Reduction of Impermeable Surface Effects:

A Rain Garden Proposal

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Executive Summary

Subject:

Impermeable surfaces are identified as either anthropogenic or those formed through natural processes (Shroder, 2010). For this project the focus will be directed at anthropogenic surfaces caused by the introduction of buildings, pavement and monoculture lawns.

Current Status:

The urbanization of watersheds has caused significant increases impermeable surfaces (CRD, 2012). As a result, most developments require a connection to the appropriate municipal stormwater system. These systems require periodic maintenance and are managed by the local governing authority. The City of Victoria is considering a model that benefits properties with permeable surfaces and penalizes those without. If approved, it may influence other municipalities in the Capital Regional District to introduce policies that penalize properties with impermeable surfaces.

Issue:

Impermeable surfaces reduce quality of stormwater as organic materials and pollutants that would normally be filtered through natural processes are carried into aquatic systems unless costly water treatment facilities are installed (Dunnett & Clayden, 2007). The increased quantity of runoff also contributes to erosion and potential flooding downstream. Furthermore, the redirected water is no longer available to replenish the vegetation or groundwater on site.

Proposal:

This proposal provides criteria for establishing rain gardens on campus to improve soil infiltration and ecosystem function. Furthermore, the document will provide targets and measureable objectives for a specific site. If effective, other areas on campus that fit the provided criteria may also be converted, drawing examples from this pilot project.

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1.0 – Introduction

With increasing urbanization across the globe the effects of impermeable surfaces have grown exponentially, wreaking havoc on the natural water cycle. Impermeable surfaces, which include roofs, paved and concrete surfaces, and lawns, do not allow infiltration of rainwater into the natural water table below. Instead, the water is captured by municipal drainage systems and sent, usually untreated, into local waterways. Water may also stagnate in low-lying and simply evaporate. Water gains speed and volume as it moves through a drainage system and when it is deposited in streams and rivers its force can be damaging to the ecosystem. Surges of water during a rainfall contribute to erosion and disturb sediment in the basin, further altering the terrain of aquatic ecosystems. Fertilizers, pesticides, oils and other chemicals also collect on roadways or are washed from lawns and make their way into waterways. This upsets the natural chemical balance in aquatic ecosystems and often results in algae blooms (Dunnett & Clayden, 2007). Stormwater runoff has been cited as the most common cause of water pollution (RCL Consulting, 2004, p. 1). It is therefore imperative to the health of our aquatic ecosystems to prevent large amounts of runoff by ameliorating the effects of impermeable surfaces at the source.

By using low-impact, bioretention based solutions to runoff of contaminated waters on the UVic Campus, we hope to reduce the effects of impermeable surfaces in the most efficient manner possible. Bioretention is "a land-based practice that uses the chemical, biological, and physical properties of plants, microbes, and soil to control both the quality of water and quantity of water within a landscape." (Dunnett & Clayden, 2007, p.38). A variety of techniques can be used in this approach including green roofs, green facades or vertical green walls, stormwater planters, porous pavement, planted swales, and constructed wetlands. Rain gardens have been diversely defined, but traditionally they are a "planted depression that is designed to take all, or as much as possible, of the excess rain water runoff from a building and its associated landscape." (Dunnett & Clayden, 2007, p.13) This is also known as a planted swale (RCL consulting, 2004) or infiltration strip (Dunnett & Clayden, 2007)

Due to logistical, funding, and time constraints we do not have the ability to actually tear up impervious surfaces such as paths or roads. Therefore, the traditional approach of a planted swale will be most effective. We have chosen a site that demonstrates the problem of considerable runoff as a starting point though there are many sites on campus that would benefit from a rain garden. Several of these sites are indicated in *appendix 9.2* and the basic framework laid out below can be used as a template to further the project across campus.

2.0 – Project Framework

2.1 - Guiding Policy:

"To reduce the amount of water runoff from campus caused by impermeable surfaces between the David Strong and Cornett Buildings. In place of stormwater pipes, rain gardens will be established so that water can be filtered and infiltrated through natural processes."

2.2 - Project Goals:

1 - ***"****Facilitate community engagement and accountability."*

To counteract the negative impacts and potential penalties of impermeable surfaces, this project will require community engagement to ensure that the public is made aware of these issues and can utilize practical solutions that do not compromise the values of the community. Potential stakeholders can be identified on and off campus.

2 - ***"****Reduce the amount of runoff that is re-directed off campus through stormwater drains."*

Current demands on stormwater systems paired with an increased frequency of storms due to climate change have caused some municipalities to reconsider utility fees. With a significant amount of stormwater being directed off campus, water is discharged into surrounding waterways and perversely impacts the surrounding ecosystems. By reducing the amount of water re-directed off campus, the University can reduce its environmental impact as well as its dependence on the municipal stormwater system.

3 - *"Identify potential sites that could benefit from rain gardens that utilize plants and techniques that require minimal maintenance."*

As a pilot project, the proposed garden between the David Strong and Cornett Buildings will set an example for future installments. While the initial set-up will be labor intensive, the maintenance and management of the established rain garden should be minimal to ensure a successful project.

4 - *"Where possible, utilize native plants that have historic cultural applications."*

To ensure that the cultural heritage of the Wsanec people is respected in their traditional territory, culturally significant vegetation that is appropriate for the site will be considered.

2.3 - Project Objectives:

1. Allow all water to filter naturally by establishing rain gardens that have the water-holding capacity to accommodate 50mm of weekly rainfall during the fall, but can function during the dry seasons.
   a. *Existing drains can be retrofitted with flow meters. This will establish an emergency overflow that can also indicate if the rain garden is successful.*
   b. *Rain gauges can be utilized to determine average rainfall at the project site, but initial data can be gathered from the Victoria School Weather Network, which has a rain gauge installed at the Social Sciences and Math building.*
   c. *Ecosystem Function will be prioritized during implementation and evaluated after the rain garden has been established.*

2. Facilitate public education surrounding the benefits of rain gardens and the project's potential.
   a. Construct an educational sign on site that explains the benefits and function of the project while indicating the potential for more rain gardens on campus.
   b. Create signage illustrating the various insects, invertebrates, birds and other animals observed using the area.
   c. Correspond with community organizations such as the Bowker Creek Initiative, the Capital Regional District (CRD) and community newspapers to communicate our project and its benefits.

3. Ensure that vegetation is established on site and requires little maintenance.
    a. Occasional watering and mulching will be required during the initial set up to ensure that invasive species and weeds do not gain a foothold.
    b. Maintenance requirements can be documented after the garden is established.
    c. Adhere to UVic's 75% quota of native plants for all newly introduced vegetation.

4. Observe a significant increase in native species on site.
    a. Measure the variety of species observed in spring, winter, summer, and fall by selecting three days per month to document insects, invertebrates, birds, and other animals that use the area.
    b. Create an inventory of native insects, invertebrates, birds, etc. that are observed on the site.

5. Promote the long term (5-10 year) vision for the project.
    a. Engage with the CRD to co-ordinate water testing from Bowker Creek establishing a baseline of water quality data and determining the need for water quality testing at Bowker Creek in the long term.
    b. Indicate potential sites that could benefit from this type of project.

2.4 – Regulatory Agencies: Relevant Policies

University of Victoria

Sustainability Action Plan Objectives

- Reduce the amount of impermeable surfaces on campus.
- Ensure that 75% of all new plants installed on campus are native to the region.
- Ensure that 50% of all natural areas on campus are healthy natural areas.

Capital Regional District

General Policies and Recommendations

- Encourage water to soak into the ground so that pollutants are filtered by soil and vegetation.
- Reduce the volume of runoff that flows into streams.
- Mimic conditions of natural wetlands to treat the runoff from impervious surfaces.
- Establish native plants to take up and filter runoff.

District Of Saanich

Official Community Plan Objectives

- Require building and site design that reduces the amount of impervious surfaces.
- Incorporate features that encourage ground water recharge.
- Support an integrated watershed planning approach that provides low impact development and healthy stream ecosystems.

District of Oak Bay

Official Community Plan Objectives

- Work with the University of Victoria and Camosun College to address issues such as the increased demands on water infrastructure.

3.0 – Site Analysis

3.1 – Historical and Cultural Conditions

All potential rain garden sites are located on the University of Victoria's Campus, which is constructed in the Coastal Douglas Fir Biogeoclimatic Zone. Historically, the area had high water retention rates as a result of its organic-rich topsoil and dense forest canopy (RCL Consulting, 2004). The territory, which has not been legally ceded, was home to Coast and Straits Salish people who originally constructed a village on site. Historically, Garry Oak ecosystems likely dominated the area, making it a prime spot for the cultivation of Camas bulbs (Office of Indigenous Affairs, n.d.).

A large portion of the land was converted into an airfield, including two runways and a flying clubhouse, in 1931. This development compromised most of the forest ecosystems that had survived previous settlement and agricultural development. This was followed by the construction of Gordon Head Army Camp in 1940, which was utilized to train recruits in World War Two. The land was purchased for Victoria College by the University Development Board two decades later and the construction of a new campus began in the early 1960s. The next several decades saw the completion of Ring Road and the construction of the buildings that are presently on campus (Turner & Lovell, 1999). There are still several naturalized areas on campus including Mystic Vale in the south-east portion, which is joined with South Woods. Students and community members use these areas for ecological study and recreation.

3.2 – Geography and Hydrology

Runoff from campus is diverted to "Bowker Creek [in] the west, Finnerty Creek [in] the north, Sinclare drainage system [in] the north east and Hobbs Creek [in] the east" (RCL Consulting, 2004, P. 1). Our initial proposed site diverts stormwater into the Bowker Creek hydrological plain (RCL Consulting, 2004). The soil type on most of the campus has been classified as having moderate to poor infiltration due to its dense sand and clay components (Farstand & Day, 1959). Currently, open lawns are subject to deep coring and top dressing to improve drainage and are watered in intervals to reduce runoff (Hocking, 2000). Of the 162 HA owned by the University, 23.5% can be classified as some type of impermeable surface. This proportion has risen by more than three times since the beginning of construction in 1956 (RCL Consulting, 2004).

Rainfall in the region has extreme seasonal variance to which native plants and animals are uniquely adapted. Consequently, native plants will be best suited to survive periods of low precipitation in the summer, followed by a significant increase in the fall. The area is also characterized as a relatively temperate zone with average highs of 22 degrees Celsius and average lows of around zero degrees. These moderate temperatures have created an ideal habitat, allowing several invasive species to become well establish on campus and in the surrounding community. Ground cover plants like English Ivy (Hedera helix) and shrubs such as Daphne Laurel (Daphne laureola) are prevalent in some areas around the project site. However, our inspection of the lawns and beds surrounding the site has revealed no threat. The immediate removal of invasive species will be an important aspect of site maintenance.

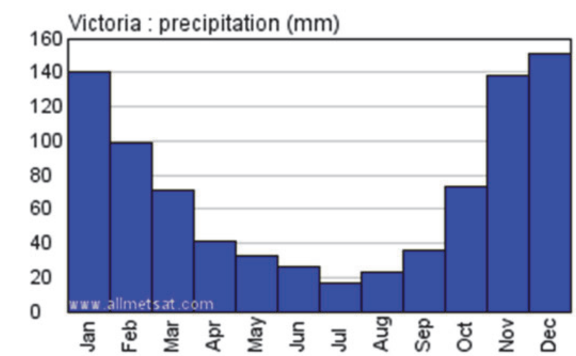

Figure 1.0 Average Annual Precipitation by Month

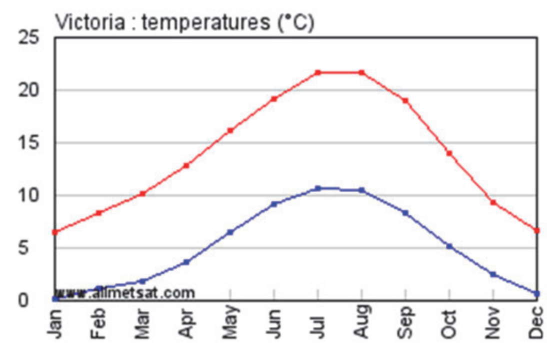

Figure 2.0 Average Temperature by Month
(Red represents average high, blue represents average low)

3.3 – Relevant Municipal and Campus Policy

Since the initial site is situated within the Distinct of Saanich, all policy developments have been made in consideration of the relevant bylaws and municipal regulations. The University campus, however, has portions situated within the District of Oak Bay (Figure 3.0). Since potential sites on campus have been identified within Oak Bay's jurisdiction, the policy considerations in this proposal have also recognized Oak Bay's requirements.

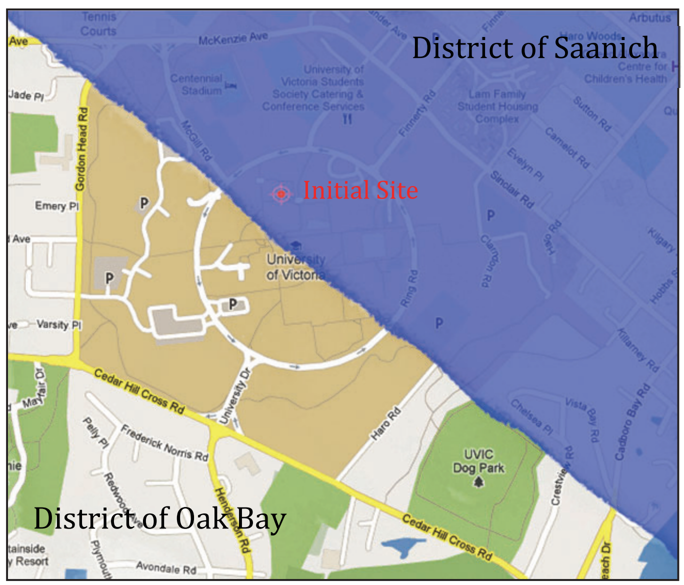

Figure 3.0 - District Division

The University's official goal is to reduce water runoff by 10% by 2012, however, only a few actions have been identified to help meet these goals. Efforts are being made to reduce water use for cosmetic purposes (Water management, n.d.). Other relevant goals include the commitment to remove all toxic chemicals used in routine landscape management by 2012. This lowers the potential negative effects of pesticides and herbicides on our initial site. Toxic chemicals will only be used by the university in extreme and isolated cases (Grounds, n.d.). The campus already uses planted swales and green roofs to manage stormwater runoff in some areas, including the Social Sciences and Math Building (sustainability: Grounds, n.d.). However, rain gardens have not been extensively developed on campus; one was constructed surrounding the Mearn's Learning Centre Building and another alongside the First People's House. According to grounds personnel, there is also a garden being planned by the University next to the Athletics Building as part of the CARSA project (B. Sly, personal communication, Nov 19, 2012).The paths surrounding our initial site are priority two for snow clearance. Snow clearance patterns may impact new plants and snow melt runoff (UVIC Grounds, 2012). While salt is used during heavy winter weather on the main roads, an alternative material with low ecological impact is used to melt ice on all pedestrian areas and will, therefore, not be a significant threat to our garden's health (B. Sly, personal communication, Nov 19, 2012).

Figure 4.0 – Inspecting Our Site

3.4 – Site Specific Conditions

Our initial site is planned for a stretch of low lying lawn adjacent to the north side of Cornett Building's C Wing (latitude 48.46 °N, longitude 123.32°W). The roughly rectangular stretch of lawn is approximately 60' x 30' and contains two small drainage pipes (12" in diameter). It is bordered by three high traffic pedestrian paths with stairwells that enter Cornett on the east and west borders. Based on our observation of the area at several times of the day, the lawn itself is not a high traffic area, therefore a garden will not be a significant impediment to students and faculty. The most significant species presence is the grass that comprises the lawn, although it is difficult to identify without seeing a full lifecycle, we believe it is Rough Bluegrass (Poa trivialis), a common species used for lawns in North America. Three young Red Maple trees line the north edge. Red Maples, native to Ontario, Quebec and the Maritimes, need deep, moist soils and grow up to 70 feet (Red Maples, n.d.). These will provide significant shading in the years to come but may benefit from increased ground water being held by the gardens. There is also a small length of Portuguese Laurel (*Prunus lusitanica*), a decorative shrub, along the south west wall of the building.

During heavy rains, runoff from most of the surrounding areas impact the site to different extents as it is comparatively low-lying. Based on our observations, water pools in the lower parts of the lawn and runs down the two drains. Once we obtain a flow meter it will be used to determine the quantity of water being directed off campus through the stormwater drains. This data will then be compared to measurements collected after the garden is established and used to evaluate its success. Water from various parts of Cornett Building's roof is directed through drainage pipes to isolated areas, mostly on the south and west faces, where the runoff is directed through stormwater drains. Therefore, it is unlikely that water from the roof will significantly impact our site.

4.0 – Site Plan

4.1 – Overview

The design of this project aims to incorporate aesthetically pleasing features that promote social awareness while maximizing the effectiveness and functionality of this rain garden. When choosing a location for this project, eleven other potential sites were identified (see Appendix 9.2). Using our criteria in the evaluation section to determine if this pilot project is successful, other rain gardens may be installed on campus in one or more of these sites.

Figure 5.0 – View from the northwest corner of the site

We chose our initial site based on its abiotic features. The middle area is already fairly level, which makes implementation easier. It is slightly downhill from water input, so there is no need for an input source because water is already diverted to the site based on existing topography. This location features two drainage pipes that can be modified to fit our design by capturing and measuring any overflow that may occur during abnormally heavy periods of rain. This area is also large enough for the garden to be placed 13 ft away the Cornett Building foundation to the south, thereby avoiding potential moisture problems (CMHC, 2012). The rain garden will be placed lengthwise about 15 ft from the western and eastern sides, having a total length of 30 ft. Widthwise, it will be 13 ft from the Cornett Building and 8 ft from the north side where the maples are situated. The garden will have a peanut-like shape with defined edges. It will be about 11 ft at its narrowest point and 13 ft at its widest. The emergency overflow drains will be located 3 ft inwards from the west and east sides, with approximately 24 ft of space between them. When the area is excavated, it will lie about 3 ft below the surrounding surface at its lowest point, with its side sloping about 45°. Figure 6.0 shows an approximation of the vertical structure we will be using in the garden.

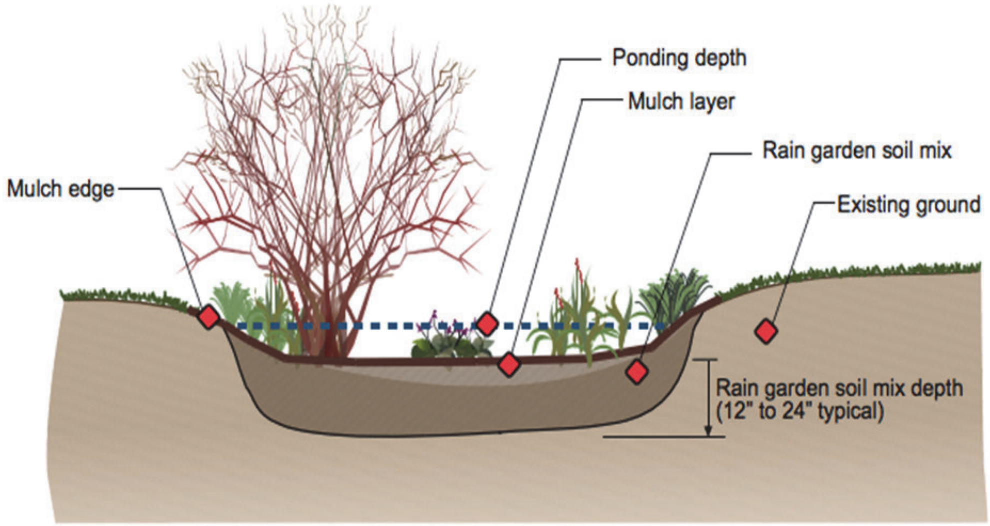

Figure 6.0 – Typical Rain Garden Cross-Section

Slight pooling does occur at this site during prolonged periods of rain, indicating that there is poor soil drainage, which further suggests that the soil is compacted with a high percentage of clay. Existing soil will be replaced with a sand/soil mixture during the implementation phase. The rain garden will consist of approximately 2 ft of sandy soil (6-4 ratio), which will allow for water to permeate further down and be retained for later use in the garden. If this approach is not successful new installments may utilize stormwater infiltrators in addition to the sand/soil ratio allow for additional water retention and permeation at a higher

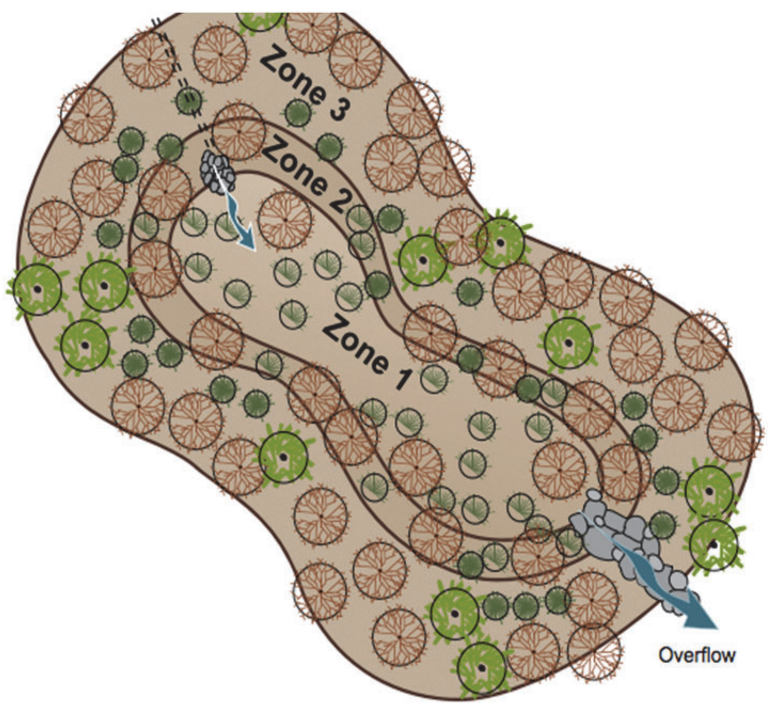

Figure 7.0 – Example of Rain Garden Plant Zones

project cost (Sunnycrest, 2005). A 3-5 inch compost layer will be worked into the upper soil to add extra nutrients for the new vegetation, and a 2-3 inch mulch layer will ensure that moisture is retained and weeds will not establish easily. Finally, an area 6 inches below the edge of the rain garden will be left for water to pond. This is also the height that the overflow pipes will be left at should heavy or prolonged periods or rain compromise the holding capacity of the garden.

Runoff will generally enter the garden from the west and north sides where the adjacent paved paths run towards lower ground. The east sloping sides will also direct runoff into the garden due to the impermeable grass surroundings. The rain garden will be broken down into three zones that are characterized by wetness. **Zone 1** is in the center and is intended for plants that can tolerate wet conditions, **zone 2** is intended for plants that can tolerate occasional standing water**,** and **zone 3** is the outer zone, which is intended for plants that thrive in drier conditions (Figure 7.0). Native plants were chosen that were recommended for shady conditions and any soil type. They tend to do better than other plants because they are adapted to this biogeoclimatic zone, where yearly extremes of wetness and dryness occur.

4.2 – Plants

In order to ensure function and good plant health, the vegetation we chose for the site thrives in moist, shady conditions. For a detailed description, including appropriate zone placement, see appendix 9.4. Potential plants include:

Perennials:	*Shrubs:*	*Ferns:*
- Bell Flower	- Salmon Berry	- Deer Fern
- Bleeding Heart	- Oregon Grape	- Licorice Fern
- Marsh marigold	- Ninebark	- Sword Fern
- Bulrush	- Andromeda	
- Sweet Flag	- Huckleberry	
- Bitterroot	- Elderberry	

4.3 – Materials and Tools

The majority of the individual use tools we require, including spades, forks, gloves, a wheel barrow, shovels and other general gardening equipment, are available for use from Facilities Management or the Environmental Studies department. See figure 8.0 for the soil components require.

Soil (ft^3)	Sand (ft^3)	Compost (ft^3)	Mulch (ft^3)
264	396	120	90

Figure – 8.0

Our compost, soil, and mulch needs can be filled by the University's composting depot in Finnerty Gardens. Sand will be purchased and delivered from Tufturf on Blenkinsop Road and has been included in the budget (Tufturf, personal communication, 2012).

Ideally, a truck bed, provided by the University, will be used to mix the correct sand to soil ratio for the rain garden. An 18-inch sod cutter can be rented from the Home Depot on Shelbourne Street. This cuts 2.5 inches down and is $62 to rent for four hours. We will use this for site preparation and edge definition.

The largest piece of equipment needed for this project is an excavator to make the rain garden the required depth. This can be rented from Richlock Rentals for $180 for 8 hours a day. This price includes the 10% discount that the university receives. Additional costs include travel ($60 each way to get the excavator to, and from the site), as well as fuel costs. Depending on the operator, excavation will likely take half a day's worth of labor. Since operators are not included with the equipment, someone qualified to use heavy machinery will be required. According to our contact at Richlock, "it is easy to learn and is a lot of fun".

Plants will be sourced from Streamside Native Plants, a local company that propagates native varieties using Vancouver Island genetic stock, ensuring the plants will be well adapted to our area (Streamside Native Plants, 2012). According to their price guide, all of the one gallon plants that we will be using cost $4.75 each. To calculate the number of plants needed, we add the diameter of the average plant size to the surrounding area each plant requires for healthy growth. We then divided the total surface area of the rain garden by that number. For this project, 138 plants are needed, which will cost $655.50. Finally, an infiltrometer, flow meter, and paid student position will be needed for monitoring.

4.4 – Public Engagement

In order to engage the public and promote social awareness, we will be using volunteers and educational signage. Posters and handouts will be distributed to educate, promote and attract volunteers. An educational sign will also be posted at the project site, explaining the purpose, function, and value of rain gardens as well as a list of the different plants utilized on site. See appendix 9.5 for potential signage content.

5.0 – Implementation

In order to ensure that the rain garden maintains function and is protected during construction, a uniform, highly organized implementation strategy will be in place for this site and future proposals. We decided that hiring a project manager was both in budget and necessary to run the project smoothly. Project management will involve implementing the above design, overseeing construction and supervising the monitoring programs for the first 4 months until it is passed on to student interns. Since the soil type on campus is classified as having moderate to poor infiltration (Farstand & Day, 1959), some sites may require additional modifications.

We recommend that construction occur in spring when the ground is moist, but not saturated with water. Disturbed ground in the winter can cause serious erosion and compaction in the soil. Implementation will occur when the winter session (second term) examinations end in April, providing an eight day window when students are less likely to be on campus, ensuring that noise pollution does not disrupt classes or pedestrians. This time period should be late enough in the season to provide the conditions described above but the project manager should visit the site a week before construction is to begin at the latest to assess the state of the soil. The project should be pushed back if the soil is still saturated with water or feels marshy.

5.1 – Budget and Labour

The project will be overseen and project manager hired by University Grounds Keeping. The project manager position will be posted on the University's co-op and career portal as well as several local job search websites. This will be a full time position for one semester and will include implementation of the project and the initiation and supervision of the work study data collection and analysis position. We calculated cost based on 3.5 months of full-time work.

The work study position will be filled through the Environmental Studies or Geography department and will be renewed each year for long-term monitoring. This ensures student engagement in the project at least until the end of long-term monitoring. To accurately calculate the monitoring and evaluation budget we totaled the approximate number of hours needed to gather and analyze data over the ten year period. This includes various frequencies of monitoring and maintaining the flow meters and infiltrometers, visual inspections of plant health and logging species presence, taking photographs, comparison with other rain gardens on campus, inspecting for weeds and invasives, and answering emails. We have not included testing of water quality as that will only be a component if further rain gardens are established on campus.

Other equipment and labour costs are reflected in figure 9.0. The cost of monitoring and evaluation over the long term period may need to be adjusted for the incorporation of the assessment of rain gardens developed after the initial garden.

Budget				
Item	**Cost**	**Size**	**Qty.**	**Total Costs**
Materials and Equipment:				
Plants	$4.75	1 gal	138	$655.50
Sand		Delivered in two trips	396	$644.00
String	$2.50	86'	1	$2.50
Print Materials	$88	Half page handbills and 11x17 postable sign	200 hand bills, 1 postable sign	$88
Sod Cutter	$62/4hrs	18in.	1	$62
Excavator				
I) Rental	$180/day		1	$180
II) Transport	$60 each way		2	$120
Infiltrometer	$2975		2	$5950
Flow Meter	$350		2	$700
Labour:				
Project Manager	$15/hr	One fulltime position for 3.5 months	490 hrs	$7,350
Excavator Operator	$22/hr		6 hrs	$132
Installation Labour	$15/hr	5 people hired	30hrs each over	$2,250
Work Study Position (Monitoring/ Evaluation)	$15/hr	One work study position per school year over the 10 year monitoring program	480 hrs	$7,200
			Grand Total:	$25,334

Figure 9.0 – Long-Term Budget

5.2 – Site and Labour Preparation:

I – End of First Term) Before implementation can occur, the absorption rate of the soil must be tested. To test this, a 6-inch deep hole can be dug on site and filled with water. If the water has not drained after 48 hours the site conditions will require soil modification (WSU, 2007).

II – Beginning of Second Term) Heavy equipment should be reserved and plant orders placed with Streamside Native Plants to ensure prompt delivery and avoid delays. Towards the end of the winter semester, the project manager should be hired. This should take place no later than the beginning of April to give adequate preparation time. Labourers can then be hired and gardening equipment collected from the sources mentioned above.

III – Day One) Prepare the site by defining the edges of the rain garden using string. A sod cutter can be utilized to remove the top layer of lawn. Any removed vegetation and topsoil may be composted at the University's compost depot located in Finnerty Gardens.

5.3 – Excavation and Soil Procedures:

I) The day following preparation, excavation may commence in the morning to ensure adequate time is provided for digging the basin. This limits the time in-between excavation and setting the foundations for the garden, ensuring that no pedestrians or animals compress the exposed soil.

II) Excavators will be required to use a rake method rather than scooping because it causes less compaction of the soil and ensures greater permeability (Brown & Hunt, 2010). Operators will slope the sides at a 45 degree angle to reduce the potential of sloughing (WSU, 2007) and dig approximately 3 ft down (an additional foot will be required if a stormwater infiltrator is utilized to counteract poor drainage). The bottom must be leveled as much as possible to ensure that water can spread and infiltrate evenly across the rain garden. Take care to dig around the existing 12" drains as they will be important to later monitoring.

III) Prepare a 6 to 4 ratio of sand and soil to add to the basin of the rain garden. (If a stormwater infiltrator is required, install it at this step). Fill the basin with the sand/soil mixture, rake to evenly spread and slightly compact it, leaving 1 ft of space at the top. Take care to avoid any compaction at this time so that the permeability of the new soil is not compromised.

IV) Carefully fill the remaining foot of space with compost to avoid compaction and provide vegetation with nutrients.

V) Create a pooling area by raking the soil so that the middle of the garden (zone 1), is approximately 6 inches below the outer edges.

5.4* – Planting Procedures*:

All vegetation for the pilot project will be sourced from Streamside Native Plants. Additional gardens may be more suited for transplanting or live staking. Live staking is a process by which vegetation is grown from live cuttings that have the ability to root.

I – Day Three) Transport all plants to the site and allow hired gardeners to plant them. Ensure that all vegetation is planted at least 1.5 ft apart to ensure they have adequate room to grow. Mulch the entire garden with 2 to 3 inches of woodchips or semi-decomposed leaves. Finally, water the plants thoroughly.

II Weekly) Providing water weekly for the first three summers will ensure the soil is kept moist and the plants can establish themselves. This helps to encourage deep roots and vigorous growth. Weeding may be required until plants are established.

III Annually) After each growing season, stems and seed heads can be left for winter, but should be cut back in the early spring to allow room for new growth. In the spring an inch, of mulch should be added as needed. As some of the species we have chosen can grown quite large, pruning should be regular so as to maintain space for other plants. University Grounds Keeping will be able to take care of regular garden maintenance. As the rain garden is established, maintenance requirements are anticipated to decline.

6.0 – Site Management

6.1 – Management Approach: Integrated Environmental Management (IEM)

Historically, environmental management approaches have been reactive rather than proactive (Regan, 2006). IEM is an approach that recognizes the interconnectedness of environmental components with human societies. This means that an understanding of the impacts of the built environment is necessary to identify the scope and scale of environmental and human issues (McNeely & Harrison, 1994). This should also include background and biological diversity monitoring (IBID).

IEM Framework:

- Informed decision making
- Accountability for information
- Physical, biological, and social considerations
- Consultation with interested stakeholders
- Identifying the social costs and benefits
- Consideration to future land-use planning

(McNeely & Harrison, 1994).

IEM is an approach that has been established worldwide with various levels of success and has been adopted in the restoration of some of the most complex, threatened, and vulnerable ecosystems in North America (Born & Sonzogni, 1995). An IEM approach will compliment the project's goals and policies to help focus the framework for ensuring ecosystem function at the proposed and future rain-garden installments.

As stated in the project goals and policies, the project is intended to have minimal maintenance. After the initial set-up and establishment of the garden, the majority of the required management will revolve around monitoring, public education, and data analysis. The establishment of new gardens to improve infiltration and ecosystem function on campus will also be required for the long-term management of the project.

7.0 – Monitoring and Evaluation

7.1 – Overview:

In order to evaluate the success level of our restoration project, we will monitor several key factors by collecting and analyzing data which is relevant to our stated goals and objectives. (SER International Science & Policy Working Group, 2004). These

Figure 10.0 – Cornett Entrance

assessments will provide the information needed to adjust and adapt the management strategy and lead to the refinement of the project's objectives and strategies for future installations (Herrick et. al, 2006). This rain garden is intended as a pilot for a series of similar projects planned for the campus (potential sites are identified in appendix 9.2). Our successes and shortcomings for this pilot project will be used as a tool for learning, which will impact the planning and implementation of future rain gardens on campus.

A combination of approaches will be used to determine the performance of the rain garden. These include testing water flow quantity (Trowsdale & Simcock, 2011), soil infiltration rates, visual inspection of the garden (Asleson, Nestingen, Gulliver, Hozalski, & Nieber, 2009), water quality observation at Bowker Creek, and a qualitative comparison with other rain gardens at UVic (SER International Science & Policy Working Group, 2004). This monitoring and evaluation will occur over short, medium and long term scales. Short-term for this project is within the first year following the installation of the garden, and medium-term planning for this project is up to five years from the original installation. Monitoring and evaluation will need to continue on into the long term and beyond, which is defined as 5-10 years, as successful rain gardens require maintenance (Asleson et. al, 2009). However, the type and

Figure 11.0 - Infiltrometer

frequency of monitoring, evaluation, and maintenance beyond 5 years will be planned more accurately once the garden has been established and has functioned for several years. At this time (year 3-4) a long-term plan will be established based on the data from the pilot project.

7.2 – Water Absorption:

Immediately after the instillation of the rain garden, soil will be tested for its rate of water absorption by using an infiltrometer (see figure 11.0). This test will be performed in multiple areas of the garden to determine the saturated hydraulic conductivity of the soil near the surface of the garden. Areas in the garden will be tested and analyzed as outlined by Asleson et. al, (2009) p.1023-1028. Results from this test depend on the soil type present, the level of compaction of this soil, and the proximity of plants. If the test results indicate the need for soil improvements, maintenance will be preformed to reduce compaction or increase soil quality until optimal range levels of saturated hydraulic conductivity are obtained (Asleson et. al, 2009).

Figure 12.0 – Drainage Pipe

After this initial infiltration rate test, tests will continue to be conducted once a year over the long-term, every July. Testing locations in the garden will remain the same each year and the data collected will be compared to previous years. The trends in infiltration rates will be used to inform the maintenance schedule, and soil maintenance will be preformed when decreases in infiltration rates are observed (Asleson et. al, 2009).

Given that one of our goals is *"to reduce the amount of runoff that is re-directed off campus through stormwater drains"*, we will be monitoring and evaluation water flow carefully. There are two overflow drainage pipes (figure 12.0) in the garden, which will be used to capture water in times of abnormally high precipitation. Excess water will overflow from the garden and be directed into municipal storm drains. Each drain will be fitted with a flow meter (see figures 13 & 14) in order to measure the amount of water the garden is not able to handle.

Figure 13.0 – Flowmeter

Figure 14.0 – Flowmeter

A sample of 12 medium to heavy rainfall events will be used over a one year period to assess water overflow quantity in relation to the amount of rainfall (Trowsdale & Simcock, 2011). Rainfall data will be monitored online from the University of Victoria Weather station at the Social Sciences and Math Building (UVic Weather Station, 2012). This data will be used to determine the beginning and end of heavy rain events and to measure the rainfall during these times. Rainfall measurements and overflow measurements will be analyzed to determine the absorption capacity of our rain garden in rainfall events of various durations and intensities (Geosyntec Consultants and Write Water Engineers, 2009). This information will be important in making recommendations and plans for future rain garden sites and designs.

Another way we will be able to determine drainage problems is through visual inspection. The garden will be checked for ponded water 48 hours after the first heavy rainfall of each month (see figures 15 & 16). If ponded water is present at this time it indicates that the garden is not adequately absorbing water and corrective measures will be need to be preformed to increase drainage (Asleson et. al, 2009).

Figure 15.0 – Non-Functional Garden

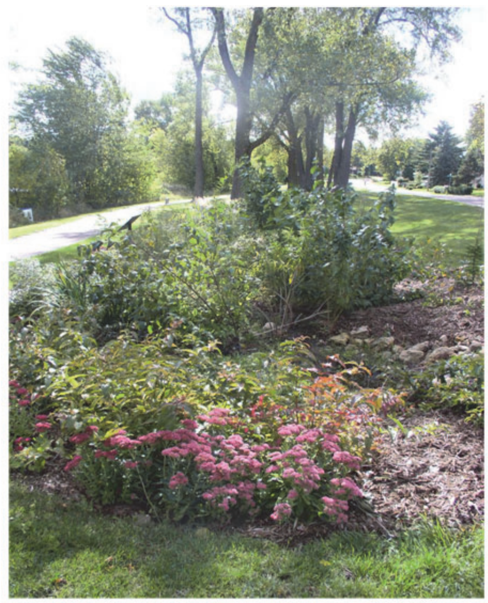

Figure 16.0 – Functional Garden

By recording when rainfall is pooled for longer than 48 hours, and analyzing the data from the flow meter and the weather station, we will be able to determine if the rain garden met our objective of successfully accommodating 50mm of weekly rainfall.

We will need to be cautious of inaccurate readings and equipment malfunctions, which could lead to potential data loss or errors. Upon installation, the flow meters will be calibrated for accuracy. This calibration will be conducted periodically as per the manufacture's guidelines to help avoid errors in data collection. The flow meters will be check for debris accumulation and function as a part of the monthly post rainfall visual check (Geosyntec Consultants and Write Water Engineers, 2009).

7.3 – Vegetation:

Monitoring and evaluating the health and presence of plants in the garden will be an important way to assess if we have met our objective to ensure that vegetation is established and requires little maintenance. A visual plant inspection will be conducted 4 times a year when the seasons change (near the end of September, December, March and June). This will be done each year over a 5 year period. The first plant inspection will take place immediately after the installation of the garden to create baseline data. The plant inspection will record the flowers, stem, and leaf quality as well as the size of each plant in a log book that will be structured with the garden design in mind. This will ensure that the correct species are present and healthy, assisting us to assess our goal of "utilizing native plants that have historic cultural applications". Analyzing this data will indicate if we have met our objective of "adhering to UVic's 75% quota of native plants for all new introduced vegetation."

The presence of weeds and invasive plants will also be documented to determine the need for weeding beyond the maintenance schedule. The garden will also be inspected for wetland plants from October to May. Wetland plants indicate the presence of hydric soils due to prolonged saturation, requiring maintenance or intervention. The final component of the plant inspection is photographing the garden from the north, south, east and west sides of the garden. The photos will be taken from the same position each time to provide a consistent, qualitative record of plant and garden progress (Asleson et. al, 2009). If visual inspection reveals that plants are unhealthy or dying despite soil based interventions, such specimens will be replaced with a new species that still meets our requirements and will thrive in wet conditions. The success of the garden will be apparent if the overall plant community is thriving, leaving room for failure of individual plants or species.

7.4 – Observation of Native Species:

When this seasonal visual inspection takes place we will also observe and document invertebrates, insects, birds, and other animals that make use of the rain garden. Each season, thirty minutes will be spent for 3 days to observe, identify, and document species found in the garden. This data will help us understand what types of non-plant species are being attracted to the site. After one and a half years of observing species on site, we will design and install a second educational sign at the rain garden. In addition to the educational signage explained in the design plan, this sign will identify species observed in the garden with images and a brief description. All of our educational signage will have a contact e-mail: raingardens@uvic.ca where the public can engage with questions, comments, observations, and suggestions for rain garden staff. The educational signage and contact e-mail are important ways for us to accomplish our objective of facilitating public education on the benefits of rain gardens.

7.5 – Water Quality:

Rain gardens have been shown to be highly effective in removing pollutants and excess nutrients and water runoff (Houng, Davis, & F.ASCE, 2009). Runoff from roads and parking lots where oil and gasoline are common is not a factor in this site due to its location between buildings. Through correspondence with UVic ground maintenance manager Bentley Sly, we have determined pesticide use is minimal on campus and an eco-friendly product is used on to prevent slipping on pedestrian sidewalks in freezing conditions (Sly, personal communication, Nov. 25, 2012). As a result of these conditions, we will not be formally measuring water quality changes after the constructions of this first rain garden. However, since storm drains from our site empty mainly into Bowker Creek (RCL Consulting, 2004), we will remain aware of the water quality of Bowker Creek by reviewing the water quality reports released by the CRD. These can be found on the Bowker Creek Initiative website and the CRD Stormwater Quality Monitoring and Reporting web page (Jody, Watson, Personal communication, Nov 26, 2012).

Although we do not expect to see a noticeable change in water quality with the implementation of this first rain garden, we do expect to see an increase in water quality with the long term implementation of more rain gardens, particularly those gardens filtering water close to roads and parking lots. At this time we will establish a monitoring and evaluation plan for testing water quality at the inflow and outflow of the garden (Houng, et. al, 2009) as well as in Bowker Creek.

Another way we will facilitate public engagement and education is by collaborating with the Friends of Bowker Creek, the Bowker Creek Initiative, the CRD, the Times Colonist, and the UVic newspapers. We will make phone calls after the installation of the rain garden to explain our project and its benefits, and we will provide these organizations with information they can include in their publications. This communication will commence approximately 2 weeks after the rain garden installation is complete, and will be carried out by a designated project staff member.

7.6 – Direct Comparison:

We will use the method of direct comparison as outlined by the Society for Ecological Restoration International Science & Policy Working Group (2004) for our rain garden with the two other rain gardens that currently exist on campus, one at the First People's House, and one by the Mearn's Learning Center Building (Sly, personal communication, Nov. 25, 2012). This comparison will take place over the first 5 years following the completion of the garden, and will act as a tool to evaluate our garden's performance in relation to other rain gardens on campus. Given the availability of data from other gardens, we compare the qualitative and quantitative data collected on water overflow versus rainfall, soil infiltration rates, and plant health with data collected from other gardens at UVic. If such data is not available from the other rain gardens at UVic, we will conduct our own tests to retrieve data on these gardens using soil infiltration rate testing and visual observation of plants and ponded water. If this data collection is necessary for other sites, it will be conducted in conjunction with our own data collection. Collecting and analyzing this data is an important process to assist in determining the planning and consideration to of future rain gardens at UVic, helping us meet our objective of "promoting the long term vision of the project."

8.0 – Conclusion

In this restoration plan we have aimed to address the presence and impacts of impermeable surfaces on the ecosystems and connected watersheds of the UVic campus. We have recommended the use of multiple rain gardens as an efficient, affordable way to address this issue, beginning with the single rain garden pilot project outlined above. Our guiding policy focuses on the reduction of water runoff by using a rain garden to function as a naturalized ecosystem and reduce the pressures of unmanaged stormwater on existing municipal drainage systems. This pilot project plans to engage the local community, provide educational opportunities, and utilize native plants in the garden, while maintaining the site to improve ecosystem function.

A qualified, knowledgeable team of staff will work together to construct the rain garden. The project staff will collaborate with facilities management and Finnerty Gardens and local businesses to access equipment and materials. Integrated Environmental Management techniques will be used to keep the consideration of both humans and the natural environment at the forefront (McNeely & Harrison, 1994). In order to monitor and evaluate the project we will assess water flow and infiltration, plant health, and water quality. Both qualitative and quantitative data will be gathered and analyzed to inform the maintenance process and assess our level of success in reaching our stated goals and objectives (SER International Science & Policy Working Group, 2004). The outcomes of this project will serve to inform and refine the planning of future rain gardens on the UVic campus proposed for the next 5-10 years.

9.0 – Appendices

9.1 – References

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9.2 – Potential Sites

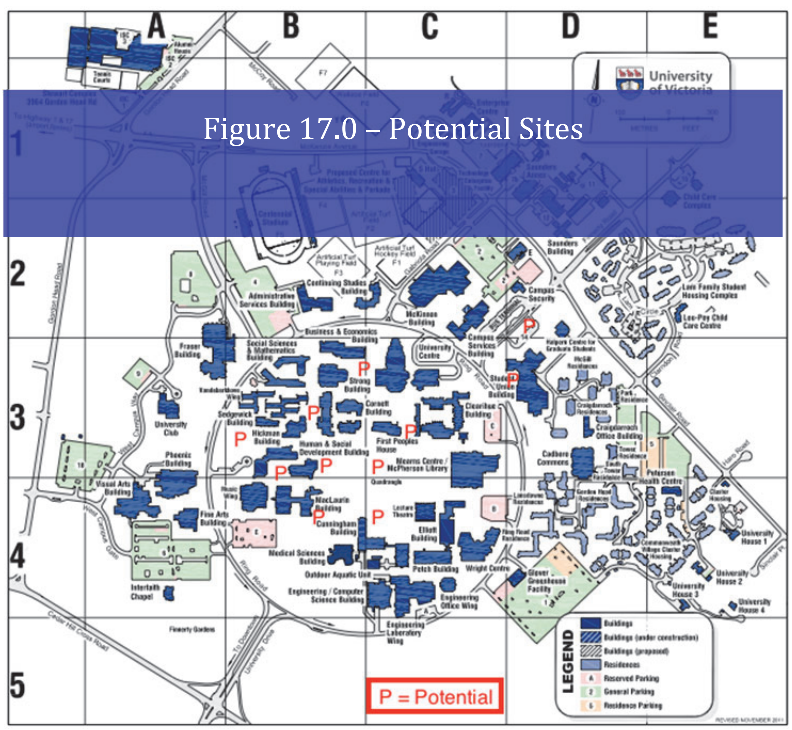

Figure 17.0 – Potential Sites

Potential sites were identified on campus following a day of inspection as a group. Sites that had little to no permeable surfaces, depended on stormwater drains, situated in low-lying areas and those with sitting water were considered eligible (examples can be seen below). Ideally, these sites could start to receive rain gardens in 5-10 years once the data from our project pilot is available.


Poorly Situated Vegetation


Example of Unattractive Surfaces


Example of Sitting Water


Low-lying and Drain Dependant


Example of Drain Dependency


Lack of Permeable Surfaces

9.3 – Figures

Figure 1.0 – A graph that indicates average annual precipitation in Victoria by month. Sourced from http://www.eldoradocountyweather.com/canada/climate/victoriaclimate.html

Figure 2.0 – A graph that indicates average temperature in Victoria by month. Sourced from http://www.eldoradocountyweather.com/canada/climate/victoriaclimate.html

Figure 3.0 – A map indicating the jurisdictional boundaries between Saanich and Oak bay, as well as the location of our site. Sourced from Google maps, but modified from its original state.

9.4 – Potential Vegetation

Perennials:

Bell Flower (Campanula sp.)

*Bellflowers are suitable for rock gardens and wildflower gardens. These plants form an attractive spreading groundcover and can grow as tall as 5 ft. They prefer cool sun to partial shade and are able to tolerate long periods of drought but will not tolerate waterlogged soils. This plant is best suited for **Zone 3**.*

Source:

Pikes Peak Area Garden Help (2009). *Bellflower: Campanula Sp.*. Retrieved 11/27, 2012, from http://peakgardening.wordpress.com/2009/06/27/bellflower/

Bleeding Heart (Dicentra Sp.)

*Bleeding Heart thrives in moist conditions growing up to 3 ft tall along the Pacific Northwest coast. They are productive self-seeders and are rarely eaten by deer. While drought tolerant, this plant is better suited for **Zone 2** as it prefers moist conditions.*

Source:

Canadian Gardening (2012). *Growing old-fashioned bleeding hearts.* Retrieved 11/27, 2012, from http://peakgardening.wordpress.com/2009/06/27/bellflower/

Marsh Marigold (Caltha Palustris)

*Marsh Marigold can grow up to 2 inches tall and prefers wet conditions and mucky soil. It can tolerate shallow standing water, thriving in constantly wet conditions with light shade. In periods of drought this plant may go into dormancy. Due to its water requirements, this plant is best suited for **Zone 1**.*

Source:

Illinois Wild Flowers (2012). *Marsh Marigold.* Retrieved 11/27, 2012, from http://www.illinoiswildflowers.info/wetland/plants/marsh_marigold.htm

BulRush (Scirpus Sp.)

*Bulrushes can grow to 5 ft tall in shallow water or moist soils, growing in dense colonies. Its foliage provides important nesting cover for waterfowl. The plant is not drought resistant but can grow in standing water. This plant is best suited for **Zone 1**.*

Source:

Plants of the wild (2012). *Our Products* 11/27, 2012, from http://shop.plantsofthewild.com/SCIRPUS-PUNGENS-Three-Square-Bulrush-10-cubic-inch-10SCPU.htm

Sweet Flag (Acorus Gramineus)

*Sweet Flag can tolerate patial shade and thrives in shallow waters and marshy areas. The plant is drought tolerant, deer resistant and can be utilized as ground cover. Note: due to its aggressive spreading it should be planted in burried containers. Sweet Flag is best suited for **Zone 1.***

Source:

De Groot, Inc. (2012). *Ornamental Grass* 11/27, 2012, from http://www.degroot-inc.com/product_info.php?products_id=821

Bitterroot (Lewisia rediviva)

*Bitterroot is a drought tolerant flowering plant that grows to 3 inches in height. It perfers full sun (but can tolerate partial shade) and well draining soils. Due to its preferences it is best suited for **Zone 3.***

Source:

Blackfoot Native Plants. (2012). *Bitterroot (Lewisia Rediviva)* 11/27, 2012, from

http://www.blackfoot

nativeplants.com/bitterroot-lewisia-rediviva/blackfoot-native-plants/

Shrubs:

Salmon Berry (Rubus Spectabilis)

*Salmon Berry thrives in wet sites and can grow as tall as 10 ft in ideal conditions. Its berries and shoots are edible and can tolerate full shade. Due to this plant's preferences it is best suited for **Zone 1.***

Source:

Washington State university. (2012). *Salmonberry* 11/27, 2012, from http://pnwplants.wsu.edu /PlantDisplay.aspx?PlantID=280

Oregon Grape (Mahonia Aquifolium)

Oregon Grape can grow 8 ft high and can tolerate wet soils and shade. The plant is drought tolerant, deer resistant and an evergreen. While it is technically edible, it is rearly eaten by people on its own. This plant is best suited for ***Zone 2.***

Source:

King Country. (2012). *Native Plant Guide* 11/27, 2012, from http://green.kingcounty.gov/gonative/Plant.aspx?Act=view&PlantID=25

Ninebark (Physocarpus Sp.)

Ninebark is a bushy shrub that can grow to 1.5 meters. The plant can tolerate poor soil, dry, and partail shady conditions. Due to its characteristics it is best suited for ***Zone 3.***

Source:

Alberta Gov. (2012). *Physocarpus sp. (Ninebark)* 11/27, 2012, from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4075?opendocument

Andromeda (Pieris Spp.)

Andromeda is a woodland shrub that can grow up to 10 ft tall. The plant thrives in *damp, shady conditions. The plant can tolerate some drought but would be best suited for* ***Zone 2.***

Source:

UC IPM Online (2012). *Andromeda – Pieris Spp* 11/27, 2012, from http://www.ipm.ucdavis .edu/PMG/GARDEN/PLANTS/andromeda.html

Huckleberry (Vaccinum sp)

Huckleberry is an edible deciduous shrub that thrives in shaded moist conditions. The shrub can reach 5 ft in height. Due to its preferences it is best suited for ***Zone 2.***

Source:

Northern Bushcraft (2012). *Black Huckleberry* 11/27, 2012, from http://northernbushcraftcom /berries/blackHuckleberry/notes.htm

Elderberry (Sambucus sp.)

E deciduous shrubs that do well in light shade, re tall. It prefers moist soild and can tolerate *occasional standing watter. Due to its characteristics it is best suited for **Zone 2.***

Source:

UC IPM Online (2012). *Elderberry – sambuscus spp.* 11/27, 2012, from http://www.ipm.ucdavis.edu/PMG/GARDEN/PLANTS/elderberry.html

Ferns:

Deer Fern (Blechnum Spicant)

*Deer Fern thrives in shady, mosit soil and can grow to 20 inches tall. It is drought tolerant after it is established but will grow best in wet conditions. Due to its requirements it is best suited for **Zone 2.***

Source:

Monrovia (2012). *Deer Fern.* 11/27, 2012, from http://www.monrovia.com/plant-catalog/plants/939/deer-fern.php#.ULXPs47quf8

Licorice Fern (Polypodium glcyyhiza)

*Licorice fern does well in moist shady conditions. It prefers to grow in moss growing on logs, rocks and humus. Ideally this would be planted with native mosses that thrive in high rain and shady conditions This plant is best suited for **Zone 2.***

Source:

Victoria Larkin (2005). *Licorice Fern.* 11/27, 2012, from

http://academic.evergreen.edu/curricular/walkingthewheel/projects/victoria/fern.pdf

Sword Fern (Polystichum munitum)

Sword fern can grow to 3 ft in height, thriving in partialy shady, moist conditions. It is highly adaptable, drought tolerant, and provides excellent groundcover. Due to this plant's characteristics it is best suited to ***Zone 2.***

Source:

King Country (2012). *Sword Fern.* 11/27, 2012, from http://green.kingcounty.gov/gonative/Plant.aspx?Act=view&plantID=37

9.5 – Educational Materials

To be used with permission as printed handouts and posted signage

Disclaimer
This sheet contains general principles only and they may not be appropriate for every property or project. Use common sense when building your rain garden. You assume the risk and are responsible for any modifications to your property or drainage flow, for legal compliance, and for necessary permits and authorizations. Check with your municipality if you are unsure of regulations or requirements.

For More Information:
CRD Hotline
250.360.3030
hotline@crd.bc.ca

CRD Stormwater, Harbours and Watersheds Program
250.360.3256
stormwater@crd.bc.ca
www.crd.bc.ca/watersheds

Residential

Building a Rain Garden

Rain gardens are landscape features that are designed to collect rainwater runoff from impervious surfaces such as roofs and driveways. They are simply depressed garden spaces that hold runoff and allow it to infiltrate into the soils.

CRD

By allowing rainwater to infiltrate rather than enter the stormwater system, we can reduce the peak flows during rainfall events which reduces flooding and erosion in downstream creeks and streams. There are many benefits of creating a rain garden. Rain gardens can help:

- reduce flooding on neighbouring property
- reduce erosion in creeks and streams
- filter out pollutants before they reach the storm drain and enter our waterways
- recharge aquifers
- provide habitat for beneficial insects, birds and wildlife.

Mosquitoes

Mosquitoes should not be a problem in a properly designed rain garden. Mosquitoes require a minimum of four days of standing water to lay and hatch eggs. A properly designed rain garden should only have surface water present for 1-2 days. Rain gardens also provide habitat for beneficial insects like dragonflies, which are natural predators of mosquitoes.

Steps To Building A Rain Garden

Determine Sizing

- Determine the roof and/or driveway area that will be draining to the rain garden.
- Measure the area you have available for the rain garden.
- Determine the path that the rain water will follow to get to the rain garden - over the yard or through a rock filled ditch or pipe (ensure that you have an overflow that directs the water toward a storm drain during large storm events).
- A general rule is to size your rain garden to at least 20% of the size of the impervious area that will be providing water for the garden, depending on how well your soils drain. This area should hold 70-100% of the water.

CRD

Choose Your Site

Contact your municipality and utility providers before you dig to ensure that you avoid any underground utilities.

- Choose an area that is at least 3 metres from any building, but not more than 10 metres from your downspouts. Consider your neighbours when choosing your site.
- Look for a level area with good drainage where water doesn't pool.
- Avoid placing the rain garden over a septic system or a water well.
- Choose an area that runoff can flow naturally.

Assess Your Soil

- Dig a small hole, about 60 cm deep. While digging, observe soil characteristics: if the soil is sticky and smooth, it may have higher clay content; smooth but not sticky, it is likely a silty soil; and if it is gritty and crumbles easily, it is a sandy soil. Soils with higher clay or silt content will have slower rates of infiltration compared to sandy soils.
- Fill the hole with 20 cm of water. If the water does not drain within 12 hours, it is not a good location for a rain garden.

Cross Section Of A Rain Garden

Design and Build

- Determine the location of the garden, measure out the size and mark.
- Determine the locations of the inflow and overflow, lining with rocks if necessary to prevent erosion.
- Dig 45-75 cm deep, ensuring the bottom of the rain garden is flat.
- Before replacing your soils, amend with compost to improve infiltration, about 2/3 soil and 1/3 compost.
- Return amended soils to the garden, leaving an area of 15-30 cm for ponding.

Plant and Mulch

There are typically three zones to consider when planting your rain garden.

- Zone 1 – bottom – choose plants that tolerate wetter conditions.
- Zone 2 – sides – plants that can tolerate wet or dry conditions.
- Zone 3 - Top edge - plants that are drought tolerant.
- It is important to consider the amount of sun the plants will receive as well as maintenance needs.
- After the plants have been placed and watered well, cover the entire rain garden with composted mulch.
- For plant lists, see **www.crd.bc.ca/raingardens**

Maintaining Your Rain Garden

It is important to maintain your rain garden, just like any other garden area. Regular maintenance will ensure that the rain garden performs well and looks good.

- Watering - Water the new plants regularly for the first 1-3 years until well established. If you have chosen appropriate native plants, the garden should require little to no watering after 2-3 years.
- Mulching – replenish mulch layers to prevent erosion, control weeds, improve infiltration and conserve water.
- Weeding – rain gardens will still function if weeds are present, however they will compete for space with the plants selected for the rain garden. Weed as necessary by hand, and do not use fertilizers or pesticides.
- Keep your inflow and outflow areas clear of debris, and use rocks to prevent erosion.

CRD

Source:

CRD (2012). *Building a Rain Garden.* Retrieved 11/27, 2012, from

http://www.crd.bc.ca/watersheds/lid/documents/RainGardenBrochure.pdf