CVC
CREDIT VALLEY CONSERVATION

Meadows in the Glen

Low Impact Development Infrastructure Performance and Risk Assessment
May 2016

Monitoring Plan

Residential Lands

Credit Valley Conservation Proposal: Monitoring of a Low Impact Green Residential Development Project

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BACKGROUND

Municipalities across Canada are struggling to address a number of issues, ranging from aging infrastructure to insufficient stormwater management, to prevent both the degradation of receiving streams and the Great Lakes, and damage to property and infrastructure from erosion and flooding.

This project is the "first of its kind" in Ontario and will help educate urban municipalities on how to balance growth, redevelopment, stormwater infrastructure refurbishment, and the environment in light of climate change. The project will provide a template that municipalities can employ to cost-effectively address environmental and development pressures.

The purpose of the study is to evaluate the effectiveness of various Low Impact Development (LID) methods used in a residential subdivision, with respect to:

- catchment hydrology,
- surface water and groundwater quality,
- receiving stream geomorphology and ecology, and
- hydrogeology.

PROJECT DELIVERABLES

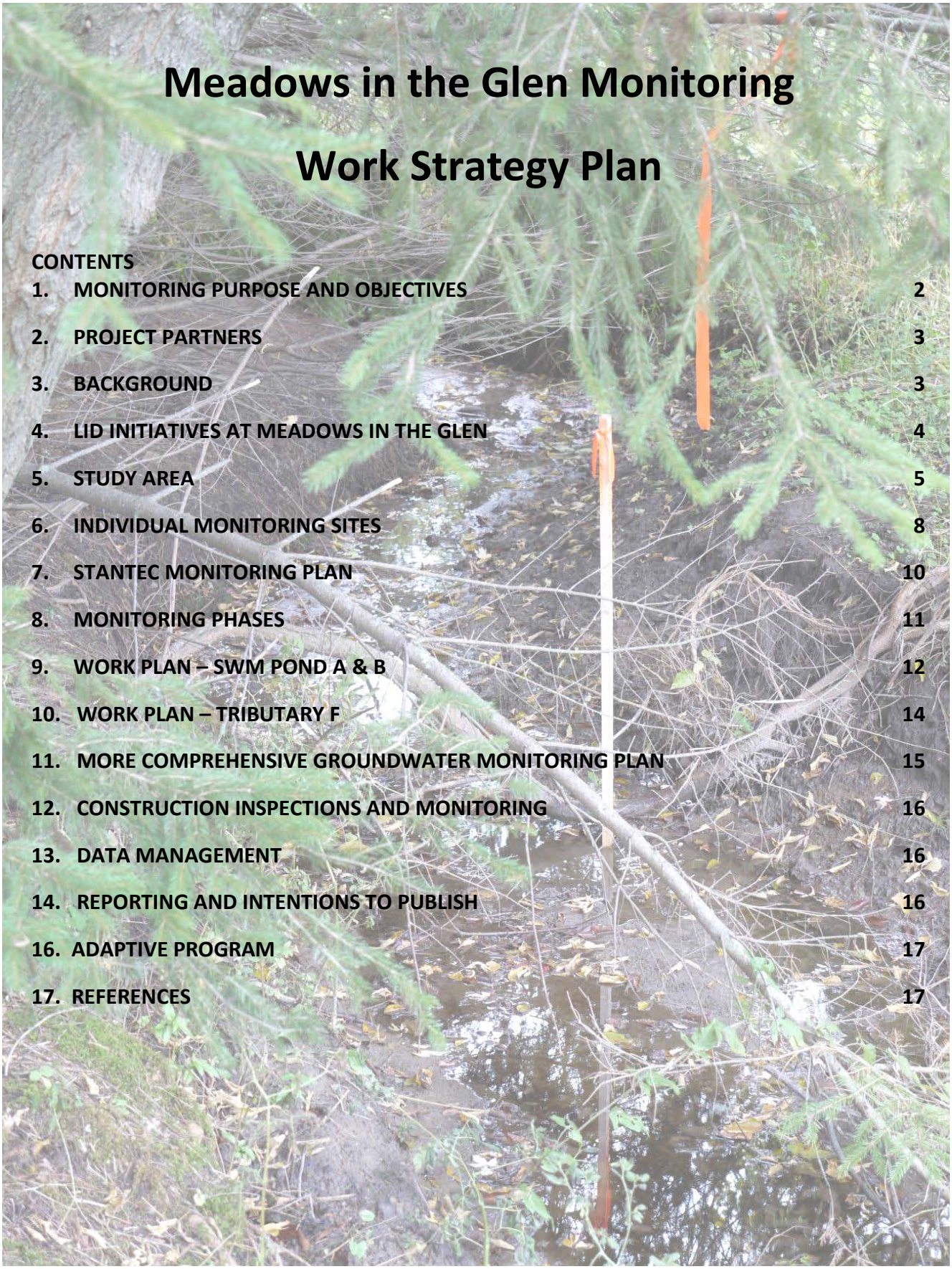
1. To support source water protection and municipal stormwater management in light of climate change.

2. This demonstration project contains stormwater treatment approaches that exceed the standard practices in place pertaining to stormwater management in residential subdivisions in Ontario. It uses many LID practices for innovative stormwater management. Monitoring this site will provide much needed performance data to support design initiatives of such practices.

3. Comprehensive effectiveness monitoring of performance data will be conducted to provide municipalities across Ontario with a template for LID implementation.

PROJECT SCHEDULE

1. Initiation of Environmental Monitoring Phase 1 – Spring 2011
2. Initiation of Environmental Monitoring Phase 2—Spring 2015
3. End of Project – Late Fall 2020



Meadows in the Glen Monitoring

Work Strategy Plan

CONTENTS

1. Monitoring Purpose and Objectives

The purpose of the study is to evaluate the effectiveness of various Low Impact Development (LID) methods used in a residential subdivision, with respect to: catchment hydrology, hydrogeology, water quality, stream geomorphology, and ecology.

Objectives/Targets:

Water Quantity

- Monitoring data will be used to calibrate the SWMHYMO models used to design the LID applications. The models will then be rerun to determine how realistic they were in estimating the post development flows for the 2 through 100 year design storms.
- Determine if any increased erosion and other stream channel changes resulted in Tributary F from increased flows from the development.
    - Verify through continuous flow monitoring that SWM Pond A is discharging below the critical threshold of $0.10m^3/s$ for Reach 3 of Tributary F during the 24 to 48hr drawdown period.
- Determine if any groundwater elevation changes resulted from increased infiltration from the LID measures.
    - At source infiltration practices have been designed to infiltrate the first 25mm of rainfall from all roof areas including garages – **estimated annual recharge of 11,000 m^3**
    - Infiltration from grass swales and the bioretention facility is to provide an annual recharge of approximately 10% of the runoff not captured by lot level infiltration – **estimated annual recharge of 6,000 m^3.**
    - Through the installation of a rainfall gauge, flow logger at the outfalls for both SWM ponds, and continuous groundwater level monitoring equipment within the existing wells, develop a water balance to estimate whether the development is meeting the estimated total post development infiltration of **41,000 m^3.**
    - Through the installation of continuous flow loggers at both inlets to SWM Pond A, determine if, and how closely post development hydrology matches pre-development hydrology.

Water Quality

- SWM Pond A has been designed to provide Enhanced treatment per MOE guidelines.
    - Monitoring to confirm that 80% of TSS is removed from the stormwater produced in the development area on an average annual basis, through measurements of flow and TSS concentrations at the inlets and outfall of SWM pond A.
- Determine if the increased infiltration from the LID measures is having an impact on groundwater quality.
    - Monitoring to detect changes in groundwater chemistry.
- Evaluate the need for a permanent pool in LID developments.
    - Determine sediment loads entering and leaving Pond A by using continuous flow monitoring and water quality sampling at the inlets and outlet to Pond A.
- Develop a water budget for SWM Pond A through continuous monitoring.
- Detect if there are changes in various water quality parameter concentrations in groundwater and surface water as a result of the development.
- Determine if there are any changes to the Benthic Invertebrate community structure of Tributary F over the course of the monitoring program.

This monitoring plan is based on the protocols and practices being used in other CVC monitoring programs.

2. Project Partners

1. Intracorp Canada
2. Town of Halton Hills
3. Credit Valley Conservation Authority (CVC)

3. Background

Our communities are supported by functions provided by our environment such as abundant, safe drinking water, and clean air. Studies conducted for the Credit River Watershed have demonstrated the need to integrate development of our communities with management of stormwater to support a sustainable environment. This framework is known as Low Impact Development (LID). The design for the Meadows in the Glen Subdivision includes LID measures, specifically; narrower road widths, porous

pavement, street swales, bioretention, soak away pits, preservation of forests, and water and energy conservation measures, which will 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: evapotranspiration, infiltration, and runoff. Stormwater infiltration occurs on natural soils with pervious cover and at special facilities (bioretention and swales) located throughout the catchment area. At the Meadows in the Glen Site, it is expected that much infiltration will occur on individual lots, in stormwater swales, and in bioretention areas. Long-term sustainable infiltration depends on soil cover, soils, hydrology, risk of clogging of infiltration sites, and infiltration facility maintenance. The process of maintaining the development water balance as close to the natural state as possible also supports the enhancement of runoff quality and ecological integrity in receiving streams (J. Marsalek and Q. Rochfort 2008).

Since Meadows in the Glen is the first LID subdivision in the Credit Valley Watershed, Credit Valley Conservation (CVC) would like to work with Intracorp in assessing if the LID practices put in place at the Meadows in the Glen development, do indeed lead to a more natural site hydrology and water quality than in conventional developments.

4. LID Initiatives at Meadows in the Glen

LID Practices on Roadways:

- The most commonly used method of stormwater drainage in residential areas is curb and gutter. It is a very effective method for draining stormwater from neighbourhoods; however, it may be too effective, since stormwater is quickly transported to receiving watercourses by impervious pipes. As a result, very little of the water has the opportunity to soak into the ground to be naturally filtered before it reaches these watercourses. This can lead to a number of problems in receiving streams including flash flooding, a decline in water quality, and a reduction of stream baseflow and groundwater levels. **Swale drainage**, which allows water to infiltrate naturally, is very beneficial for stormwater management, as it can reduce pollutant and sediment concentrations in runoff, delay peak flows, and lessen flow amounts to receiving creeks and storm drain systems.

- **Biofilters** or bioretention cells are a stormwater management technique that uses the chemical, biological, and physical properties of plants and soils to treat stormwater runoff. They are designed to mimic natural conditions promoting infiltration, retention, and the slow release of stormwater runoff.

LID Practices used on residential lots:

- **Soakaway pits** are underground storage areas that allow roof runoff to infiltrate.

- **Permeable Pavement Driveways** allow water to soak into the joints between the paving stones and into the subsurface.

5. Study Area

The subject site for the study is located in Glen Williams, Halton Region, Ontario (Figure 1). The property was formally used to grow garden plants for Sheridan Nurseries.

Figure 2 shows the development plan for the area. The subdivision is served by two SWM ponds; pond A is located in the northeast corner of the site, while pond B is located in the southwest corner. SWM Pond A will drain to Tributary F, a small tributary that runs between the Meadow in the Glen Site and the Eagle Ridge Golf Club, and discharges to the Credit River. SWM Pond B will discharge down a steep slope to a wetland and ultimately to the Credit River. Figure 3 shows the location of tributary F, SWM Pond A, SWM Pond B, and the approximate drainage area of the two ponds. Tributary F drains an area of approximately 13.6 hectares. SWM Ponds A and B drain contributing areas of 23.1 and 12.3 hectares respectively.

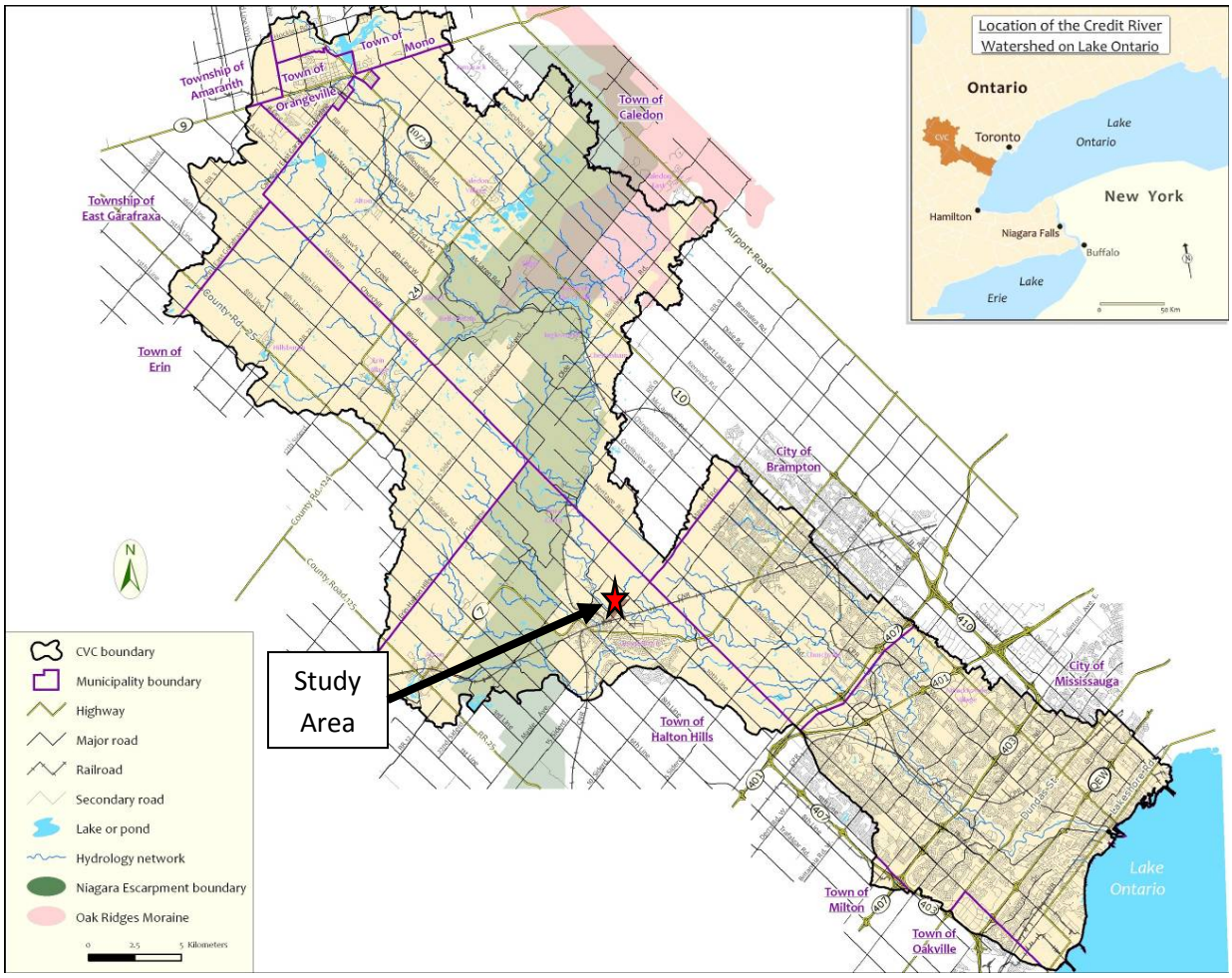


Figure 1: Meadows in the Glen Development within the Credit River Watershed.

Figure 2: Meadows in the Glen Development Plan

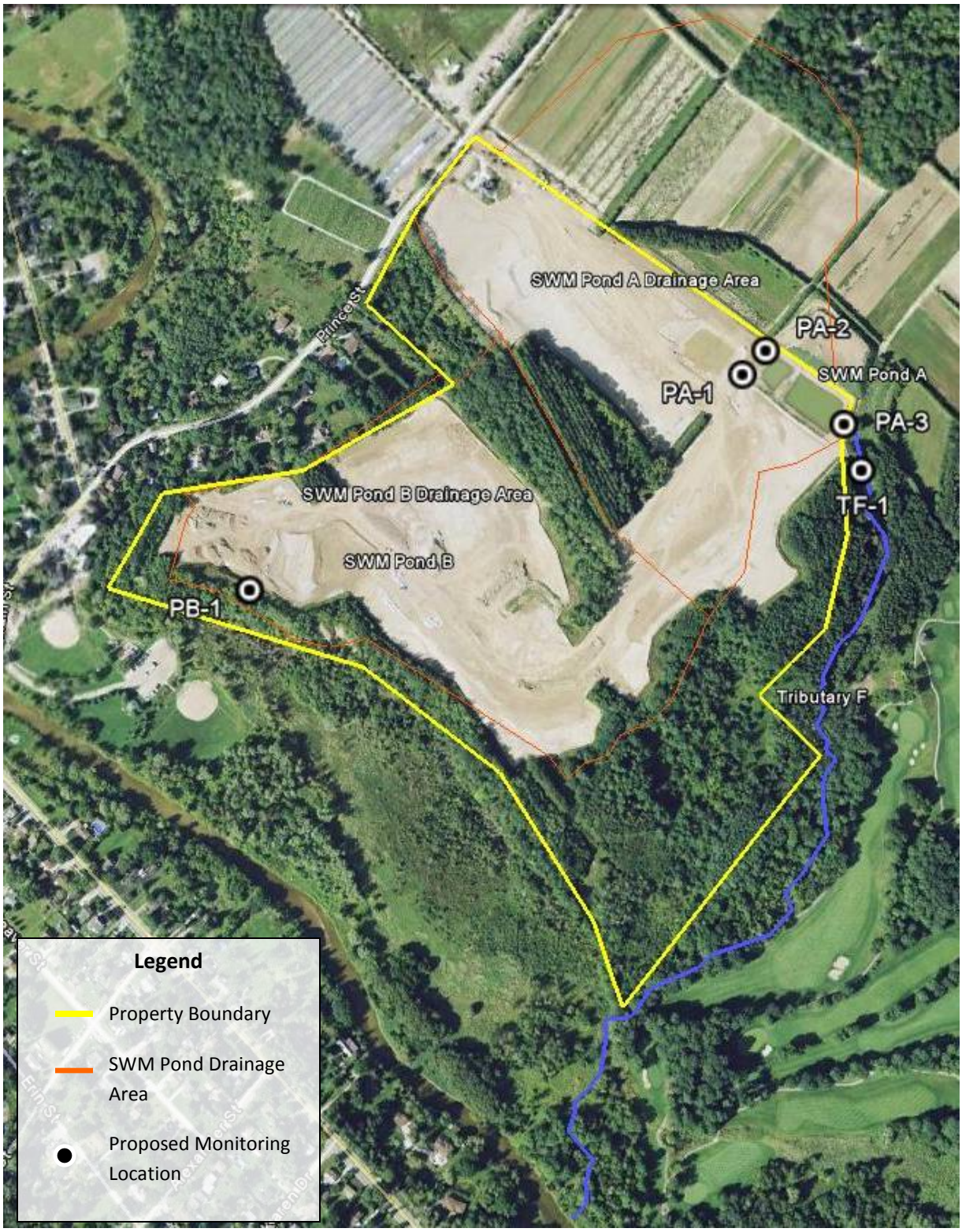


Figure 3: Meadows in the Glen SWM pond locations, drainage areas and proposed monitoring locations

6. Individual Monitoring Sites

Five monitoring stations are proposed: both inlets of SWM Pond A, the outlet of SWM Pond A and SWM Pond B, and Tributary F downstream of SWM Pond A. The individual monitoring locations will be utilized as follows:

- **SWM Pond A Inflow 1 (PA-1)** will be monitored to see the effectiveness of the LID practices put in place at the Meadows in the Glen Development. Data from this station will be combined with data from station PA-2 to estimate total inflow into SWM Pond A.
- **SWM Pond A Inflow 2 (PA-2)** will be used to collect background data, as the drainage area is mostly from Sheridan Nursery Lands similar to what was located on the Meadows in the Glen property prior to development. Data from this station will be combined with data from station PA-1 to estimate total inflow into SWM Pond A.
- **SWM Pond A Outfall (PA-3)** this station will be used to determine water quality and quantity leaving the pond and evaluate the need for a permanent pool in LID developments post-construction. It will also aid in the calculation of a water balance for the site.
- **SWM Pond B Outfall (PB-1)** this station will be used to determine water quantity leaving the pond to aid in the calculation of a water balance for the site.
- **Tributary F (TF-1)** should be monitored downstream of SWM Pond A to see if the LID measures implemented in the development were successful in mitigating impacts to the tributary (Figure 4).

Figure 4: Tributary F downstream of SWM Pond A

Figure 5: SWM Pond A

7. Stantec Monitoring Plan

The current Stantec Monitoring Plan received by CVC provides for Compliance and Inspection monitoring of the stormwater ponds (Stantec 2007b) and quarterly groundwater level monitoring in existing monitoring wells. Figure 6 shows the location of these wells. The monitoring plan will need to be amended to further evaluate the effectiveness of the LID practices used in the development. The draft Conditions of Subdivision from the Ontario Municipal Board stated, “A performance based monitoring plan should be developed by the developer for implementation by a suitable agency”.

Figure 6: Stantec groundwater monitoring well locations

8. Monitoring Phases

8.1 Phase I

Phase I began in Spring 2011 and involved the monitoring plan outlined below for groundwater as well as the installation of a precipitation gauge.

8.2 Phase II

Phase II will begin in Spring 2015, following completion of the development and stabilization of the site. It will involve the monitoring plan outlined below for SWM Ponds A and B, Tributary F, and the continuation of groundwater and

precipitation monitoring. This phase is planned to continue for approximately 5 years, afterwards less intensive monitoring may occur to help with long-term objectives.

9. Work Plan – SWM Pond A & B

9.1 Instrumentation

A site visit was conducted to review the existing drainage infrastructure and assess suitable equipment for the monitoring program. A rain gauge will be located near the SWM Pond A outfall sampling site as this is the most suitable location for installation. In addition, an area-velocity flow meter will be installed in a flow control structure (small weir) at the outlet of the 750 mm (8.2 m long and 2.4% slope) concrete pipe. An area-velocity meter will also be installed in the SWM Pond B outfall. Based on site visit observations it appears that it will be possible to monitor the SWM pond B outfall in one of the pipe sections immediately downstream of the pond (e.g., access through manhole 3), close to the riser pipe outfall. The manholes appear to be located at points where the direction changes and pipe size (27”) is reasonable.

The equipment located at each of the three SWM Pond A monitoring stations (2 inlets & outlet) is proposed as follows:

- Isco 674 Rain Gauge (outlet only)
- Flow flume or weir
- Isco 6712 sampler
- Isco 750 area-velocity flow module for 6712 sampler
- Isco cellular modem
- Solar panel and battery
- Box for secure onsite equipment storage
- Hobo temperature logger

The SWM pond B outfall station will have an Isco 1450 area-velocity meter and box for secure onsite equipment storage only. All equipment will be set to log every 5 minutes, and connected and controlled through the auto sampler as is shown in Figure 7. A Hobo water level and temperature logger will also be installed in SWM Pond A. Selection of the majority of equipment from the same manufacturer will provide savings in staff time for data management and analysis. Data will be stored in the auto sampler’s memory and downloaded either remotely or in person biweekly at minimum, using ISCO Flowlink 5 software.

The site will be visited at a minimum of every two weeks to check battery power, inspect equipment, and confirm operation. To reduce the number of site visits, cellular modems will be installed and connected to the Auto Samplers so that equipment can be downloaded and checked from the office more frequently. The modems will also enable activation and control of the Auto Samplers remotely, facilitating the sampling of rain events.

9.2 Hydrology

Weirs will be installed at the monitoring locations for the two SWM Pond A inflow points, and at the outlets for SWM Ponds A and B, in order to obtain accurate level and flow measurements. An area-velocity level and flow will measure water level and flow at 1-minute intervals and summarize and record it at 5-minute intervals. A rain gauge will be installed at the SWM Pond A outlet and will record rainfall at 5-minute intervals. In addition, a Hobo level logger will be installed in SWM Pond A to measure pond water level.

9.3 Water Quality

A target of approximately 15 precipitation events will be sampled per year at all three monitoring locations with the Isco Auto sampler; however meeting this target will depend on how much rain is required to produce flow at the different stations as well as the number of storms that occur during the monitoring season. If some sites only flow for the largest storm events it may not be possible to meet this target for those sites. Each sampler holds 24 one-litre bottles. Samples will be analysed for:

- Chloride
- Conductivity
- pH
- Total Suspended Solids (TSS)
- Nutrients:
    - Total Phosphorus
    - Orthophosphorus
    - TKN
    - Total Ammonia
    - Nitrate & Nitrite
- Metals
- TOC & DOC
- BOD
- Alkalinity

Field water quality measurement will also be taken at the time of sampling if flow is present using a Hydrolab MS5 meter. Parameters measured will be:

- Temperature
- pH
- Conductivity
- Dissolved Oxygen

Event sampling will be conducted as follows using a two-part program for the Auto Samplers:

- Part One: one initial grab sample will be collected in the samplers first six bottles. These first six will fill continuously, so this part of the program will finish within approximately four minutes. Water from these bottles will be mixed together and submitted for analysis of the same parameters as above.
- Part Two: The remaining 18 bottles will then be filled 500 mL every 15 minutes. Therefore, one bottle will be filled every 30 minutes and the program will last for nine hours. The 20 bottles will then be mixed into one flow-weighted composite sample and submitted for analysis of the same parameters as above. The program length may be adjusted depending on the forecast precipitation event duration.

- Samples will be brought to an accredited Canadian Laboratory for laboratory analysis.

In addition, Hobo continuous temperature loggers will be installed at each of the stations.

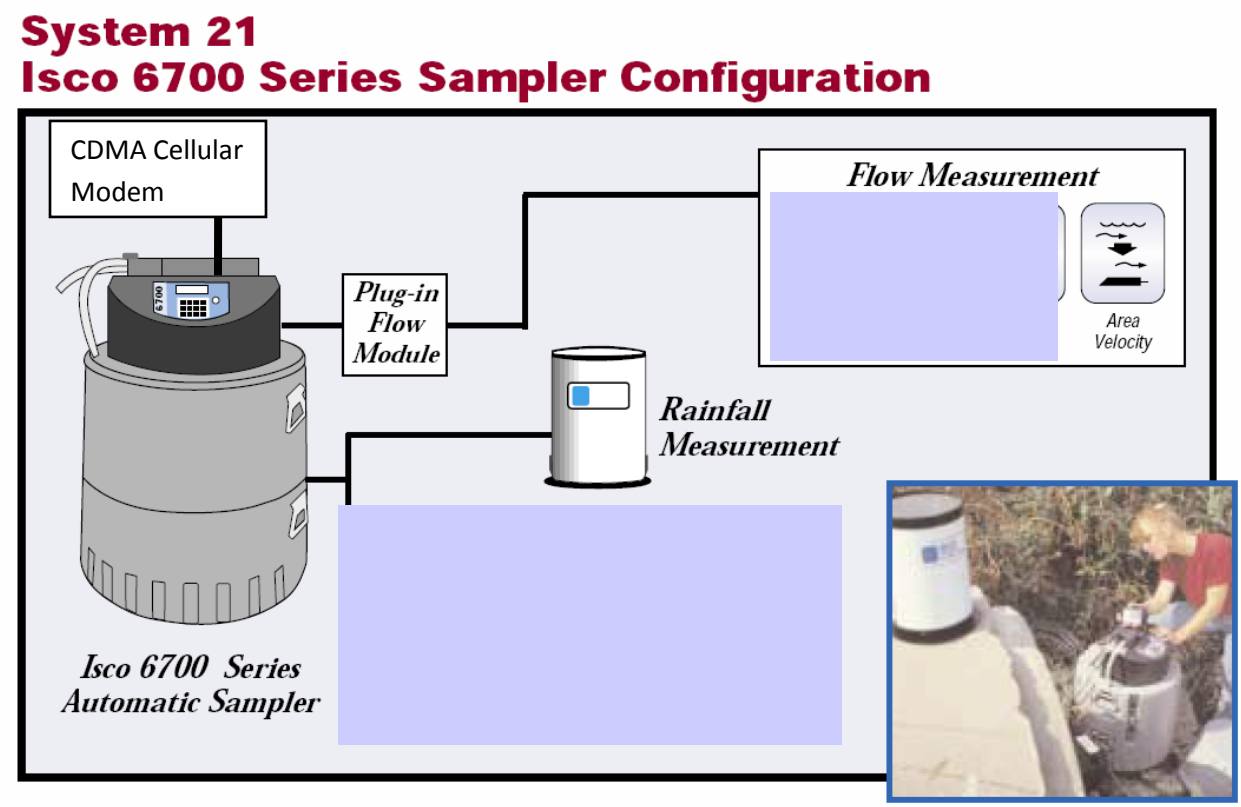


Figure 7: Diagram of how equipment will be connected

10. Work Plan – Tributary F

10.1 Benthic Invertebrates

Annual sampling of benthic invertebrates will be conducted along Tributary F to determine if there are any changes to the benthic invertebrate community structure of Tributary F over the course of the monitoring program. Samples will be collected downstream of the outlet from SWM Pond A.

10.2 Fluvial Geomorphology

Annual fluvial geomorphology assessments will be conducted along Tributary F downstream of SWM Pond A to assess if there is increased erosion and other stream channel changes resulting from increased flows from the development.

11. More Comprehensive Groundwater Monitoring Plan

11.1 Delineate Hydrogeological Condition (or Conceptual Geological Model)

- Existing data will be collected and reviewed, including GIS layers, consulting reports, etc.;
- Conduct field trips to study the physiography and geologic outcrops;
- construct an additional monitoring well with 25 meter depth and 3 meter screen on the north corner of the site (see Figure 6);
- Establish conceptual geological model, which will be used to analyse monitoring data.

11.2 Groundwater Level Monitoring

- Continuous level loggers recording at 15-minute intervals will be installed in all existing groundwater wells and the one proposed well (Figure 6);
- Wells will be visited monthly to download the loggers and ensure their operation;
- A manual depth measurement will also be taken monthly using a water level tape to check and calibrate the logger data.

11.3 Groundwater Temperature Monitoring

- Use temperature data to monitor environmental change;
- Monitoring frequency for groundwater temperature will be at 15 minute intervals;
- Create groundwater thermographs and carry out tentative morphological analysis.

11.4 Groundwater Quality Sampling

- Groundwater quality will be sampled semi-annually, in the spring and in the fall in the existing wells.
- Samples will be analyzed by an accredited Canadian Laboratory.
- At the commencement of the monitoring program the analytical parameters will be determined by CVC staff based on hydrogeochemistry condition, land use, and potential contaminant sources.

11.5 Data Analysis and Reporting

- Conduct detailed morphological analysis of groundwater hydrograph to obtain information and trends for recharge, discharge, and storage;
- Analyze the data to determine hydrogeochemistry and contamination levels;
- Establish causative relation between LID and monitored data.
- Report monitoring result as required, including data summary, presentation, memo, and detailed analytical report.

12. Construction Inspections and Monitoring

Data gathered during the monitoring program will be compared to the onsite conditions at the time the data was collected. For the purpose of inspecting and documenting Meadows in the Glen stormwater management construction, CVC staff prefers to be onsite for the following events:

- Installation of the 1st soakaway/infiltration trench. Verify that:
    - Area has not been compacted.
    - Facility will not be compromised by sediment laden runoff.
    - Geotextile and stones have been installed according to specifications.
    - Storage volume matches the management plan requirement.
    - The overflow and cleanout have been properly installed.
- Installation of the 1st permeable pavement sidewalk and/or driveway. Verify that:
    - Area has not been compacted.
    - Infiltration will not impact any foundations.
    - Stone meets plan specifications, has no fines.
    - Areas draining to the practice are stabilized and tracking of dirt onto the pavement won't occur.
- Installation of the bioretention cell/biofilter. Verify that:
    - Cell has been excavated to grade and in a way that avoids compaction.
    - Bioretention soil has been mixed thoroughly and with the right proportions (Puget Sound mix currently specified).
    - Underdrain is surrounded with clear stone and covered by drainage fabric (not currently shown on plans).
    - Bioretention soil is installed in wetted 150mm lifts.
    - Check dams, mulch, and plants are installed according to plans.
- Installation of wet pond B outfall structure.
    - This construction activity presents a major risk to erosion.
- Starting in the spring, biweekly inspections are recommended to confirm that:
    - The other on-lot practices are being built to the same standard as the 1st observed installation.
    - Installed LID practices are being protected during construction.
    - Areas for future LID practices are not being compromised.
    - Observe topsoil spreading, final grading, and stabilization/seeding, particularly for the swales system.

13. Data Management

An agreement will need to be reached between all of the parties involved in this monitoring program regarding roles for managing flow and water quality data sets, and provide data analysis for the study.

14. Reporting and Intentions to Publish

Intracorp Canada, The Town of Halton Hills, and CVC will discuss the results and their implications. While the study is underway, information collected is confidential and not to be shared with personnel outside the study team. Once the monitoring data has undergone a thorough internal review, the intention is for the information to enter into the public domain.

15. Adaptive Program

The program is intended to be adaptive in nature, implying that the program will be continually reviewed and changes may be made to the sampling protocols, methods, and locations as needed.

16. References

J. Marsalek and Q. Rochfort. 2008. Observations on Monitoring the LID Project "Meadows in the Glen". Memo to Credit Valley Conservation & Intercorp.

Stantec Consulting Ltd. 2007a. The Meadows in the Glen Environmental Implementation Report Glen Williams. Prepared for Intracorp Projects (The Meadows in the Glen) Ltd.

Stantec Consulting Ltd. 2007b. The Meadows in the Glen Subdivision, Town of Halton Hills, Region of Halton – Final Stormwater Management & Low Impact Development Strategy Report. Prepared for Intracorp Projects Ltd.