Integrated Stormwater Management Plan

University of Victoria Project No. 02-4367

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Executive Summary

The University of Victoria 2003 Campus Plan identified the need to create an Integrated Stormwater Management Plan. This plan was commissioned to provide a series of recommendations to reduce the quantity and improve the quality of stormwater leaving the Gordon Head campus.

The University is located on the height of land between Gordon Head and Cadboro Bay. This unique location results in the University being the headwater stream source for four drainage systems: Bowker Creek to the west, Finnerty Creek to the north, Sinclair drainage system to the north-east and Hobbs Creek to the east. Historically, the land has changed from a natural fir forest to farm-land then a military base and finally the University of Victoria.

Stormwater patterns have changed, as with all urban areas, owing to the construction of buildings, roads and parking lots. At the University of Victoria rainwater is directed into piped systems then discharged into the four catchment areas. Most of the campus is underlain by hard clays and fine or sandy silts that provide minimal opportunity for infiltration of stormwater.

An analysis of the storm drainage system and its evolution has shown that since 1956, the runoff volume from the campus area has doubled; however, the study identified that the University has no urgent or serious stormwater related problems that require immediate infusion of large funds. The intent of the report is to guide the University in handling stormwater issues related to new building projects so that run off will not increase or may indeed be reduced. Most of the required remedial stormwater measures can be incorporated into new construction and renovations of buildings, roads and parking lots as time and funding permits.

The University has preserved and maintained a significant percentage of natural and open space. Some of this land is used for playing fields, recreational areas, common areas and gardens; the remaining portions are in natural forested states. Much of this natural land is in flat or low lying areas that contribute to stormwater storage and detention, thus reducing the offsite detrimental influence of campus runoff. In some areas, stormwater detention has resulted in a transition from dry soil plants to more wetland tolerant vegetation.

As part of preparing this report, the Consultants have reviewed all the current new building plans and have made recommendations on stormwater best management practices (BMPs). The study also indicates that reducing the impervious surface areas of the campus and providing additional stormwater storage through in-ground and surface storage, the University could reduce its stormwater offsite discharges by up to 16%. Implementing BMPs would also improve water quality in downstream receiving environments and improve summer low flows by recharging groundwater.

The Integrated Stormwater Management Plan provides recommendations for best management practices including:

- Modification of landscape areas to swales instead of raised areas
- Modification of parking areas to permeable surfaces
- Modifications to vegetated infiltration zones
- Water detention facilities below surface parking lots
- Innovative building design techniques to reduce and treat stormwater
- Construction of surface vegetated swales and infiltration areas
- Deep soil amendment for infiltration, treatment, vegetation, evapotranspiration and detention
- Conversion of pathways and recreation areas to permeable surfaces that can treat and detain stormwater for use as irrigation and other natural water uses

Over the past few years the University has initiated a series of projects designed to improve and protect streams and these projects have made observable improvements to the off-site stream flows. UVic will continue to play a key role in working with surrounding municipalities, the Capital Regional District, and the province of British Columbia to meet or exceed bylaws, codes of practice, and regulatory guidelines. Stormwater management will continue to play a vital role in order for the University to continue with low impact development practices. All these steps, however, require the expenditure of funds. Therefore, the recommendations will need to be prioritized and dealt with over time as funds become available.

The Stormwater Management Stakeholders' Advisory Committee identified four main goals to be considered by the Campus Planning Committee and the Facilities Development and Sustainability Committee:

1. To reduce stormwater flows and improve stormwater quality;
2. To apply Best Management Practices to new buildings and facilities;
3. To apply Best Management Practices to existing buildings and facilities as time and funding allow;
4. To integrate the principles, goals, and actions of the Campus Plan 2003 with the Stormwater Management Plan.

Section 1- Rationale for Stormwater Management

WHAT IS STORMWATER?

Stormwater is precipitation (rain and snow melt) that cannot soak into impervious areas such as paved streets, parking lots, and building rooftops during rainfall and snow events. Because it cannot soak into the ground, it "runs off" the land into neighbouring waterways. Stormwater runoff often contains pollutants in quantities that could adversely affect water quality. Stormwater pollution from point sources and nonpoint sources is a challenging water quality problem. Unlike pollution from industry or sewage treatment facilities, which is caused by a discrete number of sources, stormwater pollution is caused by the daily activities of people everywhere. Rainwater and snow melt run off streets, lawns, farms, and construction and industrial sites and pick up fertilizers, dirt, sediment, pesticides, oil and grease, and many other pollutants on the way to rivers, lakes, and coastal waters. Stormwater runoff is the most common cause of water pollution.

In areas that do not have man-made impermeable surfaces, precipitation normally takes a long time to reach a stream. A small amount of water falls on the stream surface, but most of the water reaches the stream only after it has soaked into the ground and moved through the soils. When impermeable surfaces are added to a watershed, the water reaches the stream very quickly and in much larger quantities than the stream is used to. In addition, urban areas are normally serviced by a system of pipes and catchbasins which are designed to get water off the land as quickly as possible and convey it to the stream. This excessive volume of water is more than the channel can handle and erosion of the channel results. When the channel erosion occurs, it causes cloudy (turbid) water that negatively affects the organisms in the stream and the downstream users of the water, in addition to destroying habitat. It is, therefore, important to prevent runoff at source wherever possible.

In the case of the University of Victoria stormwater runs off building roofs, parking lots, roads, compacted and landscaped areas, and sidewalks. The UVic campus also receives "run-on" (stormwater) from adjacent watersheds. Typically, the stormwater is diverted into catchbasins and pipes and discharged into one of four streams: Bowker Creek to the west, Finnerty Creek to the north, Sinclair drainage system to the north-east and Hobbs Creek to the east. Some of the stormwater is detained in wetlands near the headwaters of Bowker Creek. UVic practices responsible landscape maintenance, so minimal quantities of pesticides, fertilizers and other chemical pollutants are used on campus. The most significant contaminants in UVic stormwater are sediment and oily drippings that wash off of parking lots and roads. Both of these types of pollutants can be effectively dealt with by diverting stormwater into vegetated swales (shallow channels with gently sloped sides) and wetlands where micro-organisms can break down petrochemicals and vegetation can filter sediment before the stormwater reaches a stream.

WHAT IS STORMWATER MANAGEMENT?

Stormwater management is the process of changing land use practices in the built landscape in order to maintain the quality, quantity and rate of runoff as close to the pre-development condition as possible. This includes preventing runoff at source by minimizing the amount of hard surfaces, providing areas to detain water and slow its progress toward the streams, amending soils in order to absorb more water, constructing filtration areas with vegetation to filter water as it moves across the land, and practicing good housekeeping both day-to-day and on construction sites in order to prevent sediment and other pollutants from washing into streams.

STORMWATER MANAGEMENT AND UVIC

The University of Victoria recently completed its *Campus Plan 2003* which highlights a need to maintain and continue to evolve natural open space and landscaped areas throughout its properties. The Campus Plan further notes that stormwater management must be an integral part of all projects including retrofits and new expansions. Over the last ten years, the University Facilities Management staff has recognized the need to reduce the impacts related to its development programs and has encouraged all participants to include, within their work, systems that will demonstrate advanced technologies and innovations toward reduced impact goals. The reduction of off-campus stormwater flows has been highlighted by environmental awareness of the quality and quantity of stormwater flows that traverse the University lands and drain into creeks that flow through residential areas surrounding the campus.

UVic Facilities Management determined there was a need to create clear guidelines for new works and embarked upon the creation of a Stormwater Management Plan that will form part of the basis for all future development (Action #23 Storm Water Management). The efforts of the University of Victoria will no doubt have positive impacts on the local community and natural areas in Victoria.

This Integrated Stormwater Management Plan provides general guidelines for inclusion of sound development techniques into campus development and redevelopment. It also provides visionary goals for enhancement of the University natural areas to meet the increasing demand for Low Impact Development. The recommendations in this plan can be used in new development initiatives on an on-going basis. The plan also outlines a series of small, medium and large-scale projects to improve water quality and reduce stormwater flows that should be undertaken as time and funding allow.

Throughout this report, the term Best Management Practice (BMP) has been used to include low impact development methods as well as specific practices.

STORMWATER MANAGEMENT AND THE UNIVERSITY CAMPUS PLAN

The University of Victoria Campus Plan 2003 outlines a series of goals and actions that reflect the values of smart growth, low impact development and environmental stewardship. By adhering to the many principles in the Campus Plan 2003, Stormwater Management will easily become a regular part of campus planning.

Regulatory Agencies

The University lies within the jurisdiction of The District of Saanich and the District of Oak Bay, but is also within the Capital Regional District.

District of Oak Bay

The District of Oak Bay has instituted stormwater bylaws limiting the volume and quality of stormwater discharged to its drainage systems.

District of Saanich

The District of Saanich has enacted bylaws that limit the quantity and quality of stormwater discharged from any new development into its streams and piped system. Saanich has designated Hobbs Creek watershed as a Type I watershed. This designation requires special detention of stormwater flows to restrict discharge from a development site to:

- Reduced runoff rates equivalent to 5 L/s per hectare of development
- Storage shall be 200 m^3/ha of impervious surface
- Treatment trains, infiltration or constructed wetlands may be used to detain runoff.

Bowker, Finnerty and Douglas Creeks are designated as Type II watersheds requiring the discharge flows be detained as follows:

- Reduced runoff rates equivalent to 10 L/s of total contributory catchment
- Storage shall be 100 m^3/ha of impervious surface
- Detention ponds, wetlands or underground storage may be used for storage

Capital Regional District

In the Capital Regional District (CRD), the regulatory jurisdiction over stormwater rests with each individual municipality. As part of their work on stormwater protection, the CRD has developed a model stormwater bylaw for adoption by the municipalities. This bylaw establishes guidelines for items such as the quality of stormwater permitted to be discharged to streams, ditches, and the municipal storm drainage systems. Also under development are several Codes of Practice which are industry-specific regulations designed to be used as appendices to the Model Bylaw.

The bylaw is performance-based and requires that any water other than clean precipitation runoff not be discharged to the municipal drainage system unless it meets specified standards. Currently, the code requirements are for two-year storm event but, for roads, this is superceded by a 10-year storm event limitation imposed by Saanich. The Codes of Practice require that Best Management Practices (BMP) should be employed where appropriate. For example, BMPs should be in place for all works near streams and ditches that might result in contaminants entering a downstream creek or the ocean. The codes also include requirements for a spill response plan should preventative measures fail.

UVic will to continue to work toward meeting the intent of the CRD Model Stormwater Bylaw and Codes of Practice that are applicable to the university as these regulations will likely come into force in the neighbouring municipalities within the next few years. The relevant industry sectors covered by the codes include: Automotive and Parking Lot Operations, Construction and Development Activities, Streets and Roads, Recycling Facilities and Landscaping, Golf Courses and Playing Fields.

The CRD Codes of Practice and BMP's are designed for use by specific business sectors and work alongside watershed management plans to improve watershed health and functional condition.

Bowker Creek Watershed Management Plan

The Bowker Creek Watershed Management Plan, developed in 2002 by participants in the Bowker Creek Watershed Public Forum, outlines a series of recommendations to improve water quality and protect and enhance stream characteristics.

Out of the forum, a vision was created for the Bowker Creek watershed:

The varied human uses and natural areas in the Bowker watershed are managed to minimize runoff and pollution, making Bowker Creek a healthy stream that supports habitat for native vegetation and wildlife, and provides a community greenway to connect neighbourhoods.

This vision is supported by four goals for watershed management:

Goal 1. Individuals, community and special interest groups, institutions, governments, and businesses take responsibility for actions that affect the watershed

Goal 2. Manage flows effectively

Goal 3. Improve and expand public areas, natural areas, and biodiversity in the watershed

Goal 4. Achieve and maintain acceptable water quality in the watershed

Integrated stormwater management is a key component of watershed-based planning and management. The University is in the headwaters of several watersheds and has been dedicated to participating in watershed management planning processes and working towards implementing these plans.

Section 2- Hydrology

INTRODUCTION

The changes in the stormwater hydrology caused by the development proposed in the 2003 Campus Plan are relatively small and the development can produce a reduction in runoff rates and volumes over the period of the rainstorm by installing rainfall retention roofs on the new buildings.

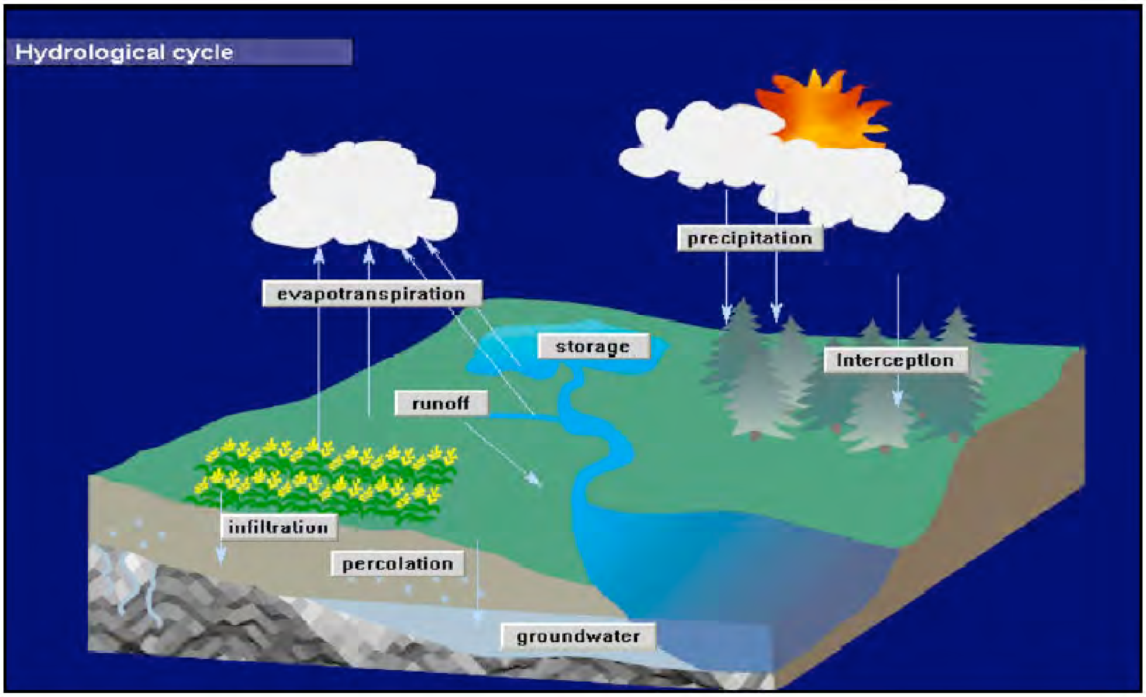
The hydrological cycle is composed of several components as illustrated in Figure 2.1. These components are in balance in both natural and developed settings. The allocation of precipitation between evapotranspiration, infiltration into the soil, runoff and change in stored water volumes is called the water balance. When land is developed from forest or agricultural use, the water balance is changed. Surface runoff increases because infiltration and evapotranspiration are reduced by the construction of relatively impervious surfaces such as roads, parking lots and building roofs. In the past, the objective of stormwater management was to remove all runoff from a site as quickly as possible. The more recent approach is restoration of the natural water balance rather than creation of drainage systems to convey surface runoff away from the site.

The planning of stormwater management systems and facilities requires an understanding of the drainage patterns and flows that were present before the UVic campus was developed and the effects to the water balance of the change in land use from forest and agriculture to a semi-urban environment. Figure 2.2, a 1956 aerial photograph of the UVic campus, shows the study area with the current and 1956 watershed boundaries. The analysis of the hydrology of the study area in its predevelopment state, in 1956, as it is in 2003, and at 2003 Campus Plan buildout, used a hydrologic simulation model. The model and its application to the UVic campus prior to the development of the University and for each of the development scenarios are described in this section of the report

STORMWATER MANAGEMENT HYDROLOGY MODEL

The computer model chosen to simulate the hydrology of the UVic campus and adjacent areas was PCSWMM (Personal Computer Stormwater Management Model), which evolved from SWMM developed by the United States Environmental Protection Agency (US EPA, 1980). The model computes the runoff produced by rainfall over any number of drainage sub-catchments. Infiltration, evaporation and surface detention are abstracted from the rainfall to calculate runoff during a rainstorm using time intervals of one minute duration. The rainstorm is input to the model as depth of rainfall over 10 minute intervals for the period of the storm event or over an extended period of days if continuous simulation is required.

The runoff produced in each sub-catchment by the hydrologic module of PCSWMM is conveyed from the source to the upstream inlets of the four major systems draining the UVic campus – Bowker, Hobbs and Finnerty Creeks and the Cadboro Bay trunk drain. Within the campus, the model simulates the existing UVic storm drain system to convey runoff for all development scenarios. The drainage system consists of catch basins, underground drains and open channels. The details of the drainage system can be viewed on the CD-ROM provided in Appendix B. This system is complex and had to be simplified for modeling purposes. The schematic of the modeled drainage system showing the sub-catchments, major drains and principal connections is shown on the Model Schematic (Figure 2.3).



Source: Province of BC Stormwater Planning Guidebook.

Figure 2.1. Hydrological Cycle.

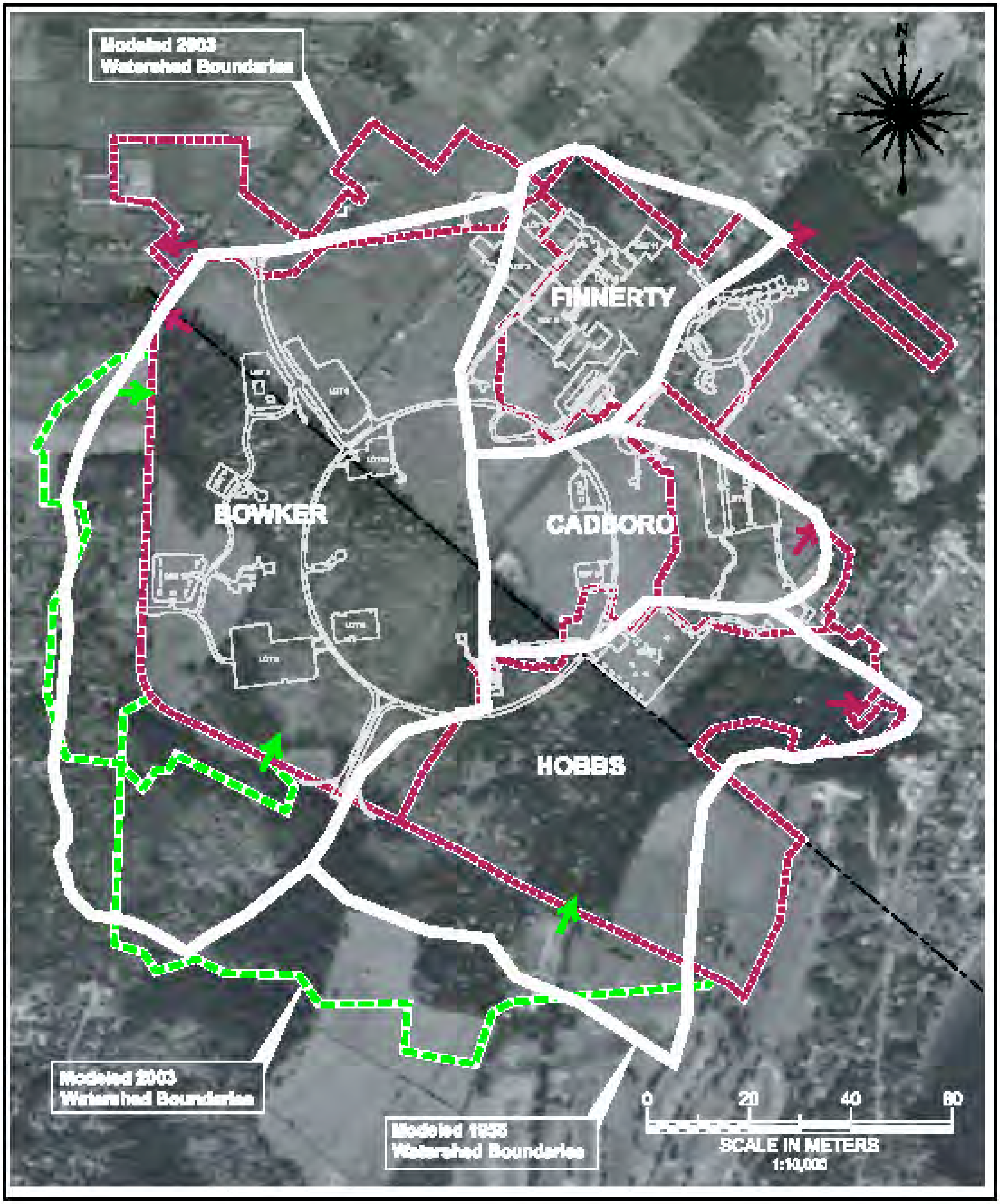


Figure 2.2. 1956 aerial photograph and catchment boundaries.

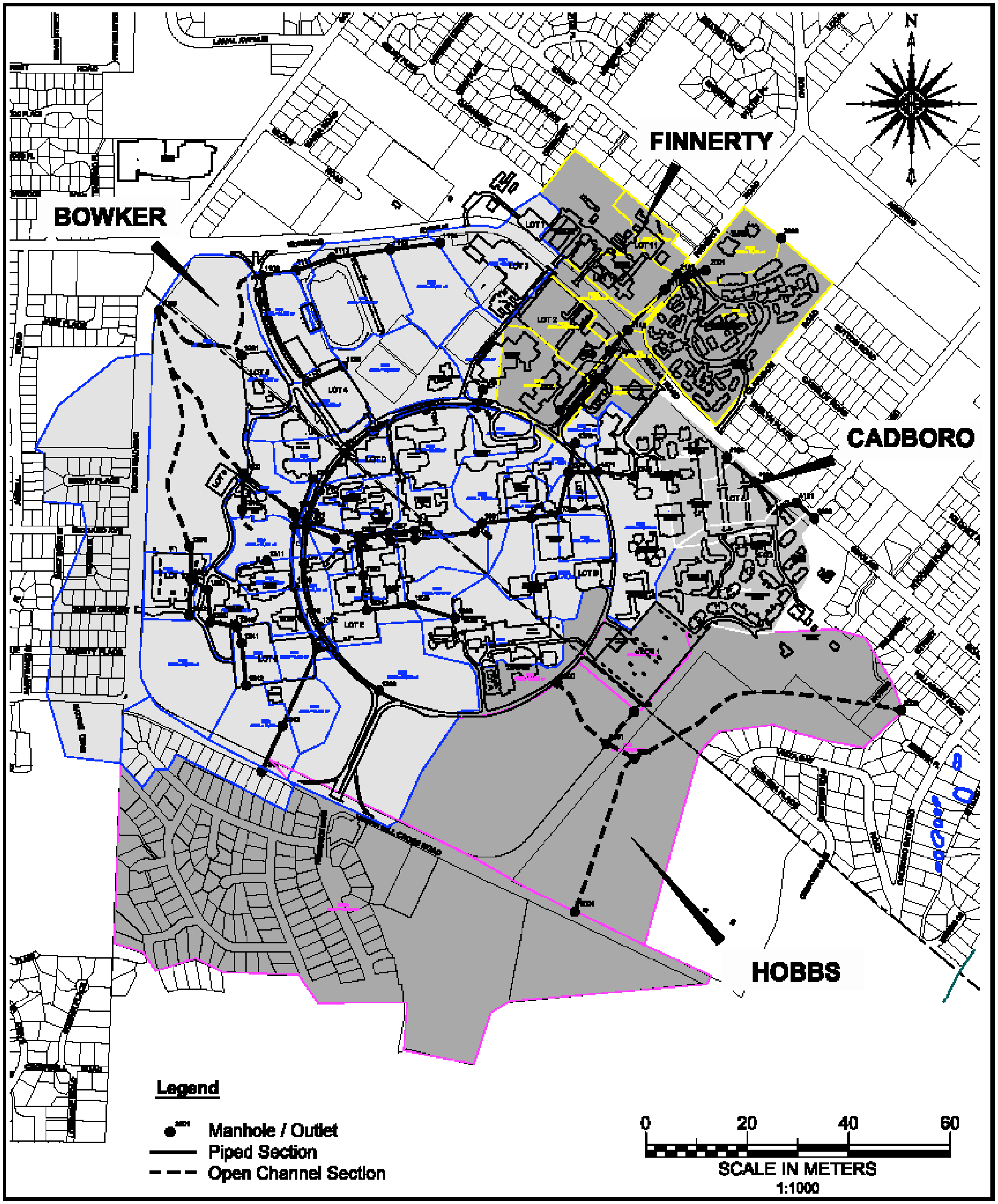


Figure 2.3. UVic SWMP- hydrological model schematic.

The key inputs to the hydrologic simulation model are:

- Rainfall hyetograph
- Pervious drainage areas
- Impervious drainage areas
- Infiltration parameters
- Ground slope of sub-catchments
- Diameter, slope and invert elevations of storm drains
- Depression storage within each catchment

The data from a previous model (HYDSYS) was used for pipe diameters, slopes and inverts of the UVic storm drain system. Reid Crowther & Partners used the HYDSYS model in 1998 to study pipe capacity within the drainage system (Reid Crowther, 1998).

The output from the PCSWMM model consists of flow hydrographs and volumes at the inlet to each major watershed, total volume of runoff, peak rate of runoff, infiltration, evaporation and surface storage volumes. The velocity of flow and the hydraulic grade line in the storm drains or watercourses can also be viewed as they change over the course of the rainstorm.

The stormwater model was used to simulate five scenarios, as follows:

Table 2.1. Hydrology model simulation scenarios.

Scenario Name	Description
Predevelopment	Land use, vegetative cover and drainage patterns prior to development as a military facility
1956	Land use, drainage network and surface cover as represented by the 1956 aerial photo
2003	The campus in its 2003 condition including buildings under construction
2003 with BMPs	2003 development with Best Management Practices
2003 Campus Plan Buildout	The campus as planned at buildout of the 2003 Campus Plan using conventional stormwater management methods
2003 Campus Plan Buildout with BMPs	The campus as planned at buildout of the 2003 Campus Plan with Best Management Practices

For each scenario, the model simulated the hydrology of the UVic campus in response to a 24 hour rainstorm that will, on average, reoccur every twenty five years. The rainstorm was developed from the Municipality of Saanich, intensity, duration and frequency curves (Appendix B). The total rainfall corresponding to the 1 in 25 rainstorm is 85 mm. Peak rainfall intensity is 29 mm/hr and occurs 12 hours into the rainstorm.

The model results were assessed for changes in stormwater volumes and peak flow rates from 1956 scenario. The hydrology of the 1956 scenario has been compared to the predevelopment condition. Each of the scenarios is described and the results from the simulation model are presented in the following report sections. Scenario results are summarized and compared in the Table 2.2– the Hydrologic Summary spreadsheet.

Predevelopment

The area, which is now occupied by the University of Victoria campus, is a local topographic high point and prior to intensive development of the land formed the headwater area for three drainage systems:

- Bowker Creek
- Hobbs Creek
- Finnerty Creek.

The hydrologic conditions that existed prior to development of the land are described in Section 4. In summary, before the University and its predecessors, the area was predominantly covered by forest. The hydrologic behavior of this terrain was typical of low relief upland with a heavy forest cover. The topography of this land, both macro and micro, was not conducive to runoff. The broad, gentle slope of the upland surface lacked sufficient gradient to induce strong lateral drainage. Beyond these general considerations, there was considerable interception and storage of runoff by forest floor debris and depressions.

The surficial soils and underlying geology were also assessed to determine the infiltration capacity of the study area and to assist in the evaluation of stormwater management facilities such as infiltration pond and swales. The soils within the UVic campus were characterized by limited on-site mapping, references to the technical literature and a summary assessment of the results of geotechnical investigations conducted for the building construction program at the University. The soils assessment report, “UVic Storm Water Disposal Study – Geotechnical/Geological Conditions” by Thurber, 2003 is provided in Appendix E. Figure 2.4 presents the results of the summary soils assessment.

The surficial soils along the eastern side of the University are silt clay till intermixed with sand. Underlying the till layer is a silty sand deposit. The upper layer is Vashon till and the underlying deposit is called the Quadra layer. From a hydrologic perspective, the most important characteristic of these soils is their permeability. The Vashon tills have low permeability and surface infiltration on the UVic campus is generally low. The Quadra deposit is inter-glacial and consists primarily of dense silty sand and poorly graded sand that is moderately permeable. An area south of the Ring Road and within the upper drainage area of Hobbs Creek generally consists of Victoria Marine Clay, which is very stiff to hard near the surface and has very low permeability. Bedrock surfaces in the southwest corner of the campus, near the main entrance but elsewhere the bedrock is relatively deep.

Table 2.2. Hydrologic summary for 25 year rainstorm.

	Bowker Creek				Finnerty				Cadboro Bay				Hobbs Creek			
	Total Runoff		Peak Flow		Total Runoff		Peak Flow		Total Runoff		Peak Flow		Total Runoff		Peak Flow	
	Volume (m3)	Relative to 1956	Rate (m3/s)	Relative to 1956	Volume (m3)	Relative to 1956	Rate (m3/s)	Relative to 1956	Volume (m3)	Relative to 1956	Rate (m3/s)	Relative to 1956	Volume (m3)	Relative to 1956	Rate (m3/s)	Relative to 1956
Predevelopment	15,520		0.40		3,906		0.11		4,022		0.11		8,417		0.22	
1956 Campus Lands	20,950		0.55		11,560		0.67		5,487		0.17		9,806		0.26	
2003 UVic Campus - "As-Is"	46,180	2.2	1.92	3.5	11,530	1.0	0.81	1.2	5,084	0.9	0.41	2.4	26,760	2.7	0.98	3.8
2003 UVic Campus - with "BMP's"	38730	1.8	1.60	2.9	8855	0.8	0.64	1.0	4562	0.8	0.33	2.0	25580	2.6	0.84	3.3
2003 Campus Plan Buildout- "As-Is Technology"	53,910	2.6	2.03	3.7	11,530	1.0	0.81	1.2	5,339	1.0	0.43	2.6	26,870	2.7	0.99	3.9
2003 Campus Plan Buildout with BMP's	37,060	1.8	1.58	2.9	8,855	0.8	0.64	1.0	3,967	0.7	0.34	2.0	25,220	2.6	0.84	3.3

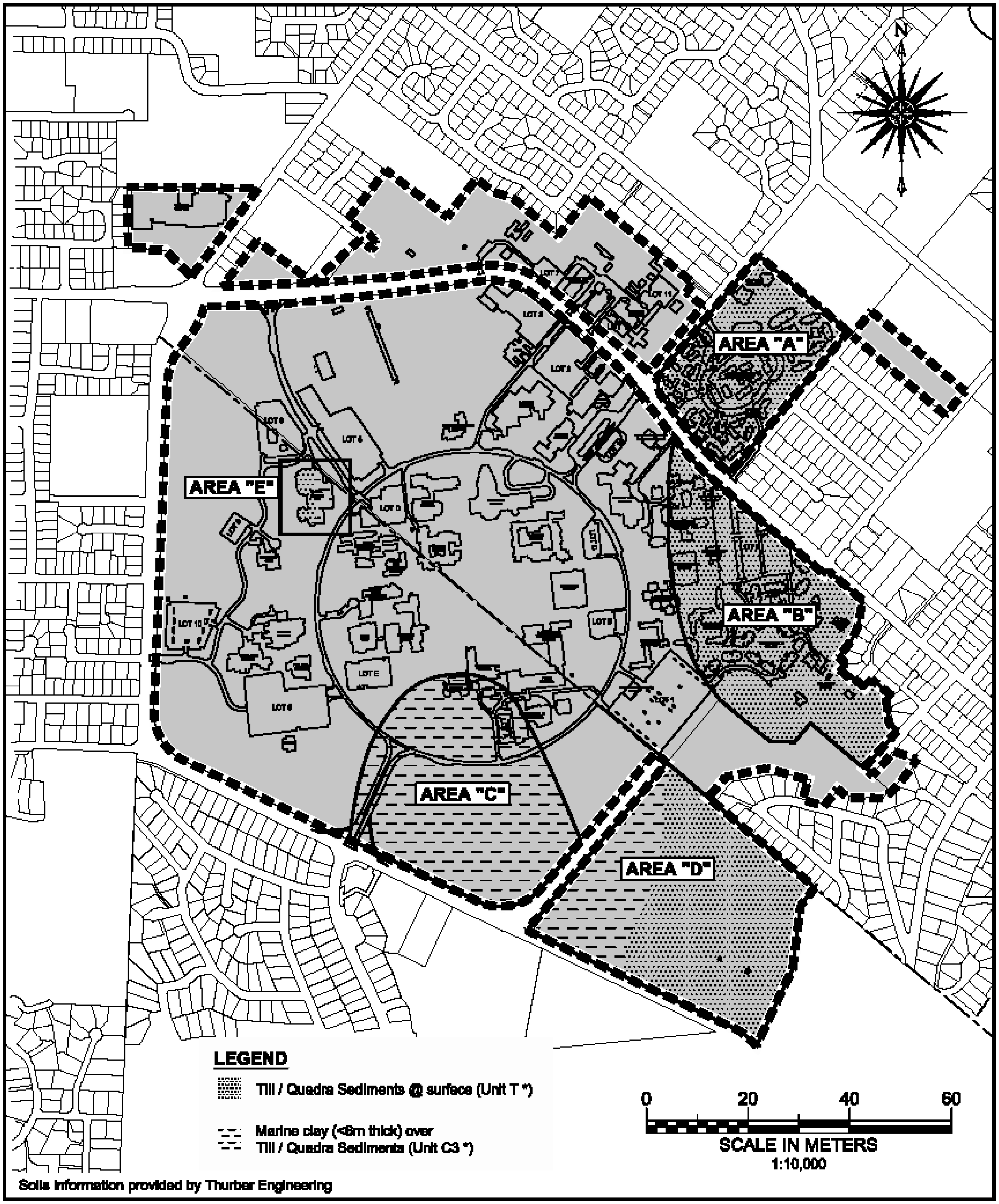


Figure 2.4. Soils assessment summary.

The predevelopment situation was simulated by designating all drainage areas to be pervious with a residual infiltration rate of 1.6 mm/hour following a relatively high initial rate of 40 mm/hr reflecting the ability of the unsaturated soil to absorb rainfall. These infiltration rates are relatively low and reflect the nature of the surficial soils that are deemed to be the least permeable of the hydrologic soil group “C” as defined by the U.S. Soil Conservation Service. Group “C” soils consist of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture (Soil Conservation Service, 1986). These soils have a low rate of water transmission (1.3 to 3.8 mm/hr). Depression storage was set at 15 mm over the total area. This value is at the high end of the range of 10 to 15 mm cited in Wright-McLaughlin Engineers, 1969 for pervious wooded areas. Water captured by depression storage on pervious areas is considered to evaporate or infiltrate in the simulation model.

The simulation model results for the predevelopment scenario are presented in Table 2.2 and are compared to the simulation results for the 1956 Scenario on Figure 2.5. The ratio of runoff to rainfall volume, the runoff coefficient, is about 20%. The peak rates of runoff are low compared to estimates using the rational method. For instance, the rational method produces a peak runoff flow from the campus area draining into Bowker Creek of 0.9 m^3/s compared to the 0.4 m^3/s calculated by PCSWMM. This discrepancy between the rational method and a rainfall/runoff model was expected because the rational method tends to produce exaggerated values for peak flow on areas > 10 ha.

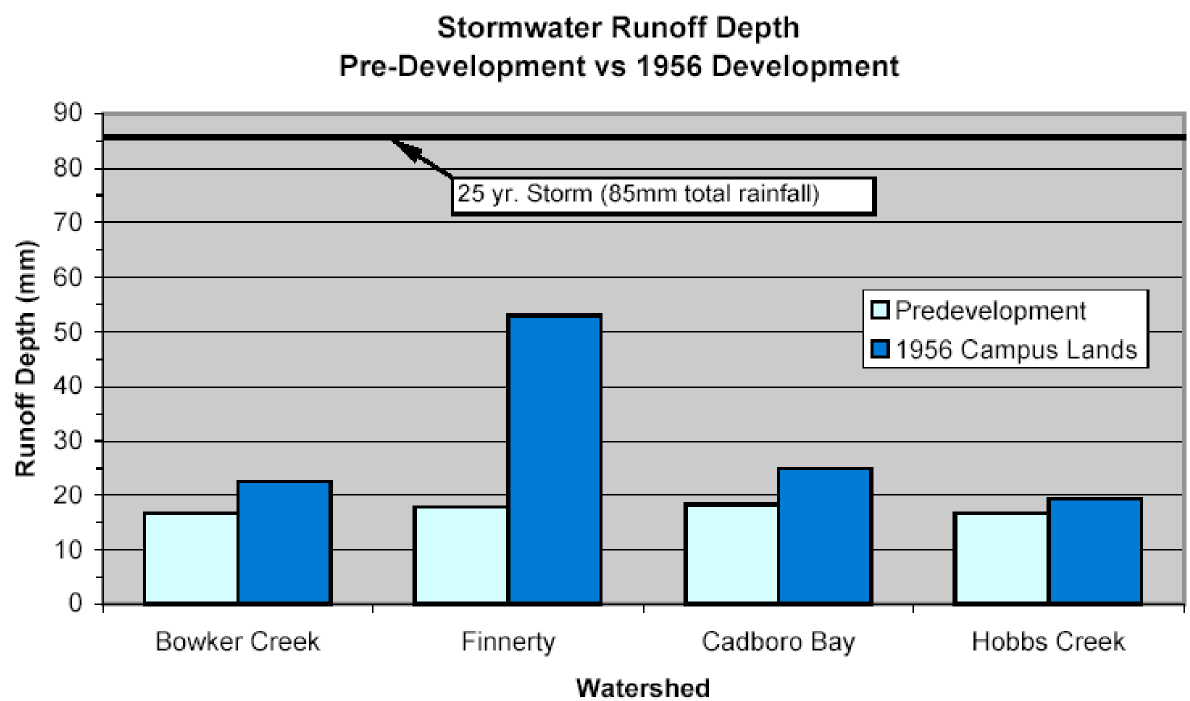
1956 Scenario

The hydrologic characteristics of the UVic campus and surrounding lands for this scenario were determined from a 1956 aerial photograph (Figure 2.2) of the site. In 1956, the area exhibited the effects of its use as an armed forces facility. Approximately 52 ha of land had been cleared of forest and the camp building, roads and hard-surfaced areas were evident north and west of Finnerty Road. For comparison with stormwater flow rates and volumes from the campus in its current condition and with future development, the campus area, which now drains to a main stormwater trunk along Sinclair Road, was separated from the predevelopment Finnerty watershed.

The watershed areas covered by natural soils and forest were input to the model as pervious sub-catchments as listed in the table below. The hard-surfaced areas within the army camp were input as impervious areas.

Table 2.3. Summary of pervious and impervious areas by watershed in 1956.

Watershed	Pervious Area (ha)	Impervious Area (ha)	Total (ha)
Bowker Creek	91.2	1.7	92.9
Hobbs Creek	50.7	0	50.7
Finnerty Creek	11.3	10.5	21.8
Cadboro Trunk Drain	21.9	0	21.9
TOTAL	175.1	12.2	187.3



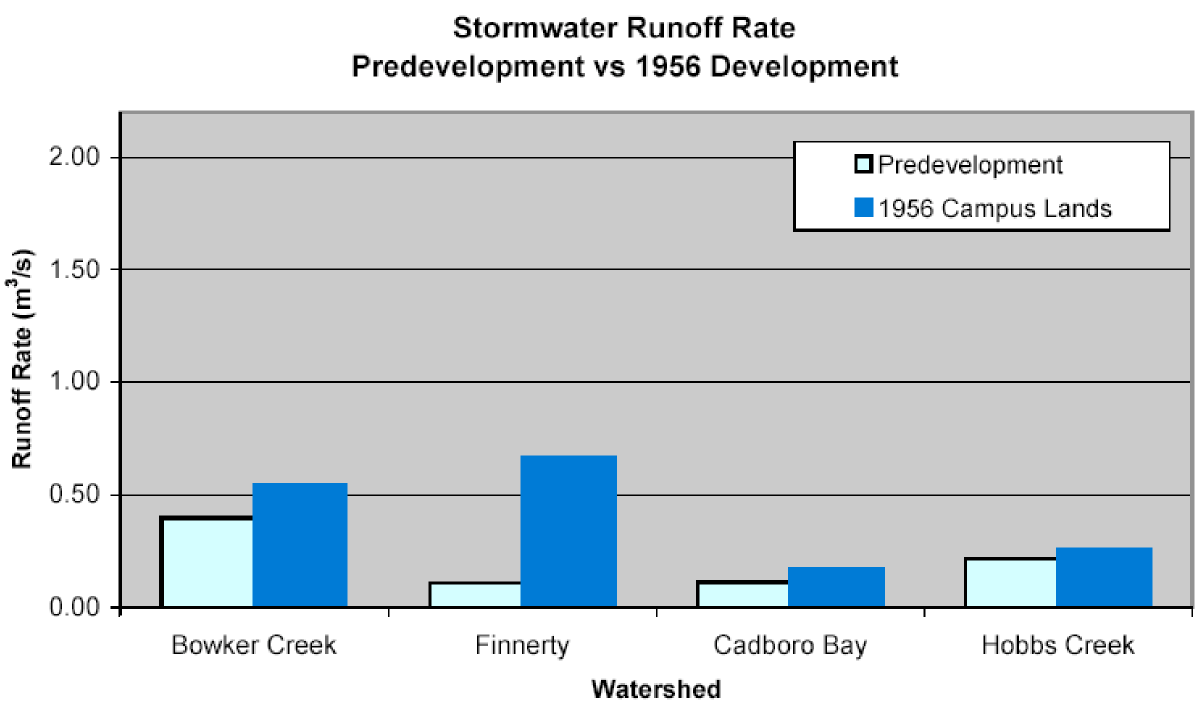


Figure 2.5. Predevelopment vs. 1956 development.

The changes in the key hydrologic parameters, total runoff volume and peak flow rate between the predevelopment and 1956 scenarios are presented in Table 2.2. The increases in runoff volumes and peak flow rates are illustrated in bar graphs for each watershed in Figure 2.5. Comparisons of the runoff hydrographs for the two scenarios are provided in Appendix B.

The hydrologic response of the Finnerty watershed was changed significantly by the development of the military facilities with the associated hard –surfaced areas. Runoff volume and rate increased markedly. The other watersheds show some increase in runoff volume and flow rate. These changes resulted from the change in land use from forest to agricultural that significantly reduced depression storage.

2003 – Current Conditions

The hydrologic characteristics of the area occupied by the University of Victoria have been significantly changed from the predevelopment and 1956 conditions. The principal changes relate to drainage patterns, the surface cover on the land and vegetation. The natural drainage pattern has also been modified by the storm drain system. The divides between the major watersheds prior to development and as modified by the storm drain system are shown on Figure 2.2.

The Bowker Creek watershed has changed in area as a result of urban development. The drainage areas west of Gordon Head Road and south of Cedar Hill Cross Road have been reduced. Hobbs Creek now receives most of the runoff from the area south of Cedar Hill Cross Road. The drainage area has been increased by an area comprising the easterly half of the area within the Ring Road and 4.7 ha east of the Ring Road as shown on the Model Schematic, Figure 2.3. Prior to the development of the campus, the runoff from these areas flowed to the Cadboro trunk drain watershed.

Hobbs Creek now receives runoff from drainage areas that were within the Bowker and Cadboro watersheds. Most of the area south of Cedar Hill Cross Road now drains to Hobbs Creek instead of Bowker Creek. The transfer of drainage area from the Cadboro watershed is relatively small and comprises an area in the vicinity of Parking Lot 1.

The impervious areas within each of the major watersheds have increased substantially from the predevelopment condition by the construction of buildings, roads, sidewalks and parking lots. The nature and size of the impervious areas within the 2003 campus area are shown in Table 2.4.

Table 2.4. Impervious Areas Within 2003 Campus

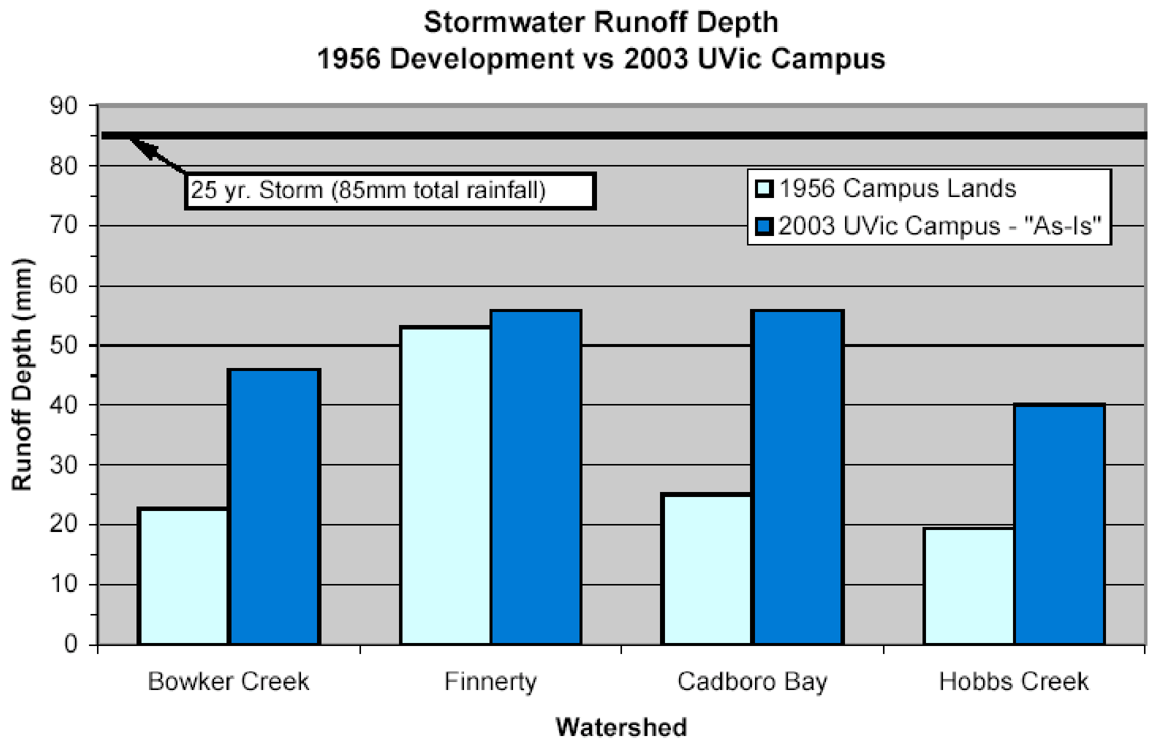
	Area (m^2)	% of Total Campus Area
Building Roof Area	150,386	9.2%
Paved Road Surfaces	77,127	4.7%
Allowance for sidewalks (25% of road surface)	19,282	1.2%
Paved Parking Lot Area	135,532	8.3%
Total Impervious Area	382,327	23.5%
Total Campus Area	1,628,363	

Also, some of the playing fields have subsurface drainage systems which direct water to the storm drain system. The change in drainage areas and the increase in impervious areas are presented in Table 2.5 below.

Table 2.5. Predevelopment To 2003 Changes In Hydrologic Characteristics

Watershed	Drainage Area (ha)		% Impervious Area		Remarks
	1956	2003	1956	2003	
Bowker	92.9	100.4	1.6	51	Some areas within the campus now drain to Bowker Creek
Hobbs	50.7	66.8	0	31	Areas south of Cedar Hill Cross Road now drain to Hobbs
Finnerty	21.8	20.6	48	61	Little change
Cadboro	21.9	9.1	0	55	Loss of drainage area to Bowker Creek

The hydrologic effects of the change in drainage areas and the increase in impervious areas on runoff rates and volumes are illustrated in the bar graphs (Figure 2.6) for each watershed. The Hydrologic Summary Table 2.2 presents the numeric values of runoff volumes and flow rates. Comparisons of the runoff hydrographs are provided in Appendix B.



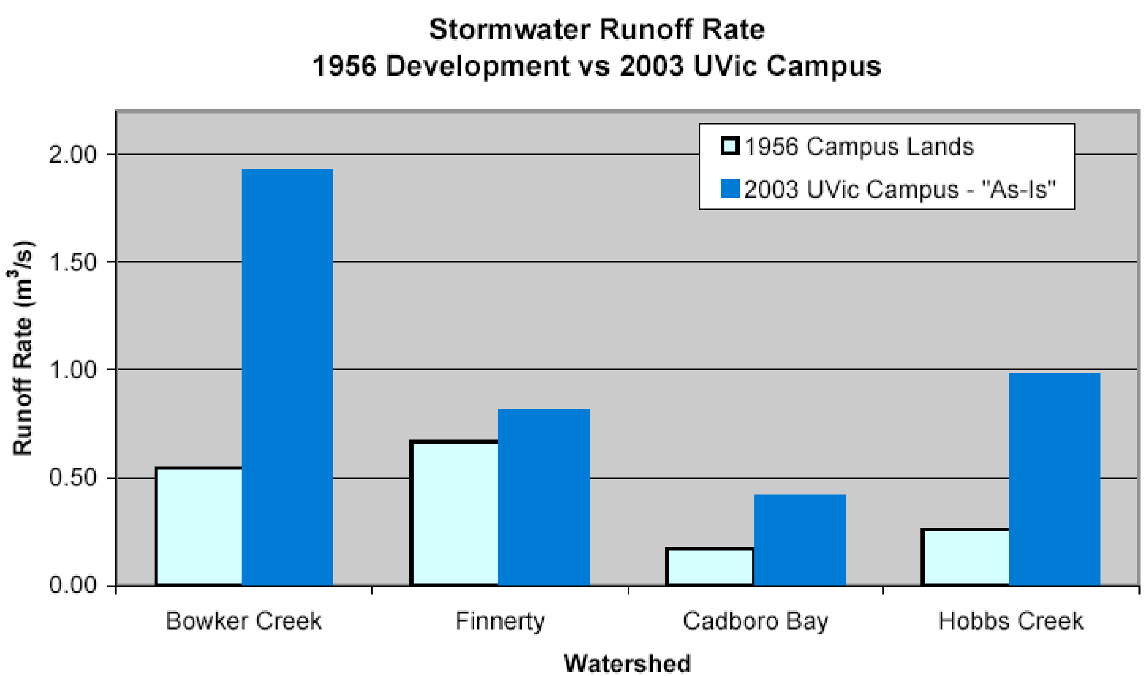


Figure 2.6. 1956 development vs. 2003 campus.

The overall effects of development on the campus between 1956 and 2003 are a doubling of the runoff volumes for Bowker and Hobbs Creeks. Runoff volume to Finnerty Creek has remained close to the 1956 value. The area of the Cadboro Bay watershed has been reduced from 1956. The decrease in area has been caused by the transfer of drainage areas to Bowker and Hobbs Creeks and results in lower run-off volumes. Though the run-off volume of the Cadboro watershed has decreased, much of the land had been made impermeable since 1956, thus the runoff rates have increased (Figure 2.6). Peak flow rates have increased by a factor between 2 and 3 on all watersheds except Finnerty where a 30% increase in flow rate has been estimated. The modest increase in the runoff volumes and rates for Finnerty Creek reflects the presence of significant impervious areas within the military facilities that existed in 1956.

2003 – With Best Management Practices

The reduction of current stormwater volumes and flow rates can be achieved by retrofitting Best Management Practices (BMPs) into the present drainage system. The principal methods for reducing volumes and flow rates are increasing infiltration and detention storage. For the UVic campus, the potential to increase infiltration is limited because of the relatively impermeable nature of the surficial soils. The surficial soil is underlain by the Quadra deposit; a moderately permeable silty sand. Stormwater introduced to this layer will infiltrate to recharge the groundwater. For most of the campus area however, the Quadra layer is over 6m deep, below a reasonable depth for infiltration trenches or ponds. In other areas such as the Lam Circle, in the vicinity of the Parking Lot 5 (Area B on Figure 2.4) and the Gordon Head residences, the Quadra deposit is close to surface but may be underlain by tight till or marine clay. The use of infiltration facilities or soil amendments to increase infiltration may be feasible at selected locations where the surficial soils or soils at shallow depth have a significant proportion of sand or gravel but these methods for stormwater management are not recommended for general application within the campus area. Sub-surface investigations will be required to confirm the effectiveness of potential sites for infiltration facilities.

Detention storage is a potential stormwater management alternative at the UVic campus. The increase of detention storage by open water or dry ponds will reduce runoff rates but not volumes. Large, open-water ponds could not be considered low impact developments and acceptance of this use for campus land may be problematic. Wide spread, small depressions, swales and detention storage below parking lots could provide the necessary storage, would have a low visual impact and only minimally reduce the land available for uses other than water storage.

The stormwater simulation model was used to evaluate the hydrologic effects of increasing detention storage by determining the storage volume required to reduce peak runoff rate by 10 to 20% in each of the major watersheds. The feasibility of providing the required storage capacity such as beneath parking lots was considered. For instance, a 0.5 m depth of drain rock below a parking lot can store the equivalent of 150mm of rainfall on the parking lot area. This storage capacity could be used to store runoff from buildings and roadways adjacent to the parking lot.

The reductions in runoff rate and the corresponding volumes of detention storage in the major watersheds were as follows.

Table 2.6. Reduction In Runoff Rate By Detention Storage

Watershed	Reduction In Runoff Rate (%)	Detention Storage (m^3)
Bowker	23	12,000
Hobbs	15	1,000
Cadboro	19	500
Finnerty	21	3,000

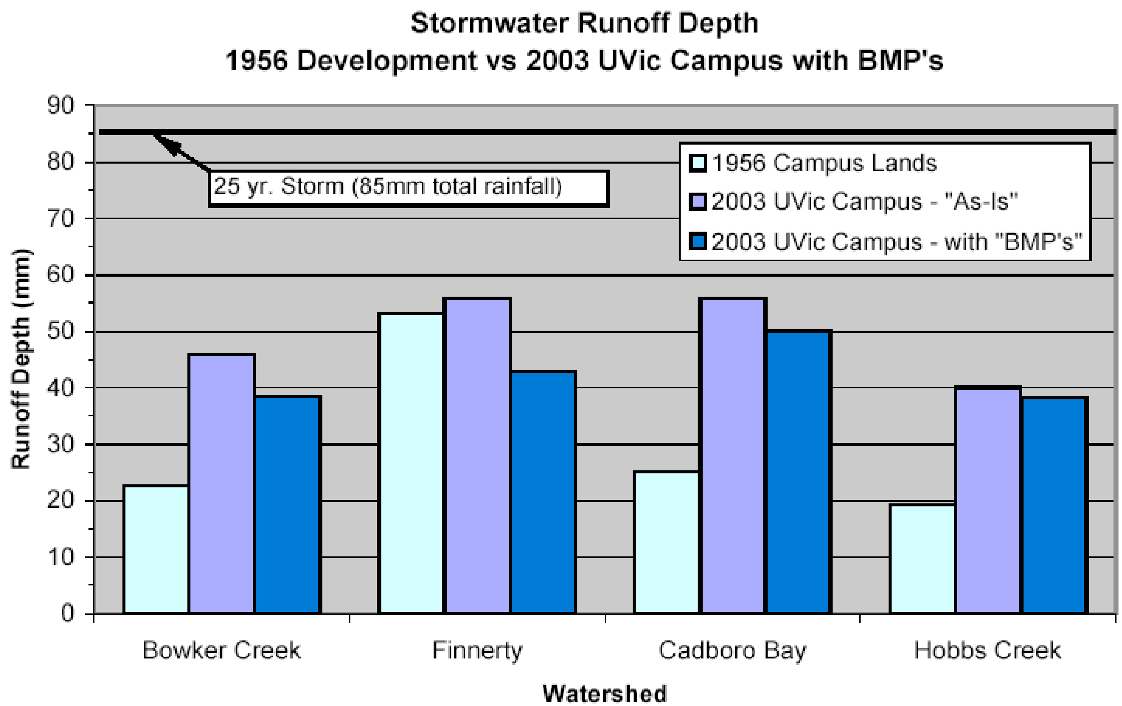
The simulation results corresponding to the development of the above volumes of detention storage are provided in Table 2.2 and are illustrated in the bar chart plots of runoff depth and peak flow rate (Figure 2.7).

The potential means of developing the requisite detention storage in the Bowker watershed is within depressions equivalent to storing a depth of 3 mm of rainfall over the pervious areas and converting Parking Lots 4, 6, 8 and 10 into sub-surface, rockfill water storage facilities. A rockfill thickness of 0.5 m will store 9,000 m^3 over these four parking lots. For the Cadboro watershed, the use of Parking Lot 5 as a storage structure holding 500 m^3 of runoff is feasible. Parking Lot 1 can be modified to hold 1,000 m^3 to provide the required storage in the Hobbs watershed.

Stormwater management in the Hobbs watershed should be a shared responsibility of the Municipality of Oak Bay and the University. Over one-half of the drainage area of Hobbs Creek is located south of Cedar Hill Cross Road. The area within Oak Bay includes the Henderson Golf Course and extensive residential development. The runoff from Oak Bay flows under Cedar Hill Cross Road to Mystic Vale.

2003 Campus Plan Buildout – Existing Stormwater Management Facilities

If the 2003 Campus Plan was fully implemented, including the potential for construction on 25 building sites, the stormwater simulation model predicts that 26.6% of campus would be impervious- a 3.1% increase from 2003. No new roads or parking lots are planned. In fact, some parking lots will become building sites. The expected changes in impervious area between 2003 and buildout of the 2003 Campus Plan are shown in Table 2.7.



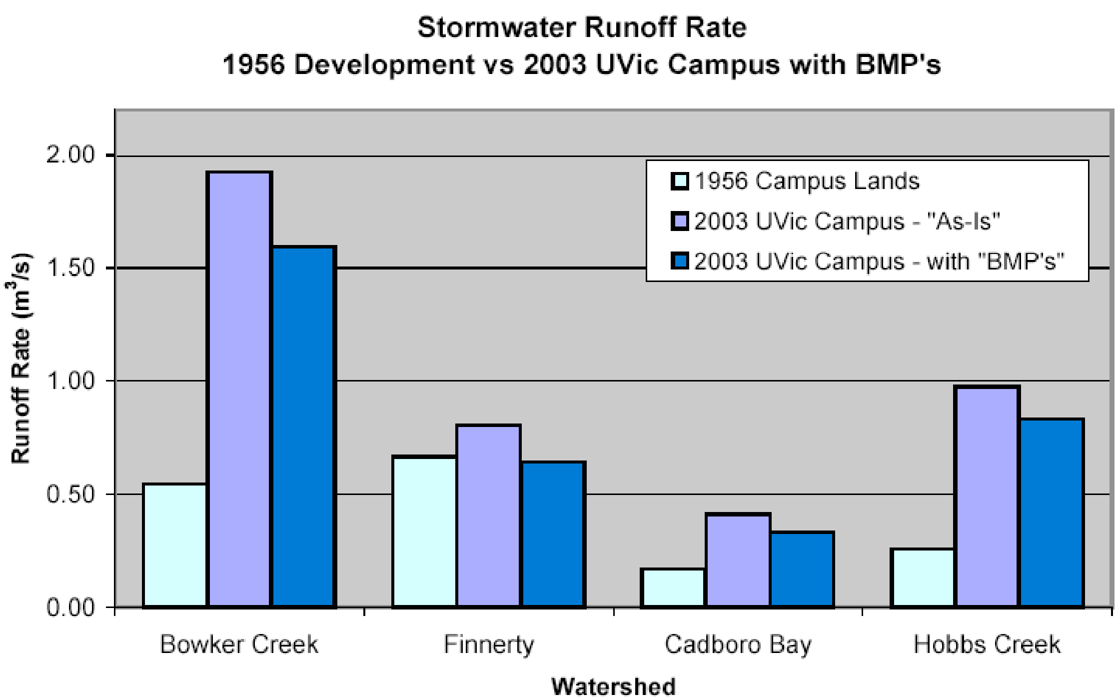


Figure 2.7. 1956 development vs. 2003 campus.

Table 2.7. Simulated impervious areas within campus at buildout of the 2003 Campus Plan

	Area (m^2)	% of Total Campus Area
Building Roof Area	150,386	9.2%
Paved Road Surfaces	77,127	4.7%
Allowance for Sidewalks (25% of road surface)	19,282	1.2%
Paved Parking Lot Area	135,532	8.3%
New Buildings (25 @ 2300 m^2)	57,500	3.5%
Allowance for sidewalks, entrances etc. (25% of building area)	14,375	0.9%
Reduction in parking lot areas (9 buildings @ 2300 m^2)	-20,700	-1.3%
Total Impervious Area	433,502	26.6%
Total Campus Area	1,628,363	

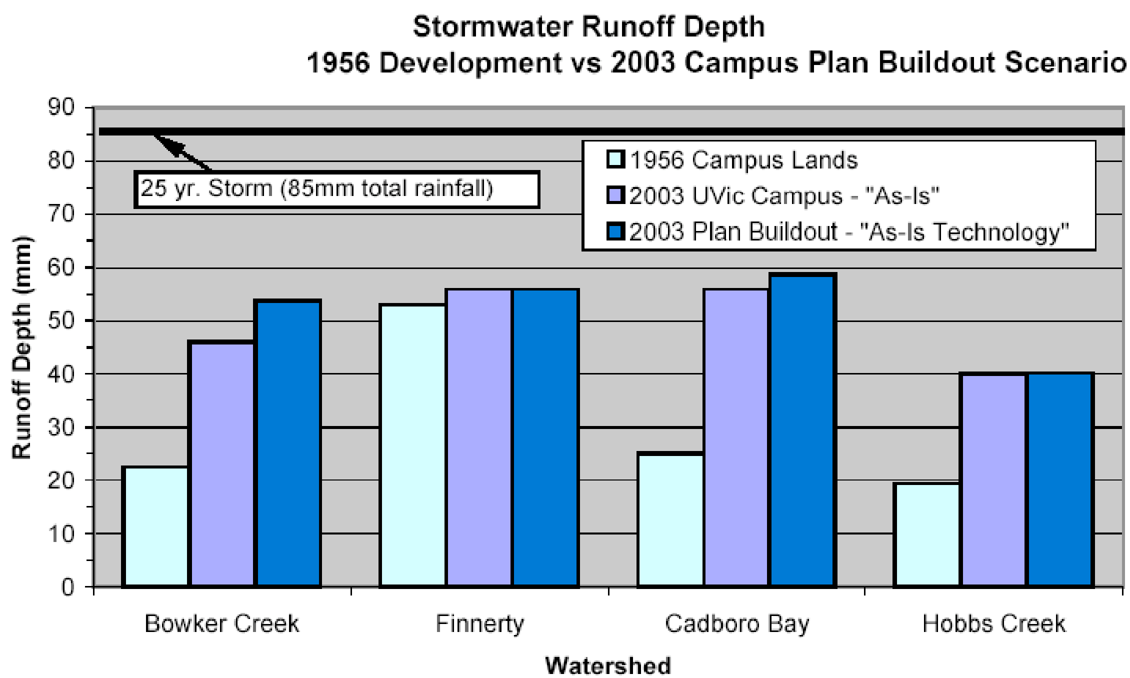
The net increase in impervious areas between 2003 and 2003 Campus Plan buildout is about 5 ha. The placement of nine new buildings on existing parking lots would reduce the impervious area by 2.1 ha. The area extent of impervious surfaces relative to the total campus area is 26.6%; a 3.1% increase from 2003.

The campus layout planned for at buildout of the 2003 Campus Plan was modeled with the drainage system in its current configuration without improvement in stormwater management facilities.

The results of the simulation show little relative change in stormwater volumes or rates between the present situation and the scenario presented by the Campus Plan. The runoff volume increased by 1,900 m^3 and the range of change in runoff rates was between 0 and 4% with no increase in the Finnerty watershed. The new building proposed within the Finnerty watershed will be constructed on an existing parking lot. The changes in runoff rates and volumes for all watersheds are displayed in Figure 2.8 for comparison with previous development scenarios and predevelopment.

2003 Campus Plan Buildout – With Best Management Practices

The primary reason for changes in the stormwater hydrology between the present condition and buildout per the 2003 Campus Plan, is the potential for construction of the 25 buildings. The siting of nine of these buildings on existing parking lots will reduce the hydrologic impact of the campus development. An appropriate method of managing the potential net increase in runoff rates and, to some extent runoff volume, is to retain and potentially use rain falling on the footprint area of the new buildings. Stormwater detention on the building roof can reach up to the total rainfall amount of 85 mm for the design event.



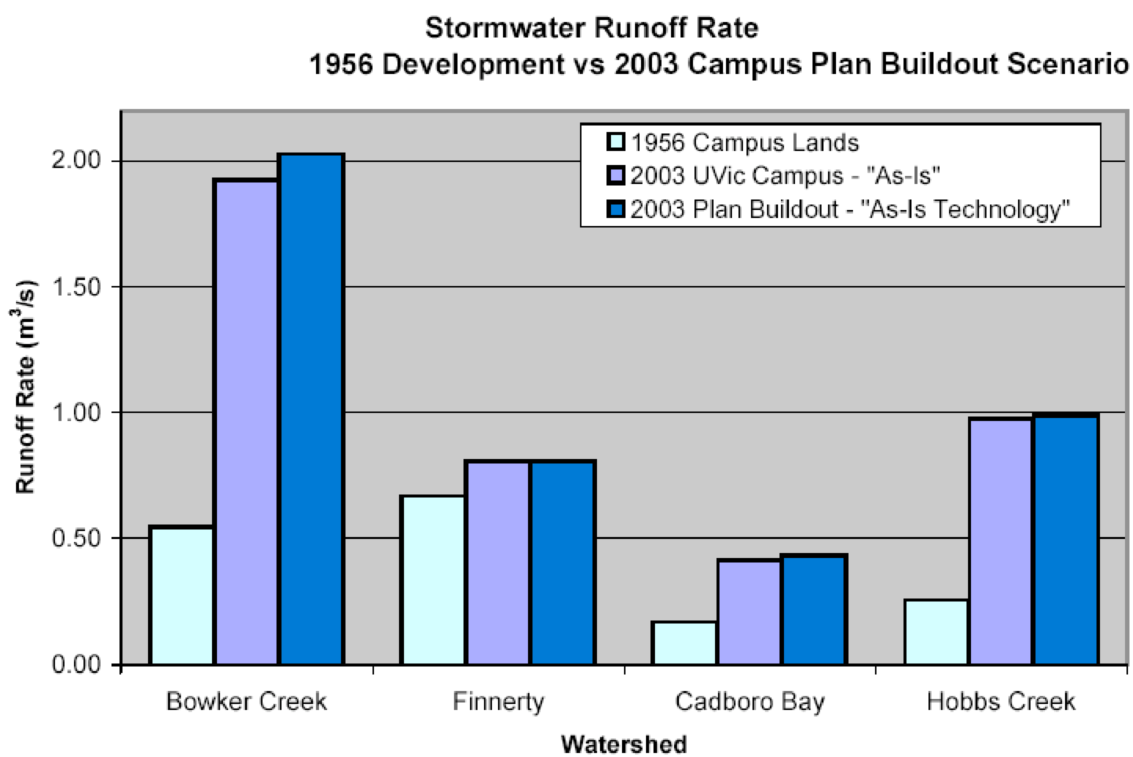


Figure 2.8. 1956 development vs. campus at buildout according to 2003 Campus Plan

The simulation model was used to evaluate the hydrologic effects of the management facilities proposed to improve the current (2003) stormwater scenario plus rainfall retention on the roofs of all new buildings within the major watersheds. There are 19 approved building sites that lie within the Bowker watershed. Assuming the roofs of these building can be designed to detain 85 mm of rainfall, the detention storage that can be provided by the buildings in the Bowker watershed is 3700 m^3. The new building in the Finnerty watershed will be constructed on an existing parking lot. By retaining rainfall on the roof, approximately 200 m^3 of detention storage will be added to the stormwater management capability. In the Cadboro watershed, the three proposed buildings could provide 600 m^3 of detention storage. Detention storage in the Hobbs watershed was increased by 400 m^3 in the simulation model to reflect the installation of rainfall retention roofs on the two buildings proposed for the watershed.

The results of the simulation of the buildout scenario with the above improvements to the stormwater management capability are provided in Table 2.2 and are presented in the form of bar graph comparison of peak flow rates and runoff depths in Figure 2.9. As expected, the runoff volumes over the period of the rainstorm have decreased by an amount almost equal to the increase in detention storage provided by the retention of rainfall on the roofs of the new buildings. The peak runoff rate in the Bowker watershed has decreased by about 10% below the value for the 2003 Scenario with BMPs. In Finnerty, the peak flow rate has remained the same as the 2003 Scenario with BMPs because the parking lot on which the building is to be built was assumed to have detention storage equal to the design event rainfall depth in the 2003 Scenario. The Cadboro peak flow decreases by 10% as a result of installing rainfall retention roofs on the three buildings proposed for the Cadboro watershed. The Hobbs watershed with two buildings proposed for buildout shows no change in peak runoff rate.

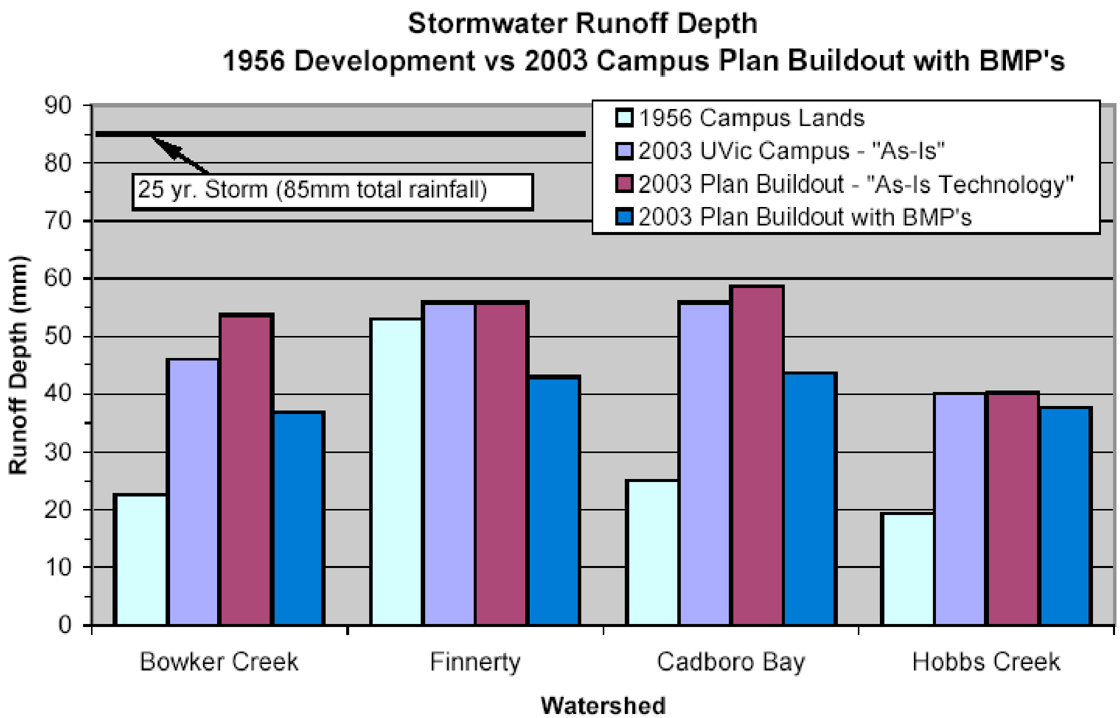
In summary, the changes in the stormwater hydrology caused by the development proposed in the 2003 Campus Plan are relatively small and the development can produce a reduction in runoff rates and volumes over the period of the rainstorm by installing rainfall retention roofs on the new buildings.

Improvements to Stormwater Simulation Model

The hydrologic simulation of stormwater on the UVic Campus would benefit from continuous monitoring of flows into the major drainage catchments. Data from stream flow gauges at the locations listed below when combined with the rainfall data, which Facilities Management collects, will allow calibration and improvement of the stormwater model over time.

Locations Of Continuous Flow Monitoring Stations

- Bowker watershed; at, or near, the entrance to the culvert under Gordon Head Road
- Hobbs watershed; at the outlet of the culvert under Cedar Hill Cross Road which conveys flow from Oak Bay into Mystic Vale
- Cadboro watershed; on the inlet to Manhole No. 4102 in the Model Schematic
- Assessment of infiltration rates and detention storage particularly within the Bowker woodlands in the northwest quadrant of the campus will assist in determining their effectiveness in reducing runoff rates and volumes.



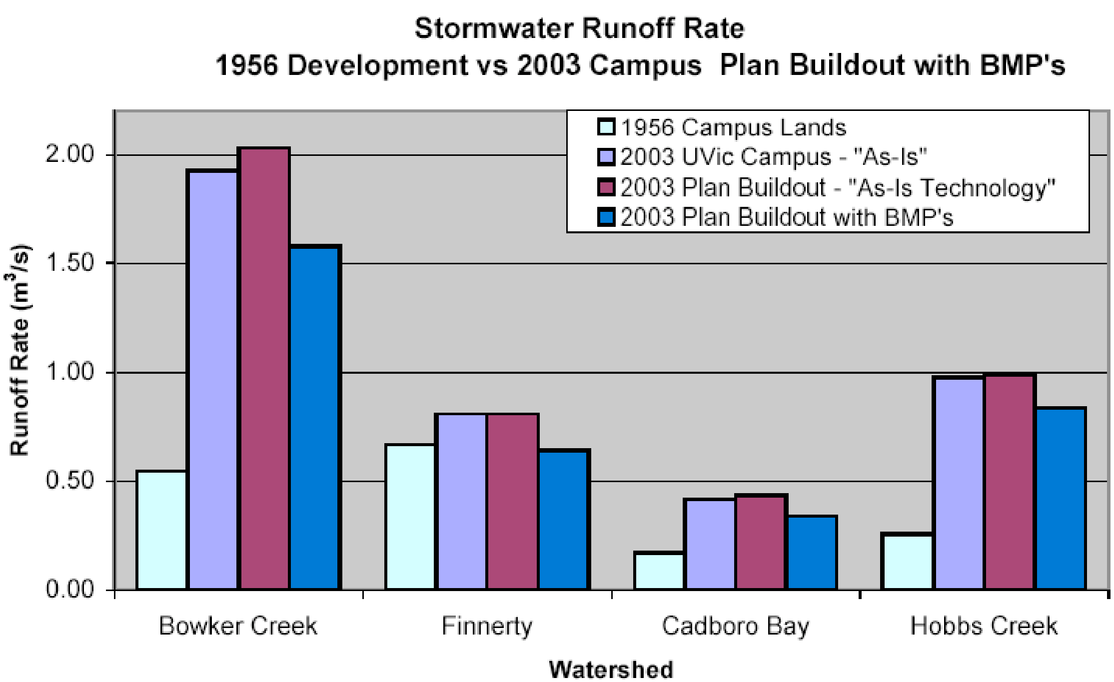


Figure 2.9. 1956 development vs. 2003 Campus Plan buildout with BMPs

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Section 3- Buildings and Facilities

Campus Plan Goal #2 “To evolve a land use and building pattern that…respects the unique physical environment…and promotes compact, pedestrian friendly and sustainable development.”

Campus Plan Principle #5: “The University will manage development carefully, respecting “smart growth” principles and practices as they may be adapted to the University context.”

Campus Plan Principle #6: “The University commits to incorporate sustainable practices in the planning, construction and operation of buildings and facilities.”

Campus Plan Principle #9: “The University recognizes the need to minimize surface parking and pursue alternatives.”

The Campus plan can be found on-line at http://web.uvic.ca/vpfin/campusplan/toc.html.

PRESENT CONDITION

Building the Campus

During the second World War, the Gordon Head Army Camp occupied the northern part of what is now the UVic Campus. The oldest available air photo of the campus was taken in the 1930’s. Approximately 52 ha of land were cleared at some time prior to 1956, most of it for the construction of the army camp.

Construction of the Gordon Head Campus began in 1962 with the Clearihue Building followed by the Student Union Building in 1963. During the remainder of the 1960’s, 18 additional buildings and the stadium were built: Elliot Building and McPherson Library (1963/64), five Craigdarroch Residence buildings (1964– 1967), the Campus Services Building (1965), Cornett and MacLaurin Buildings (1966), Centennial Stadium (1967), Sedgewick Building (1968), Cadboro Commons (1969), and six Lansdowne Residences (1969). During this time Ring Road, parking lots and access routes through the campus were constructed resulting the conversion of open space in including forested areas, to impervious surface.

The 1970’s saw less intense construction with ten buildings built: University House (1970), Cunningham Building (1971), Saunders Building (1974), McKinnon Building (1975), University Centre (1977/78), MacLaurin Music Wing (1978), three Gordon Head residences (1978), and the Visual Arts Building (1979). Seven buildings were constructed in the 1980’s: the Phoenix Theatre (1981), three McGill Residences (1981), the Faculty [University] Club (1982), Interfaith Chapel (1985), and the Science and Engineering Building (1986).

The Commonwealth Games brought another building boom to campus. The Commonwealth Village, David and Dorothy Lam Family Student Housing Complex, the George and Ida Halpern Centre for Graduate Students were all built leading up to the 1994 Games. Most of these buildings were built on open meadows, and did not require additional land clearing, but their construction converted pervious grassy areas to impervious surfaces.

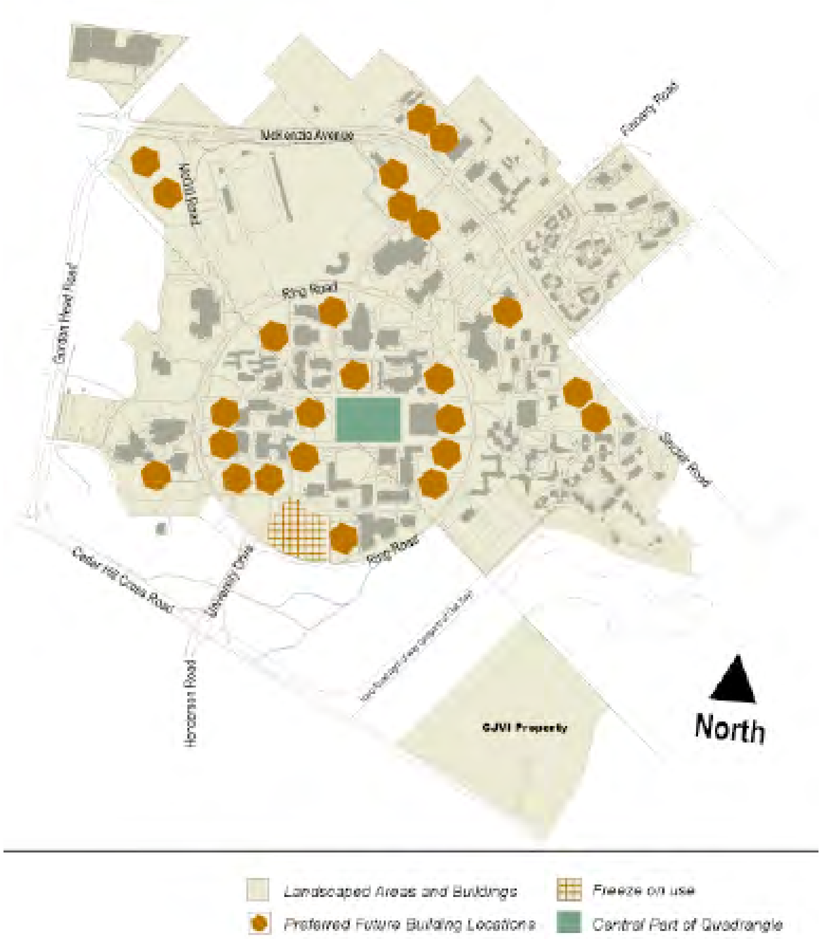
UVic in 2003

The campus is currently comprised of 162.8 ha (402 acres) including recreational use lands north of McKenzie Avenue and a parcel of land east of Mystic Vale (CJVI Property). The many open spaces comprise 116.6 ha (288 acres), or 71% of the land base. Buildings, other facilities, roads and surface parking comprise 48.8 ha (120 acres), the remaining 29%. There are 91 buildings on the campus, comprising 157 classrooms and 561 laboratories, 1,788 bed units, plus athletic facilities, libraries, student and faculty services, greenhouses, a chapel, and administrative services. There are approximately 4,600 parking spaces (Campus Plan, 2003).

Future Campus Development

The *Campus Plan 2003* (Figure 4) identifies 25 preferred future building sites. It presents a vision, and complementary principles, goals and policy directions. The plan outlines 30 action items; developing and integrated stormwater management plan is one of them.

These sites are in addition to the five buildings currently under construction. Based on information provided by Facilities Management, the average building footprint will range from 1115- 2230 square meters (12,000-24,000 square feet). The preferred building locations are spread over the campus but are concentrated within Ring Road or to the south of McKenzie Avenue.



Impervious Area

At the present time, approximately 23.5% of campus is impervious area such as roofs, roads, sidewalks and parking lots compared to 6.5% in 1956. Additional water is diverted by subsurface drainage systems from playing fields into the storm drain system. This has resulted in a doubling of the runoff volume to both Bowker Creek and Hobbs Creek. The goal is to mitigate this total impervious area by retrofitting existing buildings and using new development as an opportunity to compensate for runoff from existing structures. Detailed hydrological findings are outlined in Section 2.

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Section 4- Natural and Landscaped Open Space

Campus Plan Goal #1: “To maintain and continue to evolve an open space system which protects and enhances environmentally-significant natural areas…”

Campus Plan Principle #3: “The University is committed to protecting and restoring identified natural areas on campus…”

HISTORICAL CONDITION

Before the University and its predecessors, the area that came to be the UVic campus was predominantly upland fir forest. It was a mosaic of Douglas-fir/grand fir forest and Garry oak meadow in the upland areas and forested creek (ravine) and wetland habitat in the lowland areas. This is typical of the Gordon Head area surrounding the University of Victoria property. The Hobbs Creek area was dominated by a mixed Douglas-fir and bigleaf maple overstorey along the channel. The Bowker Creek area was primarily a black cottonwood overstorey in areas adjacent to the creek, and Douglas-fir and Garry oak in surrounding areas.

In terms of drainage, this area occupied the headwaters of three small watersheds: Bowker Creek, Hobbs Creek, and Finnerty Creek. The hydrologic behavior of this terrain was typical of low relief upland with a heavy forest cover. In the average year, less than one-third of the precipitation received was released as surface runoff to nearby streams, and that which was released, discharged slowly with long flat hydrographs

There were three main reasons for the low runoff rates. First, the forest canopy and organic-rich topsoil intercepted and absorbed large amounts of rainfall. In fact for most rainfalls, especially those occurring early in the wet season, these two mediators largely eliminated not only runoff, but also the percolation of water to the mineral soil and groundwater system below. In addition, for that moisture entering the soil system, most (as much as 35% or more of annual rainfall) was returned to the atmosphere in evapotranspiration. Second, the topography of this land, both macro and micro, was not conducive to runoff. The broad, gentle slope of the upland surface lacked sufficient gradient to induce strong lateral drainage. Moreover, the absence of upslope runoff contributions (because of the headwater's location) eliminated the potential to mount large enough masses of water to drive available water downslope. Beyond these general considerations, there was also the considerable influence of microtopography. The floors of fir forests are naturally rough, the victims of wind throws, rotting stumps and fallen tree trunks, burrowing animals, sword fern knobs, and other influences. On balance, it is difficult for surface water to move across such ground and form overland flow. The depression storage capacity alone is sufficient to store all of most large storms. Finally, there is the availability of ephemeral channels to consider. The floors of fir forests typically lack an integrated system of small channels capable of carrying water to stream heads. As a result, there is no efficient way to get water from depression storage cells, for example, to streams. In the absence of channels, runoff must take a much slower route to streams, either through the soil as interflow or through the subsoil as groundwater

With development of a military base, airstrip, farmlands and eventually a university campus, all this changed dramatically. Large sections of forest were removed and replaced with impervious materials, which shed rather than absorb water. The rough microtopography with its capacity to store surface water was replaced by smooth, graded surfaces in which depressions have been replaced by mounded lawns that shed rather than retain water. With more surface water available, the concluding step was to create an efficient network of channels and storm drains, to conduct this water quickly away from campus and into neighbouring streams. Not surprisingly, both the magnitude and frequency of peak flows increased on these streams.

CURRENT CONDITION- VEGETATION

The 2003 Campus Plan outlines a commitment to restoring natural areas and producing an ecological inventory of plant and animal species on campus. There have been many accomplishments in natural areas management, however, there is still much work that needs to be done.

The University of Victoria campus has been divided into the following analysis areas, depicted on the diagram below:

Area 1:	Ravine in proximity to Lam Circle.
Areas 2-14:	Bowker Creek.
Areas 15-16:	Woods in proximity to the Cunningham Building.
Areas 17-21:	Woods south of the Engineering Building complex.
Areas 22-25:	Upper area of Hobbs Creek.
Areas 27-28:	Mystic Vale.

These areas are described in detail on the following pages.


DOUGLAS FIR / GRAND FIR / ARBUTUS / BIGLEAF MAPLE
WITH OCEANSPRAY, SNOWBERRY, MOCK ORANGE, INDIAN PLUM AND SWORD FERN
RAVINE BOTTOM WIDENS
FINNERTY CREEK
WIDE RAVINE BOTTOM (FLAT)
1
EXISTING STORMWATER OVERFLOW DETENTION (BAKETBALL COURT)
MODERATE TO LOW SLOPE ANGLE
BERM
LAWN
HOUSING
NATURAL LOG DAM
PATCHY IVY THROUGHOUT
DAYCARE
HOUSING
4" + 8" DRAINS
BEDROCK OUTCROP
4" DRAIN
ROAD
FINNERTY
HIMALAYAN BLACKBERRY UNDERSTOREY
N
50M.
LAM CIRCLE RAVINE

Area 1: Lam Circle Ravine

General Description and Vegetation

Lam Circle Ravine is a steep sided gully (20 to 30°) with exposed bedrock and surface flow (Finnerty Creek) through the channel in the valley bottom. The channel contains some large wood along its length, and is slightly down cut in some areas. A wet area in the middle of the ravine appears to have been a wetland created by a log across the channel. This has now mostly rotted away and is no longer detaining water. Two storm drains from the daycare centre flow into the channel and a 375 mm culvert (with overflow) from Lam Circle enters the channel near the east property boundary. The vegetation consists primarily of Douglas-fir with some grand fir in the overstorey and bigleaf maple and Arbutus in the understorey. The shrub and herbaceous layers consist of oceanspray, common snowberry, Himalayan blackberry (in patches) and English ivy. Other species in the ravine include: mock orange, Indian plum, red elderberry, dull Oregon grape, daphne, English holly, English hawthorn, sword fern, Pacific water parsley, and stinging nettle.

Invasive Species

- There is a large, dense Himalayan blackberry infestation at the west (upstream) end of ravine.

- English ivy, English holly, daphne, and Himalayan blackberry occur in patches throughout the ravine area.

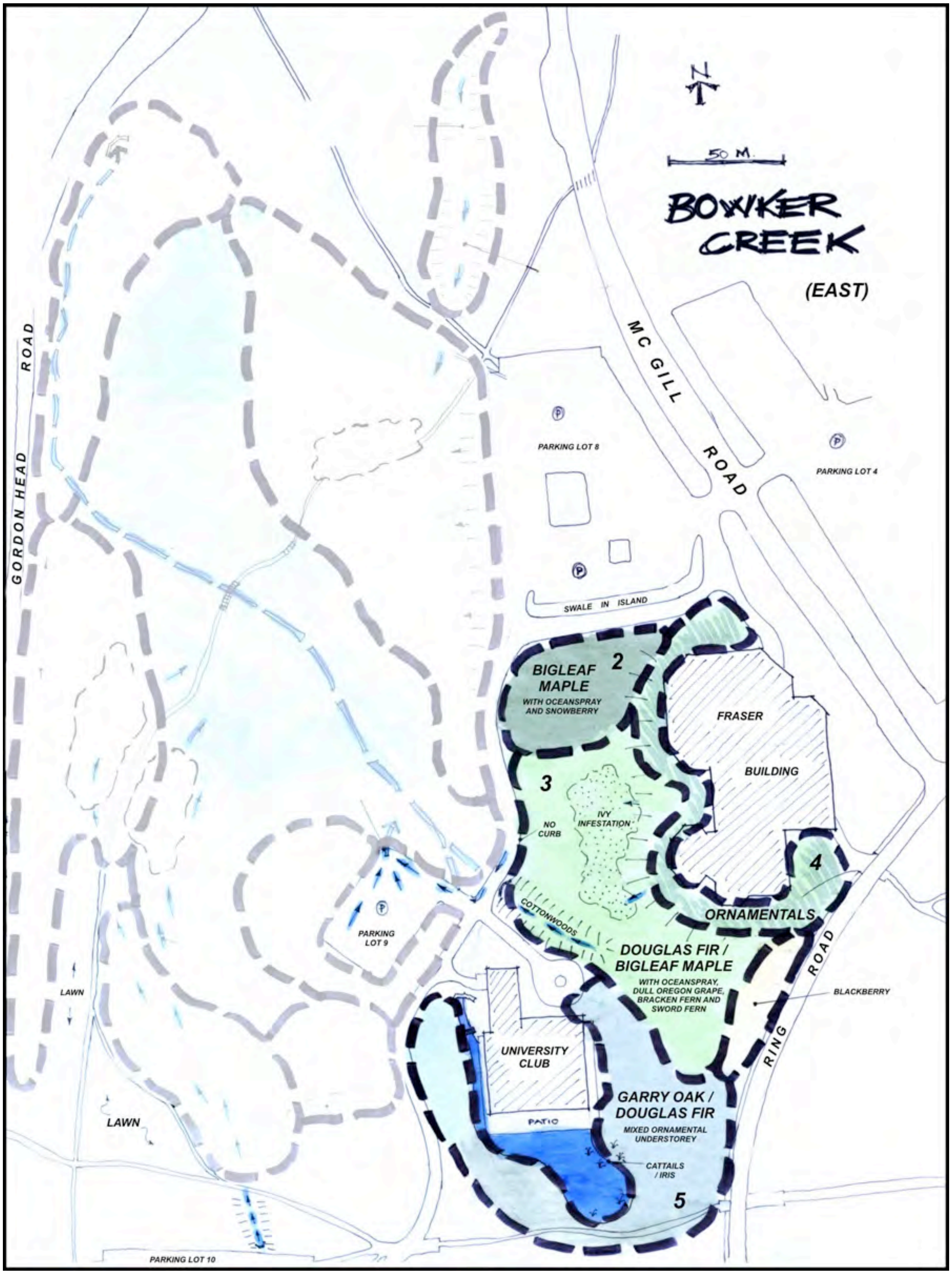
Potential for Stormwater Management

This area can tolerate more water. The west (upstream) could accommodate a stormwater detention facility such as a bioswale or wetland. In the middle section of the ravine the former wetland could be re-created. Step pools could be created throughout the ravine to increase water detention capacity, but this could potentially result in the loss of some trees through removal or changes to soil moisture.

Other Comments

There is potential for trail problems similar to those in Mystic Vale – there are already some areas of compaction and loss of riparian vegetation and beginning of channel down cutting in the ravine.

The valley bottom of the ravine widens to 15 m in the Queen Alexandra property. The characteristics of the watercourse appear to have changed, resulting in dead trees along the current channel, and a change in the steepness of side slopes (to 15°).


BOWKER CREEK
(EAST)
N
50 M.
MC GILL ROAD
GORDON HEAD ROAD
RING ROAD
PARKING LOT 8
PARKING LOT 4
PARKING LOT 9
PARKING LOT 10
SWALE IN ISLAND
BIGLEAF MAPLE
WITH OCEANSPRAY AND SNOWBERRY
2
FRASER BUILDING
3
NO CURB
IVY INFESTATION
4
ORNAMENTALS
COTTONWOODS
DOUGLAS FIR / BIGLEAF MAPLE
WITH OCEANSPRAY, DULL OREGON GRAPE, BRACKEN FERN AND SWORD FERN
BLACKBERRY
UNIVERSITY CLUB
PATIO
GARRY OAK / DOUGLAS FIR
MIXED ORNAMENTAL UNDERSTOREY
CATTAILS / IRIS
5
LAWN
LAWN

Areas 2-5 : Bowker Creek - East

General Description and Vegetation

Slopes surrounding the Fraser Building and University Club (10-15°) drain into the headwaters of Bowker Creek in Area 3 (the wet depression southwest of Fraser Building) and Area 5 (pond at University Club). The drainage flows through two culverts under the road between the buildings and into Bowker Creek. Parking Lot 8 (Fraser Building) also drains into the Bowker Creek headwaters (see Bowker Creek – West section).

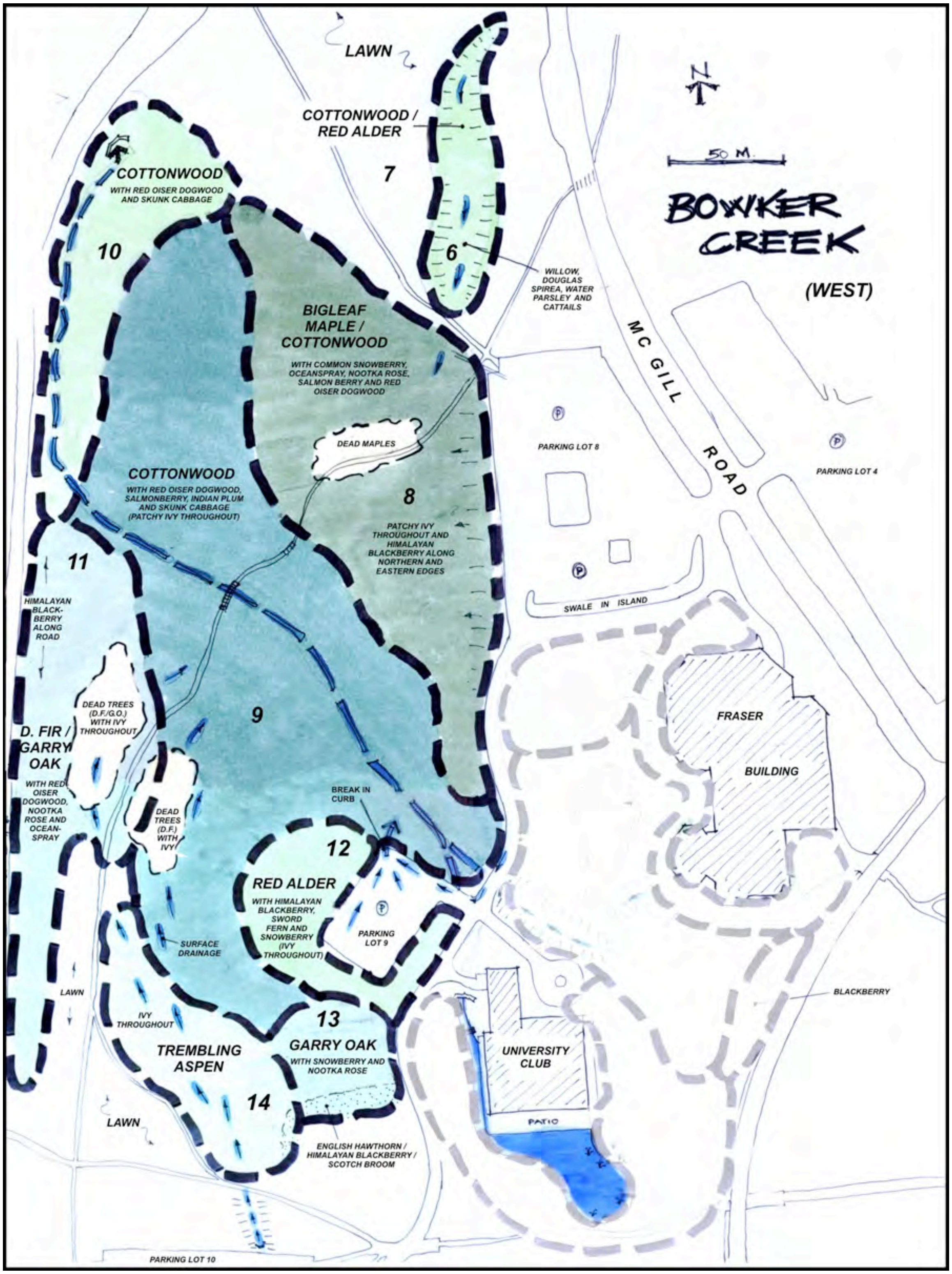
The vegetation consists of a bigleaf maple, Douglas-fir, arbutus and black cottonwood overstorey, with some planted areas of red alder, Garry oak, and western red cedar. The shrub and herbaceous layers are primarily oceanspray, common snowberry, dull Oregon grape, Himalayan blackberry (patches towards the edges of the area) and English ivy. English holly, Indian plum, cascara, daphne, saskatoon, English hawthorn, red-osier dogwood, bracken fern, sword fern are also present, and some of these are in planted areas. Areas 4 and 5 have an understorey of mixed native and non-native ornamental shrub plantings.

Invasive Species

- Himalayan blackberry is dominant along most edges and occurs in patches throughout the woods.
- English ivy is the primary groundcover in Area 3 and is growing to a height of 10-12m on the trunks of the overstorey trees.
- English hawthorn, daphne and English holly are present sporadically throughout the area.

Potential for Stormwater Management

There is potential to direct roof drainage from the Fraser Building into Area 2. Further stormwater detention at the University Club would require changes to the pond configuration and inlet/outlet points which is undesirable because the flood control is minimal, aesthetic value is high and the vegetation is adapted to the present water regime. Better storage potential is available in the Gordon Head wetland.



LAWN
COTTONWOOD / RED ALDER
7
COTTONWOOD
WITH RED OISER DOGWOOD AND SKUNK CABBAGE
10
6
WILLOW, DOUGLAS SPIREA, WATER PARSLEY AND CATTAILS
50 M.
BOWKER CREEK
(WEST)
BIGLEAF MAPLE / COTTONWOOD
WITH COMMON SNOWBERRY, OCEANSPRAY, NOOTKA ROSE, SALMON BERRY AND RED OISER DOGWOOD
MC GILL ROAD
DEAD MAPLES
PARKING LOT 8
PARKING LOT 4
COTTONWOOD
WITH RED OISER DOGWOOD, SALMONBERRY, INDIAN PLUM AND SKUNK CABBAGE (PATCHY IVY THROUGHOUT)
8
PATCHY IVY THROUGHOUT AND HIMALAYAN BLACKBERRY ALONG NORTHERN AND EASTERN EDGES
11
SWALE IN ISLAND
HIMALAYAN BLACK-BERRY ALONG ROAD
DEAD TREES (D.F./G.O.) WITH IVY THROUGHOUT
9
FRASER
BUILDING
D. FIR / GARRY OAK
WITH RED OISER DOGWOOD, NOOTKA ROSE AND OCEAN-SPRAY
DEAD TREES (D.F.) WITH IVY
BREAK IN CURB
12
RED ALDER
WITH HIMALAYAN BLACKBERRY, SWORD FERN AND SNOWBERRY (IVY THROUGHOUT)
PARKING LOT 9
SURFACE DRAINAGE
LAWN
BLACKBERRY
IVY THROUGHOUT
13
TREMBLING ASPEN
GARRY OAK
WITH SNOWBERRY AND NOOTKA ROSE
UNIVERSITY CLUB
14
LAWN
PATIO
ENGLISH HAWTHORN / HIMALAYAN BLACKBERRY / SCOTCH BROOM
PARKING LOT 10

Areas 6-14: Bowker Creek - West

General Description and Vegetation

This area is the upper Bowker Creek drainage, receiving stormwater directly from Parking Lots 8, 9, 10, the Fraser Building and the University Club. It also receives flow from Area 6 at the northern end of the site – a very wet area that is the receiving body for stormwater and irrigation water from the stadium and Parking Lot 4, playing fields and huts.

Within the moist areas, the overstorey is dominated by black cottonwood and big leaf maple with some red alder, trembling aspen and pacific willow. In the drier areas the tree canopy consists of Douglas-fir with grand fir and Garry oak. The shrub and herbaceous layers are primarily red-osier dogwood, common snowberry, Nootka rose, Himalayan blackberry, ocean spray, Indian plum, bracken fern and English ivy. Other species present include: Scouler's willow, salmonberry, English hawthorn, Pacific crabapple, Douglas (black) hawthorn, Saskatoon berry, Pacific ninebark, cascara, hardhack, Hooker's willow, English holly, Scotch broom, trailing blackberry, skunk cabbage, watercress, cattails, creeping buttercup, European bittersweet, and sword fern.

Invasive Species

Invasive species cover varies between the areas as listed below:

- Area 6 – creeping buttercup, thistle, morning glory.
- Area 7 – domestic lawn grass species.
- Area 8 – Himalayan blackberry (throughout), English ivy (in patches), English holly, European bittersweet.
- Area 9 and 10 - English ivy (around the dying trees), Himalayan blackberry (at the edges), English holly.
- Area 11 – Himalayan blackberry (at the edges), English ivy (around dying trees), English hawthorn and English holly.
- Area 12 – English ivy and Himalayan blackberry are present throughout.
- Area 13 – English hawthorn (heavy infestation), Scotch broom, Himalayan blackberry (at the edge).
- Area 14 – Scotch broom, Himalayan blackberry, English hawthorn.

Potential for Stormwater Management

Area 8 could receive stormwater drainage from parking lot 8 and depression storage could be created by re-contouring the lawn in Area 7. Area 12 could accommodate drainage from parking lot 9.

Some vegetation in the Bowker Creek West area will not tolerate increased surface or groundwater flow, particularly in Areas 13, 11 and part of 8. If more water is added to Area 4, the upland species (Douglas-fir and Garry oak) in Area 11 are likely to succumb to the change to a wetland area that is already underway. The current change in the water table in Area 11 is demonstrated by the encroachment of cottonwood and trembling aspen, and by the death of some of the Douglas-fir in this area already. This will be exacerbated by higher stormwater flows into this area. This natural transition from tree species which tolerate dry conditions to ones which prefer wet conditions, is to be expected as the ecosystem adapts to changes in water regime. University practices are being altered to prevent stormwater flow to this area.

Other Comments

Tree Health:

In Area 8, big leaf maple and conifer species (Douglas-fir and grand fir) are dead and dying along the trail at the north end of Parking Lot 8. This may be due to increased drainage from Areas 6 & 7, and Parking Lot 8. If these trees established in this area when the soil moisture was lower, and there was not as much impermeable area contributing surface and stormwater flow, then they will suffer with an increased soil moisture regime. This is also indicated by the increasing number of black cottonwood trees in this area – a species that is adapted to a high water table.

In Areas 9 and 11 there are dead and dying Douglas-fir, grand fir and Garry oak trees. Drainage from Parking Lot 10 (Fine Arts) flows into a stand of trembling aspen, and then flows overland through Areas 9 and 11 in the areas of dead and dying trees. As for the dead and dying trees in Area 8, this is likely to be the result of a change in the water table and surface flow since the dying trees first established. Areas 9 and 11 have an emerging understorey of “wet” vegetation – big leaf maple, red-osier dogwood, cottonwood and a stand of trembling aspen estimated to be about 10-15 years old, based upon size. This would coincide with the time of development of Parking Lot 10 and the subsequent increase in stormwater drainage from this area. The trees could be cored to verify their age.

The vegetation in Areas 8, 9 and 11 is indicative of a change in the ecosystem of the Bowker Creek –West area – from dry upland to increasing wetland and riparian.

A study of this ecological transition from dry to wet species would be valuable and in keeping with campus plan actions #6 (More Environmental Study) and #7 (Restoration Projects). The information gathered could be used to assist in planning and restoration elsewhere on campus should the soil moisture conditions change, either as a result of development or as a consequence of altered precipitation patterns due to climate change.

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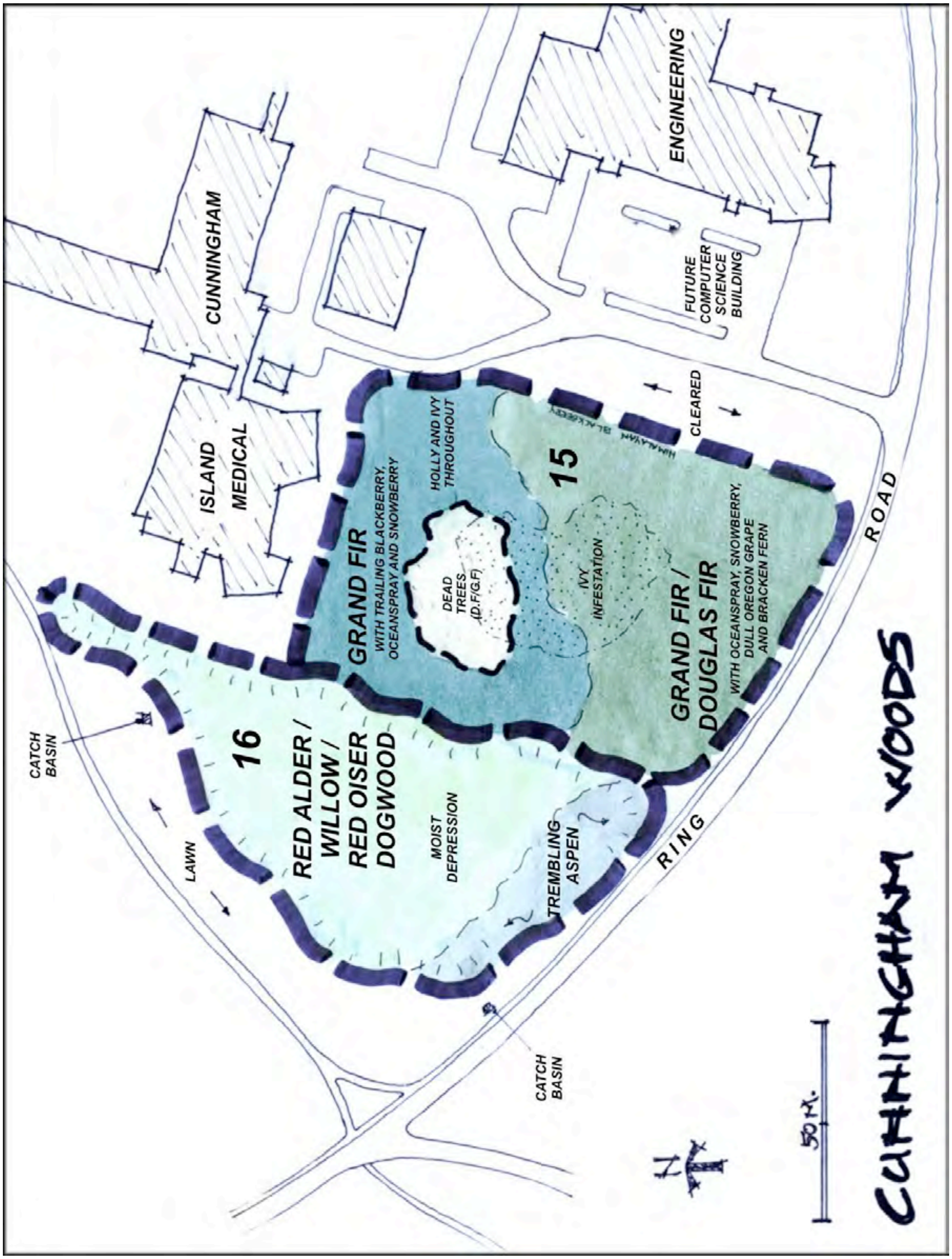
CUNNINGHAM WOODS
ENGINEERING
CUNNINGHAM
ISLAND MEDICAL
FUTURE COMPUTER SCIENCE BUILDING
GRAND FIR
WITH TRAILING BLACKBERRY, OCEANSPRAY AND SNOWBERRY
HOLLY AND IVY THROUGHOUT
DEAD TREES (D.F/G.F)
15
HIMALAYAN BLACKBERRY
CLEARED
IVY INFESTATION
GRAND FIR / DOUGLAS FIR
WITH OCEANSPRAY, SNOWBERRY, DULL OREGON GRAPE AND BRACKEN FERN
16
RED ALDER / WILLOW / RED OISER DOGWOOD
MOIST DEPRESSION
TREMBLING ASPEN
LAWN
CATCH BASIN
CATCH BASIN
RING ROAD
N
50 M.

Areas 15-16: Cunningham Woods

General Description and Vegetation

The wooded area is flat and consists of two distinct sites: a coniferous woodland and a wet depression. The conifer forest (Area 15) has no apparent overland flow, but has many small depressions in the topography. Area 16 is a wet depression that experiences ponding and is regularly inundated.

The vegetation in the coniferous area is dominated by grand fir and Douglas-fir with a shrub and herbaceous layer primarily of oceanspray, common snowberry, English ivy and trailing blackberry. Other species in this area include: red-osier dogwood, dull Oregon grape, thimbleberry, English holly, Indian plum, English hawthorn, Saskatoon, Himalayan blackberry (at the edges), woodland rose, tall Oregon grape, sword fern, bracken fern (in patches throughout), broad leaved star flower, and honeysuckle.

The wet depression consists of a red-osier dogwood, willow, and red alder thicket. The south end of the depression is dominated by a stand of trembling aspen.

Invasive Species

Invasive species cover varies between the areas as listed below:

- Area 15 - English ivy – There is a major infestation in the centre of area around the dead trees that has climbed to a height of 15-17m up the trunks of surrounding trees, English holly, daphne, English hawthorn, Himalayan blackberry (primarily along the edge of the area) are also present.

- Area 16 – Himalayan Blackberry is present at the edge of this area.

Potential for Stormwater Management

Potential for stormwater storage in Area 15 is limited because the tree species in this area will decline further if there is surface water flow. Stormwater inputs to any portion of Area 15 would likely result in a loss of the conifer overstorey. However, it could be argued that the Douglas-fir trees in this area appear to be in decline already. The area with the dead trees in the centre could potentially be used for the creation of a small pond or wetland, but extensive ivy removal would be required.

The stormwater management potential in Area 16 is better than for the adjacent woods in Area 15. Not only is Area 16 directly adjacent to the new Island Medical Building, the vegetation in this area is already inundated on a regular basis. The water storage capability of this area would need to be examined further, as would the identification of an outlet to offsite drainage area.

Other Comments

Tree Health

The cause of the large area of dead and dying trees (Douglas-fir and grand fir) at the centre of Area 15, and the general decline of overstorey conifers in this area needs to be investigated. It would appear to be the result of a raised water table in this area, but there is some evidence of fungal pathogens in the dying trees, and it is not clear whether this is the cause or result of the decline in their health.

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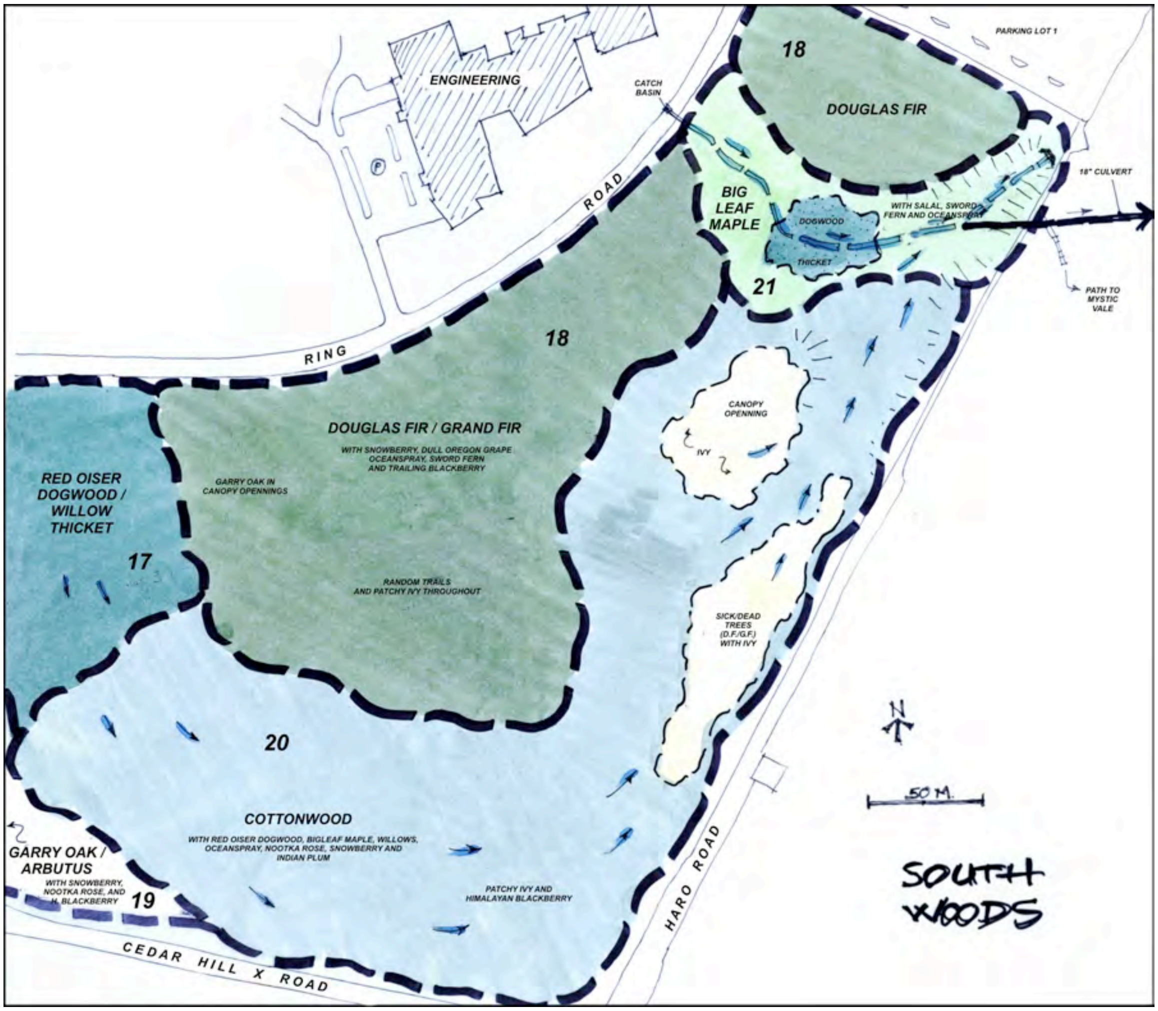
ENGINEERING
PARKING LOT 1
CATCH BASIN
18
DOUGLAS FIR
18" CULVERT
BIG LEAF MAPLE
DOGWOOD
THICKET
WITH SALAL, SWORD FERN AND OCEANSPRAY
21
PATH TO MYSTIC VALE
RING ROAD
18
DOUGLAS FIR / GRAND FIR
WITH SNOWBERRY, DULL OREGON GRAPE OCEANSPRAY, SWORD FERN AND TRAILING BLACKBERRY
GARRY OAK IN CANOPY OPENNINGS
RANDOM TRAILS AND PATCHY IVY THROUGHOUT
RED OISER DOGWOOD / WILLOW THICKET
17
CANOPY OPENNING
IVY
SICK/DEAD TREES (D.F./G.F.) WITH IVY
N
50 M.
20
COTTONWOOD
WITH RED OISER DOGWOOD, BIGLEAF MAPLE, WILLOWS, OCEANSPRAY, NOOTKA ROSE, SNOWBERRY AND INDIAN PLUM
PATCHY IVY AND HIMALAYAN BLACKBERRY
GARRY OAK / ARBUTUS
WITH SNOWBERRY, NOOTKA ROSE, AND H. BLACKBERRY
19
CEDAR HILL X ROAD
HARO ROAD
SOUTH WOODS

Areas 17-20: South Woods

General Description and Vegetation

These woods contain a flat upland conifer forest and a large moist area of red-osier dogwood and willow thicket and cottonwood-dominated overstorey. The area drains into a ravine with 30°- 40° side slopes. Drainage from the forested area, Ring Road and Parking Lot 1, collects in the ravine and flows through a culvert underneath the Haro Road right-of-way, and into Hobbs Creek (Mystic Vale). The creation of the Haro Road right-of-way using fill appears to have changed the original drainage pattern within the woods, and has likely caused the decline of the trees along the west side of the site. The Haro Road right-of-way was one of the conditions that allowed for university zoning of the Hudson's Bay property. The Haro Road right-of-way is property of the District of Oak Bay.

In the dry upland conifer forest, the overstorey is dominated by Douglas-fir, grand fir, big leaf maple, and Garry oak. The shrub and herbaceous understorey primarily consists of common snowberry, oceanspray, Indian plum, English ivy and sword fern. Other species present include: Nootka rose, dull Oregon grape, woodland rose, trailing blackberry, English holly, Himalayan blackberry, saskatoon, thimbleberry and bracken fern.

The moist area is dominated by a red-osier dogwood and willow thicket and an overstorey of black cottonwood, big leaf maple and red alder. The shrub and herbaceous understorey consists primarily of red-osier dogwood, Indian plum, common snowberry, salal, English ivy, and sword fern. Other species present include: Nootka rose, woodland rose, salal, trailing blackberry, English holly, cascara, Pacific crabapple, Scouler's willow, Hooker's willow, Himalayan blackberry, saskatoon, thimbleberry, red huckleberry, bracken fern, deer fern, creeping buttercup and stinging nettle.

Invasive Species

Invasive species cover varies between the areas as listed below:

- Area 17- English holly (distributed throughout).
- Area 18- English ivy infestation throughout.
- Area 19- Himalayan blackberry (at edges of areas) and English holly (distributed throughout).
- Area 20- There is an English ivy infestation around the dead and dying trees. Himalayan blackberry (at edges of area), and English holly (distributed throughout) are also present.
- Area 21- There is an extensive English holly infestation in the bottom of the ravine.

Potential for Stormwater Management

There is potential for stormwater detention in the ravine in Area 21. A standpipe with small holes (for detention) on the end of the culvert would allow stormwater to pool and infiltrate into the area. At the moment a plunge pool at the culvert outlet is contributing to down cutting of the channel in the ravine. 8” and 12” storm drains from Parking Lot 1 enter this culvert. Another source of stormwater collects from Ring Road across from the Engineering Building, through a dug channel into the ravine.

Although there is extensive down cutting near the entrance culvert, large wood and vegetation are dissipating some of the water energy downstream, before another down cut close to the 24” exit culvert to Hobbs Creek. Stabilization of these down cut areas needs to be considered before more stormwater is added to this system. With stabilization and the creation of some step pools in the ravine, this area would be a suitable site for detaining stormwater from the Parking Lot 1/Engineering Building areas since the vegetation already reflects the high water table.

The dogwood /willow thicket in Area 17 and leading into Area 20 has the potential to receive further stormwater drainage, but more examination of the storage capability would be required.

Established and unauthorized trails throughout Areas 17-21 are compacting soil and in some cases directing water flow to areas where damage is occurring. Decommissioning of some of these trails should be considered. Initially, blockades could be used to discourage use. Thick branches placed across trails have been successful in discouraging use in the Dallas Road area. New plantings could be used to reclaim the trails with the branches providing some protection for these plants.

Other Comments

Tree Health:

There is an area of dead and dying trees in Area 20 that have been impacted by the Haro Road right-of-way (change in water table and flow) and from the former Oak Bay compost facility that has contributed a high level of organic matter and acidic run-off to the area. These impacts have deleteriously affected the conifers and Garry oaks and promoted the development of a cottonwood overstorey. A heavy infestation of invasive species, including English ivy, is especially evident in the area around the dead and dying trees.

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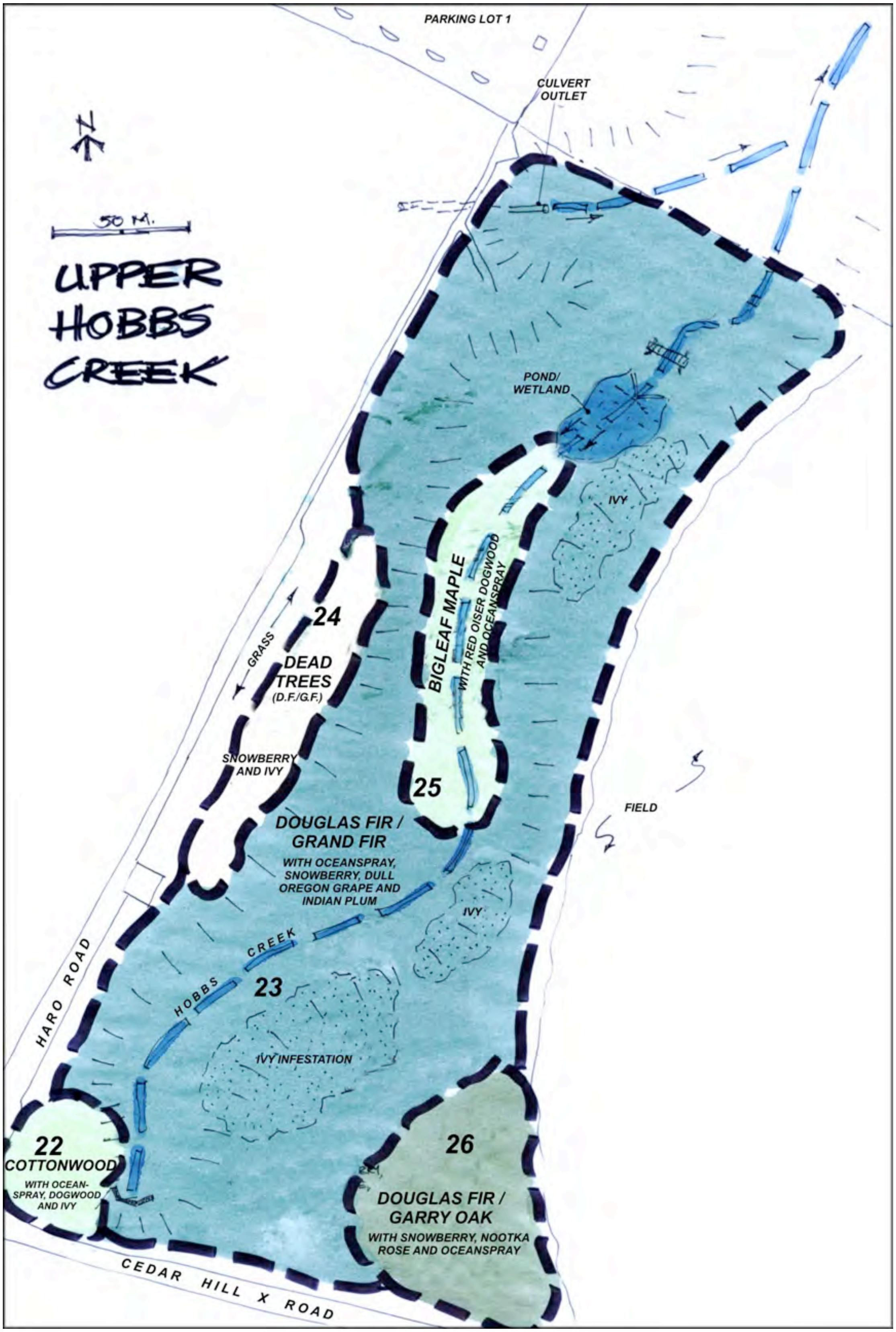
UPPER HOBBS CREEK
50 M.
PARKING LOT 1
CULVERT OUTLET
POND/ WETLAND
IVY
BIGLEAF MAPLE
WITH RED OISER DOGWOOD AND OCEANSPRAY
24
GRASS
DEAD TREES
(D.F./G.F.)
SNOWBERRY AND IVY
25
FIELD
DOUGLAS FIR / GRAND FIR
WITH OCEANSPRAY, SNOWBERRY, DULL OREGON GRAPE AND INDIAN PLUM
IVY
HOBBS CREEK
23
HARO ROAD
IVY INFESTATION
22
COTTONWOOD
WITH OCEAN-SPRAY, DOGWOOD AND IVY
26
DOUGLAS FIR / GARRY OAK
WITH SNOWBERRY, NOOTKA ROSE AND OCEANSPRAY
CEDAR HILL X ROAD

Areas 22-26: Upper Hobbs Creek

General Description and Vegetation

These areas are primarily a coniferous woodland with 20°-30° side slopes. Hobbs Creek flows through the area and receives stormwater drainage from Oak Bay through a large culvert under Cedar Hill X-Road. The channel is down cut and eroding throughout and receives additional stormwater from Parking Lot 1 and Ring Road through the culvert in Area 21. UVic Facilities Management has completed some restoration work in the Hobbs Creek area to reduce erosion and trap sediments. In Area 23 there is an area of conifers that are dead or dying as a result of runoff and organic matter from the former Oak Bay Composting Facility (this area is adjacent to the dying trees in Area 20 of the South Woods).

The overstorey vegetation consists of Douglas-fir, grand fir, big leaf maple, and black cotton wood with some red alder and western red cedar. The shrub and herbaceous understorey consists primarily of: oceanspray, common snowberry, Indian plum, English ivy and sword fern. Other species present include: thimbleberry, red-osier dogwood, red elderberry, saskatoon, woodland rose, dull Oregon grape, bracken fern, lady fern, creeping buttercup, and piggyback plant.

Invasive Species

English ivy infestation, and patches of English holly and daphne throughout all areas.

- Area 21 – Himalayan blackberry (at edges).
- Area 22 – There is a heavy English ivy infestation throughout.
- Area 23 – English ivy on dead and dying trees to a height of 10-14m.
- Area 24 – Some Himalayan blackberry is present in the valley bottom.
- Area 25 - Himalayan blackberry (at edges).

Potential for Stormwater Management

Hobbs Creek already receives a fluctuating volume of stormwater from Parking Lot 1 and areas mentioned in the South Woods section, and from the culvert running under Cedar Hill X-Road. This is causing bank erosion, sediment loss and degradation of the riparian area of the creek.

UVic Facilities Management has already done some in-stream work installing log weirs to trap sediment, and stabilizing bank erosion with large wood. Public access to some creek bank areas has been restricted to allow riparian vegetation to re-establish.

The wetland in Area 22 needs attention as the weir (small dam) is leaking and the pond level has dropped.

Trails adjacent to the creek channel are causing compaction of the riparian area. This is affecting tree health, causing loss of riparian vegetation and leading to channel erosion and down cutting especially when there is access to the creek channel by dogs, and mountain bikers.

Work on the detention function of the ravine area and culverts into Hobbs Creek, and some signs explaining the watershed and stormwater management program in this area would help to educate the users of this recreational area as to the important work being done by UVic to protect this ecosystem. There is potential for making the development of this educational process a student project for the campus.

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HOBBS ROAD
VISTA BAY ROAD
CRESTVIEW ROAD
CHELSEA PLACE
28
WIDE VALLEY BOTTOM
27
DOUGLAS FIR / GRAND FIR
WITH SWORD FERN, DULL OREGON GRAPE AND SNOWBERRY
PATCHY IVY THROUGHOUT
BIGLEAF MAPLE
WITH OCEANSPRAY, SNOWBERRY AND SWORD FERN
TRAIL ALONG CREEK
IVY
FIELD
CHANNEL FROM PARKING LOT 1 DRAINAGE
PAKRING LOT 1
N
50 M
MYSTIC VALE

Areas 27-28: Mystic Vale

General Description and Vegetation

Mystic Vale is a coniferous woodland with 20°-30° side slopes. Hobbs Creek flows through the area and the channel is down cut and eroding throughout. UVic Facilities Management has completed some restoration work in the area to reduce erosion and trap sediments. High recreational use and inappropriate trail locations (adjacent to the creek) are creating further erosion problems and negatively affecting vegetation health through soil compaction.

The overstorey vegetation consists of Douglas-fir, grand fir and big leaf maple. The shrub and herbaceous understorey consists primarily of: oceanspray, common snowberry, Indian plum, English ivy and sword fern. Other species present include: dull Oregon grape, English holly, red huckleberry, red elderberry, red-osier dogwood, mock orange, false Solomon's seal, vanilla leaf, bracken fern, trailing blackberry, and broad leaved star flower.

Invasive Species

- There is extensive English ivy infestation throughout the area.
- Patches of English holly and daphne are present throughout the area.

Potential for Stormwater Management

Hobbs Creek already receives a fluctuating volume of stormwater from Parking Lot 1 and areas mentioned in the South Woods section, and from the culvert running under Cedar Hill X-Road. This is causing bank erosion, sediment loss and degradation of the riparian area of the creek.

UVic Facilities Management has already done some in-stream work installing log weirs to trap sediment, and stabilizing bank erosion with large wood. Public access to some creek bank areas has been restricted to allow riparian vegetation to re-establish.

Trails adjacent to the creek channel are causing compaction of the riparian area. This is affecting tree health, causing loss of riparian vegetation and leading to channel erosion and down cutting especially when there is access to the creek channel by dogs etc.

Work on the detention function of the ravine area and culverts into Hobbs Creek, and some signage explaining watershed and stormwater management program in this area would help to educate the users of this recreational area as to the important work being done by UVic to protect this ecosystem. There is potential for making the development of this educational process a student project for the campus.

The construction of bridges crossing Hobbs Creek needs to be considered, as their constriction of flows in the creek channel is resulting in some downstream erosion.

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Section 5- Retrofitting The Existing Condition

STORMWATER MANAGEMENT FACILITIES

The hydrology model demonstrated that, due to the low permeability of the majority of soils on campus (see Section 2) a significant reduction in stormwater discharge cannot be achieved using a few large scale infiltration facilities. Depression storage, shallow infiltration trenches, permeable pavement and rooftop detention are likely the most effective means of reducing (through evaporation, evapotranspiration) and detaining stormwater. It is, therefore, necessary to manage stormwater through a large number of very small treatments rather than by the installation of a few large facilities. This necessitates a careful examination of all available spaces in which to place stormwater treatment. During a number of campus site visits, and the team's detailed review of the stormwater component of the new buildings under construction (or pending construction), we identified several dozen opportunities to implement small-scale stormwater treatments. These treatments will improve water quality and reduce volume of run-off.

A detailed list of sites and treatments where small, but significant, improvements could be made on campus is presented below in Table 5.1 and Table 5.2.

Following Table 5.1 are seven illustrated examples for the UVic campus which demonstrate some of the suggested Best Management Practices:

1. Alternative Pavement. Example: Parking Lot #1
2. Curb Cuts. Example: Parking Lot #8
3. Downspout Dispersion. Example: Lam Residences.
4. Grass Swale. Example: Sinclair Road
5. Green Roof. Example: Cunningham Building.
6. Vegetated Swale. Example: Parking Lot #6
7. Water Quality Protection. Example: Composting Facility

These examples are not intended to guide construction, but rather to illustrate the manner in which these techniques have been used elsewhere and to help readers visualize how the BMPs might look when implemented.

Table 5.1 Best management practices to Improve stormwater management which are suitable for use at UVic.

Best Management Practice (BMP)	Reduces Effective Impermeable Area (EIA)	Reduces run-off (amount/ timing)	Prevents pollution	First flush (Metals/ nutrients)	Sediment removal	Pollutant removal
1. Bioretention		X		X	X	X
2. Grass Swales	X	X		X	X	X
3. Vegetated Swales	X	X		X	X	X
4. Green Roofs	X	X	X	X	X	X
5. Permeable Pavement		X	X			
6. Downspout infiltration		X			X	
7. Downspout dispersion		X			X	
8. Downspout perforated stub-out		X			X	
9. Minimum road width	X	X	X			
10. Alternative Pavements (GrassPave/ GravelPave)	X	X	X	X	X	X
11. Street Storage	X	X				
12. Curb cuts/ trench	X	X				
13. Roof Storage	X	X				
14. Infiltration Trenches (IT)	X	X				
15. Porous Concrete	X	X				

Best Management Practice (BMP)	Reduces Effective Impermeable Area (EIA)	Reduces run-off (amount/ timing)	Prevents pollution	First flush (Metals/ nutrients)	Sediment removal	Pollutant removal
16. Sidewalk IT	X	X				
17. Channeling Stormwater	X	X				
18. Rain water collection	X	X				
19. Wetlands		X		X	X	X
20. Wetlands/ ponds		X		X	X	X

Table 5.2 Potential locations for stormwater management improvements. (Numbered BMP methods refer to Table 5.1).

Locations	BMP	Priority (L-M-H)	Cost (L-M-H)	Benefit (L-M-H)
Alumni House	6, 7, 8	L	L	L
Business and Economics Building	3, 6, 7, 14, 17	L	M	M
Centre for Innovative Teaching	3, 6, 7, 14, 17	L	M	M
Child Care Complex	6, 7, 10	L	L	L
Cluster Housing	6, 7, 8	L	L	L
Commonwealth Village	6, 7, 8	L	L	L
Cunningham Building	3, 4, 6, 7, 17, 18, 20	H	H	H
Engineering Building	2, 3, 6, 7	H	L	H
Engineering/Computer Science Building (new)	3, 4, 5, 7, 10,13	H	H	H
Fine Arts Building	3, 6, 7, 14, 17, 18	L	L	M
Fraser Building	3, 6, 7, 17, 18	M	M	L
Halpern Centre	6, 7, 8	H	L	L
Lam Family Student Housing	2, 3, 6, 7, 19	M	M	M
Lou-Poy Child Care Centre	6, 7, 10	L	L	L
MacPherson Library	6, 7, 14, 15, 17, 18	L	M	M
New Dormitory Residence	6	H	L	M
Petch Building	6, 7, 17, 18	M	L	M

Locations	BMP	Priority	Cost	Benefit
Petersen Health Centre	6, 7, 8	L	L	L
Phoenix Building	3, 6, 7, 14, 17, 18	M	L	M
R-Hut	6, 7, 17	L	L	M
Sedgewick Building	2, 3, 6, 7, 14, 17, 18	H	M	H
Strong Building	3, 4, 6, 7, 14, 17	L	M	L
Student Residences	6, 7, 8	H	L	H
Student Union Building	6, 7, 10, 17	H	L	H
University Houses	6, 7, 8	L	L	L
Visual Arts Building	3, 6, 7, 14, 17, 18	M	L	M
Parking				
Parking Lot 1	3, 10, 12, 14, 20	H	H	H
Parking Lot 2	3, 10, 14	H	H	H
Parking Lot 3	3, 10, 14	H	H	H
Parking Lot 4	3, 10, 12	H	H	H
Parking Lot 5	3, 10, 14	H	H	H
Parking Lot 6	3, 10, 12	H	H	H
Parking Lot 7	3, 10, 14	H	H	H
Parking Lot 8	3, 10, 12,14,19, 20	H	H	H
Parking Lot 9	3, 10, 14	H	H	H
Parking Lot 10	3, 10, 14, 19, 20	H	H	H
Parking Lot 11	3, 10, 14	H	M	H
Parking Lot D	3, 10, 14	H	H	M
Parking Lot E	1, 2, 3,10,14	H	H	H

Locations	BMP	Priority	Cost	Benefit
Lam Family Student Parking Lot	10	M	H	H
McGill Road	3, 12, 19, 20	H	L	M
McKenzie Ave.	2, 3	M	M	H
Playing Fields (west R-Hut)	2, 3	M	M	H
CJVI property	2, 3, 12	L/M	M	M
Gas Pump Facility	10	H	L	H
Glover Greenhouse	3, 10, 12,14,19, 20	H	H	H
Sidewalk between MacLaurin & Cunningham Buildings	15, 16	L	M	L
Sinclair Road (Lot 5 section)	2, 3	M	M	H
Sinclair Road (Saunders)	2, 3	M	M	H

Alternative Pavement

Timeframe:
Short-term: strips
Long-term: replacement

Example: Parking Lot 1- Grass and GravelPave

Problem:

During storm events, water runs off traditional asphalt and collects in low areas of the parking lot. Oily drippings from cars and asbestos and heavy metals from tire wear and brake linings accumulate on the parking lot during dry periods and are washed off during rainstorms. This polluted water then exits the parking area through catchbasins and is discharged into Hobbs Creek.

Benefits

- Impermeable area is reduced.
- Less water runs off the parking surface.
- Oils & grease are trapped and broken down by organisms in the root zone of the grass.

Solution

Implementation

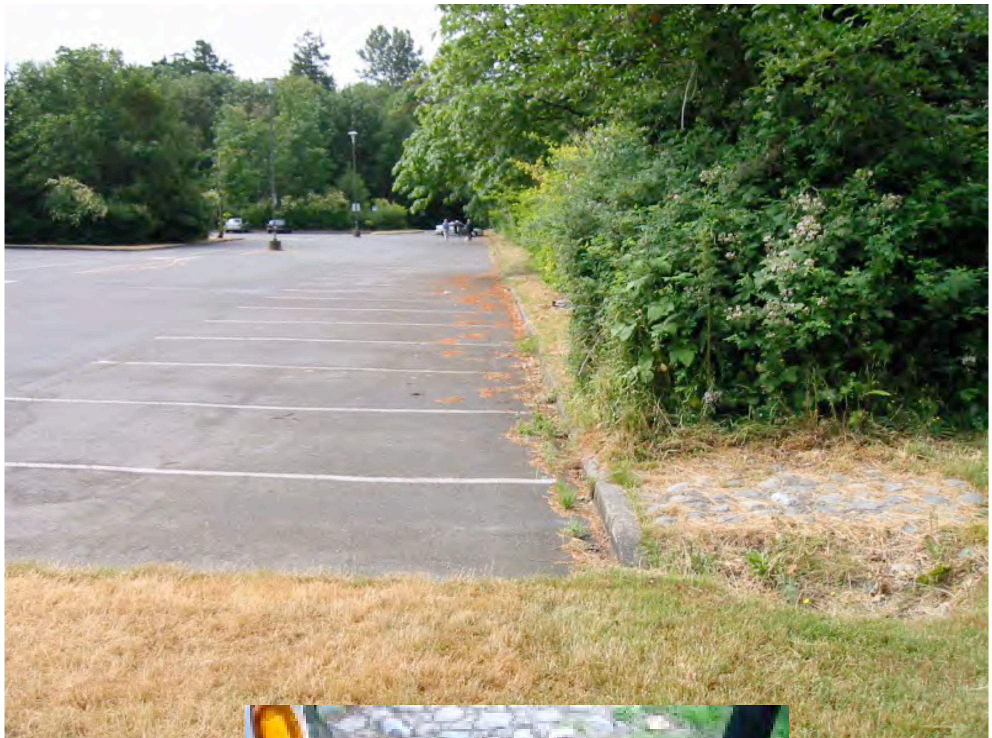
Whole parking lots can be converted to grass or gravel pave, or strips of porous paving can be added only where the cars park. This reduces the total impermeable surface and captures oils and grease which drips from the card while parked. In certain instances, the runoff from the old impermeable surface can also be directed to the porous areas for infiltration.

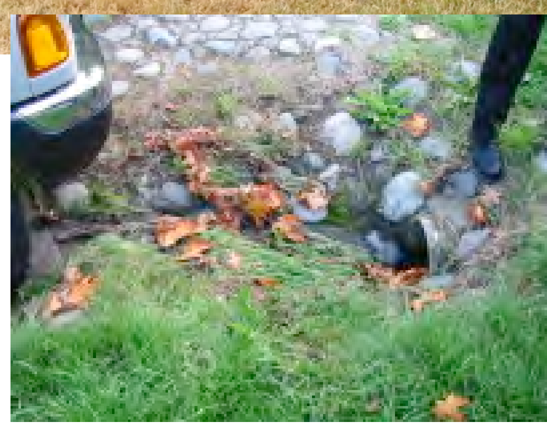
There are many brands of porous grass or gravel paving. Certain brands make provision for the installation of stall markers as an alternative to painted lines.

Curb Cuts

Timeframe:
Immediately

Example: Parking Lot 8





Problem

Water from the parking lot flows toward the vegetated area on the west side of the parking lot, but is interrupted and redirected by a curb along its full length. Small openings in the curb are overgrown by grasses and are largely ineffective. A culvert at the northwest corner of the parking lot directs runoff into Bowker Creek before it can be filtered or absorbed by vegetation. The vegetation along the parking lot would be a very good filter if the water could access it.

Benefits

- Slows runoff
- Inexpensive
- Water is directed into vegetated areas for infiltration
- Reduces ponding along parking lot edge
- Minimal maintenance

Solution

Source: France, 2002

Implementation

Creating openings in the curb will allow stormwater to reach the vegetation on the west side of the parking lot. Openings should be made large enough that they do not easily become overgrown with grasses or plugged with leaves. This will reduce maintenance frequency and ensure proper function. Openings should be spaced approximately 3 m apart along the entire length of the parking lot.

Downspout Dispersion

Timeframe:
Short-term

Lam Residences

Problem

Roof leaders, or downspouts, direct rainwater off roofs and into curtain drains that are typically connected to the storm drain system. This increases stormwater runoff from the site.

Benefits

- Reduced runoff
- Inexpensive
- Easily implemented in porous soils
- Can be visually attractive

Solution

Implementation

Downspout dispersion systems are splash blocks or gravel-filled trenches which serve to spread roof runoff over vegetated pervious areas. They can also direct water into other stormwater facilities, such as rain gardens, or stand alone. They can be designed as attractive building features and are very inexpensive to implement.

Grass Swale

Timeframe:
Immediately

Example: Sinclair Road

Problem

Roadside ditches are designed to convey water as efficiently as possible. When they become ingrown, it is common practice to clean them out along their full length and remove the grass and trapped sediment. This exposes soil and causes downstream sedimentation. Ditches do little to improve water retention or infiltration.

Solution

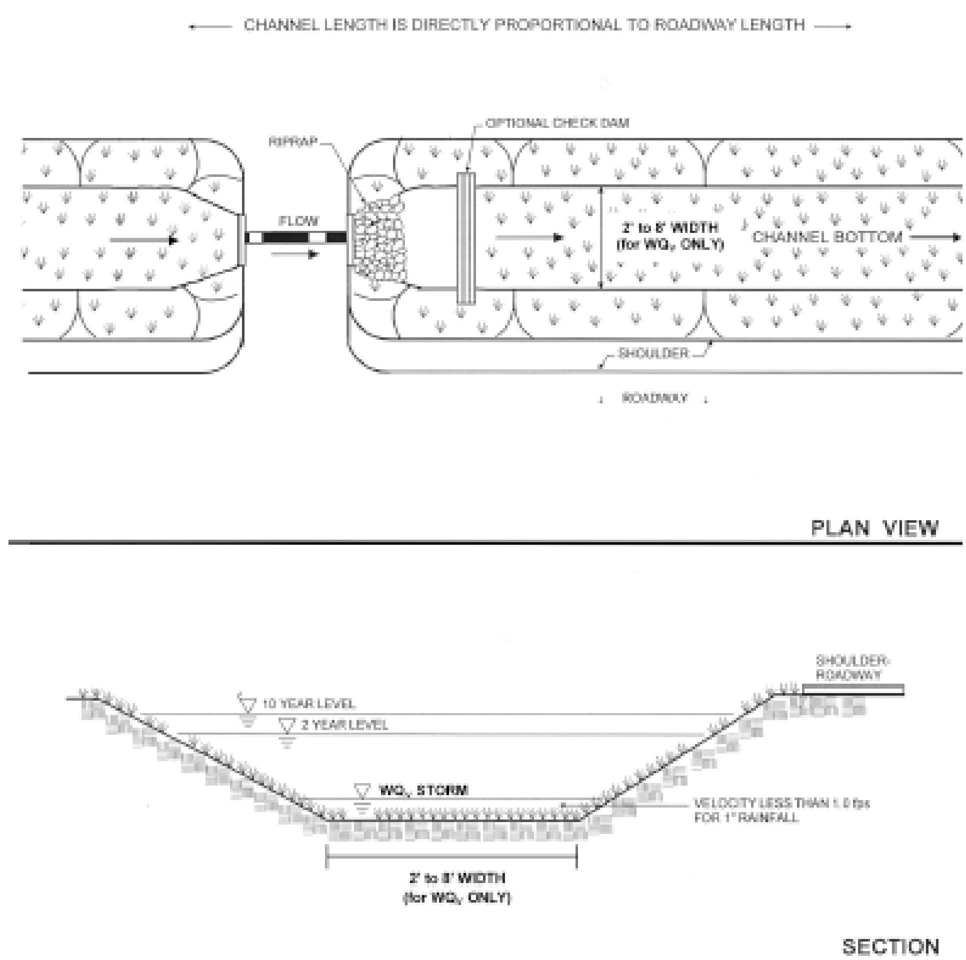
Most ditches near the UVic campus are maintained by the neighbouring municipalities of Saanich and Oak Bay. UVic should work with their neighbours to develop a maintenance plan in order to prevent stormwater which is leaving the UVic campus from causing erosion within the ditches themselves. The most effective means of accomplishing this is to reshape the ditches into grassed swales. Where this is not possible, the ditches should be left vegetated wherever possible. If ditches must be cleaned for safety reasons, they should be cleaned in alternating sections such that there is always a section with intact vegetation immediately downstream of a cleaned section. The vegetated portions will help to trap sediment eroded from the cleaned portions.

Benefits

- Slows runoff
- Captures and infiltrates stormwater
- Filters stormwater and reduces pollutants, especially sediment
- Reduces maintenance cost
- Improves safety, especially for pedestrians
- Visually more attractive

Solution

Implementation



Green Roof

Timeframe:
Long-Term
(as roof needs replacement & if structurally possible)

Example: Cunningham Building

Problem

Roofs represent a large proportion of the impervious surfaces found in urban areas. Most roofs are connected directly to the storm drain system through a system of eavestroughs, downspouts and piping. This speeds runoff directly into nearby streams.

Large expanses of roof area also increase building heating and cooling costs. Green roofs can be used to detain and retain stormwater while reducing building energy consumption by detaining and evaporating water using soil and plants.

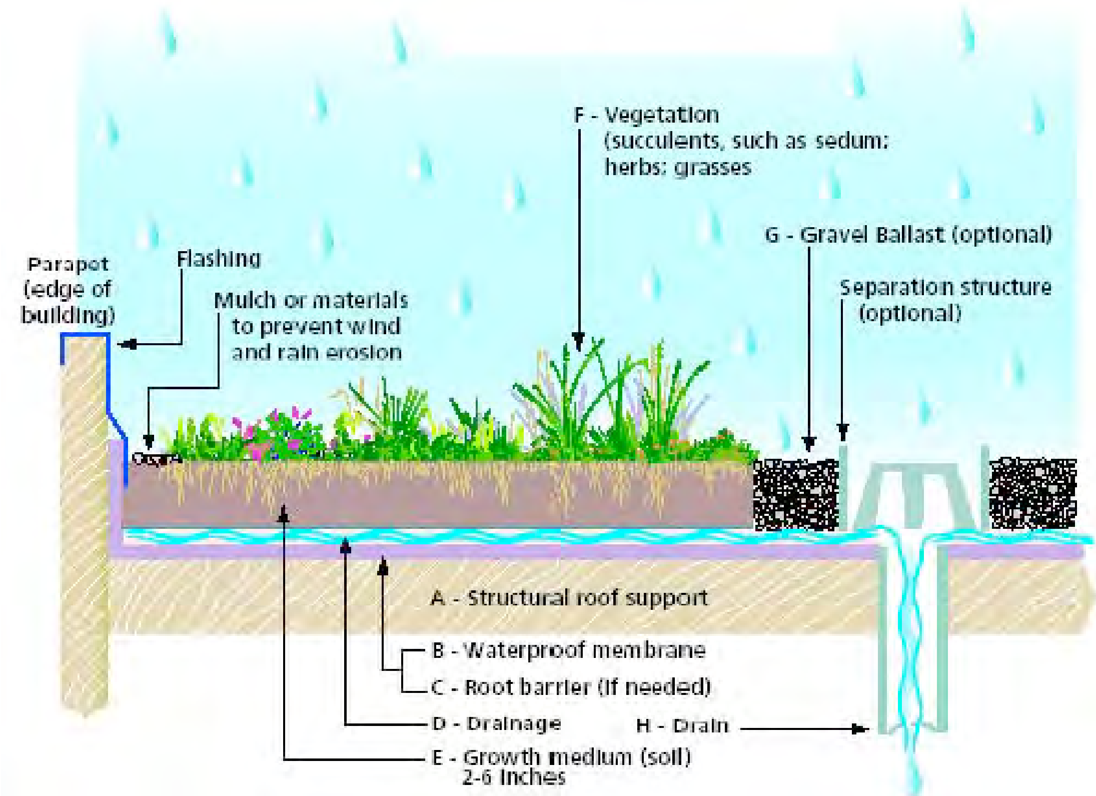
Solution

Source:
France, 2002

Benefits

- Significantly reduced runoff
- Lower building cooling costs
- Reduced heat island effect
- Comparable cost to traditional roof when all stormwater facilities are included in the costing formula.

Implementation



Source: Portland, 2002

Sedums and Succulents
Delosperma cooperi, Ice plant
Delosperma nubegenum, Ice plant
Sedum acre Stonecrop
Sedum album White Stonecrop
Sedum telephium varieties including 'Autumn Joy' and 'Variegatum'' Stonecrop
Sedum divergens Stonecrop
Sedum hispanicum Stonecrop
Sedum kamtschaticum Stonecrop

A green roof is a lightweight roof system of waterproofing material with a thin soil/vegetation protective cover that is used in place of a traditional roof. The goal is to limit impervious cover and mimic pre-developed ground cover. A green roof captures and, depending on the season, evapotranspirates 10-100% of precipitation. Green roofs reduce runoff volume and temperature and can reduce building cooling costs. They also help reduce the “heat island” effect by preventing ambient air temperature from increasing through the heating of dark surfaces such as asphalt roofing.

The new Engineering/Computer Science Building is planned to incorporate a green roof.

Vegetated Swale

Timeframe:
Medium-Term

Example: Parking Lot 6

Problem

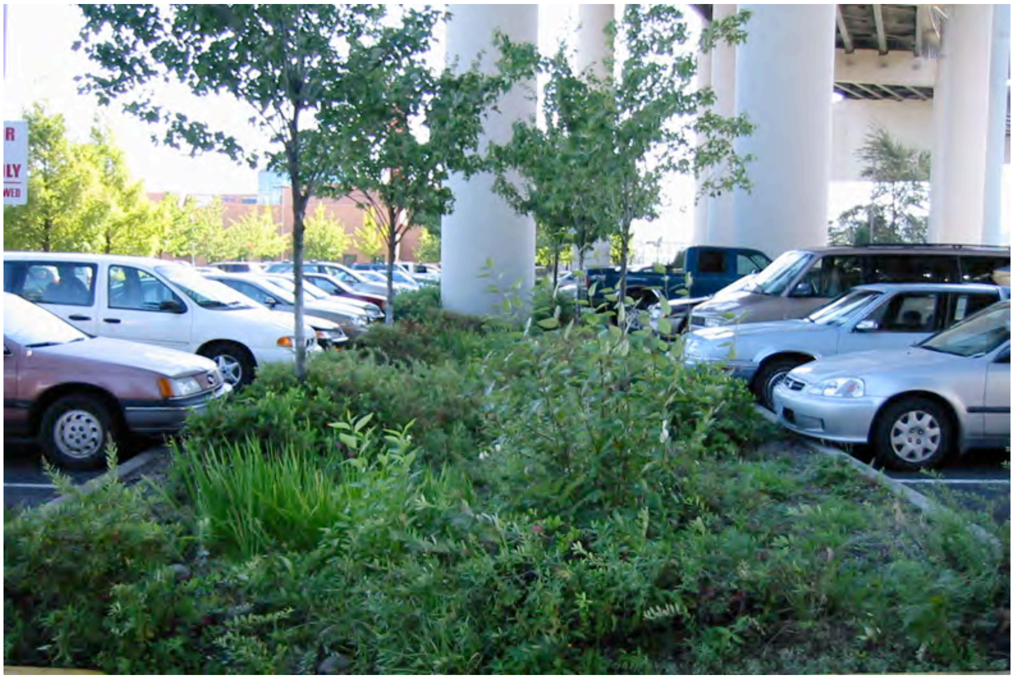
The raised berm between parking areas sheds water on to the asphalt and promotes runoff rather than detaining it. Parking lot runoff contains the oil and grease that drips from cars as well as heavy metals and asbestos that comes from brake pads. In the summer, the asphalt is very warm and heats any rainwater that falls on it, causing warm water to run off into Bowker Creek.

The berm could be converted into a vegetated swale to catch rainwater and allow it to infiltrate the ground or evaporate.

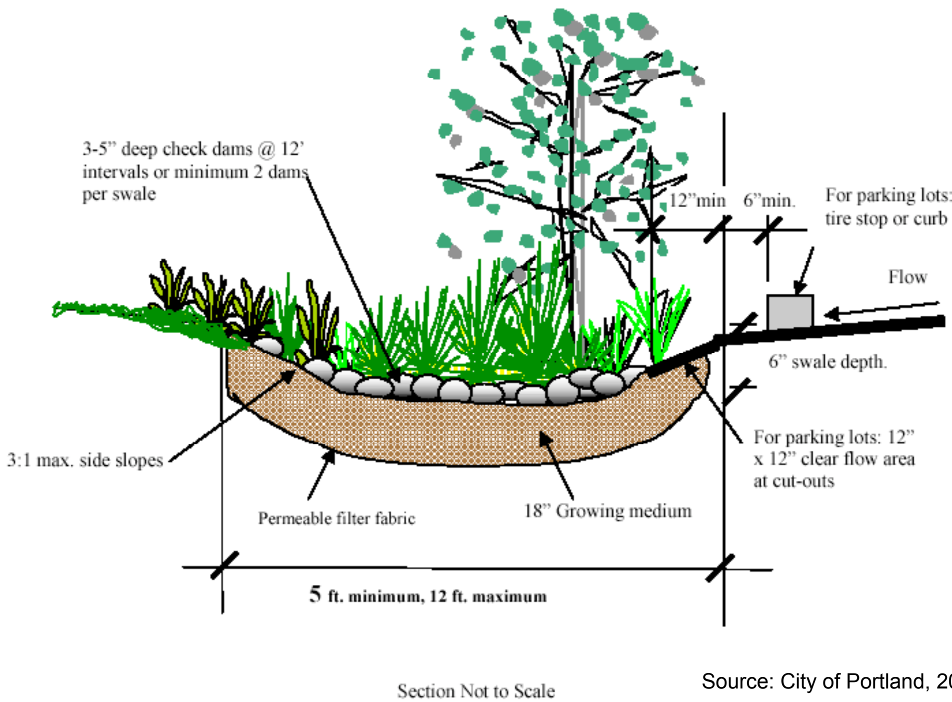
Benefits

- Reduced parking lot runoff helps reduce peak flows in Bowker Creek
- Improved quality of runoff
- Improved water quality in Bowker Creek
- Reduced water temperature in summer
- Increased number of shady parking stalls in summer
- Small trees provide bird habitat

Solution



Implementation



Source: City of Portland, 2002

The berm should be converted into a shallow, vegetated swale that is planted with native plants. These plants should tolerate a wide range of moisture conditions. A storm drain or other outlet should be installed at one end of the swale to accommodate overflow conditions during extreme storm events. Planting trees within the swale will provide shade and additional bird habitat.

Water Quality Protection

Timeframe:
Immediately

Example: Composting Facility

Problem

The composting facility produces an organic leachate which may affect the water quality of Finnerty Creek. Control of leachate during rainy periods is therefore important. The university has worked with the Ministry of Water, Land and Air Protection to identify further ways to improve the existing leachate pond. It is recommended that a series of biological treatment ponds and filtration devices be constructed to aid in the management of the compost piles to improve downstream water quality.

Benefits

- Reduces the pollutant load reaching Finnerty Creek

Solution

The existing leachate pond can be expanded readily and should be increased in size by at least 3 times. The existing pond area can be expanded with little difficulty, but requires careful design to ensure that leachate flows can enter the pond for treatment. Pond design should reflect the need for maximizing the surface area of aquatic vegetation and maximizing detention times. The edges of the pond should be planted and the new pond should have at least two water elevations for initial and final sedimentation. A small weir/berm should be constructed to separate the two areas of the pond. The leachate may not be conducive to the growth of many plants, so plant selection must be made with care.

Discharge from the pond should be directed over a weir and through a dry swale to promote infiltration, sedimentation and final polishing. Consideration should be given to using a vegetated swale depending upon the area available and underlying parent material and soil type.

Once this work is done, the pond water quality and discharge water should be monitored to ensure effectiveness. Parameters could include: pH, total suspended solids (TSS), colour, turbidity and nutrients. Monitoring frequency should be at least three times during the rainy period (beginning, middle and end) and after extremely heavy precipitation events. This may be a project that can be undertaken by students or augmented by student data.

Vegetation Restoration

The following section outlines planting zones and native plant species associated with each zone that are suggested for use in restoration and stormwater management facilities on the UVic campus.

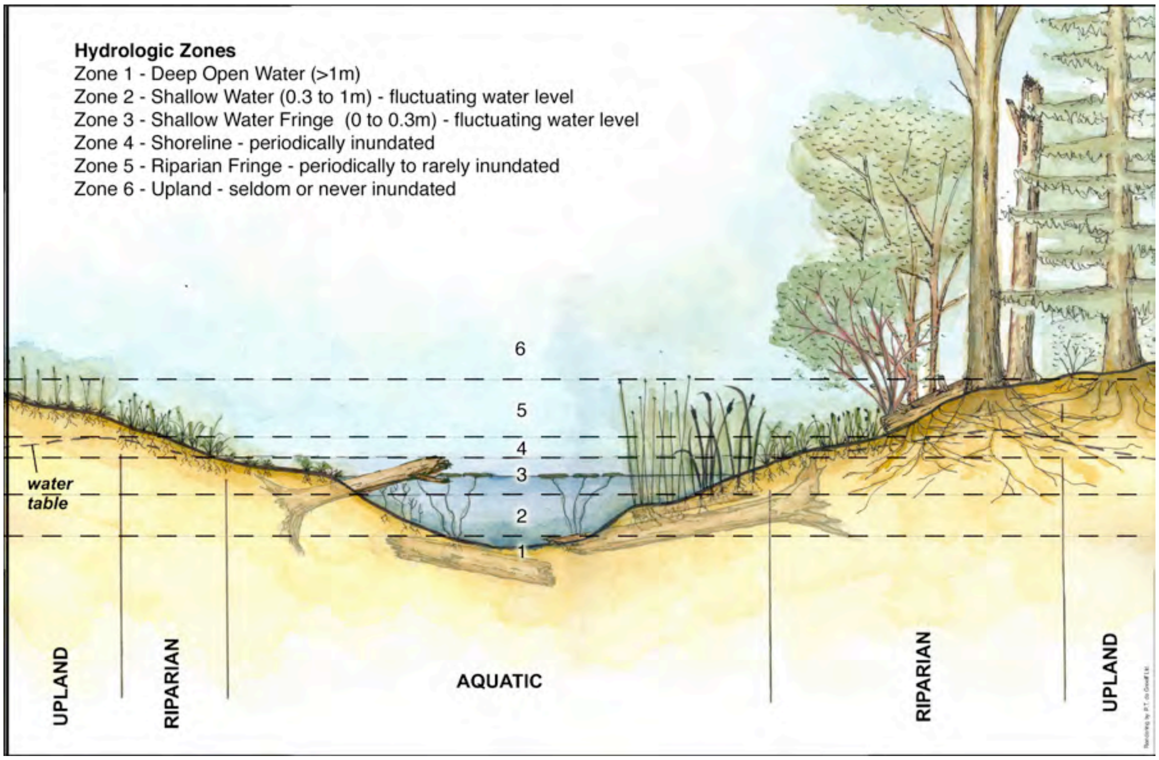


Figure 5.1 Typical Hydrologic and Native Vegetation Planting Zones

The following planting lists were considered with the zones delineated in Figure 5.1 above. These zones describe the level of water inundation typically experienced by vegetation in these areas, and the planting lists therefore identify species ranging from obligate and facultative riparian species to upland dry species. The species list here is not comprehensive. It contains native species that are commercially available and therefore most useful for implementation of stormwater management projects.

These plant lists will be useful for the creation of planting designs for wetland and stream restoration, construction of stormwater management facilities (*e.g*. constructed ponds and wetlands) and bioswales, as well as for use in landscaping. Specific areas on campus with potential for restoration and/or stormwater management are outlined in the vegetation description summaries in section 4.

Zone 1 - Deep Open Water (>1 m)

No rooted vegetation

Zone 2 - Shallow water (0.30m to 1 m) - fluctuating water level

Sagittaria latifolia	wapato, arrowhead
Scirpus acutus	hard-stemmed bulrush
Scirpus microcarpus	small-flowered bulrush
Typha latifolia	cattail

Zone 3 - Shallow water fringe (0-0.30 m) - fluctuating water, regularly inundated

Cornus stolonifera	red-osier dogwood
Salix hookeriana	Hooker's willow
Salix lucida (lasiandra)	Pacific willow
Salix scouleriana	Scouler's willow
Salix sitchensis	Sitka willow
Spirea douglasii	hardhack
Carex mertensii	Merten's sedge
Carex obnupta	slough sedge
Carex rostrata	beaked Sedge
Carex sitchensis	Sitka Sedge
Carex stipata	sawbeak Sedge
Juncus effusus	common Rush
Juncus ensifolius	dagger-leaf Rush
Lysichiton americanum	skunk cabbage
Oenanthe sarmentosa	Pacific water-parsley
Typha latifolia	cattail

Zone 4 - Shoreline - periodically inundated

Populus trichocarpa	black cottonwood
Cornus stolonifera	red-osier dogwood
Crataegus douglasii	black hawthorn
Lonicera involucrata	black twinberry
Rhamnus purshiana	cascara
Rubus spectablis	salmonberry
Salix hookeriana	Hooker's willow
Salix lucida (lasiandra)	Pacific willow
Salix scouleriana	Scouler's willow
Salix sitchensis	Sitka willow
Sambucus racemosa	red elderberry
Spirea douglasii	hardhack
Carex mertensii	Merten's sedge
Carex obnupta	slough sedge
Carex rostrata	beaked Sedge
Carex sitchensis	Sitka Sedge
Carex stipata	sawbeak Sedge
Juncus effusus	common Rush
Juncus ensifolius	dagger-leaf Rush
Lysichiton americanum	skunk cabbage

Zone 5 - Riparian Fringe - rarely inundated

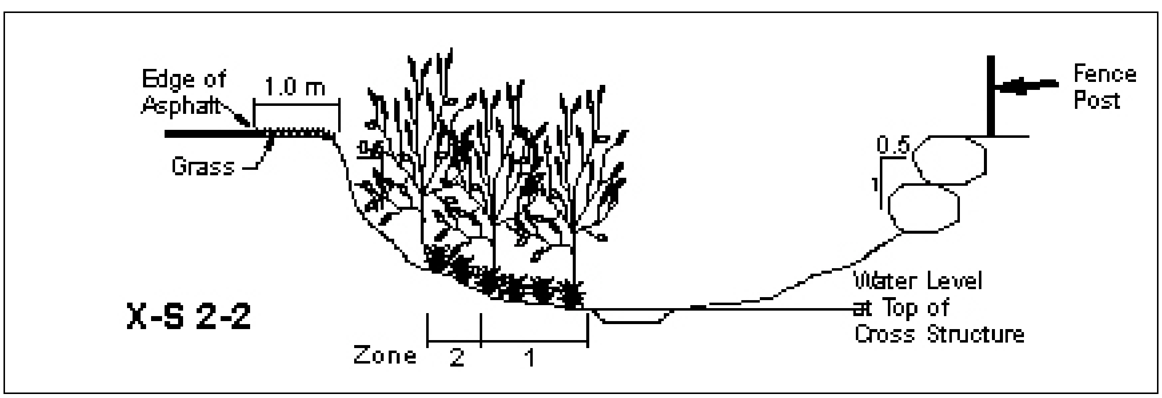
Alnus rubra	red alder
Populus trichocarpa	black cottonwood
Thuja plicata	western red cedar
Cornus stolonifera	red-osier dogwood
Crataegus douglasii	black hawthorn
Lonicera involucrata	black twinberry
Physocarpus capitus	Pacific ninebark
Populus tremuloides	trembling aspen
Rhamnus purshiana	cascara
Rubus parviflorus	thimbleberry
Rubus spectablis	salmonberry
Salix hookeriana	Hooker's willow
Salix lucida (lasiandra)	Pacific willow
Salix scouleriana	Scouler's willow
Salix sitchensis	Sitka willow
Sambucus racemosa	red elderberry
Spirea douglasii	hardhack
Athyrium felix-femina	lady fern
Aruncus sylvester	goat's beard
Blechnum spicant	deer fern
Polystichum munitum	sword fern
Pteridium aquilinum	bracken fern

Zone 6 - Upland - seldom or never inundated

Acer macrophyllum	bigleaf maple
Malus fusca (Pyrus fusca)	Pacific crab apple
Prunus emerginata	bitter cherry
Quercus garryana	Garry oak
Thuja plicata	western red cedar
Amelanchier alnifolia	saskatoon
Arctostphylos uva-ursi	kinnickinick
Holodiscus discolor	oceanspray
Mahonia nervosa	dull Oregon grape
Oemleria cerasiformis	Indian plum
Philadelphus lewisii 'Gordianus'	mock orange (Coastal)
Ribes sanguineum	red flowering currant
Rosa gymnocarpa	baldhip rose
Rosa nutkana	Nootka rose
Rosa pisocarpa	clustered wild rose
Rubus parviflourus	thimbleberry
Rubus spectablis	salmonberry
Sorbus sitchensis	Sitka mountain ash
Symphoricarpos albus	common snowberry
Vaccinium membranaceum	black huckleberry
Polystichum munitum	sword fern
Pteridium aquilinum	bracken fern

The following diagrams are examples of reconfiguring a roadside ditch for effective stormwater management. The diagram depicts vegetation on one bank of the swale to illustrate the the planting zones and show subsurface structures. During implementation planting would occur on both banks.

Existing Condition X-section 2-2



Proposed X-section 2-2

X-section 2-2 Plant List

zone 1	
hardhack	*Spirea douglasii*
willow (Sitka, Pacific, Scouler's)	*Salix sp.*
slough sedge	*Carex obnupta*
beaked sedge	*Carex rostrata*
Sitka sedge	*Carex sitchensis*
common rush	*Juncus effusus*
dagger-leaved rush	*Juncus ensifolius*
small-flowered bulrush	*Scirpus microcarpus*
zone 2	
red alder	*Alnus rubra*
black hawthorn	*Crataegus douglasii*
red osier dogwood	*Cornus sericea*
slough sedge	*Carex obnupta*
beaked sedge	*Carex rostrata*
Sitka sedge	*Carex sitchensis*
common rush	*Juncus effusus*
dagger-leaved rush	*Juncus ensifolius*
small-flowered bulrush	*Scirpus microcarpus*

Saanich #2 Grass mix from Integrity Sales will be used on the upslope areas.

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Section 6- New and Future Development

This section has been subdivided into the following sub-sections for ease of use:

I. Current Innovative Practices

II. General Future Building Guidelines

A. Parking and Roadways

Asphalt Parking Treatments with Bioswales

Permeable Surface Options:

- Porous Asphalt
- Porous Concrete
- Porous Concrete Pavers
- Concrete Block with Grass Voids
- Grass Pave/ Gravel Pave Parking Systems

B. Roof Treatments

Roof Storage

Channeling Rainwater From Roofs to Bioswales

Vegetated “Green” Roofs

Rain water Collection for Irrigation or Flushing toilets

C. Hard and Soft Landscaping Practices

Hard Landscaping Treatments

Native and Adaptive Landscaping Treatments to Reduce Potable Water Use and Runoff

Deep well Injection and/or Infiltration Trenches

Stormceptors

D. LEED™ USGBC and LEED™ BC Green Building Rating Systems

Integration of systems

Note: Brand name products are provided only as examples and are not meant to imply endorsement of a particular product as there are many brands available.

I. CURRENT INNOVATIVE PRACTICES

There are many Best Management Practices (BMPs) currently employed at UVic. Campus Plan Land and Building Policy Direction #4, Environmental Sustainability Features states that “New facilities will receive special siting and design attention to incorporate environmental sustainability features. Techniques will be used to minimize erosion and sedimentation in site development, [and] improve water efficiency…”, Policy Direction #5 indicates that “The University will continue to support sustainability practices, with particular attention on resource conservation…water management and drainage…” Both policies relate directly to stormwater management by reducing the volume of water flowing on to and off of campus as well as improving the quality of stormwater by reducing erosion and sedimentation. Though these policies are part of the 2003 plan, UVic has already implemented many innovative techniques into its building and campus management practices such as:

- Innovative building designs that incorporate multiple BMPs, including those related to stormwater, as part of an integrated plan to minimize the environmental impact of the UVic campus. The Engineering Lab Wing and Centre for Innovative Teaching both incorporate many BMPs.

- Low impact water distribution systems including dual building piping systems that will permit reuse of rainwater for flushing toilets have been planned for the new 60 bed dormitory, 126 bed dormitory and 294 bed residence.

- Permeable pavements. Walkways around the new Engineering/Computer Science Building will be made of permeable material and other new buildings will incorporate permeable materials where possible. The new 294 bed residence and Island Medical Building will incorporate GrassPave^2 fire lanes.

- Investigation of a water recycling program for the Aquatic Facility in conjunction with construction of the Engineering/Computer Science Building. Water would be reused to heat and cool the building, irrigate neighbouring areas and flush toilets.

- Dual flush toilets are planned for the new Engineering/Computer Science Building.

- Waterless urinals are planned for the new Engineering/Computer Science Building.

- Rainwater will be retained on the roofs of many of the new buildings on campus. This will permit it to evaporate and slow its release into neighbouring streams.

- Bioswales will be built in conjunction with several new buildings including the 294 bed residence, Island Medical Building, and Engineering/Computer Science Building.

- Stormwater detention is present in several areas of the campus including the University Club pond and Bowker Creek wetland.

- In-ground detention is planned for new facilities.

- Field storage for stormwater is present in the Commonwealth Village/ Cluster Housing area.

- The field adjacent to the Bowker Creek wetland at the corner of McGill Road and Gordon Head Road is unmowed. This creates a rougher surface that traps stormwater and allows infiltration.

- The basketball court in the Lam Family Student Housing Complex was constructed to detain stormwater before it reaches Finnerty Creek.

- Stream restoration is presently underway in the Hobbs Creek area. This project includes relocating trails which are damaging the riparian zone.

- Disturbed areas are being replanted with drought resistant native vegetation in order to reduce water demand.

- A sophisticated irrigation system which includes collection of weather data and a network of moisture sensors permits reduced watering schedules for most of the open green space and greatly reduces water demand.

- Surface ditching (which could be converted to swales in some areas) rather than a piped system is used to convey stormwater, especially on the northwestern part of campus.

- The Technology Enterprise Facility, Family Housing and Cluster Phase III Housing has underground water detention tanks.

II. General Future Building Guidelines

Future UVic building projects should, wherever possible, incorporate stormwater management design features into building, parking, landscaping, paths and walkways. Stormwater management consists of reducing the rate and quantity of water flows, and improving the quality of stormwater through water retention, treatment and reducing peak stormwater flows through the delayed release of water.

Reducing the rate and improving the quality of stormwater runoff at the building and site level can favorably impact the cost of stormwater infrastructure over traditional methods while enhancing and protecting ecosystems. Traditional stormwater piping infrastructure has consistently been a significant cost item for university campuses at the building site level and for campus infrastructure. As new development is added, this puts increasing pressure on existing systems resulting in upgrading requirements and higher stormwater costs at the building level, particularly since local stormwater rules are becoming increasingly stringent. New, more ecologically sound stormwater practices at the building level can significantly reduce the need to add or upgrade existing infrastructure, and can have substantial economic and ecological benefits.

Techniques such as rainwater collection for toilet flushing/irrigation have the added benefit of reducing longer-term building operating costs by avoiding the use of potable water supplied by the CRD.

The following specific techniques to reduce the rate and quantity of stormwater while improving stormwater quality were investigated for stormwater design features at the building and site level:

- Parking systems that promote ground water recharge and improve water quality through filtering – *i.e.* bioswales, porous paving, porous concrete, porous pavers, grasscrete and grass/pave gravel systems.
- Roof treatments that address runoff from roofs – i.e. bioswales and/or bio-filtration ponds, vegetated "green" roofs, deep well injection, and rain water collection for reuse in irrigation or flushing toilets.
- Hard and soft landscaping practices that utilize permeable and water efficient (drought tolerant) landscapes.
- Other (*i.e.* stormceptor systems, sand filters)

It is important to consider all of these strategies in the context of campus-wide water management. Many wide-reaching factors are at play in the stormwater management and reduction strategies discussed in this section. A prime example of this is the need to reduce whole campus impermeability. Looking to current parking design and parking "needs" in relation to transportation demand management strategies will have a significant impact on impermeability and subsequent stormwater flows. Building designs that feature more compact footprints will reduce building impermeability and subsequent stormwater collection and flows. It is important to consider these broad-reaching issues on a campus- and even community-wide scale when deciding the appropriateness and effectiveness of the different stormwater reduction, treatment and use strategies discussed in this section.

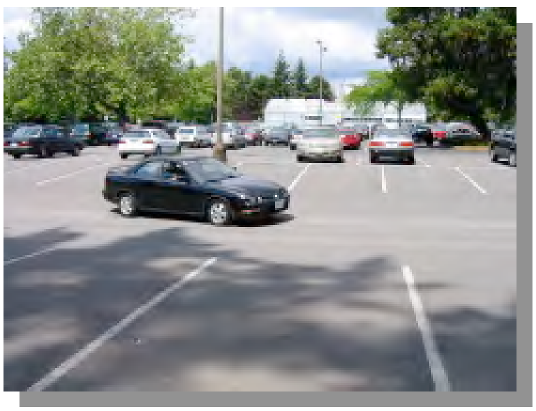
A. Parking and Roadways

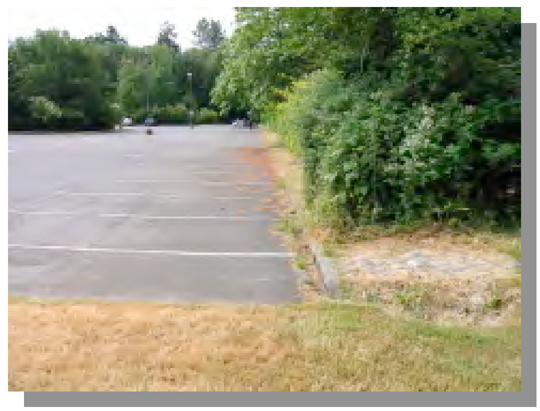
The design treatment of parking and roadways will vary from site to site and is influenced by traffic volumes, vegetation and soil considerations, aesthetic requirements and maintenance. Certain treatments are more suitable in clay soil conditions while others are more suitable in granular and/or sandy pervious conditions.

Asphalt Parking Treatments with Bioswales

Standard asphalt parking treatment is a curb and gutter approach to collect stormwater and direct to a stormwater discharge culvert. This is the common practice in the Capital Region and at UVic. Traditional asphalt parking lots do little to reduce quantity and rate of flows of stormwater and generally have a runoff coefficient of 95%. Stormwater treatment is generally limited to the use of oil and grease separators to attempt to remove contaminants.

Standard Parking Treatment:





Design Criteria

The main design criterion is to eliminate curbs in parking surfaces by channeling stormwater into bioswale areas in the parking median areas and/or to immediate off-site bioswales.

Bioswales are open channels possessing a dense cover of grasses and other herbaceous plants through which runoff is directed during storm events. The bioswales capture and cleanse the water through natural ecological processes prior to soaking into the ground. This reduces both the flow to the main stormwater drain system and the amount of contaminants in the water and promotes ground water recharge. Bioswales can be combined with bio-filtration ponds to further remove sedimentation and handle larger scale rain events.

Bioswale parking lots

Curbs are eliminated and stormwater flows directly into bioswales in median areas. The amount of groundwater recharge will depend on soil conditions and as such, overflow protection may be required.

Bioswale medians

Plants act as a bio-filter to treat oil, gas and other contaminants as well as absorb stormwater. Tree planting in medians reduce the heat island impact created by parking lots.

Overflow treatments

The overflow is directed into a bioswale treatment and then flows into a bio-filtration pond.

This particular bio-filtration pond also acts as a back-up fire suppression source and provides a nice landscape feature for the development.

The raised manhole provides an overflow measure to direct stormwater to the main storm system in the event of major rain events.

Benefits and Considerations

The use of bioswales and bio-filtration ponds combined in conjunction with parking design promotes natural treatment and groundwater recharge while reducing the rate and quantity of stormwater thereby minimizing negative impacts on downstream creeks and ecosystems.

Above ground plant parts retard flow and thereby encourage particulates and their associated pollutants to settle. The pollutants are then incorporated into the soil where they may be immobilized and/or decomposed. Bioswales are more effective at cleaning contaminants then oil and grease separators.

Besides a cleansing function, water use in plant systems reduces runoff as a result of evapotranspiration. Care must be taken in bioswale design to avoid inundation during germination of plant species. The bioswale design needs to ensure that the amount of runoff designed for the swale does not overwhelm the vegetation or circumvent filtration via channelled flow.

Aesthetics can be an issue. Some feel the look of bioswales is “messy” and prefer a look of a paved surface with subsurface drainage and curbs. Others prefer the look of a bioswale parking lot and feel the native plants and grasses promote ecology and green spaces. This is a personal choice. These concerns can largely be overcome through signage on the parking lot explaining the reason for the bioswales and through an awareness campaign.

Concerns may be raised over the use of bioswales and biofiltration ponds acting as mosquito breeding areas. It is important that an ecologist assist in the design of the ponds to ensure the ponds are designed as ecosystem to minimize this concern.

Public safety is often cited as a concern for biofiltration ponds in the event someone falls in a pond. Generally, ponds are terraced, thereby minimizing this risk and signage can be provided for safety. However, we live in a region of lakes and the ocean and such a risk is not different with these water features as they are with biofiltration ponds.

Capital Cost Implications

The cost of a bioswale/filtration pond parking system compared to a traditional curb and gutter asphalt parking lot will vary from site to site and be dependent on soil conditions. The more permeable the soil conditions, the cheaper the design.

At UVic the majority of soils are clay and generally such a system will cost less than a traditional parking lot design. The cost of excavation for swales and bio-filtration ponds and associated plants is offset (and may provide a saving) by:

- Reducing the amount of subsurface drainage and stormwater piping
- Significant reduction in curbing as stormwater is not collected or channeled.
- Oil and grease separators are eliminated.
- Overflow stormwater in the event of major rain events to the main storm system may not be required particularly in permeable soil areas.

The biggest saving, and the one most difficult to quantify, is the impact on the major stormwater infrastructure on and away from the site. By reducing the rate and quantity of stormwater flows in new parking and built areas on campus, the need to upgrade existing stormwater systems for future development may be avoided altogether.

Operating Cost Implications

Dredging of the swales and ponds will be required from time to time as sedimentation accumulates. This will be fairly infrequent as the source of sedimentation is generally reduced under this design as compared to parking lots that have raised landscaped beds. Depending on the types of plants used there may also be some ongoing landscape maintenance required.

Oil and grease separators and catch basins also require cleaning. Failure to clean these on a regular basis has a more significant impact on the environment than the failure to maintain bioswales and bio-filtration ponds.

Another benefit is the reduction in rate and quantity of stormwater during the peak flows. This minimizes the risk of downstream flooding in major rain events as compared to an enclosed piping system that will overflow.

Finally, as there is less curbing, drains and piping, maintenance costs associated with these features are reduced. Generally, once established, the bioswales are thought to be a low ongoing maintenance issue.

Permeable Surface Options

Porous Asphalt

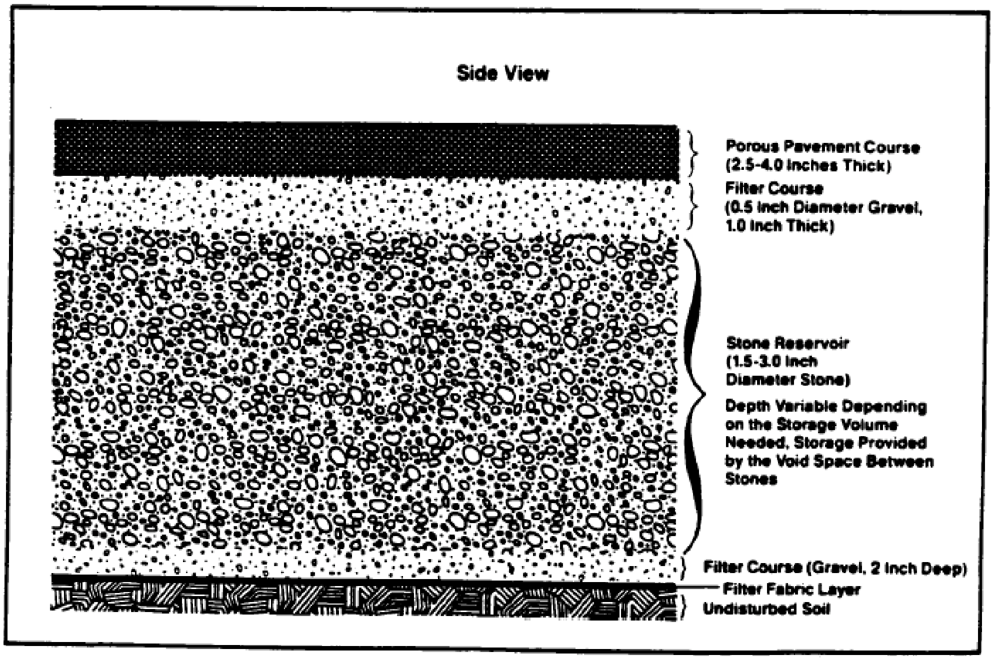
Design Criteria

Porous asphalt pavement is a paved surface and sub base comprised of asphalt, gravel, and stone, formed in a manner resulting in a permeable surface. The various layers, called "courses," have the potential for stormwater detention.

Stormwater that passes through the pavement may completely or partially infiltrate the underlying soil, with the excess being collected and routed to an overflow facility through perforated drain pipes below the courses. The pavement may also be designed to receive off-site runoff[1].

As shown in the diagram below, a typical porous asphalt pavement consists of a top porous asphalt course, a filter course, a reservoir course (designed for runoff detention and frost penetration), and existing soil or sub base material.

[1] Source: City of Rockville, Md., as copied from "Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development." The Urban Land Institute. 1981.



The top porous asphalt course is open-grade asphalt concrete surface approximately 2-4 inches thick. Porous asphalt concrete contains little sand or dust, and has a pore space of approximately 16% (as compared to 2-3% for conventional asphalt concrete). Strength and flow properties of porous asphalt concrete are similar to conventional asphalt concrete.

The filter course is a 1-2-inch thick layer of 0.5-inch crushed stone aggregate. In addition to providing some filtration (limited by the relatively large pore space), the filter course also provides stability for the reservoir course during application of the asphalt mix.

The reservoir course is a base of 1.5-3-inch stone of a depth determined by the storage volume needed. In addition to transmitting mechanical loads, the reservoir course stores runoff water until it can infiltrate into the soil. Where soils have low permeability, the reservoir course thickness should be increased to provide additional storage. With soils composed primarily of clay or silt, the infiltration capacity may be so slow that the soil is unacceptable as a sub grade, necessitating replacement by suitable borrow material. If the natural material beneath is relatively impermeable, drainage may have to be provided. The drainage may take the form of subsurface drains, French drains or Dutch drains.

Another 2-inch filter course can be applied below the reservoir course to allow additional infiltration. Below the filter course, a filter fabric is often installed to prevent migration of soils and particulate into the porous asphalt system. Under the filter fabric is the undisturbed soil.[2]

[2] Source: City of Rockville, Md., as copied from "Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development." The Urban Land Institute. 1981.

Porous asphalt should only be used on sites with gentle slopes (<5%), permeable soils, and relatively deep water table and bedrock levels. Soils should be well or moderately well drained. Since sub grade soils will differ in their capacity to infiltrate and percolate water, the design of porous pavement will vary slightly based on soil type. Subsurface drains may collect water infiltrating the reservoir course of porous asphalt pavement and route it to a bioswale, biofiltration pond and/or infiltration basin. This may be necessary for soils having marginal infiltration capabilities.

Benefits and Considerations

Permeable asphalt provides for some permeability, particularly for small rain events. Normally asphalt parking has an average runoff coefficient of 95% where porous asphalt on average as a runoff coefficient of 60%. The permeability may begin to diminish if the pores begin to clog and the system requires ongoing maintenance in order to maintain permeability, as discussed below.

Permeable asphalt has the added benefit of reducing noise levels during rain events in high traffic volume areas such as roadways.

Care must be taken when using porous asphalt because when failure occurs, it can be attributed to poor design, inadequate construction techniques, soils with low permeability, and poor maintenance. Porous asphalt systems require a very high level of construction workmanship to ensure they function as designed. It is recommend that porous asphalt pavement systems should be designed by registered professional engineers.

Capital Cost Implications

There is minimal cost difference between porous asphalt and standard asphalt mix. The base cost may be higher as compared to a conventional compacted sub base but generally this is offset by reduction in storm pipes and inlets.

Operating Cost Implications

Porous payment does require maintenance and should be vacuum swept at least four times per year, followed by high pressure jet hosing to keep the asphalt pores open. Since vacuum sweeping machines are costly, a possible partnership with neighbouring municipalities could be explored.

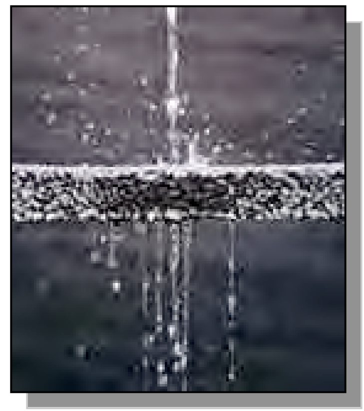
Inspections should be conducted after large storms to check for surface ponding that might indicate localized or widespread clogging. If low spots or spot clogging does develop in the parking lot, it may be advisable to install drop inlets to divert runoff into the reservoir course more quickly or drill half-inch holes through the porous asphalt layer every few feet.

Potholes and cracks can be repaired using conventional, non-porous patching mixes as long as the cumulative area repaired does not exceed 10% of the parking lot area.

Porous Concrete

Design Considerations

Porous concrete is the term for a mixture of coarse aggregate, Portland cement and water that allows for rapid infiltration of water and overlays a stone aggregate reservoir. This reservoir provides temporary storage as runoff infiltrates into underlying permeable soils and/or out through a drainage system below the reservoir.



Pervious Portland cement concrete is a zero-slump, no-fines, open-graded material consisting of Portland cement, coarse aggregate, and water with admixtures added in some situations. Fibers may be added to facilitate the workability of the mix and minimize surface raveling, but they add cost and are not needed to keep the cement from migrating through the open-graded aggregate structure. These materials produce a pavement with a void structure of 20 to 25%, readily allowing water to pass through.

Porous concrete systems can be used where the underlying *in-situ* sub soils have an infiltration rate greater than 0.5 inches per hour. Therefore, porous concrete systems are not suitable on sites with a high (>30%) clay content soils without subsurface drainage.

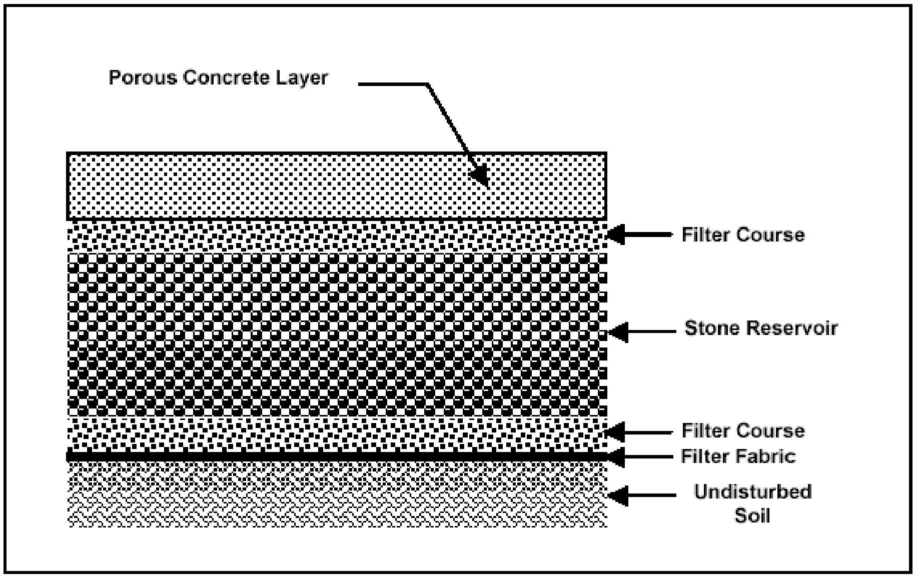
During construction and preparation of the sub grade, special care must be taken to avoid compaction of soils.

The aggregate reservoir can sometimes be avoided or minimized if the sub-grade is highly permeable and there is adequate time to infiltrate the necessary runoff volume into the sandy soil without by-passing the water quality volume. There are some locations at UVic where soil conditions would meet this profile.

Porous concrete system designs must use some method to convey larger storm event flows to a conveyance system. One option is to use storm drain inlets set slightly above the elevation of the pavement. This would result in some ponding above the surface, but would accept bypass flows that are too large to be infiltrated by the porous concrete system. This would also provide a backup system if the surface clogs.

Porous concrete is usually made with the only aggregate being 10-20mm gravel, water and Portland cement. No sand is used. The water to cement ratio is on average 0.3, but it can vary widely depending on ambient conditions. The cement slurry coats the gravel and because there is no sand (or fine aggregate) the cement coated gravel leaves openings between the gravel pieces, just as if you had gravel alone, allowing water to flow through the concrete.

Porous concrete cross section[3]



Benefits and Considerations

Porous concrete allows for the absorption of runoff into adjacent soils, where bacteria and other microbes decompose surface pollutants before they can reach groundwater or other surface water sources. This system also assists in groundwater recharge. As with porous asphalt, fine material suspended in the water is captured with the soil thus removing suspended solids.

For the purpose of sizing downstream conveyance and structural control systems, porous concrete surface areas can be assumed to 35% impervious (runoff coefficient) which exceeds the runoff coefficient of porous asphalt.

Care must be taken when using porous concrete as generally failure has been attributed to poor design, inadequate construction techniques, soils with low permeability, and poor maintenance. Porous concrete systems require a very high level of construction workmanship to ensure that they function as designed. It is recommend that porous concrete pavement systems should be designed by a registered professional engineer.

Capital Cost Implications

Porous concrete is more expensive then asphalt and concrete (about 25% more than concrete). However, these costs can be offset to some extent by the elimination of curbs, gutters, and storm drains.

[3] 3.3-36 Georgia Stormwater Management Manual Volume 2 (Technical Handbook)

A way to maximize the benefits of pervious concrete and reduce costs could be through using pervious concrete in parking stalls while drive aisles are built with normal concrete but sloped towards the stalls for drainage.

Operating Cost Implications

Installation should be inspected monthly for three months after installation. The porous concrete surface should be inspected monthly to ensure it is free of sediment. Similar to porous asphalt, landscaping practices in adjacent areas need to ensure soil stabilization and if adjacent lawns are mowed that clippings are removed.

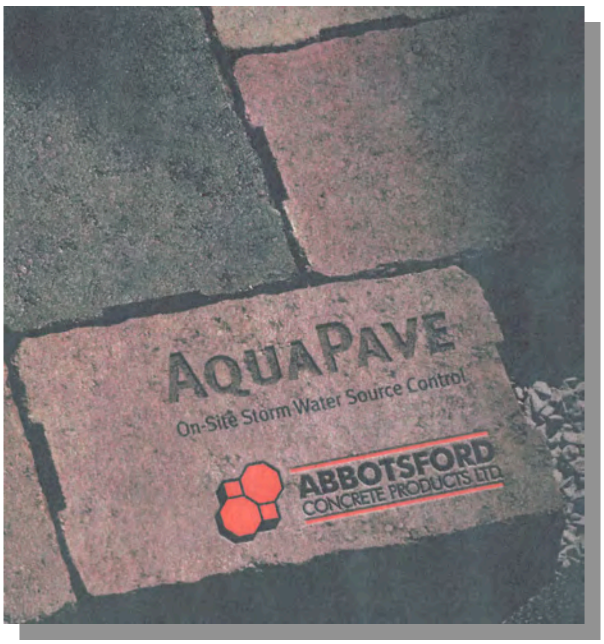
Four times per year the porous concrete should be vacuum swept followed by high pressure hosing to keep pores free of sediment. Spot clogging can be handled by drilling half-inch holes through the pavement every few feet.

Porous Concrete Pavers

Design Considerations

Concrete pavers are used quite regularly to increase groundwater infiltration. The effectiveness of such system is minimal as generally the voids are small. New products are becoming available on the market that are very porous and provide for significant infiltration.

One product with high permeability is AquaPave made by Abbotsford Concrete Products Ltd.

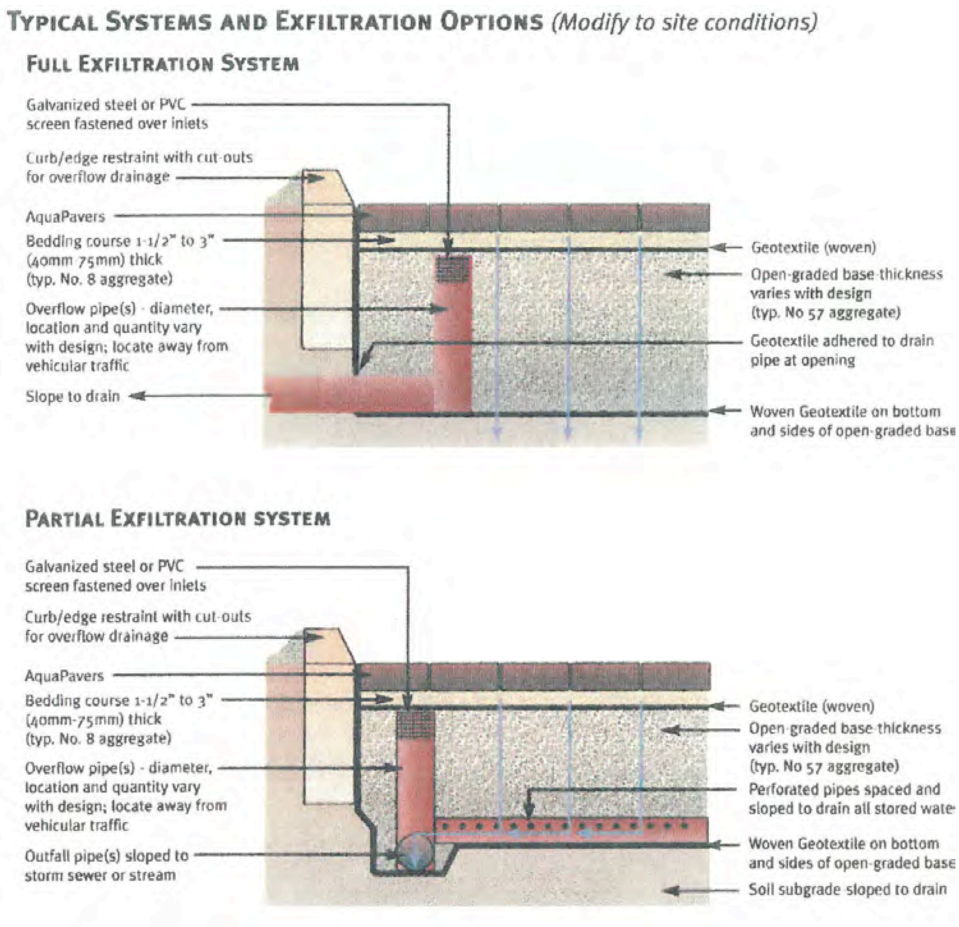


The pavers can be used in high traffic areas such as roadways and parking driveways as well as for pathways and parking stalls. Voids have been designed into the paving stones to allow for high levels of filtration.

Benefits and Considerations

The benefits are similar to what has been outlined for porous concrete and porous asphalt. These pavers promote the absorption of runoff into adjacent soils, and treat stormwater runoff while assisting in groundwater recharge. Fine material suspended in the water is captured with the soil removing suspended solids. They are aesthetically pleasing and provide a nice feature in roadways and can handle the weight of heavy vehicles with proper base design.

Below are schematic views of installation procedures. Installation is similar to that of normal pavers.



Capital Cost Implications

With respect to cost, as with most pavers, they are more expensive then asphalt or concrete.

Operating Cost Implications

It is recommended that the concrete pavers be inspected four times a year and be vacuum cleaned if noticeable clogging of voids becomes evident. There is less likelihood of this happening with this product as with porous asphalt because the voids are larger.

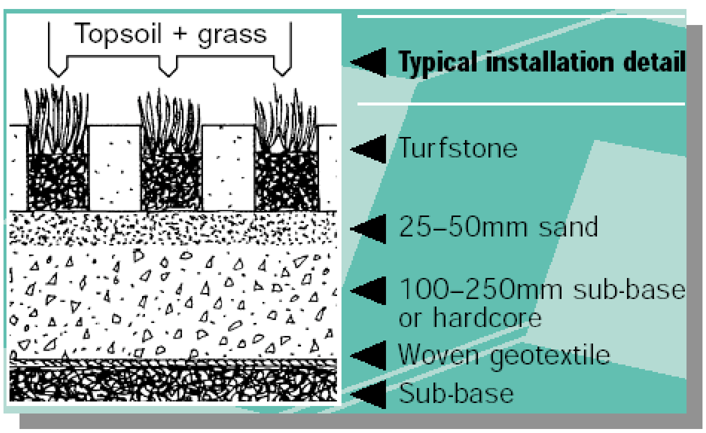
Concrete Block with Grass Voids

Design Considerations

There are a variety of products that utilize a grasscrete or turfstone type of product that is essentially concrete blocks with large voids between them where grass grows. One such product is turfstone, shown below.

Turfstone©

Typically the product is used in emergency access areas, embankments, spillways, and environmentally sensitive parking areas. There is the option of the blocks being filled with grass or with aggregates depending on the project's drainage requirements.



Below the turf grass, the sub grade should be compacted thoroughly to a 95% modified proctor, until no further movement of the soil is observed. Areas that cannot be consolidated by rolling should be removed and replaced with sound material or combined with gravel to develop the required stability.

Benefits and Considerations

The use of concrete blocks with grass promotes the absorption of runoff into adjacent soils, and treats stormwater runoff while assisting in groundwater recharge. Fine material suspended in the water is captured with the soil removing suspended solids. The benefits of this strategy are similar to porous asphalt, concrete and pavers including an enhanced ability to remove contaminants due to the presence of grass and its associated microbes and bacteria that live on the grass roots.

Turfstone is more suitable in areas with limited traffic flows such as fire lanes, and in partially shaded areas. In higher traffic areas, and areas with direct sunlight, the concrete tends to heat up the soils thus hampering the growth of grass in the voids as moisture is wicked away from the root zone.

Capital Cost Implications

Turfstone is more expensive then porous concrete and asphalt, as is the case with most pavers.

Operating Cost Implications

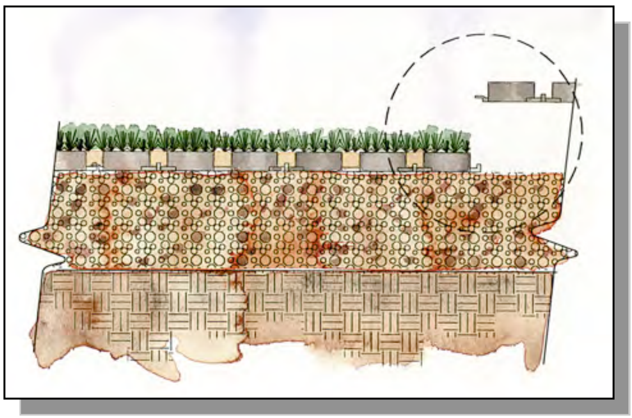
Concrete block with grass will require significant irrigation in areas with lots of sunlight because the concrete heats up and tends to dry and heat the soils quickly. This can damage roots if not carefully managed, and Success in grass growth is variable depending on location.

Grass Pave/ Gravel Pave Parking Systems

Design Considerations

Plastic grid pavers are made mainly out of recycled plastic materials with UV inhibitors that provide a highly porous surface. The plastic grid is filled in using grass and gravel to add stability, stormwater retention and treatment functions, and to make the area more aesthetically appealing.. These pavers are also flexible, allowing them to be used on uneven sites.

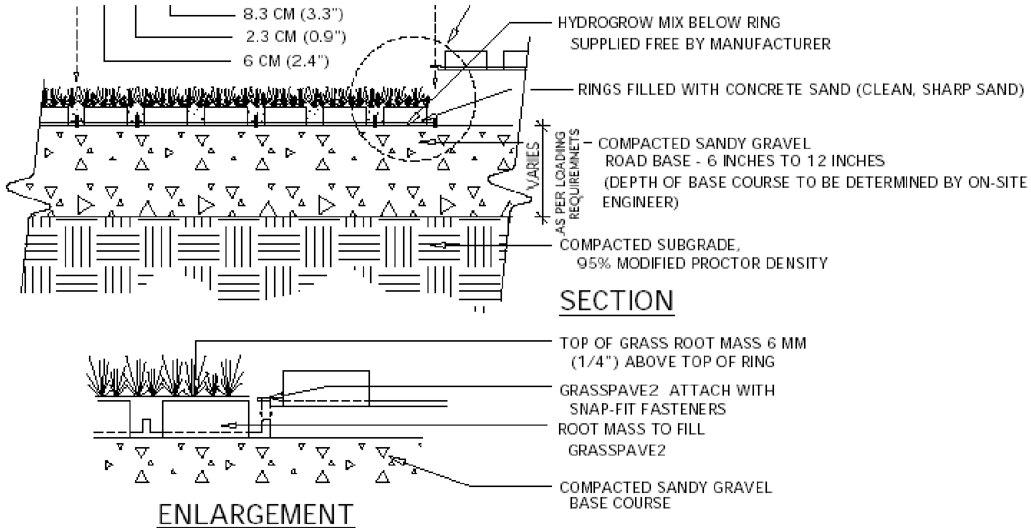
These parking systems do not require curbs and, depending on sub soil conditions, drains can be eliminated with no need for any other drainage facilities. These pavers are recommended for use as sidewalks, parking areas, golf cart paths, residential driveways, fire lanes, and emergency access roads.



There are various products on the market, including one that is manufactured locally and distributed by Invisible Structures.

Care must be given in installation, particularly over a clay base, to ensure an adequate sub base. It is recommended that if used, the distributor of the product be contracted on a design, build and install basis.

The product with an appropriate sub base can handle the weight of fire trucks.



Benefits and Considerations

The grass and gravel pave systems are highly permeable (92% pervious area) resulting in little to no surface runoff. In addition, the company purports that, on average, the system reaches a removal rate of 95% for total suspended solids (TSS) and 65% for total phosphorus (TP).

These parking systems are environmentally friendly, use recycled plastic, reduce stormwater runoff, help prevent flooding, reduce non-point source pollution, reduce imperviousness of the area, reduce heat island effects, and minimize site disturbance. Suspended pollutants and moderate amounts of engine oils are consumed by active soil bacteria, which are aided by the system's excellent oxygen exchange capacity. Trees can thrive in this parking lot, very different than in traditional concrete or asphalt parking lots where it is difficult to provide enough air and water to a tree's root-zone

Capital Cost Implications

Plastic grid pavers are competitively priced to asphalt and concrete paving, when the entire cost of parking is considered. Subsurface drainage pipes are reduced, there is minimal asphalt curbing required to collect rainwater, and catch basins and oil and grease separators are eliminated.

In permeable soil areas (sand, granular soils) the costs of grass/gravel pave will be less. Where clay systems exist, the cost of the system will be roughly equivalent to asphalt depending on how much sub base is required for storage and strength.

Operating Cost Implications

Such systems require mowing, irrigation, fertilization, and seeding. This can be minimized through the selection of grass species that are best suited to the local climate thereby reducing the need for inputs and maintenance. If cars do “donuts” on a grass/gravel pave parking lot the sheets will lift and relaying will be required. Security cameras on parking lots are recommended. Repairs are relatively straightforward and can be done manually.

The company estimates the maintenance costs for Grasspave^2 pavements over a 12 to 15 period (asphalt life cycle) will generally cost between 60% to 90% of the cost of asphalt maintenance and repair costs over the life of the parking lot. Asphalt paving requires resealing every 2 to 4 years, and resurfacing every 8 to 15 years, depending upon traffic and climate.

Trials shows that the Grasspave^2 pavement can be expected to perform over a life cycle of 25 to 30 years with proper maintenance. Asphalt would likely require complete resurfacing 3 times over 50 years.

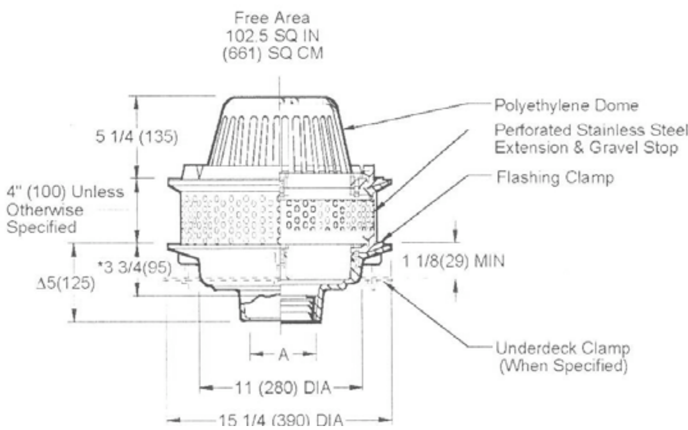
With respect to snow removal the use of skids on the corners of snowplow blades is recommended with the blade set at a high of 1 inch about the ground. This is all that is needed to protect the GrassPave system from damage in the winter months.

B. Roof Treatments

Roof Storage

Design Criteria

This is a technique to delay stormwater release, thereby reducing flows. It involves the use of roof top drains and effective roof design to allow some rainwater storage on the roof.



Benefits and Considerations

Delayed release of stormwater helps reduce peak flow volumes during rain events and, when combined with other techniques, can promote groundwater recharge rather than conveyance to the storm sewer system on smaller, frequent rain events.

Capital Cost Implications

Capital cost savings can be realized with this strategy because rainwater pipes can be downsized due to the reduced flows. The roof rainwater storage system is sized to ensure there is no structural impact on the roof design.

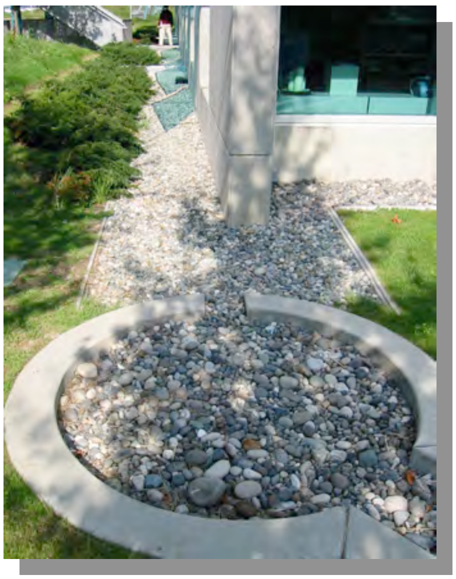
Operating Cost Implications

There is little operating cost implication versus traditional roof design.

Channeling Rainwater From Roofs to Bioswales

Design Criteria

Roof water is traditionally directed to storm drains and then to the main storm sewer system. A more ecologically based solution is to direct stormwater to bioswales and biofiltration ponds to remove suspended solids, to slow the rate and quantity of rainwater flow, and to promote on-site stormwater infiltration and groundwater recharge.



The pictures above show roof water directed to a gravel lined pit. This allows for some stormwater retention during minor rain events and reduces some of the peak flows. Once the pit is full the rainwater is channeled to the bioswales.

Rather than using a concrete channel approach an enclosed concrete drain, French drain, drain pipe or small swale could be used to direct the stormwater to the bioswales. The approach above was largely taken to provide a visual display of the treatment provided.

Benefits and Considerations

The approach above reduces the rate and quantity of stormwater flow and if small swales are used rather than concrete channels, then there is the additional benefit of filtration and treatment prior to reaching the main bioswales.

Capital Cost Implications

Depending on the technique used there can be a capital increase or decrease. The open concrete system in the pictures above is more expensive then a simple drain pipe, French drain or small swale. The latter approach would be cheaper then an underground storm drains attached to a major storm system.

Operating Cost Implications

An open concrete system above would have to be monitored for clogging from landscaping debris, leaves etc. This would be reduced if an enclosed drain or French drain system was used. From a maintenance perspective this approach is likely cheaper as compared to underground storm systems which have to be cleaned from time to time because of clogging, root penetration etc.

Vegetated "Green" Roofs

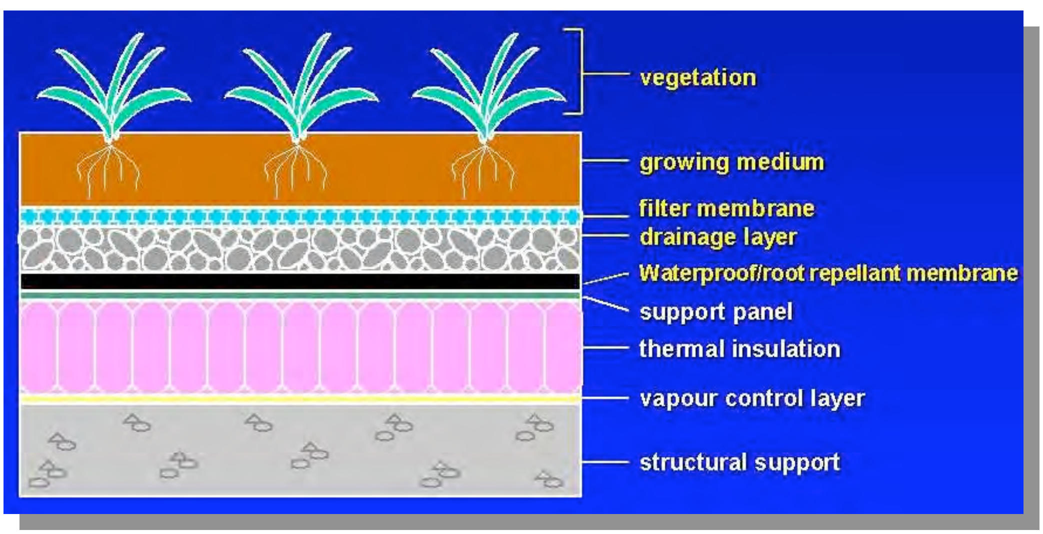
Design Criteria

Vegetated green roofs are currently used extensively in Europe as a way to save energy, reduce the "heat island" effect of urban areas, improve the livability of urban environments and reduce stormwater runoff from rooftops.

There are two types of green roofs, intensive and extensive. An intensive green roof requires a minimum of 1 foot of soil depth and supports a garden that contains trees, shrubs, and other manicured landscapes. This type of roof can add 80-150 lbs/sq. ft. to the roof and require intensive maintenance. In order to safely support the added weight, the building may require additional load bearing capacity.

An extensive green roof requires 1 to 5 inches of soil depth and mainly supports shallow root plants and typically resembles a meadow. It is not designed to support pedestrian traffic and does not require much maintenance. It adds a load of typically 15-50 lbs/sq. ft. These types of roofs typically do not require structural modifications.

As the figure below shows, a typical green roof has a rubber or plastic waterproof liner laid over the traditional rooftop. Either above or below the waterproof layer is a layer of insulation material such as perlite. Over or at the end of the insulation layer, a drainage layer may be added, depending on the pitch of the roof. Finally, a thin layer of soil mix is added and planted with grasses, ground covers or drought tolerant plants.



Source: National Research Council, Institute for Research in Construction

There are many green roof systems available on the market: American Hydrotech Inc., Roofscapes Inc., Roofmeadow , Weston Solutions, Inc., GreenGrid™ Systems and Soprema systems.

Vegetated roof installation involves the creation of a complete, contained plant growing system on a roof surface. The roof surface can be at any height – both below and above grade – but the plantings are made in the roof system rather than in the ground. The plantings are made in the specialized green roof system and structure, not in pots or planters that are separate structures.

The green roof structure is similar to most roofing systems in that it consists of a series of materials in layers designed to protect the building from the elements. The difference between traditional systems and green roofs are the types of layers.

Benefits and Considerations

Increased stormwater retention
Instead of stormwater landing on a roof surface, flowing down it, and being directed into a stormwater system, water is retained by the growing media on the green roof and absorbed into plants. A grass roof with a 4 – 20 cm layer of growing medium can hold 10 – 15 cm of water, and green roofs can retain 70-80% of summer precipitation and 25-40% of winter precipitation. This retention function delays the time when runoff occurs, often delaying peak flows after storm events have peaked, thus reducing stress on sewer systems.

Reduction of heat island effects, (especially important in urban areas):
The heat island effect is seen in urban areas where waste heat accumulates in the urban core resulting in a higher overall temperature than surrounding, more rural or undeveloped areas. This accumulation of waste heat is a result of many urban activities – transportation, the nature of built surfaces, heating and ventilation systems, etc. Traditional roof surfaces tend to absorb solar energy and re-radiate it as heat, thus contributing to the heat island effect. Green roofs have an opposite effect as they tend to absorb heat and use it for biological processes that instead help to cool the urban surroundings.

Improved water filtration
Green roofs act as natural water filters, with plants and growing media filtering out some of the suspended solids and pollutants found in rainwater. These features make any green roof water that runs off much healthier for the receiving environment.

Reduced need for interior building insulation due to insulating effects of the green roof
The natural process of evapotranspiration – where plants use heat energy from the sun to evaporate water – helps to cool the building on a hot day. Plants can also provide building shading from the sun, as the leaves form a reflective "umbrella" of sorts that prevents solar energy from reaching the building surface. The insulating effects of the green roof materials and the plants can reduce heat escape from the building interior during the colder months. This insulating effect also provides a sound buffer, making green roofs a great way to quiet a buildings interior from exterior noise.

Provision of habitat
Green roofs often become habitat for some living organisms, especially insects and birds. They can be specifically designed for this purpose. Certain plant species can be chosen to create habitat for specific plant and animal species.

Provision of recreation and community space
Some green roofs are used as recreational spaces, depending on their design.

Capital Cost Implications

An intensive green roof is expensive as the added weight requires additional load bearing capacity. In contrast, an extensive green roof adds a load of typically 15-50 lbs/sq. ft. These types of roofs typically do not require structural modifications. The premium cost on extensive roof systems is approximately $4 per square foot.

Operating Cost Implications

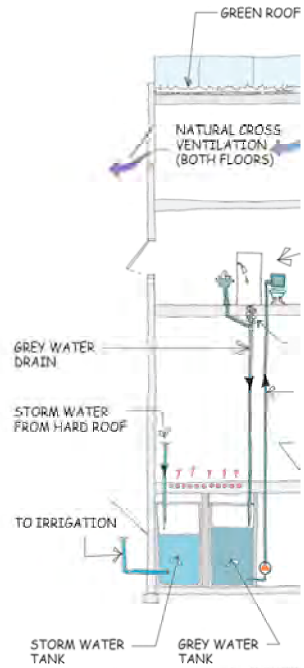
Green roofs are typically expected to last twice as long as a comparable conventional roof. Plant material selected should be native, drought tolerant and low maintenance such as sedum.

Maintenance consists of weeding unwanted herbaceous plants and young woody plants, and collecting cuttings. Watering may be required during prolonged dry spells.

Rain water Collection for Irrigation or Flushing toilets

Design Criteria

This generally requires a roof collection system that channels stormwater to a storage device (e.g. cistern, underground tank, concrete storage tank). Depending on design, pumping will likely be required to utilize the water for flushing toilets (with dual plumbing also required) or irrigation.



The system (collection and storage) should be designed and sized based on calculations of water volumes required for desired stormwater uses, and the capacity of the system and of local rainfall to meet the demands.

An overflow discharge system is required for times when rainfall collected exceeds the storage capacity. A potable water supply to the storage tank or cistern with a float system may be desirable to top up rainwater stored in tanks particularly when using rainwater to flush toilets. This avoids duplicated plumbing lines to toilets and allows for a backup water supply when demand exceeds the stored rainwater capacity.

Benefits and Considerations

Besides reducing stormwater runoff there is the added benefit of reducing potable water used for flushing toilets and/or for irrigation.

This strategy reduces demand for local potable water supplies, potable water distribution infrastructure and stormwater infrastructure. It also reduces peak stormwater flows through collection and use of the stormwater rather than discharge .

Local government approvals are required and approval is largely dependent on a cooperative plumbing inspector.

Capital Cost Implications

When combined with reduced stormwater flows and lifecycle costing the benefits of rainwater reuse becomes more attractive. Consistently rising water prices must be factored into the lifecycle cost analysis for this system, as it helps futureproof building systems for many years to come due to the consistently lower rates of potable water consumption. There will be some additional plumbing costs, and there may be a cost associated with purchasing storage tanks (these can sometimes be found or made quite cheaply) compared to a traditional plumbing system.

The new Technology Enterprise Facility on campus utilized a underground storage tank to release stormwater on a slow release basis to reduce peak flows and stormwater. This is not a very cost effective approach given the option listed above. Instead it is more ecologically and fiscally effective to have a sealed tank and utilize that water for toilet flushing and irrigation with a stormwater overflow mechanism sending excess water to a bioswale or the main storm system.

Operating Cost Implications

There are few operating cost implications other than pump maintenance, and a major cost savings due to the reduction of potable water use in favour of stormwater consumption.

C. Hard and Soft Landscaping Practices

Hard Landscaping Treatments

Design Criteria

Porous concrete, paving stones, gravel or grass pave and porous asphalt all can be used to reduce stormwater runoff in hard landscaped areas. Wherever possible design sidewalks to follow site contours and encourage sheet flow of stormwater to adjacent vegetated areas. Disconnect sidewalks from the roadway with a bio swale area in order to prevent runoff.

If hard landscaped areas are located over a clay base, consider sloping sub base toward the bioswales to remove excess stormwater not stored in the granular material below the hard landscaping.

Benefits and Considerations

The benefit is the reduction of stormwater runoff. These reductions can be maximized by using the most permeable material applicable to the site, like porous concrete rather than porous asphalt, which is also not as environmentally friendly as concrete. Several of the alternatives proposed have additional benefits like aesthetic appeal, stormwater treatment, and reduced heat island effects.

Capital Cost Implications

This depends on site conditions and the type of material selected *e.g.* porous concrete costs more than porous asphalt. These surface and sub-surface design features for removal of excess stormwater cost less when compared to more traditional underground drainage systems.

Operating Cost Implications

Porous material should be monitored for clogging and may require vacuum sweeping and/or power washing from time to time.

Native and Adaptive Landscaping Treatments to Reduce Potable Water Use and Runoff

Design Criteria

Plant selection is very important in landscaping design and to reduce potable water used for irrigation. Avoid mounded landscape beds as this results in the runoff of suspended solids from landscaping during prolonged rain events.

Careful attention should be paid to plant choices and their short- and long-term irrigation needs. In most cases if native and adapted plant species are selected, irrigation will only be needed to establish the plants in the first few years after planting. If planned well, these temporary irrigation systems can use collected stormwater instead of potable water for irrigation and greatly reduce the need for potable water for the site over the long-term.

Benefits and Considerations

Water used in plant systems through evapotranspiration is a way of reducing stormwater runoff. If stormwater is channeled through planted landscapes, water will be taken up by the plants and reduce both total and peak flow volumes of stormwater. This can also be used to moderate microclimates, as the evapotranspiration process can cool landscapes in summer months.

Capital Cost Implications

Use of native plants can dramatically reduce the need for an irrigation system thus saving capital dollars.

Operating Cost Implications

Native landscaping can be cheaper to maintain and has reduced operating and maintenance costs. If treated well, native plants will require smaller amounts of fertilizer (depending on soil conditions), water, and should survive extreme weather events better than introduced, non-native species.

Deep well Injection and/or Infiltration Trenches

If there are areas of highly permeable soils then deep well injection or infiltration trenches can be used to infiltrate excess stormwater into the ground. This is particularly effective when used in conjunction with other strategies that are already reducing the rate and quantity of stormwater flows.

Stormceptors

This is a technology used for the treatment of stormwater rather than for a reduction in quantity. This treatment is appropriate in situations where bioswales or green roofs are not used and a treatment option is required for contaminants. A stormceptor is an oil, grit and sediment (OGS) separator for stormwater runoff and spill control. Comprised of a round pre-cast concrete tank and fiberglass partition with its treatment based on gravity separation. The system purports to remove fine sediments of >20mm (80% of annual TSS), and to separate up to 97% of oil from stormwater runoff and spills.

D. LEED™ USGBC and LEED™ BC Green Building Rating Systems

Campus Plan Land and Building Policy Direction #3 Green Guidelines: "…Future buildings, including materials, will be designed using the LEED rating system, or Canadian equivalent appraisal system."

The Canada Green Building Council (CaGBC) was formed in the summer of 2003 and has signed a licensing agreement with the United States Green Building Council (USGBC) to utilize the Leadership in Energy and Environmental Design (LEED™) green building certification system in Canada. More information about the US and the CaGBC and the different LEED programs for different building project types can be found on the following websites:

www.usgbc.org

www.cagbc.org

The implications of this are that all LEED™ projects in Canada will in the future be certified in Canada by a Canadian review committee. Project seeking LEED™ certification are currently registered and reviewed by the USGBC. the LEED™ Canada rating system and structure is expected to be approved early in 2004 for use in Canada. LEED™ BC will simply be a supplement to LEED™ Canada for regional variations specific to British Columbia.

Registering and certification of LEED™ BC projects is expected to be administered by the Canada Green Building Council (CaGBC) by the first quarter of 2004. The implications to UVIC are that the Engineering/ Computer Science Building and any subsequent potential LEED™ buildings will be registered with the CaGBC beginning in 2004 to ensure that they are certified under the CaGBC banner.

Listed below are the four credits in LEED™ relating to stormwater techniques. The first is a prerequisite, meaning that this credit must be achieved to get a LEED™ certification.

The only difference between the United States Green Building Council (USGBC) LEED™ rating system and the LEED™ BC system with respect to these credits is that an additional prerequisite has been added for streamside protection in the BC version.

Site Prerequisite 1: Erosion and Sedimentation Control

Required

Intent
Control erosion to reduce negative impacts on water and air quality.

Requirement
Design a sediment and erosion control plan, specific to the site, that conforms to United States Environmental Protection Agency (EPA) Document No. EPA 832/R-92-005 (September 1992), *Storm Water Management for Construction Activities*, Chapter 3, OR local erosion and sedimentation control standards and codes, whichever is more stringent.

The plan shall meet the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation of storm sewer or receiving streams and/or air pollution with dust and particulate matter.

Commentary:

This prerequisite does not have significant implications for UVic as the requirements of local municipalities are consistent with LEED™ requirements. It essentially requires adoption of an erosion and sedimentation control plan for the project site during construction employing strategies such as temporary and permanent seeding, mulching, earth dikes, silt fencing, sediment traps, sediment basins and protection for wind erosion for stockpiling of soils.

Site Prerequisite 2: Riparian-wetland protection

Required

Intent
To protect freshwater riparian ecosystems within British Columbia.

Requirement
Until such time that the Streamside Protection Regulation of the BC Fish Protection Act is operational:

- Comply will the streamside protection areas in urban areas as determined by the Streamside Protection Regulation of the BC Fish Protection Act,

OR,

- Provide evidence that the proposed development (buildings, infrastructure and landscaping) encroaches within setback distances as determined by the Streamside Protection Regulation of the BC Fish Protection Act, it contributes to the increased health and stability of the watershed within which the site is located to a standard of "no net loss" or preferably, "net ecological gain" as authorized by DFO.

Potential Technologies & Strategies

- Strategies include maintaining appropriate buffers, preserving critical or sensitive riparian areas, and designing landscaping to provide riparian ecological services (such as shade, nutrients, runoff filtering, flow control, ponding etc.); riparian-wetland areas must be designed to restore and maintain their proper functioning condition to the highest capability possible.
- Provide designated crossing areas or footbridges in high traffic areas; all riparian-wetland crossings must be designed to protect the system's functional condition.

Commentary:

The LEED™ BC prerequisite for riparian-wetland protection is also not thought to be a major issue for UVic projects, and allows for some options other than simply meeting setback requirements if can be demonstrated that there is not net ecological loss of habitat.

Site Credit 6: Stormwater Management

1-2 points

Intent
Limit disruption of natural water flows by minimising stormwater runoff, increasing on-site infiltration and reducing contaminants.

There are two (2) sub-credits for the Stormwater Management credit:

- *Credit 6.1:* Rate and Quantity (1 point)
- *Credit 6.2:* Treatment (1 point)

Site Credit 6.1: Rate and Quantity
1 point

Requirement

- If existing imperviousness is less than or equal to 50%, implement a stormwater management plan that prevents the post-development 1.5 year, 24 hour peak discharge rate from exceeding the pre-development 1.5 year, 24 hour peak discharge rate.

OR,

- If existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff.

Potential Technologies & Strategies
Design the project site to maintain natural stormwater flows by promoting infiltration. Specify garden roofs and pervious paving to minimize impervious surfaces. Reuse stormwater volumes generated for non-potable uses such as landscape irrigation, toilet and urinal flushing and custodial uses.

Commentary:

These credits are not required, but are consistent with the recommendations of this stormwater plan. These LEED™ credits are achievable with the stormwater techniques listed above. Furthermore, if SS credit 6.1 is exceeded there is the potential for an innovation point to be earned. For instance, with respect to the Engineering/Computer Science Building, the techniques being planned for this site will decrease the rate and quantity of stormwater runoff well in excess of the 25% requirement. The stormwater management techniques recommended for this project at the design stage are expected to decrease the rate and quantity of stormwater runoff for a 1.5 year, 24 hour peak discharge rate by 100% as compared to the predevelopment conditions. This is well in excess of the 25% requirement and would thus, in all likelihood, earn an innovation credit.

Integration of systems

There is often an opportunity to use stormwater management techniques to simultaneously reduce potable water use. For instance, collecting rainwater in tanks for reuse in flushing toilets will reduce stormwater flows while reducing operating costs to UVic by allowing the University to purchase a smaller quantity of potable water. Alternatively, water stored in biofiltration ponds can be used for irrigation or as backup fire suppression system.

In addition, a combination of techniques can be used on buildings where one solution does not fit all. The project team for this report had the opportunity to meet on several occasions with the project team for the Engineering/Computer Science Building. Several recommendations were made and are discussed in Appendix C as a case study.

Section 7- Data Gaps & Future Research Needs

In order to fully address stormwater management on the UVic campus in an integrated fashion over the long-term, further information needs to be collected. Fortunately, UVic possesses an excellent resource, its faculty and students, who can take on take on the task of collecting and synthesizing some of the needed information in a very cost-effective manner. Students would have the opportunity to conduct research and collect data that would be directly applicable to a real-world management scenario, while UVic campus managers obtain useful information. The intent of these projects would not be to add additional workload to faculty, but rather to provide some applied projects/topics in which their classes and graduate students they might actively engage with the campus.

Campus Plan Action #6 aims to produce a campus-wide ecological inventory. Student projects and data management should be co-ordinated through the Sustainability Office, to ensure consistency and quality of data. Standard data collection formats must be established and resources must be dedicated toward maintaining the database. This task could be undertaken by a co-op student under the direction of the Sustainability Office. Ideally, the data formats chosen should be consistent with those used on campus and by neighbouring municipalities and the CRD. Hard copies of the new data, as well as existing data, should be archived in Special Collections at the McPherson Library. As technology and data storage formats change, paper copies often become the only accessible source of specific data. As an example, biological data stored at the BC Ministry of Environment on large reel tapes only 20 years ago is now inaccessible because it was not transferred to a new format and the hardware required to read the tapes no longer exists in British Columbia.

The UVic Sustainability Project (UVSP)

The UVSP could be a valuable link between the campus managers and faculty and staff, with respect to collecting stormwater information. The UVSP houses a resource library and class project ideas list that could be expanded and targeted towards stormwater issues under the direction of Facilities Management.

The UVSP has also begun the Campus Information Management System initiative that aims to integrate the research and learning activities of students and faculty with the decision-making and planning activities of UVic's administration and FMGT. The intent of this initiative is to establish a database consisting of all existing information about UVic lands and use student and faculty research to support the land management activities of Facilities Management, following established protocols for collecting, storing and reporting ecological information. Toward that end, UVSP is currently working to identify the research needs, identify current courses/projects and research relevant to FMGT's information needs, and create standards for students and researchers to use by collecting and preparing established protocols for gathering, storing and reporting ecological information.

The Campus Information Management System initiative supports the following Campus Plan Action Items: #6- More Environmental Study, #7- Restoration Projects, #11- Impact Studies, #23- Stormwater Management

Suggested Student Projects:

1. Field Data Collection for Hydrological Model Calibration

There is a need to collect additional flow data in order to accurately calibrate the hydrology model for campus. While this could not be left entirely to students, students could assist by providing supplementary data either in terms of more frequent data collection or by gathering data from additional sites. Facilities Management could establish a protocol and basic schedule which would remain constant, regardless of student involvement and students could then supplement this program.

Continuous flow monitoring stations are required at the following locations:

- Bowker watershed; at, or near, the entrance to the culvert under Gordon Head Road
- Hobbs Watershed; at the outlet of the culvert under Cedar Hill Cross Road which conveys flow from Oak Bay into Mystic Vale
- Cadboro watershed, on the inlet to Manhole No. 4102 in the Model Schematic

2. Terrestrial Ecosystem Mapping (TEM)

Current vegetation community information has been compiled by the University of Victoria Sustainability Project. Terrestrial Ecosystem Mapping has been completed for the Bowker Creek Headwaters. There is the potential for further TEM mapping to be completed by UVic students provided an appropriate QA/QC program is followed. TEM would provide a useful inventory and mapping of vegetation resources for the University. This could be used to further define potential areas to receive and treat stormwater, as well as identifying areas that would be most harmed by the addition of stormwater.

This project supports Campus Plan Action Item #6 "…Complete an ecological inventory and map of the entire campus…"

Dr. Richard Hebda's classes in the Restoration of Natural Systems Program currently learn TEM mapping skills and could be approached for assistance with this project.

3. Soils Inventory

During the preparation of this Integrated Stormwater Management Plan, it became apparent that a complete map of the surficial soils and underlying geology does not exist for the campus. Numerous cores have been taken around campus in conjunction with building construction and these data are housed with Facilities Management, There is a need to assemble this information into a single, comprehensive database and map in order to identify gaps and provide direction on the siting of future stormwater facilities.

This project supports Campus Plan Action Item #6 "…Complete an ecological inventory and map of the entire campus…"

This project could be undertaken by a Geography co-op student.

4. Photopoint Monitoring Of Vegetation Changes At The Bowker Creek Wetland

The composition of the vegetation in the Bowker Creek headwaters has changed over recent years due to water level fluctuation. Photopoint Monitoring (PPM) is a standardized method of tracking these changes that is cost-effective and easily done by students. Initial photographs were taken by Dr. Don Eastman's class in the Restoration of Natural Systems program in April of 2003. It is critical that complete PPM protocols be followed including duplicate photos and archiving. The photo archive should be maintained in Special Collections at the McPherson Library.

5. Low Impact Development Practices

Many Low Impact Development practices are new to Southern Vancouver Island and their effectiveness in UVic's climate has not been thoroughly assessed. There is great potential for construction of pilot-scale stormwater management projects that could then be studied by students in order to determine which types of facilities/structures will be most effective at UVic. For example:

a) Testing of the durability and effectiveness of different porous paving materials. An example of a test facility is shown below:

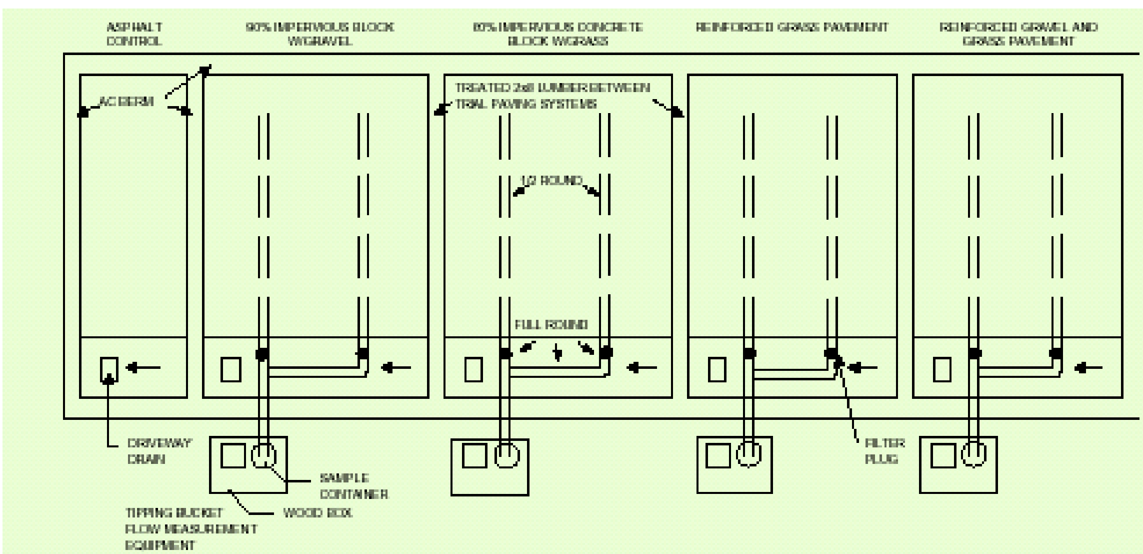


Figure 2. Schematic of the test facility showing treatments and runoff collection devices.

Source: EPA-841-B-00-005B (USEPA, 2000)

b) Water quality monitoring of contaminants in Hobbs Creek, Bowker Creek and Finnerty Creek;

c) Water quality monitoring of water discharged from stormwater facilities; and

d) Water quality and runoff characteristic monitoring of green roofs.

While water quality analysis can be expensive if undertaken at a commercial lab, both the Chemistry Department and Biology Department have the appropriate equipment to undertake nutrient, metals, and organic chemical analysis. UVic should approach the CRD to determine whether this testing could be undertaken co-operatively as supporting information for the new CRD stormwater bylaw.

6. Air, Ground And Water Temperature Monitoring To Assess Heat Island Effects And Energy Consumption

Inexpensive data logging thermistors could be installed in parking lots, on building roofs in vegetated areas, in the forests and on (new) green roofs to determine what effect parking lots and other impervious, low albedo surfaces are having on the air, ground and water temperature. A model could then be constructed to determine the effects of replacing conventional roofs with green roofs, impermeable paved surfaces with permeable surfaces and providing shade with additional trees. This data could be compared to energy consumption for heating and cooling within the buildings to assess the cost-benefit of retrofitting the campus.

7. Monitoring Of Groundwater Level

Simple piezometers could be installed throughout campus in order to track water table levels and groundwater recharge. In the Bowker Creek headwaters these data could be linked to the photopoint monitoring of the vegetation in order to assess the effect of water level on vegetation health.

Section 8- Education Needs

Education of faculty, staff, students, contractors and the public is critical if stormwater management is to succeed on campus. Many people have no knowledge of stormwater and do not recognize that all stormwater on campus is discharged into either Bowker, Hobbs or Finnerty Creek or to Cadboro Bay.

CAMPUS-WIDE EDUCATION

Many municipalities have undertaken storm drain marking programs in which a fish is painted near the drain to remind people that substances placed in the storm drain will end up in a nearby creek. This is a good first step and is an especially valuable to remind contractors who may have paint, concrete or muddy water to dispose of.

Signage near stormwater management facilities is especially helpful. An example of a sign at the Oregon Museum of Science and Industry is shown below:

Source: Aqua-Tex, 2003

There are many sources of pre-written and customizable documents for public stormwater management education. Many documents are available on the web. Two that are particularly helpful are the USEPA and Center for Watershed Protection. Their website addresses and other useful sites are listed below:

USEPA Stormwater Outreach Materials:
http://cfpub.epa.gov/npdes/stormwatermonth.cfm

Center for Watershed Protection:
www.cwp.org

Low Impact Development Center Publications:
ftp://lowimpactdevelopment.org/pub/

Non-Point Source Education for Municipal Officials:
http://nemo.uconn.edu/publications/index.htm

Sample brochures and other educational materials are provided on CD in Appendix F.

Facilities Management Staff

Facilities Management staff are responsible for maintaining the land and buildings on campus including any existing or proposed stormwater management facilities on-site. Given their extensive knowledge of the campus, it will be essential to obtain the input of facilities management staff in the design of new stormwater facilities. In addition to written maintenance materials, staff will require training on-site in order to work out any potential maintenance issues and provide an opportunity to discuss the rationale behind the stormwater management program.

There are many operational stormwater facilities including bioswales, wetlands, detention ponds, stormceptors, Grass and GravelPave parking lots, permeable pavers and porous concrete pavement within the District of Saanich. Saanich Parks and Engineering have contacted Aqua-Tex for assistance in training staff to maintain these facilities. UVic could conduct joint training with Saanich and use the opportunity to view existing installations. This would allow staff to consider how they might be modified for use at UVic and alleviate potential concerns about their maintenance requirements.

Section 9- Conclusions and Recommendations

Conclusions

Vegetation

- The Lam Circle Ravine has the potential to accommodate stormwater detention.
- Area 2 of the Bowker Creek drainage near the University Club, could receive additional stormwater drainage without affecting the surrounding vegetation.
- Some vegetation in the Bowker Creek West area will not tolerate increased surface or groundwater flow, particularly in Areas 13, 11 and part of 8. If more water is added to Area 4 (completion of the Engineering/Computer Science and Island Medical Buildings and stormwater flow from these towards Bowker Creek), the upland species (Douglas-fir and Garry oak) in Area 11 are likely to succumb to the change to a wetland area that is already underway.
- In Area 8, big leaf maple and conifer species (Douglas-fir and grand fir) are dead and dying along the trail at the north end of Parking Lot 8. This is possibly due to increased drainage from Areas 6 & 7, and Parking Lot 8.
- No additional stormwater should be diverted into Area 15 near Cunningham Woods unless it can be transported to the wetlands on either side of Ring Road. This could include bioswale overflow from the ECS building.
- The cause of the large area of dead and dying trees (Douglas-fir and grand fir) at the centre of Area 15 of Cunningham Woods, and the general decline of overstorey conifers in this area needs to be investigated.
- There is potential for stormwater detention in the ravine in Area 21of Upper Hobbs Creek/South Woods. A stand pipe with small holes (for detention) on the end of the culvert would allow stormwater to pool and infiltrate into the area.
- The dogwood /willow thicket in Area 17 and leading into Area 20 (Engineering/ South Woods) has the potential to receive further stormwater drainage, but more examination of the storage capability would be required.
- Established and unauthorized trails throughout Mystic Vale are compacting soil and in some cases directing water flow to areas where damage is occurring. Decommissioning of some of these trails should be considered

Hydrology

- At the present time, approximately 23.5% of campus is impervious area such as roofs, roads, sidewalks and parking lots compared to 12.2% in 1956. Additional water is diverted by subsurface drainage systems from playing fields into the storm drain system. This has resulted in a doubling of the runoff volume to both Bowker Creek and Hobbs Creek.

- Surface infiltration on the UVic campus is generally low. The soils along the eastern side of the University are silt clay till intermixed with sand. The upper layer is Vashon till which has low permeability and this is underlain by the moderately permeable Quadra layer. An area south of the Ring Road and within the upper drainage area of Hobbs Creek generally consists of Victoria Marine Clay, which is very stiff to hard near the surface and has very low permeability. Bedrock surfaces in the southwest corner of the campus, near the main entrance but elsewhere the bedrock is relatively deep. Sites for stormwater infiltration and effective groundwater recharge are therefore limited; however, detention and treatment are still possible in these areas.

- The Bowker Creek watershed has changed in area as a result of urban development. The drainage areas west of Gordon Head Road and south of Cedar Hill Cross Road have been reduced. Hobbs Creek now receives most of the runoff from the area south of the Cedar Hill Cross Road. This caused an increase in impermeable area from 0% in 1956 (without diverted drainage) to 31% in 2003 (with diverted drainage).

- In 1956 approximately 1.6% of the Bowker Creek drainage was impermeable; in 2003 51% of the drainage is covered by impermeable surfaces.

- The Finnerty watershed has been the least affected by campus development. Impermeable area increased from 48% in 1956 to 61% in 2003.

- The Cadboro watershed is now experiencing reduced runoff. The decrease in Cadboro runoff has been caused by the transfer of drainage areas to Bowker and Hobbs Creeks.

- Peak flow rates have increased by a factor between 2 and 3 between 1956 and 2003 on all watersheds except Finnerty where a 30% increase in flow rate has been estimated

- The reduction of current stormwater volumes and flow rates can be achieved by retrofitting stormwater Best Management Practices into the present drainage system. The principal methods for reducing volumes and flow rates are increasing infiltration and detention storage.

- The use of infiltration facilities or soil amendments to increase infiltration may be feasible at selected locations where the surficial soils or soils at shallow depth have significant proportion of sand or gravel but these methods for stormwater management are not recommended for general application within the campus area.

- Sub-surface investigations will be required to confirm the effectiveness of potential sites for infiltration facilities.

- The increase of detention storage by open water or dry ponds will reduce runoff rates but not volumes.

- Widespread, small depressions, swales and detention storage below parking lots could provide the necessary storage, would have a low visual impact and only minimally reduce the land available for uses other than water storage.

- The stormwater simulation model demonstrates that it is possible to increase detention to reduce peak runoff rate by 10 to 20% in each of the major watersheds. This could be accomplished by:

  - In the Bowker watershed storage depression storage equivalent to storing a depth of 3 mm of rainfall over the pervious areas and converting Parking Lots 4, 6, 8 and 10 into sub-surface, rockfill water storage facilities would store 9,000 m^3 over these four parking lots and reduce runoff by 23%.

  - For the Cadboro watershed, the use of Parking Lot No. 5 as a storage structure holding 500 m^3 of runoff is feasible which would reduce runoff by 19%.

  - Parking Lot No. 1 can be modified to hold 1,000 m^3 to provide the required storage in the Hobbs watershed and reduce runoff by 15%.

  - Stormwater management in the Hobbs watershed should be a shared responsibility of the District of Oak Bay and the University. Almost one-half of the drainage area of Hobbs Creek is located south Cedar Hill Cross Road. The area within Oak Bay includes the Henderson Golf Course and extensive residential development. The runoff from Oak Bay flows under the Cedar Hill Cross Road to Mystic Vale.

  - It will take a great deal of time to arrest the erosion in Hobbs Creek. Heavy rains in October 2003 caused significant erosion and have caused the pond at the mouth of Mystic Vale to once again fill with sediment. The University should work with local residents to acquire this pond and then restore its functional habitat sometime in the future once excessive erosion in Hobbs Creek has been stopped. The pond would be a logical addition to the Mystic Vale lands.

  - If the 2003 Campus Plan were fully implemented and all the proposed buildings were constructed, this would result in a 3.1% increase in impervious area and corresponding increase in runoff of between 0 and 4% for each watershed. The siting of nine of these buildings on existing parking lots reduces the hydrologic impact of the campus development. Implementing LID techniques would reduce the increase by about 10% in Bowker and Cadboro watersheds but would not significantly alter runoff in the Finnerty or Hobbs watersheds.

- In summary, the changes in the stormwater hydrology caused by the development proposed in the 2003 Campus Plan are relatively small and the development can produce a reduction in runoff rates and volumes over the period of the rainstorm if the recommendations in this report are implemented.

RECOMMENDATIONS

The University should:

1. Formally receive this Plan and use it as the basis for future specific planning and visionary programs.

2. Implement a strategy for ensuring that all new construction works including building construction or renovation, rerouting of pathways or roadways, landscaping and parking lots, have the BMP options applied to the design and construction practices.

3. Ensure the new development and redevelopment is compliant with current and future municipal stormwater bylaws and codes and practice.

4. Ensure that the natural storage area at the headwaters of Bowker Creek are preserved for stormwater management.

5. Work with the Bowker Creek Watershed Management Plan Steering Committee, the Districts of Oak Bay and Saanich, and the CRD towards fulfilling the community vision for the Bowker Creek watershed.

6. Wherever possible, detain stormwater before it leaves the Campus.

7. Wherever possible, ensure designs of future buildings employ methods of reuse for stormwater.

8. Continue to apply stream enhancement techniques to Mystic Vale and Hobbs Creek to reduce the amount of stream damage resulting from high storm discharges.

9. The University should work with local residents to acquire the pond at the terminus of Mystic Vale and then restore its functional habitat sometime in the future once excessive erosion in Hobbs Creek has been stopped.

10. As designs for on-site projects progress, ensure that the impermeable areas of the Campus are reduced to permit reduction in off-site stream discharges.

11. Embark upon a stormwater education program.

12. Create guidelines for silt and sedimentation control for all future construction projects on Campus.

13. Participate with the University faculty in using the stormwater programs on the Campus as educational tools and as research opportunities for student studies.

14. Wherever possible, co-ordinate opportunities to partner stormwater projects with students and community groups to enhance basic knowledge and health of the local stormwater systems.

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Glossary

Bioswale- a generic term for a vegetated swale or grass swale, either wet or dry.

BMP- Best Management Practice

Catchbasin- structural facility located just below the ground surface, used to collect stormwater runoff for conveyance purposes. Generally located in streets and parking lots, catch basins have grated lids, which allow stormwater from the surface to pass through for collection.

Detention- holding back stormwater flow in order to slow its progress toward a water body.

Drainage basin- a specific area that contributes stormwater runoff to a particular point of interest, such as a stormwater management facility, stream, wetland, or pipe.

Drainage channel- this type of open channel is solely designed to have enough capacity to safely convey runoff without erosion. Unlike a swale, it is not designed to treat runoff, but rather only to convey it.

Dry swale- dry swales are designed to completely store the runoff volume from the water quality storm event and filter it through soil before it is collected by and underdrain. Dry swales therefore contain standing water only for a very short period.

EIA- Effective Impermeable Area. The area of impermeable surface whose runoff is directly connected to a stream or receiving water body, usually via a storm drain system. EIA is the total impermeable area (TIA) minus those areas which are not connected to a stream or water body. For example, the total combined impermeable area of a typical residential lot would include the house roof, sidewalk and driveway which drain into subsurface drains and catch basins before entering the storm drain system. If the roof leaders were disconnected and the water from the roof was discharged on to the lawn where it could infiltrate the soil, the effective impermeable would be the total impermeable area minus the roof area.

First Flush- During dry periods, pollutants accumulate on hard surfaces. When they are washed off by rain after a prolonged dry period (for example in the fall after a dry summer), this is termed “first flush”.

Grassed channel- grass channels are difference from drainage channels in that they are designed to meet runoff velocity targets under three storm conditions- a water quality design storm, the two year design storm and the ten year design storm. Grassed channels are also called biofilters.

Grassy swale- a long, narrow trapezoidal or circular-shaped channel, planted with a dense grass mix. Stormwater runoff from impervious surfaces is directed through the swale, where water velocity is slowed and in some cases infiltrated, allowing pollutants to settle out.

Green roof- a lightweight, low-maintenance, vegetated roof system used in place of a conventional roof. Also called eco-roofs, green roofs provide stormwater management by capturing, filtering and evaporating rainfall.

Hydrology- The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Impermeable/ Impervious surface - any surface that has runoff coefficient greater than 0.8 (>80% of the water falling on the surface will run off). Types of impervious surface include rooftops, traditional asphalt and concrete parking lots, driveways, roads, and sidewalks. Gravel surfaces are considered pervious unless they cover impervious surfaces or are compacted to a degree that causes their runoff coefficient to exceed 0,8.

Infiltration- the percolation of water into the ground.

LEED™- Leadership in Energy and Environmental Design. A rating system for buildings that was first developed by the U.S. Green Building Council (USGBC) and has now been adapted for use by the Canadian Green Building Council (CaGBC) as well as adapted further for use in British Columbia.

LID- Low Impact Development.

Permeable- able to have water pass through into the groundwater.

Pollutant- an elemental or physical product that can be mobilized by water or air, and creates a negative impact on the environment. Pollutants include suspended solids (sediment) heavy metals (such as lead, copper, zinc and cadmium), nutrients (such as nitrogen and phosphorus), bacteria and viruses, organics (such as oil, grease, hydrocarbons, pesticides, and fertilizers), floatable debris, and increased temperature.

Retention- keeping stormwater on-site such that it is infiltrated, evaporated, or evapotranspirated.

Runoff coefficient- a number expressed as a decimal or a percentage that describes how much water will run off a site or surface e.g. a runoff coefficient of 1.0 indicates that 100% of the water will run off.

Runoff- stormwater which flows across the ground surface during and after a rainfall or snowmelt event.

Run-on- stormwater which originate in an upstream watershed or catchment. It is often conveyed between watersheds through a piped storm drain system.

Stormwater- Stormwater is precipitation (rain and snow melt) that cannot soak into impervious areas such as paved streets, parking lots, and building rooftops during rainfall and snow events and therefore “runs off” the land into neighbouring waterways. Stormwater runoff often contains pollutants in quantities that could adversely affect water quality.

Stormwater management- The overall collection of techniques used to reduce pollutants from, detain and/or retain, and dispose of water to best preserve or mimic the natural hydrologic cycle. Public health and safety, aesthetics, maintainability, capacity of existing infrastructure and sustainability are important characteristics of a site’s stormwater management plan.

Swale- a shallow channel with at least a 3:1 sideslope which is designed to force water to flow as sheetflow along its length. A swale in usually planted with grasses and/or other dense vegetation which will slow the flow of water and trap sediment and other pollutants. There are two basic types of swales which are used for treating stormwater runoff– dry swales and wet swales.

TIA- Total Impermeable Area.

Vegetated swale- a long, narrow trapezoidal or circular-shaped channel, planted with a variety of trees, shrubs and grasses. Stormwater runoff from impervious surfaces is directed through the swale, where water velocity is slowed and in some cases infiltrated, allowing pollutants to settle out. Check dams are used to create small ponded areas to facilitate infiltration.

Weir- a small dam built across a stream to raise the level of water upstream or regulate its flow. Weirs may also be used to trap sediment and create stream complexity.

Wet swale- Wet swales act much like small wetlands. Water exits the swale over a small weir. Where the water table is very close to the surface and a dry swale is not feasible, wet swales can be effective at removing pollutants, particularly sediments.

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Appendix A- Maintenance & Operations

UNIVERSITY DRAINAGE SYSTEM OPERATING PROCEDURES

Each of the drainage systems within the University is unique. As such, each has equally unique operating issues that should be addressed:

Bowker Creek

This system is based mostly on piped drainage discharging into surface storage at the University Club and the Bowker Creek wetlands then into the District of Saanich enclosed system of Bowker Creek. About 50% of the site is now hard surface so the runoff is fast and the potential for contaminant loading is high.

Some of the most critical sources of pollution are catch basins in parking lots and roadways. Pollutants are usually attached to fine sand particles that wash off the road and enter the catch basin. If the sump of the catch basin is not cleaned regularly, the silts will be stirred up with the next rainfall then carried into the downstream systems thus carrying with them the collected pollutants. It is important that the system be kept free of deleterious materials so regular cleaning of roads, parking lots and catch basins should be monitored and cleaning dates recorded to ensure adequate maintenance is performed.

Another source of contamination is storm discharge from construction sites. The University is in a significant growth period and the risk of overland flooding from construction sites is high. Normally these flows carry with them construction pollutants such as paints, oils and preservatives etc that are considered toxins to the downstream systems. Therefore, on-site containment systems must be constructed on each site to prevent discharge of stormwater. In addition, specific areas for storage and maintenance of equipment/ toxic materials should be required to ensure pollutants do not have an opportunity to enter the overland flow systems.

The Bowker drainage is the most naturally protected system at the University because the water is extensively filtered through surface ponds and natural bio-treatment areas. These are very valuable in the “treatment train” effect for stormwater quality and should be protected from development. The surface storage systems do not require much maintenance except for periodic cleaning of initial silt settling ponds. These structures, if well designed are easily accessible and can be cleaned using a backhoe. Material removed from the settling pond should be transported to a secure site and tested for contaminants. If the level of contamination is low, the material should be added to the compost materials for future use in gardens around the Campus. If the material contains sufficiently high levels of contamination that it requires special treatment, it should be contained and either proportionately mixed with soils used in garden development or combined with materials from adjacent municipalities for transport to an off-site disposal facility. Most of the materials contained in the settlement ponds are low in contaminants but very silty so can easily be added to compost material as filler.

Hobbs Creek

Hobbs Creek is probably the most sensitive receiving system on Campus. Flows generating from parking lots and roadways are discharged directly to the stream and result in significant high runoff conditions. It is therefore important to ensure upstream collection systems are well maintained or upgraded to reduce the runoff rates and the amount of untreated water entering the stream. Of particular importance is the cleaning of silt trapping catch basins in Parking Lot #1 and the catch basins on Ring Road.

As part of this Plan, there are recommendations for modifications of storm storage at Lot 1 and diversion of stormwater around the new Engineering/Computer Science Building parking lot through the Cunningham Woods to the south, across Ring Road to the South Woods areas of Hobbs Creek drainage. These modifications would provide significant additional storage, detention and treatment of the stormwater discharging to Hobbs Creek. In addition, there is the added benefit of reduced maintenance and improved slow discharge of stormwater to both the groundwater and to the creek itself. Once installed, the maintenance requirements of these new systems would be very low compared to current costs for catch basin cleaning and solids disposal.

Creek Channel Restoration and Maintenance

Channel restoration has begun on Hobbs Creek with the installation of weirs to trap sediment (Figure A-1). This has slowed erosion considerably and without these measures the channel would likely have downcut to a point where it could not be rehabilitated. Permanently stopping the erosion is a very slow process however, and erosion is still occurring and will continue for some time. The pond at the terminus of Mystic Vale still receives a great deal of sediment. Though the sediment was removed from this pond in April of 2001 through a co-operative effort by UVic, the District of Saanich and the owner of the pond, heavy rains (+100 year event) in the fall 2003 caused the pond to once again fill in (Figure A- 2). This sediment load puts lower Hobbs Creek and Mystic Pond at risk of heavy sedimentation and could undo restoration works undertaken over the last three years by the District of Saanich and the neighbours downstream. The University should work with local residents to acquire this property. Once erosion in Hobbs Creek has been arrested, the pond could be cleaned of its sediments and restored to functional habitat as an adjunct to Mystic Vale.

Figure A-1. A weir installed by UVic to trap sediment in a downcut section of Hobbs Creek.

Figure A- 2. The pond at the terminus of Mystic Vale (October 22, 2003)

Finnerty Drainage

The Finnerty system was mostly designed to accommodate drainage from the Athlete's Village, now the married student's residence. It also includes runoff from part of the northern section of the Campus, the area west of Finnerty Road and Finnerty road itself. The design incorporated in-pipe storage and surface detention as well as overland flow patterns that allow surface cleaning of the drainage waters. The system is reasonably low in maintenance and is an example of the value of careful design. If more of the stormwater could be kept on the surface or run through surface filtration islands or boulevards, then this drainage system would be even further enhanced.

Maintenance needs include: periodic checking of the large pipes to ensure no buildup of sediments. If sediment is observed, then the pipes must be pumped and flushed. Catch basins must be routinely cleaned to reduce the amount of sediment and contaminants entering the sub-surface storage. The new storage tank at the IPI Building also requires inspection and cleaning to remove sediments. Again, wherever possible, road and surface drainage should be diverted to swales or infiltration areas of parking lots etc to both reduce contaminant loads but also reduce flows and maintenance.

Cadboro System

Flows from the northeast portion of the Campus flow toward the piped system on Sinclair Hill and the Cadboro Bay drainage system. Flows eventually discharge to the Gyro Park drainage system and to the ocean at Cadboro Bay. Most of these flows originate from buildings and parking lots so are quick response flows with minimum infiltration or storage. It is therefore important that the catch basins and parking lot areas be kept clean of silts, car greases and debris. A routing cleaning and recording system should be implemented to ensure the maintenance is provided at a sufficiently high level to reduce the risk of off-site contamination.

CONSTRUCTION MANAGEMENT

Sediment and Erosion Control Plans

The purpose of this guidance section is to help University staff develop and implement a Sediment and Erosion Control Plan, as part of a Stormwater Pollution Prevention Plan, designed for each specific construction site. With the information contained within this guidance document, staff should be able to assemble the major elements of the plan using an integrated team approach consisting of their own managers, construction managers and engineers, architects, and other consultants. The step-by-step guidelines and checklists in the following sections should enable University staff to work through the process of developing a sediment and erosion control plan. Because most aspects of the plan require careful advance planning, its development must be closely connected to the development of the overall site plan for construction. The checklists are designed to help staff organize the required information, using a simple, six-phase process. The six phases are:

1. Site Evaluation and Design Development
   - Collect site information
   - Develop site plan
   - Prepare pollution prevention site map
2. Assessment
   - Measure the site area
   - Determine the drainage areas
   - Calculate the runoff coefficient
3. Control Selection/ Plan Design
   - Select erosion and sediment controls (see sample checklist below)
   - Select other controls
   - Select stormwater management controls
   - Indicate the location of controls on the site map
   - Prepare an inspection and maintenance plan
   - Identify photopoint monitoring locations
   - Co-ordinate controls with construction activity
   - Prepare sequence of major activities
   - Incorporate regulatory requirements
4. Certification/ Notification
   - Certify the plan
   - Submit notice of intent
   - Plan location and public access
5. Construction/Implementation
   - Implement controls
   - Inspect and Maintain Controls (see sample checklist below)
   - Update/change the plan
   - Report release of reportable quantities
6. Final stabilization/ termination
   - Final stabilization (see sample checklist below)
   - Notice of termination

A sediment and erosion control plan is required (Prerequisite) for all LEED™ buildings. We recommend that the University adopt these protocols for all buildings, regardless of whether they are LEED™ registered. Complete written and photographic documentation of all aspects of construction are essential. A checklist of the essential elements of a complete plan is presented below.

A complete sediment and erosion control plan must contain:

Project Name and Location/Address
Owner Name & Address
Description of Project: (Purpose & type of soil disturbing activities)

A site description, including:

- ❑ The nature of the activity
- ❑ Intended sequence of major construction activities:
- ❑ Total site area
- ❑ Area of site expected to undergo excavation
- ❑ Runoff coefficient of the site after construction is complete
- ❑ Existing soil or stormwater data
- ❑ A site map with:
    - ❑ Drainage patterns
    - ❑ Appropriate slopes after major grading
    - ❑ Area of soil disturbance
    - ❑ Outline of areas which won't be disturbed
    - ❑ Location of major structural and non-structural controls
    - ❑ Area where stabilization practices are expected to occur
    - ❑ Surface waters
    - ❑ Stormwater discharge locations
- ❑ Name of receiving waters

Description of controls

Erosion and sediment controls, including:
- ❑ Stabilization Practices for all areas disturbed by construction
- ❑ Structural Practices for all drainage/discharge locations

Stormwater Management controls, including:
- ❑ Measures used to control pollutants occurring in stormwater discharges after construction activities are complete.
- ❑ Velocity dissipation devices to provide non-erosive flow conditions from the discharge point along the length of any outfall channel

Other Controls, including:
- ❑ Waste disposal practices which prevent discharge of solid materials to waters of Canada
- ❑ Measures to minimize offsite tracking of sediments by construction vehicles
- ❑ Measure to ensure compliance with provincial or local waste disposal, sanitary sewer or septic system regulations

Timing of controls

- ❑ Description of the timing during the construction when control measures will be implemented.
- ❑ Are the most stringent of local, provincial or federal requirements incorporated into the plans?
- ❑ Are maintenance procedures for control measures identified in the plan?
- ❑ Identification of allowable non-stormwater discharges and pollution prevention measures.
- ❑ Contractor certification
- ❑ Plan certification

Construction General Stormwater Management Plan
Stormwater Pollution Prevention Plan
Discharges Associated with Construction Activities

Erosion & Sediment Control Selection Checklist

Stabilization Practices

Stabilization Practices will be initiated on all disturbed areas where construction activity will not occur for a period of more than 21 calendar days **by the 14th day after construction activity has permanently or temporarily ceased**. Stabilization measures to be used include:

- ❑ Temporary seeding
- ❑ Permanent seeding
- ❑ Mulching
- ❑ Sod stabilization
- ❑ Geotextiles
- ❑ Other___

Structural Practices

Structural Practices: flows from upstream areas will be diverted from exposed soils to the degree attainable. Measures to be used include:

- ❑ Earth dike
- ❑ Drainage swale
- ❑ Interceptor dike and swale
- ❑ Pipe slope drain
- ❑ Block and gravel
- ❑ Sod inlet
- ❑ Other___

Drainage locations serving less than 10 disturbed acres

Drainage locations serving less than 10 disturbed acres. Sediment controls will be installed. Sediment controls include:

- ❑ Sediment basin
- ❑ Sediment trap
- ❑ Silt fence or equivalent controls along all sideslopes and downslope boundaries
- ❑ Wetland pond construction

Structural Practices: drainage locations serving 10 or more disturbed acres

- ❑ A sediment basin will be installed
- ❑ A sediment basin is not attainable on the site; therefore the following sediment controls will be installed
- ❑ Sediment trap
- ❑ Silt fence or equivalent controls along all sideslopes and downslope boundaries
- ❑ Wetland pond construction

Sediment basin runoff storage calculation

______Acres area drainage to the sediment basin

X

3,200 cubic feet of storage/acre

=

Cubic feet of storage required for the basin

Construction General Stormwater Management Plan

Stormwater Pollution Prevention Plan

Construction/Implementation Checklist

- ❑ Maintain Records of Construction Activities, including:
  - ❑ Dates when major grading activities occur
  - ❑ Dates when construction activities temporarily cease on a portion of the site
  - ❑ Dates when construction activities permanently cease on a portion of the site
  - ❑ Dates when stabilization measures are initiated on the site

- ❑ Prepare Inspection Reports summarizing:
  - ❑ Name(s) of inspector and/or Stormwater Pollution Prevention Team (SWPPT)
  - ❑ Qualifications of inspector
  - ❑ Measures/area inspected
  - ❑ Observed conditions
  - ❑ Changes necessary to the Stormwater Pollution Prevention Plan

- ❑ Report Release of Reportable Quantities of Oil or Hazardous Materials (if they occur):
  - ❑ Notify CRD and WLAP/DFO agencies
  - ❑ Notify permitting authority in writing within 14 days
  - ❑ Modify the Pollution Prevention Plan to include:
    - ❑ The date of release
    - ❑ Circumstances leading to the release
    - ❑ Steps taken to prevent reoccurrence of the release

- ❑ Modify Pollution Prevention Plan as necessary to:
  - ❑ Comply with minimum permit requirements when notified by the CRD or local municipality that the plan does not comply
  - ❑ Address a change in design, construction operation or maintenance which has an effect on the potential for discharge of pollutants
  - ❑ Prevent reoccurrence of reportable quantity releases of a hazardous material or oil

Construction General Stormwater Management Plan

Construction Pollution Prevention Plan

Maintenance/Inspection Procedures Checklist

These are the inspection and maintenance practices that will be used to maintain erosion and sediment controls.

1. Structural Practices: flows from upstream areas will be diverted from exposed soils to the degree attainable. Measures to be used include:

   - ❑ Less than one half of the site has been denuded at one time.
   - ❑ All control measures have been inspected at least once each week and following any storm event of 13mm or greater.
   - ❑ All measures are being maintained in good working order; if a repair is necessary, it will be initiated within 24 hours of report.
   - ❑ Built up sediment has been removed from silt fences when it has reached one-third the height of the fence.
   - ❑ Silt fences have been inspected for depth of sediment, tears.
   - ❑ Silt fence fabric is securely attached to the fence posts.
   - ❑ Fence posts are firmly in the ground.
   - ❑ Sediment build up in sediment basin is less than 10% of the design capacity
   - ❑ Diversion dikes have been inspected and any breaches promptly repaired.
   - ❑ Temporary and permanent seeding and planting have been inspected for bare spots, washouts, and healthy growth.
   - ❑ Water from water line flushings has been properly diverted away from erodible areas.
   - ❑ Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred) have been properly diverted away from erodible areas.
   - ❑ Uncontaminated groundwater (from dewatering excavation) has been properly diverted away from erodible areas.

2. Photopoint Monitoring:

   - ❑ Repeat photographs have been taken at each camera location.

3. Routine building site inspection conducted to ensure potential pollutants are properly stored:

   - ❑ CRD protocols followed for washing concrete surfaces and equipment.

- ❑ Other sources include pesticides, petroleum products (fuels and lubricants), nutrients (mainly from fertilizers used in re-vegetation), solid wastes (trees, shrubs, wood, paper, sanitary wastes, scrap metals, rubber, glass, food wrappings, waste food, cigarette packages, etc.), construction chemicals (paints, cleaners, curing compounds, etc.).

4. Routine building site inspection conducted to ensure potential pollutants are properly stored:

   - ❑ CRD/ municipal protocols followed for handling petrochemicals and maintaining and cleaning equipment.

5. Routine building site inspection conducted to ensure adequate disposal facilities have been provided:

   - ❑ Disposal and on-site temporary storage facilities have been located at convenient site(s).
   - ❑ Disposal and on-site temporary storage facilities have been properly maintained and emptied when full and replaced with clean, empty facility.
   - ❑ Oily wastes and dumpsters covered or bermed.

6. Soil and debris stockpiles:

   - ❑ Soil and debris stockpiles have not been placed near storm drains or catchment areas which contain water.

7. Work areas:

   - ❑ Clean and organized work area is being maintained.

8. Cleaning, fueling of vehicles and the changing of hydraulic fluids and other oils:

   - ❑ A specific area has been allocated for fueling of vehicles and the changing of hydraulic fluids and other oils.
   - ❑ Maintenance area is properly bermed off from storm drains or other transportation corridors.
   - ❑ Vehicles and parts washed only in designated and properly drained or bermed areas.

9. Storm sewer connections:

   - ❑ No improper and/or illegal connections to storm sewers have been detected.

10. Spill Cleanup Kit:

    - ❑ Spill Cleanup Kit is complete, easily accessible and in proper working order.

- ❑ Equipment operators have been properly trained in the use of the Spill Cleanup Kits.

11. Storm drain contamination:

- ❑ Residue such as paint chips are being properly maintained and kept from entering storm drains.
- ❑ Paints, solvents, chemicals, waste containers, and soiled rags are properly covered from the rain.

Final Stabilization/Termination Checklist

1. ❑ All soil disturbing activities are complete.
2. ❑ Temporary erosion and sediment control measures have been removed or will be removed at an appropriate time.
3. ❑ All areas of the construction site not otherwise covered by permanent pavement or structure have been stabilized with a uniform perennial vegetative cover with a density of 70% or equivalent measures have been employed.

Contractors

UVic employs contractors on a regular basis, particularly in the construction of new buildings. It is essential that all contractors undergo basic training and are given a clear set of instructions as to what is acceptable practice with respect to stormwater at UVic. A modified sample set of site procedures from the University of Texas is given on the following pages:

CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS

Equipment Cleaning

Equipment must be cleaned in a manner that does not create any discharge of cleaning agents, paints, oil or other pollutants to a storm sewer or waterway. Soaps and detergents must never be discharged to the ground or off-site. When rinsing painting equipment outside, rinse water must be contained in a bucket or other container. Water based or latex paint rinse water may be discharged to the sanitary sewer. Oil-based paint wastes, including solvents and thinners, must not be disposed of in the sanitary sewer; they must be collected and disposed of through the contractor's disposal company in accordance with applicable laws and regulations. Cement handling equipment must be rinsed in a contained area and there must be no drainage off-site.

Pressure Washing

Discharges from pressure washing must not be allowed to enter a storm sewer or waterway. Consider vacuuming up the water or berming the process water and allowing it to evaporate. If the rinsate only contains water and dirt or sediment it may be spread on the ground with prior permission from Facilities Management and if it will not enter a storm sewer or waterway. Depending on the content of the material it may also be possible to discharge to a sanitary sewer with prior permission from Environmental Health & Safety.

Waste Disposal

Any trash or debris must be contained on site and disposed of in a recycling bin or waste receptacle in accordance with applicable laws and regulations to prevent wind or rain from carrying it off-site into a storm drain or waterway. Petroleum wastes, such as waste oil and used oil filters, must be containerized for recycling or disposal by the contractor. Non-hazardous solid wastes, such as general construction debris may be recycled or disposed of in the trash container. *Never dispose of liquid wastes of any kind in dumpsters*.

Sediment

Proper erosion and sedimentation controls must be in place to prevent sediment or silt run-off. Sediment (including cement) should never be rinsed off the site, instead it must be cleaned up in a manner that does not allow it to reach a storm drain or waterway. Equipment tires must be rinsed before leaving the site if necessary to avoid tracking sediment into the roadway or off the site. *All vehicles must leave the site through a stabilized construction entrance meeting the requirements of the University's Construction Standard regarding Erosion and Sedimentation Controls.*

Site Dewatering, Tank, & Pipe Testing

Discharges from dewatering, hydrostatic tank testing or pipe pressure testing must be free from sediment, chemicals, and any other pollutants. Some discharges, such as those from underground storage tank pits, may require City of Austin temporary discharge permits and contractor is responsible for obtaining such permits.

Petroleum

Spills of hydraulic fluid, oil and other petroleum products must always be immediately cleaned up to prevent discharge of these fluids with stormwater run-off. Petroleum contaminated soil must be cleaned up and disposed of properly in accordance with applicable laws and regulations. Storage containers must be kept closed, clean and free of oily residue. Containers over 250 gallons (including mobile tanks) must be stored inside secondary containment.

Separators or Traps

Before removing oil/water separators or traps connected to storm sewers, the materials in them must have been tested (by Toxicity Characteristic Leachate Procedure or TCLP) within the last two years before they are cleaned out. Be aware that this test may take three weeks to complete if a recent test has not been completed. Contractor is solely responsible for accommodating the time for such testing and no claims for delay arising out of such testing will be permitted. Documentation of the test results must be submitted to EH&S staff for review and approval before emptying or removing the trap.

SPILL PREVENTION, CLEAN-UP AND DISPOSAL

Be prepared to contain spills to prevent spreading. Small areas are easier to clean than large ones. Keep sorbent materials such as clay (kitty litter), polypropylene booms and pads, rags and sawdust on hand for clean-up of spilled liquids.

Clean-Up

Sorbent materials can be used to effectively clean-up various materials spilled on pavement, water and soil. Soil or other media which has been contaminated with petroleum or other pollutants must be excavated or remediated in accordance with applicable laws and regulations to prevent contaminated discharges to a storm drain or waterway. Excavated contaminated materials must be stored in containers or on plastic and covered so as to ensure that the contamination is not flushed back onto the ground during a rainstorm.

Contaminated Material Disposal

Proper disposal of waste materials depends partly on the type of contaminant. Hazardous wastes (such as flammable petroleum products and solvents, thinners) and materials contaminated with hazardous wastes are considered regulated wastes, and should be containerized for transport and disposal by a permitted company in accordance with applicable laws and regulations. Disposal also depends on the amount of contaminant.

CONTRACTOR REQUIREMENTS AND RESPONSIBILITIES

Contractors are solely responsible for cleaning up and properly disposing of all spilled pollutants brought to the site as part of the contractor's work, including oil, paint, fuels, antifreeze, solvents, etc. in accordance with applicable laws and regulations. Contractor must keep accurate records (such as receipts, copies of analytical results, etc.) indicating proper disposal of spilled materials in accordance with applicable laws and regulations. Furthermore, Contractor is responsible for ensuring that all discharges from the site are in compliance with all applicable laws and regulations.

No substance may be dumped or leaked onto the ground or allowed to run-off of a construction site that might cause pollution. Be aware that Contractor is responsible for pollutant contaminated run-off and proper disposal of all waste materials generated as a result of Contractor's activities.

NOTIFICATION REQUIREMENTS AND PROCEDURES

We should be notified immediately in the event of:

* Any spill that threatens to enter a storm sewer or watercourse.

* All petroleum spills *e.g.* hydraulic fluid, transmission fluid, diesel, gasoline, etc.

* Any hazardous or unknown material spill, *e.g*. many solvents, cleaners, etc.

* Any discharge from your site which you suspect may be in violation of city, provincial or federal regulations, or other applicable laws and regulations, *e.g.* discharges which are cloudy, foul smelling, colored, contain chemicals or heavy sediment loads.

Notification can be accomplished by calling UVic EH&S at (250) 721-XXXX.

In addition to these basic procedures, all new buildings should have a sediment and erosion control (S &EC) plan in place prior to commencement of construction (A sample S&EC plan is given Appendix A). This is a requirement of buildings applying for LEED certification. All contractors on the building site should be required to read, sign and keep a copy of the S&EC plan. We recommend that the site crew visit the point of stormwater discharge (*i.e.* discharge point on Hobbs Creek) in order to reinforce the need for good site practices and provide an opportunity for education about the ecology and management practices at UVic. It is our experience, that, when approached in a proactive, positive manner, most contractors are very conscientious and willing to employ new practices if they know why they are required. If they are simply given a “rule book” without adequate explanation or opportunity to ask questions, the rules will inevitably be broken and the entire process of re-education an co-operative management will be set back.

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Appendix B- Hydrological Analysis

Provided on enclosed CD.

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Appendix C- Case Study of Engineering/Computer Science Building

The traditional design approach for this site would have been to direct stormwater from the roofs into a storm drain and then into the main stormwater system. The parking lot to be constructed in front of the existing engineering building would have been asphalt paving with the standard drainage and curb and gutter approach. The new road would have either been impervious with subsurface drainage pipes or a semi-pervious surface with subsurface storm piping. The net result would have been maximum stormwater runoff with no treatment other than potentially some oil and grease separators. This would essentially equate to pre-development conditions as the site was previously an asphalt parking lot. This type of approach would continue to put a significant burden on the overall stormwater system for the campus and downstream municipal stormwater infrastructure.

In reality, however, this approach would not have been possible because of local regulations, and the solution would likely have been to put an underground stormwater tank to store and slowly release the stormwater as was done at the Technology Enterprise Facility on campus. Although we could not obtain the cost of this approach used at the facility it was obviously not inexpensive given the size of the tanks.

Fortunately the project team was willing to look at various stormwater options for the Engineering/Computer Science Building and, as a result, the approach is very innovative. At the time this report was finished the design had not been completely finalized but in summary the options be looked at included:

Roof Treatment

The treatment of the stormwater from the roof of the building is different for the various parts of the roof. There are four distinct roof areas:

Roof Area A- Roof West of Atrium

The stormwater treatment for Roof Area A will be as follows:

Allow for some roof top storage of stormwater to reduce peak flows and to delay discharge to roof drains. This approach has no structural implications to the roof as the amount of water being stored is designed to the building code loads for the building. This treatment will not add costs and will result in some cost savings as the roof drains can be downsized because of the reduced rate of flows.

The stormwater flow is then directed to a bio-swale located alongside the new road being constructed (see E above). The roof drain will be directed through piping to the swale or potentially through a concrete cutter to keep the drain closer to the surface. This allows more of the storm drain to be directed north thereby extending the size of the bioswales and increasing their filtration and storage capacity.

In the event of a major rain event, an overflow mechanism is required to direct the stormwater to the main storm drain. One technique will be to put a stormwater control chamber underground near the storm drain and direct the overflow outlet to the main storm pipe.

This option does require an additional capital cost and a longer length of storm pipe to the main drain. The other option, a more ecologically beneficial choice and likely cheaper as well, is to create an over flow pond with a raised manhole to store water. This will allow for some further ground water recharge and treatment prior to discharge to the main storm system.

Raised Manhole

Roof Area B- Roof East of Atrium

The stormwater treatment for Roof Area B will be as follows:

Allow for some roof top storage as in roof area A

Direct roof drains to green roof (roof area C). The green roof has significant storage capacity and for the majority of rain events will store roof water from rain that falls on roof areas B and C. Plants and evapotranspiration will handle the majority of the rainwater. When soils are saturated the excess rainwater will be directed to a bioswale or biofiltration pond (depending on sizing requirements) - see area F. This will result in additional filtration and recharge. In the event of major rain events the relatively small amounts of excess stormwater will be allowed to spill into the area south of area F.

Roof Area B- Atrium Roof

The flows of stormwater from the atrium will likely be split between roof areas A and B with potentially some direct discharge into the bioswales or biofiltration pond in area F.

Roadway

To the west of the building, the Aqua-pave pavers will be used to promote groundwater recharge and filtration. The road and the subsurface clay base below the granular material will be sloped towards the bioswales in area E. The road section near the south entrance and to the north will be directed to a bioswales area wherever possible. In the north area the opportunity exists to drain excess water to the tank where it will be stored and used for flushing toilets along with water reused from the aquatics center (see other below).

Parking Lot

The parking lot area G will be constructed of Aqua-pave (or porous asphalt could be considered), and the overflow area will be directed to bioswales adjacent to the parking lot and to a biofiltration pond with a raised manhole. If asphalt is used then no curbs will be used and the parking areas will be sloped toward a bioswale.

Other

The aquatics building currently discharges a significant flow of water into the storm sewer system. This water is now being treated and the design team is obtaining water quality tests in order to determine the feasibility of directing this water into the underground tank and use it to flush toilets in the building. The amount of water produced by the aquatic facility is more then can be used for this building alone, and the opportunity exists to redirect this water to other buildings nearby that are being dual plumbed. Also, given the volume of water available, the University could direct excess water to another tank or even a water tower to then be used for irrigation on campus. (This may require application to the provincial government for permission). This would reduce the excess water directed to the main storm system and potentially result in there being enough water to avoid using potable water for irrigation on the entire campus. This would substantially reduce the University's water bill and futureproof against increased water prices.

Once the water quality report is received discussions will be undertaken with the District of Oak Bay to utilize this water for toilet and irrigation use. Furthermore, there are plans for utilizing the water as a heating and cooling source for the building. In summary, there is the potential that the water in the aquatics system is used four times before being discharged – a very innovative solution.

Conclusion

The Engineering Computer Science Building is an example of where various stormwater techniques implemented at the building level can significantly reduce post-development and site runoff as compared to pre-development conditions. In addition, site selection played a role in stormwater runoff. Approximately half the site was previously an asphalt parking lot with a net imperviousness of 95%. The net result for the building was an amount of runoff for the post-development condition that was less than pre-development condition.

Interestingly enough, the run off from the Engineering/Computer Sciences Building will not be any more than if the site had been a Greenfield site. The implications are obvious that through good design additional traditional stormwater infrastructure will not be required and the building will add no additional requirements to the overall campus stormwater infrastructure. Further, the quality of the runoff has been significantly improved compared to traditional practices contributing to the surrounding watershed.

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Appendix D- Terms of Reference

The University wishes to commission an overall Storm Water Management Plan which will lead to the implementation of drainage facilities that will protect and enhance the valued natural resources both on and off the University lands while providing an appropriate level of flood protection for the Campus buildings.

1.0 Background

Drainage from developed University lands currently discharges to three (3) main conveyance systems. These include the storm drain systems that flow to Cadboro Bay, Finnerty Cove, and the headwaters of Bowker Creek. The northeastern areas discharge via storm drains to undeveloped lands at the corner of Finnerty Road and Arbutus Road owned by the Queen Alexandra Centre for Children's Health. This drainage is intercepted at Arbutus Road and conveyed again in storm drains to Finnerty Cove. A portion of the southeastern University lands discharge to storm drains on Sinclair Road that reach Cadboro Bay. The District of Saanich is planning to restore ("daylight") the lower portion of this Creek system hence peak flows and water quality will be a concern. A significant development area in the southeast University lands may also potentially discharge to Hobbs Creek in Mystic Vale, which is a Protected Area. Special attention to drainage routing and control will be required in this catchment. The majority of the undeveloped University lands, to the west and south of Ring Road, has been designated as a Special Study Area (Draft Campus Plan, May 2002). Along Gordon Head Road, these areas include Wetlands forming the headwaters of Bowker Creek. These Terms-of-Reference require that a complete understanding of the drainage in these headwaters be developed, including hydrology and ecology (refer also to Item 2.1, first item).

The District of Saanich now has a Stormwater Management and Erosion Control component to their Subdivision By-Law. In addition, Saanich has Development Area Permit Guidelines for the purpose of protecting riparian zones, and for ensuring runoff volumes and peaks to receiving streams are affected as little as

1.0 Background (Cont.)

possible. Under these guidelines, stormwater controls are to be installed in new developments so as to replicate the nature runoff regime. It stipulates that all land development is required to provide control on the rate of runoff and improvement to drainage water quality while minimizing erosion.

In 1998, the University completed a hydraulic model of the storm drain system (Site Services Project No. 578 - Storm Drain by Reid Crowther and Partners Ltd., July 1998) which assessed the relative capacities of the drains but did not examine off-site impacts, nor did it address stormwater management issues. The model, however, could form the basis of a comprehensive stormwater management plan if it is updated and expanded to incorporate the Campus Plan and provide information for stormwater control and treatment.

The Stormwater Management Plan shall identify the potential issues related to the impact of the Draft Campus Development Plan including providing viable options and areas of further study for review and decision.

2.0 Plan Requirements

Specific tasks for the development of a Stormwater Management Plan to be completed for this assignment include, but are not limited to, the following:

2.1 The Plan shall be an “integrated” (biological, ecological, environmental, hydrological, architectural, and engineered) approach to address issues, options, and solutions relating to all associated watersheds and drainage systems.

2.2 Meet with client representatives to confirm scope of work, schedule, budget and deliverables.

2.3 Review and incorporate the requirements of the Campus Plan. Include all contiguous University lands in the Plan and allow for future development.

2.0 Plan Requirements (Cont.)

2.4 Plan with an awareness of potential off-site impacts and the requirements, policies, By-Laws, and environmental guidelines and concerns of the District of Saanich, District of Oak Bay, the Capital Regional District (CRD), and other senior governments and provide feedback.

2.5 Summarize the design criteria to be used for stormwater management, including runoff return periods for flood control and for water treatment, types of facilities to be used for drainage control, and treatment and methods of analysis. A Management Plan is required that uses various return period events depending on the type of structure being designed.

2.6 Update and extend the 1998 hydraulic model to reflect future development, Include off-site drain components downstream to Finnerty Cove, Cadboro Bay, and to the downstream side of Gordon Head Road (for Bowker Creek).

Use the model to calculate existing and future controlled runoff rates. Determine the best flow routing for newly serviced areas that, where viable, optimizes existing drain capacities and considers receiving water impacts. Of particular concern are the vulnerable areas of Mystic Vale and Bowker Creek.

2.7 Determine the stormwater storage volumes and maximum release rates that are required to protect off-site natural resources and existing drain capacities. These should be allocated on a sub-catchment basis so the requirements for each development area are known and tabulated. This would allow stormwater detention or treatment “credits” to be banked and used as the Campus Plan is developed.

2.8 Provide conceptual design including preliminary sizing for stormwater management facilities to support future Campus development. This will include site selections with client representatives in attendance. The concepts may include a mix of above ground and below ground detention and water quality treatment components.

2.9 Provide conceptual landscape sketches for stormwater treatment practices and any site reforestation or re-vegetation community profiles.

2.10 Complete an examination of the Bowker Creek Special Study Area including:

2.10.1 the appropriateness of the pond and weir system near the Faculty Club and the inlet structure at Gordon Head Road.

2.10.2 the drainage impacts on the Wetland area near Gordon Head Road.

2.0 Plan Requirements (Cont.)

2.10 (Cont.)

2.10.3 identify development constraints resulting from the Client's best functional use for this area.

2.10.4 an assessment of the potential for a University research project to study the water quality improvements achieved by the existing and an improved Wetland in this area.

2.11 Prepare an overall Conceptual Plan, suitable for presentation, at a scale of 1:2000 which shows all existing and proposed major catchment boundaries, storm drains, channels, detention facilities, and water treatment facilities. Separately provide critical storm drain profiles, pond / wetland concepts and channel / swale options.

2.12 Prepare an operating plan for proposed stormwater management facilities, which should include coordination with the Districts of Saanich, Oak Bay, and the CRD.

2.13 Prepare a review outlining how the requirements of the following would guide the Stormwater Management Planning:

2.13.1 U.S. Green Building Council's Green Building Rating System (Leadership in Energy and Environmental Design - LEED).

2.13.2 Proposed Canadian and/or British Columbia Green Building Council's Green Building Rating System (LEED).

2.13.3 Proposed CRD Stormwater Quality Code of Practice for the Automotive Section. Please Note: The CRD is also planning to prepare Codes of Practice relating to graffiti removal, building, and sidewalk mobile washing, use of paints, fertilizers, playing fields, and other issues.

2.13.4 Proposed CRD Model By-Law.

2.13.5 Please Note: The following reports are also available from the District of Saanich:
2.13.5.1 Hobbs Creek - Watershed Management Plan (Aqua-Tex).
2.13.5.2 Flood Flows in Bowker Creek - Haultain to Oak Bay (KPA).
2.13.5.3 Rain & Flood Frequency - Colquitz & Bowker (KPA).
2.13.5.4 Flood Flows & Stormwater Storage in McKenzie Section of Bowker Creek (KPA).

2.14 Summarize findings for a client review. Attend meetings, present findings, and receive input for finalization of the analysis and documentation. The Summary of Findings shall include viable options and areas of further study.

2.15 Prepare a summary report that includes methods, analysis, results, and recommendations.

2.16 Submit draft report, receive client input, and finalize report. Provide ten (10) copies of the final report.

2.17 Attend a presentation of the report to the client's representatives.

2.18 It is anticipated that the Plan will be completed early 2003.

3.0 Information to be Provided by Facilities Management

3.1 AutoCad files of building sites and existing site services. The existing AutoCad As-Built information is not fully updated. The Consultant shall make due allowance for contacting the Maintenance Services Division and other parties to obtain sufficient current as-built information in order to complete this Plan. The impact of current and proposed building works shall also be incorporated within the Plan.

3.2 Site Services Project No. 578 - Storm Drain by Reid Crowther & Partners Ltd., July 1998.

3.3 Logs of borehole investigations that may have been performed along with supporting geotechnical reports.

3.4 Draft Campus Plan dated May 2002 which identifies proposed future building sites.

3.5 Sinclair storm sewer capacity upgrade at Gyro Park by The District of Saanich (letter to Earth Tech dated 02-Jan-21 refers).

3.6 Existing sewer flow monitoring results by The District of Saanich (letter to Earth Tech dated 02-Mar-18 refers).

3.7 CRD Stormwater Quality Code of Practice for the Automotive Section - Minutes of Task Force Meeting dated 02-Oct-10 including Schedule "X".

3.8 CRD 'Draft' Model By-Law dated 02-Jun-15.

4.0 Proposal Requirements

The proposal should be concise, without excess verbiage.

The proposal shall contain as a minimum:

4.1 A description of the method by which the work will be performed,

4.2 A description of deliverables including one (1) copy in AutoCad format that is compatible with the Client,

4.3 A list of all personnel to be used, their relationship during the project, their office location, and a resume of their experience in work related to this type of project.

The Consulting Project Team shall comprise members fully coversant with the issues, options, and remedies necessary for the successful completion of the Plan,

4.4 A list of all sub-consultants, complete with their relationship to the project, their office location, and a description of the work they will perform, together with experience as noted in Item 4.3,

4.5 Details of all resources available to the key personnel for the project (computer equipment, software, etc.),

4.6 Project Schedule in a bar chart or similar format utilizing the same headings from the consultants proposed methodology,

4.7 Confirmation of Professional Liability Insurance (Errors and Omissions) coverage for a minimum $500,000 for the specific project,

4.8 An outline of the Project Team's successful completion of similar projects including references, contact names, and phone numbers.

4.9 Identify any specific tasks, issues, or opportunities not covered under Item No. 2.0 - Plan Requirements that may be necessary for the successful preparation of the Site Plan.

4.0 Proposal Requirements (Cont.)

The fee information shall include as a minimum:

4.10 A lump sum fee including:

4.10.1 sub-consultant fees,

4.10.2 disbursements, meetings, and all other costs to complete the work, and

4.10.3 an allowance for the Federal Goods and Services' Tax (GST).

4.10.4 the Consultant shall identify the number of Project Meetings included in the proposal.

4.10.5 the University does not consider the following items as recoverable disbursements as they are regular overhead expenses and should be included in the rate schedule: facsimile charges, photocopying, computer time, secretarial or clerical charges, telephone or cellular charges, and mileage. Copies of all supporting documentation (i.e. invoices, waybills, etc.) for disbursements claimed must accompany your invoice.

4.11 An explanation of the company's billing procedures.

Discipline (Amend as Necessary)	Initial Investigation & Report Brief	Draft Plan with Options	Final Plan	Total Fee	% of Total	Additional Fees $ / hr.
Prime Consultant	$	$	$	$	%	$
Biological	$	$	$	$	%	$
Ecological	$	$	$	$	%	$
Environmental	$	$	$	$	%	$
Hydrological	$	$	$	$	%	$
Architectural	$	$	$	$	%	$
Engineering	$	$	$	$	%	$
Others (Please Name)	$	$	$	$	%	$
Sub-Total	$	$	$	$	%	$
G.S.T.	$	$	$	$	%	$
Total	**$**	**$**	**$**	**$**	**100%**	**$**

Any change in the Scope of Work, which may result in additional Consultant fees, must be identified and mutually agreed to by the University prior to proceeding with the Work.

The following points shall be applied to the preparation of the proposal:

4.13 These Terms-of-Reference and the accepted proposal documents will form part of the Contract made with the Consultant.

4.14 Only personnel listed in the successful proposal shall perform the work unless otherwise approved by the University of Victoria.

4.15 All questions regarding this proposal call should be directed to:

Michael Nelms
Project Manager
c/o Facilities Management
UNIVERSITY OF VICTORIA
Tel: 250-721-6103 Fax: 250-721-8999
Email: mnelms@fmgt.uvic.ca

5.0 Selection Criteria and Procedure

This Request for Proposal is being released without the procedure of requesting Expressions of Interest. It is expected that the study will be awarded to a highly qualified consultant that has demonstrated successful experience in hydraulic modeling, retention pond design, and stormwater treatment.

The consultant will be selected on the basis of:

5.1 Availability, ability, and past experience of personnel.

5.2 Ability and past experience of the company in similar work.

5.3 Methodology outlined in the submitted proposal.

5.4 Quality of support resources.

5.5 Fees.

The University reserves the right to reject any or all proposals and to accept the proposal deemed most favourable in the interests of the University.

6.0 Closing Time for Submissions

Two (2) copies of the proposal shall be delivered before **3:00 P.M., Friday, December 20, 2002,** to:

G. A. Robson, P.Eng.
Executive Director
Facilities Management
UNIVERSITY OF VICTORIA
Saunders Building
P.O. Box 1700, Stn CSC
Victoria, B.C. V8W 2Y2

DWL/slg

S:\PROPERTY\LAND\2002\STORMWATER MANAGEMENT SYSTEM - TERMS OF REFERENCE

Appendix E- Soils Report

THURBER ENGINEERING LTD.
[illegible]

THURBER

October 21, 2003

File: 19-3220-1

Komex International Ltd.
201 – 2840 Nanaimo Street
Victoria, B.C.
V8T 4W9
Fax: 384-1499

Attention: Mr. Mike Thompson

UVIC STORM WATER DISPOSAL STUDY
GEOTECHNICAL/GEOLOGICAL CONDITIONS

Dear Sir,

This report presents the results of a preliminary geotechnical/geological study carried out for the University of Victoria Storm Water Disposal study. The scope of work was outlined in our proposal letter dated October 14, 2003 and authorization to proceed with the work was given in your letter dated October 20, 2003.

Use of this report is subject to the attached Statement of General Conditions.

1. INTRODUCTION

Komex International Ltd. (Komex) is conducting a study to determine the viability of in-ground storage/disposal of surface water runoff at the University of Victoria. Thurber Engineering Ltd. (TEL) has conducted numerous geotechnical studies across the campus and is therefore familiar with the various types of soil and geological conditions at the University.

Our scope of work for this study included a review of available borehole information in our project files. TEL has completed 85 design and construction projects at the campus since 1964. Borehole information is available for 46 of these projects. The available borehole data was used to identify general areas across the campus where near surface granular deposits are present and could possibly be used for in-ground disposal of surface water.

The results of our preliminary assessment are given in the following sections of this report. Further work will be required to assess the suitability of in-ground disposal at each potential site that is selected from this study.

2. GENERAL GEOLOGICAL CONDITIONS

The general geology of the area is shown on the attached Figure 1. A drumlinoid ridge of thick Pleistocene deposits (Unit T) lies along the eastern side of the University. These deposits are generally greater than 10 m thick and consist of Vashon Till and Quadra sands and silts. The Vashon till often caps the Quadra deposit and consists of variable amounts of sand, silt and clay. The Quadra deposit is inter-glacial and consists primarily of dense silty sand and poorly graded sand that is typically moderately permeable. However, the deposit often contains seams of less permeable silts and clays.

The area north, south and within the University Ring Road lies on the flank of the drumlinoid ridge and generally consists of more recent Victoria Marine Clay (C3, C4a and C5) that has been deposited onto the flank of the ridge. The clay deposit is generally very stiff to hard near the surface, but becomes firm to soft below depths of about 6 m. The clay varies is thickness from less than 5 m (C3) to greater than 8 m (C5) and has low permeability.

In some areas, a thin layer of surficial beach lag silty sand lies above the relatively impermeable Vashon Till. The deposit is typically thin (less than 2 m thick) and often becomes saturated during the wet winter months.

To the southeast of the Ring Road lies a small gully which contains deep deposits (> 8 m thick) of marine clay (Unit C5).

3. ASSESSMENT RESULTS

In-ground disposal of storm water is not considered feasible in the low permeability marine clay and glacial fill deposits. The surfical silty sand deposit has a moderate permeability, however this layer is generally thin and will likely be saturated during the wet winter months. It will therefore be of limited value for in-ground disposal purposes.

The Quadra deposit is generally moderately permeable and is the geological unit best suited for in-ground disposal of storm water. Our review of the available geotechnical soil logs has therefore focused on identifying areas where the Quadra deposit has been encountered at depths of less than 5 to 6 m below the ground surface. In areas where the Quadra deposit is deeper than this depth, in-ground disposal is not considered practical as this will require the use of injection wells into the underlying Quadra deposit.

Five general areas have been identified across the campus where the Quadra deposit is found at depths of less than 6 m below the ground surface. These areas are shown on the attached Drawing No. 19-3220-1-1 and are discussed below.

Area A (Family Student Housing Complex)

This site is located to the east of Finnerty Road and north of Sinclair Road.

The available borehole information in this area indicates that the Quadra deposit extends to depths of at least 8 m below the ground surface. The surficial silty sand deposit is about 1 to 1.5 m thick and is underlain by Vashon Till. The till at this site is typically silty sand and appears to have less clayey material than found elsewhere at the campus. The Quadra deposit lies beneath the till.

Area B (Residences to the south of Sinclair Road)

Quadra deposits were found to a depth of at least 6 m in the vicinity of the Cadboro Commons building and the southern block of the Craigdarroch residences. Marine clay was not encountered at this location.

The south-eastern block of the Gordon Head residences encountered surfical silty sand to about 2 m depth below the ground surface. The boreholes in this area met refusal on dense glacial till at this depth. Marine clay was not encountered in this area.

It is likely that the Quadra deposit is present to substantial thickness in the area due west of these structures (i.e. Commonwealth Village and Parking Lot 5).

Area C (Island Medical Building and Engineering Laboratory)

Glacial till and Quadra deposits were encountered beneath a cap of marine clay in the vicinity of the Island Medical Building (presently under construction), the Engineering Lab Wing and Parking Lot A (immediately west of the Lab), and in the forested area to the south-east of the Island Medical building and west of Parking Lot A.

The marine clay deposit in this area is generally 1.5 m to 5 m thick. One borehole in Parking Lot A encountered the Quadra deposit to a depth of 9.5 m below the ground surface (maximum depth of the borehole).

It is likely that the Quadra deposit extends across the ring road to the south. However, we have no boreholes in this area and the thickness of marine clay overlying the deposit is unknown.

Area D (Cedar Hill Cross Road)

TEL investigated the property on the north side of Cedar Hill Cross Road for a proposed Forest Research facility. The site is bounded by residential properties on the south side of Chelsea Place, and a deep ravine on the western perimeter.

The western portion of the property (immediately adjacent to the ravine) encountered 3.5 m to 5 m of marine clay overlying glacial till and Quadra sediments. The eastern portion of the property consisted primarily of glacial till and Quadra deposit. The Quadra deposit extended to a depth of at least 18 m below the ground surface in one of the boreholes drilled in this area.

Area E (Fraser Building)

Glacial till and Quadra deposits were encountered at the surface across the western half of the Fraser Building (Law Building) and extended to a depth of at least 14 m in one of the boreholes.

Marine clay was encountered at the surface across the eastern half of the building and was typically about 1 to 2 m thick. The marine clay deposit was about 5.5 m thick at the extreme east end of this site. Quadra sediments were encountered beneath the marine clay in this area.

No boreholes were available in the area to the west of the Fraser Building (between Parking Lots 8 and 9). It is possible that the Quadra deposits extend into this area.

Other Areas

Glacial till and Quadra sediments were encountered in boreholes below a depth of 6 m from the ground surface in the following areas:

- The south-east end of the running track at the Stadium;
- The Continuing Studies building;
- The Campus Services building;
- The Cornett building;
- The Human and Social Development building;
- The Phoenix Theatre;
- The south-west and north-east corners of the MacLaurin building;

- The Engineering Office Wing; and
- The area immediately east of the Petch and Elliot buildings.

4. SUMMARY

The information provided in this report is of a preliminary nature and is intended to assist in the selection of a site for possible in-ground disposal of storm water. As noted earlier, the glacial till deposit is typically very dense and has a high percentage of silt and clay sizes, which gives the deposit a low permeability. The Quadra sediments are typically more pervious but the composition of the deposit is quite variable. Low permeable silt and clay lenses are often found within the Quadra sediments and will impede water infiltration if encountered.

A site specific investigation and assessment of the feasibility of in-ground disposal of storm water will be required for the selected site(s).

When a preferred site has been selected, we can provide a more detailed review of the available geotechnical information in the selected area as the next phase of work. At that time, the general suitability of the site can be assessed before proceeding with the detailed investigation.

We trust this information is of assistance. If we may be of further assistance with this project, please do not hesitate to contact us.

Yours truly,
Thurber Engineering Ltd.
Stephen M. Bean, P.Eng.
Review Engineer

Kevin B. Sterne, P.Eng.
Senior Project Engineer

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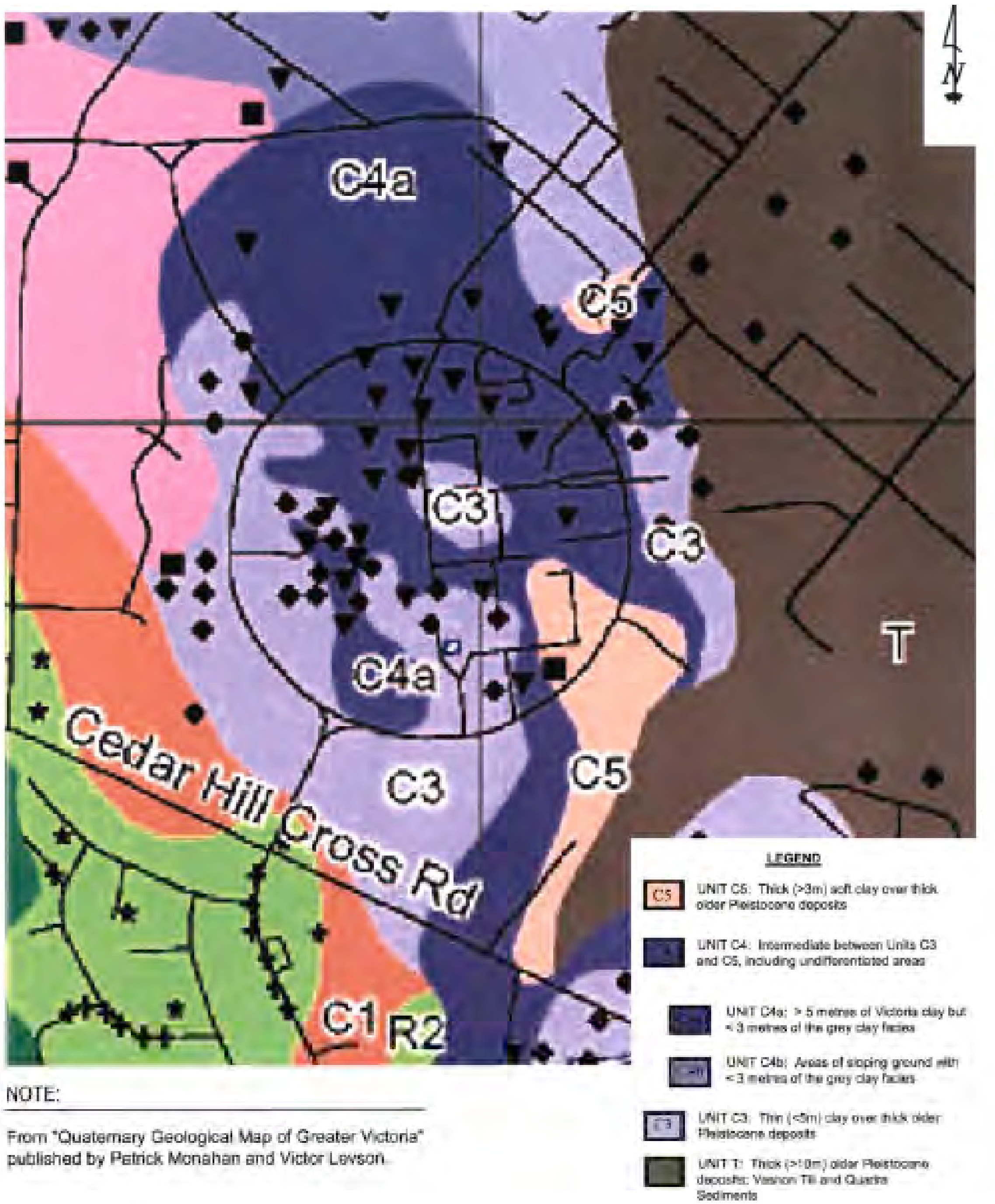
Attachments



NOTE:

From "Quaternary Geological Map of Greater Victoria" published by Patrick Monahan and Victor Levson.

SITE GEOLOGY MAP

Not to Scale

FIGURE 1

THURBER

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorized use of the Report.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgemental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

INTERPRETATION OF THE REPORT *(continued)*

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of persons providing information.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

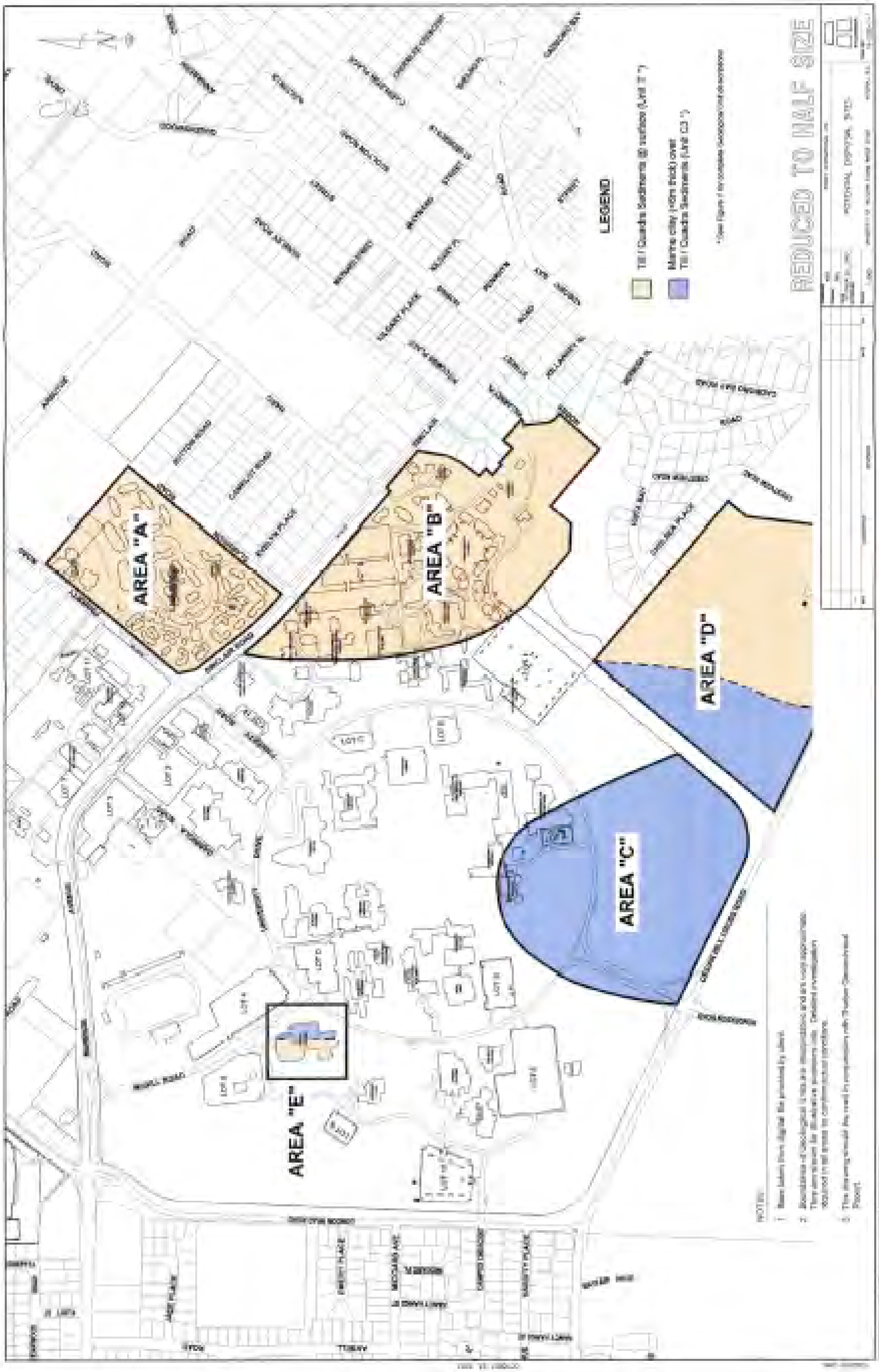
The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Clients' benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes decisions made to either purchase or sell land.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Appendix F- Educational Outreach Materials

Provided on enclosed CD.

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Appendix G- Public Feedback

Public Feedback on UVic DRAFT Integrated Stormwater Management Plan

<u>Comments received during period of March 25th – April 19th 2004:</u>

- Good plan overall; need some sort of action list of next steps.
- You should rename the title to be: "Stormwater Management Study" rather than "plan". There are no goals or targets so it is just a study.
- There needs to be a shorter version of the plan – one that an average reader can look at without needing a master's in hydrology!
- Very good plan overall. Clear explanation of concepts.
- I liked the inclusion of 'consideration of place' within Bowker Creek watershed.
- There needs to be more on the CRD model bylaws and how they impact this plan.
- I very much enjoyed reading the plan and especially liked the "retrofit" section.
- Landscaping techniques are very important; UVic needs to move away from hills and into swales. The entire campus landscaping should be redone over the next few years.
- I like the continuity of options – it is easily doable in the long term.
- Always pleased to see the university engaging in consultation processes in their ongoing path to sustainability.
- Who will enforce this plan?
- The display boards were sometimes confusing – which of the options is the university actually going to do?
- Innovative building design is critical. If the university follows through with LEED buildings then they won't have to worry as much about stormwater plan.
- I am a student and just saw a poster for this Open House. Very good plan but it is a little long.
- Parking lot upgrades should be the least of concern. I am sick of the automobile getting priority. Buildings and landscaping should be done first.

- To the point, effective, and good examples.
- Needs more emphasis on improving water quality not just flow.
- How will this plan work with the Bowker Creek Watershed management plan?
- Hydrology section: good background information and proposals.
- There were too many tables and charts in the hydrology section that weren't clearly explained.
- Great to see native plants being used.
- I am concerned that there is not enough public awareness around urban water quality. Have you thought of partnering with the CRD to educate more people?
- Excellent descriptions of natural areas. This information should be used in restoration work to remove ivy etc. in Mystic Vale and Cunningham woods.

Date: April 19, 2004

To: Sarah Webb, Interim Sustainability Coordinator

From: The POLIS Project on Ecological Governance

Re: Submission on the Draft Integrated Stormwater Management Plan

This memo sets out highlights, questions for clarification, and recommendations to the University of Victoria in regard to the Draft Integrated Stormwater Management Plan and UVic's general approach to development from the perspective of stormwater management.

The POLIS Project supports:

UVic's stated commitment to build on parking lots, create compact development, pursue transport demand management, and preserve green spaces. These are critical to ecologically sound stormwater management;
To reduce surface parking, UVic must evolve a campus that is focused on "alternative" transportation. This is crucial because parking lots and roads have the greatest impact on the quantity, quality and timing of stormwater runoff, and they can only be replaced if they are not needed. Minimizing building footprints further reduces impervious surfaces, and preserving greenspaces maintains nature's capacity to capture, store and release stormwater.

The myriad progressive solutions to stormwater management such as water cisterns, green roofs, grass/gravel pave parking lots, and bioswales.
UVic should implement these solutions in a fashion that will result in multiple benefits such as reduce impacts from stormwater runoff, minimized pollution, and hands-on learning opportunities for students.

The integration of student research into campus operations by providing support to projects that would fill stormwater data gaps and future research needs; and
By weaving student research into physical operations, students gain hands on experience. If their work actually contributes to the implementation of sustainable solutions for the long-term development of the campus community, this support will be meaningful.

UVic's integrated, rather than piecemeal, approach to stormwater management.
The plan takes a comprehensive view of potential best management practices (BMP's) for development and potential retrofits across the entire campus rather than focusing on mitigating problems building-by-building or area-by-area.

The full implementation of the recommendations outlined on page 128.

There are, however, some serious gaps in the Plan that need to be addressed. Below are the recommendations (and points of clarification) that POLIS feels are important to be addressed for this Plan to have a meaningful impact on future development:

The Stormwater Management Plan needs to state an overarching goal for stormwater management on the Gordon Head Campus, and what BMP's are to be implemented.

Section 5 outlines a number of BMP's for retrofits. Section 6 outlines BMPs for new and future developments. Table 2.2 provides figures on total volume and peak flows in each watershed for predevelopment, 1956 campus lands, 2003 UVic Campus "As-Is", 2003 UVic Campus with "BMP's", 2003 Campus Plan Buildout "As-Is Technology", and 2003 Campus Plan Buildout with "BMP's".

It is unclear what "BMP's" would be implemented in order to achieve "BMP's" volumes and peak flow rates outlined in table 2.2. It is also unclear whether the "BMP's" volumes and flow rates included in this table are the stormwater targets UVic is striving to meet. If these are UVic's targets, it is not clear how they are arrived at. Are they based on specific goals that will restore ecological functions and allow the return of aquatic life in the various watersheds? If the answer is yes, have they been set using scientific evidence?

The Plan needs to articulate a University goal to reduce stormwater impact on each watershed to a degree that allows for full restoration of aquatic ecosystems.
UVic's stormwater focus should not be only to mitigate the impact of future development but to reduce current impact. Targets should be set based on scientific evidence to achieve runoff levels.[4] Objective 4B in the Bowker Creek Watershed Management Plan refers to the community's desire to "meet or exceed provincial water quality guidelines for aquatic life". UVic should be striving for the same objectives in the implementation of the stormwater management plan as the surrounding community.

The Plan needs to be reoriented from its current status as an informational document into a true "plan" by undertaking clear commitments in an implementation section.
The plan doesn't establish what UVic is planning towards (see Recommendation #2 above). The document presents information (such as vegetative and hydrological information, and a list of potential best practices) but doesn't outline how to implement the BMP's outlined on pages 58-61, nor which are of highest priority. It does not provide a timeline for implementation. Without a proposed plan for implementation, there is no "take-home" commitment from the University. This is a critical omission that must be rectified for the Plan to serve its potential functions fully.

The Plan needs to commit to retrofitting existing buildings, parking lots and roads on campus (at p.128). Though Saanich's Stormwater Management and Erosion Control By-Law appears only to refer to new developments, UVic's commitment to the restoration of Bowker Creek and the other watersheds that the campus intersects requires the University to undertake retrofits in existing developments to reduce stormwater runoff, and its impacts.

The Plan needs to be better integrated with overall water management on campus to as to prioritize stormwater solutions that achieve other sustainability goals.
Reducing the impact from stormwater runoffs presents opportunities to improve the sustainability and efficiency of water use on campus, for example, by setting up a water reuse system that uses stormwater along with other wastewater streams (eg. greywater or the water from the Outdoor Aquatics Facility). Many of these opportunities are outlined in section 6 and appendix C. UVic should capitalize on these opportunities.

Rainharvesting should be considered a priority stormwater management practice.

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[4] The level of groundwater recharge should also be considered.

Stormwater expert and SCA consultant[5], Thomas Holtz, favours this option as it reduces the amount of water the soil has to handle. Every time a site is cleared, more runoff is generated for the stream to handle. By harvesting some of this excess runoff that has been created, one can help bring the hydrologic cycle back to what it was before the disturbance. This will also reduce the need to extract water from streams or a reservoir elsewhere, and thus leave more water for the ecosystem. By taking water that would basically have been discarded, power and sewer bills could be reduced.[6]

The Stormwater Management Plan should acknowledge the importance of adhering to principles 2, 3, 4, 5 and 8 of the 2003 Campus Plan and the implementation of related action items.
The best way to solve the problem of stormwater is to avoid problems from the start. This can be accomplished by "rethinking development" through implementing the principles 2, 3, 4, 5, and 8 as outlined in the 2003 Campus Plan.

8) For the University of Victoria and its community to fully benefit from what integrated stormwater management has to offer, the Plan must be explicitly placed in the larger context of campus planning and sustainability.
Such components as oversight of broader sustainability goals, and assessing whether the plan meets an overall sustainable vision for the University, should be informed by the new Campus Planning Committee (and its operational sub-committee) on an ongoing basis.

[5] http://www.thescagroup.com/

[6] Holtz, Thomas, Consultant, the SCA Group, *Personal Communication*, April 16, 2004.

Recommendations for UVic campus watersystem draft plan

Gregory Randall

To the general understanding that the water is the lifeblood of the ecosystems, here is a list of possible additions to the plan to enhance its message which is already very good.

Design points:

_The plans and incentive to design new water features are important to the health and recreation of the university: man made lakes, ponds, streams, pools, fountains, waterworks etc. Consider these water features as desirable landscape enhancement and beautification elements.

_Restoration of old natural water features such as creek beds with water flow restored from grid drainage systems, daylighting streams out of culverts and other such things.

_The addition of trembling aspen to the upland zone listing of plants is required. It is a very significant tree in our area and abundant in wetland locations around the fringes of ring road and borders of forests such as the Cunningham woods and Bowker Creek.

_Berms serve a function as grassy walking corridors that are good in some locations. They could be fitted with outflowing gutters to collect water and send it to desired locations. They are also esthetic elements. Some can be converted to swales, others not, it should be decided on a location by location basis.

_ A contour map of UVic campus showing the gravity drainage in the topography would be of visual benefit to the plan.

_A description of how the impact of newly constructed buildings and their sites on campus will affect the drainage patterns

Other points:

_There should be a heightened awareness of landscape water management in the community. In addition to stormwater management add "and natural water systems" etc.

_The university can function as a model showcase for other hydrology projects around the city, so what is done on campus has the potential to initiate other projects.

Make small, inexpensive changes whenever possible to fix problems. However,
I don't think the university should be too trivial with restorations, but where to draw the line?

Ian P. Graeme *2615 Dean Avenue, Victoria, BC, V8R 4X5 ph/fax: (250) 370-1271*

April 21, 2004

Sarah Webb
Interim Sustainability Coordinator
Facilities Management
University of Victoria
PO Box 1700 STN CSC
Victoria, BC V8W 2Y2

Dear Sarah Webb:

Re: U-Vic Integrated Stormwater Management Plan - March 2004 Draft

Here are some comments based on a very quick review of the above report. Please forward to the authors as appropriate. Unfortunately time limitations did not permit a detailed review so some of the comments may not be relevant. Please contact me if you have any questions. Thanks for the opportunity to comment.

Yours truly,

Ian Graeme

Ian P. Graeme

Comments on Integrated Stormwater Management Plan – March 2004 Draft (U-Vic Project 02-4367)

General:

- The report is an excellent step forward in recognizing the importance of integrating land use planning, building design and construction practices, and the protection of water quality, quantity and aquatic ecosystems. The plan helps to fulfill one of the commitments in the 2003 Campus Plan and sets a progressive example that other major public institutions—both local and national—will follow.
- A plan typically includes goals, objectives and strategies with specific actions or recommendations and associated timelines. Having read the report (albeit very quickly) the specific objectives are not clearly stated. The rationale (page 1) and terms of reference (appendix) in part establish the objectives but these, along with the intended audience of the report, should be more clearly stated up front.
- The level of detail in the report lacks consistency—there are sections that go into considerable technical detail (e.g., simulation modeling) while other sections might be better suited to a public information circular (pages 63-76). There is some significant duplication in material between chapters. A heavy technical edit would improve readability and consistency.
- In a number of locations the plan discusses the importance of taking a broad watershed approach. However, it is disappointing that no reference or explicit linkage to the recently adopted *Bowker Creek Watershed Management Plan* (or other applicable watershed-level plans) was made in the report. The university's past and present impacts on this system, its location as a headwaters, and the severity and complexity of issues downstream, make this linkage all the more important.

Section 1

- More context on the existing regulatory framework would be helpful. For example, the statement, "Oak Bay has instituted stormwater bylaws limiting volume and quality…" is not very specific, particularly given that much of U-Vic lies within and is tied to the infrastructure of that municipality. What is the nature of the bylaws, is U-Vic meeting them and are there any specific issues?
- The statement on page 3 "…at U-Vic most of the area drains a Type 1watershed…" does not appear to be consistent with the figures in table 2.5.

Section 2

- I couldn't easily find a simple table that summarizes some basic watershed statistics. For example, are 2003 figures analogous to those in table 2.3 showing today's pervious/impervious area by watershed available?

Ian P. Graeme

- What is the difference between the "Total campus area" in table 2.4 (162.8 ha) and the "Total drainage area" in table 2.5 (196.9 ha). Presumably the latter includes off-campus areas that drain into the campus (?).
- Information describing the component drainages areas within the campus by watershed is important, but so is the *contribution* of the campus to each of the overall watersheds. Suggest including a table something like this to paint the picture:

Watershed Name	Total area of (entire) watershed (a)	Area within or draining into campus (b)	Area within campus (c)	Percent of watershed (c/a)	Percent of campus area (c/total c)
Bowker	1028 ha	100.4	etc	etc	
Hobbs	Etc	66.8			
Cadboro	Etc	9.1			
Finnerty		20.6			
Totals	**--**	**196.9**	**162.8**	**--**	**--**

- In a number of places you use the term watershed where I think you mean sub-drainage.
- Including a description of the downstream issues—to which U-Vic and its activities contribute—would also be appropriate. Any related analysis or associated recommendations?

Section 3

- Some of this information would be easier to absorb if tabulated. The graphic on page 29 is virtually illegible. Enlarging the image and including a simple reference to the 2003 Campus Plan website would probably suffice.

Section 4

- summarizes some useful descriptions of the key vegetation associations, their conditions and restoration opportunities. This content is not well reflected in the report's title.

Section 5

- The tables summarizing the suitability of various BMPs on pages 58-62 is perhaps the most useful part of the entire report.
- Were the plant species suggested on pages 78-79 prescribed specifically for U-Vic environment?

Section 6

- With the exception of the first few pages and the local photographs, the bulk of this section does not deal with any specific "New and Future Development" at U-Vic. Most of the material described is typical of stormwater management strategies that can be found in available guidebooks (e.g., BC Stormwater Planning Guide" It would be nice to see some specific strategies customized for the University's own situation and tailored to its current building program.

- The specifics of each LEEDs credits might be better included as an appendix. The body of the report could then emphasize the specific technologies and strategies that U-Vic will use to achieve these credits.

Section 7

- The section suggests some worthy student projects but does not describe any specific responsibilities or suggest commitments for the university administration or other potential partners.

Section 8

- The importance of education is acknowledged. There are many opportunities to build on existing partnerships. Perhaps examples could be referenced in greater detail.
- It would be nice to see a specific recommendation for some resourcing to support education such as a modest demonstration project or two (e.g., "convert this raised berm in parking lot X to a vegetated swale…").

Conclusions

- The summary states that "development can produce a reduction in runoff rates and volumes…by installing rainfall retention roofs on the new buildings". Perhaps this conclusion could be reworded and carried forward as a recommendation in the following section.

Recommendations

- I can't argue with any of the recommendations. As general principles they should be easily adoptable by the University administration. Given the depth of the consulting team, however, I would have expected to see more 'hard-hitting' recommendations specific to the university's current and future building program.
- For example, was an in-depth consulting study required to conclude that "wherever possible, detain stormwater before it leaves campus" (recommendation #4) or "embark upon a stormwater education program"(recommendation #9)? In short, I would expect to see more policy advice, along with some specific action plans, suggested targets, resource requirements, monitoring program, etc. Perhaps these elements were outside the scope of the Terms of Reference.

Other:

- Appendix A: It is not clear if the proposed checklists represent an existing program or describes recommended procedures to be adopted by maintenance staff.

Ian P. Graeme

- Does the report describe any flows that may also contribute to the storm drainage system? For example, are there any specific issues or considerations like swimming pools or aquaculture facilities that need referencing? How are these being integrated into the university's and municipalities' storm drain plans.
- It would be useful to have a list of references summarizing the existing local information considered and reviewed as part of the report.
- You might consider investigating an alternative title. I find the existing title cumbersome, although I can't suggest a better one at this point. Adding an inspiring photo or two on the cover might also help elicit interest and convey the overall theme of the report.
- Again, tying the report back to an overall watershed context (e.g.*, Bowker Creek Watershed Management Plan*, *Hobbs Creek,* etc) helps to underscore the overall downstream benefits of U-Vic's stormwater planning. It will also help leverage resources and foster collaboration among government agencies, institutions, local community and stewardship groups.

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