Alexander Shulyarenko

Caduceon Environmental Laboratories
160 Charlotte St. Suite 206
Peterborough, Ontario, K9J 2T8
Tel: 705-748-1506
Fax: 705-748-6514

DATE RECEIVED: 25-Aug-09
DATE REPORTED: 09-Sep-09
SAMPLE MATRIX: Surface Water

JOB/PROJECT NO.: HM; Sh.N
P.O. NUMBER: 6076, 6112
WATERWORKS NO.

	Parameter:		Nitrite (N)	Nitrate (N)	Ammonia (N)-Total	Total Kjeldahl Nitrogen	Phosphorus-Total
	Units:		mg/L	mg/L	mg/L	mg/L	mg/L
	M.D.L.:		0.002	0.02	0.01	0.05	0.002
	Reference Method:		SM 4500	SM 4500	EPA 350.2	EPA 351.2	EPA 365.4
	Date/Site Analyzed:		27-Aug-09/P	27-Aug-09/P	04-Sep-09/O	04-Sep-09/O	04-Sep-09/O
Client I.D.	**Sample I.D.**	**Date Collected**					
A 1	B09-26185-1	21-Aug-09	0.010	0.52	< 0.01	1.08	0.587
A 2	B09-26185-2	21-Aug-09	0.009	0.64	< 0.01	0.59	0.258
A 3	B09-26185-3	21-Aug-09	0.008	0.92	< 0.01	0.31	0.099
A 4	B09-26185-4	21-Aug-09	0.015	0.13	< 0.01	1.54	0.412
A 5	B09-26185-5	21-Aug-09	0.012	0.42	< 0.01	0.90	0.264
A 6	B09-26185-6	21-Aug-09	0.015	0.21	< 0.01	0.64	0.180
SN 1 - B	B09-26185-7	24-Aug-09	--	--	--	--	0.042
SN 2 - I	B09-26185-8	24-Aug-09	--	--	--	--	0.034
SN 3 - C	B09-26185-9	24-Aug-09	--	--	--	--	0.021

Christine Wright
Lab Supervisor

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,P-Peterborough,M-Moncton

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Page 1 of 2.

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1, Lindsay
, K9V 4RI
Phone: 705-328-2271, Fax:705-328-2286, excel, pdf

Wednesday, September 16, 2009

Date Rec. : 10 September 2009
LR Report: **CA10245-SEP09**

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A 1	7: A 2	8: A 3
Sample Date & Time			03-Sep-09	03-Sep-09	03-Sep-09
Temperature Upon Receipt [°C]	---	---	6.0	6.0	6.0
Tot. Suspended Solids [mg/L]	14-Sep-09	15:42	828	404	85
Hardness [mg/L as CaCO3]	15-Sep-09	15:38	446	195	70.8
Silver [mg/L]	16-Sep-09	14:54	0.00006	0.00003	< 0.00001
Aluminum [mg/L]	16-Sep-09	14:54	4.12	3.31	0.759
Arsenic [mg/L]	16-Sep-09	14:54	0.0022	0.0024	0.0007
Barium [mg/L]	15-Sep-09	15:38	0.0839	0.0683	0.0153
Beryllium [mg/L]	15-Sep-09	15:38	0.0001	0.0001	< 0.0001
Boron [mg/L]	15-Sep-09	15:38	< 0.002	< 0.002	< 0.002
Calcium [mg/L]	15-Sep-09	15:38	166	72.1	26.2
Cadmium [mg/L]	16-Sep-09	14:54	0.000303	0.000150	0.000041
Chromium [mg/L]	15-Sep-09	15:38	0.027	0.024	0.003
Cobalt [mg/L]	16-Sep-09	14:54	0.00278	0.00214	0.000454
Copper [mg/L]	16-Sep-09	14:54	0.0305	0.0222	0.0050
Iron [mg/L]	15-Sep-09	15:38	7.55	5.61	1.19
Potassium [mg/L]	15-Sep-09	15:38	2.79	2.65	0.92
Magnesium [mg/L]	15-Sep-09	15:38	7.47	3.55	1.29
Manganese [mg/L]	16-Sep-09	14:54	0.276	0.214	0.0424
Molybdenum [mg/L]	16-Sep-09	14:54	0.00114	0.00057	0.00021
Sodium [mg/L]	15-Sep-09	15:38	12.0	3.25	2.08
Nickel [mg/L]	16-Sep-09	14:54	0.0082	0.0055	0.0017
Lead [mg/L]	16-Sep-09	14:54	0.0351	0.0175	0.00399
Antimony [mg/L]	16-Sep-09	14:54	0.0019	0.0036	0.0003
Selenium [mg/L]	16-Sep-09	14:54	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	15-Sep-09	15:38	0.352	0.131	0.0536
Titanium [mg/L]	16-Sep-09	14:54	0.132	0.122	0.0279
Thallium [mg/L]	16-Sep-09	14:54	0.0004	0.0002	< 0.0002
Uranium [mg/L]	16-Sep-09	14:54	0.000692	0.000225	0.000076
Vanadium [mg/L]	16-Sep-09	14:54	0.0114	0.00677	0.00191
Tungsten [mg/L]	16-Sep-09	14:54	0.00032	0.00021	0.00005
Zinc [mg/L]	16-Sep-09	14:54	0.184	0.103	0.027
Zirconium [mg/L]	16-Sep-09	14:54	0.00116	0.00060	0.00013

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1, Lindsay
, K9V 4RI
Phone: 705-328-2271, Fax:705-328-2286, excel, pdf

Tuesday, October 13, 2009

Date Rec. : 02 October 2009
LR Report: **CA12052-OCT09**
Reference: PO No.: HM

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A1	7: A2	8: A3	9: A4	10: A5
Sample Date & Time			30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
Temperature Upon Receipt [°C]	---	---	9.0	9.0	9.0	9.0	9.0
Tot. Suspended Solids [mg/L]	06-Oct-09	12:23	374	253	45	92	40
Silver [mg/L]	07-Oct-09	11:15	0.00017	0.00006	0.00003	0.00002	0.00002
Aluminum [mg/L]	07-Oct-09	11:15	2.00	1.45	0.514	0.631	0.318
Arsenic [mg/L]	07-Oct-09	11:15	0.0019	0.0015	0.0007	0.0009	0.0008
Barium [mg/L]	13-Oct-09	08:03	0.0884	0.0363	0.0126	0.0189	0.0115
Beryllium [mg/L]	13-Oct-09	08:03	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	13-Oct-09	08:03	0.027	0.016	0.009	0.007	0.006
Calcium [mg/L]	13-Oct-09	08:03	126	60.7	19.8	28.0	17.0
Cadmium [mg/L]	07-Oct-09	11:15	0.000352	0.000169	0.000061	0.000075	0.000046
Chromium [mg/L]	13-Oct-09	08:03	0.014	0.009	0.010	0.010	0.008
Cobalt [mg/L]	07-Oct-09	11:15	0.00202	0.00124	0.000388	0.000513	0.000333
Copper [mg/L]	07-Oct-09	11:15	0.0397	0.0241	0.0085	0.0095	0.0059
Iron [mg/L]	13-Oct-09	08:03	5.59	2.68	0.73	0.98	0.45
Potassium [mg/L]	13-Oct-09	08:03	2.64	1.67	1.47	1.19	1.06
Magnesium [mg/L]	13-Oct-09	08:03	7.75	3.09	1.24	1.31	0.933
Manganese [mg/L]	07-Oct-09	11:15	0.271	0.139	0.0384	0.0591	0.0435
Molybdenum [mg/L]	07-Oct-09	11:15	0.00082	0.00039	0.00029	0.00028	0.00022
Sodium [mg/L]	13-Oct-09	08:03	73.3	2.84	3.18	1.87	2.49
Nickel [mg/L]	07-Oct-09	11:15	0.0086	0.0044	0.0015	0.0019	0.0012
Lead [mg/L]	07-Oct-09	11:15	0.0220	0.0127	0.00308	0.00587	0.00290
Antimony [mg/L]	07-Oct-09	11:15	0.0019	0.0009	0.0005	0.0007	0.0005
Selenium [mg/L]	07-Oct-09	11:15	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	13-Oct-09	08:03	0.272	0.112	0.0459	0.0566	0.0391
Titanium [mg/L]	07-Oct-09	11:15	0.0744	0.0568	0.0195	0.0250	0.0116
Thallium [mg/L]	07-Oct-09	11:15	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	07-Oct-09	11:15	0.000980	0.000181	0.000085	0.000074	0.000067
Vanadium [mg/L]	07-Oct-09	11:15	0.00739	0.00468	0.00180	0.00216	0.00127
Tungsten [mg/L]	07-Oct-09	11:15	0.00016	0.00017	0.00006	0.00008	0.00007
Zinc [mg/L]	07-Oct-09	11:15	0.193	0.097	0.030	0.045	0.026
Zirconium [mg/L]	08-Oct-09	16:00	0.00063	0.00045	0.00022	0.00024	0.00014

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: C13123

REPORT No. B09-30882

Report To:

Kawartha Conservation
277 Kenrei Road
Lindsay, Ontario, K9V 4R1
Attention: Alexander Shulyarenko

Caduceon Environmental Laboratories
160 Charlotte St. Suite 206
Peterborough, Ontario, K9J 2T8
Tel: 705-748-1506
Fax: 705-748-6514

DATE RECEIVED: 02-Oct-09
DATE REPORTED: 09-Oct-09
SAMPLE MATRIX: Surface Water

JOB/PROJECT NO.: LSEMP
P.O. NUMBER: 6008
WATERWORKS NO.

	Parameter:		Nitrite (N)	Nitrate (N)	Ammonia (N)-Total	Total Kjeldahl Nitrogen	Phosphorus-Total
	Units:		mg/L	mg/L	mg/L	mg/L	mg/L
	M.D.L.:		0.002	0.02	0.01	0.05	0.002
	Reference Method:		SM 4500	SM 4500	EPA 350.2	EPA 351.2	EPA 365.4
	Date/Site Analyzed:		06-Oct-09/P	05-Oct-09/P	06-Oct-09/O	08-Oct-09/O	08-Oct-09/O
Client I.D.	**Sample I.D.**	**Date Collected**					
A1	B09-30882-1	30-Sep-09	0.009	1.32	< 0.01	2.00	0.533
A2	B09-30882-2	30-Sep-09	0.008	0.44	< 0.01	1.36	0.394
A3	B09-30882-3	30-Sep-09	0.006	0.50	< 0.01	0.56	0.172
A4	B09-30882-4	30-Sep-09	0.012	0.50	0.06	0.46	0.125
A5	B09-30882-5	30-Sep-09	0.010	0.45	< 0.01	0.60	0.177
PR18	B09-30882-6	30-Sep-09	0.003	0.16	< 0.01	0.12	0.005

Christine Wright
Lab Supervisor

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,P-Peterborough,M-Moncton

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1
Lindsay, ON
K9V 4RI,

Phone: 705-328-2271
Fax:705-328-2286, excel, pdf

Monday, October 26, 2009

Date Rec. : 21 October 2009
LR Report: **CA12403-OCT09**
Reference: Po # 6077 Project HM

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A1	7: A2	8: A3	9: A4	10: A5
Sample Date & Time			15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09
Temperature Upon Receipt [°C]	---	---	10.0	10.0	10.0	10.0	10.0
Tot. Suspended Solids [mg/L]	23-Oct-09	08:38	82	31	782	256	90
Hardness [mg/L as CaCO3]	26-Oct-09	11:18	86.7	45.6	393	148	54.6
Silver [mg/L]	26-Oct-09	11:18	0.00002	0.00001	0.00006	0.00003	< 0.00001
Aluminum [mg/L]	26-Oct-09	11:18	0.205	0.0854	1.30	0.674	0.244
Arsenic [mg/L]	26-Oct-09	11:18	0.0004	0.0003	0.0012	0.0009	0.0004
Barium [mg/L]	26-Oct-09	11:18	0.0174	0.0093	0.0804	0.0286	0.0116
Beryllium [mg/L]	26-Oct-09	11:18	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	26-Oct-09	11:18	0.017	0.015	0.025	0.019	0.015
Calcium [mg/L]	26-Oct-09	11:18	32.4	16.9	149	54.8	20.3
Cadmium [mg/L]	26-Oct-09	11:18	0.000070	0.000019	0.000289	0.000144	0.000031
Chromium [mg/L]	26-Oct-09	11:18	0.002	0.002	0.011	0.004	0.001
Cobalt [mg/L]	26-Oct-09	11:18	0.000309	0.000129	0.00211	0.000901	0.000299
Copper [mg/L]	26-Oct-09	11:18	0.0074	0.0033	0.0395	0.0165	0.0053
Iron [mg/L]	26-Oct-09	11:18	0.38	0.12	2.38	0.91	0.33
Potassium [mg/L]	26-Oct-09	11:18	1.05	0.95	1.58	1.07	0.93
Magnesium [mg/L]	26-Oct-09	11:18	1.39	0.788	5.28	2.82	0.933
Manganese [mg/L]	26-Oct-09	11:18	0.0389	0.0128	0.255	0.122	0.0353
Molybdenum [mg/L]	26-Oct-09	11:18	0.00023	0.00018	0.00078	0.00029	0.00013
Sodium [mg/L]	26-Oct-09	11:18	3.83	2.80	9.01	4.57	2.26
Nickel [mg/L]	26-Oct-09	11:18	0.0014	0.0007	0.0070	0.0029	0.0009
Lead [mg/L]	26-Oct-09	11:18	0.00485	0.00196	0.0398	0.0134	0.00375
Antimony [mg/L]	26-Oct-09	11:18	0.0006	0.0003	0.0023	0.0008	0.0003
Selenium [mg/L]	26-Oct-09	11:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	26-Oct-09	11:18	0.0685	0.0407	0.262	0.0990	0.0442
Titanium [mg/L]	26-Oct-09	11:18	0.0085	0.0034	0.0475	0.0295	0.0085
Thallium [mg/L]	26-Oct-09	11:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	26-Oct-09	11:18	0.000128	0.000076	0.000441	0.000281	0.000072
Vanadium [mg/L]	26-Oct-09	11:18	0.00126	0.00070	0.00529	0.00291	0.00129
Tungsten [mg/L]	26-Oct-09	11:18	0.00003	< 0.00003	0.00015	0.00006	< 0.00003
Zinc [mg/L]	26-Oct-09	11:18	0.037	0.014	0.234	0.086	0.026
Zirconium [mg/L]	26-Oct-09	11:18	0.00009	0.00004	0.00060	0.00024	0.00012

Page 1 of 2

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1
Lindsay, ON
K9V 4RI,

Phone: 705-328-2271
Fax:705-328-2286, excel, pdf

Monday, October 26, 2009

Date Rec. : 21 October 2009
LR Report: **CA12403-OCT09**
Reference: Po # 6077 Project HM

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A1	7: A2	8: A3	9: A4	10: A5
Sample Date & Time			15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09
Temperature Upon Receipt [°C]	---	---	10.0	10.0	10.0	10.0	10.0
Tot. Suspended Solids [mg/L]	23-Oct-09	08:38	82	31	782	256	90
Hardness [mg/L as CaCO3]	26-Oct-09	11:18	86.7	45.6	393	148	54.6
Silver [mg/L]	26-Oct-09	11:18	0.00002	0.00001	0.00006	0.00003	< 0.00001
Aluminum [mg/L]	26-Oct-09	11:18	0.205	0.0854	1.30	0.674	0.244
Arsenic [mg/L]	26-Oct-09	11:18	0.0004	0.0003	0.0012	0.0009	0.0004
Barium [mg/L]	26-Oct-09	11:18	0.0174	0.0093	0.0804	0.0286	0.0116
Beryllium [mg/L]	26-Oct-09	11:18	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	26-Oct-09	11:18	0.017	0.015	0.025	0.019	0.015
Calcium [mg/L]	26-Oct-09	11:18	32.4	16.9	149	54.8	20.3
Cadmium [mg/L]	26-Oct-09	11:18	0.000070	0.000019	0.000289	0.000144	0.000031
Chromium [mg/L]	26-Oct-09	11:18	0.002	0.002	0.011	0.004	0.001
Cobalt [mg/L]	26-Oct-09	11:18	0.000309	0.000129	0.00211	0.000901	0.000299
Copper [mg/L]	26-Oct-09	11:18	0.0074	0.0033	0.0395	0.0165	0.0053
Iron [mg/L]	26-Oct-09	11:18	0.38	0.12	2.38	0.91	0.33
Potassium [mg/L]	26-Oct-09	11:18	1.05	0.95	1.58	1.07	0.93
Magnesium [mg/L]	26-Oct-09	11:18	1.39	0.788	5.28	2.82	0.933
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Sodium [mg/L]	26-Oct-09	11:18	3.83	2.80	9.01	4.57	2.26
Nickel [mg/L]	26-Oct-09	11:18	0.0014	0.0007	0.0070	0.0029	0.0009
Lead [mg/L]	26-Oct-09	11:18	0.00485	0.00196	0.0398	0.0134	0.00375
Antimony [mg/L]	26-Oct-09	11:18	0.0006	0.0003	0.0023	0.0008	0.0003
Selenium [mg/L]	26-Oct-09	11:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	26-Oct-09	11:18	0.0685	0.0407	0.262	0.0990	0.0442
Titanium [mg/L]	26-Oct-09	11:18	0.0085	0.0034	0.0475	0.0295	0.0085
Thallium [mg/L]	26-Oct-09	11:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	26-Oct-09	11:18	0.000128	0.000076	0.000441	0.000281	0.000072
Vanadium [mg/L]	26-Oct-09	11:18	0.00126	0.00070	0.00529	0.00291	0.00129
Tungsten [mg/L]	26-Oct-09	11:18	0.00003	< 0.00003	0.00015	0.00006	< 0.00003
Zinc [mg/L]	26-Oct-09	11:18	0.037	0.014	0.234	0.086	0.026
Zirconium [mg/L]	26-Oct-09	11:18	0.00009	0.00004	0.00060	0.00024	0.00012

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: C13122 REPORT No. B09-32825

Report To:

Kawartha Conservation
277 Kenrei Road
Lindsay, Ontario, K9V 4R1
Attention: Alexander Shulyarenko

Caduceon Environmental Laboratories
160 Charlotte St. Suite 206
Peterborough, Ontario, K9J 2T8
Tel: 705-748-1506
Fax: 705-748-6514

DATE RECEIVED: 20-Oct-09
DATE REPORTED: 30-Oct-09
SAMPLE MATRIX: Surface Water

JOB/PROJECT NO.: LSEMP
P.O. NUMBER: 6008
WATERWORKS NO.

	Parameter:		Nitrite (N)	Nitrate (N)	Ammonia (N)-Total	Total Kjeldahl Nitrogen	Phosphorus-Total
	Units:		mg/L	mg/L	mg/L	mg/L	mg/L
	M.D.L.:		0.002	0.02	0.01	0.05	0.002
	Reference Method:		SM 4500	SM 4500	EPA 350.2	EPA 351.2	EPA 365.4
	Date/Site Analyzed:		24-Oct-09/P	23-Oct-09/P	23-Oct-09/O	28-Oct-09/O	28-Oct-09/O
Client I.D.	**Sample I.D.**	**Date Collected**					
A1	B09-32825-1	15-Oct-09	0.004	0.64	< 0.01	0.34	0.093
A2	B09-32825-2	15-Oct-09	0.007	0.68	< 0.01	0.12	0.041
A3	B09-32825-3	15-Oct-09	0.006	0.44	0.01	2.33	0.617
A4	B09-32825-4	15-Oct-09	0.007	0.72	< 0.01	1.28	0.262
A5	B09-32825-5	15-Oct-09	0.005	0.20	< 0.01	0.24	0.072

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,P-Peterborough,M-Moncton

Christine Wright
Lab Supervisor

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

SGS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : ORMCP

Kawartha Conservation
Attn : Alexander Shulyaenko ashulyarenko@kawarthaconservation.com

277 Kenrei Rd., RR #1, Lindsay
, K9V 4RI
Phone: 705-328-2271, Fax:705-328-2286, excel, pdf

Tuesday, December 01, 2009

Date Rec. : 24 November 2009
LR Report: **CA10200-NOV09**
Reference: 6081

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	6: A1	7: A2	8: A3	9: A4	10: A11
Sample Date & Time			20-Nov-09	20-Nov-09	20-Nov-09	20-Nov-09	20-Nov-09
Temperature Upon Receipt [°C]	---	---	4.0	4.0	4.0	4.0	4.0
Tot. Suspended Solids [mg/L]	27-Nov-09	10:47	178	132	93	46	206
Hardness [mg/L as CaCO3]	27-Nov-09	10:05	135	93.9	67.8	54.1	143
Silver [mg/L]	01-Dec-09	13:10	0.00003	0.00002	0.00002	< 0.00001	0.00004
Aluminum [mg/L]	01-Dec-09	13:10	2.08	1.69	1.61	0.703	2.50
Arsenic [mg/L]	01-Dec-09	13:10	0.0013	0.0012	0.0007	0.0005	0.0009
Barium [mg/L]	27-Nov-09	10:05	0.0404	0.0291	0.0239	0.0176	0.0389
Beryllium [mg/L]	27-Nov-09	10:05	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Boron [mg/L]	27-Nov-09	10:05	0.012	< 0.002	< 0.002	< 0.002	< 0.002
Calcium [mg/L]	27-Nov-09	10:05	49.4	34.6	24.6	19.6	53.0
Cadmium [mg/L]	01-Dec-09	13:10	0.00153	0.000096	0.000064	0.000052	0.000138
Chromium [mg/L]	27-Nov-09	10:05	0.006	0.004	0.003	< 0.001	0.006
Cobalt [mg/L]	01-Dec-09	13:10	0.00148	0.00136	0.000932	0.000571	0.00167
Copper [mg/L]	01-Dec-09	13:10	0.0161	0.0110	0.0074	0.0058	0.0167
Iron [mg/L]	27-Nov-09	10:05	2.99	2.24	2.00	0.83	3.40
Potassium [mg/L]	27-Nov-09	10:05	1.78	1.39	1.24	1.00	2.39
Magnesium [mg/L]	27-Nov-09	10:05	2.74	1.84	1.56	1.22	2.58
Manganese [mg/L]	01-Dec-09	13:10	0.116	0.0894	0.0700	0.0470	0.132
Molybdenum [mg/L]	01-Dec-09	13:10	0.00045	0.00026	0.00021	0.00014	0.00030
Sodium [mg/L]	27-Nov-09	10:05	11.4	7.15	4.81	5.61	2.50
Nickel [mg/L]	01-Dec-09	13:10	0.0056	0.0041	0.0036	0.0023	0.0053
Lead [mg/L]	01-Dec-09	13:10	0.0140	0.00969	0.00761	0.00499	0.0143
Antimony [mg/L]	01-Dec-09	13:10	0.0010	0.0006	0.0005	0.0003	0.0007
Selenium [mg/L]	01-Dec-09	13:10	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Strontium [mg/L]	27-Nov-09	10:05	0.100	0.0684	0.0515	0.0434	0.102
Titanium [mg/L]	01-Dec-09	13:10	0.0741	0.0573	0.0546	0.0218	0.0878
Thallium [mg/L]	01-Dec-09	13:10	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Dec-09	13:10	0.000257	0.000179	0.000156	0.000138	0.000243
Vanadium [mg/L]	01-Dec-09	13:10	0.00520	0.00409	0.00365	0.00196	0.00579

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: C13118 **REPORT No. B09-37951**

Report To:
Kawartha Conservation
277 Kenrei Road
Lindsay, Ontario, K9V 4R1
Attention: Alexander Shulyarenko

Caduceon Environmental Laboratories
160 Charlotte St. Suite 206
Peterborough, Ontario, K9J 2T8
Tel: 705-748-1506
Fax: 705-748-6514

DATE RECEIVED: 08-Dec-09
DATE REPORTED: 11-Dec-09
SAMPLE MATRIX: Surface Water

JOB/PROJECT NO.: LSEMP
P.O. NUMBER: 6008
WATERWORKS NO.

	Parameter:		Nitrite (N)	Nitrate (N)	Ammonia (N)-Total	Total Kjeldahl Nitrogen	Phosphorus-Total
	Units:		mg/L	mg/L	mg/L	mg/L	mg/L
	M.D.L.:		0.002	0.02	0.01	0.05	0.002
	Reference Method:		SM 4500	SM 4500	EPA 350.2	EPA 351.2	EPA 365.4
	Date/Site Analyzed:		09-Dec-09/P	09-Dec-09/P	10-Dec-09/O	10-Dec-09/O	10-Dec-09/O
Client I.D.	**Sample I.D.**	**Date Collected**					
A 1	B09-37951-1	04-Dec-09	0.013	0.65	< 0.01	1.18	0.608
A 2	B09-37951-2	04-Dec-09	0.010	0.52	< 0.01	1.21	0.373
A 3	B09-37951-3	04-Dec-09	0.041	3.3	0.55	2.19	0.380
A 4	B09-37951-4	04-Dec-09	0.021	1.80	0.55	1.79	0.269
A 5	B09-37951-5	04-Dec-09	0.016	0.68	0.43	1.25	0.216

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,P-Peterborough,M-Moncton

Christine Wright
Lab Supervisor

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

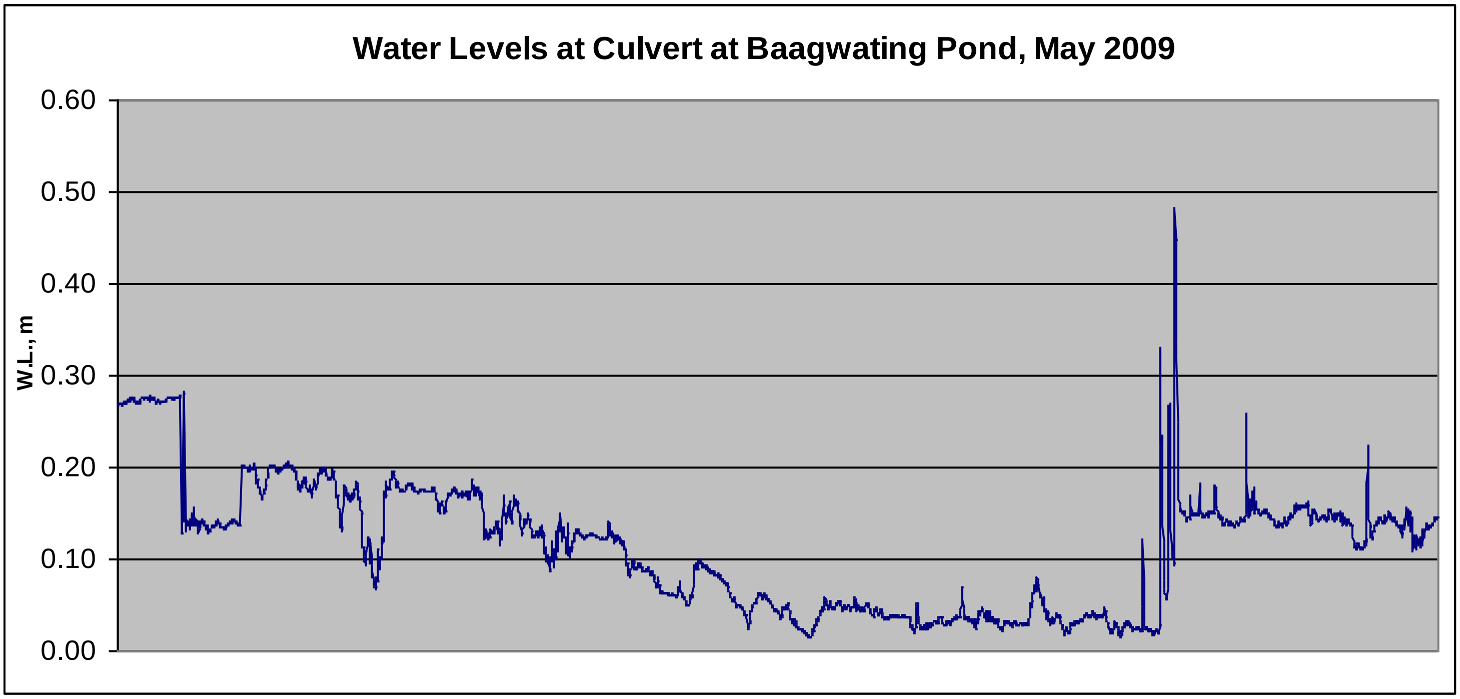
Page 1 of 2.

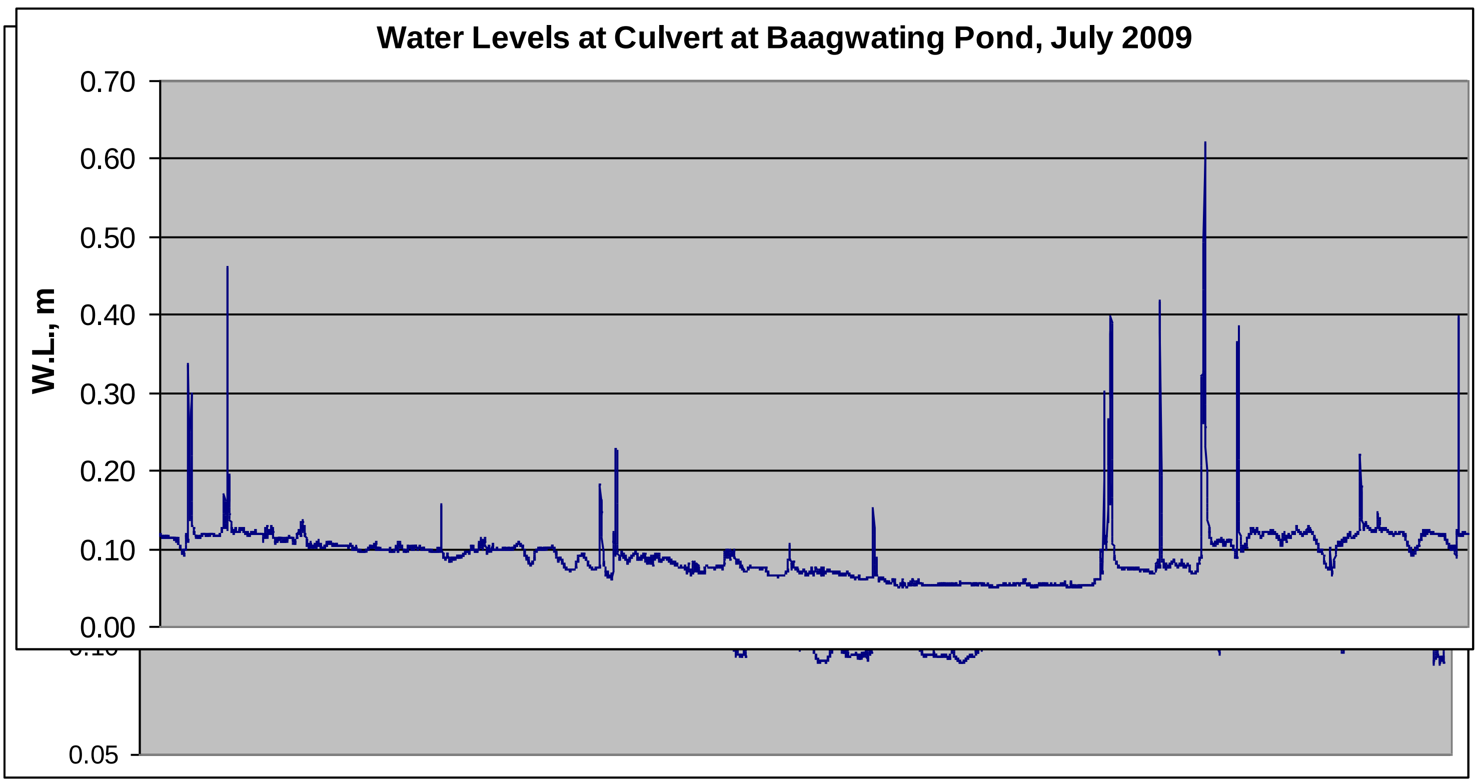
SGS Lakefield Research

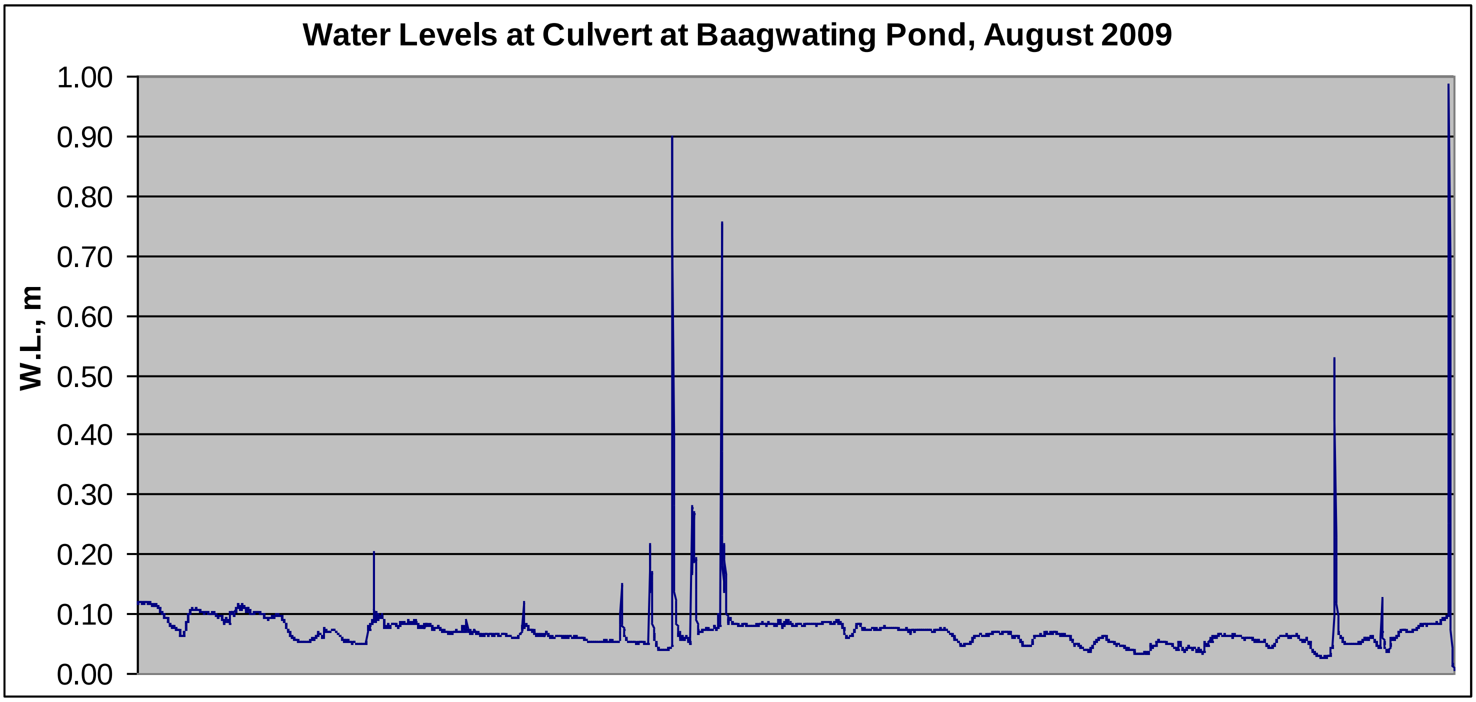
Report No.	**CA10116-DEC09**
Customer	**Kawartha Conservation**
Attention	**Alexander Shulyarenko**
Reference	**PO#6081 Project:HM**
Works#	
Title	**Final Report**

Sample ID		Analysis	A1	A2	A3	A4	A5
Sample Date/Time		Date	25-Nov-09	25-Nov-09	29-Nov-09	29-Nov-09	29-Nov-09
Analysis	**Units**						
Temperature Upon	Receipt °C	---	1.0	1.0	1.0	1.0	1.0
TSS	mg/L	10-Dec-09	452	288	399	236	168
Hardness	mg/L as CaCO3	11-Dec-09	377	182	319	164	125
Ag	mg/L	10-Dec-09	0.00042	0.00033	0.00040	0.00016	0.00014
Al	mg/L	10-Dec-09	7.98	5.09	4.12	3.18	2.57
As	mg/L	10-Dec-09	0.0049	0.0031	0.0010	0.0020	0.0037
Ba	mg/L	11-Dec-09	0.111	0.0619	0.0827	0.0440	0.0355
Be	mg/L	11-Dec-09	0.0002	0.0001	0.0001	0.0001	< 0.0001
B	mg/L	11-Dec-09	0.016	0.004	0.014	0.002	< 0.002
Ca	mg/L	11-Dec-09	138	67.1	115	60.0	46.0
Cd	mg/L	10-Dec-09	0.000452	0.000336	0.000310	0.000226	0.000194
Cr	mg/L	11-Dec-09	0.022	0.013	0.013	0.009	0.007
Co	mg/L	10-Dec-09	0.00441	0.00269	0.00248	0.00175	0.00143
Cu	mg/L	10-Dec-09	0.0386	0.0200	0.0274	0.0183	0.0131
Fe	mg/L	11-Dec-09	9.02	5.06	5.34	3.36	2.63
K	mg/L	11-Dec-09	3.45	2.34	2.75	1.96	1.73
Mg	mg/L	11-Dec-09	7.83	3.55	7.95	3.37	2.46
Mn	mg/L	10-Dec-09	0.318	0.178	0.207	0.133	0.106
Mo	mg/L	10-Dec-09	0.00109	0.00062	0.00109	0.00070	0.00047
Na	mg/L	11-Dec-09	16.5	8.45	29.3	9.90	7.59
Ni	mg/L	10-Dec-09	0.0116	0.0059	0.0061	0.0041	0.0031
Pb	mg/L	10-Dec-09	0.0401	0.0197	0.0221	0.0150	0.0110
Sb	mg/L	10-Dec-09	0.0016	0.0007	0.0017	0.0009	0.0004
Se	mg/L	10-Dec-09	0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sr	mg/L	11-Dec-09	0.246	0.121	0.228	0.115	0.0887
Ti	mg/L	10-Dec-09	0.270	0.180	0.161	0.117	0.103
Tl	mg/L	10-Dec-09	0.0002	0.0002	< 0.0002	< 0.0002	< 0.0002
U	mg/L	10-Dec-09	0.000814	0.000456	0.00103	0.000374	0.000277
V	mg/L	10-Dec-09	0.0169	0.0107	0.00957	0.00719	0.00559
W	mg/L	10-Dec-09	0.00033	0.00019	0.00026	0.00024	0.00013
Zn	mg/L	10-Dec-09	0.230	0.116	0.155	0.099	0.074
Zr	mg/L	10-Dec-09	0.00179	0.00119	0.00093	0.00089	0.00076

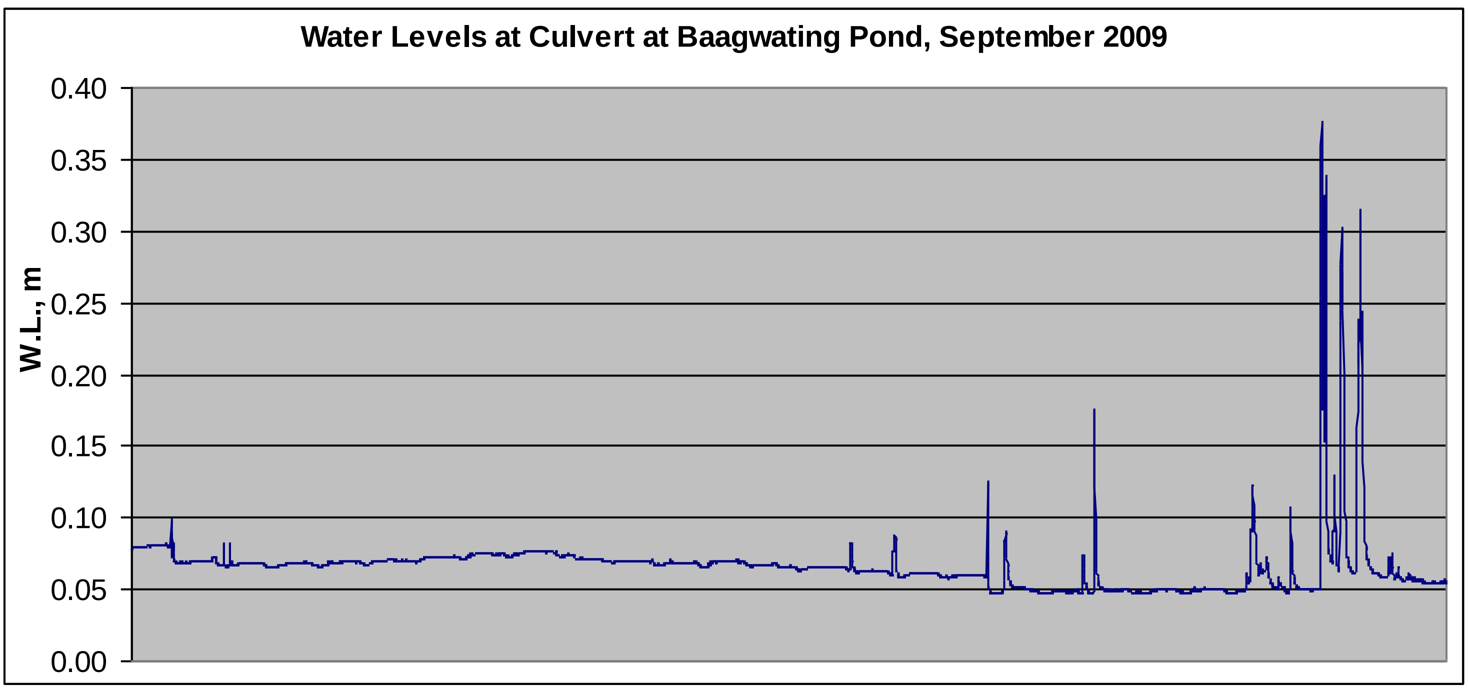
APPENDIX D. WATER LEVELS AT BAAGWATING POND



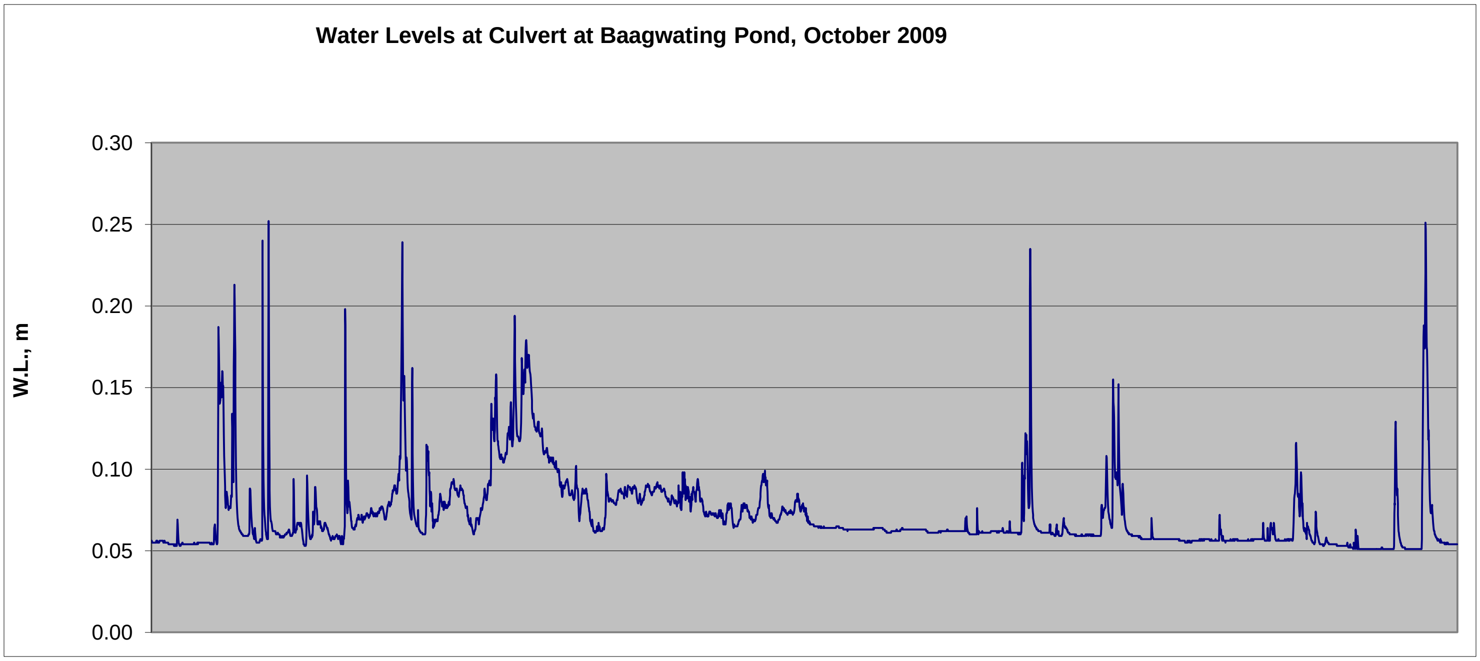




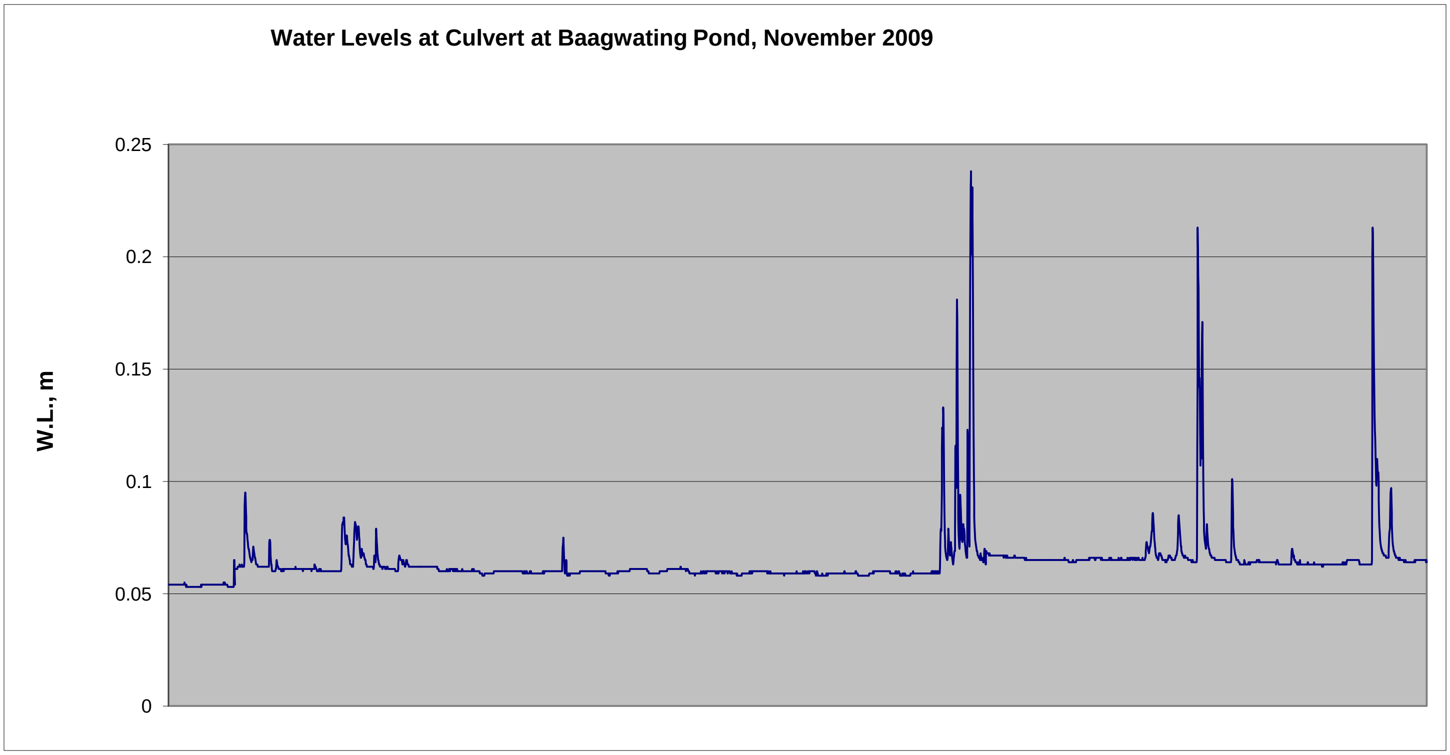
Water Levels at Culvert at Baagwating Pond, August 2009
W.L., m
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00



Water Levels at Culvert at Baagwating Pond, September 2009
W.L., m
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00



Water Levels at Culvert at Baagwating Pond, October 2009
W.L., m
0.30
0.25
0.20
0.15
0.10
0.05
0.00


Water Levels at Culvert at Baagwating Pond, November 2009
W.L., m
0.25
0.2
0.15
0.1
0.05
0

APPENDIX E. OPEN HOUSE QUESTIONNAIRE

Port Perry Stormwater Management Plan

Open House – Questionnaire

We appreciate your input!

Please answer the following questions by circling the appropriate answers or filling in the blanks.

1. How did you hear about this open house?

   Radio *Newspaper* *Website* *Email* *Other* ______________________________

2. What capital options do you feel are the best? (circle those that apply)

(OPTIONS)

Casimir Outlet	*1*	*2*	*3*	*4*	*5*
Queen Street	*1*	*2*	*3*		
John Street	*1*	*2*	*3*	*4*	
Perry Street	*1*	*2*	*3*	*4*	
Water Street	*1*	*2*			
North Street	*1*	*2*	*3*	*4*	

3. What additional options do you feel are the best? (circle those that apply)?

(OPTIONS)

By-laws	*1*	*2*	*3*
Engineering Design			
Standards	*1*	*2*	*3*
Municipal Operations			

1 2 3 4

4. Are there other options that should be considered that haven't been mentioned here?

____

____

5. Were your questions answered? *Yes No*

6. What is your overall rating of the open house? (1 for satisfactory to 5 for excellent)

   1 2 3 4 5

7. General comments and/or suggestions:

____

____

____

____

Thank You for Your Participation!

APPENDIX F. NEW TECHNOLOGIES

STORM DRAIN DEFENDER/CATCHBASIN INSERT

A catch basin insert is a temporary device that fits into a storm drain to effectively improve the water quality of our lakes and streams. Catch basin inserts can go into many sizes of catch basins that include a grate or curb inlet where storm water enters the catch basin and a sump captures sediment, debris and associated pollutants. They are also used in combined sewer watersheds to capture floatable and settle some solids.

Catch basins operate as precaution to reduce the amount of pollutants that enter the water way. The storm drain defender catch basin insert shown below is constructed of 8 ounce geotextile fabric that is held in place under the basin grate utilizing a simple wire frame. The wire frame is adjustable to expand or reduce to fit a wide variety of sizes. Rectangular and round models are available. Regular maintenance is required to preserve the quality and effectiveness of the catch basin insert. The catch basin insert used properly and maintained will drastically reduce the amount of pollutants that enter the storm water system including sediment, oil, heavy metals, trash and debris. Price ranges from $51 to $59. The wire frame allows for easy installation and removal.

(Http://www.spill-kit.com)

RAINWATER HARVESTING

Rain Barrel Features:

- Childproof safety wheel
- Debris/bug screen
- Hose attachments plus a hose clip
- Overflow valve and tube
- Aesthetically pleasing green, plastic design
- 200 litre capacity
- Interconnect capability

Why harvest Rainwater:

- Decrease the volume of potable water used for irrigation
- Decrease the burden on Port Perry's stormwater sewer
- Recharge groundwater
- Help reduce flooding and storm sewer discharges

Chartwell School, Monterey, CA

Size: 5,000 gallons

Primary use: toilet flushing overflow/bypass line feeds the irrigation system

Photos: courtesy of Sherwood Design Engineers

Cesar Chavez Elementary School

DaVinci Water Garden Outdoor Learning Lab

PERMEABLE PAVEMENTS

Port Perry has soils with good to excellent drainage. 88% of urban area soils in fall within the hydrologic soil group of A and B which have moderate to high infiltration rates and are suitable for pervious pavements. These pavements can substantially reduce the surface runoff quantities in the stormwater sewer system and improve the quality of stormwater discharge to Lake Scugog.

A variety of product alternatives to traditional paving exist that allow for the infiltration of stormwater. Certain products are more applicable in certain settings; therefore, each paving type contains information regarding the best use of the product. Limitations are also highlighted.

The following is from: http://nemo.uconn.edu/tools/stormwater/pavements.htm

Types of Permeable Pavements

Concrete Block Pavers

They add anywhere from 20% to 50% of open surface that would not have been there had an impermeable surface been used. They can also add aesthetic value to any area. These pavers are recommended for use in driveways, parking areas, shoulders along airstrips and highways, ditch liners, embankment stabilization, roadway medians, boat launching ramps, emergency access roads, fire lanes, sidewalks, grassed rooftops, pool decks and patios.

Concrete Grid Pavers

Concrete grid pavers are similar in composition to concrete block pavers, but the structure and pattern is different. The construction of the permeable base is the same. Driveways, parking areas, highway shoulders, ditch liners, embankment stabilization, roadway medians, boat launching ramps, emergency access roads, fire lanes, sidewalks, grassed rooftops, pool decks and patios.

Plastic Grid Pavers

Plastic grid pavers are made mainly out of recycled plastic materials that provide a high porous surface using grass or gravel to make the area more attractive. These pavers are also flexible, allowing them to be used on uneven sites. This system is environmentally friendly, it uses recycled plastic, reduces the imperviousness of the area, and therefore the volume of stormwater runoff.

They do not require curbs, catch basins, detention or retention ponds or any other associated drainage facility. Plastic grid pavers are competitively priced to asphalt and concrete paving, when their required drainage costs are factored in.

These pavers are recommended for use as sidewalks, parking areas, golf cart paths, residential driveways, fire lanes, emergency access roads and others that are product specific.

Best used in: overflow parking lots, sidewalks, shoulder parking, or other low-traffic areas

Pervious Asphalt

Pervious asphalt is fundamentally the same as regular asphalt, but it does not contain the fine particles that asphalt does. This creates porosity in the matrix, which allows water to flow through and infiltrate into the ground. As would be expected, the volume of stormwater runoff that flows off the pavement is greatly reduced, and the need for curbing, catch basins, and large detention facilities is reduced.

Pervious Concrete

Pervious concrete is a variation of traditional concrete. Similar to pervious asphalt, pervious concrete does not have the fine particles in the mix. The installation of this type of concrete is quite different from the traditional method, and requires experienced installers.

This surface is recommended for use in driveways, parking areas, shoulders along airstrips and highways, ditch liners, roadway medians, boat launching ramps, emergency access roads, fire lanes, sidewalks, and patios.

Design Considerations

Permeable pavements can be used in a wide variety of land use settings. However, areas that have high potential for contamination such as transfer stations, gas stations, or highly industrial areas may not be suitable for permeable pavements due to the increased risk of groundwater contamination. Research has shown that in most urban, suburban, and commercial areas, the use of permeable pavements will not increase the risk of groundwater contamination. The most successful installation of alternative pavements has been stated to be in coastal areas with sandy soils and flatter slopes.

- Native soils on the site should be conducive to infiltration, with an infiltration rate at least 0.3 inches/hour.
- <u>sandy or loamy sand in-situ soil</u> (Soils that contain significant levels of silt or clay or that are highly compressible, lack cohesion, or expand or contract with moisture may not be feasible for permeable pavers without the use of geotextiles to provide support. A detailed analysis of the soils and feasibility should be conducted when these conditions are encountered.)
- A properly designed and installed base is critical to a successful permeable pavement application. Most product manufacturers will provide specifications for the base and installation.
- Pervious pavements should not be used in areas with a slope > 15%, as erosion of the fill material may occur.
- The seasonal high water table should be at least 3 feet below grade.
- Pervious pavements should be installed at least 75 feet from drinking water wells.
- low traffic volume
- a seasonally high water table at least 3 to 4 feet from the surface (Water tables approaching the surface will prevent the water from exfiltrating and can cause structural damage to the system through freeze/frost and floatation processes.)
- minimal upstream disturbance (This will prevent clogging of the system, which can significantly shorten the pavers lifetime. Permeable pavers should not be used to treat runoff from large, sparsely vegetated upland areas or areas prone to wind erosion. Sediment control measures should also be carefully followed when upland construction activities take place, and for the longest system lifetime, active street sweeping programs should be employed in the contributing area.)

Load and Gravel Base

When designing the chosen site with permeable pavers, several calculations and considerations must be made. First, the load requirements over the site's expected lifetime must be determined based on the typical vehicle weight, the typical number of vehicle passes per day, and the design life. Most permeable pavement applications will have life spans ranging from 10 to 20 years, with a conservative design life of 10 years recommended as a general rule. The designer must ensure that over this lifetime, the permeable paver system is strong enough to support the applied traffic. Part of this ability will depend on the inherent strength of the actual paver chosen. Generally the design strength of grass and gravel pavers is listed near 5700 psi, interlocking concrete paving blocks are typically designed to meet a minimum of 8000 psi, and porous concrete supports from approximately 1800 to 2400 psi. The other component contributing to system support is the underlying soil strength. Highly permeable soils, such as sands and sandy loams, have the best ability to carry loads. Depending on the paver chosen and the underlying soils, the depth of the system's final gravel base can then be calculated in order to ensure that load requirements are met.

For example, in some locations, a gravel layer may not be needed at all for infrequent car and pick-up truck access, while a layer of approximately 4 to 6 inches depth may be required for infrequent fire truck access. For interlocking concrete paving blocks, certain manufacturers recommend a minimum base of 4 inches for pedestrian applications over well-drained soils and 8 to 10 inches for residential streets. In locations with numerous freeze-thaw cycles, weak soils or an extremely cold climate, a thicker base should be used. The stone and gravel base layer not only provides support but also acts as a storage reservoir to achieve extra detention and serves as a buffer from frost problems.

Infiltration and Water Release

Regional environmental factors, such as the amount and frequency of rainfall and the local soil's permeability, will determine the ability of the paver system to pass stormwater easily through its top layers and then store and release the water in a timely manner into the underlying soil. Whether or not runoff will be generated from the paver for a given storm will depend on the paver's ratio of open to impervious spaces, the storm's precipitation rate, the surface's slope, and the storage capacity in the base layer below. The depth of this storage layer is dictated by the structural considerations discussed above, while the void space in the layer is a function of the stone fill. The system should be designed to infiltrate the design storm and then complete release of the water within at least 48 hours (24 hours is recommended). If the in-situ soil does not allow for release within 48 hours, the site is not suitable for the use of permeable pavers. Possible modifications to the system, however, include the use of an overflow drainage pipe for low permeability subgrades and / or for storms exceeding the design storm. Systems can also be designed to drain water away from the pavement to more pervious layers that can accommodate the inflow, to storage areas that allow for slow infiltration, or to a pipe for discharge as filtered stormwater. In situations with a discharge pipe, infiltration does not occur, but the system is used to enhance storage, reduce peak runoff rates and filter pollutants.

BENEFITS OF PERMEABLE PAVERS

- Accommodates detention facility requirements.
- Qualifies for Credit 6 – LEED: Limits disruption of natural water flows by minimizing stormwater runoff, increases on-site infiltration, and reduces contaminants
- Qualifies for Credit 7 – LEED: Reduces heat island affect (light colored pavers).
- Long-term durability of paver units.
- Ease in repair.
- Low Impact Development
- Provides groundwater recharge.
- Controls erosion in streambeds and riverbanks.
- Facilitates pollutant removal.
- Reduces thermal [water] pollution.
- Eliminates standing water on pavement.

Permeable Paver Research Summary, Lake County Forest Preserves, February 2003

A. FREEZE-THAW

Porous pavement installations have withstood freeze-thaw conditions. (Keating, 2001) (Miller, 1997) (Gutowski, 2003) (Holland, 2003)

Porous pavement experiences less effects from frost heave than impermeable pavement. (Backstrom, 1987, 1999)

Safety – The pavement is actually safer in the winter because it does not accumulate icy buildup. Typical pavement puddles when snow melts, the puddles then freeze again – with permeable pavement, the periodic melt enters the pavement and is not able to refreeze on the surface. (Gutowski, 2003) (Backstrom, 1987)

The system is designed to flow the water through it – not to have the water stay for extended periods of time. It should be designed so that the water does not stay in the base longer than 12 hours* following the end of a weather cycle. (Smith, 2001)

Pavers are installed on a sand bed without mortar. They can expand and contract with the temperature without cracking or spalling. If unsettling occurs, the displaced pavers can be removed, the base leveled and then replaced.

B. LOW-PERMEABLE SOILS

The base is engineered to accommodate the water through depth and composition of gravel base, and drain tiles.

Permeable pavers are feasible in low permeable soils. (Knapton, et al. 2002)

C. HIGH-HEEL SHOES

The voids between the paving units are filled completely by the gravel material, preventing heels from entering the gaps. (UniLoc)

Proper filling and compaction is necessary to sustain optimum performance. (Bretschneider, 1994)

The parking lot can be designed to accommodate safe walking corridors. If a bisurface design were used, the primary walking surface would accommodate a variety of shoes.

D. MAINTENANCE – LIFE CYCLE COSTING

Savings occur from not having to place stormwater management structures on site or to use land for detention areas because the parking lot qualifies as detention.

Permeable pavement installations have experienced less need for repair than pervious pavements within the same installations. (Gutowski, 2003) (Holland, 2003)

E. COST COMPARISON SPECIFIC TO LAKE COUNTY FOREST PRESERVES

This is a very preliminary figure based upon conceptual designs; no engineering design has been completed to date:

40,000 SF - Uni-Lock Eco-Loc Pavers – 25 years

Total Life-cycle cost over 25 years: $190,200

40,000 SF - Asphalt Parking Lot - LCFP costs – 25 years

Total Life-cycle cost over 25 years: $275,875

F. LONG-TERM VIABILITY OF PAVERS

Tests have shown that if lost, permeability can be restored. (Dierkis et al, 2002) (James, 2001, 2002)

Tests and case studies have shown that pavement remains permeable over time. (Brattebo et al, 2002) (Dierkes et al, 2002) (Gutowski, 2003) (Holland, 2003) (Miller, 1997)

Permeable pavement has lasted as long as or longer than impermeable asphalt. (Gutowski, 2003) (Holland, 2003)

<u>CASE STUDIES</u>

A. Naval District Washington

Low Impact Development Projects"

Retrofit pilot project to restore and maintain the water quality of the Anacostia and Potomac Rivers and the Chesapeake Bay.

Retrofitted parking lot included: permeable pavers in the parking lanes, bioretention islands, sand filters, gutter strips.

B. Annsville Creek Paddlesport Center - New York State Parks Ken Allen, Landscape Architect NYS Office of Parks, Recreation and Historic Preservation

Governor of New York directly approved use of permeable pavers.

No puddling, ponding, or heaving through snow and rain.

The pavers were installed in November of 2001. No problems through the winters and pouring rains of spring. No heaving, no clogging, no ponding."

C. Morris Arboretum – University of Pennsylvania, Philadelphia Bob Gutowski, Director of Programs

Designed by Cahill Associates and Andropogon Associates, Inc.

The parking lot has lasted for 10 years.

Mr. Gutowski “advocates and promotes” the use of permeable pavement.

The parking lot does not heave and won’t heave if it is designed well.

Periodically the parking lot needs to be vacuumed (say after a leaf fall)

Maintenance is not a problem

They have patched the non-porous entry drive and have not needed to patch the porous pavement.

BIORETENTION

Bioretention at Evergreen Walk mall in South Windsor. For *details* ***about this project from the CT LID database,*** *visit* ***http://clear.uconn.edu/tools/lid/pdf/CT0012.pdf***

BIOSWALES

Bioswales can be used to manage and treat stormwater runoff from larger developments and parking lots. These bioswales are designed to filter pollutants, regulate flows and increase infiltration.

Overview
Bioswales go by many names—including vegetated swales, grassy swales, bioretention areas, and filter strips—and serve many functions depending on how they are engineered.

In their simplest forms, bioswales are linear rain gardens planted with native vegetation that receive and absorb stormwater runoff from impervious surfaces.

Bioswales are sometimes planted on a gentle slope so that runoff flows along the length of the swale, the vegetation slowing and filtering the water as it infiltrates the soil. Sloping bioswales may have check dams to help slow and detain the flow.

More complex bioswales (usually installed with underdrains and infiltration trenches) are used to manage and treat stormwater runoff from larger developments and parking lots. These bioswales are designed to filter pollutants, regulate flows, and increase infiltration.

Filtering Pollutants
Studies have found that properly designed and constructed bioswales are able to achieve excellent removal of heavy metals, total suspended solids, and oil/grease. Bioswales remove suspended solids through settling and filtration. Dissolved pollutants are removed and/or transformed as runoff infiltrates into the ground.

Retention and Infiltration
Bioswales can be used to temporarily store runoff water and increase infiltration. Resulting benefits can include:

- Reduces impervious runoff volumes and rates.
- Recharges groundwater and sustains stream base flows.
- Reduces detention needs.

Thermal Pollution
Bioswales can also reduce thermal pollution. Stormwater can rise in temperature as it washes across impervious surfaces, e.g. hot parking lots in summer. Heated stormwater flowing into streams can impact fish and other wildlife that depends on cold water streams to live and breed.

Heated runoff from impervious surfaces can be cooled as it filters through a bioswale. One study observed a temperature drop of 12°C between stormwater entering a bioswale and stormwater filtering out of the bioswale.

Other Benefits
Larger bioswales planted with native flowering perennials can be attractive landscaping features that provide food and shelter for birds and butterflies.

Cost Considerations

- Unit costs range from $3 to $10 per square foot depending on complexity of system and planting plan.
- Replaces storm sewers within parking lots.
- Reduces cost premium where parking islands are already required.
- Reduces detention volume and land area necessary for detention.

Combining Practices

Bioswales are often coupled with other watershed friendly landscaping practices like permeable hardscaping. See the green parking section of our permeable hardscaping web page. Also see the visit a bioswale near you section to learn about the bioswale/porous asphalt combination at the Ryerson Welcome Center in Deerfield, IL and the bioswale/permeable paving combination at the Morton Arboretum.

Adopt a Catch Basin

Catch basins are those semi-circular grids that you see at almost every street corner throughout the City. They are the entryway from our streets to our sewer system. Litter and leaves can clog the catch basins, which, during rainstorms, may result in neighborhood flooding.

Catch basins have grids to prevent large objects from falling into the sewer system. However, the bars are fairly widely spaced so that the flow of water is not blocked. Consequently, many objects fall through.

When catch basins get clogged with leaves and debris, water can no longer flow into sewers and can flood street intersections and homes. In addition, any debris that enters our sewer system puts added burden on our treatment facilities.

By cleaning our neighbourhoods or moving debris away from catch basin grates, we can keep our catch basins flowing freely.

Keep Me Clean & Clear

Keep Me Clean & Clear

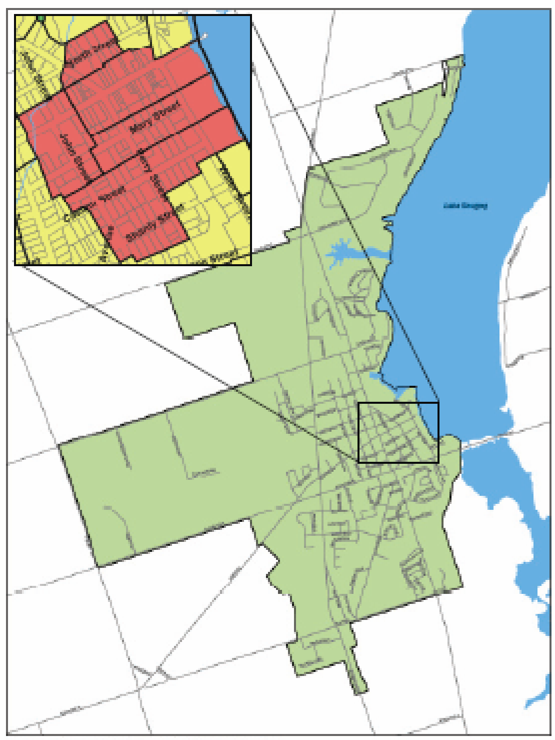
I Discharge into Lake Scugog

APPENDIX G. NOTICE OF COMMENCEMENT AND NOTICE OF PUBLIC OPEN HOUSE

NOTICE OF COMMENCEMENT

Port Perry Stormwater Management Plan

The Township of Scugog, Durham Region and Kawartha Region Conservation Authority (KRCA) are undertaking a study in accordance with the Schedule B requirements of the Municipal Class Environmental Assessment (EA), to develop a stormwater management plan for the Port Perry Urban Area. The plan will identify measures to mitigate the effects of stormwater runoff on Lake Scugog and surrounding water bodies. This will be achieved by recommending and developing best management practices and stormwater controls to be implemented in the entire Port Perry Urban Area, with a focus on the downtown core. The downtown study area, as shown, is generally bounded by North Street in the north to Shanly Street in the south and John Street in the west to Water Street in the east, including the waterfront park area. In this area, stormwater drains from commercial and residential lands directly into Lake Scugog and Cawkers Creek with limited, if any, quality or quantity controls.



PORT PERRY URBAN AREA

The recommendations generated by the Port Perry Stormwater Management Plan will focus on the following objectives as outlined in the Municipal Class EA:

- Improve the quality of effluent produced by the stormwater system;
- Improve treatment efficiency; and
- Control erosion and sedimentation.

Public consultation is a key component of this study and public open houses will occur on two occasions. Further advertisements will be posted when the meetings are scheduled. As part of the planning process, KRCA will be collecting comments and information from the public regarding this project, which will form part of the official record.

Please direct any comments, questions or requests for information to Kawartha Conservation:

Christie Peacock, P. Eng.
Kawartha Region Conservation Authority
277 Kenrei Road, Lindsay ON K9V 4R1
Phone: (705) 328-2271 ext. 234
www.kawarthaconservation.com

Celebrating 30 Years KAWARTHA CONSERVATION

DURHAM REGION

TOWNSHIP OF Scugog

NOTICE OF PUBLIC OPEN HOUSE

Port Perry Stormwater Management Plan

The Township of Scugog, Region of Durham and Kawartha Region Conservation Authority (KRCA) are undertaking a study in accordance with the schedule B requirements of the Municipal Class Environmental Assessment (EA), to develop a stormwater management plan for the Port Perry Urban Area. The plan will identify measures to mitigate the effects of stormwater runoff on Lake Scugog and surrounding water bodies. This will be achieved by recommending and developing best management practices and stormwater controls to be implemented in the entire Port Perry Urban Area, with a focus on the downtown core. The downtown study area, as shown, is generally bounded by North Street in the north to Shanly Street in the south and John Street in the west to Water Street in the east, including the waterfront park area. In this area, stormwater drains from commercial and residential lands directly into Lake Scugog and Williams Creek with limited, if any, quality or quantity controls.

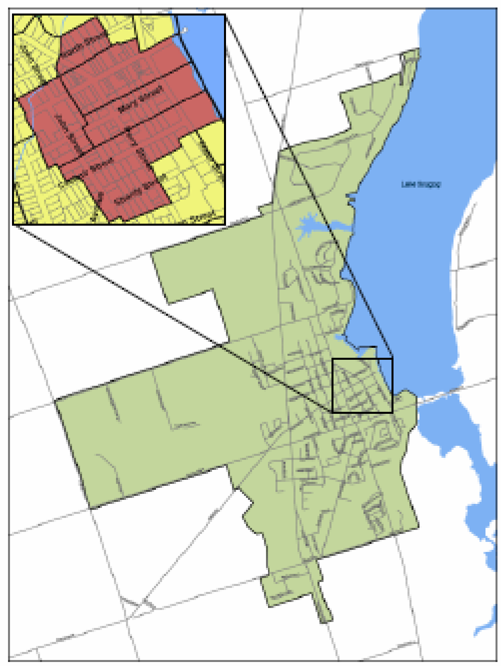
A public open house is scheduled to provide further information to the public on the plan and to receive input and comment from interested persons:

Open House:

Time: 3:00 pm to 8:00 pm
Date: Thursday, December 10th, 2009
Location: Scugog Community Recreation Centre, 1655 Reach Street, Port Perry, Ontario

Please direct any comments, questions or requests for information to Kawartha Conservation:

Christie Peacock, P.Eng.
Kawartha Region Conservation Authority
277 Kenrei Road,
Lindsay ON K9V 4R1
Phone: 905.885.8173 ext. 248
www.kawarthaconservation.com



PORT PERRY URBAN AREA

This Notice issued November 17, 2009

KAWARTHA CONSERVATION

DURHAM REGION

TOWNSHIP OF Scugog

NOTICE OF PUBLIC OPEN HOUSE

Port Perry Stormwater Management Plan

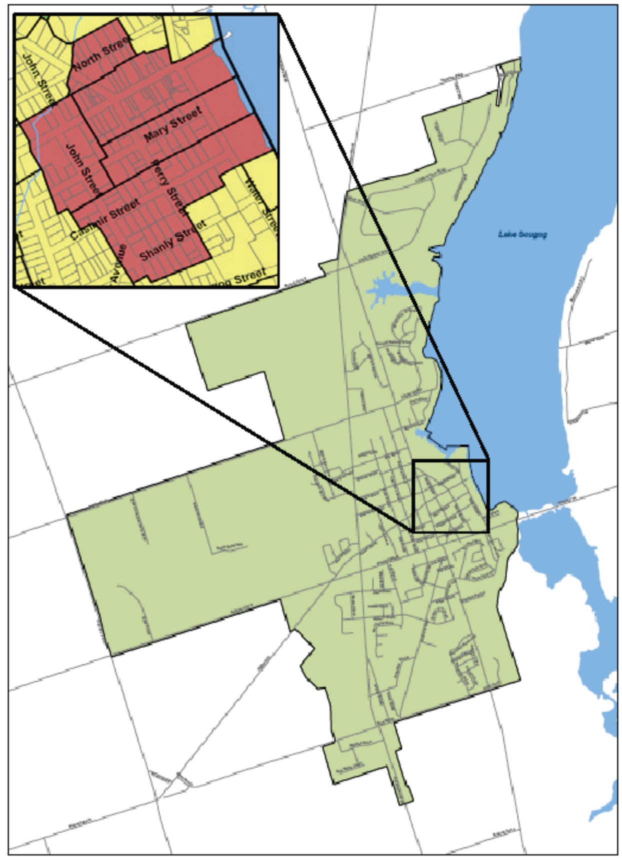
Open House

Weds, Dec. 12, from 3 to 7 p.m.

Scugog Council Chambers
181 Perry Street, Port Perry

The Township of Scugog, Region of Durham, and Kawartha Region Conservation Authority (Kawartha Conservation) have undertaken a study in accordance with the Schedule B requirements of the Municipal Class Environmental Assessment (EA), to develop a stormwater management plan for the Port Perry Urban Area. The plan identifies measures to mitigate the effects of stormwater runoff on Lake Scugog and surrounding water bodies. This is achieved by recommending and developing best management practices and stormwater controls to be implemented in the entire Port Perry Urban Area, with a focus on the downtown core. The downtown study area, as shown, is generally bounded by North Street in the north to Shanly Street in the south, and John Street in the west to Water Street in the east, including the waterfront park area. In this area, stormwater drains from commercial and residential lands directly into Lake Scugog and Williams Creek with few, if any, quality or quantity controls.

A public open house is scheduled to provide the final recommended solution identified in the plan to the public and to receive input and comment from interested persons.



PORT PERRY URBAN AREA

DURHAM REGION

KAWARTHA CONSERVATION

TOWNSHIP OF Scugog

www.kawarthaconservation.com

Notice issued Nov. 8, 2012

Please direct any comments, questions, or requests for information to:

Saleem Sial, P.Eng., Kawartha Conservation
705.328.2271 ext. 232
ssial@kawarthaconservation.com

Ian Roger, P. Eng., Township of Scugog
905.985.7346 ext. 149
iroger@scugog.ca

APPENDIX H: VO_2 MODELING RESULTS

Outlet 11-Casimir Street Results

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{\rtf1\ansi\deff0{\fonttbl{\f0\fnil\fcharset0 Courier New;}}
\viewkind4\uc1\pard\lang1033\f0\fs17
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\par        V     V    I     SSSSS  U    U     A     L
\par        V     V    I     SS     U    U    A A    L
\par         V   V     I      SS    U    U   AAAAA   L
\par         V   V     I       SS   U    U   A   A   L
\par          VV       I     SSSSS  UUUUU   A   A   LLLLL
\par
\par         OOO    TTTTT  TTTTT  H    H   Y    Y  M    M   OOO     TM, Version 2.0
\par        O    O    T      T    H    H    Y Y   MM MM  O    O
\par        O    O    T      T    H    H     Y    M    M  O    O   Licensed To: KRCA
\par         OOO      T      T    H    H     Y    M    M   OOO                    VO2275000L1UN
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\par All rights reserved.
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\par                        *****  D E T A I L E D   O U T P U T *****
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\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
11\\Outlet 11 Existing.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
11\\Outlet 11 Existing.sum
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\par
\par DATE: 11/17/2009                           TIME: 9:22:02 AM
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\par USER:
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\par COMMENTS: ____________________________________________________________
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\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
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\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWM
\par |                  |              P\\Casamir\\Casamir\\Quality.stm
\par | Ptotal= 24.98 mm |    Comments: Quality Event
\par --------------------
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\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .11    3.15 |   .67   26.35 |  1.22    8.56 |  1.78    3.60
\par                   .22    3.60 |   .78   89.64 |  1.33    5.85 |  1.89    3.38
\par                   .33    4.28 |   .89   22.07 |  1.45    5.18 |  2.00    3.15
\par                   .44    6.08 |  1.00   12.61 |  1.56    4.73 |
\par                   .56    9.23 |  1.11    9.23 |  1.67    4.05 |
\par
\par -------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB              |
\par | STANDHYD  (0001) |   Area    (ha)=   9.43
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  63.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=       5.94         3.49
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     250.70        40.00
\par      Mannings n           =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083    3.15 |  .583   14.88 | 1.083    9.25 |  1.58    4.51
\par                  .167    3.45 |  .667   26.35 | 1.167    8.79 |  1.67    4.05
\par                  .250    3.83 |  .750   89.39 | 1.250    7.68 |  1.75    3.60
\par                  .333    4.28 |  .833   44.91 | 1.333    5.85 |  1.83    3.46
\par                  .417    6.08 |  .917   18.97 | 1.417    5.19 |  1.92    3.31
\par                  .500    8.17 | 1.000   12.61 | 1.500    4.88 |  2.00    3.15
\par
\par      Max.Eff.Inten.(mm/hr)=      89.39         8.64
\par                 over (min)        5.00        25.00
\par      Storage Coeff.  (min)=       4.64 (ii)   23.43 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        25.00
\par      Unit Hyd. peak  (cms)=        .22          .05
\par                                                             *TOTALS*
\par      PEAK FLOW       (cms)=        .87          .04            .872 (iii)
\par      TIME TO PEAK    (hrs)=        .75         1.17             .75
\par      RUNOFF VOLUME    (mm)=      23.98         3.70           13.84
\par      TOTAL RAINFALL   (mm)=      24.98        24.98           24.98
\par      RUNOFF COEFFICIENT   =        .96          .15             .55
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   2 **
\par   ****************************
\par
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\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\
\par |                  |              PPSWMP\\4hr-25mm.STM
\par | Ptotal= 25.00 mm |    Comments: 25mm/4hr
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .17     .00 |  1.33   12.90 |  2.50    3.30 |  3.67    1.80
\par                   .33    1.65 |  1.50   56.10 |  2.67    2.85 |  3.83    1.50
\par                   .50    1.95 |  1.67   16.95 |  2.83    2.55 |  4.00    1.50
\par                   .67    2.10 |  1.83    8.85 |  3.00    2.25 |  4.17    1.50
\par                   .83    2.70 |  2.00    6.15 |  3.17    2.10 |
\par                  1.00    3.60 |  2.17    4.65 |  3.33    1.95 |
\par                  1.17    5.40 |  2.33    3.90 |  3.50    1.80 |
\par
\par --------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB            |
\par | STANDHYD  (0001) |   Area    (ha)=   9.43
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  63.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=       5.94         3.49
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     250.70        40.00
\par      Mannings n           =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083     .00 | 1.167    5.40 | 2.250    3.90 |  3.33    1.95
\par                  .167     .00 | 1.250   12.90 | 2.333    3.90 |  3.42    1.80
\par                  .250    1.65 | 1.333   12.90 | 2.417    3.30 |  3.50    1.80
\par                  .333    1.65 | 1.417   56.10 | 2.500    3.30 |  3.58    1.80
\par                  .417    1.95 | 1.500   56.10 | 2.583    2.85 |  3.67    1.80
\par                  .500    1.95 | 1.583   16.95 | 2.667    2.85 |  3.75    1.50
\par                  .583    2.10 | 1.667   16.95 | 2.750    2.55 |  3.83    1.50
\par                  .667    2.10 | 1.750    8.85 | 2.833    2.55 |  3.92    1.50
\par                  .750    2.70 | 1.833    8.85 | 2.917    2.25 |  4.00    1.50
\par                  .833    2.70 | 1.917    6.15 | 3.000    2.25 |  4.08    1.50
\par                  .917    3.60 | 2.000    6.15 | 3.083    2.10 |  4.17    1.50
\par                 1.000    3.60 | 2.083    4.65 | 3.167    2.10 |
\par                 1.083    5.40 | 2.167    4.65 | 3.250    1.95 |
\par
\par      Max.Eff.Inten.(mm/hr)=      56.10         5.66
\par                 over (min)       5.00        30.00
\par      Storage Coeff.  (min)=       5.59 (ii)    27.86 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        30.00
\par      Unit Hyd. peak  (cms)=        .20          .04
\par                                                             *TOTALS*
\par      PEAK FLOW       (cms)=        .64          .03           .642 (iii)
\par      TIME TO PEAK    (hrs)=       1.50         2.00           1.50
\par      RUNOFF VOLUME    (mm)=      24.00         3.70          13.85
```

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\par      TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
\par      RUNOFF COEFFICIENT   =        .96          .15            .55
\par
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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\par  FINISH
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Outlet 16 Results

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\viewkind4\uc1\pard\lang1033\f0\fs17
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\par
\par        V    V   I    SSSSS  U   U    A    L
\par        V    V   I    SS     U   U   A A   L
\par         V  V    I     SS    U   U  AAAAA  L
\par         V  V    I      SS   U   U  A   A  L
\par          VV     I    SSSSS  UUUUU  A   A  LLLLL
\par
\par         OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
\par        O   O    T      T    H   H   Y Y   MM MM  O   O
\par        O   O    T      T    H   H    Y    M   M  O   O   Licensed To: KRCA
\par         OOO     T      T    H   H    Y    M   M   OOO                 VO2275000L1UN
\par
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\par All rights reserved.
\par
\par
\par                       *****  D E T A I L E D   O U T P U T *****
\par
\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet 16\\Auto
Sampler.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet 16\\Auto
Sampler.sum
\par
\par
\par DATE: 12/14/2009                                TIME: 9:54:44 AM
\par
\par USER:
\par
\par
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\par COMMENTS: ____________________________________________________________
\par
\par
\par ------------------------------------------------------------------------------------------
-----------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\
\par |                  |              PPSWMP\\4hr-39.7mm.STM
\par | Ptotal= 39.71 mm |    Comments: 4 hour 39.7mm
\par --------------------
\par                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .16     .00 |  1.28   21.30 |  2.40    5.50 |  3.52    3.00
\par                  .32    2.70 |  1.44   92.80 |  2.56    4.70 |  3.68    2.50
```

```
\par                  .48    3.20 |  1.60   28.00 |  2.72    4.20 |  3.84    2.50
\par                  .64    3.50 |  1.76   14.60 |  2.88    3.70 |  4.00    2.50
\par                  .80    4.50 |  1.92   10.20 |  3.04    3.50 |
\par                  .96    6.00 |  2.08    7.70 |  3.20    3.20 |
\par                 1.12    8.90 |  2.24    6.50 |  3.36    3.00 |
\par
\par -------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB              |
\par | STANDHYD  (0001) |   Area    (ha)=  18.86
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  53.00   Dir. Conn.(%)=  35.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=      10.00         8.86
\par      Dep. Storage     (mm)=       1.00         1.50
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     354.60        40.00
\par      Mannings n          =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                               ---- TRANSFORMED HYETOGRAPH ----
\par                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                 .083     .00 | 1.083    8.90 | 2.083    7.65 |  3.08    3.34
\par                 .167     .22 | 1.167   15.84 | 2.167    6.50 |  3.17    3.20
\par                 .250    2.70 | 1.250   21.30 | 2.250    6.38 |  3.25    3.08
\par                 .333    2.78 | 1.333   67.06 | 2.333    5.50 |  3.33    3.00
\par                 .417    3.20 | 1.417   92.80 | 2.417    5.34 |  3.42    3.00
\par                 .500    3.27 | 1.500   46.14 | 2.500    4.70 |  3.50    3.00
\par                 .583    3.50 | 1.583   28.00 | 2.583    4.56 |  3.58    2.62
\par                 .667    3.82 | 1.667   17.28 | 2.667    4.20 |  3.67    2.50
\par                 .750    4.50 | 1.750   14.60 | 2.750    4.02 |  3.75    2.50
\par                 .833    5.10 | 1.833   10.73 | 2.833    3.70 |  3.83    2.50
\par                 .917    6.00 | 1.917   10.20 | 2.917    3.61 |  3.92    2.50
\par                1.000    7.39 | 2.000    7.80 | 3.000    3.50 |  4.00    2.50
\par
\par      Max.Eff.Inten.(mm/hr)=      92.80        55.29
\par                 over (min)        5.00        15.00
\par      Storage Coeff.  (min)=       5.63 (ii)   14.57 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        15.00
\par      Unit Hyd. peak  (cms)=        .20          .08
\par                                                          *TOTALS*
\par      PEAK FLOW       (cms)=       1.35          .76          1.686 (iii)
\par      TIME TO PEAK    (hrs)=       1.42         1.58           1.42
\par      RUNOFF VOLUME    (mm)=      38.71        21.00          27.20
\par      TOTAL RAINFALL   (mm)=      39.71        39.71          39.71
\par      RUNOFF COEFFICIENT   =        .97          .53            .68
\par
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  85.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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\par  FINISH
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Outlet 17 – Queen Street Results

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{\rtf1\ansi\deff0{\fonttbl{\f0\fnil\fcharset0 Courier New;}}
\viewkind4\uc1\pard\lang1033\f0\fs17
==========================================================================================
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\par
\par       V    V   I    SSSSS  U   U    A    L
\par       V    V   I    SS     U   U   A A   L
\par        V  V    I     SS    U   U  AAAAA  L
\par        V  V    I      SS   U   U  A   A  L
\par         VV     I    SSSSS  UUUUU  A   A  LLLLL
\par
\par        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
\par       O   O    T      T    H   H   Y Y   MM MM  O   O
\par       O   O    T      T    H   H    Y    M   M  O   O   Licensed To: KRCA
\par        OOO     T      T    H   H    Y    M   M   OOO                 VO2275000L1UN
\par
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\par All rights reserved.
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\par
\par                    *****  D E T A I L E D   O U T P U T *****
\par
\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
17\\Outlet 17 existing.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
17\\Outlet 17 existing.sum
\par
\par
\par DATE: 11/17/2009                          TIME: 10:01:18 AM
\par
\par USER:
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\par
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\par COMMENTS: ____________________________________________________________
\par
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\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWM
\par |                  |              P\\Casamir\\Casamir\\Quality.stm
\par | Ptotal= 24.98 mm |    Comments: Quality Event
\par --------------------
\par                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .11    3.15 |   .67   26.35 |  1.22    8.56 |  1.78    3.60
\par                  .22    3.60 |   .78   89.64 |  1.33    5.85 |  1.89    3.38
\par                  .33    4.28 |   .89   22.07 |  1.45    5.18 |  2.00    3.15
\par                  .44    6.08 |  1.00   12.61 |  1.56    4.73 |
\par                  .56    9.23 |  1.11    9.23 |  1.67    4.05 |
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\par -------------------------------------------------------------------------------
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\par --------------------
\par | CALIB              |
\par | STANDHYD  (0001) |   Area    (ha)=  10.02
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=       4.51         5.51
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     258.50        40.00
\par      Mannings n           =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083    3.15 |  .583   14.88 | 1.083    9.25 |  1.58    4.51
\par                  .167    3.45 |  .667   26.35 | 1.167    8.79 |  1.67    4.05
\par                  .250    3.83 |  .750   89.39 | 1.250    7.68 |  1.75    3.60
\par                  .333    4.28 |  .833   44.91 | 1.333    5.85 |  1.83    3.46
\par                  .417    6.08 |  .917   18.97 | 1.417    5.19 |  1.92    3.31
\par                  .500    8.17 | 1.000   12.61 | 1.500    4.88 |  2.00    3.15
\par
\par      Max.Eff.Inten.(mm/hr)=      89.39         2.69
\par                 over (min)        5.00        35.00
\par      Storage Coeff.  (min)=       4.72 (ii)   34.71 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        35.00
\par      Unit Hyd. peak  (cms)=        .22          .03
\par                                                             *TOTALS*
\par      PEAK FLOW       (cms)=        .92          .02            .917 (iii)
\par      TIME TO PEAK    (hrs)=        .75         1.42             .75
\par      RUNOFF VOLUME    (mm)=      23.98         2.23           13.10
\par      TOTAL RAINFALL   (mm)=      24.98        24.98           24.98
\par      RUNOFF COEFFICIENT   =        .96          .09             .52
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
\par
\par  FINISH
\par
==========================================================================================
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Outlet 27 – Perry Street Results

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{\rtf1\ansi\deff0{\fonttbl{\f0\fnil\fcharset0 Courier New;}}
\viewkind4\uc1\pard\lang1033\f0\fs17
==========================================================================================
==================
\par
\par       V    V   I    SSSSS  U   U    A    L
\par       V    V   I    SS     U   U   A A   L
\par        V  V    I     SS    U   U  AAAAA  L
\par        V  V    I      SS   U   U  A   A  L
\par         VV     I    SSSSS  UUUUU  A   A  LLLLL
\par
\par        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
\par       O   O    T      T    H   H   Y Y   MM MM  O   O
\par       O   O    T      T    H   H    Y    M   M  O   O   Licensed To: KRCA
\par        OOO     T      T    H   H    Y    M   M   OOO                  VO2275000L1UN
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\par                     *****  D E T A I L E D   O U T P U T *****
\par
\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
27\\Outlet 27 existing.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
27\\Outlet 27 existing.sum
\par
\par
\par DATE: 11/17/2009                             TIME: 10:14:48 AM
\par
\par USER:
\par
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\par
\par COMMENTS: ____________________________________________________________
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\par ------------------------------------------------------------------------------------------
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\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWM
\par |                  |              P\\Casamir\\Casamir\\Quality.stm
\par | Ptotal= 24.98 mm |    Comments: Quality Event
\par --------------------
\par                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .11    3.15 |   .67   26.35 |  1.22    8.56 |  1.78    3.60
\par                  .22    3.60 |   .78   89.64 |  1.33    5.85 |  1.89    3.38
\par                  .33    4.28 |   .89   22.07 |  1.45    5.18 |  2.00    3.15
\par                  .44    6.08 |  1.00   12.61 |  1.56    4.73 |
\par                  .56    9.23 |  1.11    9.23 |  1.67    4.05 |
```

```
\par
\par ------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB            |
\par | STANDHYD  (0001) |   Area    (ha)=    .83
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                              IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=        .75          .08
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=      74.40        40.00
\par      Mannings n           =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                               ---- TRANSFORMED HYETOGRAPH ----
\par                      TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                       hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                      .083    3.15 |  .583   14.88 | 1.083    9.25 |  1.58    4.51
\par                      .167    3.45 |  .667   26.35 | 1.167    8.79 |  1.67    4.05
\par                      .250    3.83 |  .750   89.39 | 1.250    7.68 |  1.75    3.60
\par                      .333    4.28 |  .833   44.91 | 1.333    5.85 |  1.83    3.46
\par                      .417    6.08 |  .917   18.97 | 1.417    5.19 |  1.92    3.31
\par                      .500    8.17 | 1.000   12.61 | 1.500    4.88 |  2.00    3.15
\par
\par      Max.Eff.Inten.(mm/hr)=      89.39       382.65
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       2.24 (ii)    6.12 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .30          .15
\par                                                            *TOTALS*
\par      PEAK FLOW       (cms)=        .10          .03           .108 (iii)
\par      TIME TO PEAK    (hrs)=        .75          .83            .75
\par      RUNOFF VOLUME    (mm)=      23.98        11.20          17.59
\par      TOTAL RAINFALL   (mm)=      24.98        24.98          24.98
\par      RUNOFF COEFFICIENT   =        .96          .45            .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par ------------------------------------------------------------------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   2 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\
\par |                  |              PPSWMP\\4hr-25mm.STM
\par | Ptotal= 25.00 mm |    Comments: 25mm/4hr
```

```
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .17     .00 |  1.33   12.90 |  2.50    3.30 |  3.67    1.80
\par                   .33    1.65 |  1.50   56.10 |  2.67    2.85 |  3.83    1.50
\par                   .50    1.95 |  1.67   16.95 |  2.83    2.55 |  4.00    1.50
\par                   .67    2.10 |  1.83    8.85 |  3.00    2.25 |  4.17    1.50
\par                   .83    2.70 |  2.00    6.15 |  3.17    2.10 |
\par                  1.00    3.60 |  2.17    4.65 |  3.33    1.95 |
\par                  1.17    5.40 |  2.33    3.90 |  3.50    1.80 |
\par
\par --------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB             |
\par | STANDHYD  (0001) |   Area    (ha)=    .83
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=        .75          .08
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=      74.40        40.00
\par      Mannings n          =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083     .00 | 1.167    5.40 | 2.250    3.90 |  3.33    1.95
\par                  .167     .00 | 1.250   12.90 | 2.333    3.90 |  3.42    1.80
\par                  .250    1.65 | 1.333   12.90 | 2.417    3.30 |  3.50    1.80
\par                  .333    1.65 | 1.417   56.10 | 2.500    3.30 |  3.58    1.80
\par                  .417    1.95 | 1.500   56.10 | 2.583    2.85 |  3.67    1.80
\par                  .500    1.95 | 1.583   16.95 | 2.667    2.85 |  3.75    1.50
\par                  .583    2.10 | 1.667   16.95 | 2.750    2.55 |  3.83    1.50
\par                  .667    2.10 | 1.750    8.85 | 2.833    2.55 |  3.92    1.50
\par                  .750    2.70 | 1.833    8.85 | 2.917    2.25 |  4.00    1.50
\par                  .833    2.70 | 1.917    6.15 | 3.000    2.25 |  4.08    1.50
\par                  .917    3.60 | 2.000    6.15 | 3.083    2.10 |  4.17    1.50
\par                 1.000    3.60 | 2.083    4.65 | 3.167    2.10 |
\par                 1.083    5.40 | 2.167    4.65 | 3.250    1.95 |
\par
\par      Max.Eff.Inten.(mm/hr)=      56.10       191.33
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       2.70 (ii)    7.37 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .29          .13
\par                                                           *TOTALS*
\par      PEAK FLOW       (cms)=        .06          .02           .079 (iii)
\par      TIME TO PEAK    (hrs)=       1.50         1.58          1.50
\par      RUNOFF VOLUME    (mm)=      24.00        11.22         17.60
\par      TOTAL RAINFALL   (mm)=      25.00        25.00         25.00
\par      RUNOFF COEFFICIENT   =        .96          .45           .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par            CN*  =  65.0    Ia = Dep. Storage  (Above)
```

```
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
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\par  FINISH
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Outlet 28 – Water Street Results

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{\rtf1\ansi\deff0{\fonttbl{\f0\fnil\fcharset0 Courier New;}}
\viewkind4\uc1\pard\lang1033\f0\fs17
==========================================================================================
==================
\par
\par        V    V   I    SSSSS  U   U    A    L
\par        V    V   I    SS     U   U   A A   L
\par         V  V    I     SS    U   U  AAAAA  L
\par         V  V    I      SS   U   U  A   A  L
\par          VV     I    SSSSS  UUUUU  A   A  LLLLL
\par
\par         OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
\par        O   O    T      T    H   H   Y Y   MM MM  O   O
\par        O   O    T      T    H   H    Y    M   M  O   O   Licensed To: KRCA
\par         OOO     T      T    H   H    Y    M   M   OOO                 VO2275000L1UN
\par
\par Developed and Distributed by Greenland International Consulting Inc.
\par Copyright 1996, 2001 Schaeffer & Associates Ltd.
\par All rights reserved.
\par
\par
\par                    *****  D E T A I L E D   O U T P U T *****
\par
\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
28\\Outlet 28 Existing.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
28\\Outlet 28 Existing.sum
\par
\par
\par DATE: 11/17/2009                            TIME: 10:22:45 AM
\par
\par USER:
\par
\par
\par
\par COMMENTS: ____________________________________________________________
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\par
\par ------------------------------------------------------------------------------------------
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\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWM
\par |                  |              P\\Casamir\\Casamir\\Quality.stm
\par | Ptotal= 24.98 mm |    Comments: Quality Event
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .11    3.15 |   .67   26.35 |  1.22    8.56 |  1.78    3.60
\par                   .22    3.60 |   .78   89.64 |  1.33    5.85 |  1.89    3.38
\par                   .33    4.28 |   .89   22.07 |  1.45    5.18 |  2.00    3.15
\par                   .44    6.08 |  1.00   12.61 |  1.56    4.73 |
\par                   .56    9.23 |  1.11    9.23 |  1.67    4.05 |
```

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\par ---------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB              |
\par | STANDHYD  (0001) |   Area    (ha)=   2.64
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=       2.38          .26
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     132.70        40.00
\par      Mannings n          =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083    3.15 |  .583   14.88 | 1.083    9.25 |  1.58    4.51
\par                  .167    3.45 |  .667   26.35 | 1.167    8.79 |  1.67    4.05
\par                  .250    3.83 |  .750   89.39 | 1.250    7.68 |  1.75    3.60
\par                  .333    4.28 |  .833   44.91 | 1.333    5.85 |  1.83    3.46
\par                  .417    6.08 |  .917   18.97 | 1.417    5.19 |  1.92    3.31
\par                  .500    8.17 | 1.000   12.61 | 1.500    4.88 |  2.00    3.15
\par
\par      Max.Eff.Inten.(mm/hr)=      89.39       155.97
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       3.17 (ii)    7.04 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .27          .14
\par                                                            *TOTALS*
\par      PEAK FLOW       (cms)=        .28          .08           .316 (iii)
\par      TIME TO PEAK    (hrs)=        .75          .83            .75
\par      RUNOFF VOLUME    (mm)=      23.98        11.20          17.59
\par      TOTAL RAINFALL   (mm)=      24.98        24.98          24.98
\par      RUNOFF COEFFICIENT   =        .96          .45            .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par ---------------------------------------------------------------------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   2 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM     |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\
\par |                   |              PPSWMP\\4hr-25mm.STM
\par | Ptotal= 25.00 mm |    Comments: 25mm/4hr
```

```
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .17     .00 |  1.33   12.90 |  2.50    3.30 |  3.67    1.80
\par                   .33    1.65 |  1.50   56.10 |  2.67    2.85 |  3.83    1.50
\par                   .50    1.95 |  1.67   16.95 |  2.83    2.55 |  4.00    1.50
\par                   .67    2.10 |  1.83    8.85 |  3.00    2.25 |  4.17    1.50
\par                   .83    2.70 |  2.00    6.15 |  3.17    2.10 |
\par                  1.00    3.60 |  2.17    4.65 |  3.33    1.95 |
\par                  1.17    5.40 |  2.33    3.90 |  3.50    1.80 |
\par
\par --------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB              |
\par | STANDHYD  (0001) |   Area    (ha)=   2.64
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=       2.38          .26
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=     132.70        40.00
\par      Mannings n           =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083     .00 | 1.167    5.40 | 2.250    3.90 |  3.33    1.95
\par                  .167     .00 | 1.250   12.90 | 2.333    3.90 |  3.42    1.80
\par                  .250    1.65 | 1.333   12.90 | 2.417    3.30 |  3.50    1.80
\par                  .333    1.65 | 1.417   56.10 | 2.500    3.30 |  3.58    1.80
\par                  .417    1.95 | 1.500   56.10 | 2.583    2.85 |  3.67    1.80
\par                  .500    1.95 | 1.583   16.95 | 2.667    2.85 |  3.75    1.50
\par                  .583    2.10 | 1.667   16.95 | 2.750    2.55 |  3.83    1.50
\par                  .667    2.10 | 1.750    8.85 | 2.833    2.55 |  3.92    1.50
\par                  .750    2.70 | 1.833    8.85 | 2.917    2.25 |  4.00    1.50
\par                  .833    2.70 | 1.917    6.15 | 3.000    2.25 |  4.08    1.50
\par                  .917    3.60 | 2.000    6.15 | 3.083    2.10 |  4.17    1.50
\par                 1.000    3.60 | 2.083    4.65 | 3.167    2.10 |
\par                 1.083    5.40 | 2.167    4.65 | 3.250    1.95 |
\par
\par      Max.Eff.Inten.(mm/hr)=      56.10       116.51
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       3.81 (ii)    8.49 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .25          .12
\par                                                             *TOTALS*
\par      PEAK FLOW       (cms)=        .19          .06           .241 (iii)
\par      TIME TO PEAK    (hrs)=       1.50         1.58           1.50
\par      RUNOFF VOLUME    (mm)=      24.00        11.22          17.61
\par      TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
\par      RUNOFF COEFFICIENT   =        .96          .45            .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
```

```
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
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\par  FINISH
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Outlet 29 – North Street Results

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{\rtf1\ansi\deff0{\fonttbl{\f0\fnil\fcharset0 Courier New;}}
\viewkind4\uc1\pard\lang1033\f0\fs17
==========================================================================================
==================
\par
\par        V    V   I    SSSSS  U   U    A    L
\par        V    V   I    SS     U   U   A A   L
\par         V  V    I     SS    U   U  AAAAA  L
\par         V  V    I      SS   U   U  A   A  L
\par          VV     I    SSSSS  UUUUU  A   A  LLLLL
\par
\par         OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
\par        O   O    T      T    H   H   Y Y   MM MM  O   O
\par        O   O    T      T    H   H    Y    M   M  O   O   Licensed To: KRCA
\par         OOO     T      T    H   H    Y    M   M   OOO                VO2275000L1UN
\par
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\par All rights reserved.
\par
\par
\par                    *****  D E T A I L E D   O U T P U T *****
\par
\par
\par   Input   filename: C:\\Program Files\\Visual OTTHYMO v2.0\\voin.dat
\par   Output  filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
29\\Outlet 29 Existing.out
\par   Summary filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWMP\\Outlet
29\\Outlet 29 Existing.sum
\par
\par
\par DATE: 11/17/2009                             TIME: 10:29:37 AM
\par
\par USER:
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\par
\par COMMENTS: ____________________________________________________________
\par
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\par ------------------------------------------------------------------------------------------
-----------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   1 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\PPSWM
\par |                  |              P\\Casamir\\Casamir\\Quality.stm
\par | Ptotal= 24.98 mm |    Comments: Quality Event
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .11    3.15 |   .67   26.35 |  1.22    8.56 |  1.78    3.60
\par                   .22    3.60 |   .78   89.64 |  1.33    5.85 |  1.89    3.38
\par                   .33    4.28 |   .89   22.07 |  1.45    5.18 |  2.00    3.15
\par                   .44    6.08 |  1.00   12.61 |  1.56    4.73 |
\par                   .56    9.23 |  1.11    9.23 |  1.67    4.05 |
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\par
\par --------------------
\par | CALIB            |
\par | STANDHYD  (0001) |   Area    (ha)=    .99
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                              IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=        .89          .10
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=      81.20        40.00
\par      Mannings n          =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                               ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083    3.15 |  .583   14.88 | 1.083    9.25 |  1.58    4.51
\par                  .167    3.45 |  .667   26.35 | 1.167    8.79 |  1.67    4.05
\par                  .250    3.83 |  .750   89.39 | 1.250    7.68 |  1.75    3.60
\par                  .333    4.28 |  .833   44.91 | 1.333    5.85 |  1.83    3.46
\par                  .417    6.08 |  .917   18.97 | 1.417    5.19 |  1.92    3.31
\par                  .500    8.17 | 1.000   12.61 | 1.500    4.88 |  2.00    3.15
\par
\par      Max.Eff.Inten.(mm/hr)=      89.39       155.97
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       2.36 (ii)    6.24 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .30          .15
\par                                                            *TOTALS*
\par      PEAK FLOW       (cms)=        .11          .03           .127 (iii)
\par      TIME TO PEAK    (hrs)=        .75          .83            .75
\par      RUNOFF VOLUME    (mm)=      23.98        11.20          17.59
\par      TOTAL RAINFALL   (mm)=      24.98        24.98          24.98
\par      RUNOFF COEFFICIENT   =        .96          .45            .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
\par   ****************************
\par   ** SIMULATION NUMBER:   2 **
\par   ****************************
\par
\par
\par --------------------
\par |    READ STORM    |    Filename: C:\\Program Files\\Visual OTTHYMO v2.0\\
\par |                  |              PPSWMP\\4hr-25mm.STM
\par | Ptotal= 25.00 mm |    Comments: 25mm/4hr
```

```
\par --------------------
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                   .17     .00 |  1.33   12.90 |  2.50    3.30 |  3.67    1.80
\par                   .33    1.65 |  1.50   56.10 |  2.67    2.85 |  3.83    1.50
\par                   .50    1.95 |  1.67   16.95 |  2.83    2.55 |  4.00    1.50
\par                   .67    2.10 |  1.83    8.85 |  3.00    2.25 |  4.17    1.50
\par                   .83    2.70 |  2.00    6.15 |  3.17    2.10 |
\par                  1.00    3.60 |  2.17    4.65 |  3.33    1.95 |
\par                  1.17    5.40 |  2.33    3.90 |  3.50    1.80 |
\par
\par --------------------------------------------------------------------------------
\par
\par --------------------
\par | CALIB            |
\par | STANDHYD  (0001) |   Area    (ha)=    .99
\par |ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  50.00
\par --------------------
\par                               IMPERVIOUS    PERVIOUS (i)
\par      Surface Area     (ha)=        .89          .10
\par      Dep. Storage     (mm)=       1.00         5.00
\par      Average Slope     (%)=       1.00         2.00
\par      Length            (m)=      81.20        40.00
\par      Mannings n          =       .013         .250
\par
\par          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
\par
\par
\par                                ---- TRANSFORMED HYETOGRAPH ----
\par                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
\par                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
\par                  .083     .00 | 1.167    5.40 | 2.250    3.90 |  3.33    1.95
\par                  .167     .00 | 1.250   12.90 | 2.333    3.90 |  3.42    1.80
\par                  .250    1.65 | 1.333   12.90 | 2.417    3.30 |  3.50    1.80
\par                  .333    1.65 | 1.417   56.10 | 2.500    3.30 |  3.58    1.80
\par                  .417    1.95 | 1.500   56.10 | 2.583    2.85 |  3.67    1.80
\par                  .500    1.95 | 1.583   16.95 | 2.667    2.85 |  3.75    1.50
\par                  .583    2.10 | 1.667   16.95 | 2.750    2.55 |  3.83    1.50
\par                  .667    2.10 | 1.750    8.85 | 2.833    2.55 |  3.92    1.50
\par                  .750    2.70 | 1.833    8.85 | 2.917    2.25 |  4.00    1.50
\par                  .833    2.70 | 1.917    6.15 | 3.000    2.25 |  4.08    1.50
\par                  .917    3.60 | 2.000    6.15 | 3.083    2.10 |  4.17    1.50
\par                 1.000    3.60 | 2.083    4.65 | 3.167    2.10 |
\par                 1.083    5.40 | 2.167    4.65 | 3.250    1.95 |
\par
\par      Max.Eff.Inten.(mm/hr)=      56.10       116.51
\par                 over (min)        5.00        10.00
\par      Storage Coeff.  (min)=       2.84 (ii)    7.51 (ii)
\par      Unit Hyd. Tpeak (min)=       5.00        10.00
\par      Unit Hyd. peak  (cms)=        .28          .13
\par                                                           *TOTALS*
\par      PEAK FLOW       (cms)=        .08          .02          .094 (iii)
\par      TIME TO PEAK    (hrs)=       1.50         1.58          1.50
\par      RUNOFF VOLUME    (mm)=      24.00        11.22         17.60
\par      TOTAL RAINFALL   (mm)=      25.00        25.00         25.00
\par      RUNOFF COEFFICIENT   =        .96          .45           .70
\par
\par ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
\par
\par        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
\par             CN*  =  65.0    Ia = Dep. Storage  (Above)
```

```
\par       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
\par            THAN THE STORAGE COEFFICIENT.
\par      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
\par
\par -------------------------------------------------------------------------------
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APPENDIX I RATIONAL METHOD CALCULATIONS

Casimir Street Outlet (Outlet 11) – Rational Method Calculations

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											
John Street	1	7	59.2	15.00	0.60	84.03	1.260	0.45	0.567	0.57	132.5	1.1%	375	180.8	1.64	73.3%
John Street	7	10	70.5	15.60	0.79	82.08	0.281	0.45	0.13	0.69	158.3	0.7%	450	236.8	1.49	66.8%
Casimir	10	20	18.2	16.39	0.20	79.67	0.000	0.00	0.00	0.69	153.6	0.7%	450	236.8	1.49	64.9%
Casimir	20	ditch	107	16.60	0.83	79.07	0.000	0.00	0.00	0.69	152.5	1.9%	375	237.9	2.15	64.1%
Casimir	ditch inlet	mh2	8.5	17.42	0.07	76.75	2.232	0.45	1.00	1.70	362.3	2.0%	300	135.6	1.92	267.2%
Casimir	mh2	cb4	34	17.50	0.18	76.55	0.000	0.90	0.00	1.70	361.3	3.7%	400	396.5	3.15	91.1%
Casimir	cb4	dcb5	65	17.68	0.39	76.07	0.131	0.90	0.12	1.82	384.0	2.8%	400	348.3	2.77	110.3%
Casimir	dcb5	dcb6	15	18.07	0.06	75.04	0.547	0.90	0.49	2.31	481.5	4.6%	500	804.3	4.10	59.9%
Casimir	dcb6	cbmh	35	18.13	0.11	74.88	0.368	0.90	0.33	2.64	549.5	8.0%	500	1060.6	5.40	51.8%
Casimir	cbmh	cb20	96.65	18.24	0.50	74.61	0.423	0.90	0.38	3.02	626.4	2.8%	500	627.5	3.20	99.8%
Water	cbmh32	cbmh30	63.5	10.00	0.56	105.57	0.076	0.90	0.07	0.07	20.1	1.3%	400	235.6	1.88	8.5%
Water	cbmh30	mh26	14	10.56	0.22	102.52	0.118	0.90	0.11	0.17	49.8	0.4%	400	130.7	1.04	38.1%
Mary Street	ditch inlet	cb7	10	15.00	0.14	84.03	0.784	0.45	0.35	0.35	82.4	0.6%	375	134.7	1.22	61.2%
Mary Street	cb7	cb8	7.4	15.14	0.09	83.58	0.176	0.45	0.08	0.43	100.4	0.7%	375	143.4	1.30	70.0%
Mary Street	cb8	mh9	39	15.23	0.67	83.27	0.194	0.45	0.09	0.52	120.2	0.3%	450	155.0	0.97	77.5%
Perry Street	cb12	cb13	11.3	10.00	0.22	105.57	0.211	0.45	0.09	0.09	27.9	0.5%	250	42.9	0.87	65.0%
Perry Street	cb13	mh9	15.2	10.22	0.20	104.38	0.211	0.45	0.09	0.19	55.1	0.9%	300	88.9	1.26	62.0%
Mary Street	mh9	excb	64.5	15.90	0.85	81.16	0.315	0.90	0.28	0.99	224.0	0.5%	450	200.1	1.26	111.9%
Mary Street	excb	cb28	83	16.75	0.44	78.62	0.432	0.90	0.39	1.38	301.9	4.0%	375	347.9	3.15	86.8%
Mary Street	cb28	cb27	8.8	17.19	0.07	77.38	0.432	0.90	0.39	1.77	380.8	2.0%	375	246.0	2.23	154.8%
Mary Street	cb27	mh26	7	17.26	0.03	77.20	0.000	0.00	0.00	1.77	379.9	3.3%	500	681.2	3.47	55.8%
Water	mh26	cbmh24	12.3	18.74	0.12	73.35	1.056	0.90	0.95	2.90	590.4	0.8%	500	335.4	1.71	176.0%
Water	cbmh24	cbmh20	109.6	18.86	1.05	73.06	0.180	0.90	0.16	3.06	620.9	0.7%	600	491.9	1.74	126.2%
Water	cbmh20	mh19	18.5	19.91	0.14	70.60	0.000	0.00	0.00	6.08	1192.9	1.0%	600	610.1	2.16	195.5%
Water	mh19	mh18	7.5	20.05	0.06	70.28	0.000	0.00	0.00	6.08	1187.5	1.0%	600	610.1	2.16	194.6%
Park	mh18	outlet	77	20.11	0.49	70.16	0.000	0.00	0.00	6.08	1185.3	1.5%	600	747.3	2.64	158.6%
				20.60			9.427				1185.3					

Manning's coefficient = 0.013, Total time to outlet = 20.6 minutes, Runoff Volume = 1185.3 L/s

Queen Street Outlet (Outlet 17) – Rational Method Calculations
Manning's coefficient = 0.013, Total time to outlet = 12.2 minutes, Runoff Volume = 1380.8 L/s

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											
Queen Street	CBMH12	CBMH4	74.5	10.00	0.35	105.57	2.908	0.450	1.309	1.309	384.1	3.9%	450	559.0	3.51	68.7%
Queen Street	CBMH4	CBMH6	63.0	10.35	0.28	103.64	0.704	0.450	0.317	1.625	468.3	4.5%	450	600.4	3.78	78.0%
Queen Street	CBMH6	DCBMH11	119.5	10.63	0.45	102.17	1.911	0.750	1.433	3.059	868.7	5.0%	525	955.2	4.41	91.0%
Queen Street	DCBMH11	DCBMH15	118.5	11.08	0.43	99.89	1.151	0.450	0.518	3.577	993.2	5.3%	525	983.4	4.54	101.0%
Queen Street	DCBMH15	CBMH14	4.5	11.52	0.02	97.80	2.260	0.450	1.017	4.594	1248.9	5.3%	525	983.4	4.54	127.0%
Queen Street	CBMH14	CBMH3	99.6	11.53	0.49	97.72	0.000	0.000	0.000	4.594	1247.9	3.0%	525	739.9	3.42	168.7%
Queen Street	CBMH3	Williams Creek Queen Outlet	60.0	12.02	0.18	95.50	0.720	0.450	0.324	4.918	1305.6	6.8%	600	1591.1	5.63	82.1%
Queen Street	MH	Williams Creek Queen Outlet	21.0	10.00	0.26	105.57	0.229	0.900	0.206	0.206	60.5	1.0%	300	95.9	1.36	63.1%
Queen Street	Williams Creek Queen Outlet	0	0.0	12.20	n/a	94.72	0.133	0.900	0.120	5.244	1380.8	0.0%	0	0.0	0.00	n/a
				12.20			10.02				1380.8					

John Street Outlet (Outlet 18) – Rational Method Calculations

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											

Manning's coefficient = 0.013, Total time to outlet = 12.25 minutes, Runoff Volume = 542.3 L/s

Perry Street	DI	CB	20.0	10.00	0.39	105.57	0.129	0.900	0.116	0.116	33.9	1.0%	150	15.1	0.85	225.3%
Perry Street	CB	MHCB	52.0	10.39	0.40	103.43	0.129	0.900	0.116	0.231	66.5	2.5%	300	151.6	2.14	43.9%
Queen Street	MHCB	MH6	27.0	10.80	0.19	101.33	0.129	0.900	0.116	0.347	97.7	2.3%	375	265.5	2.40	36.8%
Queen Street	MH6	MH5	105.0	10.98	0.92	100.39	0.500	0.900	0.450	0.797	222.4	0.9%	525	409.7	1.89	54.3%
John Street	CB	MH11	34.0	10.00	0.30	105.57	0.680	0.450	0.306	0.306	89.8	1.9%	300	132.1	1.87	68.0%
John Street	MH11	MHCB14	85.0	10.30	0.61	103.91	0.394	0.900	0.355	0.661	190.8	3.0%	300	165.5	2.34	115.3%
Queen Street	MHCB14	MH5	36.0	10.91	0.41	100.76	0.473	0.700	0.331	0.992	277.8	0.7%	450	235.1	1.48	118.1%
John Street	MH5	Williams Creek John Outlet	55.0	11.91	0.35	96.01	0.270	0.900	0.243	2.032	542.3	1.8%	525	573.1	2.65	94.6%
				12.25		94.48										
				12.25			2.70				542.3					

Perry Street Outlet (Outlet 27) – Rational Method Calculations

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											
Perry Street	bldg drain	mhcb1	10.0	10.00	0.06	105.57	0.096	0.900	0.086	0.086	25.3	10.0%	150	47.6	2.70	53.2%
Perry Street	mhcb1	mhcb2	54.0	10.06	0.46	105.22	0.000	0.000	0.000	0.086	25.2	2.0%	300	136.9	1.94	18.4%
Perry Street	mhcb2	mhcb3	13.0	10.53	0.18	102.72	0.288	0.900	0.260	0.346	98.7	0.6%	375	134.7	1.22	73.3%
North Street	excb	mhcb3	51.0	10.00	0.45	105.57	0.201	0.900	0.181	0.181	53.1	1.9%	300	132.1	1.87	40.2%

Manning's coefficient = 0.013, Total time to outlet = 10.94 minutes, Runoff Volume = 212.1 L/s

Perry Street	mccb3	outlet 27	17.0	10.70	0.23	101.80	0.248	0.900	0.223	0.749	212.1	0.6%	375	134.7	1.22	157.4%
				10.94		100.62										
				10.94			0.83				212.1					

Water Street Outlet (Outlet 28) – Rational Method Calculations

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											
Queen Street	cb2	mh4	7.0	10.00	0.07	105.57	0.787	0.900	0.709	0.709	208.0	1.0%	375	174.0	1.57	119.5%
Water Street	mh4	mh6	95.0	10.07	0.99	105.16	0.878	0.900	0.791	1.499	438.2	0.7%	525	347.0	1.60	126.3%
Water Street	mh6	mh10	64.0	11.06	0.70	99.99	0.317	0.900	0.285	1.784	496.0	0.5%	600	431.4	1.53	115.0%
Water Street	mh10	mh11	50.0	11.76	0.24	96.67	0.232	0.900	0.209	1.993	535.7	2.5%	600	964.7	3.41	55.5%

Manning's coefficient = 0.013, Total time to outlet = 12.04 minutes, Runoff Volume = 632.2 L/s

Water Street	mh11	outlet (28)	5.0	12.01	0.04	95.57	0.429	0.900	0.386	2.379	632.2	0.8%	700	823.6	2.14	76.8%
				12.04		95.40										
				12.04			2.64				632.2					

North Street Outlet (Outlet 29) – Rational Method Calculations

LOCATION			Length (m)	TIME (MIN)		Rainfall Intensity (mm/hr)	Area (Ha)	C	AC	Cumul AC	Runoff Q (L/s)	Slope (%)	Pipe Diameter (mm)	Capacity (L/s)	Full Flow Velocity (m/s)	% Full
Street	From	To		To Upper End	In Reach											
North Street	EXCB1	EXCB2	58.8	10.00	0.78	105.57	0.236	0.900	0.212	0.212	62.3	0.9%	300	88.4	1.25	70.5%
North Street	PLUG	EXCB2	21.0	10.00	0.20	105.57	0.444	0.900	0.400	0.400	117.3	1.1%	400	216.8	1.72	54.1%
North Street	EXCB2	EXCB3	6.5	10.78	0.06	101.39	0.128	0.900	0.115	0.727	205.0	1.3%	400	235.6	1.88	87.0%
North Street	EXCB3	EXCB4	3.2	10.84	0.03	101.10	0.185	0.900	0.166	0.894	251.1	1.3%	400	235.6	1.88	106.6%

Manning's coefficient = 0.013, Total time to outlet = 12.38 minutes, Runoff Volume = 250.8 L/s

North Street	EXCB4	Outlet	140.5	10.87	1.51	100.95	0.000	0.000	0.000	0.894	250.8	1.3%	300	109.3	1.55	229.4%
				12.38		*93.91*										
				12.38			0.99				250.8					

Kawartha Conservation

T: 705.328.2271

F: 705.328.2286

277 Kenrei Road, Lindsay ON, K9V 4R1

geninfo@kawarthaconservation.com

www.kawarthaconservation.com