CREDIT VALLEY CONSERVATION

Laurelwood

Low Impact Development Infrastructure Performance and Risk Assessment
May 2016

Monitoring Plan

Residential Lands

CONTENTS

1 PROJECT OVERVIEW

Municipalities across Canada are struggling to address a number of issues, ranging from aging infrastructure to insufficient stormwater management, in order to prevent both the degradation of receiving streams and the Great Lakes, and damage to property and infrastructure from erosion and flooding. Low Impact Development (LID) is an innovative approach to stormwater management that can help meet some of these challenges.

Long-term performance of LID is an important consideration and source of uncertainty for municipalities contemplating the use of green infrastructure. This study focuses on monitoring LID facilities that were installed and monitored briefly more than a decade ago in order to evaluate the long-term performance of Low Impact Development facilities relative to the following factors:

1) **Determine if infiltration rates within infiltration galleries continue to achieve pre-development water-balance according to design.**

2) **Determine the quality of water being discharged by the treatment train as a whole, and compare to original design targets. In addition to the original parameters, monitor conductivity as a proxy for chlorides to determine if there is potential for contamination by road salt.**

2 BACKGROUND

Our communities are supported by functions provided by our environment such as abundant, safe drinking water, and clean air. We need to integrate development of our communities with management of stormwater to support a sustainable environment. This approach is known as Low Impact Development. The Laurelwood subdivisions were designed to incorporate LID measures, specifically infiltration galleries to convey water from road runoff, while infiltrating it to the ground along the way, thereby striving to maintain infiltration levels closer to the pre-development hydrology. In addition, other practices to improve stormwater management include equipping the catchbasins with Goss-traps, and designing the stormwater management facility as a wetland to help to reduce the impact of the subdivision on the environment.

Since LID attempts to mimic natural processes, its performance depends on local conditions including climate, soils, and drainage. Individual LID measures should be examined with respect to basic hydrological cycle components including; evapotranspiration, infiltration, and runoff. In the Laurelwood subdivisions, stormwater infiltration occurs on natural soils with pervious cover and at special facilities (infiltration galleries) located along the roads (either under the road or in the boulevards). Long-term sustainable infiltration depends on soils, hydrology, risk of clogging of infiltration sites, and infiltration facility maintenance. Total infiltration must be maintained to ensure local groundwater recharge for baseflow in Laurel Creek. Development must also strive to maintain surface water and groundwater relationships and to prevent contaminants from entering surface or groundwater. The process of maintaining the post-development water balance as close to the natural state as possible also supports the enhancement of runoff quality and the ecological integrity of receiving streams.

LID is a relatively new approach and one of the priority questions for many stakeholders relates to the long-term performance, maintenance, and life cycle costs of LID. Since the Laurelwood subdivisions were developed over a decade ago, monitoring at these sites provides an opportunity to answer some of the questions related to long-term performance of LID. The new results of the ongoing performance of stormwater management facilities in Laurelwood will be compared to results from the original monitoring activities. To our knowledge, no monitoring or maintenance of the LID facilities has been conducted by the City of Waterloo since the subdivisions were assumed.

3 MONITORING OBJECTIVES AND TARGETS

The primary purpose of the proposed monitoring for these LID facilities is to evaluate their long-term performance; therefore, it is important to maintain consistency with past monitoring efforts conducted at this site. The original monitoring of the Laurelwood subdivisions was conducted by consultants hired by the developers. They conducted baseline monitoring before the development, construction monitoring during the development, and short-term performance monitoring immediately after development was complete. The following objectives and targets for the LID practices in Laurelwood are consistent with the original objectives and targets as specified by the consultants responsible for the immediate post-development monitoring. In addition, a new research objective related to the potential for contamination of surface and groundwater by road salt has been added. Keeping the objectives and targets mostly consistent between previous and present monitoring efforts facilitates comparison between current results and those from old monitoring reports; however the current monitoring plan will be more comprehensive.

Water Quantity and Quality Targets and Monitoring Objectives:

A. Water Quantity Monitoring Objective

i. Estimate outflows from the stormwater management treatment train to allow comparison with performance targets and previous monitoring results

a. Water Quantity Targets

i. Infiltration and detention of stormwater to mimic natural hydrologic cycle

ii. Match pre-development infiltration rates as much as possible (for the subwatershed where this site is located infiltration to groundwater ranges from 24-149 mm/yr).

iii. Provide detention storage for the first flush of rainfall

B. Water Quality Monitoring Objectives

i. Monitor water quality of discharge from stormwater management facilities and assess ability to meet *Laurel Creek Watershed Study* performance targets.

ii. Determine potential for contamination to surface water and groundwater recharge areas by road salt by continuous monitoring of conductivity within infiltration galleries and the effluent from stormwater management facilities.

b. **Water Quality Targets**

i. *Laurel Creek Watershed Study* water quality targets. Since these are in-stream targets with the exception of TSS, they are intended for comparison, rather than to determine strict compliance.

- Temperature:
  - Cold Water Streams : <22°C from April 1 to Oct 31/ 4-14°C from November to March 31

  - Warm Water Streams: <26 □C from June 1 to August 1/<29□C from August 1 to October 31

- Phosphorous: Upstream of Laurel Reservoir (<0.03 mg/L), Downstream of Laurel Reservoir (0.05-0.08 mg/L)

- Total Suspended Sediment: Stormwater management facility effluent target: 25 mg/L

4 STUDY AREA

The study area is located in the Laurelwood subdivisions; Laurelwood Area 4-A, Laurelwood Area 4-B, Laurelwood Area 5, and Laurelwood Area 6. These subdivisions were developed in the late 1990s and early 2000s. Laurelwood Area 4 covers 14 ha with estimated impervious cover of approximately 50%, and is located on the Northeast corner of Erbsville Rd. and Columbia St.; Laurelwood Area 5 covers 41 ha with approximately 30% impervious cover, and is located in the Laurelwood Drive/Beaver Creek Rd. area.; Laurelwood Area 6 was developed slightly later (construction monitoring began in August 2000) and is located north of Laurelwood Drive.

The Laurelwood subdivisions were built within rural Laurel Creek subwatersheds 313 and 309. Subwatershed 313 is a headwater basin with a drainage area of 1.8 km^2. Its main surface drainage feature is the north branch of Clair Creek. Subwatershed 309 has a drainage area of 3 km^2, and an upstream drainage area that contributes an additional 17.5 km^2. This subwatershed is dominated by flow through and lateral inflow into the basin. There are three tributaries within this subwatershed that convey water to Laurel Creek.

One of the primary goals of the LID approach is to maintain the pre-development water balance as closely as possible by encouraging infiltration and minimizing and delaying runoff from impervious areas. The elements of the estimated pre-development water balance were;

- precipitation 830-1000mm/year;
- evaporation 550-575mm/year;
- surplus 300-425mm/year;
- discharge to Creek (baseflow and runoff) 276mm/year; and
- infiltration to regional groundwater 24-149 mm/year.

One of the management targets of the Laurel Creek Watershed Study is to prevent contamination of groundwater in recharge areas. Groundwater is an important resource in the Waterloo area because it forms the majority of the local water supply. Municipal water supply wells are located to the south and east of the study area. The site of the Laurelwood subdivisions has been identified as a potential groundwater recharge area. Surrounding the study area, the overburden is approximately 75-95m thick (Watershed report), and more than 50% of the soil cover in this area was identified as the Brant-Waterloo soil association. Laurelwood Areas 4 and 5 are underlain by low conductivity silt and silt/clay tills. The soils in Laurelwood area were observed to have extremely low infiltration capacity with percolation rates less than 10mm/hr. Laurelwood Area 6 is underlain by silt, sand, and clay till with conductivity ranging from 2.2×10^{-3} -4.9×10^{-5} cm/s.

5 LID INITIATIVES IN LAURELWOOD SUBDIVISIONS

In the Laurelwood Subdivisions stormwater is managed using practices including: stormwater management ponds and wetlands, water quality trenches, and infiltration galleries. Some of the infiltration galleries are located in the roads under the storm sewer while others are located in the boulevards. The dimensions, location and details of facilities vary between the different subdivisions Laurelwood 4A, 4B, 5, 6. Due to feasibility constraints the monitoring will be conducted within the subdivision Laurelwood Area 6, therefore a specific description of the stormwater management practices in this area are provided.

- The subdivision is serviced by two stormwater management facilities, specifically basins B and C as shown in the map (Figure 2). They are **extended detention wetlands** that are used as end-of-pipe controls to treat stormwater.

- **Infiltration galleries**: these facilities are located under the road, adjacent to and under the storm sewer and are designed to treat the first flush of stormwater (approximately the first 25mm of rainfall). During a rain event, stormwater enters the catchbasins and is pretreated by Goss traps located within. Once the water has been pretreated it travels through a 150mm diameter pipe that is connected to an infiltration gallery.

  As illustrated by Figures 1 and 2, the infiltration galleries consist of 1m x 1m trenches with two different layers of soil; the bottom layer is 700mm of sand and the top layer is 300mm of clear stone wrapped in a geotextile. Within the upper stone layer of the trench there is a series of separate 1.5m sections of perforated pipe, each connected to an individual catchbasin. Another 200mm diameter perforated pipe runs continuously for the length of the trench in the sand layer below.

  Stormwater from each catchbasin enters a section of perforated pipe in the upper layer, then flows out through the perforations and percolates to the lower sand layer. Upon reaching the sand layer the water enters the lower, continuous perforated pipe, which conveys the water to the outlet. Cleanout pipes are located periodically along this pipe for monitoring and cleaning activities. Residential sump pumps from the houses are connected directly to the lower pipe.

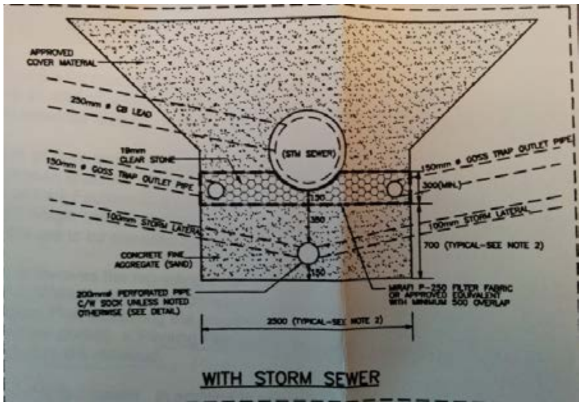

Figure 1 Infiltration gallery with storm sewer above. From Stantec Consulting Ltd. (2000) Laurelwood Community-Stormwater Management Operations, Monitoring, and Maintenance Report.

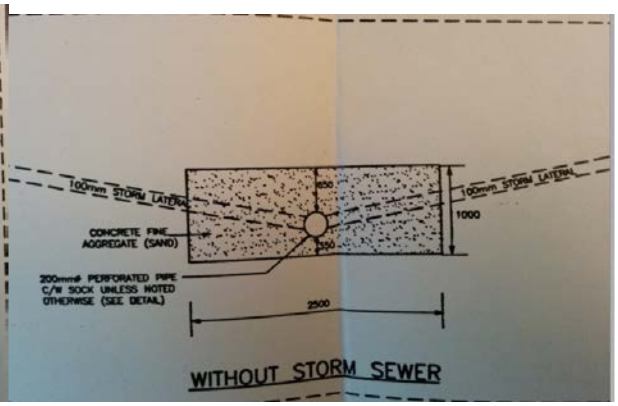

Figure 2 Infiltration gallery without storm sewer. From Stantec Consulting Ltd. (2000) Laurelwood Community-Stormwater Management Operations, Monitoring, and Maintenance Report.

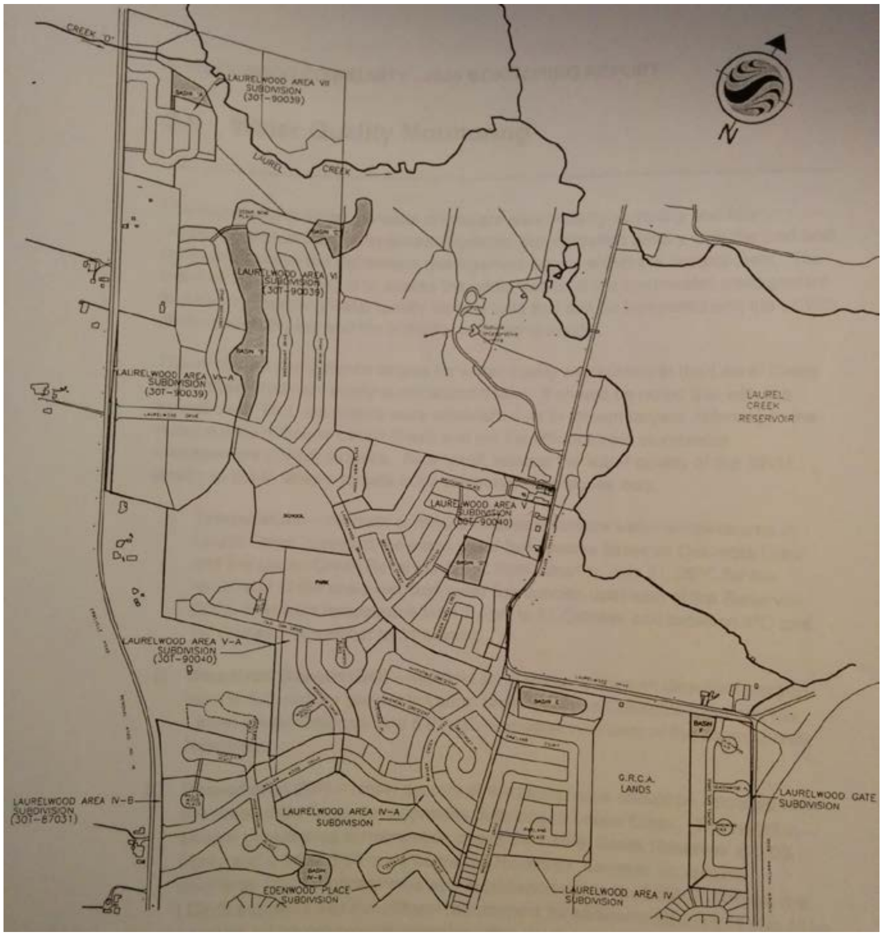

Figure 3: Shows the location of the different basins described for Stormwater management, Basin E (which includes Area 4) Basin D (which includes Area 5) Pre-development Sites A, B, C, D, and Basin D (which includes Areas 6 and 7) from Stantec Consulting Ltd. (1999). Final Stormwater Management Design Report Laurelwood Area VI.

6 PROPOSED MONITORING ACTIVITIES

Since the primary objective of this study is to compare current performance of stormwater management features to their performance at the time of development, it is necessary that the new monitoring initiative incorporates aspects of the original monitoring done when the subdivision was first developed. This will facilitate comparison with the results of the previous monitoring study. However, in the original monitoring program, water quality monitoring included analysis for the following parameters: total suspended solids, phosphorous, coliforms, dissolved oxygen, water temperature. In the new monitoring plan, the sampling effort will shift focus to total suspended solids, phosphorous, temperature and conductivity.

A. Stormwater Management Facility:

I. Monitoring will be performed at pond 53, which is the stormwater management facility for Laurelwood Basin B
   i. Continue inspections, monitoring, and maintenance as per consultants' recommendations at all infiltration galleries to the degree practicable. Monitoring was performed monthly and for events >15mm. The original monitoring program included:
      a. *Regular inspections*
      b. *Oil and grease analysis*
      c. *Catchbasin sedimentation analysis*
      d. *Flow measurement at the inlets and outlets*
      e. *Water quality at the inlet, basin outlet, and combined outlet*

II. To provide a more complete understanding of the stormwater management facility's present-day performance, the following additional monitoring activities will be performed:

   i. Outlet:
      a. Continuous flow monitoring using ISCO Area-Velocity Flow Modules at the outlets for the stormwater management facility
      b. Use Auto Samplers to facilitate event sampling, for events >15mm. In this study, distinct rain events will be defined as separated by a period of 6 hours with no rain or flow. These can be connected to the ISCO Flow Module to be triggered by increases in flow at the outlet. An example of this setup is provided in Figure 4.
      c. Use temperature and conductivity loggers for continuous monitoring of water quality leaving the stormwater management facility

B. Infiltration gallery:

I. Continue inspections, monitoring, and maintenance as per consultants' recommendations at all infiltration galleries to the degree practicable. Monitoring at all stations was performed monthly and for events >15mm. Regular inspections of all facilities were also carried out. The original monitoring program included:

   a. *Water quality samples at the gallery outlet*

   b. *Inspection of outlets during storm events: flow should be expected at outlet during most storms, or infiltration gallery may be clogged*

   c. *Water quality sampling at 2 cleanout risers.*

II. To provide a more complete understanding of the infiltration gallery's present-day performance, the following additional monitoring activities will be performed:

i. Inflow:

a. Inflows for the catchment will be estimated using the Simple Method applied to the drainage area being served by the infiltration galleries and wetland; this value will be used along with the measured flow from the outlets to estimate the quantity of water infiltrated.

ii. Outlets:

a. Continuous flow monitoring using ISCO Area-Velocity Flow Modules at the outlets of the two infiltration galleries that discharge adjacent to the outlet of Laurelwood Basin B

b. Use Auto Samplers to facilitate event sampling at the outlets for events >15mm. In this study, distinct rain events will be defined as separated by a period of 6 hours with no rain or flow. The Auto Samplers can be connected to the ISCO Flow Module to be triggered by increases in flow at the outlet.

c. Temperature and conductivity loggers will be installed at the outlets, to provide a continuous record of water quality in addition to the samples.

Figure 4: Monitoring setup showing the ISCO Area-Velocity Flow Module and an Auto Sampler

7 MONITORING OBJECTIVES MET

Each portion of the monitoring plan relates to meeting different aspects of the original monitoring objectives:

I. Determine if water quality targets are being met as per Laurel Creek Watershed Study in-stream parameters. Although these are in-stream targets, they were also set as the original water quality targets for outflows from the stormwater management facility. Monitoring will determine whether the facility with LID upstream is still able to meet the performance targets after a decade.
II. Resumed monitoring efforts will also determine if water is filling the infiltration gallery and reaching the outlet. If water fails to flow at the outlet during storms, the consultant reports indicate the facility may require maintenance.
III. A temperature logger at the outlets for the infiltration galleries and stormwater management facility would provide continuous records that could determine whether the treatment train is meeting the stated target of maintaining the water cooler than 22□C for outflow.
IV. The Simple Method can be used to determine an estimate of the quantity of water being infiltrated calculated using the difference between modelled runoff generation and the combined outflows for the Basin B catchment. This could be compared with the pre-development infiltration rates. There is room for error and overestimation of the quantity of water being infiltrated using this method; however, it is the most feasible option available for estimating infiltration in this case.
V. The conductivity loggers used at the outlets for the treatment train would estimate the extent of contamination by road salt for the effluent stormwater.

8 REFERENCES

Grand River Conservation Authority (1993). *Laurel Creek Watershed Study*

Paragon Engineering Limited (1993). *Laurelwood Subdivision Area 4, Trillium Estates Limited: Detailed Stormwater Management Report.*

Stanley Consulting (1997). *Laurelwood Subdivision Area V, Trillium Estates Limited: Final Stormwater Management Report.*

Stantec Consulting Ltd. (1999). *Final Stormwater Management Design Report Laurelwood Area VI, Volume 2*

Stantec Consulting Ltd. (2000) *Laurelwood Community-Stormwater Management Operations, Monitoring, and Maintenance Report*

Stantec Consulting Ltd. (2006) *Laurelwood Community-Stormwater Management Operations, Monitoring, and Maintenance Report Basins B and C*