Managing Water Resources in a Climate Changed World: An Annapolis Pilot Project

Project Report 2010

Produced for Clean Annapolis River Project
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Clean Annapolis River Project

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Executive summary

Managing Water Resources in a Climate Changed World: An Annapolis Pilot Project was created by Clean Annapolis River Project (CARP) as a means of demonstrating methods for improving storm water management using Annapolis Royal as a test case.

This was accomplished through partnerships with homeowners and local businesses in identifying opportunities for improving storm water management and filtration. These opportunities included the establishment of rain barrels, rain gardens, cisterns, and gravity fed irrigation.

As a result of the implementation of this project in 2009, the following results were achieved:

- The installation of 14 rain barrels
- A 2.6m^2 rain garden at a private home
- A conceptual design developed for Annapolis Home Hardware which includes a 50m^2 retention pond, over 375m of renaturalized ditches, and a 1,500L cistern
- A conceptual design and action plan for a 60m^2 demonstration rain garden at the Annapolis Royal Train Station
- Increased capacity to mitigate the impacts of potential flooding
- A resource for other towns and municipalities interested in alternative means of storm water management
- Potentially 180,000L of rain water captured a year for use
- Three completed study tours with 10 participants
- Preparation and distribution of a brochure entitled "How to Make Your Own Rain Barrel."
- Preparation of a leaflet explaining the potential uses of cisterns
- Updates to the Clean Annapolis River Project website (annapolisriver.ca), including information on this program under the title "Managing Stormwater in Annapolis Royal"

Introduction

In *Historical and Projected Temperature and Precipitation Trends in the Annapolis Valley, Nova Scotia* (Mehlman, 2003) it was projected that although annual volume of precipitation would not change for the Annapolis Valley, there would be fewer but more voluminous precipitation events as a result of an increase in the number of warm and very warm days in the summer. Therefore, the likelihood of localized flooding would be expected to increase. Landscape features such as bogs, marshes, swamps, and riparian areas are natural flood controls; they retain excess water and release it in times of drought.

In the past many wetlands were viewed as wasted space and over 80% of wetlands near major urban centres have been filled in to meet development needs (Natural Resources Canada, 2009). Their services in flood protection and water filtration were unknown or undervalued. They were replaced with pipes and sewage treatment plants and natural drainage patterns were lost. Vegetated and absorbent soils were replaced with pavement and buildings. With an increase in impervious surfaces, storm water can quickly become a problem. In British Columbia, 10% impervious area within a watershed or drainage area is thought to be a critical threshold; once this threshold is surpassed storm water impacts dramatically increase (British Columbia Ministry of Water, Land and Air Protection, 2002).

Conventional storm water management focuses on moving water from a developed area as quickly as possible (Natural Resources Defense Council, 2009). In older storm water systems, storm water and sanitary wastewater are sent through a treatment plant before being redirected into a waterway (Environment Canada, 2008). For communities with sewage treatment plants that receive both sanitary wastewater and storm water this can lead to the input of more water than a treatment plant can handle, especially at times of heavy precipitation. In some cases this causes flooding in basements and streets, and in other cases the untreated water is dispelled directly into a watercourse.

In newer systems, storm water is sent directly to a waterway. Although storm water is generally less polluted than the combination of both sanitary and storm water (Environment Canada, 2008) whatever pollutants the storm water contains (Table 1) enter the waterway untreated (Metro Vancouver, 2009).

Table 1. Summary of common urban pollutants and their potential effects on the environment[1]

Pollutants	**Effects**
Sediments • Suspended solids • Turbidity	Stream turbidity Habitat Changes Recreation/aesthetic loss Contaminant transport Filling of lakes and reservoirs Channel capacity
Nutrients • Nitrate • Nitrite • Ammonia • Organic nitrogen • Phosphate • Total phosphorus	Algae blooms Eutrophication Ammonia and nitrate toxicity Recreation/aesthetic loss
Microbes • Total and fecal coliforms • Fecal streptococci • Viruses • E.Coli • Enterocci	Ear/intestinal infections Shellfish bed closure Recreation/aesthetic loss
Organic matter • Vegetation • Sewage • Other oxygen demanding materials	Dissolved oxygen depletion Odours Fish kills
Hydrocarbons • Oil • Grease • Gasoline	Human & aquatic toxicity Recreational/aesthetic loss
Toxic pollutants • Heavy metals (cadmium, copper, lead, zinc) • Organics • Hydrocarbons • Pesticides/herbicides	Human & aquatic toxicity Bioaccumulation in the food chain
Thermal pollution	Dissolved oxygen depletion Habitat changes
Trash and debris	Recreation/aesthetic loss

[1] Reproduced from ISWM Resource Guide: Case for Storm Water Management retrieved on November 18, 2009 from: http://iswm.nctcog.org/Documents/Resources/Case_for_Storm_Water_Management.pdf

However, integrated storm water management (ISM) is a more environmentally conscious method of storm water management. ISM focuses on dealing with runoff where it originates, not transporting it to another location (Table 2 shows the differences between traditional and integrated approaches to storm water management). This may involve mimicking or improving existing natural features that promote drainage, slowing the velocity of storm water to allow for water treatment, increasing green space, or redirecting storm water flow to an area that is more conducive to natural drainage.

Table 2. Integrated storm water management planning[2]

Traditional approach	**Integrated approach**
Drainage systems	Ecosystems
Reactive (solve problems)	Proactive (prevent problems)
Engineer-driven	Interdisciplinary team-driven
Protect property	Protect property and habitat
Pipe and convey	Mimic natural processes
Unilateral decisions	Consensus-based decisions
Local government ownership	Partnerships with others
Extreme storm focus	Rainwater integrated with land use
Peak flow thinking	Volume-based thinking

The Annapolis Rain Gardens Project (*Managing Water Resources in a Climate Changed World: An Annapolis Pilot Project*) sought to creatively manage storm and rain water runoff. The central goals of this project were:

1. To improve the quality of storm water before it enters other watercourses
2. To divert rainwater runoff from the storm water treatment system and use it effectively for lawn and garden irrigation
3. To increase the capacity of Annapolis Royal to mitigate projected impacts of climate change
4. Conserve water through improved resource management
5. To share methods and successes with other municipal units through tours and a report on lessons learned

[2] Reproduced from Source Storm water Management: A Guidebook for British Columbia (Stephens *et al.*, 2002).

Integrated stormwater beneficial management practises

A beneficial management practise (BMP)[3] describes an action or series of actions that reduce the environmental impact of an undertaking. An example could be paving a parking lot. Paving would be the undertaking, and the beneficial management practise could be adding a rain garden adjacent to the parking lot to detain and treat runoff. Although there are multiple BMPs for integrated storm water management, only the BMPs used in this project are highlighted within the body of this report. Resources for other BMPs can be found in Appendix E.

Rain gardens

One of the major methods of storm water treatment in this project was the use of rain gardens. These are depressed gardens of aesthetically pleasing water-loving plants. Rain gardens must be located approximately 3 m away from a building. Rainwater is directed into them through a downspout and into a vegetated swale or dry creek bed. The idea of a rain garden is not to absorb rainwater, but to create an attractive detention area where water can infiltrate into the ground, be used by plants or dispelled through evapotranspiration. It is not unusual to have water pooling in the garden after a precipitation event. However, the water should drain in a few hours (normal rain) or a few days (unusually heavy rain).

Rain gardens must be established on land that has little or no slope and must be in areas of well-drained soil. They are constructed to be slightly depressed to contain water that is directed into them. The size and depth of a rain garden is dependent upon soil type, slope of land and area of impervious surface that will provide water for the garden (Table 3). This table was taken from Harvesting Rain from the Pacific Northwest Rain Gardens (Water Stewards, 2008).

Table 3. Factors for Sizing Rain Gardens

Slope of land		Less than 5%	5%-8%	8%-12%
Rain Garden Depth		7.5-12.5 cm	15-17.5 cm	20 cm
Rain Garden Size Factors	Sandy soils	0.19	0.15	0.08
	Silty soil	0.34	0.25	0.16
	Clay rich soils	0.43	0.32	0.20

To determine the rain garden sizing factor, the slope of the land must be determined. Soil type must be identified. Where slope and soil type intersect on the table is the appropriate rain garden sizing factor. For example, if the slope is 11% and the soil is clay, the sizing factor would be 0.20. The rain garden depth would be 20 cm. Figure 1 is an example of determining rain garden size.

[3] In this report the phrase 'beneficial management practises', abbreviated as BMPs is used. In other literature, especially older publications 'best management practises' is also abbreviated as BMPs is used. Beneficial (as opposed to best) is preferred because best is a subjective term and often does not designate who or what the practise is best for. Therefore, beneficial is used instead.

$$\text{Example: } \frac{Slope}{11\% \rightarrow 0.11} x \frac{\begin{matrix} Soil \\ Type \end{matrix}}{clay} x \frac{\begin{matrix} Garden \\ Depth \end{matrix}}{0.2m} x \frac{\begin{matrix} Size \\ Factor \end{matrix}}{0.20} x \frac{\begin{matrix} Area \\ Drained \end{matrix}}{1125m^2} = \frac{\begin{matrix} Garden \\ Size \end{matrix}}{4.9m^2}$$

Figure 1. Sizing the rain garden

There are three zones within a rain garden (Figure 2). The zone in the very centre is the lowest lying area and will be the wettest part of the garden. The next zone encircles the centre and is a slightly less wet area. The third zone is the outermost ring of the rain garden. It is the driest part of the rain garden and also the closest in elevation to the surrounding land.

A list of native plants suitable for a rain garden has been generated and can be found in Appendix A. These plants are suggested because they are adapted to the climate, soils and pests in Nova Scotia and therefore require very little maintenance beyond the first year or so. Native plants also protect native biodiversity by competing with invasive species as well as providing habitat, shelter and food for a variety of wildlife species. Some native plants also have phytoremediation potential to mitigate environmental problems. For example, the common cattail (*typha latifolia*) is able to sequester heavy metals in its roots, which can be encapsulated for many years if undisturbed[4].

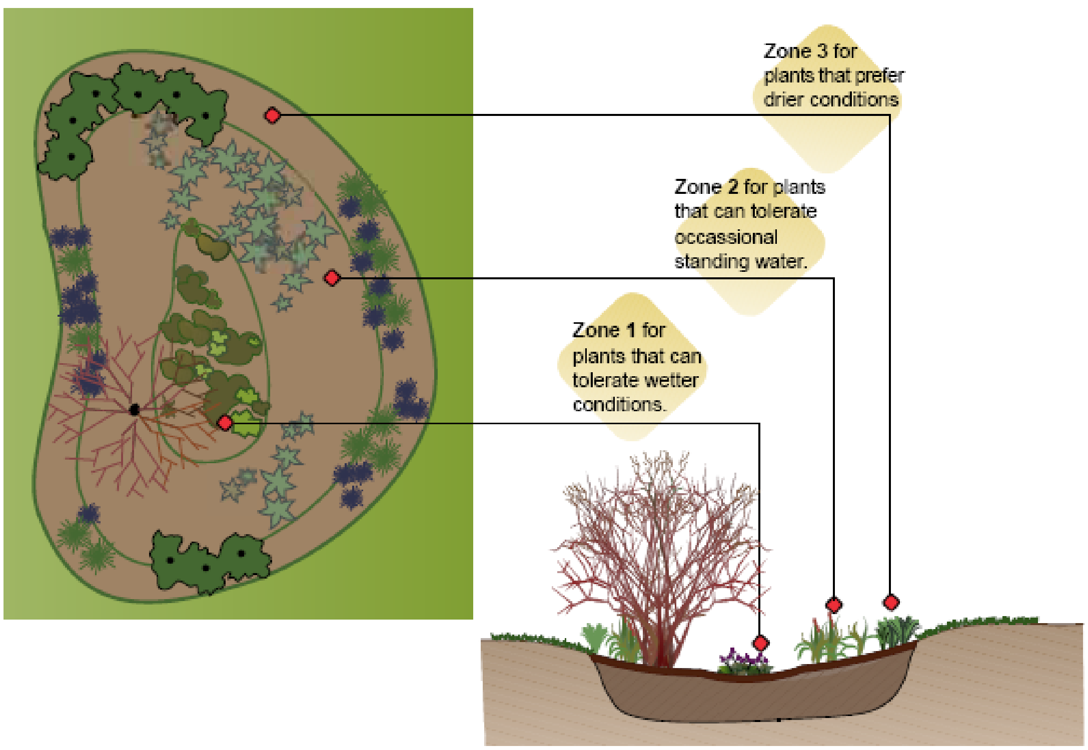

Figure 2. Schematic illustration of rain garden with three zones indicated[5].

[4] It is not anticipated that significant concentrations of heavy metals will be present in the soil or water where these rain gardens are constructed. If an area were heavily contaminated then a special harvesting and disposal protocol would need to be devised for the plants.
[5] This image is the property of Washington State University Pierce County Watershed Stewards. It was retrieved from http://www.pierce.wsu.edu/Water_Quality/WSS/index.htm on August 25, 2009.

Dry creek bed

A dry creek bed is a way of creating an attractive feature and transporting runoff on a property. A dry creek bed is a small trench that mimics the meanders of a natural waterway. A semi-permeable fabric such as plastic or landscaper's fabric is laid over the trench and the trench is filled with pebbles and gravel. Larger rocks and ferns can be added for visual interest. As a general rule dry creek beds tend to be wider than they are deep. Images of a dry creek bed can be found in Appendix B.

Check dam

A check dam is a small-scale dam constructed in a swale or channel to reduce flow velocity of runoff and overland flow by reducing the slope's gradient. By slowing the flow velocity, erosion is reduced, debris and sediment are able to fall out of suspension and water filtration is improved. These structures are most commonly used for their ability to reduce erosion.

Rain barrels and gravity fed irrigation

A rain barrel is a container that is used to collect and hold water. It can be a regular barrel refit with a tap or a store bought model. Some rain barrels contain a spigot near the base to fill watering cans and some have removable tops for access. For gravity fed irrigation, barrels are placed on platforms with a hose attached to the spigot. The pressure of the water in the barrel combined with the force of gravity will send water out the hose when the spigot is open.

Retention ponds

A retention pond is a storm water management feature that receives water from drains, pipes, and culverts (Winnipeg, 2009). The storm water is released over time, usually a few days, through soil infiltration and evaporation (Canadian Mortgage and Housing Corporation, 2009). Not only do retention ponds protect downstream aquatic habitats from erosion and scouring, but they also improve water quality. Suspended particulates settle out in times of slower flow velocity. Plants, algae, and bacteria can remove pollutants from the water (Table 4; Canadian Mortgage and Housing Corporation, 2009). Retention ponds are different from detention ponds, in that there is always water present (Canadian Mortgage and Housing Corporation, 2009).

Table 4. Pollutant removal by plants[6].

Pollutant	Removal efficiency
Plant nutrients • Total phosphorus • Total nitrogen	 Moderate to high Moderate
Sediment • Total suspended solids	 High
Metals • Lead • Zinc	 High Moderate
Organic matter • Biochemical and chemical oxygen demand	 Moderate
Oil and grease	High
Bacteria	High

Cisterns

Cisterns are tanks that are designed to collect and store water. They are often used to collect rainwater for irrigation purposes. They vary in size from small rain barrels or toilet tanks that can store several litres of water to very large, such as underground facilities capable of storing thousands of cubic metres of water. For a homeowner, cisterns ranging in capacity from 200 – 7500 litres are likely the most practical sizes depending on several factors, such as drainage area, average rainfall and size of area that will be watered.

Rainwater collection systems are useful for many different types of people and organizations, such as:

- towns with public gardens, planters and/or hanging baskets.
- businesses such as nurseries, ornamental gardens and farms.
- residents who have large lawns and gardens and whose water is supplied by a municipal system.
- rural homeowners whose wells dry up seasonally.
- arid locations that often experience water shortages and places that do not have their own groundwater supplies, such as small, ocean-bound islands.

Rainwater collected by cisterns is suitable for irrigation and washing items such as cars. It is not suitable for human or livestock consumption without prior treatment.

Cisterns perform a similar function to rain barrels, but on a larger scale. They are capable of holding much larger amounts of water, but are more elaborate and have a higher initial cost. The construction or installation of a rainwater cistern will likely require the services of a contractor (City of Indianapolis, 2008) and may need to be installed to comply with local building codes. Generally, the use of cisterns is more practical for larger operations, but the cost is not prohibitive for private homeowners.

[6] Table reproduced from: http://www.cmhc-schl.gc.ca/en/inpr/su/waho/waho_010.cfm. On November 10, 2009.

A variety of methods and materials can be used to make cisterns. Some are custom-built out of materials such as brick, concrete and ferrocement, a composite building material. For a more decorative look, materials like wood or stone and mortar can be used. In addition, ready-made tanks made out of metal, polypropylene or fibreglass can be purchased (Texas Water Development Board, 2005). Cisterns can also be adapted from other materials and containers. For instance, a large, clean steel culvert can be placed on its side and sealed, or surplus unused septic tanks can be converted into cisterns. Many of these will need to be lined with plastic before they can be used, especially ones made of wood, concrete, stone, brick and metal.

A rainwater harvesting system that uses a cistern is composed of several parts: a drainage system, the cistern itself, a mechanism for controlling overflow and a delivery system. The drainage system may involve the redirection of downspouts or the installation of French drains to direct runoff water toward the cistern. This should also contain some screening or a first-flush diverter to keep debris and dust out of the cistern. The delivery system provides a method of using the rainwater and may be as simple as having a faucet on the cistern or as complicated as installing a pump and plumbing.

Ideally, cisterns are placed so that they will receive runoff water from a non-permeable surface such as a roof or parking lot. They can be placed either above ground or underground. There are advantages and disadvantages to each option (Table 5).

Table 5. Advantages and disadvantages to above and below ground cisterns.

Position	Advantages	Disadvantages
Above Ground	- Possibility of a gravity-fed delivery system - Simpler and less expensive to install; does not require excavation - Problems such as leaks or rusting are easier to identify and repair	- Possibility of freezing in the winter - Subject to high winds and extreme weather - Problems with aesthetics. Cisterns tend to be large and may not fit in with the landscape - Limits drainage surfaces to those above the ground, such as roofs - More likely to have algae growth, especially if it is not completely opaque - If at an elevated level, the cistern will become very top heavy, posing a risk of falling over
Below Ground	- Not exposed to the sun, whose ultraviolet rays can harm some types of containers - Less subject to extreme weather; less likely to freeze in winter - Can be larger and more elaborate - Out of sight - Surfaces like roads and parking lots can be drained into the cistern	- More expensive to install; generally requires an excavator - More difficult to perform maintenance if necessary - Must be conscious of surrounding soil composition, rocks and nearby rooting systems - Must be conscious of how the weight of the cistern will compact the soil - A pump is required to move water

Project Implementation

Annapolis Royal Historic Gardens

The Annapolis Royal Historic Gardens are comprised of 17 acres, 10 of which are cultivated and 7 of which are marshland. There are over 1500 different plant species within the garden. The Gardens feature an innovative garden, an Acadian potager (kitchen) garden, and over 200 different rose cultivars. With such a large area and many water thirsty plant species, irrigation is not only a major task, but also a major expense. The Historic Gardens partnered with the Clean Annapolis River Project on this project to find creative, economical solutions to their water needs and reduce the use of potable water. For images, refer to Appendix B.

Rainwater collection

Entry

The terra cotta style barrels were placed in the main entrance to the Gardens. They are made of plastic and they are fed from the downspout by tubing. When the barrel is full, the water bypasses the barrel and empties out through the downspout. The top is also a planter, adding to the beauty of the barrel and giving it a more natural look. It has a spigot two thirds of the way down the barrel for filling watering cans. There is also a hose attachment at the base of the barrel for localized watering.

Innovative garden

The Gardens received two metal drums as a donation. A local metal worker refitted these drums with threaded attachments for hoses. A piece of window screen has been secured over the top of the barrel to keep leaves and other debris out of the water. The downspouts have been refitted with an elbow to direct the flow into the barrel. The overflow is directed out a soaker hose near the top of the barrel. Currently three beds in the innovative garden are receiving drip or soak irrigation. The plan is to eventually have all beds and planters in the innovative garden on this irrigation system. Drip irrigation is a hose system with a small hole at the end of the hose inserted directly into the soil, which releases a single drip at a time. This is best suited for singular plants like tomatoes or peppers.

The third type of barrel is a collapsible, vinyl barrel. By putting this barrel on a platform, beds are watered using gravity and the mass of the water in the barrel. A soaker hose is connected to the spigot and water is released when the spigot is open. A soaker hose is essentially a hose with small holes in it that weeps water when the spigot is open. This works well with gardens that are planted in rows.

Kerr house

The Kerr house is one of the Gardens buildings. Eaves troughs have been added to this building and rain barrels have been purchased to collect rainwater for irrigation within the Garden.

With all rain barrels combined, the gardens could collect 1,500L of water each time it rains (assuming enough precipitation falls to fill the barrels). This could translate to total of 92,000L of water during the months of April to October. This could be a potential savings of $80/year[7].

Sullivan rain garden

The Sullivan property is relatively low-lying. When it rains, runoff from the adjacent road often enters the front yard. Previously the runoff was making its way into the dirt basement of this house and a drain was redirecting the water into the town storm water waste stream.

A small dry creek bed was developed along the side of the house to bring rainwater from the downspout to the rain garden located in the back yard (See Appendix B). Water was already running in this area and the homeowner suspected that it was infiltrating the basement walls. The dry creek bed was dug and landscape fabric was placed inside the trench. The trench was filled with pebbles and rocks, forming a connection to the rain garden situated 6m away from the foundation. The rain garden area (~ 2.6m^2) was established based on soil type, slope, and rainfall (Table 3). Overflow from the rain garden is directed towards the back of the lot where there is an existing ditch.

The garden contains species such as bog rosemary, spirea, irises, arabis, and purple Albany St. John's wort. Bog rosemary and spirea are native species that grow in wet environments. The other species are ornamentals. These plants will slow the flow of water and absorb it through their roots. The depression will allow the water to pond and infiltrate the ground or evaporate. In the event of an extreme precipitation event, the rain garden will simply overflow and run downhill to the back of the property. Bark mulch was added to the garden to retain moisture in the soil and reduce erosion.

Annapolis Home Hardware

In the summer of 2009, the Annapolis Home Hardware expanded operations at a new site. At the new site there are two buildings. The larger building (100' by 100'; 10,000 ft^2 ~3,000m^2) is the main store. The second building (120' by 70'; 8400 ft^2 ~2,500m^2) is the lumber warehouse. There is a possibility of expanding to a second warehouse building in future years. It would likely be smaller than the existing buildings. The existing buildings combined with the parking lot create a significant amount of runoff. There are ditches all around the property but there are lots of opportunities for improvement in terms of storm water management and filtration. As it stands now, the majority of the water from the site is directed into the French Basin via ditches.

[7] This value was calculated by determining the number of days there is a rainfall over 5mm in Annapolis Royal for the months April to October (~62 days) and multiplying this number by the total volume that can be collected by the rain barrels (~1,500L). Savings were calculated by multiplying the total volume of water by the unit price the Historic Gardens is charged for water. Precipitation data was retrieved from Environment Canada's National Climate Data and Information Archive on November 18, 2009:
http://www.climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html?Province=NS%20%20&StationName=&SearchType=&LocateBy=Province&Proximity=25&ProximityFrom=City&StationNumber=&IDType=MSC&CityName=&ParkName=&LatitudeDegrees=&LatitudeMinutes=&LongitudeDegrees=&LongitudeMinutes=&NormalsClass=A&SelNormals=&StnId=6289&&autofwd=0

A cistern will be installed below the frost line to receive runoff from the store. This will provide sufficient water for the garden centre. Any overflow could be directed into a ditch beyond the garden centre. Most of the ditches on the property will undergo a naturalization process, adding native water loving species to reduce flow velocity and reducing sediment loading and promoting water filtration. The ditch adjacent to the garden centre will be open to the public to act as a demonstration site.

A $50m^2$ retention pond will be constructed adjacent to Highway 1 and will receive runoff from the warehouse, driveway, and possibly from the highway. It will be designed to resemble a marsh so that the water from the site will receive treatment before entering the French Basin. If a second warehouse were to be built a second retention pond would be constructed to receive its runoff. It would be similar to the first, except smaller in size, as it would receive less water.

The work on this project is scheduled to begin in the 2010 summer season. A conceptual design can be found in Appendix C.

<u>Town of Annapolis Royal stormwater management infrastructure</u>

The Town of Annapolis Royal is constructing a storm water retention pond that will also act as a back-up supply of water for the fire department. Currently, the fire department uses potable water during fire practice, but when the pond is constructed it will supply water for practice. The pond will allow sediments and debris to settle out of the water and provide filtration. It will also serve as habitat for aquatic species. As the pond water will be replacing the use of potable water in fire practice, it will be a better use of water as a resource, conserving economically and environmentally expensive drinking water. By using untreated water, this will reduce the water drawn from the town supply. In turn this will reduce the energy and resources required to treat the water as well as reduce wear on the equipment through reduced use.

Currently, details are being finalized for this plan. The construction will take place over the winter and be completed by the end of the fiscal year.

<u>Annapolis Royal train station demonstration rain garden</u>

At the Annapolis Royal train station there is a large ditch on the southeast side of the property bordered by the old railway line. The ditch is approximately 210m in length (from St. George Street to the entrance of the French Basin Trail). There are a variety of nonnative plants growing in and around the ditch. Examples include lupines, multiflora rose, and vetch. However there are also dispersed natural wetland plant communities containing common cattails and rushes. This ditch receives rainwater from St. George Street as well as overland flow from the train station lawns. It may also receive runoff from the parking lot and other homeowner properties that border the area.

This is an ideal site for a demonstration rain garden. The old railway line leads to the popular French Basin Trail. The trail is used daily by members of the community with many passing between the train station and this ditch. Although the invasive multiflora rose is slowly encroaching on more land each year, a significant portion could very easily be removed. The ditch will be developed from where it originates at St. George Street to the train station, creating a rain garden approximately 60m long.

Several steps are necessary to convert this ditch into a rain garden. First, invasive species will be removed using an excavator. Second, a series of check dams will be installed to slow the runoff flow velocity. The check dams will be constructed of large rocks (approximately 25 cm in diameter) placed together. The third step will be adding sediment in between the check dams. The bottom layer will be gravel (~6 cm diameter) with a soil mix on top of that. These layers will be thick enough to gradually decrease slope by bringing them almost to the height of the check dams. The fourth step involves adding native plants and shrubs. These plants will provide pollution filtration and act as barriers to further slow the flow of runoff. It will essentially be a series of tiered rain gardens.

This rain garden will be completed during the 2010 summer. It will serve as a demonstration site, highlighting the importance of removing invasive species and creating native habitats, as well as environmentally friendly runoff management.

Work plan:

The landscaping company that will be designing and installing the rain garden has developed a work plan for the project. It is described below and a conceptual design for the rain garden and can be found in Appendix C.

Fall 2009:
Complete conceptual design
Collect materials and transport them to the worksite
Plant collection and propagation
Plant sourcing

Winter 2010:
Plant sourcing

Spring 2010:
Rain garden construction
- Removal of invasive species and ditch excavation
- Construction of check dams
- Addition of gravel and soil layers
- Addition of native plants

Summer 2010:
Completion of rain garden with ongoing maintenance and improvement as required

<u>Homeowner rain barrels</u>

Eight refitted rain barrels were distributed within Annapolis Royal. The plastic blue barrels hold up to 190L. A small hole was drilled about 20 cm from the bottom of the barrel for the spigot. A hole was drilled in the lid of the barrel and a PVC reducer pipe was covered with window screen and fit into the hole to receive rainwater from the downspout, as well as filter out debris and prevent the creation of mosquito habitat.

Each homeowner was given a small packet of information on general rain barrel maintenance tips. Other community members received information on how to build a rain barrel of their own.

During the months of April to October each homeowner has the potential to collect over 11,000L of rainwater[8].

A brochure containing instructions on how to construct a rain barrel was designed and printed. These instructions were based on directions by the North East Avalon Atlantic Coastal Action Program and the Conservation Corps of Newfoundland and Labrador (No date). The brochure included what supplies are required, the procedure of how to make a rain barrel and information on how to set up a downspout and diverter system to collect rainwater. Several copies of these brochures will be distributed to local nurseries and gardens. In addition, copies of the pamphlet will be distributed with the Town of Annapolis Royal's monthly newsletter, the Town Crier. There are approximately 450 recipients for this newsletter. This brochure is also available on the Clean Annapolis River Project's website at http://annapolisriver.ca/downloads/rain_barrel_brochure.pdf.

Study tour

Study tours were developed to capture two main audiences: gardening clubs and enthusiasts and public works employees. The tour included stops at the Annapolis Royal sewage treatment plant, Annapolis Royal Historic Gardens, the Annapolis Royal Train Station, homeowner rain barrels, and the Sullivan rain garden.

Three tours were completed with the Middleton Public Works Department, Berwick Public Works Department, and Digby Regional High School Envirothon team.

The Middleton Public Works attended the first tour. As the town is installing a water treatment wetland to receive water from the sewage lagoon, it was an excellent opportunity for public works to participate in this tour. This presented Public Works with valuable information about wastewater treatment wetlands and creative, ecologically focused methods for managing storm water runoff.

The Berwick Public Works Department participated in the second tour. The Town of Berwick is very interested in actions that lessen their environmental impact. The Town follows a no idling policy, has installed LED bulbs for streetlights, and has purchased town vehicles that can burn biodiesel. The tour

[8] This value was calculated by determining the number of days there is a rainfall over 5mm in Annapolis Royal for the months April to October (~62 days) and multiplying this number by the total volume that can be collected by the rain barrels (~190L). Precipitation data was retrieved from Environment Canada's National Climate Data and Information Archive on November 18, 2009: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html?Province=NS%20%20&StationName=&SearchType=&LocateBy=Province&Proximity=25&ProximityFrom=City&StationNumber=&IDType=MSC&CityName=&ParkName=&LatitudeDegrees=&LatitudeMinutes=&LongitudeDegrees=&LongitudeMinutes=&NormalsClass=A&SelNormals=&StnId=6289&&autofwd=0

participants mentioned that there is marshland in close proximity to their sewage lagoons and sewage outlet and that developing a tertiary treatment wetland for Berwick may be a possibility. They were also interested in the use of rain gardens and rain barrels as methods of storm water diversion as something that could be encouraged within the Town and used on private properties.

The Digby Regional High School Envirothon team attended the final tour. Envirothon is a high school environmental science competition. Each year a different environmental issue is selected as a topic and this year it is Protection of Groundwater through Urban, Agricultural, and Environmental Planning. The study tour was an opportunity for the team to understand how better use of water as a resource can protect groundwater resources.

Cistern leaflets

A one page, double-sided leaflet describing the possible applications of larger scale rainwater collection systems using cisterns was prepared. The leaflet described potential uses of cisterns, outlined some construction materials and described possible setups for the collection system. This leaflet can be found at http://annapolisriver.ca/downloads/cistern_leaflet.pdf.

A distribution list for this leaflet was drawn up. This list included different organizations within the watershed as well as the surrounding region, such as garden centres, nurseries, building centres, ornamental gardens, municipalities and landscape designers.

Poster on stormwater management

A poster describing the benefits of stormwater collection and management was designed and printed (See Appendix B), and will be on display in the CARP office. The poster describes the potential uses of rain gardens, rain barrels and cisterns. The CARP office is housed in an old train station in Annapolis Royal and is a regular stop for locals and people visiting the area. In addition to learning about the station itself, these people usually take the opportunity to learn about CARP and its projects. Having this poster displayed in the CARP office will allow anyone who stops into the office to learn about stormwater and how management practices are beneficial. In addition, the poster displays are often taken to presentation and outreach events, which will allow this information to reach a wider audience.

Updates to the CARP website

Information on this project has been added to the Clean Annapolis River Project website. A section under the "Program Areas" tab called "Managing Stormwater in Annapolis Royal" contains information on the importance of managing stormwater and ways to help reduce runoff volumes. Information on rain garden construction as well as rain barrel and cistern installation has been included. The brochure on rain barrel construction and the informational leaflet on cisterns have been uploaded to this page. This page can be found at http://annapolisriver.ca/projects_raingardens.php.

Lessons learned

It would have been beneficial to have discussions with local greenhouse workers about rain gardens. Especially during the construction of the Sullivan garden there was some difficulty in obtaining plants suitable for a rain garden. As well, the rain garden construction took much longer than anticipated. Unfortunately the weather was a factor but that could not be helped. More time should have been budgeted to the process.

It may also be beneficial to begin this project earlier in the spring. If the project were to start in March, initial research could be conducted before the gardening season so that the project could take place during the height of the gardening season. Rain barrels could be used all season, there may be increased participation by gardening clubs and it may be easier to obtain suitable plants for the garden.

In terms of project management, there was a lot of reliance on project partners to complete actions previously agreed to. It would have been beneficial to set firm deadlines with partners for when these actions were to be completed. This way, expectations would have been clearer and overall project flow would have been much smoother.

Recommendations

This project has focused on demonstrating integrated storm water management. However, many of these 'demonstration sites' could very easily be replicated and widely applied within the Town. A list of easily incorporated integrated storm water BMPs are included below.

1. Encourage the use of rain barrels – This is a very inexpensive way to meet nonpotable water needs
2. Promote rain gardens – an aesthetic, ecological approach to gardening
3. Maintain vegetated buffers and wetlands – these provide natural water management and filtration
4. Incorporate ISM into new developments – retention ponds, rain gardens or rainwater collection systems are all possibilities and must be tailored to meet the needs of the development
5. Reduce road widths – this reduces impervious space
6. Redesign ditches to maximize retention time and reduce flow velocity – like the demonstration rain garden at the Annapolis Royal train station, other ditches can be managed to promote water filtration
7. Public education – an informed and proactive population is key to incorporating integrated storm water management into a community
8. Incorporate ISM into bylaws – several examples of bylaws from other communities have been included in Appendix D

Conclusion

Unlike conventional storm water management, integrated storm water management focuses on working with natural drainage patterns and ecosystems that detain and treat water. It is an economical as well as environmental approach. Rainwater is used in the place of potable water; therefore less water needs to be treated and fewer resources are used to do so. Less water is removed from the environment and runoff receives treatment before entering watercourses. By incorporating integrated storm water management, not only is storm water volume reduced but the Town's capacity to deal with storm water in greatly increased. Integrated storm water management will allow the Town to meet its storm water needs, while improving the quality of the local environment.

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Appendix A – Plants suitable for a rain garden

Native Water loving plants

Although these plants are native and can be found within natural ecosystems, harvesting them from the wild is *strongly discouraged.* Without proper experience, unintentional harm may be done.

Table A1. A list of native plants that are potential candidates for a rain garden[9]

Common	Height (cm)	Bloom	Colour	Natural Habitat	Soil preferences	Shade/sunlight	Place to purchase
Bog Labrador tea (*Ledum groenlandicum)*	50-150	Apr-Jun	White/cream	Wet Meadow/Field (less than 35-65% cover) Swamp/Marsh (nutrient rich) Fresh Water Aquatic (pond, lake, river)	Moist, wet, clay-sand-loam, Acidophile	Sun, partial shade, shade	Baldwin Nurseries
Blue flag iris (*Iris versicolor)*	60-90	May-Aug	Blue, Purple	Wet Meadow/Field (less than 25% cover) Swamp/Marsh (nutrient rich) Fresh Water Aquatic (pond, lake, river)	Moist, wet,	sun, partial shade, shade	Baldwin Nurseries, Springvale Nurseries
Wild raisin (*Viburnum nudum var. cassinoides)*	0-5m	May-Jul	White/cream	Swamp/Marsh (nutrient rich)	Moist, Sand, Loam	Sun, Partial Shade	Baldwin Nurseries, Windhorse Farm, Oceanview Garden Centre and Landscaping
Common serviceberry (*Amelanchier arborea)*	3-10m	Apr	White/cream	Woodland (35-60% cover) Riparian (edge)	Normal, Moist, Wet. Clay-Sand Acidophile	Sun, Partial Shade	Blomidon nurseries, Baldwin nurseries
Bog rosemary (*Andromeda polifolia)*	15-80	May-Jun	White/cream, pink	Swamp/Marsh (nutrient rich)	Moist, Wet. Sand, Loam Acidophile	Partial Shade	Bunchberry Nurseries

[9] This table was created with information collected from the EverGreen Native Plant Database. More information can be found at: http://www.evergreen.ca/nativeplants/search/

Common	Height (cm)	Bloom	Colour	Natural Habitat	Soil preferences	Shade/sunlight	Place to purchase
Ostrich fern (*Matteuccia struthiopteris)*	100-150			Woodland (35-60% cover)	Moist	Shade	den Haan's Garden World
Jack in the pulpit (*Arisaema triphyllum triphyllum)*	30-90	Apr-Jun	Purple, green brown	Forest (over 65% cover) Woodland (35-60% cover) Swamp/Marsh (nutrient rich)	Normal, Moist, Wet. Humus Enriched (forest floor)	Deciduous Shade (Spring Sun)	EL Summit nurseries
Swamp milkweed (*Asclepias incarnata)*	30-150	Jun-Aug	Purple, pink	Wet Meadow/Field (less than 25% cover) Riparian (edge) Swamp/Marsh (nutrient rich)	Moist, Wet. Clay, Loam	Sun	EL Summit Nurseries
New England aster (*Symphyotrichum novae angliae)*	0.9-201m	Aug-Oct	Blue, Purple, Pink	Meadow/Field Wet Meadow/Prairie/Field (less than 25% cover)	Dry, Normal, Moist. Clay, Sand, Loam	Sun, Partial Shade	EL Summit Nurseries
Blood root (*Sanguinaria canadensis)*	15-25	Mar-May	White/cream	Woodland (35-60% cover) Wet Meadow/Field (less than 25% cover) Riparian (edge)	Moist, Wet	Shade	EL summit nurseries, Oceanview Garden Centre and Landscaping
Marsh marigold (*Caltha palustris)*	30-60	Apr-Jun	Yellow	Woodland (35-60% cover) Wet Meadow/Field (less than 25% cover) Swamp/Marsh (nutrient rich)	Moist, Wet	Sun, Partial Shade	EL Summit Nurseries, Ouest-ville perennials, Village Nurseries, Oceanview Garden Centre and Landscaping, den Haan's Garden World
Goat's beard (*Aruncus dioicus)*	120-180	Apr-May	White/cream	Forest Edge	Moist	Shade	EL Summit Nurseries, Ouest-ville perennials, Woodlands and Meadows, Oceanview Garden Centre and Landscaping, den Haan's Garden World
Christmas fern (*Polystichum acrostichoides)*				Woodland (35-60% cover) Wet Meadow/Field (less than 25% cover) Riparian (edge)	Dry, Moist	Sun	Oceanview Garden Centre and Landscaping, den Haan's Garden World

Common	Height (cm)	Bloom	Colour	Natural Habitat	Soil preferences	Shade/sunlight	Place to purchase
American elder (*Sambucus nigra ssp. Canadensis)*	0.9-3.6m	Jun-Jul	White/cream	Forest Edge Meadow/Field Wet Meadow/Field (less than 25% cover) Riparian (edge) Swamp/Marsh (nutrient rich) Lakeshores	Moist, Wet. Clay, Sand, Loam	Sun, Partial Shade	Wind Horse Farm
Red-osier dogwood (*Cornus sericea)*	1-4.6m	May-Jun	White/cream	Forest Edge Wet Meadow/Field (less than 25% cover) Riparian (edge) Swamp/Marsh (nutrient rich) Fresh Water Aquatic (pond, lake, river) Lakeshores	Normal, Moist, Wet. Clay, Sand, Loam	Sun, Partial Shade	Wind Horse Farm, Village Nursery
Hobblebush (*Viburnum lantanoides)*	0.9-3m	May-Jun	White/cream, pink	Forest (over 65% cover) Woodland (35-60% cover) Riparian (edge) Swamp/Marsh (nutrient rich)	Moist. Clay, Sand, Loam Acidophile	Sun, Partial Shade, Shade	Windhorse farm
Common ladyfern (*Athyrium filix-femina)*	0-200			Forest (over 65% cover) Woodland (35-60% cover) Wet Meadow/Field (less than 25% cover) Swamp/Marsh (nutrient rich) Lakeshores	Normal, Moist, Wet. Humus Enriched (forest floor)	Partial Shade, Shade	Woodlands and Meadows Nursery
Turtlehead (*Chelone glabra)*	30-90	Jul-Sep	White/cream, pink	Wet Meadow/Field (less than 25% cover) Riparian (edge) Swamp/Marsh (nutrient rich) Fresh Water Aquatic (pond, lake, river)	Moist, Wet	Partial Shade, Shade	Woodlands and Meadows Nursery

Common	Height (cm)	Bloom	Colour	Natural Habitat	Soil preferences	Shade/sunlight	Place to purchase
Sensitive fern (*Onoclea sensibilis)*	0-60			Woodland (35-60% cover) Riparian (edge) Swamp/Marsh (nutrient rich)	Moist	Partial Shade, Shade	Woodlands and Meadows Nursery
Cinnamon Fern (*Osmunda cinnamomea)*	50-100			Woodland (35-60% cover) Swamp/Marsh (nutrient rich)	Wet. Acidophile		Woodlands and Meadows Nursery, Oceanview Garden Centre and Landscaping, Springvale nurseries, den Haan's Garden World
Maidenhair Fern (*Adiantum pedutum)*	30-60		Green/brown	Woodland (35-60% cover) Meadow/Field Riparian (edge)	Moist. Humus Enriched (forest floor)	Partial Shade	Woodlands and Meadows Nursery, Village Nursery

Table A2. Nurseries in Nova Scotia that carry native plants suitable for rain gardens.

Name	Phone	Location	Website
Blomidon Nurseries	542-2295	Wolfville	http://www.blomidonnurseries.net/home/
El Summit Nurseries	866-0541	Mt. Uniacke	http://plants.chebucto.biz/
Woodlands and Meadows Perennial Nursery and Gardens	895-8727	Truro	http://www.woodlandsandmeadows.ca/
Baldwin Nurseries	798-9468	Falmouth	http://baldwinnurseries.com/
Springvale Nursery	538-7007	Berwick	http://www.springvalenurseries.com/
Oceanview Garden and Landscaping	275-2505	Chester	http://www.plantcrazy.ca/
Ouest-ville perennials	762-3198	West Pubnico	http://www3.ns.sympatico.ca/ovp/
Village nurseries	543-5649	Pleasantville	http://www.villagenursery.net/
den Haan's Garden World	825-4722	Brickton	http://www.denhaansgardenworld.com/
Windhorse Farm	543 6955	New Germany	http://www.windhorsefarm.org/
Bunchberry Nurseries	532-7777	Upper Clements	http://bunchberrynurseries.ca/

Table A3. Additional suitable species with no known local commercial source.

Common	Height (cm)	Bloom	Colour
Speckled alder (*alnus incana)*	2-4m	Apr-may	Yellow green/brown
Smooth serviceberry (*amelanchier laevis)*	2-10m	Apr-may	White/cream
Canada anemone *(anemone Canadensis)*	20-70	May-Aug	White/cream
Wood anemone (*anemone quinquifolia)*	10-20	Apr-Jun	White/cream green/brown
Ironwood (*carpinus caroliniana)*	4-9m	Apr-May	Red, green brown
Buttonbush (*cephalanthus occidentalis)*	0-3.6m	Jul	White/cream, pink
Leatherleaf (*chamaedaphne calyculata)*	30-120	Mar-Jun	White/cream
Spotted water-hemlock *(cicuta maculata)*	90-180	Jun-Sep	White/cream
Alternate leaf dogwood (*cornus alternifolia)*	4-6m	Jun	White/cream
Gold hawthorn *(crataegus chrysocarpa)*	0-3m	May-Jun	White/cream
Shrubby cinquefoil *(dasiphora fruticosa floribunda)*	30-130	Jun-Oct	Yellow, white/cream

Common	Height (cm)	Bloom	Colour
Boneset (*eupatorium perfoliatum)*	60-120	Jul-Oct	White/cream
Northern bedstraw *(galium boreale)*	30-60	May-Aug	White/cream
Purple fringed orchid *(habenaria psycodes)*	30-60	Jul-Aug	Purple
Sweetgrass (*hierochloe odorata)*	30-60	May-Jun	Yellow
American water-pennywort (*hydrocotyle Americana)*		Jun-Sep	White/cream
Cranberry (*vaccinium macrocarpon)*	0-20	Jun-Aug	Pink
Small cranberry (*vaccinium oxycoccus)*	0-20	Jun-Jul	Pink
Bog blueberry (*vaccinium uliginosum)*	0-60	Jun-Jul	White/cream, pink
Blue vervain (*Verbena hastate)*	60-180	Jul-Sep	Blue, Purple
Squashberry (*Viburnum edule)*	100-200	Jun-Jul	White/cream
Highbush cranberry (*viburnum opulus var. americanum)*	2-3m	Jun-Jul	White/cream

Common	Height (cm)	Bloom	Colour
Flat-top white aster (*doellingeria umbellate)*	60-200	Aug-Sep	White/cream
Arrowhead (*sagittaria latifolia)*	30-120	Jul-Sep	White/cream
Pussy willow *(salix discolor)*	2-10m	Mar-Apr	White/cream, Green/brown
Pitcher plant (*sarracenia purpurea)*	20-60	May-Aug	Red, Purple
Softstem bulrush, great bulrush (*schoenoplectus tabernaemontani)*		Jul-Sep	Green/brown

Common	Height (cm)	Bloom	Colour
Marsh blue violet (*viola cucullata)*		May-Jul	Blue, purple
Common cattail (*typha latifolia)*	0.9-2.7m	May-Jul	Green/brown
Canada goldenrod (*solidago Canadensis)*	30-90	Aug-Oct	Yellow
Nodding trillium (*trillium cernuum)*	15-60	Apr-Jul	White/cream, pink

Appendix B – Project Images

Figure B1. Drilling the hole for the PVC reducer.
Figure B2. Drilling the hole for the spigot.

Figure B3. The spigot, o-ring, and faucet lock nut for the rain barrel.
Figure B4. A working rain barrel.

Figure B5. Creating the outline for the Sullivan rain garden.
Figure B6. Nearly dug out rain garden.

Figure B7. The completed rain garden.

Figure B8. Dry creek bed leading to the rain garden.
Figure B9. Laying the landscaper's fabric and securing it with staples.

Figure B10. Laying the rock in the dry creek bed.
Figure B11. Completed dry creek bed.

Figure B12. The vinyl, collapsible barrel at the Historic Gardens
Figure B13. A soaker hose

Figure B14. The refit metal drum at the Historic Gardens
Figure B15. Drip irrigation hose at the Historic Gardens

Figure B16. Clay pot styled rain barrels
Figure B17. The black tubing is the downspout diverter that fills the barrel.

Figure B18. Berwick Public Works employees participating in the study tour.

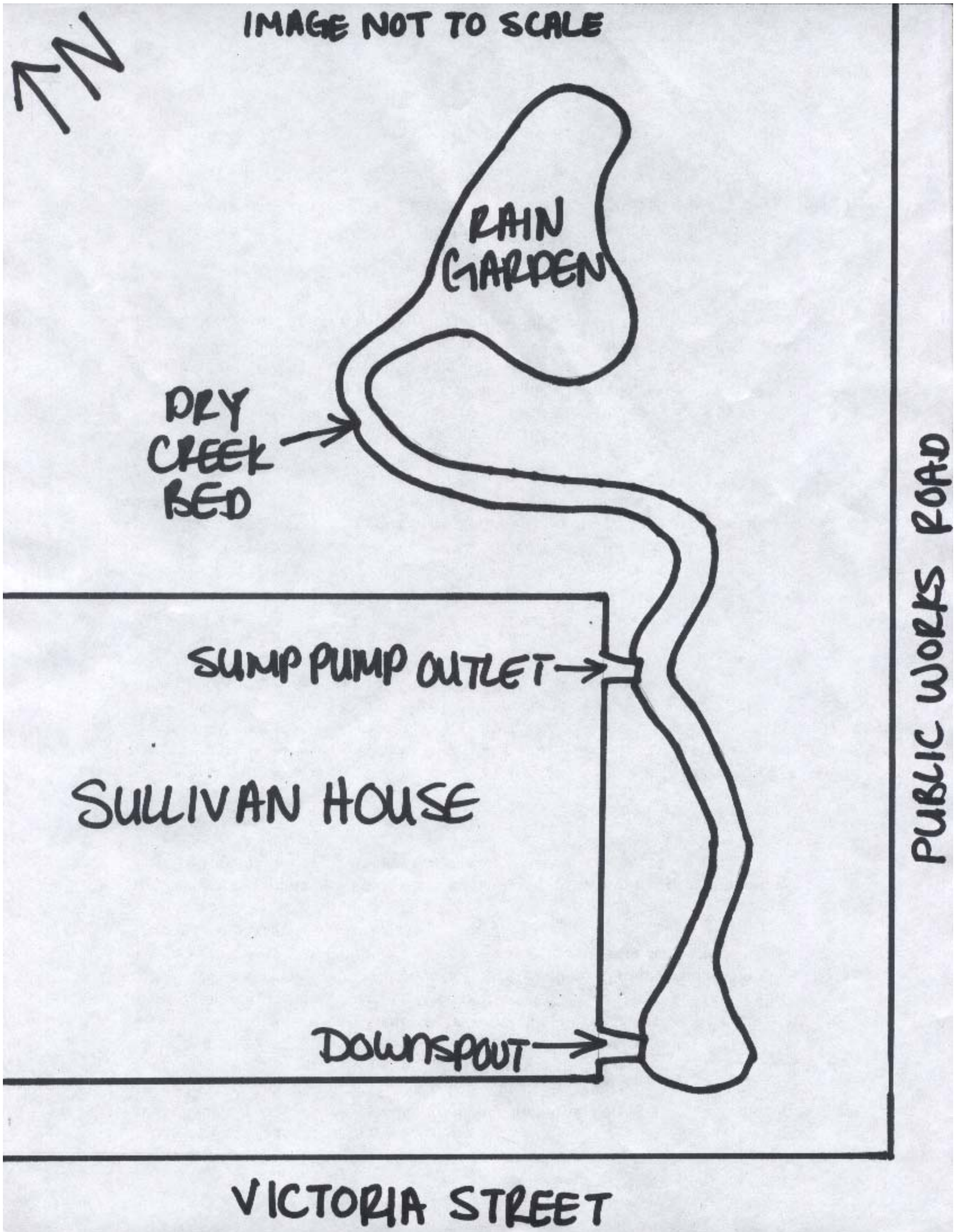

Figure B19. Site plan of Sullivan property after rain garden and dry creek bed were installed.

Managing Stormwater

Surfaces such as roads, parking lots and roofs are impermeable and prevent water from seeping into the ground. In some locations, this water enters the wastewater treatment system, which can cause a treatment plant to overflow, resulting in environmental damage. In other locations, stormwater is routed directly into waterways. During heavy rains, environmental contaminants such as oil, salt or rubber that have accumulated on impermeable surfaces can be flushed into watercourses.

There are several ways of reducing or delaying stormwater inputs. Rainwater can be collected using rain barrels or cisterns, storing it for later use. Rainwater drainage can also be incorporated into property landscaping, using features such as rain gardens.

Rain Gardens

These are depressed gardens filled with water-loving plants. Rain gardens collect rainwater from downspouts, often using dry watercourses.

The water pools in the garden, allowing it to nourish the plants and giving it time to infiltrate the ground, which prevents it from entering a wastewater treatment system. Rain gardens are dug to be deepest in the centre, where the most water-loving plants will be situated.

For rain gardens, native plants are used, which helps enhance natural biodiversity. In addition, some native plants have the capability of absorbing harmful toxins in water, such as heavy metals.

Rain Barrels and Cisterns

Barrels and cisterns can be configured to collect rainwater from downspouts, which can be used for a variety of purposes, such as irrigation or lawn watering. Not only will this reduce stormwater inputs into wastewater treatment systems, but it also reduces the use of potable water, which in turn can help save money.

Rain barrels are small, but versatile vessels that can be easily made with items readily available at hardware stores. Cisterns are larger storage systems that are ideal for bigger operations such as nurseries, ornamental gardens and farms. They can be made from a variety of materials and can be designed to fit in with the landscape of a property.

Project Partners

This project was funded by Environment Canada's ecoACTION community fund.

Figure B20. Display poster for stormwater management

Appendix C – Conceptual designs

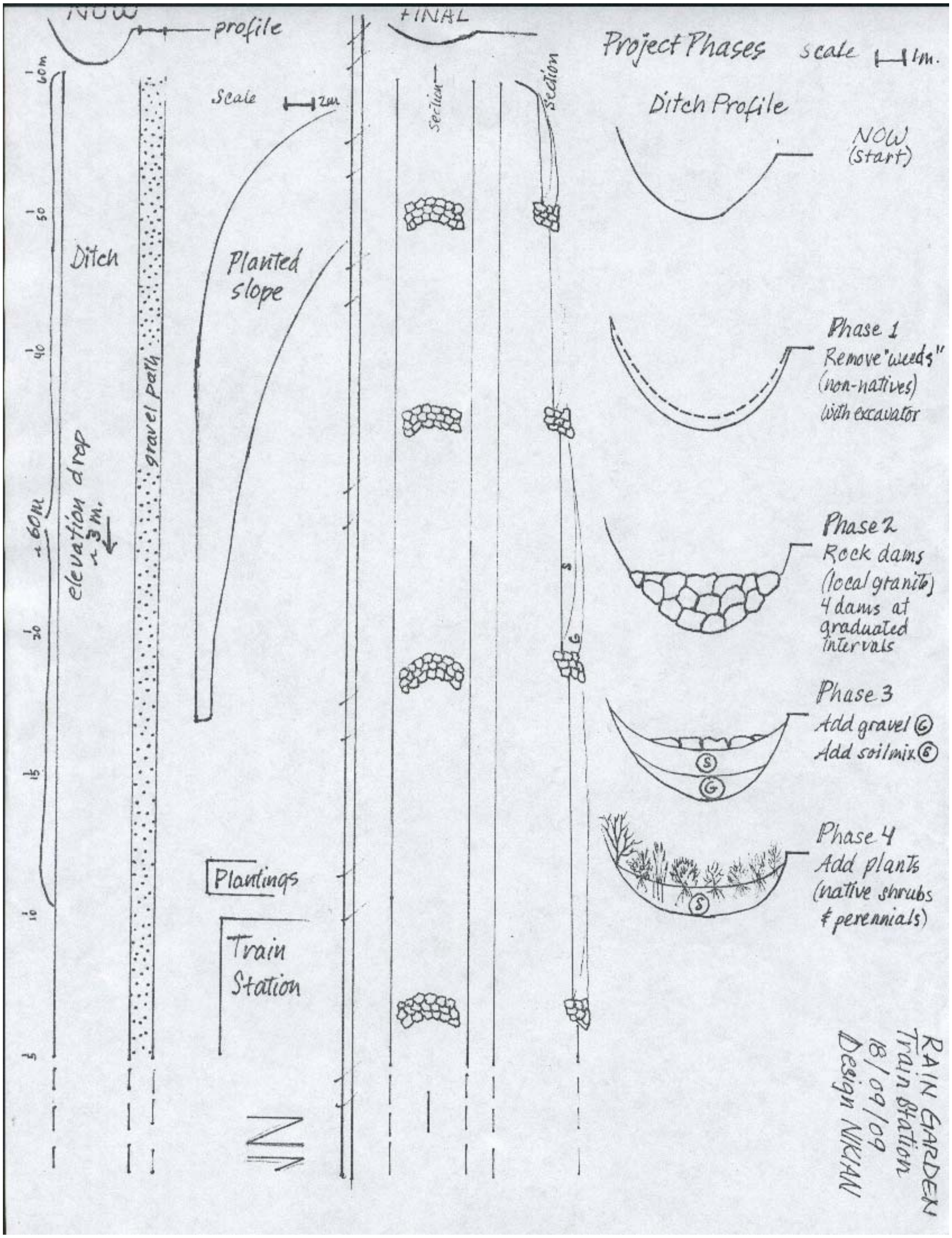

Figure C1. This is the conceptual design for the Annapolis Royal train station demonstration garden, completed by Nikian Landscaping.

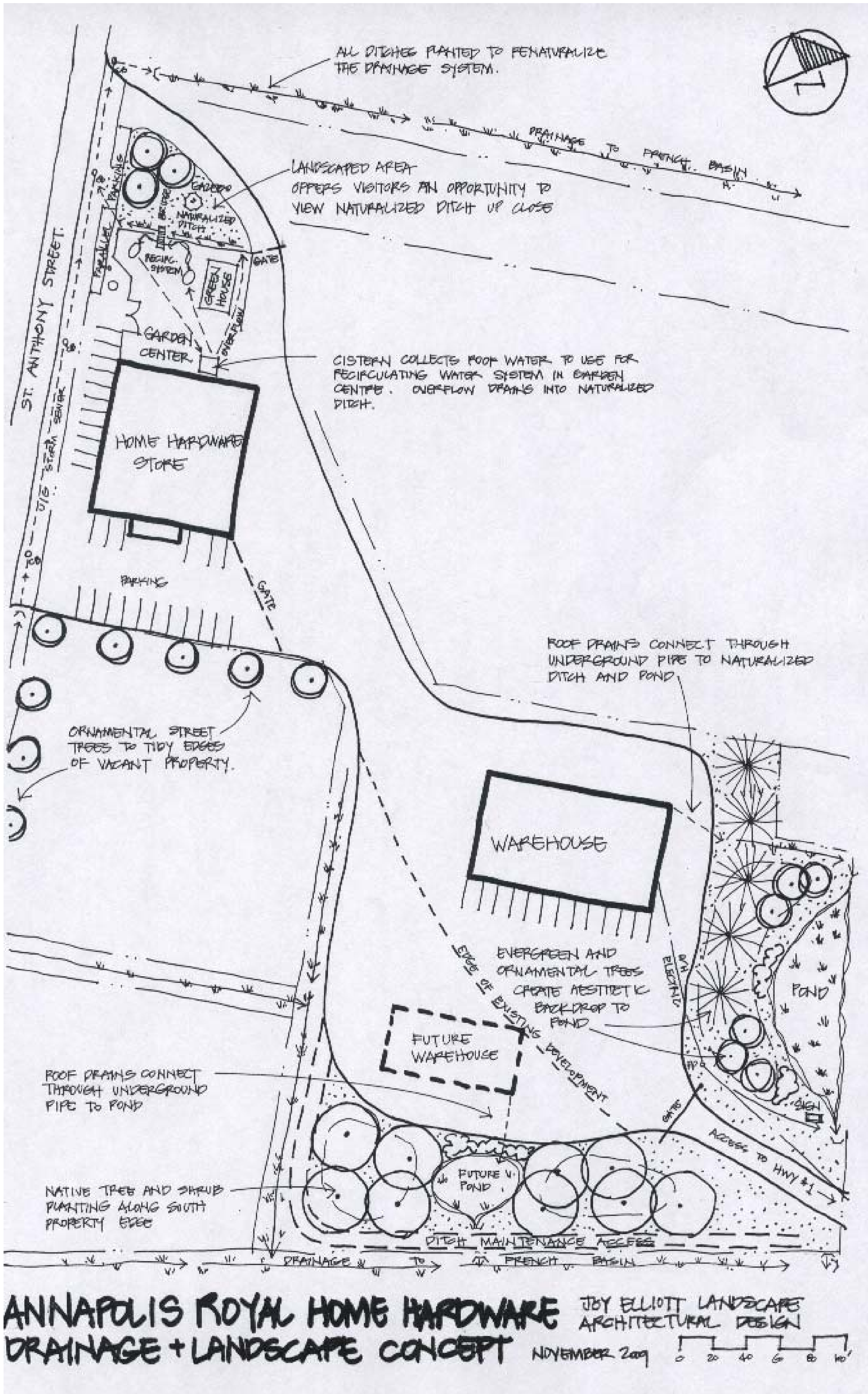

Figure C2. The conceptual design for storm water runoff management at the Annapolis Royal Home Hardware, completed by Joy Elliott Landscape Architectural Design.

Appendix D – Examples of municipal bylaws and primers for integrated storm water management

Resources

Source/Author(s): Deborah Curran
Title: A Case for Smart Growth
Location: http://www.wcel.org/issues/urban/sbg/
Summary:
This document has been developed by West Coast Environmental Law to provide a tool for governments to encourage smart growth through policy and bylaw. It explains smart growth, and provides case studies and examples of bylaws. It includes three parts: A Case for Smart Growth, Smart Bylaws – Summary, and Protecting the Working Landscape of Architecture: A Smart Growth Direction for Municipalities in British Columbia.

Source/Author(s): Massachusetts Government
Title: Model Low Impact Development (LID) Bylaw
Location: http://www.mass.gov/envir/smart_growth_toolkit/bylaws/LID-Bylaw.pdf
Summary:
This document, developed by the Massachusetts government, is an example of a low impact development bylaw. It is written in a way that it can be easily adapted to for another community to use.

Source/Author(s): Massachusetts Government
Title: Massachusetts Low Impact Development Toolkit
Location: http://www.mapc.org/resources/low-impact-development-toolkit
Summary:
This is a primer for a low impact development bylaw, which answers common questions such as: why develop the bylaw, and how will it work?

Source/Author(s): District of Lantzville
Title: District of Lantzville Subdivision and Development Bylaw No. 55, 2005
Location: http://www.lantzville.ca/upload/dcd263_BylawNo55.pdf
Summary:
This is the Lantzville bylaw for subdivisions and developments, which includes LID practises.

Source/Author(s): City of Coquitlam
Title: City of Coquitlam Low Impact Development Policy and Procedures Manual
Location:
http://www.coquitlam.ca/Business/Developing+Coquitlam/Development+Requirements/Subdivision+and+Development+Bylaw.htm
Summary:
This document is a supplement to the Coquitlam Subdivision and Development Bylaw. This manual outlines procedures and recommendations for storm water management that protects life and property, prevents erosion, improves water quality, and conserves social and financial resources. It is aimed at the homeowner/developer.

Source/Author(s): District of Central Saanich

Title: Integrated Storm water Management Plan – Appendix 16
Location:
http://www.centralsaanich.ca/Assets/Central+Saanich/District+Projects/ISMP+Appendix+16.pdf
Summary:
This Appendix contains examples of progressive storm water management bylaws in British Columbia.

Appendix E – Resources for integrated storm water management beneficial management practises

Resources

Source/Author(s): Gibb, A., Kelly, H., Schueler, T., Horner, R., Simmler, J. and Knutson, J.
Title: Storm water best management practises guide Vol. 1 & 2
Location: http://www.metrovancouver.org/services/wastewater/sources/Pages/StormwaterManagement.aspx
Summary:
This report examines BMP's in respect to Vancouver's economic, geologic, and climatic conditions. It is an excellent tool for evaluating cost efficiency and effectiveness of specific BMP's. Although created for Metro Vancouver, it can be adapted to other communities.

Source/Author(s): International storm water BMP database
Title: International storm water BMP database
Location: http://www.bmpdatabase.org/
Summary:
This is a database of storm water management BMP's. This database contains performance analysis results, tools for use in BMP performance studies, monitoring guidance, and other study-related publications.

Source/Author(s): Blair Conservation District
Title: Pennsylvania Storm water Best Management Practices Manual (2006)
Location: http://www.blairconservationdistrict.org/SWBMP.htm#pa%20manual
Summary:
Pennsylvania Storm water Best Management Practices (BMP) Manual is to provide guidance, options, and tools that can be used to protect water quality, enhance water availability, and reduce flooding potential through effective storm water management.

Source/Author(s): Low Impact Development Center, Inc
Title: LID Practises and controls
Location:
http://www.lowimpactdevelopment.org/lidphase2/lid_bmps.htm#Afforestation/Reforestation
Summary:
This is a website that gives a brief description of a variety of different BMP's.

Source/Author(s): Urban storm water Bow Basin
Title: Urban storm water basics
Location: http://www.urbanswm.ab.ca/usb.asp
Summary:
This website gives a fairly in-depth description of a wide variety of BMP's.

Appendix F – Resources for building a rain barrel

Web-based resources

PDF

Wise Water Use – joint initiative between Green Venture and the City of Ottawa
Retrieved on November 4, 2009 from:
http://water.greenventure.ca/instructions-make-your-own-rain-barrel

Make a Rain Barrel to Save Water
City of Medicine Hat
Retrieved on November 4, 2009 from:
http://www.medicinehat.ca/City%20Government/Departments/Utilities/Environmental%20Utilities/Solid%20Waste/How%20to%20Convert%20a%20Garbage%20Can%20to%20a%20Rain%20Barrel.pdf

Videos

Home and Garden Television's Gardening by the Yard program
http://www.youtube.com/watch?v=MGFDlkJOdaM

Lowe's Building Supplies – How to Make a Rain Barrel for Collecting Rainwater
http://www.youtube.com/watch?v=ueNXjPgdcqg&feature=related

Additional maintenance tips

Mosquitoes

- A tablespoon of olive oil in your water will keep mosquitoes from breeding.
- Make sure to empty your rain barrel completely once a week. This will kill all mosquito larvae that may be in your barrel.
- Use a fine piece of mesh where your downspout enters the barrel to block mosquitoes from entering.
- Make sure your barrel is covered between rain events. This will prevent mosquitoes and other animals from entering.
- Keep your barrel free of organic material.

Smell and algae

- Empty your rain barrel frequently (do not let water lay stagnant for more than a month). A capful of chlorine bleach can be added to a full barrel if algae begins to grow.

Clogged spigot

Sediment

- If your barrel accumulates sediment, agitate it when you are using the water. The sediment will suspend in the water and go through the spigot.

Other debris

- Your spigot may become clogged with debris that falls into your rain barrel. You can use a skewer to push material through the spigot. You can use cheesecloth or muslin as an additional filter for your rain barrel.

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Other useful links

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