

# BOWKER CREEK RESTORATION PLAN



*Photo by Marten Hansen*

*“Whatever befalls the earth befalls the son of the earth. Man did not weave the web of life; he is merely a strand of it. Whatever he does to the web, he does to himself.”*

*- Chief Seattle*

# ECOLOGICAL CONSULTING ORGANIZATION (E.C.O.)

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## Contents

	Page
<b>Section A - Introduction, Site Analysis</b> - Rachel Gutman	<b>3</b>
1.0 Introduction	3
2.0 Site Analysis	5
2.1 Site Location	5
2.2 Geography	6
2.3 Hydrology	7
2.4 Culture and History	8
2.5 Problem Identification	9
<b>Section B - Goals and Objectives</b> - Kristen Voghell	<b>14</b>
1.0 Vision Statement	14
2.0 List of Goals and Objectives	14
<b>Section C - Design of the Plan</b> - Marten Hansen	<b>18</b>
1.0 Stream Flow Management Plan	19
1.1 Re-Channeling Bowker Creek	19
1.2 Weir Design	20
2.0 Stormwater Management Plan	22
2.1 Legal Land-use Protection	23
2.1.1 Development Permit Areas	23
2.1.2 Zoning	24
2.1.3 Stream Corridor Protection	24
2.2 Filter Strips	26
3.0 Awareness Program	28
4.0 Rabbit Control Plan	29
4.1 Rabbit Prevention Fencing	30
4.2 Enhancing Raptor Habitat	31
<b>Section D - Implementation</b> - Joy Mensink	<b>32</b>
1.0 Introduction	32
2.0 Qualitative Factors	33
2.1 Acquiring Volunteers	33
2.2 Recruiting Volunteers	34
2.3 Getting Permission	34
3.0 Quantitative Factors	35
3.1 Budget	35

3.2 Timeline	36
4.0 Conclusion	37
<b>Section E - Monitoring and Evaluation</b> - Rajiv Dasanjh	<b>37</b>
1.0 Introduction	37
2.0 Public Interest	38
3.0 Historic Trajectory	40
4.0 Stormwater and Sedimentation	42
5.0 Native Riparian Vegetation	46
<b>References</b>	<b>48</b>

## Section A - Introduction, Site Analysis - *Rachel Gutman*

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### 1.0 Introduction

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The health of both ecosystems and communities depends on the health of watersheds. Watersheds provide habitat for many species of plants and animals. In addition, watersheds supply invaluable ecosystem services such as water purification which is necessary to provide water for irrigation, industry and drinking. The degradation of a watershed as a result of development and pollution has deleterious impacts on the health of the watershed ecosystem and its ability to provide such services. One of the most significant impacts on a watershed is the construction of impervious surfaces. These structures, such as roads, sidewalks, and parking lots, inhibit the absorption of water into the water table, thereby increasing the amount of surface runoff present. Furthermore, because of the riparian degradation associated with increased surface runoff and construction of impermeable surfaces, pollutants that wash off impervious surfaces during periods of rain flow directly into the watershed.

Bowker Creek, an urban stream which flows through Victoria, Oak Bay and Saanich, has been significantly affected by the construction of impervious surfaces and the degradation of its riparian zone. Today, approximately 2.5km of its 8km channel are still above ground and approximately 50% of the watershed consists of impervious surfaces (CRD, 2009). In the words of Michael M’Gonigle, professor of environmental law at the University of Victoria, Bowker Creek is “the perfect metaphor for the literal enclosure of the commons” (123).

The University of Victoria is the site of the Bowker Creek headwaters. As this restoration proposal is a project with the school of environmental studies, it is therefore appropriate that restoration efforts be conducted at the headwaters. In addition, because the health of the headwaters affects the health of the entire creek, it is imperative that attempts be made to alleviate problems which negatively affect the watershed downstream. This project attempts to address the greatest challenge to the health of the Bowker Creek watershed: increased storm runoff as a result of the construction of impermeable surfaces. Therefore, the restoration design will attempt to reduce the rate of surface runoff in Bowker Creek and allow for sections of the headwaters which are currently underground to flow through a more historically appropriate trajectory. Furthermore, initiatives which foster both community involvement and awareness towards the Bowker Creek headwaters will be instigated ensuring further success of the project.

## 2.0 Site Analysis

### 2.1 Site Location

The Bowker Creek watershed has a total drainage area of 1028 hectares, and a main channel length of approximately 8km (CRD). The headwaters, located on the University of Victoria campus, are fed by springs and storm runoff which run through culverts under the quadrangle until they meet off ring road near the

University club. There, half the flow is diverted through a culvert, and the remainder runs above ground in a stream bed into the University pond (J. Mitchell, personal communications, November 5, 2009). The two flows then rejoin and flow through a culvert under Gordon Head road. Bowker Creek then makes its way through the municipalities of Saanich, Victoria, and Oak Bay, before entering the ocean near the Oak Bay

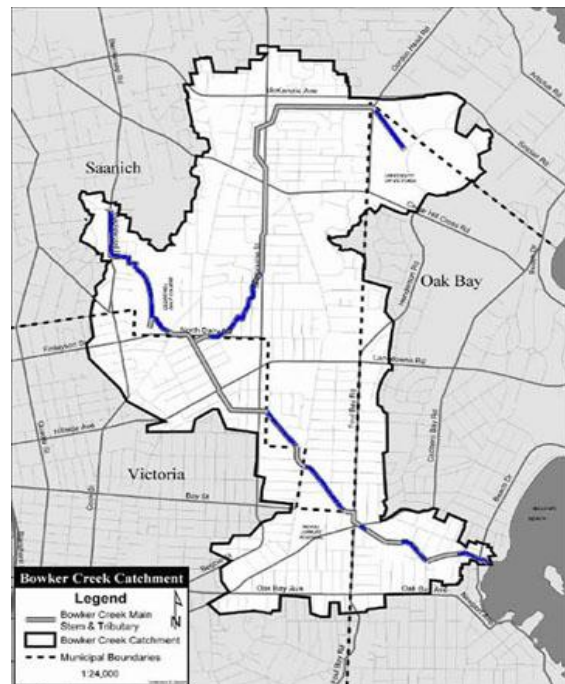


Figure 1 Bowker creek watershed and main channel

Marina (See fig 1.0). For the sake of relevance and feasibility, the reach where restoration efforts will be conducted will be at a 30 meter section of the headwaters located east of University club.

## 2.2 Geography

The Bowker Creek watershed is located in the coastal Douglas fir biogeoclimatic zone. The climate of the region is characterized by relatively dry summers and mild rainy winters typical of a sub-mediterranean climate. Victoria typically experiences a yearly average rainfall of 607mm (Environment Canada, 2009).

The native vegetation prevalent in the restoration site consists of big leaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), black cotton wood (*Populus balsamifera*), and some arbutus (*Arbutus menziesii*). The herbaceous layer is composed primarily of common snowberry (*Symphoricarpos albus*), salal (*Gaultheria shallon*), Oregon grape (*Mahonia sp.*), willows (*Salix sp.*), red-osier dogwood (*Cornus stolonifera*), Kinickinnic (*Arctostaphylos uva-ursi*) and Indian plum (*Oemleria cerasiformis*) (CRD). In addition there is a significant presence of non-native invasive species. Himalayan blackberry is particularly pervasive along the edge of the stream and in the surrounding forest. English ivy is also prevalent and can be found growing on tree's to heights of 10-12m. In addition, Daphne, English hawthorn, and English holly can

be found along the edge of the stream and in the surrounding forest (Integrated Storm management Plan).

### **2.3 Hydrology**

Historically, the topography, and vegetation of what is now the University of Victoria allowed for hydrological conditions conducive to run-off retention. In an average year, only one third of the annual precipitation was received by the streams on campus (Integrated Stormwater Management Plan). The forest canopy and organic-rich topsoil floor typical of the surrounding watershed, intercepted large quantities of runoff. This decreased the magnitude and volume of the creek's flow thereby abetting the percolation of rain water into the water table. In addition, the topography of the region, characterized by broad, gently sloping upland surface did not have a steep enough incline to induce high runoff velocity, thus allowing for infiltration of storm runoff into the water table (Integrated Storm Management Plan).

The soil composition of the campus is primarily Quadra deposit, Vashon till, and Victoria marine clay. The permeability of the soils is low, and thus in order for water to percolate into the water table the velocity of the running water must be very low (Integrated Storm Management Plan).

The riparian vegetation, macroinvertebrates and microbes present in streams, also assist in removing pollutants from the water. As sediment-laden water flows through a stream ecosystem, pollutants, both organic and synthetic, are absorbed by the silt particles and settle at the bottom of the stream. The settling of the silt thereby removes the pollutants from the flowing water (Integrated Storm Management Plan).

## 2.4 Culture and History

Historically, Bowker Creek was a small, sinuous stream that consisted of many tributaries, ponds, and, wetland areas. The creek provided habitat to species of fish such as coho and chum salmon, and cutthroat trout, which was a valuable food source for First Nations (CRD). In addition, the incidence of Garry oak ecosystems in the Bowker Creek watershed provides compelling evidence that the area was once used by First Nations to cultivate camas meadows (Holmen).

After the outbreak of World War II, the Canadian government decided to improve defenses on the pacific coast. The Gordon Head army camp, located on what is now the University of Victoria campus was completed 1940. In 1959, both the army base and a 141 acre parcel of land were purchased by Victoria College. By 1967, 780,000 square feet of the purchased land had been developed (Lovell and Turner, 1999).

The diversion of the creek on ring road was built in the 1980's in order to keep oil slicks from contaminating the University Club pond (see Map 1). At the



time, the university still used an oil heating system left by the military to heat some of the buildings on campus. These underground oil tanks would occasionally leak, spilling oil into the pond. As the pond is man-made and for ornamental purposes, the university built the diversion to prevent such occurrences. This however did not prevent oil from spilling into the creek, and in the late 1980's there was a large oil spill which flowed through Bowker and entered the ocean in Oak Bay. Today, because these oil tanks have been removed, the diversion is superfluous and costly to maintain (J. Mitchell, personal communications, November 5, 2009).

The University has expanded greatly since 1967, and today there are 91 buildings on campus; however, a large portion of the campus is still natural space. This natural aesthetic is one of the reasons why the University of Victoria is such an ideal location to study, teach, and work. In addition, many of these areas are valuable teaching resources as they allow instructors from various departments to give hands on learning experiences pertaining to the course content.

## **2.5 Problem Identification**

Today, as a result of the prolific development that has occurred in the last half century, approximately 2.5km of Bowker creek is above ground, with the remainder flowing through pipes and culverts. In addition, 50% of the watershed consists of impermeable surfaces, namely parking lots, roofs, roads, and sidewalks (CRD). When land is developed from forest or agricultural use

into a structure with impervious properties, surface runoff increases as less water is percolated into the water table. This increases both the quantity and rate of flow through the system (Integrated Stormwater Management Plan). At the University of Victoria, stormwater is diverted into catch basins where it is then diverted into Bowker Creek. Since the surface runoff is flowing across impervious surfaces, little is percolated into the water table causing both the volume and rate of flow of the Bowker Creek headwaters to increase. The consequences of a diminished water table are precarious for both the health of the watershed ecosystem and its ability to provide provisioning services such as drinkable water. Table 1.1 demonstrates the relationship between development of impermeable surfaces on the University of Victoria Campus and increased flow of the Bowker Creek headwaters (Integrated Stormwater Management Plan).

Table 1.1 Bowker creek peak flow and total volume in relation to %impermeable surfaces on the University of Victoria campus.

	Total Volume (m <sup>3</sup> )	Peak Flow (m/s)	% impermeable surfaces of watershed
Pre- development	15,520	0.40	1.6%
1956	20,950	0.55	1.6%
2003	46,180	1.92	51%

During periods of precipitation, stormwater that flows over impermeable surfaces picks up pollutants such as oils and grease from cars, fertilizers, and dirt as it flows into storm drains and catch basins. The contaminated water then flows directly into streams causing problems for biodiversity as well as public health (Pineo & Barton, 2009). Although the University of Victoria practices responsible landscape management and uses minimal pesticides and fertilizers, significant quantities of pollutants wash off parking lots, roads, and sidewalks where they then enter Bowker Creek through storm drains. Furthermore, as urban streams such as Bowker Creek typically have a degraded riparian zone and stream bed, biological filtration is hindered, allowing further contamination of the watershed by polluted stormwater. The University of Victoria, as part of the 2003 Stormwater Management Plan, has done an excellent job installing bioswales, retention ponds, and weirs on campus which effectively manage storm runoff. However, there is still much more that could be done to effectively manage stormwater in the Bowker Creek headwaters (J. Mitchell, personal communication, November 5, 2009). Thus, our group proposes the installation of a weir system along a 30m section of the headwaters east of the University Club. In addition, upon successful completion of the weir, the diversion of the creek along ring road will be removed. The weir system would both slow the stream, allowing for percolation into the water table, and filter water contaminated with pollutants using natural purification processes such as sedimentation, filtration, and microbial

degradation (Scholz and Yadi, 2009). Furthermore, the removal of the diversion would allow the creek to flow in manner more closely resembling its historical trajectory.

As the University of Victoria is the site of the headwaters of Bowker Creek, conducting restoration efforts at the headwaters may help to alleviate stresses downstream. A significant portion of the creek once it leaves the University of Victoria is below ground, channeled or in culverts; and as a result, the velocity of the creek is considerably higher than at the headwaters, especially during times of peak flow. When the volume of water in a stream is more than the stream channels can handle, erosion ensues (Integrated Stormwater Management Plan). Many areas downstream of the headwaters are wrought with issues of eroding banks and channels, especially during winter months when there is increased precipitation (I. Graeme, personal communication, November 8, 2009). Erosion causes turbid water that is cloudy with sediment which negatively affects both organisms in the stream and downstream water usage (Integrated Stormwater Management plan). It is therefore imperative to the health of areas downstream that the rate of runoff from the headwaters be managed. In addition, because there is considerably less vegetation and organic matter in the watershed downstream, contaminants from the headwaters are not likely to be filtered before entering the ocean.

Despite natural areas on campus being vitally important to the University, they are not protected from development. Although the Mystic Vale is protected in perpetuity from development, for many natural spaces on campus

this is not the case. According to the 2003 Campus Plan, areas such as the South Woods, Finnerty Gardens, Garry Oak Meadow and Bowker Creek wetlands have a 10 year moratorium against development; however once the moratorium is up, they area could potentially be rezoned for development. Although it is unlikely that the University would build on the Bowker Creek wetlands, with the BC government hoping to increase university and college enrollment by 25,000 students by 2010, it is certainly not beyond the realm of possibility (“Throne Speech Envisions Bringing out the Best in BC”, 2004). There is a definite need for restoration efforts on campus, particularly to the Bowker Creek headwaters; however, in order for a restoration project to be successful in the long run, the ecological importance of the system and the need for restoration and conservation must be recognized by the community. There is minimal knowledge about the Bowker creek headwaters in the University community, particularly amongst the student body. Therefore it is the conclusion of this proposal that an effective community engagement project be undertaken to increase awareness about the importance of the Bowker Creek watershed. The University of Victoria student body has a history of being a steward of land conservation and preservation on campus; we would therefore like to see students engaged in the restoration process, creating more connectedness between students and their watershed. Furthermore, by increasing awareness about the importance of the Bowker Creek headwaters, we hope that future campus plans will deem the area to be protected from development indefinitely.

## Section B - Goals and Objectives - *Kristen Voghell*

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### 1.0 Vision Statement

The headwaters of the Bowker Creek Watershed at the University of Victoria encompass a mosaic of uses both human and wildlife and multitude of challenges in keeping it protected for future enjoyment.

Our vision is to see the headwaters of Bowker creek restored to its historical trajectory and to promote stewardship within its watershed while providing a place for humans, wildlife and community to come together to enjoy a safe and healthy watershed for generations to come.

### 2.0 Goals and Objectives

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We believe the best way to see a vision realized is through the creation of a solid foundation of common goals. We aim to meet this vision with a clearly outlined series of goals and objectives. Our approach to meeting the vision follows five major goals:

1. Return the headwaters of Bowker Creek to a more historical trajectory.
2. Reduce the rate of stormwater flow and decrease sediment load carried through the system.
3. Restore native riparian vegetation communities

4. Generate public knowledge and promote stewardship regarding the protection and restoration of the Bowker Creek Watershed at the University of Victoria.
5. Protect the headwaters of Bowker Creek in perpetuity.

**Goal 1: Return the headwaters of Bowker Creek at the University of Victoria to a more historical trajectory.**

The 30-meter section of Bowker Creek we are focusing our restoration efforts on was diverted from one direction of flow into two separate channels. This diversion was created using sandbags to redirect part of the channel in a new direction.

- ❖ **Objective 1: Remove sandbags creating the diversion and return the channel to its original flow pattern.**

In the 1980's, concerns mounted regarding oil contamination reaching the University Club pond as a consequence of using oil heat on campus. Due to these concerns, the stream diversion was put in place. The university of Victoria no longer heats the campus buildings with oil heat and as such the original diversion is obsolete, but remains in place. The sand bags have long since broken down and are only partially preventing creek flow into the original direction through the University pond. The stream diversion is located underneath a manhole cover on the North West area of ring road. We intend to

open up the manhole and remove the old sandbags that block water access from its original flow direction and place new sandbags at the mouth of the old diversion as a secondary measure to further prevent runoff from going down the diversion.

**Goal 2: Reduce the rate of flow within the stream during high flow periods allowing prolonged percolation of water back into groundwater and reduce sediment load through the watershed.**

Slower moving streams allow for greater percolation of the flow back into groundwater. During high peak flows, rapidly moving channels are not as likely to slowly seep back into the ground. This effect can cause a host of problems including rapid erosion of stream banks and flooding (Carmon et.al, 1997).

❖ **Objective 1: Install two weirs into the 30-meter channel.**

Weirs effectively slow channel flow rates during times of heavy runoff and thus, reduce bank erosion and prevent the amount of stormwater runoff by allowing for increased percolation in to groundwater.

❖ **Objective 2: implement a series of mesh barriers on the front face of the weirs to capture sediment and prevent large amounts from carrying on through the watershed.**



During periods of periods of high flow, the rapid runoff causes banks to erode at higher rates, as this occurs more sediment is pulled into the channel and carried throughout the entire system. (D'Andrea et al., 2004)

**Goal 3: Restore native riparian vegetation.**

- ❖ **Objective 1: Remove invasive plants that have taken over the study site.**

These include large communities of English Ivy and Himalayan Blackberry that choke out native understory vegetation.

- ❖ **Objective 2: Plant native species along the bank to improve stabilization and promote filtration of stream water.**

Species such as cattail and several species of sedges are useful in not only stabilizing the stream banks but also effectively filter stream water (Chongyu et al. 1992).

**Goal 4: Improve campus-wide knowledge about the Bowker Creek watershed and its headwaters at the University of Victoria and encourage local interest in its protection.**

- ❖ **Objective 1:** Put a system of interpretive signage in place that detail the perils of Bowker Creek and highlight the benefits of a healthy watershed.
- ❖ **Objective 2:** Place advertisements in the Martlet and other campus publications informing readers about the health of our watershed and upcoming events on how to get involved in restoration initiatives.

**Goal 5: Achieve protection in perpetuity of the Bowker Creek watershed on the university grounds.**

- ❖ **Objective 1:** Use the outcomes outlined in goal 4 to harness support for the protection of Bowker Creek.

If students, faculty and local community members are more aware of the issues surrounding the Bowker Creek watershed, the more likely they are to become active in pursuing and being a part of its permanent protection. Pressure from the student body, faculty and community of the University of Victoria is the best way to see that vision realized.

## Section C - Design - *Marten Hansen*

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The Bowker Creek restoration project as proposed in this section will encompass physical alterations, by-law amendments, legal protection, community awareness and habitat enhancement to bring the creek back to its

historical projected state. To physically embody the objectives as before mentioned, the design of this restoration project includes four sections: a stream flow management plan, a stormwater management plan, an awareness plan and a rabbit control plan that altogether provide a holistic and collaborative design to deal with the issues surrounding the Bowker Creek headwaters on the University of Victoria campus.

## **1.0 Stream Flow Management Plan**

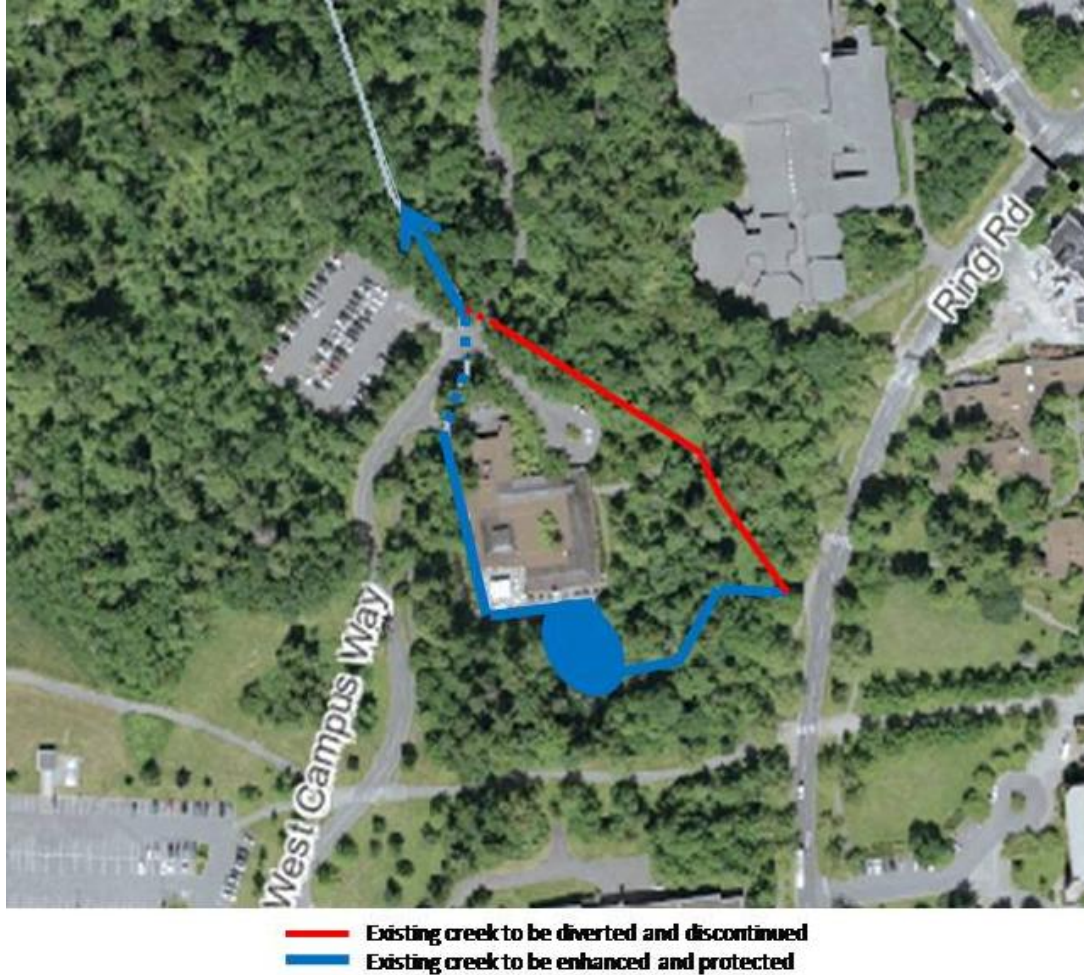
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The stream flow management plan uses natural and innovative design techniques to return the Bowker Creek headwaters to its historic state and provide channel stability during channel flow variability. The stream flow management plan introduces the physical re-channeling of Bowker Creek as well as the incorporation of weirs to effectively manage the streams resulting increase in flow during peak stormwater events.

### **1.1 Re-channeling Bowker Creek**

Currently Bowker Creek diverges into two separate flows just beyond the headwaters on the north-eastern side of ring road. To restore the creek to its original single flowing stream, the creek will be re-channeled through the eastern divergence as shown in the Map 1 below.

## Map 1 Proposed Creek Re-Channeling



Prior to re-channeling it can be assumed that the remaining channel to and from the detention pond outside the University Club will increase significantly during high flow variability. To support this increase in flow, bank widening will need to take place to ensure a hazardous flooding event does not occur.

### 1.2 Weir Design

Discontinuing the divergence of the creek at the headwaters will increase the flow of water in the remaining single stream that flows

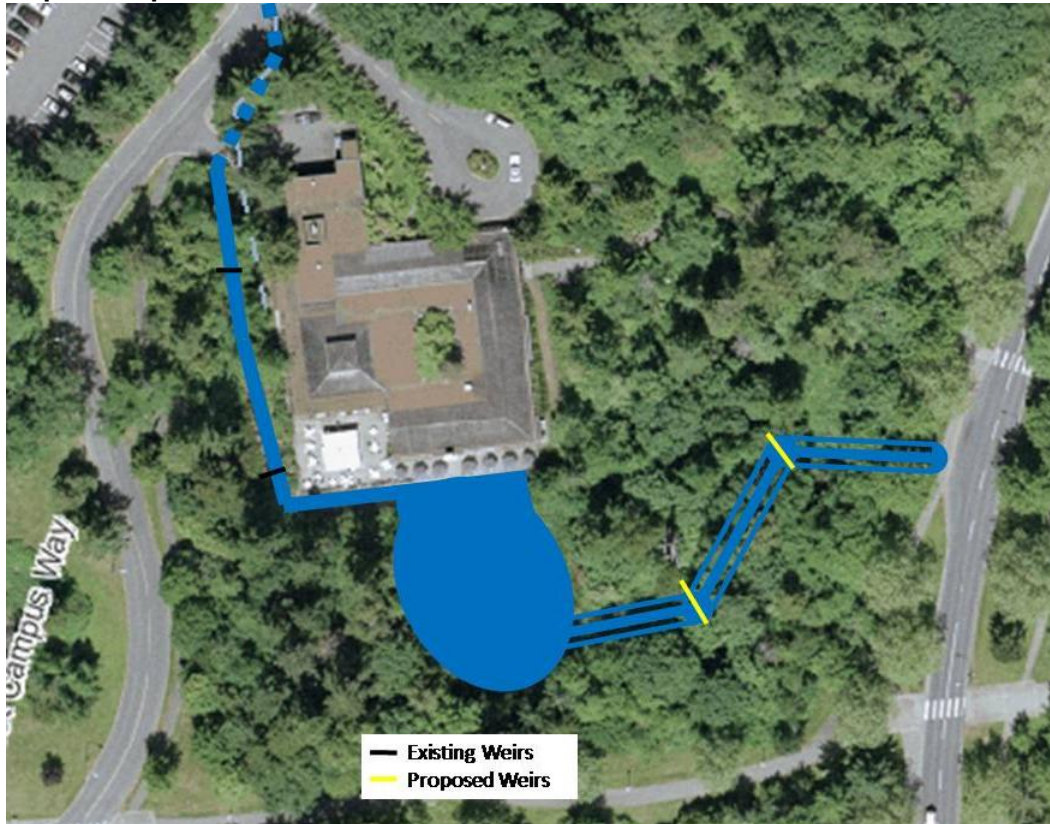
easterly into the pond outside the University Club building. In order to mitigate the onset of flooding weirs will be put in place. A weir is a small dam that regulates the flow of water in a channel of water. The implementation of weirs will be used to maintain water levels during times of peak stormwater flows to prevent flooding around the headwaters of Bowker Creek. The design of the weirs proposed in this report will be similar to the weirs currently in place in place as shown in the image below.




**Figure 2 Existing weir (south)    Figure 3 Existing weir (north)**

The weirs are proposed to be situated upstream from the current detention pond outside the University Club in order to control the flow of water before it reaches the pond. The Map 2 illustrates the orientation of the weirs.

**Map 2 Proposed Weirs**



 - Proposed Bowker Creek Channeling (The inner and outer lines indicate the approximation of creek width during regular flow and peak stormwater flow.)

## **2.0 Stormwater Management Plan**

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The stormwater management plan is designed to reduce peak flows, filter pollutants, alleviate stream bank erosion and increase infiltration in order to protect and enhance the Bowker Creek urban stream system.

## **2.1 Legal Land Use Protection**

Storm water is collected through permeable surfaces throughout the University of Victoria campus and collected in an aquifer below grade. During times of saturation, the aquifer drains from a culvert just outside the University Club on the West side of Ring Road, and creates the headwaters for Bowker Creek. To maintain a more consistent stream level, the following legal protection for the Bowker Creek riparian area will be proposed.

### **2.1.1 Development Permit Areas**

Development Permit Areas are an important tool that can be used to mandate how development proceeds through establishing a set of guidelines. No development can occur within a DP Area until the municipality issues a development permit. DP applications usually involve a rigorous review of the proposal and will usually be subject to approval by council. This process allows for important communication between the developer or property owner and municipal staff. DP Areas can be used to protect Environmentally Sensitive Areas (ESA's) and conserve biodiversity. Establishing the University of Victoria campus as a Development Permit area will ensure future development is not detrimental to the health of Bowker Creek.

### 2.1.2 Zoning

Currently the District of Saanich and Oak Bay have very lenient zoning by-laws for stormwater management. The adopting strict regarding stormwater management regulations within the zoning by-law will ensure future development is supportive and protective of the Bowker Creek Stream System. The following amendments are proposed for the existing Saanich zoning by-law *UNIVERSITY ZONE•P-1U* (District of Saanich, 2009):

Building: The Building must be designed to a minimum LEED Gold (Canadian Green Building Council, 2009) of design to ensure sustainable measures are implemented. Development requires of a stormwater recycling system.

Lot: The lot must contain a permeable surface which makes up no less than 80% of the aerial surface area.

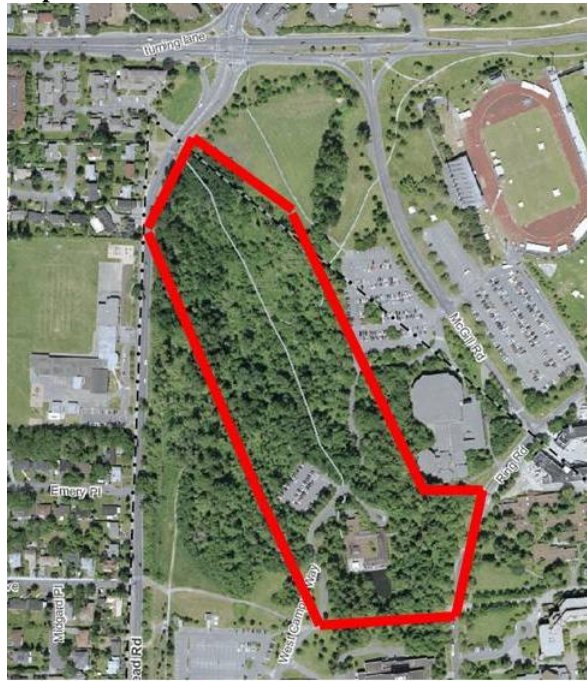
Impervious surfaces may include: porous pavement, gravel paths, green roofs and vegetation.


### 2.1.3 Stream Corridor Protection Zone

A stream corridor protection zone consists of the stream and the riparian area along the stream. Its purpose is to allow the natural, lateral movement of open water courses and prevent structures from being impacted by natural stream bank erosion. The Stream Corridor Protection Zone will be delineated based on a proximity basis from Bowker Creek. The following map shows the area under protection.



**Map 3 Stream Corridor Protection Zone**



 Stream Corridor Protection Boundary

The stream corridor protection zone shall be kept in as natural state as possible so that it can perform its inherent function of erosion protection, flood storage, and water quality protection. Uses permitted within stream corridor protection zone include, but are not limited to, the following:

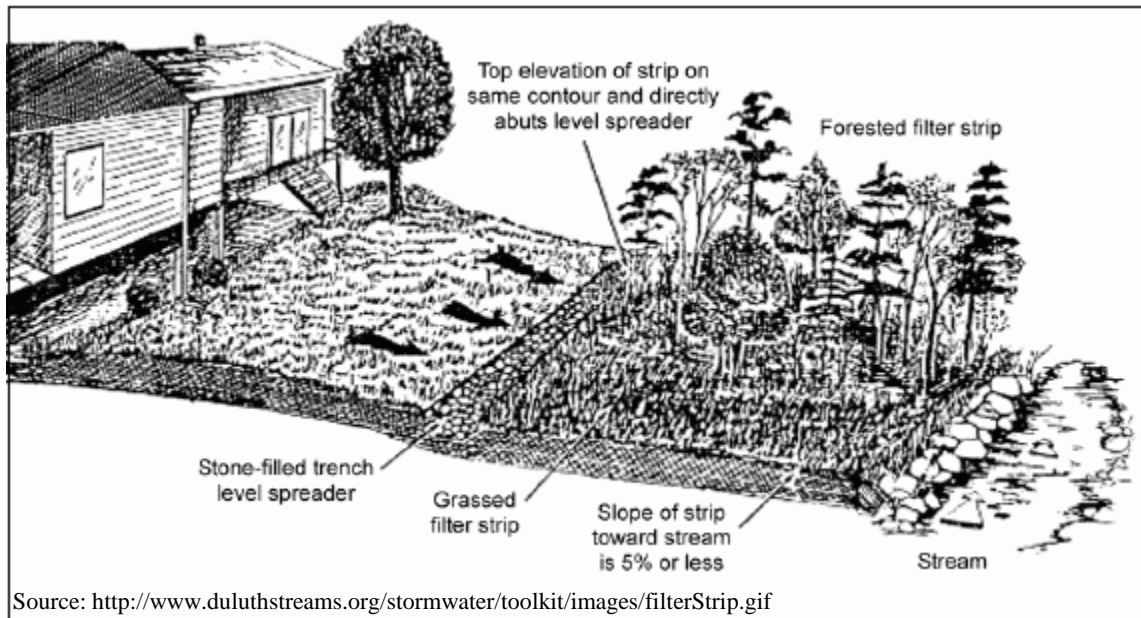
- 1) Walking, Cycling along marked paths
- 2) Ecological Restoration
- 3) Revegetation of native species
- 4) Public utilities (owned by the University of Victoria, District of Saanich and Oak Bay Municipality)

**Exemption:** The size of the stream corridor may be reduced if the project is a redevelopment, and the existing buildings already exist within the protection zone. The redevelopment shall not encroach further into the protection zone. Example: University Club, Murray and Anne Fraser Building.

## 2.2 Filter Strip Treatment

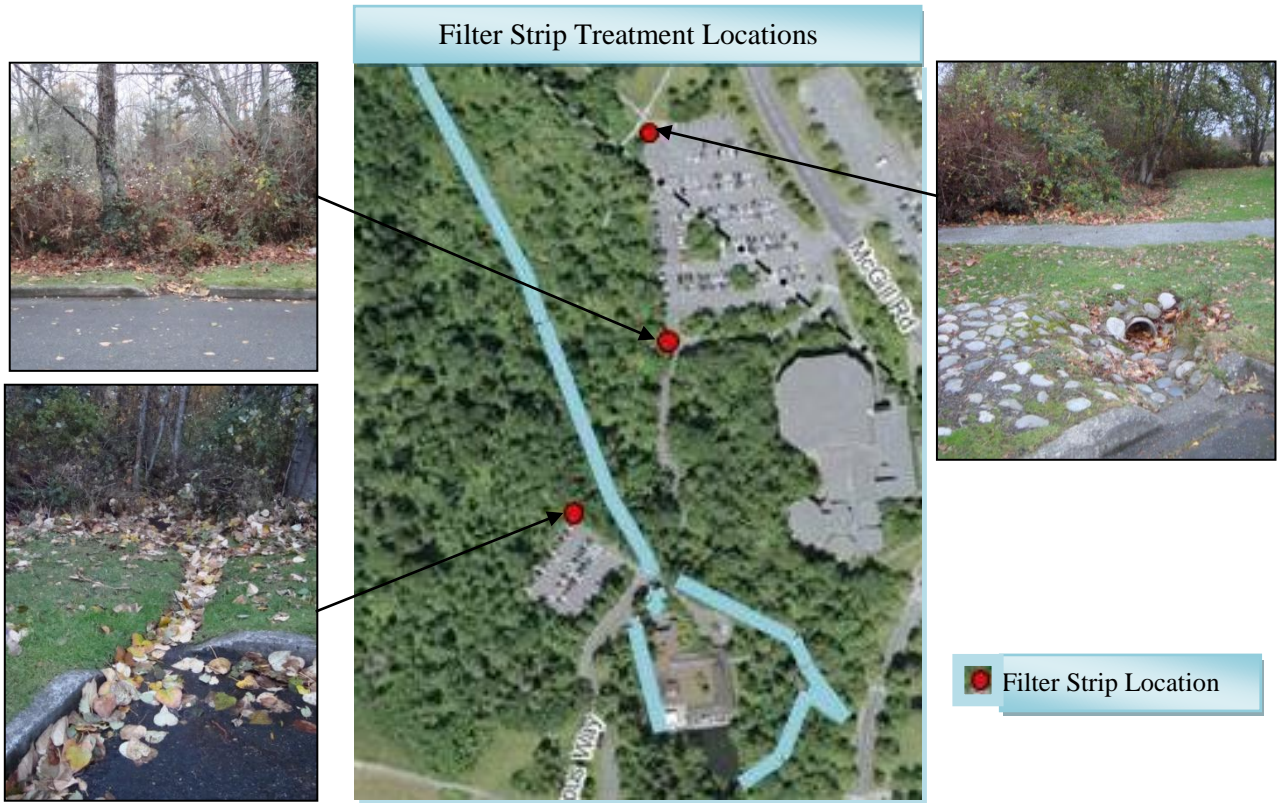
Surrounding the Bowker Creek headwaters are large parking lot and roadway surfaces. In order to mitigate automotive and human waste pollution, a storm water treatment system is necessary to avoid water contamination that could detrimental effect surrounding biodiversity and the health of the stream.

In order to filter out pollutants, filter strips will be implemented. This filtering system incorporates a vegetative slope where run off is evenly distributed and can be filtered and treated through vegetation as seen in Figure 4 (Randolph, 2004).



**Figure 4** This diagram shows a grassed and forested filter strip in proximity to a stream.

The following map shows the locations where filter strips are necessary due to the high levels of potentially contaminated stormwater that is channeled to these specific locations. The locations of implementation and management of filter strips are delineated in Map 4 below.



Map 4 Proposed Filter Strips

### 3.0 Awareness Program

Raising awareness regarding Bowker Creek will help engage the University of Victoria in voluntary participation to help mitigate ongoing damages from pollution on campus. To help with restorative efforts, it is integral to engage people with the issues and solutions to make Bowker Creek as healthy and natural as possible.

To raise awareness regarding the Bowker Creek watershed, signs will be placed around campus showing the route of the stream underground as it passes through campus, interesting facts about the stream. Feeling more informed and more connected to their environment, students and other campus users may

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Bowker Creek Headwaters Restoration Project

Members: Raj Dasanjh, Rachel Gutman, Marten Hansen, Joy Mensink and Kristen Voghell

feel more inclined to participate in restorative action. Following is a conceptual design for awareness signs that are to be placed around the University of Victoria campus.



Figure 5 Proposed Bowker Creek awareness sign.

#### 4.0 Rabbit Control Plan

The population of rabbits on campus has been consistently growing over the years and as a result there has been large ecological damage on campus. Rabbits are eating the natural vegetation as well as eroding soil conditions on campus by



Figure 6 A rabbit foraging at the Bowker Creek headwaters on the University of Victoria campus. *Photo by Marten Hansen*

digging holes; consequently the rabbits have direct negative impact on Bowker

Creek by the physical removal of both soil and vegetation, which is integral for reducing stream bank erosion and alleviated the stresses of peak storm water events. In order to curtail the rabbit problem, this plan incorporates the implementation of two design implementation strategies. The first will see the construction of perimeter rabbit prevention fencing around areas deemed to be sensitive to the health of Bowker Creek. The second strategy will provide habitat to native raptor bird species.

#### 4.1 Rabbit Prevention Fencing

Rabbit prevention fencing will be used to prevent rabbits from entering ecological sensitive areas that are integral to the health of



**Figure 7 Existing rabbit fencing adjacent to Bowker Creek**

Bowker Creek. The design of the fencing system will be the same as the existing rabbit fencing around the University of Victoria campus as seen in Figure 7.

The following map (Map 5) delineates the existing rabbit prevention fencing and the proposed rabbit prevention fencing around the Bowker Creek area on the University of Victoria campus.

Map 5 Rabbit Fencing



## 4.2 Enhancing Raptor Habitat

Rabbits are prey for many raptor bird species in the Greater Victoria region. By enhancing and conserving raptor habitat around the University of Victoria, rabbit populations will be controlled by the natural scenario of predator versus prey. The raptor birds in the Victoria area pertinent to this plan include the recently introduced Barred Owl, the Western Screech

Owl, the Great Horned Owl and the Cooper's Hawk. With further research into habitat requirement, this strategy calls for the enhancement and conservation of habitat for these raptor species.



Figure 8 A Cooper's Hawk finds a tasty meal on the University of Victoria campus.

## Section D - Implementation

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### 1.0 Introduction

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For the true implementation of such a complex storm-water management proposal, it is vitally important to build a realistic set of parameters to use as reference points. These parameters can take place in the form of a budget and a timeline as quantitative means of measurement of the restorative process (Society for Ecological Restoration, 2004). This is a logistical place to start when mapping the process of a restoration project as it gives a tangible sense of how the project will work. In this way it is practical to start with developing a timeline and budget in order to understand what will be needed for the project.

It is also extremely important to establish a qualitative set of parameters in order to keep the restoration engaging as well as instilling restoration as a part of the culture of the area. Qualitative means can be any guidelines that cannot be understood through numerical values such as the



visual appeal of the area, and a sense of communal belonging to the area. This will be the more tricky part of implementation for two reasons. One is because the project will be located on a university campus where there is a turnover of students approximately once every four years. Therefore, most of the people who experience the Bowker Creek headwaters are not able to establish a strong connection with the land because those options are only temporary. The other reason is that qualitative parameters can be more abstract than quantitative, and therefore it is more difficult to make the implementation seem tangible.

These two forms of guidelines are equally vital to the success of the implementation of the restoration on Bowker Creek. One cannot be successful without the other. Therefore, both are going to be integrated into the project with equal significance.

## **2.0 Qualitative Factors**

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While being difficult to measure, qualitative factors can be the point deciding whether or not a restoration project really goes through. It requires the recruitment of volunteers and leaders within the community. It is engaging and gathers widespread support to approach local governments.

### **2.1 - Acquiring Volunteers**

These are the steps that will need to be taken in order to find people willing to restore the creek and care about it.

- Going to environmental studies, urban planning, geography, and other related classes at the University of Victoria to speak about the volunteering opportunity.
- Going to other sources such as Camosun College, high schools, and local businesses to speak to potential volunteers.
- Putting up flyers around the community on stoplight poles, bulletin boards, and in mailboxes
- Getting alumni and faculty at the University of Victoria to support the cause, as they are likely to have an invested interest in the health of the creek

## 2.2 Recruiting Volunteers

- Buy refreshments and snacks
- Give a short history of Bowker Creek
- Give a brief overview of the importance of the creek as an underground watershed for a large portion of Victoria
- Give a brief overview of the importance of the headwaters to the rest of the creek
- Send volunteers to raise awareness in the community
- Send volunteers to put up signs around the headwaters

## 2.3 - Getting Permission

- Use community support to approach governments in Central Saanich and Oak Bay

- Propose to both districts amendments to zoning bylaw: University Zone P-1U
- Propose to both districts to implement stream-corridor protection zones.

### 3.0 Quantitative Factors

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This section involves the budget and the timeline.

#### 3.1 Budget

Below are spreadsheets outlining the amount of money needed for each task. It is impossible to know the exact amount that it will cost, however, these spread sheets can be used as guideline to estimate total costs.

<b>Implementing the Weir System</b>		<b>Food &amp; Drink from Costco for Volunteers</b>		<b>Printing costs for flyers &amp; signs</b>	
# Workers	4	1kg		# of Flyers	300
Wage (avg)	\$22	Coffee		Cost per flyer	\$0.10
Hours	20	Beans	\$59.99	# of Signs	10
Materials	\$75	Tea	\$20.00	Cost per sign	\$50
<b>Total</b>		Fruit & Nuts		<b>Total</b>	
<b>(4x22x20+75)</b>	<b>\$1,835</b>	sampler	\$29.99	<b>(300x0.1 + 10x50)</b>	<b>\$530</b>
		<b>Total</b>	<b>\$109.98</b>		

<b>Installing Rabbit Fences</b>		<b>Total Costs</b>	
# Workers	2	Food & Drink	\$109.98
Wage (avg)	\$22	Weir	\$1,835
Hours	8	Printing	
Fence Materials	\$17	Costs	\$530
<b>Total (2x22x8 + 17)</b>	<b>369</b>	Fences	\$369
		<b>TOTAL</b>	<b>\$2,843.98</b>

According to these estimated costs, the final cost will be \$2,843.98.

### 3.2 Timeline

The goal is to complete this project within a year. Here is how it's going to work.

- January - April:
  - Acquire volunteers
  - Recruit volunteers
  - Promote community awareness
  - Bring together consensus in the community
- April - July
  - Work to change legal restrictions
- July - October
  - Implementing the fences and weir
- October - December
  - Extensive monitoring

## 4.0 Conclusion

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This section is meant to provide the information needed to allow the restoration project to occur. It outlines everything that needs to be done, and what resources it will take in order to make the previous two sections tangible and realistic.

## Section E - Monitoring and Evaluation - Rajiv Dasanjh

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### 1.0 Introduction

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During the course of implementing our restoration project's goals and objectives, it becomes necessary to quantify and ultimately verify the success of the changes we are making to the landscape in order to discover if we have actually achieved said goals. This will enable us to justify the notion that we are in fact restoring a given area and not further degrading it. The importance of collecting data in terms of quantitative, as well as qualitative figures is therefore evident and embodied in a timeline that begins far before the actual implementation of a project and really has no end. For example, data and research must be compiled on an area prior to any physical landscape changes are carried out in order to accurately compare data after restoration has been completed. As well as collecting data just after implementation, it is the evaluation of an area at least 2-3 years after the restoration has been completed that will verify the greatest success. Coupled with measuring the validity of goals and objectives, is the fact that by evaluating a projects yield

of successful change on an area, mistakes and perhaps goals that have a higher priority than the ones first chosen may surface. This can help us make the appropriate changes to our or future projects in order to maximize restorative ideals and intentions. In order to evaluate the success of our project, it is necessary to go through each goal or objective independently and outline the appropriate data collection and observatory operations that should be carried to justify the entire projects purpose.

## **2.0 Public Interest**

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*Generate public interest and knowledge regarding The Bowker Creek watershed*

The use of interpretive signage around the University is implemented to create a general knowledge about the Bowker Creek watershed that exists under the feet of people and buildings on the schools property. The desire behind this goal is to create an awareness of the fountains, parking lots, and other areas that drain into the watershed and the reasoning behind not polluting these headwater hotspots. To accurately measure whether or not signage and advertisement is contributing to the general knowledge on the headwaters importance, campus-wide polls will be conducted. A poll before and after the signage has been implemented can help us compare whether or not the general campus population learned anything of the drainage systems around them and how they can help keep them clean. Students and faculty on campus will be interviewed at random before the restoration project has been implemented and asked a few simple questions, such as:

1. Do you know where over half of the University's fountains and parking lots drain into?
2. If so, did you know that this water system spans throughout a vast area of greater Victoria and is used as the backbone for municipal water-drainage systems? (Mcgillivray, 2009)

After a minimum of 100 people have been interviewed, a general conclusion can be drawn using percentages of people who answered no questions right, people who answered question 1 right and of people who answered both questions right; giving us an idea of what the average person at Uvic knows about the watershed. The same amount of people are to be interviewed again after the restoration project has been completed and signs/advertisements have been in existence for at least a month's time. Conducting the same poll and comparing percentages of questions answered correctly will then enable us to see if our goal of generating public knowledge of the watershed has been a success.

However if it has not been a success, obviously more intense actions must be taken. Perhaps setting up a booth outside of the campus library and simply drawing attention to it by means of free goods; then giving the passing by people a brief run through of the watershed's importance and existence. Informative seminars and tours could also be set up with guest speakers to cultivate an interest in the importance of the Bowker Creek Watershed.

### 3.0 Historic Trajectory

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#### *Restore Bowker Creek headwaters to historical trajectory*

The diversion that had been put into place at the headwaters of Bowker Creek created an alternate water flow to primarily avoid contamination of the pond behind the University Club. This secondary water flow, which changed the water direction into a predominantly underground system, completely skewed the headwaters from its natural and historical trajectory. This diversion was only done to avoid gas and oil contaminations, when those types of fuels were used for heating: This route is no longer necessary. Since this type of contamination is no longer a major threat to the pond, the sandbags that were used to divert flow into the underground system can be removed and the natural flow of water into the pond can be brought back into place. With this sudden change and the blockade of the underground water flow, it is important to understand that the process of an area falling back to its historical trajectory and having the surrounding biotic species become familiar to it, takes time. This is where a photographic analysis can be used to measure success. By taking photos, before, during, and just/long after restoration has taken place, we are able to compare the success of bringing back a historical form of an ecosystem. A photo will be taken before any restoration has taken place and compared to one after it has happened. This is mostly for cosmetic purposes and to see if this version of the ecosystem is in fact more appealing to the eye; this is because the surrounding biomass has had little time to cope and change with the sudden increase of water flow. A photo taken long after the project has taken place, for example over a year's time, can be compared to a similar

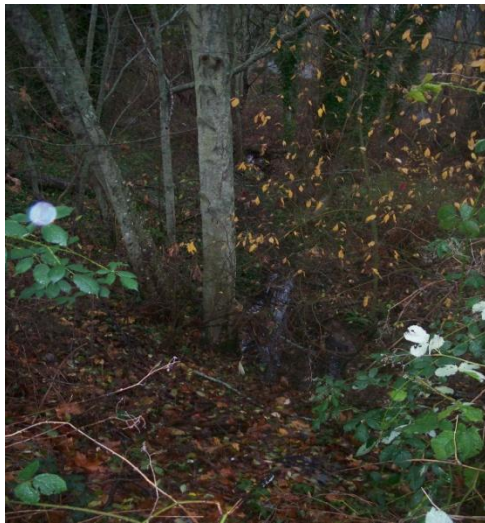
*November 2009*

Bowker Creek Headwaters Restoration Project

*Members: Raj Dasanjh, Rachel Gutman, Marten Hansen, Joy Mensink and Kristen Voghell*



photograph taken of the Bowker Creek headwaters before the diversion was put into place. Now that the area has time to cope with the change, we can see if it is in fact a positive shift for the surrounding environment and not negative one. Its physical appearance may be compared with the older photograph in order to determine accuracy of historical restoration (J. Mitchell, personal communications, November 5, 2009). Evaluation of the area also involves observing the changes on the environment where the water diversion once led. Shutting of the water to an area should have great impacts on the surrounding environment, but luckily the water flow of the diversion was mostly underground and in a pipe-system so its changes only need be monitored and dealt with if drastic in scale.



1.



2.

1. A recent photo of proposed Restoration Area and 2. An Example of proposed Weir System

### 3.0 Stormwater and Sediment

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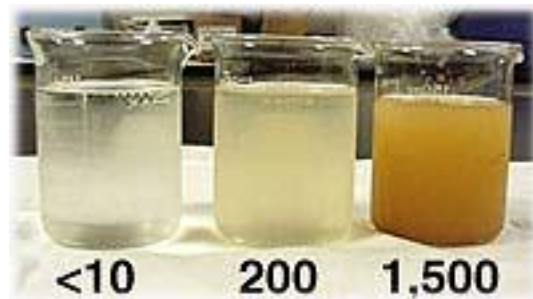
#### *Reduce storm water and sediment loads carried through water system*

The implementation of a weir system into this area will also bring about great changes to the environment surrounding the once small, but now constant flow of water into the pond. The objectives of this weir system are to reduce heavy storm water flow, reduce sediments carried downstream and therefore prevent further pollution, and increase groundwater levels below the vegetation by recycling the rain water, which will increase overall nutrient uptake for surrounding vegetation. To measure the success of these objectives it is necessary to take sediment samples of the water and surrounding soil, as well as observe the general livelihood of the surrounding vegetation over time; before and long after restoration has taken place.

Taking a sample from the small flow of water that is already going into the pond before the weir system will be put into place can give us a comparison for the amount of sediment and debris this water is carrying before restoration.

This is called a turbidity sample and it measures the scattering effect that suspended solids have on light: the higher the intensity of scattered light, the higher the turbidity/sediment levels. (See Figure 1). Materials that effect turbidity are clay, silt, microorganisms, and insoluble/soluble organic or inorganic matter. The water sample must be taken from the best representative of the waters sediment levels, so we will be taking our sample from the exact halfway point between the man-hole diversion of the creek and the pond behind the University Club. This sample must be contained in a sterile and clean container, such as a test tube. It also must be taken from a depth of

the water that is not too close to the bottom substrate, nor too high off the top, but right in the middle. This sample may then be tested using a hand-held turbidity meter that will read how much light is reflected back from the sample and give us a reading of sediment and debris levels (See Figure 2). This turbidity test will also be carried out after restoration is completed and will be followed up on for at least a one or two year period after completion to ensure or calibrate the weir's success. The test must be completed in the same spot as it was first done to ensure consistency (Swanson, 1965). The sediment sample with the lower light reading will have the cleaner and more sediment free water.



**Figure 1** Comparing Turbidity



**Figure 2** Turbidity Meter

To check the success rate of the weir-system in reducing storm water flow, water levels must be recorded before and after restoration. Taking measurement samples in again, the best representing spot of the water levels, before restoration gives us a comparison for results after completion. Using a meter stick in the middle of the University Club pond during calm weather and during a storm will give us an idea of how much the water levels currently rise during peak water flow. After the weir-system has been put into place, the same test can be completed to see if the water level of the pond is lower during a storm than without the weir-system in place. Although the degree of the rainfall offsets the consistency of this test, it will give us a general observation of storm water reduction. Sediment samples at the top of the weir systems can also be taken. Higher sediment levels should be found above the beams of the weir-system, where the water pools, after heavy rainfall has come through the area. This is because the water should be slowing down due to the weirs, therefore allowing sediment to collect on the bottom substrate of the stream. This can be done by using a bed-sediment sampler, which is essentially a push-tube core sampler that measures the depth of the sediment below the water.



**Figure 3 Piezometer Measurements**

Taking a sample before and after a storm in the same spot will give us results; showing whether sediment is building up or not (Quinn, 1998).

Measuring the success of storm water recycling can be done multiple ways. One way, as mentioned earlier, is simply by taking photographs from before and after restoration and viewing the differences in biomass growth. The weir-system enables water to pool and sit on top of a substrate longer, therefore allowing it more time to seep into the ground where surrounding vegetation can use it for nutrients. The more water seeping into the ground, the more growth will be seen in surrounding vegetation. Quadrat samples of the area can also be taken before and long after restoration, giving species reasonable time to grow. This will help us quantify the biomass percentages that have increased since having a larger ground water supply. It can be done by counting the number of same or different species found in varying quadrat sample sizes and comparing it to before the weir-system was implemented. A piezometer is a more accurate way to get exact figures of how much groundwater is in an area and it does so by measuring the water pressure underground (See Figure 3). Several readings will be taken along the length of the stream before the weir system is put into place and after the project is completed. These values will be compared and can show whether or not the weir system has aided in providing better storm-water recycling and groundwater retention for this specific area of the headwaters (Baxter, 2003).

#### 4.0 Native Riparian Vegetation

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##### *Restore native riparian vegetation*

Restoring the Bowker Creek headwaters also involves removing invasive plant species to ensure its proper historical trajectory. It is important to note that the ecosystem will be used to having these invasive species around and that removing them and then planting native species, although a good change, is not necessarily easy to do. Once an invasive has started growing in an area it is very hard to remove it forever. Again, photographs can be used to observe the growth of invasive species on the restored area. A photograph taken of invasive species, such as English Ivy and Himalayan Blackberry, grown in on the area can be compared to a photograph taken just after removal, but more importantly compared to photographs taken years down the road. This is the monitoring part of the project and it requires a constant upkeep to ensure a historical trajectory. Invasive species are almost guaranteed to keep reappearing over time and it is important that we evaluate the area at least once every 2 months to keep them at bay. Cattails and sedges, native species to Bowker Creek, are also more adapted to absorbing surrounding water by a process called phytoremediation. Water levels could also be used as a measurement for the succession of native plant species. For example, years after when many native species are prevailing around the weir system, groundwater samples that are taken can be compared to biomass levels of native plant species and plotted together on a graph looking for correlation or not (Cock, 2001).

If results show that the two-dam weir system is not portraying results that were expected or high enough to correlate with any real success, more weir systems

could be put into place and re-tested. If this as well fails, the Bowker Creek headwaters may require a more extensive overhaul to reduce its storm water levels, yet at the same time keep its historical trajectory. The Bowker Creek requires space like any wetland needs for its water flows to pool and settle. By building roads, parking lots, and essentially paving over its entire ecosystem, we have eliminated the space that a wetland needs to do its job properly and replaced it with impermeable surfaces. Only by creating more space for water to pool and have time to be naturally recycled through the ground will we see a more drastic change in storm water and sediment load reduction.

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*Report formatted by Marten Hansen*

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## Price Estimates

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8655

Rabbit Fences: <http://www.nextag.com/rabbit-fencing/compare-html>

Weir System: Home Depot Victoria - 250-853-5350

Food and Drink:

<http://www.costco.ca/Common/Category.aspx?cat=20418&eCat=BCCA|20418&>

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Bowker Creek Headwaters Restoration Project

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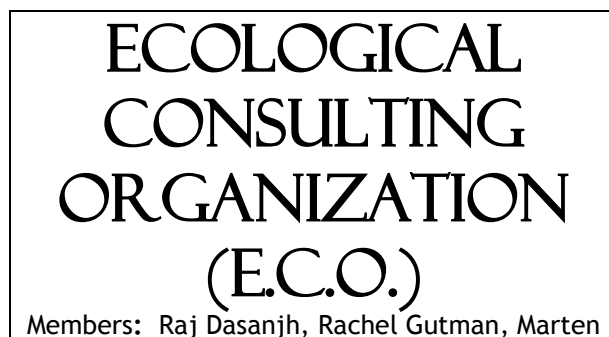
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