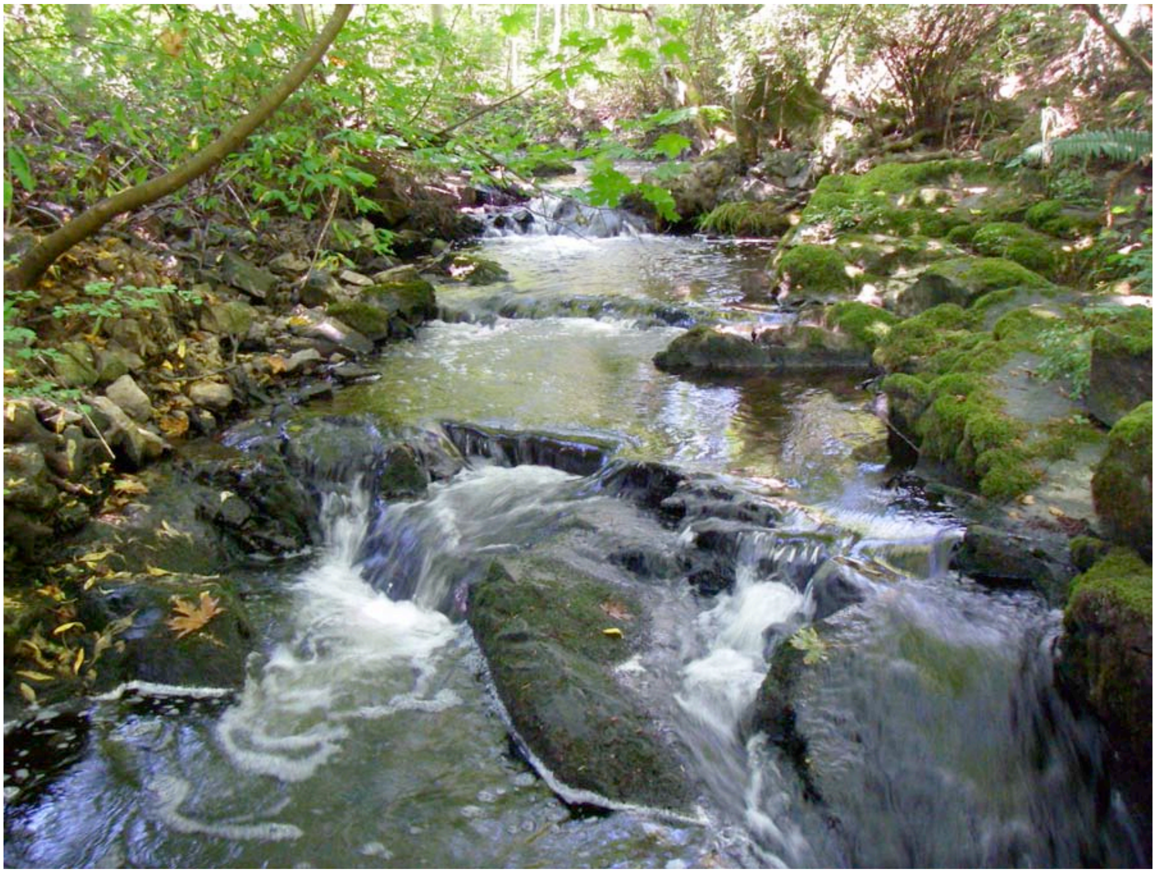
Colquitz River Watershed

Proper Functioning Condition Assessment



July 2009

Prepared for: *The District of Saanich*

Funding provided by: *The Real Estate Foundation of BC and The Federation of Canadian Municipalities*

Aqua-Tex Scientific Consulting Ltd. (1993)

Cooperative riparian Restoration

The Real Estate Foundation of British Columbia

Federation of Canadian Municipalities

Table of Contents

Abstract

A Proper Functioning Condition assessment (PFC) was conducted in the Colquitz River Watershed to determine the condition of the riparian-wetland areas and "health" of the river. This qualitative, yet science-based process considers both abiotic and biotic factors as they relate to physical function. It facilitates communication about the condition of a riparian-wetland area and focuses attention on the physical processes before considering values. A standard checklist is used to ensure consistency in reporting the condition of riparian-wetland areas. The PFC assessments were conducted during the months of July and August 2007. The purpose of this study was to determine the health and function of the creeks and other water bodies found within the Colquitz River Watershed and provide recommendations as to how to maintain and improve these areas. The 45.6 km^2 watershed drains areas of rural agriculture, residential neighbourhoods, commercial, and industrial land uses. In addition to the main channel, the major tributaries were also assessed and included: Durrell Creek, Blenkinsop Creek, Swan Creek, and Viaduct Creek. Fifty-nine reaches in total were evaluated and ratings ranged from non-functional to functional-at-risk to proper functioning condition. The reaches that are functional at risk are the highest priority for intervention and restoration.

Please note this report contains a separate volume with 7 appendices.

Citation

Buchanan, S., C.L Barraclough, L. Townsend, D. Hegg, L. Malmkvist, and W.P. Lucey. 2009. Colquitz River Watershed Proper Functioning Condition Watershed Assessment. Aqua-Tex Scientific Consulting Ltd. 129 pp + appendices.

Contributors and Participants

Project Leader
Cori L. Barraclough
Freshwater Ecologist
Aqua-Tex Scientific Consulting Ltd.
390 7th Avenue
Kimberley, B.C.
V1A 2Z7
(250) 427-0260
aqua-tex@islandnet.com

Watershed Assessment Team
Cori L. Barraclough, M.Sc. R.P. Bio - Freshwater Ecologist,
Brian LaCas, P.Eng.- Hydrologist
Wm. Patrick Lucey, M.Sc. R.P. Bio - Aquatic Ecologist
Lehna Malmkvist, M.Sc. R.P. Bio - Vegetation Ecologist
Lise Townsend, B.Sc.-Vegetation Ecologist

Oversight and Training Staff
Sarah E. Buchanan, B.Sc- Project Co-ordinator
Cori L. Barraclough- Editor

GIS Mapping
Stuart Barker, B.A.

Participants
Sarah Buchanan, B.Sc.
Daniel Hegg, B. Comm.
Kevin O'Riordan

Acknowledgements

The authors would like to thank the following individuals for the time and expertise they offered to this project: Brian LaCas, hydrologist (LaCas Consultants), Lehna Malmkvist, vegetation ecologist (Swell Environmental Consulting), and Adriane Pollard, Gerry Powell and Dwayne Halldorson of the District of Saanich. Much of this report format is based on previous work by John Anderson (Cold Stream Consulting) to whom we extend special thanks. We would also like to express our gratitude to those residents and institutions who permitted access to the streams running through their properties, including the staff of the Vancouver Island Regional Correctional Centre on Wilkinson Road.

Funding for this assessment was provided by the Real Estate Foundation of BC and the Federation of Canadian Municipalities, through the Green Municipal Fund, to whom we are greatly appreciative. The team would particularly like to acknowledge the support of Jas Michalski (Federation of Canadian Municipalities), Tim Pringle (Real Estate Foundation of BC) and Jim Bennett (Victoria Real Estate Board) and thank them for their championship of this project.

Executive Summary

Creeks and Communities

(Riparian Coordination Network, 2002).

"Healthy watersheds and riparian-wetland areas are critical to providing communities with the economic, ecological, and social benefits that come from the reliable availability of adequate supplies of clean water. The storage of water in riparian-wetland areas is important to ensuring a life-sustaining supply of this precious resource. Riparian-wetland areas are also unique features that connect landscapes and communities, providing unlimited opportunities to bring people together to create a common vision for productive and sustainable conditions. While there is growing agreement regarding the importance of watershed and riparian-wetland function, there continues to be considerable disagreement about existing conditions and appropriate treatments. This disagreement has led to an environment of lawsuits and regulatory approaches, often leaving out the people most affected by the decisions. However, there is increasing evidence that effective solutions arise from the workings of citizens and stakeholders."

"A better approach to managing riparian wetland areas is to facilitate efforts designed to build capacity within communities to confront and resolve the complex and contentious problems surrounding these resources. People are now recognizing that using the best science to make management decisions is not enough. Successful management of these resources is dependent upon bringing communities of people together, working at the landscape level."

"As an assessment tool, the Proper Functioning Condition (PFC) process provides a qualitative and standardized approach for assessing the physical functionality of riparian wetland areas. It can be applied in a variety of settings to gain consistent information that helps people begin to discern what is working well, what may be limiting, how management could be improved, or what further evaluations might be appropriate… The PFC ratings of streams within a watershed can guide the prioritization of restoration and management activities to those areas with the highest probability for positive change with a reasonable investment... Use of the PFC concepts and the assessment process increases awareness and understanding of riparian-wetland functions and builds capacity for cooperative decision-making and management that benefits both the land and dependent communities".

Objective

The objective of this report is to provide a baseline assessment of the health of the Colquitz River and its major tributaries. This assessment can then be used to develop a prioritized list of management activities in the Colquitz River watershed to ensure that present function is preserved, loss of function does not occur in the future, and restoration activities are prioritized in a manner that ensures that each activity is as successful as possible. When stream restoration is undertaken in a piecemeal fashion it can be compromised by degradation in neighbouring reaches. A watershed approach, such as the one presented here, ensures that each project builds on the success of the previous ones and makes the best use of scarce resources.

This report highlights further improvements that could be made when development occurs adjacent to a stream, to the extent that restoration activities are often associated with the development and approval process. Additionally, in the event that funds unexpectedly become available, they should be used in a prioritized manner for restoration of some of the key reaches. This report provides guidance to ensure that the priorities are addressed first and thus prevents further damage, before funds are spent on enhancement of comparatively healthy portions of the streams.

Background

The Colquitz River Watershed is located on southern Vancouver Island within the District of Saanich. The watershed drains an area of approximately 46 km^2, collecting water from the Blenkinsop, Swan Lake, Viaduct, and Durrell subwatersheds. The Colquitz River watershed is located in the Coastal Douglas-Fir moist maritime (CDFmm) biogeoclimatic zone. This zone is characterised by warm, fairly dry summers due to the rain shadow from the Olympic and Vancouver Island mountains, and mild, wet winters. The tree layer in the CDFmm zone includes: Douglas fir (*Pseudotsuga menziesii*) in many site series except the wettest; Garry oak (*Quercus garryana*) in dry/rich sites; arbutus (*Arbutus menziesii*) in dry/nutrient-poor sites; and western redcedar (*Thuja plicata*) and grand fir (*Abies grandis*) in moist to wet sites (Green and Klinka, 1994). Understorey species are also variable and may include dense shrubs in dry conifer forests, sedges, shrubs and skunk cabbage in wetlands, and grasses and forbs in open Garry oak savannas. The watershed includes a variety of land types, ranging from dry, rocky outcroppings to low-lying lands with underlying clay and/or peat. Garry oak savannas were maintained as open grassland ecosystems in this area in part through burning by aboriginal peoples, prior to European settlement (Fuchs, 2001). A map dated 1858 indicates three major vegetation types in the Colquitz watershed, which although not accompanied by a legend, are taken to indicate (based on corroboration with other sources, and the landscape/topographical context): conifer-dominated forest; Garry oak savanna; and riparian/wetland corridors and wetlands. Soils in the watershed along riparian corridors are composed of primarily clay and silt, with some bedrock outcroppings.

The watershed has been extensively altered with agricultural, residential, commercial, industrial, and institutional land uses. From 1872 until 1925, Elk/Beaver Lake was used as the main drinking water source for the Greater Victoria area, until the Sooke reservoir and pipeline was completed; however, small numbers of households continued to obtain drinking water from Elk Lake into the 1970s. Water licenses for irrigation and rural residential domestic uses have been granted and are still in place today, although extraction is less significant than in past decades.

Because the Colquitz River Watershed is contained within an urbanized area, water quality issues and other effects of impervious surface areas have important effects on the health of this system. Flows from impervious areas are “flashy” during rain events and contribute significant energy (and potential erosion) to the stream channels, while paved areas and inaccessible floodplains are incapable of storing and releasing water in the dry season. Typical of urban areas, almost the entire length of all the stream channels in the watershed have been altered to some extent in the past to reduce flooding, *i.e.* dredged or ditched; and most large wood has been removed. Although stormwater flows are successfully conveyed in this regime, effects on stream function include a lowered water table, simplified stream morphology that is less able to dissipate the energy of high flows, and no accessible floodplain to allow water to spread out and slow down. Repeated cycles of degradation and stream channel erosion are maintained by altered runoff processes from impervious areas, and invasive species that prevent re-colonization with native riparian species. Within this watershed, non-point source pollution can be attributed to agricultural run-off, septic field infiltration, and run-off from urban structures such as roads and residences (Butterfield, 1997).

Colquitz River

The Colquitz River is a third order stream found within the boundaries of the District of Saanich in Victoria, British Columbia. Flowing for a length of approximately 9.5 km from its headwaters in Elk/Beaver Lake south to its outlet at Portage Inlet, it passes through areas of forest, agriculture, and increasingly urban regions.

Historically, the Colquitz River has been home to numerous species of fish including cutthroat trout (*Oncorhynchus clarki clarki*), stickleback (*Gasterosteus aculeatus*), prickly sculpin (*Cottus asper*), Chum salmon (*Oncorhyncus kisutch*), Coho salmon (*Oncorhyncus keta*), and brown bullhead (*Ictalurus nebulosus*). Anecdotal reports attest to sizeable runs, such that old-timers recalled "the salmon were so thick you could just walk across them," (Morrison, 1983) and so plentiful that farmers speared them for use as fertilizer on their fields (Neate, 1967). While the species present in Colquitz River remain the same, the number of fish has been decreasing within this ecosystem and in recent years returning salmonid spawners have numbered only some several hundred (Victoria Fish and Game Protective Association, 2002). This reduction in the size of the fish population has been linked to urban development, degraded stream channel characteristics and habitat, poor water quality and an obstruction at Quick's Bottom that prevents the fish from reaching the spawning beds of the upper Colquitz. Additionally, the dam at the outlet of Beaver Lake, which was originally built in 1860 for the purpose of storing water for the use by a sawmill near West Saanich and Wilkinson Roads, has changed the natural hydrological regime of the river.

Swan Lake and Swan Creek

The Swan Lake watershed (including the drainage areas for Swan Creek and Blenkinsop Creek) is approximately 1,200 hectares (12 km^2) in size and is a sub-catchment of Colquitz watershed. Swan Lake itself is a 9.8 hectare lake surrounded by wetlands totalling an additional 15 hectares in size. Presently, Swan Lake is part of the 47-hectare Swan Lake/Christmas Hill Nature Sanctuary. The main inflow stream, Blenkinsop Creek, flows south and west from Blenkinsop Lake into Swan Lake. The outflow stream, Swan Creek, flows west and joins with Colquitz River near Violet Avenue and Interurban Road. Land use in the watershed includes agriculture to the north in the Blenkinsop Valley, varying densities of residential housing, and commercial lands. Previously, two wineries dumped large amounts of effluent into Blenkinsop Creek during 40+ years of operation, and sewage pollution was also once a concern. This material, as well as ongoing runoff from agricultural and urban areas, has created a highly eutrophic condition in Swan Lake, which is characterised by algal blooms and extremely low dissolved oxygen content (Dawson, 1986; Zaccarelli, 1975).

Swan Creek has been regularly excavated to convey stormwater and to prevent flooding. Immediately downstream of Swan Lake, the stream channel takes the form of a straight, low-gradient ditch through lands used for public allotment gardens. Despite regular channel dredging up until recent years, the gardens regularly flood in the winter. This area was previously a wetland that extended from the lake to north of McKenzie Avenue.

Blenkinsop Creek

Agriculture has dominated land use in the Blenkinsop Valley since the late 1800s and has led to considerable changes in habitat. By 1956 most of the original vegetation community was destroyed by clearing and cultivation and the installation of high-tension lines for the transmission of power (Hardy, 1956). Old maps dating back to 1858 show that there was no channel directly linking Blenkinsop Lake to Swan Lake; rather, the headwaters for Swan Lake appeared to be a relatively small wetland in the present location of the Public Works Yard on Borden Street near McKenzie Avenue. Today, a man-made ditch (now partially culverted) connects the two lakes. This ditch was constructed in order to drain the large bog wetland that previously existed south of Blenkinsop Lake. The continued lowering of the channel to improve the rapidity of water drainage caused such a concern over erosion that much of the channel had to be culverted (Langford and Burns, 1977).

Today, flow is regulated by a weir at the south end of Blenkinsop Lake as well as a dam just upstream of Cedar Hill Cross Road (Cumberland Dam). A restoration project undertaken in 2001 immediately downstream of Blenkinsop Lake restored approximately 650 m of the ditch to a functional stream which, due to the dams upstream and downstream of this reach, currently functions as a slow moving, lentic pond. Should regulation of water flows be discontinued in the future, it is designed with the correct morphology to function as a stream (Aqua-Tex 2007).

Viaduct Creek and wetland

The Viaduct Creek subwatershed, located west of Quick’s Bottom, is dominated by agricultural and rural residential land use, including the area that is now Viaduct Flats.

Up until 1993, when the agricultural lease on the Viaduct Flats area expired, farming was conducted alongside Viaduct Creek in this vicinity. At this time, the Viaduct flats area experienced flooding during the winter months with dry periods in the summer. In 1993 however, material jammed the outlet channel and Viaduct Flats remained flooded for the duration of the year. In 1994, this jam took on the appearance of a beaver dam and beaver activity was noted among the bordering vegetation. This consistent supply of water created a unique habitat for numerous plants, bird species, and other wildlife (Carson, 1996). As a result, the dam was maintained for this purpose and a permanent dam was installed in 2007 at the outlet of the flats.

Other human-induced alterations have occurred within this subwatershed such as the ditching of a wetland for agricultural reclamation upstream of Interurban Road within the last 20 years (Askew, pers. comm.).

The reach of the creek between Viaduct Flats and Quick's Bottom is also referred to as "Goward Springs A" Creek. For ease of discussion, the entire channel is presented in this report as Viaduct Creek.

Durrell Creek

The Durrell Creek subwatershed drains an area of about 530 hectares, and has been an agricultural area since the late 1800's. The valley portion of the Durrell watershed is composed of primarily organic Metchosin soils which are the remains of historic wetlands. The rich soil is thus is ideal for agriculture but is also susceptible to flooding. Flooding in the area occurs seasonally, beginning with the winter rainfall, as backwater from the controlled flows of Colquitz River. There have been claims by local residents that the installation of a culvert beneath Interurban Road has led to flooding issues more extreme than what had occurred prior to culvert placement. There are eight wetland areas located within this subwatershed and 25% of the land is forested (Pottinger Gaherty Environmental Consultants *et al*., 2000).

General

Each creek system assessed in this report has been subjected to ditching or dredging to allow for agricultural and other land uses. Unfortunately, the lowering or dredging of creek systems to drain the land concentrates energy within the stream channel and leads to erosion and loss of ecological function. With effective management, properly functioning creeks are better able to dissipate the energy of peak flow events, store water in floodplains, recharge groundwater, rebuild soils, and prevent downstream flooding. In addition, they provide valuable habitat, and provide desirable values such as recreation and education opportunities, and increased property values.

Key Issues

The Colquitz River watershed has been heavily altered by encroaching urbanization, historical and present agricultural activities, and some industry. As a result, many reaches of this watershed have been ditched and dredged to allow for drainage of the land to accommodate the needs of the surrounding communities. Watershed peak flows have been augmented due to an increase in effective impervious area and erosion is an issue in many reaches. The loss of riparian vegetation and the subsequent intrusion of invasive species have reduced the ability of the streams to accommodate these increased flows. Furthermore, removal of riparian vegetation increases water temperatures which can negatively impact fish inhabiting the stream.

The District of Saanich embarked on a program of land acquisition and protection for the watershed in the 1970's. It is a desire of the municipality and of many residents, to see the Colquitz restored to its functional condition and, in particular, to restore the salmon runs as far as practical. For the most part, Saanich is largely developed, with few remaining greenfield sites. The process of restoring the stream will therefore require retrofitting and redevelopment to control excessive stormwater flows, and active rehabilitation of key portions of the stream by controlling public access, restoring floodplain access and wetland storage, managing invasive species and replanting riparian vegetation. The watershed is very large and therefore this work will need to be conducted in stages, by determining which areas should receive priority and setting measurable goals to assess the success of the remedial actions. This report provides a baseline against which to measure the success of rehabilitation.

Conclusions

Over eighteen kilometers of stream channel were assessed throughout the Colquitz watershed. Approximately 37% was in a non-functional condition, 5% was functional-at-risk with a downward trend and is thus a priority for restoration, 13% was functional-at-risk with no apparent trend, a small percentage (<1%) was functional-at-risk with an upward trend, and 45% was in Proper Functioning Condition (PFC).

PFC Category:	
Non-functional	6852 m
Functional-at-risk with downward trend	893 m
Functional-at-risk with no apparent trend	2390 m
Functional-at-risk with an upward trend	172 m
Proper Functioning Condition	8297 m
TOTAL KM	18.6 km

All the reaches assessed during the fieldwork in July and August, 2007 have been displayed in a table indicating restoration priorities. Each assessment character group has been further broken down into high priority, moderate priority, and low priority. If opportunity and/or funding arises, this table aims to give an indication of which restoration/rehabilitation projects should be targeted first. However, the order of this table should not deter action on low priority reaches if an opportunity should appear in that area, for example due to development/ redevelopment on property adjacent to the stream. The table can be read from top to bottom, with the highest priorities in the category of "functional-at-risk, high priority" and the lowest priority being "Non-functional, low priority".

Table 1. List of Reaches by Restoration Priority

Priority Level (separated by condition)	Reach Names
Functional-At-Risk	
High Priority	Blenkinsop Reach 2. Colquitz Reach 18. Viaduct Reach 2b.
Moderate Priority	Colquitz Reaches 5, 10, 12, 20. Viaduct Reaches 2a, 5, 8, 12, 13.
Low Priority	Viaduct Reach 14.
Proper Functioning Condition	
High Priority	Blenkinsop Reach 1. Colquitz Reaches 7, 14, 21,

	22. Swan Reaches 3, 6. Viaduct Reaches 10, 11.
Moderate Priority	Blenkinsop Reaches 5, 6. Colquitz Reaches 1, 2, 4, 15, 16, 17. Swan Reaches 4, 9. Viaduct Reach 15.
Low Priority	Colquitz Reaches 3, 6, 10b, 11, 13, 19. Durrell Reach 4. Swan Reaches 1, 5. Viaduct Reaches 1, 3, 7, 16.
Non-Functional	
High Priority	Colquitz Reaches 8, 9. Swan Reaches 2, 7, 8.
Moderate Priority	Blenkinsop Reach 4. Durrell Reach 1. Viaduct Reaches 4, 6.
Low Priority	Durrell Reaches 2, 3. Viaduct Reaches 9.

Data Needs

- More data for stream flow is needed in order to create a comprehensive hydrograph for Colquitz River and its tributaries within the Colquitz River Watershed. The improved understanding of the movement of water within the watershed will enable planning for better restoration, enhanced maintenance, and flood events. Additionally, more detailed information could further explain the impact of impervious surfaces on stream conditions to interested parties. (Some of this information is presently in draft format with the District of Saanich, but this team has not had the opportunity to review the information). Using this data, the municipality can track changes in water flow over time as climate and other environmental conditions are altered.

Education Needs and Public Involvement

- The members of the public, and other groups, located within the watershed should be educated on the impact of run-off from impervious surfaces. Mitigation efforts should then be encouraged throughout the watershed such as reducing impervious surfaces and using on-site infiltration measures such as absorptive soils and vegetated swales.
- There are several interested community groups who are very active within the watershed, including the Gorge-Tillicum Community Association. Such groups could (and we believe would) act as ambassadors to promote rainwater management if they were provided with the educational materials to do so.

- School stewardship programs such as those that have occurred through Spectrum Community School and Strawberry Vale School (under the Urban Salmon Habitat Program) could be reinstated and expanded to involve students in stewardship activities.
- Community outreach events could be organized to bring awareness to the presence and function of the streams within communities. Additionally, these events could explain the importance of maintaining riparian zones and reducing invasive species, thus promoting public action on these two fronts.
- Many of the riparian areas in the Colquitz River watershed that require restoration or preventative maintenance are within Saanich Parks. Saanich Parks does not have resources to address all the issues. Control of invasive species is a major problem, but is one that could be addressed, in part, by active community groups.

Recommendations

The following recommendations represent opportunities to ensure the creeks of the Colquitz River Watershed maintain their current function and advance toward their potential and desired future conditions. Additionally, the recommendations of the five top priority reaches (based on Table 1) are examined in more detail.

Critical Actions

There are several issues that should be addressed immediately, in order to prevent degradation and significant damage to property and/or significant future expense:

Headcuts

1. The headcut at 4484 Markham Road (downstream of Markham Road at the entrance to VITP) is significant and in need of immediate attention. Additional flows from recent work at Layritz Park have exacerbated the poor condition of the channel and accelerated the headcut. This headcut has the potential to increase, in the near future, to the point where it will undercut Markham Road.

2. There is (presently) a very small headcut upstream of 389 Viaduct Avenue West on Viaduct Creek in a reach that is otherwise in very good condition. This headcut should be addressed to prevent downcutting and loss of a significant area of functional, healthy stream habitat. What is presently less than a 60 cm drop, could easily become a significant gully, similar the one seen at VITP.

Invasive Plant Species

1. In addition to the ubiquitous invasive species such as Himalayan blackberry, there are several emerging invasive species which are present in small numbers and can still be eradicated before they become a significant problem. They include Japanese knotweed, purple loosestrife and bamboo. All three plants have been found in the Colquitz watershed and should be immediately eradicated from these locations:

   Japanese Knotweed — Reach 2, Blenkinsop Creek, near the north end of the Swan Lake (Lochside) trestle.

Purple Loosestrife	Reach 4, Durrell Creek between Interurban Road and Granville Avenue Reach 7, Swan Creek, just upstream (south) of McKenzie Avenue
Bamboo	Reach 12, Viaduct Creek near 365 Viaduct Avenue West Reach 10 a, Colquitz River near 4252 Moor Park Place Reach 20, Colquitz River just upstream of 4674 Pipeline Road

The loosestrife and knotweed near Swan Lake (Swan Creek reach 7 and Blenkinsop Creek reach 2) are of particular concern, because they could easily invade the Nature Sanctuary or the restored wetland area immediately north of McKenzie Avenue.

General Recommendations

Planning and management at the watershed scale is necessary to address many of the concerns highlighted in this assessment. Integrated watershed management (IWM) is a concept variously defined but generally acknowledged to include ideas such as (Townsend, 2006):

- utilising the watershed as an effective management unit for planning and development;
- addressing multiple and interrelated land use values, as opposed to managing for narrow values such as drinking water or flood control;
- involving various stakeholders and levels of government in planning and implementation;
- maintenance and restoration of watershed ecosystems;
- an attempt to preserve or restore natural hydrological cycles and habitat; and
- integration across multiple disciplines and knowledge.

IWM would therefore enable a holistic and long-term approach to restoration and conservation. There is currently a high level of interest in IWM among local public and government agencies. This type of management could address multiple resource objectives beyond riparian restoration, such as improved water quality, climate change adaptation, urban forest stewardship, West Nile virus management and enhancement of quality of life in the municipality. Implementation of IWM could also allow for more funding opportunities, for example through Ministry of Community and Rural Development grants and LiveSmart BC initiatives. Watershed management, land use planning, and stream restoration, although not without costs, can also offer significant economic benefits to communities and land owners/ managers (Barraclough and Hegg, 2008; Center for Watershed Protection, 1997).

The second general recommendation is the need to implement best management practices (BMPs) for stormwater, particularly at the small site level across the watershed. This would substantially reduce the volume of runoff and increase the lag time (time between maximum rainfall and maximum river stage), and move toward a more natural flow regime. High-energy, erosive flows are responsible for a large percentage of degraded conditions observed in the field. Water quality, although not directly assessed in this report, would also be significantly improved. Locally relevant BMP resources are listed in Malmkvist and Townsend (2008).

More focused recommendations, as highlighted from field observations, include the following:

1. Control invasive plant species, plant native riparian species on and near the banks, and use bioengineering such as willow wattles to moderate erosion activity in degraded areas. To be most effective, this would be best implemented as a municipal or watershed-scale effort (*i.e.* part of an IWM plan as described above), entailing prioritization and planning, research and trial of various methods, as well as long-term follow up, maintenance and monitoring.
2. Fence riparian corridors in park areas with high visitation to keep dogs and people out of the creeks and off the banks and permit vegetation to re-grow.
3. Create specific viewing areas to permit people to view and access the creeks without trampling vegetation.
4. Increase educational signage in parks and green spaces to inform, educate and promote stewardship. Engage local schools to assist in developing the text wherever possible. Create signs that target different age groups and interests.
5. When woody debris enters a creek system it should be allowed to remain (where flooding is not a risk to private property or infrastructure) to mitigate peak flows, and aid in the creation of meander and floodplain.
6. Continue acquiring property adjacent to the Colquitz River for management and protection purposes and extend this to the other creeks in the watershed wherever possible.
7. Ensure that large tracts of floodplain, including Viaduct Flats, Quick's Bottom, Panama Flats, and key areas around Blenkinsop Lake and Swan Lake remain accessible to flood waters in perpetuity. This may require property acquisition, leasing arrangements or other legal instruments. While this may appear cost-prohibitive, without these key areas, the potential costs of flood damage to downstream property and infrastructure could be very significant.
8. Develop an "adopt-a-stream" program, similar to the "adopt-a-highway" programs where community groups and companies sponsor litter control, to care for specific reaches of creeks within the watershed.

Recommendations by Reach (Top 5 Priorities)

Viaduct Creek Reach 2b (From the upstream boundary of 4484 Markham Road to the weirs at the outlet of Viaduct Flats)

In the lower section of the reach, small weirs can be installed to trap sediment and build up the channel so that it can access its floodplain. Additional native riparian and upland species should be planted. This planting will aid in shading out reed canary grass and keeping the channel open. The headcut resulting from flows from Layritz Park must be mitigated to prevent downstream sedimentation. More detailed suggestions for mitigation of the headcut are included in the reach summary for Reach 2b.

Colquitz Reach 18 (From the waterfall at 4525 Cheeseman Road to the first cascade at 4650 Pipeline Road)

This area is currently over-grown with English ivy which is affecting the health of the remaining trees and thus jeopardizing the integrity of the stream channel. The ivy in this reach must be removed in stages in order to prevent soil erosion from vacated areas and to ensure the survival of those native species at the site. Landowner outreach will be necessary to improve the condition through ivy removal, as well as increasing awareness as to what impacts human activity can have upon creek systems.

The riparian area is very narrow in this section and if a park trail were to be installed it may damage the area extensively. Trails should not be considered until the ivy is controlled and new trees have been re-established.

Blenkinsop Creek Reach 2 (From the upstream end of Lochside Trail Trestle to the box culvert downstream of Quadra St.)

Installing rock weirs and large wood would create more sinuosity, increase habitat complexity, and aid in mitigating the energy of peak flows. Bioengineering techniques can be used to stabilize eroding banks, especially in the lower portion of the reach where rip-rap has already been installed. Signage should be placed in easy view of the trail to designate environmentally sensitive areas and educate trail users. Just downstream of the box culvert, a viewing platform could be constructed in the heavily trampled area to provide a lookout point and to prevent trampling of the banks. Japanese knotweed must be eradicated. Educational signs could be set-up on this viewing platform. Invasive species control should also be a priority.

Colquitz Reach 10a (From upstream of Gabo Creek confluence in Rosee Grove to the trail off Lindsay Road)

The overgrowth of Himalayan blackberry in Copley Park should be removed and replaced with native riparian vegetation. The trail throughout this reach should be moved back from the creek where possible with the vacated area being replanted with native species, preferably thorny shrubs such as rose and black hawthorn, to reduce the excessive trampling that is occurring. The area just upstream of the playground in Rosee Grove, where banks and upland areas are bare, needs to be planted and fenced until suitable vegetation has become dense enough to stabilize the banks. The addition of large wood will improve habitat complexity and aid in absorbing the energy of peak flows.

Colquitz Reach 5 (From the end of the northernmost boardwalk bridge to upstream of large cement platforms below the overhead footbridge)

Landowner education regarding the functions of riparian vegetation is important to maintain the stability of the right bank of this reach, which is already showing evidence of heavy erosion. Park mowing practices should be altered to reduce the access of trail users to the edge of the banks in order to avoid excessive trampling that prevents vegetation from growing. Planting along the stream banks is recommended if vegetation recovery does not occur following elimination of trampling.

The addition of large woody debris will add habitat complexity while creating sinuosity that will help reduce the velocity of peak flows.

List of Tables

List of Figures

Introduction

This report presents the findings, conclusions, and recommendations of the PFC Team's field assessment of the Colquitz River watershed. The purpose of the assessment is to determine the functional state of the river and its tributaries and provide recommendations that can be used to design strategies to maintain and/or improve its condition.

Aqua-Tex staff members have been monitoring and conducting restoration projects within the Colquitz River watershed since the early 1980's both through the University of Victoria and as a private consulting company. Prior to that, Dr. Alan Austin's laboratory at UVic (of which Aqua-Tex principals were members) conducted studies in these watersheds dating back to the 1960's. Aqua-Tex recognized the need for a current comprehensive assessment of the watershed such that Saanich could establish a new baseline condition for each reach of the river and its tributaries while prioritizing protection and restoration activities. Aqua-Tex approached Saanich staff and council for support of a proposal to the Federation of Canadian Municipalities and other funding partners to fund the project. The funding application was successful and matching funds for this portion of the project were obtained from the Real Estate Foundation of BC with support from the Victoria Real Estate Board.

The PFC Team assessed the Colquitz River and its tributaries over the course of two and a half months in the summer of 2007. The team members were Cori Barraclough, freshwater ecologist, Brian LaCas, hydrologist, Patrick Lucey, aquatic ecologist , Lehna Malmkvist, vegetation ecologist and Lise Townsend, vegetation ecologist with field and office assistance from Sarah Buchanan, Daniel Hegg, and Kevin O'Riordan.

Following completion of the field work and analysis of the results, Stuart Barker, a practicum student from the Advanced GIS program at Vancouver Island University, was retained to create a GIS layer of the PFC assessment for inclusion in Saanich's GIS system.

Project Area Description

Location

The Colquitz River Watershed is located on southern Vancouver Island within the District of Saanich. The watershed has an area of approximately 46 km^2 with Colquitz River as the major stream. Six tributaries, four of which are included within this report, enter Colquitz River along its path to Portage Inlet. Elk/Beaver Lake located at the north end of the watershed serve as the source waters for Colquitz River. From Elk Lake, the Colquitz River flows south through the District of Saanich to Portage Inlet. Blenkinsop Creek flows south-west from Blenkinsop Lake to Swan Lake whose outflow is Swan Lake Creek. Swan Lake Creek flows out of Swan Lake and travels south-west until it merges with Colquitz River near Violet Avenue. Durrell Creek flows south and east from its headwaters near Francis King Park and enters the Colquitz River just downstream of Loenholm Road. Viaduct Creek has its headwaters near Logan Park and travels in an easterly direction where it is joined by Goward Springs Creek and flows through Quick's Bottom, where it joins the Colquitz River.

This watershed has been significantly altered by urban encroachment, agricultural, and industrial land uses. Woodland areas still exist and Grant *et al*. (1993) indicate that the upper portion of the Colquitz River drainage area is 33% forest, 28% urban, and 16% agricultural. However, the percentage of urbanization increases as Colquitz River and its tributaries journey south toward Portage Inlet (95% urban development).

The assessment was conducted by walking upstream from the mouth to the headwaters of each stream, and thus reaches are numbered with the lowest numbers at the downstream end of each creek. In order to avoid confusion, the reaches are designated with both a letter and number *e.g.* Colquitz River reach 1 is CR1, Blenkinsop Creek reach 1 is BR1.

Vicinity Map

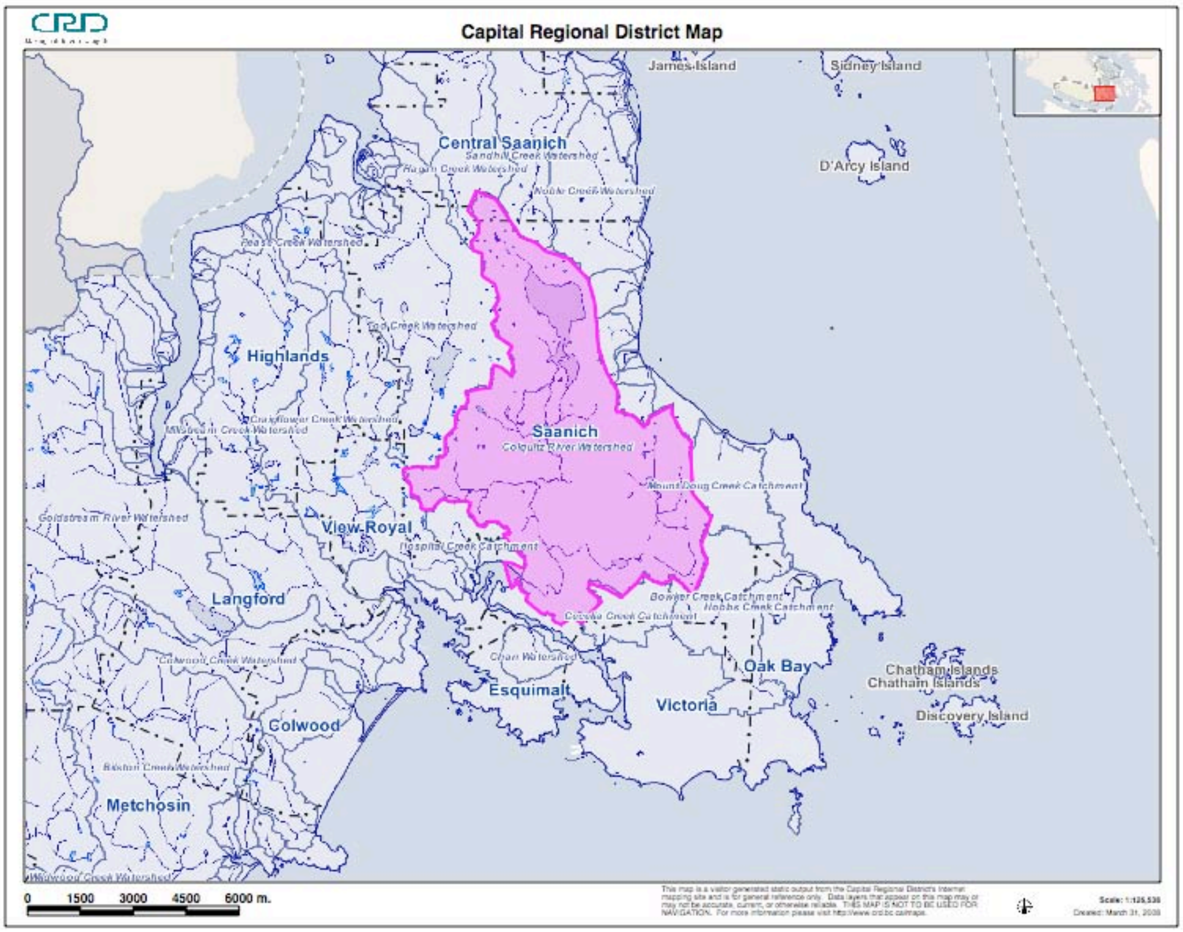


Figure 1. Location of Colquitz River Watershed (pink polygon) in the Municipality of Saanich, Southern Vancouver Island, British Columbia. **(Source: CRD Natural Areas Atlas http://www.crd.bc.ca/es/natatlas/atlas.htm)**

Location Map

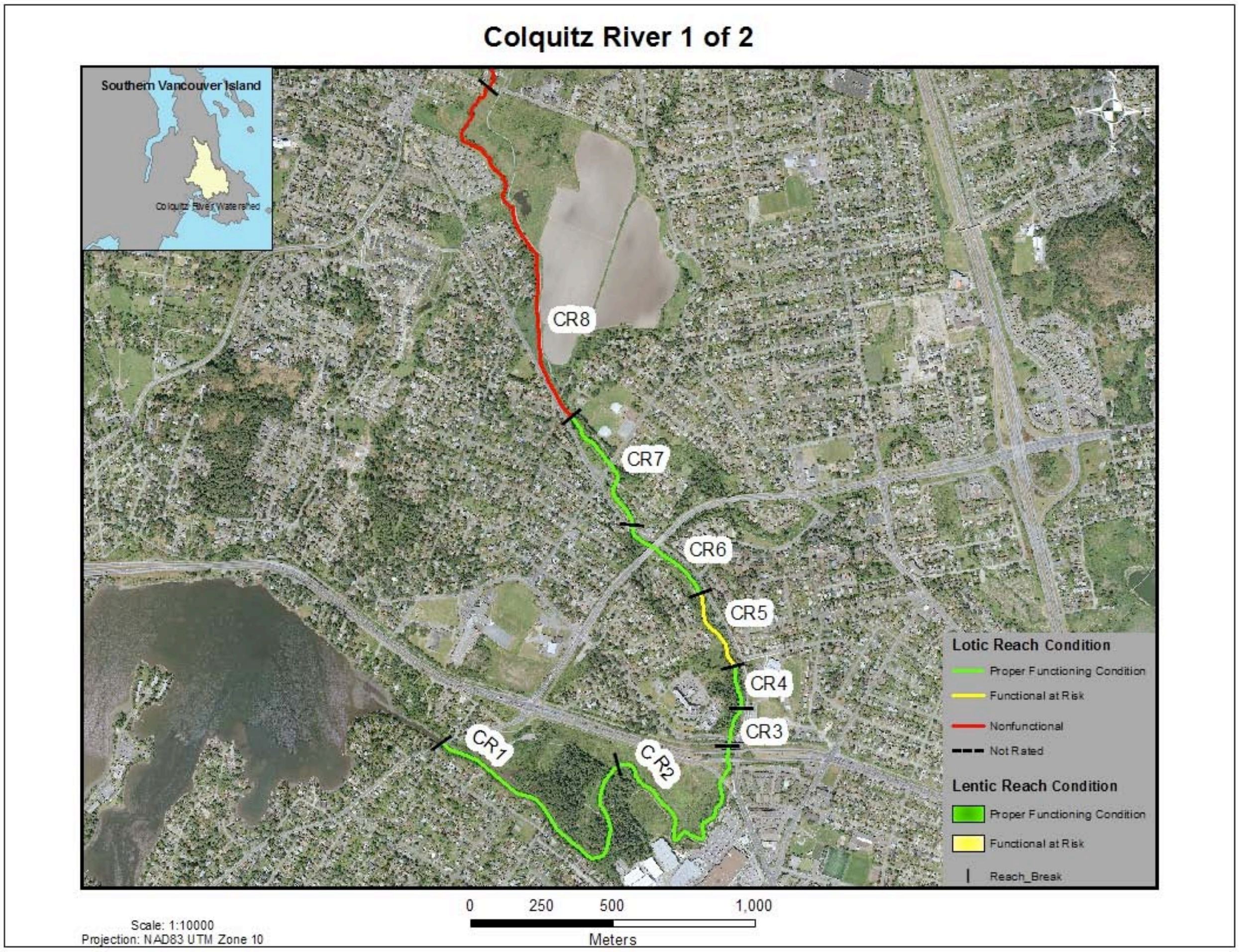


Figure 2. Map showing Colquitz River with the lower reach breaks used for the PFC assessment.

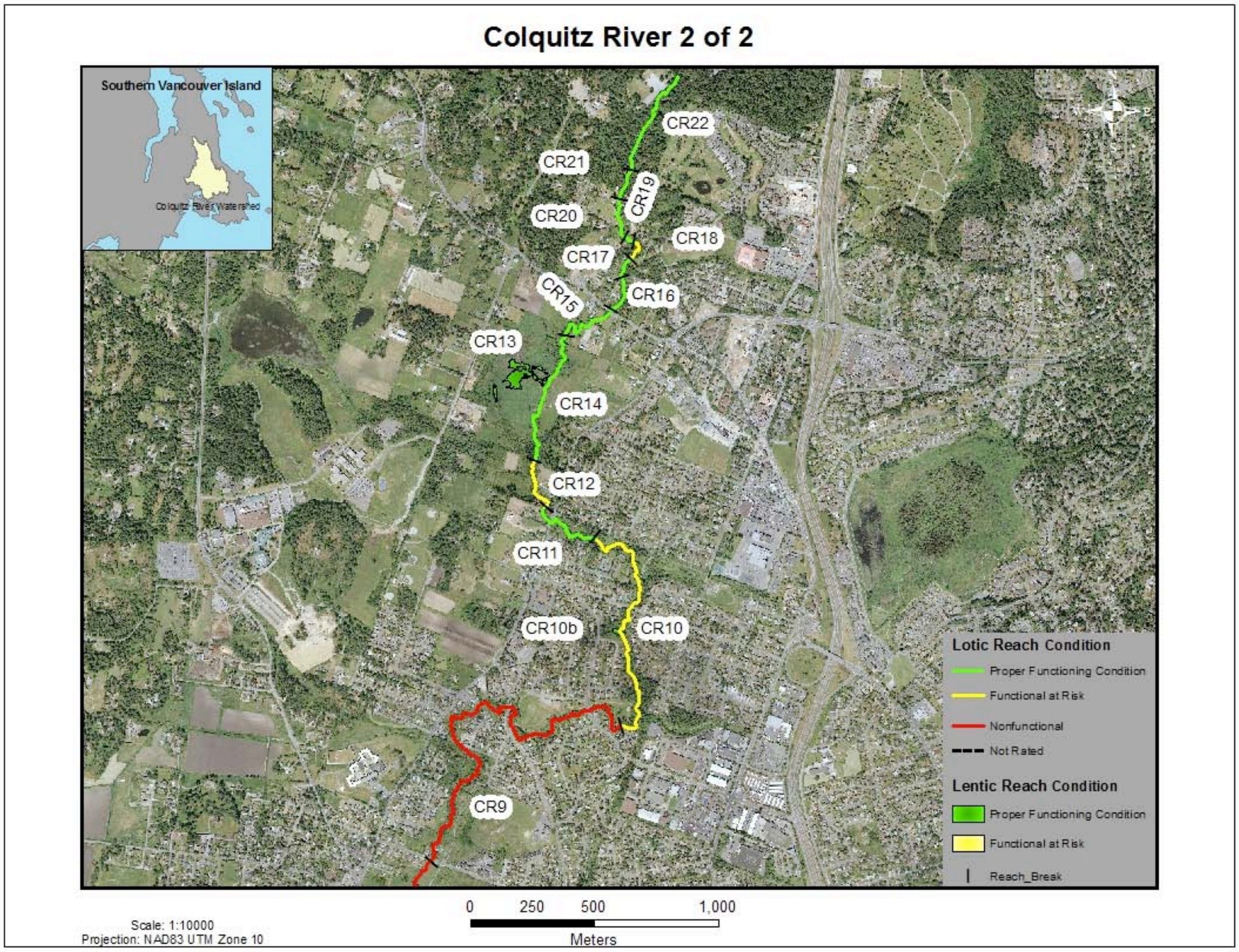


Figure 3. Map showing Colquitz River with the upper reach breaks used for the PFC assessment.

Table 2. Colquitz River Reach Locations.

Reach Number	GPS Reach Break Co-ordinates	Approximate Reach Length (m)
1	N 48° 27’ 30.6” W 123° 24’ 31.8”	1,066
2	N 48° 27.468’ W 123° 24.025’	814
3	N 48° 27.509’ W 123° 23.713’	155
4	N 48° 27.587’ W 123° 23.676’	145
5	N 48° 27.663’ W 123° 23.692’	297
6	N 48° 27.801’ W 123° 23.795’	343
7	N 48° 27.928’ W 123° 23.996’	450
8	N 48° 28.127’ W 123° 24.174’	1,374
9	N 48º 28.758’ W 123º 24.408’	1,809
10a	N 48º 29.074’ W 123º 23.744’	944
10b	N 48º 29.265’ W 123º 23.809’	N/A
11	N 48º 29.468’ W 123º 23.871’	47
12	N 48º 29.553 W 123º 24.040	229
13	N 48º 29’ 49.9” W 123º 24’ 7.9”	N/A
14	N 48° 29’38.0’’. W 123° 24’4.0’’	810
15	N 48°29.908’ W 123°23.969’	300
16	N 48° 29.963’ W 123° 23.826’	156
17	N 48° 30.032’ W 123° 23.791’	93
18	N 48° 30.076’ W 123° 23.766’	100
19	N 48° 30.115’ W 123° 23.750’	40
20	N 48º 30’ 7.4” W 123º 23’ 46.8”	168
21	N 48° 30.205’ W 123° 23.800’	136
22	N 48° 30.273’ W 123° 23.768’	403
TOTAL		9,879

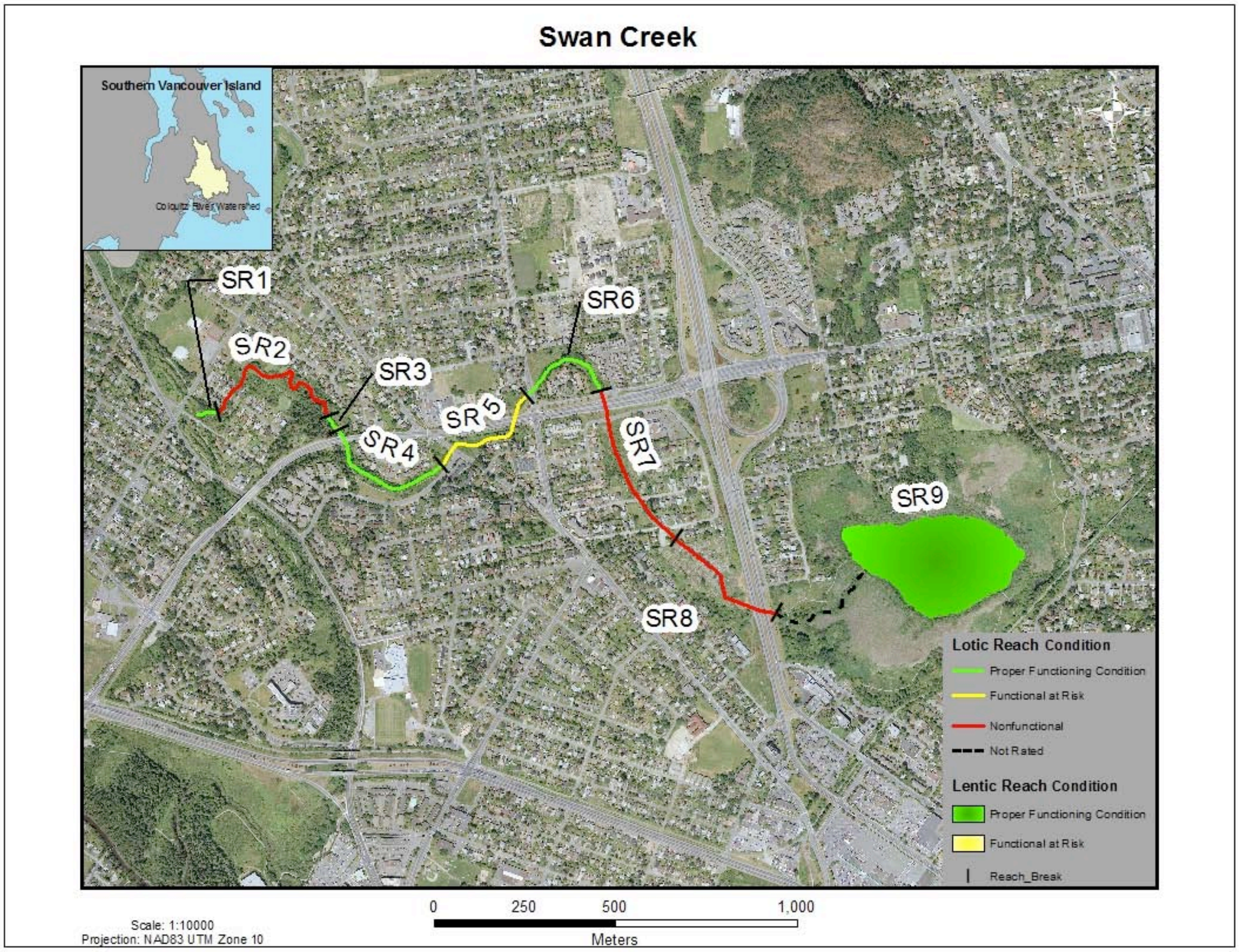


Figure 4. Map showing Swan Creek with the reach breaks used for the PFC assessment.

Table 3. Swan Lake Creek Reach Locations

Reach Number	GPS Reach Break Co-ordinates	Approximate Reach Length (m)
1	N 48º 28.009’ W 123º 24.039’	61
2	N 48º 28.018’ W 123º 23.987’	490
3	N 48º 28.011’ W 123º 23.987’	54
4	N 48° 27.994’ W 123° 23.719’	351
5	N 48º 27.935’ W 123º 23.480’	361
6	N 48º 28.044’ W 123º 23.296’	292
7	N 48º 28.052’ W 123º 23.132’	367
8	N 48º 27.847’ W 123º 22.941’	353
9	N 48º 27.753’ W 123º 22.807’	N/A
TOTAL		2,329

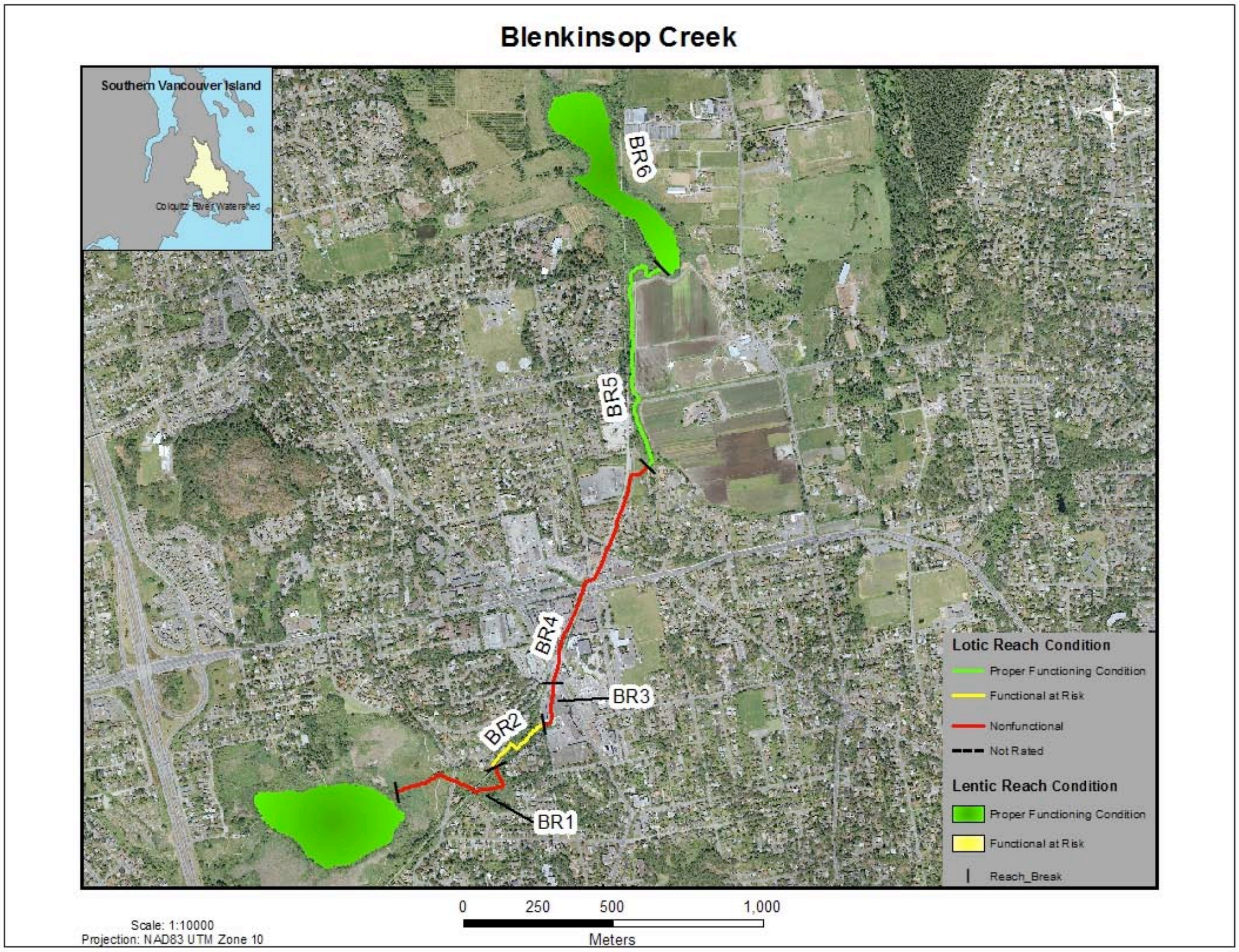


Figure 5. Map showing Blenkinsop Creek with the reach breaks used for the PFC assessment.

Table 4. Blenkinsop Creek Reach Locations.

Reach Number	GPS Reach Break Co-ordinates	Approximate Reach Length (m)
1	N 48º 27.905' W 123º 22.091'	335
2	N 48º 27.905' W 123º 22.932'	249
3	N 48º 27.984' W 123º 22.807'	140
4	N 48º 28.053' W 123º 21.780'	1,073
5	N 48º 28.560' W 123º 21.557'	517
6	N 48º 28.821' W 123º 21.590'	N/A
TOTAL		2,314

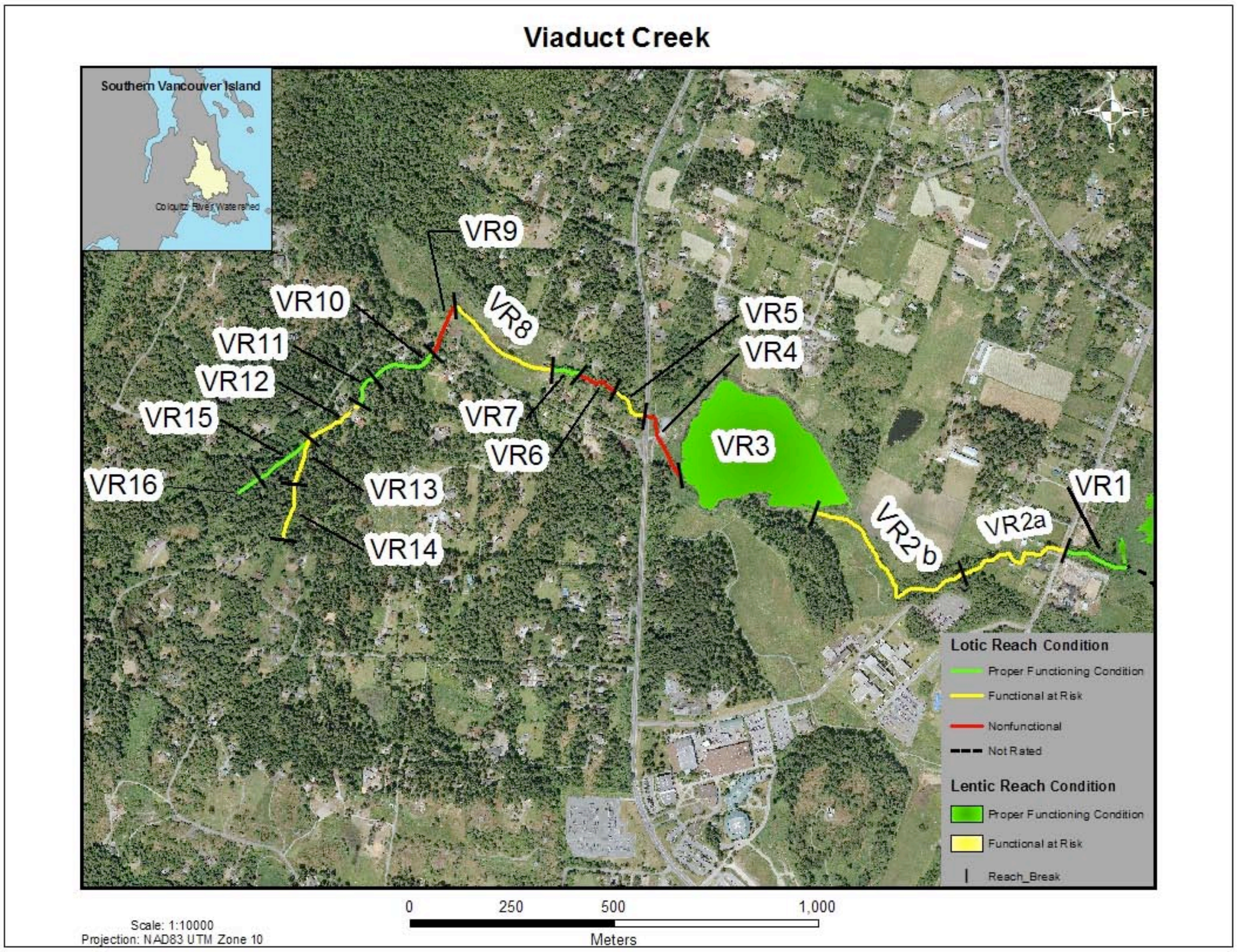


Figure 6. Map showing Viaduct Creek with the reach breaks used for the PFC assessment.

Table 5. Viaduct Creek Reach Locations

Reach Number	GPS Reach Break Co-ordinates	Approximate Reach Length (m)
1		386
2a	N 48º29.782’ W 123º 24.317	287
2b	N 48º 29.757’ W 123º 24.528’	439
3	N 48º 29.823’ W 123º 24.763’	N/A
4	N 48º 29.802’ W 123º 25.119’	60
5	N 48° 29.959’ W 123° 25.159’	104
6	N 48° 29.981’ W 123° 25.221’	157
7	not accessible	28
8	N 48° 30.016’ W 123° 25.344’	N/A
9	N 48º 30.114’ W 123º 25.534’	132
10	N 48º 30.038’ W 123º 25.582’	177
11	N 48º 30.001’ W 123º 25.699’	68
12	N 48º 29.970’ W 123º 25.729’	105
13	N 48° 29.294’ W 123° 25.800’	N/A
14	N 48º 29.865’ W 123º 25.858’	172
15	N 48º 29’ 55.6” W 123º 25’ 51.4”	135
16	N 48º 29.884’ W 123º 25.942’.	N/A
TOTAL		2,250

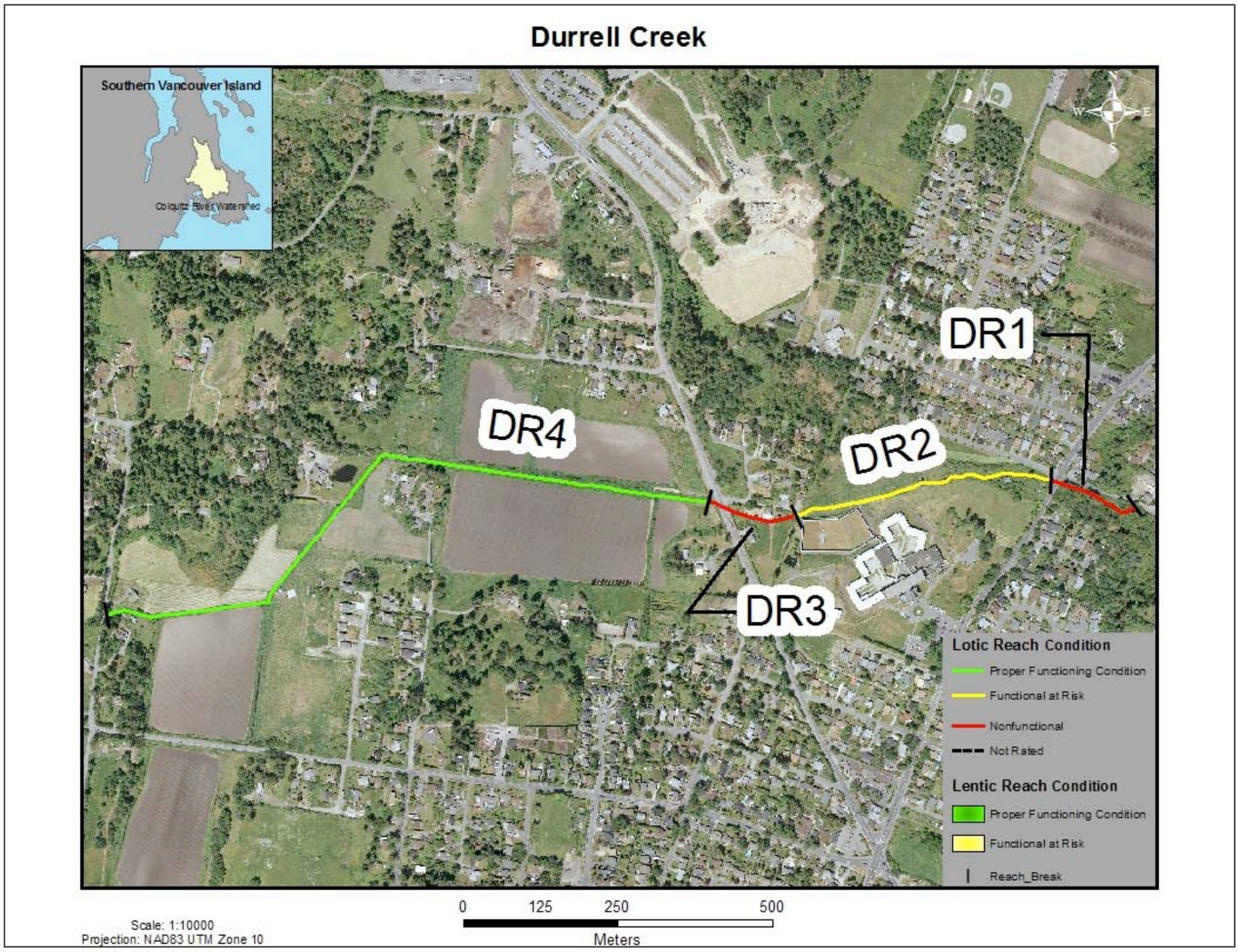


Figure 7. Map showing Durrell Creek with the reach breaks used for the PFC assessment.

Table 6. Durrell Creek Reach Locations

Reach Number	GPS Reach Break Co-ordinates	Approximate Reach Length (m)
1	N 48º 29.018 W 123º 24.332	138
2	N 48º 29.034 W 123º 24.417	436
3	N 48º 29.005 W 123º 24.756	128
4	N 48º 29.014 W 123º 24.872	1123
TOTAL		1,825

*N/A represents reaches that are lentic and have an area (m^2 or ha) rather than a length.

Ownership and Land Use

The Colquitz River Watershed is located entirely within the District of Saanich between latitudes N 48º 27’ to 48º 33’ and longitudes W 123º 23’ to 123º 25’. The watershed drains an area of approximately 46 km^2 including the Blenkinsop, Swan Lake, Viaduct, and Durrell subwatersheds.

From 1872 to the 1920’s the Colquitz River Watershed, primarily the headwaters of Elk/Beaver Lake, acted as the water source for the Greater Victoria area. Water was withdrawn for domestic use, on a small scale, until the 1970’s. A dam was installed in 1860 for the purpose of waterworks construction and led to the amalgamation of two separate lakes (Beaver and Elk lakes) into one large lake. Although it is no longer used to the same extent as when it was the city’s water supply, water licenses are still in place for the extraction of water for irrigation and rural residential domestic uses (Walsh *et al.*, 1994).

The major historical land use activity in the watershed was agriculture with attendant ditching and draining for the creation of pastures and fields leading to the significant alteration of the hydrology of the watershed. A major result of this activity was the connection, through channelization and culverts, of Blenkinsop Lake to Swan Lake via Blenkinsop Creek. This connection allowed the boggy areas of what is now farmland in the Blenkinsop valley to be drained. Areas of the Durrell subwatershed have also been drained in the recent past including the draining of Hastings and Courtland Flats in 1993-1994. Despite this, seasonal flooding is still experienced in the Durrell Creek lowlands as a result of backwater moving up the creek from Colquitz River (Pottinger Gaherty Environmental Consultants Ltd. *et al.*, 2000).

Presently, agriculture is still part of the watershed, but urbanization, including residential and commercial development, is the major land use. As a result, impervious surface area is increasing, and urban run-off flows into the creeks. Coupled with the increasing impervious surfaces, riparian vegetation is being reduced with the encroachment of urban activities. Consequently, the peak flows in the creeks are heightened and are more damaging to the banks in terms of scour and erosion. In addition, the reduction and/or removal of the riparian vegetation, that functions to stabilize the banks with strong root systems, compounds the effects of scouring and erosion.

Throughout the watershed, effluent from municipal and institutional treatment plants was discharged into Colquitz River and its tributaries in the past (Neate, 1967). Particularly important was the discharge of effluent from two wineries that flowed directly into Swan Lake and increased the silt and sediment of the lake and led to its eutrophic condition. Failing septic systems have largely been replaced, but for many years nutrient input from these sources was significant.

Water Licences

There are presently nine separate water licences on the Colquitz River. They are listed in the table below:

Licence_ No	WR Map/Point Code	Stream Name	Purpose	Quantity	Unit	Qty Flag	Licensee	Licence Status	Priority Date	Issue Date
C045295	8792 D5 (PD32843)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19710903	0
C045295	8792 G5 (PD32840)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19710903	0
C045295	8792 H5 (PD32841)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19710903	0
C054452	8792 M5 (PD32836)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19791231	0
C054452	8792 P5 (PD32838)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19791231	0
C054452	8792 R5 (PD32839)	Colquitz River	Land Improve	100	GD	M	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19791231	0
C112499	8792A (PD73412)	Colquitz River	Conserv.- Stored Water	5.7	AF	T	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19970715	20011016
C118045	8792 (PD77590)	Colquitz River	Conserv.- Construct. Works	0	TF	T	FISH & WILDLIFE SCIENCE & ALLOCATION SEC ATTN: GEORGE REID 2080A LABIEUX RD	Current	20030205	20030703

							NANAIMO BC V9T6J9			
F017535	8792A W5 (PD33097)	Colquitz River	Domestic	500	GD	T	HANRY RENE M 4641 WEST SAANICH RD RR 3 VICTORIA BC V8Z3G7	Current	19400626	0
F017535	8792A W5 (PD33097)	Colquitz River	Irrigation	.5	AF	T	HANRY RENE M 4641 WEST SAANICH RD RR 3 VICTORIA BC V8Z3G7	Current	19400626	0
F039430	8792A R6 (PD33098)	Colquitz River	Watering	.3	AF	T	OLIVER JOHN 4654 W SAANICH ROAD VICTORIA BC V8Z3G8	Current	19031120	0
F053274	8792A T3 (PD33095)	Colquitz River	Irrigation	.13	AF	T	BOUGHEN PAUL F 4525 CHEESEMAN RD VICTORIA BC V8Z5M9	Current	19400626	0
F053274	8792A T3 (PD33095)	Colquitz River	Land Improve	500	GD	T	BOUGHEN PAUL F 4525 CHEESEMAN RD VICTORIA BC V8Z5M9	Current	19400626	0

There are three water licences on Durrell Creek, listed below.

Licence_No	WR Map/Point Code	Stream Name	Purpose	Quantity	Unit	Qty Flag	Licensee	Licence Status	Priority Date	Issue Date
C069466	8792A P (PD33109)	Durrell Creek	Domestic	50	GD	T	TO BE DETERMINED C/O WATER REVENUE UNIT PO BOX 9340 STN PROV GOVT VICTORIA BC V8W9M1	Pending	19770818	0
C069466	8792A P (PD33109)	Durrell Creek	Irrigation	3	AF	T	TO BE DETERMINED C/O WATER REVENUE UNIT PO BOX 9340 STN PROV GOVT VICTORIA BC V8W9M1	Pending	19770818	0
C069466	8792A P (PD33109)	Durrell Creek	Storage	3	AF	T	TO BE DETERMINED C/O WATER REVENUE UNIT PO BOX 9340 STN PROV GOVT	Pending	19770818	0

							VICTORIA BC V8W9M1			
C115893	8792A F9 (PD707 68)	Durrell Creek	Conserv.-Stored Water	0	TF	T	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	20001228	20010328
C115893	8792A F9 (PD707 68)	Durrell Creek	Land Improve	4	CS	T	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	20001228	20010328

There is one water licence on Viaduct Creek (C114261), held by the Horticulture Centre of the Pacific, which is an 80 AF conservation license, permitting the water to be stored on Viaduct Flats. There are 14 licences on Blenkinsop Creek and Lake. They are listed in the table below.

Licence_No	WR Map/Point Code	Stream Name	Purpose	Quantity	Unit	Qty Flag	Licensee	Licence Status	Priority Date	Issue Date
C047347	8792A C (PD330 58)	Blenkinsop Lake	Irrigation	5.8	AF	T	CRONK KENNETH C 4316 BLENKINSOP RD VICTORIA BC V8X2C4	Current	19630827	0
C047348	8792A B6 (PD330 60)	Blenkinsop Lake	Irrigation	4.2	AF	T	CANADA GARDENWORKS LTD 6250 LOUGHEED HWY BURNABY BC V5B2Z9	Current	19630827	0
C047549	8792A Q4 (PD330 56)	Blenkinsop Lake	Irrigation	4.25	AF	T	HORWOOD CLIFFORD EXECUTOR OF WH STREET 300 1006 FORT ST VICTORIA BC V8V3K4	Current	19561122	0
C048554	8792A C (PD330 58)	Blenkinsop Lake	Irrigation	4.6	AF	T	CRONK KENNETH C 4316 BLENKINSOP RD VICTORIA BC V8X2C4	Current	19760810	0
C049841	8792A D (PD330 79)	Blenkinsop Creek	Land Improve	0	TF	T	SAANICH DISTRICT OF 770 VERNON AVE VICTORIA BC V8X2W7	Current	19770126	0
C053369	8792A S4 (PD330 76)	Blenkinsop Lake	Irrigation	6	AF	T	GALEY RAYMOND R & GORDON H 4400 BLENKINSOP	Current	19510426	0

							RD VICTORIA BC V8X2C4			
C053533	8792AV (PD33070)	Blenkinsop Lake	Irrigation	4.8	AF	T	QUAN RICHARD & SHARON 4228 RLENKINSOP RD VICTORIA BC V8X2C4	Current	19520111	0
C053534	8792AY4 (PD33075)	Blenkinsop Lake	Irrigation	10	AF	T	568365 BC LTD 2580 BOWKER AVE VICTORIA BC V8R2G1	Current	19520111	0
C060678	8792AZ8 (PD33077)	Blenkinsop Creek	Storage	64	AF	T	BLENKINSOP LAKE WUC C/O WAYNE HOPKINS 2175 BARTLETT AVE VICTORIA BC V8S2R1	Current	19771212	0
C107149	8792AS4 (PD33076)	Blenkinsop Lake	Irrigation	25	AF	T	GALEY RAYMOND R & GORDON H 4400 BLENKINSOP RD VICTORIA BC V8X2C4	Current	19520517	19940311
C107150	8792ANN (PD33067)	Blenkinsop Lake	Frost Protection	23	AF	T	BECKWITH HOLDINGS LTD (INC NO 615130) C/O 2175 BARTLETT AVE VICTORIA BC V8S2R1	Current	19570411	19940421
F016513	8792ANN (PD33067)	Blenkinsop Lake	Irrigation	10	AF	T	BECKWITH HOLDINGS LTD (INC NO 615130) C/O 2175 BARTLETT AVE VICTORIA BC V8S2R1	Current	19510417	0
F017198	8792ANN (PD33067)	Blenkinsop Lake	Irrigation	17	AF	T	BECKWITH HOLDINGS LTD (INC NO 615130) C/O 2175 BARTLETT AVE VICTORIA BC V8S2R1	Current	19570121	0
F039428	8792AGG (PD33068)	Blenkinsop Lake	Irrigation	8	AF	T	PATTERSON KENNETH L & DIANA M 4264 BLENKINSOP RD VICTORIA BC V8X2C4	Current	19520111	0

There are no water licenses on Swan Creek, and one on Swan Lake (C026753) held by the Swan Lake Nature Society for 3 Acre Feet for irrigation. There is one licence on Goward Springs Creek (C043730) held by W. Harding at 4754 Elk Road (0.53 Acre Feet for irrigation).

Key Issues and Concerns

The Colquitz River watershed has been heavily altered by encroaching urbanization, historical and present agricultural activities, and some industry. As a result, many reaches of this watershed have been ditched and dredged to allow for drainage of the land to accommodate the needs of the surrounding communities. Watershed peak flows have been augmented due to an increase in effective impervious area and erosion is an issue in many reaches. The loss of riparian vegetation and the subsequent intrusion of invasive species have reduced the ability of the streams to accommodate these increased flows. Furthermore, removal of riparian vegetation increases water temperatures which can negatively impact fish living in the stream.

The District of Saanich embarked on a program of land acquisition and protection for the watershed in the 1970's. It is a desire of the municipality and of many residents, to see the Colquitz restored to its functional condition and, in particular, to restore the salmon runs as far as practical. For the most part, Saanich is largely developed, with few remaining greenfield sites. The process of restoring the stream will therefore require retrofitting and redevelopment to control excessive stormwater flows, and active rehabilitation of key portions of the stream by controlling public access, managing invasive species, restoring floodplain access, restoring wetland detention and replanting riparian vegetation. The watershed is very large and therefore this work will need to be completed in stages, by determining which areas should receive priority and setting measurable goals to assess the success of the remedial actions. This report provides a baseline against which to measure the success of rehabilitation.

General Physical Character

The riparian area and stream channel are products of the geology and soils, topography, vegetation, large woody material, climate and hydrology of a watershed. Alteration of these attributes can bring about changes in the functionality of the riparian zone, stream channel and biological habitat related to it. Additionally, a stream's channel morphology and energy sources change from headwaters to mouth, and its biological community adapts accordingly. The lower reaches of the watershed are generally the fish producers while smaller headwater tributaries are a significant source of aquatic macroinvertebrates and nutrients.

The Colquitz River Watershed has three major land use areas/types: woodland, urbanization, and agriculture. With these land uses come significant alterations to the landscape. Dredging and ditching is common throughout the watershed and is used for flood control, drainage, and agricultural reclamation. Areas of Blenkinsop Creek have been culverted and erosion mitigation structures (concrete, rock, brick, etc.) are located in many of the creeks, typically in the more urban areas where riparian vegetation is sparse. As a result of the ditching and dredging, floodplain access has been significantly reduced thereby concentrating much of the flow within the channel. Subsequently, the energy of peak flows is not dissipated as effectively and erosion activity is evident in many reaches.

The headwaters of Colquitz River are at an elevation of 91 m a.s.l. with the majority of the creek at an elevation of 21 m or less creating an average gradient of 0.6% (Ptolemy, 1982). The topography of the watershed is relatively flat with a few bedrock outcrops and Garry Oak knolls, the latter observed predominantly within the Durrell subwatershed.

Climate (precipitation, hydrograph, temperature)

There is not a long-term meteorological station within the Colquitz watershed, though there are several new stations at elementary schools which have been installed in the last 3 years. There is an Environment Canada station at the Victoria International Airport 9.5 km to the north of the northern watershed boundary and another at Gonzales Heights 6 km south of the southern watershed boundary. At the Victoria Airport (48º 39.000'N, 123º 25.800' W, elevation 19.2 m) temperatures fluctuate between an average daily maximum of 20.7°C in the summer months (June – September) to 1.5°C in winter (December – February) (Environment Canada, 2004). At Gonzales Heights (48º 24.784' N, 123º 19.500' W, elevation 69.5 m) the temperatures range from an average daily maximum of 15.9°C in the summer months (June – September) to 5.0°C in winter. The majority of the precipitation falls in November, followed closely by the months of December and January, and averages approximately 883 mm per year at the airport and 607.6 mm at Gonzales Heights (values are Climate Normals 1971-2000) (Environment Canada, 2004). For the most part, precipitation falls as rain with a few, rare, snow flurries.

Peak flows in Colquitz River and its tributaries typically occur in the months of highest rainfall (November to January). However, it is important to note that the flow coming out of Elk/Beaver Lake is controlled by a weir system, hence, flows experienced in the Colquitz today are not the flows historically experienced in the Colquitz River. Water movement in Blenkinsop Creek is also controlled by a small dam.

Geomorphology (general geologic type and soils type)

The area encompassing the Colquitz River Watershed was created by the action of glaciers flowing and ebbing historically. The basin is formed of four different types of bedrock namely Vancouver volcanics, Wark gneiss, Colquitz gneiss, and grandiorite (Lucey, 1982). From the top of the watershed to the mouth, the geology morphs from Cordova sands and gravels, to Colwood sands and gravels, to marine clays. Bedrock outcrops are intermittent throughout the watershed although fewer are present around Swan Lake Creek, Blenkinsop Creek, and Durrell Creek than the Colquitz River and Viaduct Creek.

Vegetation (forest type, shrub type, grassland type, etc.)

The Colquitz River watershed is found within the Coastal Douglas Fir biogeoclimatic zone which is found along southeastern Vancouver Island and includes some Gulf islands and a small portion of the mainland (Nuszdorfer *et al*., 1991). The Coastal Douglas Fir zone has a climate like that of the Mediterranean and is much drier as a result of the rain shadow effect created by Vancouver Island and the Olympic Mountains. As a result, unique species such as Garry Oak (*Quercus garryana*) and arbutus (*Arbutus menziesii*) can be found here.

Land has been altered within the Colquitz River watershed as a result of agriculture and general urbanization; therefore, the amount and form of vegetation present within the watershed are only minimally representative of the extensive vegetation that would have covered the area. Some of the species present in the Colquitz River watershed that are typical of Coastal Douglas fir zones include:

- Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), big leaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), grand fir (*Abies grandis*), western redcedar (*Thuja plicata*), and some areas of Garry Oak (*Quercus garryana*) and arbutus (*Arbutus menziesii*);
- Shrubs including Indian plum (*Oemleria cerasiformis*), ocean spray (*Holodiscus discolor*), Nootka rose (*Rosa nutkana*), common snowberry (*Symphoricarpos albus*), dull Oregon grape (*Mahonia nervosa*), willows (*Salix spp*.), salal (*Gaultheria shallon*), hard hack (*Spirea douglasii ssp. douglasii*), and red osier dogwood (*Cornus stolonifera*).
- Herbaceous plants including skunk cabbage (*Lysichiton americanum*), lady fern (*Athyrium filix-femina*), bracken fern (*Pteridium aquilinum*), sword fern (*Polystichum munitum*), sedges (*Carex sp*.), and rushes (*Juncus spp*.).

Invasive species have also been introduced throughout the Colquitz River Watershed. Those of note are: Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), holly (*Ilex aquifolium*), laurel-leafed daphne (*Daphne laureola*), Japanese knotweed (*Fallopia japonica*), morning glory (*Ipomoea indica*), yellow-flag iris (*Iris pseudacorus*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum sp*.), Scotch broom (*Cytisus scoparius*), and numerous agricultural grasses. Residential properties often have gardens containing plants that are not native to the area and can act as a source of non-native and invasive species in riparian and upland areas.

Fish Habitat

The Colquitz River is one of the few remaining salmon-bearing streams in the Greater Victoria area. In the past, the Colquitz River has supported many fish species: Coho salmon

(*Oncorhyncus keta*), catfish, Dolly-Varden char (*Salvelinus malma*), cutthroat trout (*Salmo clarki clarki*), stickleback (*Gasterosteus aculeatus*), and sunfish (Neate, 1967). Currently, the Colquitz River is home to cutthroat trout (*Salmo clarki clarki*), 3-spine stickleback (*Gasterosteus aculeatus*), Chum salmon (*Oncorhyncus kisutch*), Coho salmon (*Oncorhyncus keta*), prickly sculpin (*Cottus aspen*), and brown bullhead (*Ictalurus nebulosus*) although they are not as abundant as they have been historically (HAT, 2005). This reduction in the size of the fish population began in the 1960's and has been linked to issues of siltation, peak flow scouring activity, and the alteration of channels by human forces such as road construction, culverts, agricultural and urban development (Langford, 1975), ocean survival and fishing pressure. Quick's Bottom has also been seen as a barrier to fish migration (Grant *et al*., 1993). Once Quick's Bottom was no longer actively farmed, the stream channel became overgrown with reed canary grass, leading to expansion of the wetland, slower flows and very low oxygen tensions. This created both a physical and physiological barrier to upstream fish migration. This barrier has been removed through a multi-year channel reconstruction project undertaken by Saanich Parks from 2000-2004. The channel is, however, starting to become overgrown again and will need additional maintenance. A dam first constructed at the outlet of Beaver Lake in 1860 for the purpose of storing water for the use by a sawmill near West Saanich and Wilkinson Roads also resulted in the alteration of the natural flow pattern of Colquitz River. Since salmon migration is cued to water levels, these alterations have inhibited migration of fish into the upper reaches of the Colquitz and its tributaries.

Methods

PFC Assessment

The Proper Functioning Condition (PFC) assessment involves using a standard checklist to consistently assess the hydrology, soils and vegetation of riparian areas. The checklist and its summarization are used to classify the health or state of physical processes of the riparian-wetland area. The PFC assessment method was chosen because it could provide an efficient, proven, scientifically defensible method for assessing riparian and stream channel condition. A PFC assessment method is also available for wetland ecosystems. A detailed explanation of the PFC assessment methods and examples of the checklists can be found in Appendix 1.

The PFC method was originally developed for the US Bureau of Land Management by a team of fifty scientists specializing in hydrology, soils/geology, vegetation, and biology. They developed the Riparian-Wetland Functional Checklist (for streams) of seventeen hydrology, vegetation, and soils/geology attributes that must be considered when evaluating riparian areas to determine their physical functionality. The assessment is used to identify any significant attributes that may be out of balance with the natural processes necessary for the system to function properly. The PFC teams commonly use Rosgen stream channel typing to determine whether the stream fits the expected landscape setting or is outside the natural range of variability (Rosgen, 1996). Rosgen channel typing is described in Appendix 4.

The PFC method has been tested and utilized for over a decade in wildland environments managed by the United States Department of the Interior (USDI/ BLM), United States Department of Agriculture (USDA/Forest Service), and private agricultural lands in coordination with the Natural Resources Conservation Service (USDA/NRCS). The methodology has been applied in Canada, Mexico, and several other countries. It is currently being taught in a number of universities and is now being used in metropolitan areas where it is successfully being applied to collaboratively resolve issues associated with urban streams and wetlands. It is the basis of the BC Ministry of Forests and Range’s range assessment procedure and forms the basis of several other pieces of legislation including the Rainwater Bylaw in the District of Metchosin.

Appropriate use of this assessment requires an interdisciplinary team of individuals with journey-level skills in hydrology, vegetation, soils/geology, and ecology in order to adequately perform a field assessment using the Riparian-Wetland Functional Checklist. For assessment purposes, the team divides the stream into a series of finite segments (reaches), each having common attributes and processes. Results of the assessments are provided to land management agencies and citizen groups to build a mutual understanding of the physical processes that are governing the stream and watershed. Managers, landowners, and concerned citizens have used PFC assessments for development of management strategies designed to bring about outcomes that are realistic and achievable. PFC assessment findings for stream and riparian zones provide indicators of the limits of the watershed’s capacity to produce certain values. An accurate portrayal of the physical processes and their present condition is essential in designing plans to manage the watershed for values important to the community.

In the Colquitz River Watershed, the assessment area was stratified by defined segments (reaches) of stream that share common processes and attributes, particularly hydrological features. A total of 59 reaches were defined and assessed. While exceptions to these common processes and attributes existed within each reach, they were limited in nature and not large enough to create additional reaches. The assessment for the Colquitz River started at the point where the creek passes beneath the bridge at Admirals Road just upstream of the mouth of Portage Inlet and proceeded upstream to the outlet of Beaver Lake. The Swan Lake Creek assessment ran from Violet Avenue at its confluence with Colquitz River to Swan Lake. Swan Lake was also the starting point of the Blenkinsop Creek assessment working upstream to the headwaters at Blenkinsop Lake. The assessment for Viaduct Creek commenced where the creek flows into Quick's Bottom, up to its headwaters in Logan Park. In the Durrell watershed, only that portion of the creek from Loenholm Road upstream to Granville Avenue (where access was available) was assessed due to time constraints and because much of the remaining area is ditched through farmers' fields. All reaches, for each creek, were numbered sequentially from downstream to upstream and tied to a GPS waypoint or prominent landmark for map reference (see Tables 2-6).

Each reach was classified according to Rosgen's stream classification system and the team's estimate of the potential for the reach (Rosgen, 1996). Rosgen channel types are delineated in Table 2 of Appendix 4 and on the PFC checklist for each reach. The Rosgen channel type is based on the valley form, geology, and gradient of the creek in both in its present condition and potential condition (See Appendix 4, Rosgen channel types). Deviation from potential channel type is a key to recognizing changes in channel characteristics and vegetation that are often due to management practices amongst varying ownerships.

Findings

Note: PFC = Proper Functioning Condition; FAR= Functional at Risk; NF = Nonfunctional; only FAR ratings require a trend statement.

Table 7. PFC Summary Determinations for Colquitz River

Reach Number/Description (GPS coordinates are contained in each reach summary)	Approx. Reach Length (m)	Rosgen Channel Type	PFC Determination (PFC/ FAR/ NF)	Trend: Upward/ Not Apparent/ Downward*	Potential Riparian Community Type**
1 – Admirals Rd. to stake off path past 2nd pedestrian bridge	1, 088m	N/A	PFC		**
2 –From stake off path to Trans Canada hwy	795m	E6	PFC		**
3 –Trans Canada hwy to end of 1st boardwalk bridge	155m	G1	PFC		**
4 –End 1st boardwalk bridge to end 2nd boardwalk bridge	145m	B2	PFC		**
5 –End 2nd boardwalk bridge to U/S cement steps below overhead walkway	297m	Bc6	FAR	Not Apparent	**
6 – U/S cement steps below overhead walkway to Interurban Rd.	343m	Gc6	PFC		**
7 –Interurban Rd. to big willow opposite Hyacinth Park playground	450m	C6	PFC		**
8- Hyacinth Park to Roy Rd.	1374m	ditch	NF		wetland with surrounding deciduous forest
9- Roy Rd. to Gabo Cr. confluence in Rosee Grove	1809m	G6-Gc6	NF		**
10a-Gabo Cr. confluence in Rosee Grove to trail off Lindsay Rd.	944m	F6-Fb6	FAR	Not Apparent	**
10b-Pond at Vanalman Ave. and Northridge Cres.	0.044 ha	~	PFC		wetland with surrounding deciduous forest
11-From trail off Lindsay Rd. way pt. 31 D/S Wilkinson Rd.	191m	B1	PFC		**
12- From the bridge at 4444 Wilkinson Rd. to Quick's Bottom footbridge	229m	undetermined	FAR	Not Apparent	**
13-Quicks Bottom	18.8 ha	~	PFC		wetland with surrounding

					coniferous/deciduous forest
Reach Number/Description	**Approx. Reach Length (m)**	**Rosgen Channel Type**	**PFC Determination (PFC/ FAR/ NF)**	**Trend: Upward/ Not Apparent/ Downward***	**Potential Riparian Community Type****
14-Quick's Bottom pedestrian bridge off Wilkinson Rd. to footbridge at 4654 W. Saanich Rd.	810m	C6	PFC		wetland and deciduous community
15-4654 W. Saanich Rd. footbridge to W. Saanich Rd.	300m	Cb3	PFC		**
16-W.Saanich Rd. to 4521 Cheeseman Rd.	156m	B1	PFC		**
17-4521 Cheeseman Rd. to waterfall at U/S edge of 4525 Cheeseman Rd.	93m	A1	PFC		**
18- Waterfall U/S edge 4525 Cheeseman Rd. to cascade at the edge of 4650 Pipeline Rd.	100m	Bc6	FAR	Downward	**
19 – Cascade at 4650 Pipeline Rd. to cascade in line with fence at 4656 Pipeline Rd.	40m	A1	PFC		**
20- Cascade at fence on 4656 Pipeline Rd. to U/S property line of 4674 Pipeline Rd.	168m	C6	FAR	Not Apparent	**
21-U/S property line 4674 Pipeline Rd. to footbridge with weir in Elk/Beaver Lk. Park	136m	Bc3	PFC		**
22-Footbridge with weir to outlet at Beaver Lake	403m	Bc2-Bc3	PFC		**

Table 8. PFC Summary Determinations for Swan Lake Creek

Reach Number/Description	**Approx. Reach Length (m)**	**Rosgen Channel Type**	**PFC Determination (PFC/ FAR/ NF)**	**Trend: Upward/ Not Apparent/ Downward***	**Potential Riparian Community Type****
1- Violet Ave. to U/S property line 763 Daisy Ave.	61m	C4	PFC		**
2- U/S property line 763 Daisy Ave. to red alder D/S open grassy area	490m	Gc6	NF		**
3-Red alder D/S grassy area to willow D/S	54m	E6	PFC		**

Reach Number/Description	Approx. Reach Length (m)	Rosgen Channel Type	PFC Determination (PFC/ FAR/ NF)	Trend: Upward/ Not Apparent/ Downward*	Potential Riparian Community Type**
McKenzie Ave overpass					
4-Willow D/S McKenzie Ave overpass to start of rock wall D/S Carey Rd.	351m	C6	PFC		**
5- Rock wall D/S Carey Rd. to Glanford Rd.	361m	B6	FAR	Not Apparent	**
6- Glanford Rd. to McKenzie Ave.	292m	C6	PFC		**
7-McKenzie Ave. to pedestrian bridge at Kent Rd.	367m	Gc6	NF		Shrubby wetland with more trees
8-Kent Rd. to Patricia Bay Hwy	353m	ditch with C6 character	NF		Coniferous/deciduous if kept as channel or wetland veg.
9-Swan Lake	9.79 ha	~	PFC		Wetland and deciduous community

Table 9. PFC Summary Determinations for Blenkinsop Creek

Reach Number/Description	Approx. Reach Length (m)	Rosgen Channel Type	PFC Determination (PFC/ FAR/ NF)	Trend: Upward/ Not Apparent/ Downward*	Potential Riparian Community Type**
1-Willow line at N end Swan Lake to U/S end Swan Lake Trestle	335m	Ditch with C6 character	NF		**
2-U/S end Swan Lake Trestle to box culvert D/S Quadra St.	249m	B2	FAR	Downward	**
3- Box culvert to daylighted section	140m	______	______	______	______
4- Daylighted section D/S Quadra St. to Cumberland Dam	1073m	ditch with G character	NF		**
5- Cumberland Dam to Blenkinsop Lake	517m	C6	PFC		Shrubby, deciduous, herbaceous riparian
6- Blenkinsop Lake	7.24 ha	~	PFC		Wetland, deciduous, and coniferous community

Table 10. PFC Summary Determinations for Viaduct Creek

Reach Number/Description	Approx. Reach Length (m)	Rosgen Channel Type	PFC Determination (PFC/ FAR/ NF)	Trend: Upward/ Not Apparent/ Downward*	Potential Riparian Community Type**
1- Confluence with Quick's Bottom to Markham Rd.	386m	C6	PFC		**
2a- Markham Rd. to U/S property fence 4484 Markham Rd.	287m	G3	FAR	Not Apparent	**
2b- U/S property fence 4484 Markham Rd. to weirs at Viaduct Flats	439m	Gc6 ditch-like	FAR	Downward	**
3-Viaduct Flats	9.06 ha	~	PFC		wetland with surrounding coniferous/deciduous
4- Confluence with Viaduct Flats to Interurban Rd.	60m	ditch	NF		**
5- Interurban Rd. to footbridge at 478 Viaduct Ave. W.	104m	C4	FAR	Not Apparent	**
6- Footbridge at 478 Viaduct Ave. W. to fence between 471 Green Mtn. Rd. and 458 Viaduct Ave W.	157m	C6	NF		**
7-Fence between 471 Green Mtn. Rd. and 458 Viaduct Ave W to footbridge at 458 Viaduct.	28m	G6	PFC		Shrubby and deciduous tree community
8- Footbridge 458 Viaduct Ave. to confluence with Excelsior Cr. (414 Viaduct Ave.)	0.897 ha	~	FAR	Not Apparent	Mixed herbaceous and shrub community
9- Confluence with Excelsior Cr. to Viaduct Ave. W. crossing	132m	G6	NF		Transition wetland to coniferous/deciduous
10- Viaduct Ave. W. crossing to headcut U/S 489 Viaduct Ave. W.	177m	B1-B6	PFC		**
11-Headcut to bedrock outcrop D/S 365 Viaduct Ave. W	68m	Bc6	PFC		**
12-Bedrock outcrop 365 Viaduct Ave W to driveway crossing 353 Viaduct Ave. W.	105m	C6	FAR	Downward	**
13-Wetland area 353 Viaduct Ave W driveway to Logan Park	0.231 ha	~	FAR	Downward	Herbaceous and shrubs with conifers at

					fringe
14- Opposite end of wetland from Viaduct Ave to U/S pond where channel disappears (headwaters)	172m	E6	FAR	Upward	**
15- End of wetland along Viaduct Ave. W. to trail crossing in Logan Park	135m	G3	PFC		**
16- Trail crossing in Logan Park to where peters out (headwaters)	0.442 ha	~	PFC		Coniferous/deciduous with shrubby understorey

Table 11. PFC Summary Determinations for Durrell Creek

Reach Number/Description	Approx. Reach Length (m)	Rosgen Channel Type	PFC Determination (PFC/ FAR/ NF)	Trend: Upward/ Not Apparent/ Downward*	Potential Riparian Community Type**
1-Confluence with Colquitz Cr. to Wilkinson Rd.	138m	ditch	NF		**
2- Wilkinson Rd. to Charlton Rd.	436m	ditch	NF		Small tree and shrub
3-Charltong Rd. to Interurban Rd.	128m	ditch	NF		**
4-Interurban Rd. to Granville Ave.	1123	"ditch"	PFC		Wetland species

* *The PFC protocol requires that trend ratings only be given to reaches that are FAR. Reaches that are rated PFC do not receive a trend rating. Trend in the PFC context means to be moving toward or away from reach PFC.*

****Mature coniferous and/or/mixed deciduous forest.*

~ Denotes a Lentic System and no channel type applies.

N/A channel is influenced by tidal and estuarine processes.

_____ was separated out solely for analysis of potential restoration opportunities if section is daylighted. See Blenkinsop Creek Reach 4.

Table 12. Results of PFC analysis in the Colquitz River Watershed, 2007

PFC Category:	
Non-functional	6852 m
Functional-at-risk with downward trend	893 m
Functional-at-risk with no apparent trend	2390 m
Functional-at-risk with an upward trend	172 m
Proper Functioning Condition	8297 m
TOTAL KM	18.6 km

Vegetation

Species List

Table 13. Master list of riparian species identified throughout the Colquitz River Watershed listed alphabetically by common name.

Note: * indicates a non-native species

Common Name	Scientific Name
Agronomic grasses	
Alaska alkali grass	*Puccinellia nutkaensis*
Alberta rose *	*Rosa acicularis*
Alfalfa	*Medicago sativa*
Arbutus	*Arbutus menziesii*
Arrow root	*Maranta arundinacea*
Ash	*Fraxinus sp.*
Aster	*Aster sp.*
Baldhip rose	*Rosa gynnocarpa*
Bamboo *	*Bambusa sp.*
Big leaf maple	*Acer macrophyllum*
Birch sp.	*Betula sp.*
Black cottonwood	*Populus balsamifera ssp. trichocarpa*
Black hawthorn	*Crataegus douglasii*
Black spruce	*Picea mariana*
Black twinberry	*Lonicera involucrata*
Bracken fern	*Pteridium aquilinum*
Bulrush	*Juncus sp.*
Bur-reed	*Sparganium sp.*
Canada thistle *	*Cirsium arvense*
Cascara	*Rhamnus purshiana*
Cattail	*Typha latifolia*
Cherry tree	*Prunus sp.*
Chestnut tree	*Castanea sp.*
Clover	*Trifolium sp.*
Coastal strawberry	*Fragaria chiloensis*
Common bulrush	*Typha latifolia*
Common horsetail	*Equisetum arvense*
Common rush	*Juncus effusus*
Common snowberry	*Symphoricarpos albus*
Creeping buttercup	*Ranunculus repens*
Daisy	*Erigeron sp.*
Deer fern	*Blechnum spicant*
Ditch grass	*Ruppia maritima*
Dock	*Rumex sp.*
Douglas fir	*Pseudotsuga menziesii*

Common Name	Scientific Name
Duckweed	*Lemna sp.*
Dull Oregon-grape	*Mahonia nervosa*
English hawthorn *	*Crataegus monogyna*
English holly *	*Ilex aquifolium*
English ivy *	*Hedera helix*
Entire-leaved gumweed	*Grindelia integrifolia*
European bittersweet *	*Solanum dulcamara*
Evergreen blackberry	*Rubus laciniatus*
False lily of the valley	*Maianthemum dilatatum*
False Solomon's seal	*Smilacina racemosa*
Fringecup	*Tellima grandiflora*
Fruit trees	
Garry oak	*Quercus garryana*
Geranium	*Geranium sp.*
Grand fir	*Abies grandis*
Grasses (non-native) *	
Gunnera	*Gunnera sp.*
Hardhack	*Spirea douglasii ssp. douglasii*
Hard-stemmed bulrush	*Scirpus lacustris ssp. glaucus*
Himalayan blackberry *	*Rubus armeniacus* (formerly *Rubus discolor*)
Honeysuckle	*Lonicera sp.*
Hooker's willow	*Salix hookeriana*
Indian plum	*Oemleria cerasiformis*
Ivy *	*Hedera sp.*
Japanese knotweed *	*Fallopia japonica*
Knotweed	*Polygonum sp.*
Laburnum	*Laburnum anagyroides*
Lady fern	*Athyrium filix-femina*
Laurel sp.	*Prunus sp.*
Laurel-leafed daphne *	*Daphne laureola*
Lesser duckweed	*Lemna minor*
Licorice fern	*Polypodium glycyrrhiza*
Lilac	*Syringa sp.*
Lombardy poplar	*Populus nigra 'Italica'*
Lyngby's sedge	*Carex lyngbyei*
Manna grass	*Glyceria grandis*
Maple sp.	*Acer sp.*
Marsh skullcap	*Scutellaria galericulata*
Mock orange	*Phyladephus lewisii*
Morning glory *	*Ipomoea indica*
Mountain ash	*Sorbus aucuparia*
Mustard	*Brassica campestris*
Nootka rose	*Rosa nutkana*
Oak *	*Unknown species (non-native)*

Common Name	**Scientific Name**
Oceanspray	*Holodiscus discolor*
Orchard grass	*Dactylis glomerata*
Ornamental cedar*	
Ornamental dogwood*	*Cornus florida*
Ornamental maple*	
Ornamental rock garden*	
Other ornamental species*	
Pacific crabapple	*Malus fusca*
Pacific ninebark	*Physocarpus capitatus*
Pacific water parsley	*Oenanthe sarmentosa*
Pacific willow	*Salix lassiandra*
Pea	
Pine sp.	*Pinus sp.*
Poison hemlock	*Conium maculatum*
Poplar	*Populus balsamifera*
Purple loosestrife *	*Lythrum sp.*
Queen Anne's lace	*Daucus carota*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa ssp. pubens*
Red-flowering currant	*Ribes sanguineum*
Red huckleberry	*Vaccinium parvifolium*
Red osier dogwood	*Cornus stolonifera*
Reed canary grass *	*Phalaris arundinacea*
Rhododendron	*Rhododendron macrophyllum*
Rose sp.	*Rosa sp.*
Rush species	*Juncaceae sp.*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Saltmarsh rush	*Juncus gerardii*
Saskatoon	*Amelanchier alnifolia*
Scots pine	*Pinus sylvestris*
Scouler's willow	*Salix scouleriana*
Scouring rush	*Equisetum hyemale*
Scotch broom *	*Cytisus scoparius*
Seashore saltgrass	*Distichlis spicata var. spicata*
Sedge sp.	*Carex sp.*
Shore pine	*Pinus contorta var. contorta*
Silverweed	*Potentilla anserine ssp. pacifica*
Sitka Mountain-Ash	*Sorbus sitchensis*
Sitka willow	*Salix sitchensis*
Skunk cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Smartweed (Lady's thumb)	*Polygonum lapathifolium*
Spruce	*Picea sp.*

Common Name	**Scientific Name**
Stinging nettle	*Urtica dioica*
Swamp birch	*Betula pumila var. glandulifera*
Sword fern	*Polystichum munitum*
Tall Oregon grape	*Mahonia aquifolium*
Thimble berry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Trailing ornamental *	*Unknown*
Trembling aspen	*Populus tremuloides*
Variegated dogwood	*Cornus alba elegantissima*
Vetch	*Vicia sp.*
Water-cress	*Rorippa nasturtium-aquaticum*
Water-plantain	*Alisma plantago-aquatica*
Weeping willow *	*Salix babylonica*
Western hemlock	*Tsuga heterophylla*
Western redcedar	*Thuja plicata*
Western St. John's wort	*Hypericum formosum*
Willow sp.	*Salix sp.*
Woodland strawberry	*Fragaria vesca*
Yellow flag iris *	*Iris pseudacorus*
Yellow water lily	*Nuphar polysepalum*

* denotes non-native species.

Physical Watershed Function

The Colquitz River was once a major waterway that provided abundant fish and wildlife habitat. Residents of the Colquitz region used the creek for fishing and recreation purposes but this activity has decreased over the past 50-100 years due to concern surrounding the quality of the water and the reduction in trout and salmonid populations (Neate, 1967). The tributaries of Colquitz River have also experienced similar reductions in habitat and water quality as a result of encroaching urbanization, agriculture, and industrial land uses. The increase in effective impervious area (EIA) throughout the watershed occurring hand-in-hand with urban development has led to increased run-off into the creeks, lakes, and wetlands. Consequently, peak velocity flows have been augmented which has caused erosion and scouring in the majority of the reaches assessed in this report. Ditching and dredging for drainage for agricultural land "improvement" or other land uses have altered the watershed landscape significantly by reducing floodplain accessibility, sinuosity, hydraulic and habitat complexity, and biodiversity. Additionally, riparian vegetation has been reduced, thus amplifying the affects of erosion due to the removal of an important stream bank buffer and stabilizer.

Flows in the Colquitz River Watershed are attenuated and controlled in various locations before they reach the marine environment at Portage Inlet. These attenuation and control points are as follows:

- Elk/Beaver Lake where a weir controls the flow of water into Colquitz River proper;
- Viaduct Flats where a large wetland stores water and recently implemented weirs control flow downstream into Viaduct Creek;
- Quick's Bottom, a large wetland slowing and storing water received from Colquitz River and Viaduct Creek;
- Wetland areas in the Durrell Creek subwatershed, although their function is significantly reduced due to extensive dredging;
- Blenkinsop Lake, the headwaters of Blenkinsop Creek, has a weir at the outlet controlling flow to the creek;
- The small dam on Blenkinsop Creek used to control flow intensity (Cumberland Dam). The reduction in water flow controlled at the dam causes seasonal flooding in the agricultural land of Blenkinsop Valley;
- Blenkinsop Creek flows into Swan Lake which acts to attenuate flows entering Swan Creek;
- Panama Flats, the last attenuation area before Colquitz River, augmented by the convergence of all its tributaries, enters Portage Inlet.

Although Colquitz River Watershed has been altered significantly by human activity, many areas of it are still ecologically functional. With the proper management, these areas can be maintained and the reaches that are failing, as highlighted in this report, can be restored.

Reach Description Summaries (from checklists)

Note: Additional photos are contained in Appendix 3. "Right" and "left" bank are described when looking downstream.

Reach 1 Colquitz River: Admirals Road bridge crossing to upstream of the second footbridge in Cuthbert-Holmes Park

Reach 1 is approximately 1,066m long and consists of a salt marsh with marine influence from Portage Inlet. The right bank of Colquitz River, within Cuthbert Holmes Park, is well-vegetated with primarily native vegetation. A tributary enters the Colquitz River from the north along this bank and is easily visible from the headland just off the main park path. This tributary flows from a wet meadow depression on the north side of the Trans Canada Highway at McKenzie Avenue. The left hand bank, from Admirals Road bridge until the first footbridge in Cuthbert Holmes Park, consists of mostly residential lawns that extend nearly to the water's edge. The lack of riparian vegetation on the left bank may lead to problems of bank erosion in the future and structures to prevent this, such as the log anchor downstream of the first footbridge, are already in place in certain areas. A stormwater outfall (from the residential area) is also visible entering the creek downstream of the first footbridge.

This reach of the Colquitz River represents an historic delta and has a clay bottom with some till. A Rosgen channel type classification is not applicable to this reach due to its tidal nature. However, as it is a wide, shallow channel with a low gradient it does have Rosgen "F" type morphology.

The majority of the surrounding vegetation is native and consists of species such as sedges (*Carex spp.*), seashore salt grass (*Distichlis spicata* var. *spicata*), salal (*Gaultheria shallon*), gumweed, common snowberry (*Symphoricarpos albus*), red osier dogwood (*Cornus stolonifera*), Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and Indian plum (*Oemleria cerasiformis*). Non-native species, including Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and English hawthorn (*Crataegus monogyna*), among others, are abundant. A complete list of species in contained in the Reach 1 checklist found in Appendix 2. Although native vegetation is more abundant than invasive vegetation, there are large bare areas created by trampling along the main park pathway. These bare spots create opportunities for non-native species to colonize and could lead to increased sediment transport into the creek altering the water-sediment balance. This reach has the potential to achieve a vegetation community similar to what it was historically: a mature forest dominated by conifers with sedge, rush, and salt-tolerant species as well as an abundant riparian shrub understorey. Presently, there is a lack of large wood in this reach and, due to the narrow age-class diversity of conifers, there is little

supply. Such wood is important for dissipating the energy of high flows, trapping sediment, creating new floodplain, and adding to habitat complexity.
A blue heron and three mallard ducks were observed during the course of the assessment and river otters were seen in 2007.

Reach 1 represents a good location for a potential shoreline program with the residents in order to educate residents and community members them about the importance of riparian areas and to engage them in protecting these areas. Invasive species control and the rehabilitation of the upland trampled areas are high priorities for this reach to prevent the spread of invasive species and increased sedimentation to the stream.

Reach 1 was determined to have a rating of Proper Functioning Condition, although one would expect healthier conifers and other vegetation, as well as more large woody debris. Consequently, despite this reach being fully functional, it is not performing at its potential. Addressing the concerns described above - including trampling/erosion, invasive species and lawns adjacent to the stream - will help this reach of the Colquitz River attain its full potential.

Reach 2 Colquitz River: Upstream of the second footbridge in Cuthbert Holmes Park to beneath the first span of the Trans Canada Highway Bridge

Reach 2 is approximately 814m long and is within a portion of the Colquitz River linear park. This channel extends from where the creek narrows upstream of the second footbridge in Cuthbert Holmes Park, past Tillicum Mall, under Burnside Rd. ending beneath the first span of the Trans Canada Highway bridge. Reach 2 is much narrower than reach 1 and is tidally influenced only for a short section at the downstream end (a transition zone). A gravel path is located on the left bank of Colquitz River, and a portion of it (adjacent to the movie theatre) is known to flood during periods of heavy rain in the winter months. Downstream of the movie theatre, the banks of the creek were noted to be vertical and bare, likely due to past excavation, ditching, and regular tidal inundation. Adjacent to Silver City movie theatre, a large culvert directs water from bordering parking lots, into Colquitz River. On the opposite side of the path, a stormwater pond, not connected to the aforementioned culvert, treats water running off the adjacent parking lots. Across the path from the stormwater pond, the grassy area is experiencing erosion at an excessive rate exemplified by large clumps of bank falling into the creek. Trampling and a lack of appropriate vegetation is a probable cause of the excessive erosion. A fish-counting fence and staff gauge is located next to the parking lot.

The Rosgen channel type was determined to be an “E” channel with some “C” channel characteristics. In fact, in some areas of the reach, the channel resembles a “C” channel that has been dug out and deepened. This channel form is maintained by stormwater flows and the high degree of effective impervious areas (EIA) within the watershed.

Historically, the vegetation of reach 2 was a conifer-dominated forest with a shrub understorey and some Garry Oak (*Quercus garryana*). In the past, large wood would have been abundant throughout the reach and would have contributed to a less entrenched channel and larger floodplains. These characteristics could be restored with deliberate planting and addition of large wood.

Currently, the vegetation in the downstream portion of the reach is dominated by English hawthorn (*Crataegus monogyna*), hybrid hawthorns, and a mix of native and non-native shrubs and grasses. The upstream portion has a more diverse mix of trees, shrubs and herbaceous species than the downstream area. For a more detailed list of the vegetation, refer to the reach checklist in Appendix 2. Due to historical agricultural land use, Reach 2 is dominated by shrubs and has little mature vegetation except for that in the upstream end of the reach. It is important to note that the vegetation community is still in an early successional phase, and should be allowed to continue to grow to a mature state, with aid from additional planting and invasive species management.

The potential for Reach 2 is a Rosgen channel type ”C6”. The prospective restoration for this site would include invasive species removal and replanting with native vegetation, focusing on a mix of deciduous and coniferous trees. The locations where turf grass has been planted should be targeted first, as turf does not have a strong enough root system to maintain a stable bank as compared to the roots of native riparian vegetation. If allowed, the succession of vegetation over time will not only stabilize the banks but there will provide a natural supply of large woody debris (LWD) to the system to create habitat complexity and manage high flows. In the meantime, the addition of large wood, rock and gravel to key areas will increase habitat complexity creating an environment more conducive to wildlife. Opportunities for restoration in Reach 2 are numerous as there are no extreme land constraints acting as limiting factors.

Reach 2 was determined to have a rating of Proper Functioning Condition despite the fact that it has flashy flows and has, therefore, and altered hydrology. There is a large amount of effective impervious area (EIA) in the upper watershed that contributes simultaneously to high peak flows and low summer flows, as there is less permeable area to slow down, absorb, and store runoff. However, no major erosion or deposition was noted due to the current vegetation, though some areas are dominated by invasive species. Reach 2 will not achieve its potential if the hydrology is not restored to more natural patterns. In addition, invasive species and a planting regime would greatly benefit the function of the stream.

Reach 3 Colquitz River: Beneath the first span of the Trans Canada Highway Bridge to the North end of the southernmost boardwalk bridge alongside Interurban Road.

Reach 3 is approximately 155m long and extends from the Trans Canada Highway bridge upstream to the end of the southernmost boardwalk footbridge in the linear park alongside Interurban Road. There is a concrete weir located in the lower portion of the reach directly beneath the Trans Canada highway bridge. Its function is to control water flow and dissipate energy by creating a small pool upstream. An unreadable staff gauge is visible in the middle of the channel further upstream under the second span of the Trans Canada highway bridge (gauge should be replaced). This area is known to flood up and across the path in high flow events. The edges of the bank in this location are armoured with rip-rap and no vegetation is present. Evidence of heavy trampling exists around the rip-rap area while further upstream trampling is less evident.

The channel of reach 3 is a bedrock-controlled gully with a slope of approximately 3-4%. Consequently, the Rosgen channel type is a “G1”. Historical maps from 1858 reveal that the channel in this area may have been to the west of where is it located now. Therefore it is possible that this channel may have been blasted or deepened and worn down over time by the movement of water. A couple of rocks had visible drill holes in them but these may be associated with the boardwalk installation rather than channel blasting.

Taking into account that it may have been blasted, and due to the stable nature of the bedrock walls, the potential Rosgen channel type is similar to its current classification of “G1.” Erosion is not a concern within this reach due to the stable nature of the rock walls and the hardening of the bank alongside the path with constructed features. There is some sinuosity in the system, but it is highly constrained by the bedrock.

Historically, the vegetation community in Reach 3 would have been conifer-dominated forest with interspersed Garry Oak (*Quercus garryana*) habitat. This type of habitat is the potential vegetation for this area as well. Presently, reach 3 vegetation consists of both native and non-native (appendix 2). Both young and old conifers are present, although in localized areas the grand firs (*Abies grandis*) were either dead or dying. Removal of the invasive species such as English hawthorn (*Crataegus monogyny*), Himalayan blackberry (*Rubus armeniacus*), and reed canary grass (*Phalaris arundinacea*), is the only feasible restoration option as the channel of Reach 3 is so highly constrained by bedrock.

A lone barred owl was observed sitting on a Douglas fir (*Pseudotsuga menziesii*) in this section of Colquitz River.

Reach 3 was determined to have a rating of Proper Functioning Condition even though it is a flashy system with more silt/sediment than should be present. The bedrock channel effectively prevents erosion.

Reach 4 Colquitz River: From the end of the southernmost boardwalk bridge along Interurban Road, upstream to the North end of the northernmost boardwalk bridge at the stand of alders and poplars

Reach 4 is approximately 145m long. It extends from the end of the southernmost boardwalk footbridge across from the large Douglas fir (*Pseudotsuga menziesii*) to the north end of the northernmost boardwalk bridge at the stand of red alder (*Alnus rubra*) and non-native poplar (*Populus sp*.). On the left bank, this reach is bordered by Interurban Road and on the right, the Pacific Forestry Center and some residential properties. The creek is no longer contained within a steep bedrock channel; instead, the channel is composed of cobble-boulder overlaying clay with interspersed bedrock outcrops. The slope is approximately 2-4% and the creek is approximately 40% wider than it is deep. The Rosgen channel type is a “B2”, formed in clay/silt.

Although the vegetation in Reach 4 is abundant, it is composed of primarily invasive species, notably European bittersweet (*Solanum dulcamara*) and morning glory (*Ipomoea indica*). It is possible that yard waste may be contributing to their abundance. For a complete list of the native and non-native species found within Reach 4 refer to the reach checklist in Appendix 2. Historically, the vegetation in this area would have consisted of a mixed deciduous/conifer forest, with diverse native riparian shrubs. The potential vegetation community is also a conifer forest. While some conifers are present in Reach 4 now, there are no large replacement trees to substitute for the mature ones when they fall. These large conifers are important for the stabilization of the creek bank and for providing large woody debris in the channel.

The reach is presently at its potential channel type of“B2”. Nonetheless, there are some bare patches indicative of erosion and trampling that can be restored by removal of the invasive species and replanting with appropriate native vegetation. Because of the high density of non-native plants along the stream banks, removal will need to be carried out systematically to prevent erosion. It will therefore be necessary to replant immediately with fast growing native vegetation. Adding willow wattles and planting black cottonwood (*Populus balsamifera ssp. trichocarpa*) in the bare patches will shade out some of the invasives. The elevated boardwalk and trail have had a positive impact on the area as they have kept people off of the banks of the creek, lessening some of the effects of trampling.

Reach 4 was determined to have a rating of Proper Functioning Condition despite the concerns noted above, and augmented flows due to urban runoff from impervious areas within the watershed. Improvements could be made by implementing a successional planting program starting with fast-growing species such as willow, red osier dogwood, red alder and cottonwood, to create a shade canopy, and followed by conifers and herbaceous understorey species.

Reach 5 Colquitz River: From the end of the northernmost boardwalk footbridge to upstream of the cement stepping stones below the overhead footbridge

Reach 5 is approximately 297 m long and extends from the end of the second boardwalk footbridge to where the creek narrows again just upstream of the cement platforms and the overhead walkway. A small channel, that may act as an overflow channel is located near the downstream end of the reach. The creek appears to have achieved its potential floodplain extent. Facing downstream, a residential community is located on the steep right bank whereas the left bank is bordered by the park trail and, beyond that, Interurban Rd.

The Rosgen channel type is a “B6c” and has less than a 1% slope, an entrenchment ratio of approximately 2.0, and a width/depth ratio of greater than 12 (all characteristics representative of a “B” channel). The low gradient channel is composed of silt and clay substrate with the lower portion of the reach heavily eroded. On the right bank, a residential lawn that extends right to the water’s edge is lined with rip-rap placed to mitigate the erosion. Upstream of the lawn, the bank is cut straight down and the upper edge is lined with piles of garden debris. In addition, a wall of bricks has been constructed in the same area, presumably for stabilization purposes. On the left bank, extensive trampling has occurred right up to the edge of the water thereby preventing the growth of vegetation, and increasing the amount of erosion taking place. The edges of the trail have been mowed, unwittingly encouraging this trampling activity.

Further upstream, near a pool, a set of cement stepping-stones crosses Colquitz River. This area may have been dug out to accommodate water from Panama Flats located upstream, or to perform other drainage functions, or may have been created as a landscape feature. The area has been heavily armoured likely due to the construction of the overhead footbridge spanning the width of the creek at this location. A vigorous population of large-fruited bur-reed (*Sparganium eurycarpum*) and water plantain (*Alisma plantago-aquatica*) is located in this area. Such vegetation within the Colquitz is a rare example of emergent vegetation, indicating an accessible floodplain and a low energy area.

Historically, the vegetation in the area would have been similar to the downstream reaches described above. A more extensive community of conifers is the potential vegetation for this reach. Currently, there are few conifers with the tree species being dominated by red alder (*Alnus rubra*), various maple species (*Aceraceae*) and shrubs, including a large proportion of invasive species (refer to the checklist in Appendix 2 for a complete list of vegetation). The presence of duckweed (*Lemna spp.*) in this reach indicates that the water is moving considerably slower than the reaches downstream.

The potential Rosgen channel type of this reach is a “B6c,” but with a much narrower channel. The current channel may be over-widened due to excessive peak flows and ongoing erosion. The historic Rosgen channel form is undeterminable as there is strong evidence to suggest that it has been significantly altered, through excavation, fill, railway (now Interurban Road), and road construction.

Restoration of this reach would include the removal of invasive species and planting of native riparian and upland species. Furthermore, the addition of large woody debris, and/or strategically placed drop-log weirs, would create more sinuosity, thereby narrowing the channel. The area containing the stepping-stones could be improved through the removal of current vegetation choking the channel, and the installation of a step pool. To address the trampling issues, it would be advisable to discontinue mowing along the creek side of the path and begin planting with riparian vegetation to reduce the ease of access to the edge of the creek. Reach 5 presents an opportunity for landowner education on the effects of dumping garden debris in or near waterways, and how to address and prevent erosion problems from occurring.

Reach 5 has been assigned a rating of Functional-at-Risk with no apparent trend due to the large lawn areas, active erosion, and rip-rap within the system. Without the stream-bank armouring, more erosion and bank slumping would be occurring. If the system is pushed any further it will likely disintegrate in a downward trend toward a nonfunctional condition and thus it is key that the restoration of this reach occur quickly.

Reach 6 Colquitz River: Upstream of cement stepping stones beneath the pedestrian walkway to Interurban Road crossing

Reach 6 is approximately 343 m long and extends from where the creek narrows into a deep gully upstream of the overhead footbridge, underneath the McKenzie Road overpass to the Interurban Road bridge that crosses Colquitz River. The banks are steep and the creek is located down at the bottom of a gully. The Rosgen channel type is a “G6c” as it is gully-shaped, and has a slope of less than 1%. The stream bank is densely vegetated and is well protected from damaging activities such as trampling. The extent of erosion was difficult to determine due to dense vegetation and difficult access preventing a true close-up look for evidence of erosion. The potential Rosgen channel type of this reach “G6c” is the same as its current condition as the gully is highly constrained and does not allow for much lateral channel movement.

Although there are more conifers in this reach than the previous reach, there is only a very narrow strip of vegetation that is capable of contributing large woody debris. Historically, there would have been many more large conifers present in this area because the vegetative community would have been a mature coniferous forest with some deciduous species interspersed throughout it. The potential plant community is similar to the historical community, and should be dominated by conifers. The vegetation located within this reach consists of plants such as black cottonwood (*Populus balsamifera ssp. trichocarpa*), grand fir (*Abies grandis*), poplar (*Populus sp*.), Nootka rose (*Rosa nutkana*), and Himalayan blackberry (*Rubus armeniacus*) (for a complete list refer to the Reach 6 checklist in Appendix 2).

Although a long way from its potential, Reach 6 was determined to have a rating of Proper Functioning Condition. If Panama Flats, located upstream, were not attenuating water flow as it does now, the ability of this reach to withstand all the flow from the watershed would be questionable. Restoration of this reach would include: removing invasive species, planting native vegetation, and adding channel complexity. Unfortunately, access is difficult due to the gully-shaped, entrenched channel and thus, opportunities for restoration are limited.

Reach 7 Colquitz River: From Interurban Road crossing to the playground in Hyacinth Park

Reach 7 is approximately 450 m long. It runs from the Interurban Rd. bridge crossing, through a picnic area, under Violet Avenue through a culvert with a weir, under Marigold Avenue bridge and ends in Hyacinth Park near the playground.

The Rosgen channel type is a “C6” with a silt and clay substrate overlaying bedrock. Between Interurban Road and Violet Avenue, the floodplain is currently being utilized but lacks riparian vegetation. There are picnic benches near the left bank whose use leads to trampling along the water’s edge. Slightly downstream of the picnic benches, used oil spill mats and a spill boom were observed. Additionally, rip-rap lines the banks, on both sides, in several areas. The culvert crossing below Violet Avenue contains a weir with a rectangular notch approximately 0.5 m wide and functions to hold water back and create a small pool where a stream gauge is located. This site has also been used for water quality sampling in the past. Two shopping carts were observed, partially submerged in the channel. Just upstream of Violet Avenue, Swan Creek enters into the Colquitz system from the left bank.

From Violet Avenue to Marigold Avenue the banks are heavily vegetated, primarily with black cottonwood (*Populus balsamifera ssp. trichocarpa*), red alder (*Alnus rubra*), western redcedar (*Thuja plicata*) and willows (*Salix sp*.) (refer to the reach checklist in Appendix 2 for a list of vegetation). The pilings for the Marigold Avenue bridge over the Colquitz River are lined with toxic creosote that may be degrading water quality and animal habitat. If this bridge is to be upgraded, the creosote-lined pilings should be replaced with cured concrete or steel. The section of the reach upstream of Marigold Avenue meanders gently and floods up to the pedestrian path in heavy flows. A remnant of 1970s or 1980s landscaping, numerous weeping willows (*Salix babylonica*) line the bank. Although these trees do stabilize the bank, they also secrete a substance that prevents other riparian plants from growing. Upstream of the weeping willows, near concrete stepping stones leading down to the stream, there was a hydrogen sulphide odour present, indicating that the sediment is anoxic. The stream banks are muddy in this area and sparsely vegetated, however little erosion is present.

Historically, the vegetation in the area would have been dominated by coniferous forest with a riparian corridor and some Garry Oak (*Quercus garryana*). The potential vegetation condition is similar to the historic plant community. Currently, the reach has only a few sedges with primarily deciduous trees such as black cottonwood (*Populus balsamifera ssp. trichocarpa*), red alder (*Alnus rubra*), red osier dogwood (*Cornus stolonifera*), and willow (*Salix sp*.).

The channel in this reach has the appearance of having been restored in recent decades, given the age of the trees and the presence of some ornamental species. The channel appears to have been widened to create additional floodplain, likely undertaken in the early 1970's following initiatives by Saanich (Neate, 1969). Supporting this assumption is a newspaper article from 1969 depicting stream 'cleaning' and replanting, stating Colquitz River was previously choked with vegetation and ditch-like (Dogwood Star, Dec. 4 1969). Although some species (*e.g.* weeping willow) would not be chosen today, this prior restoration has resulted in accessible floodplain, an approximation of natural sinuosity, and channel morphology.

The potential Rosgen channel type of "C6" is currently present although a more sinuous channel could be created. In order for this reach to fully reach its potential, improvements should include the removal of every second weeping willow near Marigold Avenue and replacement with a shrub understorey and conifers. Once the newly planted vegetation is strong enough to stabilize the bank, the remaining willows should be removed. This area is easily accessible and thus it is a good candidate for the realignment of the creek channel to increase meander and floodplain access, and the addition of wood, rock, and gravel to improve habitat complexity. In the upland area bordering Hyacinth Park (on the creek side of the path), lawn mowing and maintenance should be discontinued in order to increase the density of vegetation alongside the creek. Furthermore, areas of the park that are not used for playing fields should be planted with native vegetation.

Reach 7 has been determined to have a rating of Proper Functioning Condition, due in part, to the protection and planting already conducted in previous years by Saanich.

Reach 8 Colquitz River: Panama Flats from the playground in Hyacinth Park to Roy Road

Reach 8 is approximately 1374 m long and extends from the weeping willow across from the playground in Hyacinth Park, through Panama Flats, to the Roy Road bridge. The channel type is a ditch and is located on the west side of Panama Flats. Panama Flats floods annually during the winter months due to overflow from the Colquitz River. The historical wetland was drained for agriculture and thus flood waters tend to cover the entire field for weeks to several months of the winter. The hydrological storage effected by this flooding is important for downstream flood abatement. The open body of water created in the winter is used by many species of migratory and resident waterfowl; however, farmers in the area have long called for increased drainage to ensure a longer growing season. Historical maps indicate that Panama Flats was once a large wetland (labeled as a "swamp" on maps), either with no stream channel noted, or with a stream channel meandering through the middle. According to these maps, the outlet of the channel appears to have been located about 100 m to the north of its present location. The wetland was eventually drained for agriculture, probably near the turn of the 19^{th} century. There is no detailed information available as to the vegetation composition of this wetland, but it is reasonable to suggest that is was a shrub swamp, dominated by species such as willow (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), hardhack (*Spirea douglasii*), crabapple (*Malus fusca*), as well as sedges (*Carex* spp.), rushes (*Juncus* spp.; *Scirpus* spp.), and cattail (*Typha latifolia*). This could easily be determined through sediment cores and pollen analysis. Deciduous and coniferous trees would have characteristically populated transition zones. Beavers may have been present, which would have periodically created bodies of open water and submersed/emergent aquatic vegetation. If a defined stream channel was present, it would have been a low-gradient channel type, such as a Rosgen “C” or “E” channel, with high sinuosity and very large floodplains.

Today, the creek flows on the west side of Panama Flats in a ditch along Interurban Road. A tributary flows south in another ditch through the middle of the fields, turns west and then joins the main stem at the downstream end of the fields. This ditch has no complexity such as wood, rock or overflow structures, to dissipate the energy of high flows. Although high flows access the field as a floodplain, this only occurs during the wettest months, and is a result of increased peak flows from the surrounding effective impervious areas (EIA) in the watershed. If the channel had its historical shape and depth, it would flood more frequently and reduce the erosive forces in the channel. Not surprisingly, the stream banks in this reach are visibly eroding and slumping.

The vegetation in this reach is dominated by reed canary grass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus armeniacus*), and interspersed with native and non-native vegetation such as red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), English hawthorn (*Crataegus monogyna*), black hawthorn (*Crataegus douglasii*), willow (*Salix* spp.), red osier dogwood (*Cornus stolonifera*), Nootka rose (*Rosa nutkana*) and common snowberry (*Symphoricarpos albus*). Some residential lawns extend and encroach upon the stream banks, while English ivy (*Hedera helix*) is fully engulfing numerous trees near the residential properties. Despite the presence of many appropriate riparian species, only a very narrow band immediately adjacent to the stream channel is composed of species that indicate saturated soil conditions. Many upland (or facultative) species are present on or very near the stream banks, indicating a lowered water table due to the ditching conducted to drain the wetland.

Panama Hill Pond is located on the left side of the path (looking downstream) but does not seem to be connected by surface flow to Colquitz River. It is an old stormwater pond that has been recently retrofitted. The banks of the pond are overly steep and sparsely vegetated while the pond itself appears to be anoxic. An abundance of algae was observed. Aquatic and riparian vegetation is quite diverse and abundant. This pond also provides habitat for wildlife. Downstream of the blue footbridge, Peers Creek, bringing flows from the Wilkinson Valley, enters Colquitz River. At the upper end of the reach, beneath Roy Road bridge, red alder (*Alnus rubra*) trees are holding a steep bank in place with stable, although exposed, roots.

In the short term, the potential for this reach is a Rosgen “C” channel, but with proper restoration it could become an “E” channel with a wetland over the long term. Currently, the riparian vegetation present along this reach is dominated by non-native species (refer to the table in the reach checklist in Appendix 2 for a full list of species).

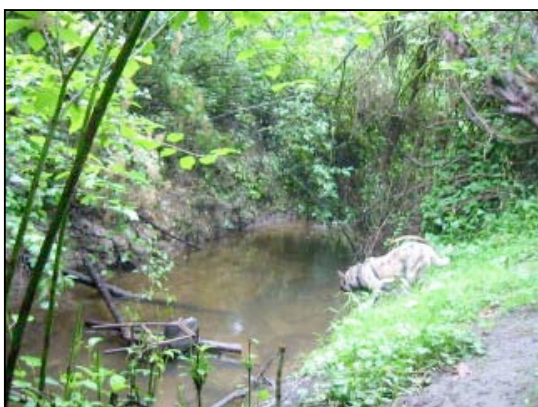
Given that there is a large amount of land available, there is great potential for restoration of this section of the reach. Restoration efforts should include reconstructing the channel with a large amount of sinuosity appropriate to a “C” channel type, with a series of constructed ponds/wetlands and floodplain areas. A replanting regime should focus on removing invasive species, establishing a shade canopy with fast-growing deciduous trees and shrubs, and an understorey with conifer plantings. This will ensure less competition from shade-intolerant invasive species and improve survival of native plantings.

Long-term restoration along Panama Flats (given a land ownership scenario that permits it) would focus on wetland creation and realignment of a sinuous “C” or “E” channel bordered by generous floodplains. In the short term, the channel could be realigned to meander in wider areas and to establish floodplain terraces to allow for the dissipation of energy from peak flows. Removal of invasive species and replanting would occur during such work.

Connecting the existing pond to the creek may also provide some energy dissipation and add oxygenated water to the pond to reduce the anoxic state. Due to the importance of Panama Flats in attenuating water flow for the reaches of Colquitz River downstream, it is absolutely essential to maintain the function of this area to act as a floodplain. If the functionality of this floodplain is jeopardized, areas downstream of Panama Flats, including residential, commercial, highway, roads, and parks are likely to flood in high flow events.

This reach has been classified as Nonfunctional due to its ditch-like characteristics, inappropriate shape to handle high flows, and active erosion throughout.

Reach 9 Colquitz River: From Roy Road Bridge to upstream of the Gabo Creek confluence in Rosee Grove



Reach 9 is approximately 1809 m long. The reach begins at the Roy Road Bridge, passes through an open field of vegetation on Saanich Park land, and extends through Copley Park ending downstream of the playground in Rosee Grove (Vanalman Avenue). Single-family detached homes surround the park.

General Characteristics: Roy Road to Copley Park

Upstream of Roy Road, facing downstream, on the right side of the creek, residential lawns extend to the top edge of the bank. Opposite to the houses, on the other side of the creek, a wet depression is located in an open field suggesting an active area of floodplain. On the left bank, a large stand of aspen (*Populus tremuloides*), interspersed with sedges (*Carex spp*.) and rushes (*Juncus spp*.), indicates moist soil conditions, possibly due to a perched water table. Immediately adjacent to the stream, vegetation includes black hawthorn (*Crataegus douglasii*), Garry oak (*Quercus garryana*), red alder (*Alnus rubra*), willow (*Salix* spp.), and various shrubs. For a full list of vegetation refer to the vegetation table of the reach checklist in Appendix 2.

The creek flows within a ditch-like channel that was artificially deepened or dug out. Downstream of the blue footbridge, the channel may have been straightened as well. In the vicinity of the blue bridge, the banks are steep, heavily eroded, and downcut. These characteristics are representative of the trend occurring within the remainder of the reach, which is entrenched. The Rosgen channel type for this reach is a “G6” or a “G6c” as the characteristics of the creek suggest it may have been a “C” type channel which downcut and/or was dug out to its current state.

In general, areas of trampling are localized near the path. However, in some areas there is evidence of “bush parties” and bonfires at the edge of the creek, leading to increased trampling of vegetation and an increased risk of bank erosion and creek sedimentation. Upstream of the blue bridge, the creek is more sinuous but the banks remain vertical and entrenched. Between 1120 Gerta Rd. and 4246 Grange Rd., the creek has an extremely steep, eroding bank on the outside bend. Dense wood debris from the clearing of the property remains along the bank and has impeded the growth of native vegetation that would act to stabilize the bank. Upstream, near the convergence of Loenholm Road and Wilkinson Road, Durrell Creek enters the Colquitz River. Where Loenholm Road crosses the Colquitz River, garbage, including a car battery, has been dumped and a vinegar smell was noted to be emanating from the creek.

In general, the stream channel form reflects historic channelization and a flashy flow regime from the relatively urbanized watershed; the channel is bare, entrenched, eroded, and over-widened. The banks are steep, with no large wood present or accessible floodplain to protect against erosion. At a few points along the creek, running water could be heard, possibly due to debris jams and slight changes in elevation. Overall, the slope throughout the reach is very low, around 1-2%.

General Characteristics: Copley Park to Gabo Creek

A soccer pitch and tennis courts are located upland of the Colquitz River in Copley Park between Carey Road and Vanalman Avenue. In this section of the reach, residences line the left bank with lawns extending to the edge of the bank. The banks are steep, and in some areas have been armoured with rock walls to reduce erosion. Although there is little floodplain throughout, the downstream end of Copley Park does have a small, vegetated floodplain, possibly created through past restoration activities. Debris jams and rafts and over steepened banks are also found in this section of Reach 9. Flows from residential drains are adding to the erosion and steepening of the banks. Himalayan blackberries (*Rubus armeniacus*) and European bittersweet (*Solanum dulcamara*) choke the channel impeding the growth of appropriate riparian vegetation. The substrate is silty and heavy scouring is evident at some points.

Upstream of the blue pedestrian bridge off of Vanalman Avenue, a large box culvert discharges flows into the Colquitz. Gabo Creek enters the Colquitz near this location and drains the area surrounding Rithet’s Bog found in the northeastern portion of the Colquitz watershed.

Historically, the riparian vegetation would have included the typical assortment of coniferous and deciduous trees, shrubs, and herbaceous plants, surrounded by an upland conifer forest interspersed with Garry Oak (*Quercus garryana*), and arbutus (*Arbutus menziesii*) communities, Fewer alders (*Alnus rubra*) than what would be expected for such a disturbed environment, were noted within this reach although they did become more abundant toward the end of the reach. The conifers present were lacking age-class diversity and were not as healthy as they should be.

This is a cause for concern as there is a lack of large woody debris in the system and there is little future supply. Invasive species are actively encroaching upon what native vegetation is vigorous.

The historic channel type in this reach was probably a Rosgen "C" channel, characterized by a low gradient and a highly sinuous channel with well-developed point bars and floodplains. The reach would have also contained a large amount of large wood. The stream has since been excavated and has downcut due to high peak flows from an urbanized watershed. At the present time, the Colquitz River within this reach is not able to access its floodplain and therefore it is not capable of mitigating increased peak flows and reducing erosion.

Due to the current entrenchment of the channel, it is not feasible to bring the channel bed elevation back up to its historic level. Furthermore, adjacent development will not allow for restoration of natural floodplains due to flooding concerns. Therefore, the potential Rosgen channel type for Reach 9 is a "G6" channel; a gully similar to its present form. However, smaller floodplain terraces and wetlands could be created at selected locations within and around the stream to allow for greater hydrological storage and attenuation of peak flows. Planting with diverse native vegetation, suited to the local site conditions, would stabilize newly created banks. Furthermore, overflow channels could be created to help divert, slow, and decrease the amount of flow in the main channel. Wetlands could be constructed in the area near Grange Road and Gerta Road by re-sloping and terracing the bank on the cleared property, as well as in the field area downstream of Gerta Road. Additionally, hydrological modeling of the flows would contribute to better understanding of the dynamics of the system and designing the optimal dimensions and size of constructed features. In the vicinity of Copley Park, the addition of stone weirs would aid in slowing down the water during low flows protecting the banks on a day-to-day basis. Removing the Himalayan blackberries (*Rubus armeniacus*) and creating a terraced area around the park would improve the ecological function of Reach 9 and also improve aesthetics.

Reach 9 was determined to have a rating of non-functional. This reach has some sinuosity, but not enough to dissipate the energy associated with high peak flows experienced by the Colquitz River. Furthermore, there are few areas of active floodplain that can be accessed during high flows and consequently, over-steepened and highly eroded banks are the norm within this reach. The large amount of impervious area in the upper watershed is the main contributor to this degradation.

Reach 10a Colquitz River: Upstream of Gabo Creek confluence in Rosee Grove to the staked trail off Lindsay Road

Reach 10a is approximately 944 m long and extends from Rosee Grove, upstream through park and residential areas, to the point where the channel narrows, just off Lindsay Road. Upstream from the playground in Rosee Grove a footbridge crosses the Colquitz River. Trampling in this location has severely reduced the amount of vegetation within this riparian area. There is little variation in species or age class within this reach. A similar age class of species creates a large risk as there is no successional growth to replace populations that die. It is especially concerning in this reach as there is little riparian vegetation growing because of heavy trampling which has left the stream banks bare and open to erosion. The vegetation that is present along the banks is dominated by red alder (*Alnus rubra)* whose roots are currently holding the banks in place. Gravel, riffles, small point bars, and some undercutting banks were noted within this reach and the channel is more sinuous than Reach 9. The wide and flat-bottomed channel of Reach 10 has a slope of less than 2% with some areas of 2.5 to 3% and contains a silt/clay substrate with some gravel and cobble. This reach has been classified as a Rosgen "F6" channel type, with some areas classified as an "F6b." There is little large woody debris in the creek itself, despite the large coniferous and deciduous trees adjacent to the creek banks, indicating stream clearing activities may be (of were) occurring. A wetland is located upstream of the green footbridge and can be accessed by walking across the footbridge to Northridge Crescent. This wetland is marginally connected to Colquitz River and appears to have been a dug out as a pond that has subsequently filled in with sediment. A tributary, Mahon Brook, enters into the Colquitz River upstream of Mann Road.

Reach 10a is dominated by big-leaf maple (*Acer macrophyllum*), Himalayan blackberry (*Rubus armeniacus*), Oregon grape (*Mahonia sp*.), Indian plum (*Oemleria cerasiformis),* red alder (*Alnu*s *rubra*), and, upstream of the second footbridge, Douglas fir (*Pseudotsuga menziesii*) (see Appendix 2 for full vegetation list). Highly invasive bamboo (*Bambusa sp*.) was observed off the path near 4252 Moor Park Place and its immediate removal is recommended. Throughout this reach, soils have been eroded by high flows exposing the tree roots that hold the stream bank together. If these roots were not in their present location, the banks of the stream would be slumping heavily. Consequently, this reach is in critical condition. In the event of a large windstorm, like those experienced in the winter of 2006/2007, the large alders could be blown out jeopardizing the stability of the banks if there is no other vegetation to take on their stabilizing role.

Historically, the vegetation in this reach would have been a coniferous forest with patches of deciduous trees and shrubs throughout. Riparian shrubs would have grown densely along the stream banks; side channels, floodplains and calm pools would have contained emergent aquatic vegetation. This scenario also represents the "potential" community, although it may be difficult or impossible to eradicate all invasive species. In order to support lush stream bank vegetation and emergent species, the flashiness of upstream flows would need to be reduced and the floodplains restored.

Given the low gradient of the land in this area and the present sinuosity of the channel, the historic stream was probably a Rosgen “C” channel, with the main difference being that the channel was not entrenched as it is now. Abundant large wood would have slowed stream flow energy, and created additional floodplains and sheltered pools.

It is not feasible to restore the historic channel elevation given the current flow regime and the immense volume of material that would be required to replace that which was eroded. The potential Rosgen channel type for Reach 10 is therefore also an “F6,” with more “C” characteristics such as accessible floodplain and well-developed point bars. These point bars could be created with careful placement of large wood (and/or small weirs), re-grading steep banks, and stabilizing with native vegetation.

Invasive species should be removed in order to preserve the health of the native species and to better protect stream banks from erosion. Areas of excessive trampling need to be addressed with fencing and replanting. Planting native vegetation with thorns such as Nootka rose (*Rosa nutkana*), salmonberry (*Rubus spectabilis*), devil’s club (*Oplopanax horridus*) and black hawthorn (*Crataegus douglasii*) as an understorey would make access difficult and allow the roots to stabilize the eroding banks without being trampled. Adding large woody debris to the system would also make it more stable through the dissipation of energy from high peak flows. Furthermore, when the existing large trees in the reach do fall down, it is essential that the wood be left in the creek to perform this mitigation function. This may require modifying the maintenance procedures used by Saanich Parks and Engineering staff. In the areas where the park trail is located next to the edge of the bank, it would be prudent to move it back as far as possible in order to reduce trampling at the bank and allow for re-vegetation and thus, stabilization of the channel.

Reach 10a was determined to have a rating of Functional-at-Risk with no apparent trend. Even though it may be stable at the moment, if a big storm or localized wind event were to take down the large trees holding the banks together, the system would degrade rapidly and become extremely difficult to restore. To improve the reach and bring it up to proper functioning condition, revegetating trampled areas, removal of invasive species, and realignment of the trail away from the stream bank are necessary.

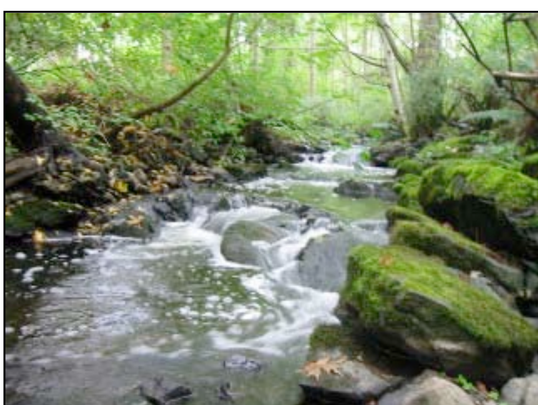
Reach 10b Colquitz River: The wetland at Vanalman Avenue and Northridge Crescent

Reach 10b is approximately 0.047 hectares. It is a wetland found near Vanalman Avenue and Northridge Crescent just upstream of the green footbridge in Reach 10. The wetland is surrounded on the edges by English ivy (*Hedera helix*) and Himalayan blackberry (*Rubus armeniacus*). The wetland is protected from wind and is small enough that it does not experience wave events. The riparian-wetland vegetative community is vigorous and consists of species such as Pacific water-parsley (*Oenanthe sarmentosa*), red alder (*Alnus rubra*), smartweed (*Polygonum spp*.), and willow (*Salix spp*.) (For a full list refer to the reach checklist in Appendix 2).

Surrounded on north, west and south sides by residential properties, the wetland abuts the Colquitz River on the east side. At this location, the Colquitz River enters and leaves the east end of the wetland almost simultaneously, therefore the water has a very short residence time. The land immediately adjacent to the wetland on Northridge Crescent slopes gently, suggesting that the wetland may have been dug out or if historically bigger, has filled in over time.

Reach 10b was determined to have a rating of Proper Functioning Condition, as the riparian-wetland vegetation is vigorous and protected from wind and wave events. Invasive species control and removal in conjunction with replanting of native riparian-wetland vegetation would improve the function of this wetland.

Reach 11 Colquitz River: The small trail off Lindsay Road to bridge at 4444 Wilkinson Road



Reach 11 is approximately 191 m long, beginning at the trail that connects to Lindsay Road extending to the bridge at 4444 Wilkinson Road. With the exception of one large residential lawn area, this reach is quite heavily vegetated throughout. This is likely due to surrounding park and paths that are a considerable distance from the creek. Adjacent to the lawn extending to the edge of the right bank, numerous fish were observed in a rocky pool; given their size (>15 cm long), some may have been cutthroat trout. There was very little erosion observed throughout the reach as the large rocks and vegetation stabilize the banks in the system. Nearby, homeowners have been dumping yard waste and compost into the park vicinity downstream of Wilkinson Road while another pile of yard waste is present just outside the fence of 4444 Wilkinson Road. Such practices, although thought to be harmless, are one of the main contributors to invasive species problem. Quick's Bottom attenuates flows upstream of Reach 11, and favourably reduces the volume of water that passes through this reach.

The Rosgen channel type was determined to be a "B2" channel with its historic and potential stream channel type to be the same. Major species of vegetation within the reach consisted of big leaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), and red alder (*Alnus rubra*) (see the detailed list of species in Appendix 2).

Reach 11 was determined to have a Proper Functioning Condition (PFC) rating. Restoration of this reach would be minimal, but would include an invasive species removal program that should encompass educating nearby residents on invasive species removal and prevention including the proper disposal of compost. Invasive species removal should be paired with planting a mixture of native coniferous and deciduous species to create a diverse age class of vegetation for maintenance and recovery purposes.

Reach 12 Colquitz River: The bridge at 4444 Wilkinson Road to the pedestrian bridge at entrance to Quick's Bottom

Reach 12 is approximately 229 m long extending from the bridge at 4444 Wilkinson Road through residential property to the footbridge at the entrance to Quick's Bottom. This section of Colquitz River is armoured on the left bank immediately upstream of the bridge by a rock wall up to the bend in the channel. Past this corner, the left bank is no longer armoured and contains a small section of accessible floodplain on 4450 Wilkinson Road property. While the right bank of this reach is initially unarmoured, upstream of the bend a wood piling wall holds this bank in place. The design of this wall suggests that the area may have been cribbed and then filled in order to extend the property to the edge of the creek. At this point, the right bank is substantially higher than the left bank. Further upstream, the wood piling wall ends and a concrete wall begins to maintain the high right bank. While this silt/clay channel has the gradient of a C and some accessible floodplain, the armoured nature of the channel makes the determination of Rosgen channel type difficult.

Historically, this section of Colquitz River would have been dominated by coniferous trees with intrusions of deciduous trees, and a shrubby understorey. Presently, residential plots have opened up the land reducing the vegetation community. Red alder (*Alnus rubra*), big leaf maple (*Acer macrophyllum*), hardhack (*Spirea douglasii ssp. douglasii*), and snowberry (*Symphoricarpos albus*) are the primary vegetation of the area, while Himalayan blackberry (*Rubus armeniacus*) is also in abundance at the upstream end of the reach. A section of slope on the left bank at 4450 Wilkinson Road has been recently planted in the last two years, but it is sparse.

The potential Rosgen channel type of C6 has not been attained for Reach 12 due to the highly constraining nature of the wood, rock, and cement walls. Additionally, the floodplain access and use is only intermittent throughout the reach and upland plant species outnumber riparian plant species.

In order to achieve the potential for this reach a number of tasks could be undertaken. The recently planted section should be augmented with more riparian species to provide a root system capable of withstanding high-energy flows. Additionally, invasive species should be removed to allow for the full and healthy succession of native riparian plant species. This can be accomplished by planting fast growing, shade creating plants such as willows (*Salix sp*.) to shade out persistent invasive species. Ultimately, the removal of the tall, wood piling wall should be undertaken and the fill pulled back. If the wall is allowed to remain, this wood will fail over time and slump into the creek. Upon this slumping, due to the amount of material behind it, flooding of the area would occur damaging the residential properties in the immediate vicinity. This addition of sediment, and other material, will also place the downstream reaches of the Colquitz River at risk.

As a result of the presence of the walls constraining the channel, the lack of consistent accessible floodplain, and not enough native riparian vegetation, Reach 12 is Functional-at-Risk with no apparent trend.

Reach 13: Quick's Bottom

Reach 13 is an approximately 18.8 ha wetland located south of West Saanich Road between Wilkinson and Markham Roads. This area is a designated park space within the Municipality of Saanich and as such is protected and in good condition. Restoration efforts have been conducted in the past to improve fish passage through this area (discussed in Reach 14).

Historically, Quick's Bottom would have been a wetland area surrounded by a coniferous/deciduous forest. Closer to the wetland shrub species would have been dominant. Presently, reed canary grass (*Phalaris arundinacea*) has created a distinctive monoculture throughout the wetland except for areas that were planted during restoration efforts between 2000 and 2004. The other vegetation species currently inhabiting Quick's Bottom include: black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), red osier dogwood (*Cornus stolonifera*), willows (*Salix* sp.), black hawthorn (*Crataegus douglasii*), English hawthorn (*Crataegus monogyna*), and cattails (*Typha latifolia*). A complete list of vegetation can be found in the reach checklist in Appendix 2.

In order to maintain the integrity of the wetland, a reduction in the reed canary grass monoculture would be beneficial. Planting of willows and other shade forming shrubs and trees would aid in this endeavour. Successional planting of native riparian vegetation over a number of years would create age class diversity as well as increasing habitat complexity. The likelihood of success of plantings in this location is high as there is access to water all year round and previous revegetation efforts have been successful.

Reach 14 Colquitz River: Quick's Bottom Pedestrian Bridge to the footbridge at 4654 West Saanich Road

Reach 14 is approximately 810 m long and begins at the pedestrian bridge within Quick's Bottom and extends to the footbridge located on the property of John Oliver (4654 West Saanich Road). Prior work and restoration has been completed on this reach. Between 2000 and 2004, Saanich Parks re-aligned the ditch through the east side of Quick's Bottom wetland, removed the reed canary grass and restored the channel morphology. At the time, the plan was to place additional large woody material into the channel as well as plant various riparian and deciduous/coniferous species. This has not occurred and thus has led to the invasion and encroachment of invasive species such as reed canary grass (*Phalaris arundinacea*). Furthermore, during the year 2000, upstream from this work, a sewer line was installed on John Oliver's property at the footbridge crossing. Following excavation, this site was successfully replanted with riparian species, which have thrived, and gravel was placed in the channel to augment fish habitat at the request of DFO.

The existing Rosgen channel type (also it potential) has been determined to be a "C6", as compared to a Rosgen "E" or "C" type historically meandering through the wetland area (if a defined channel existed). It should be noted that during restoration, the creek running beside the wetland area was constructed as a 9-foot wide channel, but due to encroaching vegetation (primarily reed canary grass) the channel is now 2-3 feet wide and is continually shrinking. Planting native riparian trees and shrubs would shade out the encroaching reed canary grass and allow the reach to remain a channel. The reach has considerable access to floodplain and has been able to manage the energy from high flow events, thus avoiding stream bank erosion and damage. Some weirs are present, but more wood is required within the system to further define the channel. Vegetation within the reach consists mainly of reed canary grass (*Phalaris arundinacea*) with willow (*Salix spp*.) along the banks. The detailed list of species within this reach can be found in the reach checklist in Appendix 2.

Reach 14 is at Proper Functioning Condition (PFC). The restoration work required is minimal and should include removing the existing reed canary grass, laying down mulch, installing large wood (in the vicinity) into the channel, and planting willow cuttings, and others species such as cottonwood, red osier dogwood, red alder and trembling aspen.

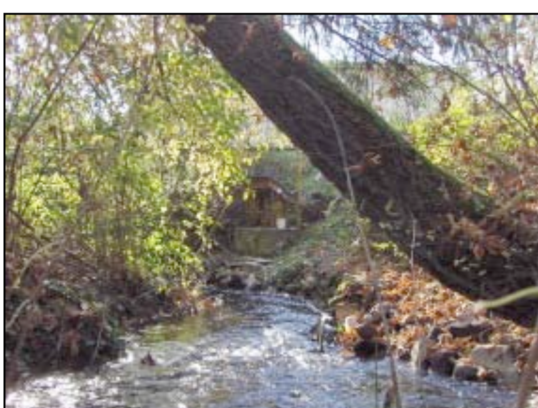
Reach 15 Colquitz River: From the footbridge at 4654 West Saanich Road Property to the West Saanich Road crossing

Reach 15 is approximately 300 m long and extends upstream from the footbridge located on the property of John Oliver (4654 West Saanich Road) to the West Saanich Road bridge. The reach is in fair condition with insignificant erosion evident within the reach. This is in part due to the available floodplain, and the two weirs that function to dissipate energy during high velocity flows. One weir is a rock weir downstream of the West Saanich Road Bridge and the other is a wooden weir located underneath the pedestrian bridge at 4654 West Saanich Road. The Rosgen channel type has been classified as a "C3b" channel. This is a wide, slightly entrenched, sinuous channel with a slope of 2-4%. The potential and historic conditions have both been classified as "C3b" channels.

The majority of the vegetation within this reach consists of big leaf maple (*Acer macrophyllum*), common snowberry (*Symphoricarpos albus*), Himalayan blackberry *(Rubus armeniacus)*, red alder (*Alnus rubra*), and red osier dogwood (*Cornus stolonifera).* For a detailed list of vegetation within this reach, see the Reach 15 checklist in Appendix 2.

The reach has been determined to be in Proper Functioning Condition (PFC). Enhancement of this reach would involve planting the channel with more conifers and removing invasive species. Furthermore, adding wood and large rock to the channel would create more hydraulic complexity and habitat. At the beginning of the reach, it was noted that the homeowner maintains a mowed lawn very close to the channel. The homeowner should be asked to leave a buffer strip between the grass and the creek so that riparian vegetation may grow undisturbed, thereby improving floodplain characteristics and erosion mitigation, while increasing available wildlife habitat.

Reach 16 Colquitz River: West Saanich Road bridge to 4521 Cheeseman Road



Reach 16 is approximately 156 m long and extends from West Saanich Road, upstream to the middle of the property at 4521 Cheeseman Road (where the slope increases near the dead cedar tree and rock outcrop between two stumps). A sheep paddock borders the creek on the right bank, but is separated from the creek by a fence and a dense thicket of Himalayan blackberry (*Rubus armeniacus*). Alongside the residential properties, there are a number of small trails and trampled areas leading down to the creek. There is a notable amount of garbage (*i.e.* beer cans, concrete slabs, etc.) that has been left on the upslope and along the banks. Throughout most of the reach the banks are well vegetated, except an area of lawn extending to the edge of the water (4521 Cheeseman Road). This section of Colquitz River is dominated by bedrock and has a moderate gradient with riffles, small cascades, and a few small pools. The Rosgen channel type is a "B1" with a moderate slope and some sinuosity. A tributary, Normandy Creek, enters Colquitz River in this reach at the small footbridge just upstream of West Saanich Road bridge.

The vegetation in this reach is dominated by red osier dogwood (*Cornus stolonifera*) throughout, Pacific ninebark (*Physocarpus capitatus*) in the lower section, and Himalayan blackberry (*Rubus armeniacus*). *Laburnum* was also noted near the sheep paddock and should be removed before it is allowed to spread any further as it is highly invasive. Historically, this reach would have been dominated by coniferous forest with western redcedar (*Thuja plicata*), grand fir (*Abies grandis*), Douglas fir (*Pseudotsuga menziesii*) and patches of red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), red osier dogwood (*Cornus stolonifera*), and a sword fern (*Polystichum munitum*)/salal (*Gaultheria shallon*) understorey. While some of these species of vegetation are present (see complete list of vegetation in Appendix 2), invasive species must be removed in order for the vegetation community to reach its "potential." Nevertheless, the existing vegetation is capable of withstanding high flows and is adequate to supply large woody debris. A few large trees were noted to have fallen into, and over, Colquitz River in this reach. In one location, the roots of the fallen tree are still attached to the bank and are playing a key role in maintaining bank stability. These trees should be left in place, as well as any others that fall, in order to increase the channel habitat complexity, uphold bank stability, and aid in dissipating energy from high flow events.

With little erosion noted and accessible floodplain present, this reach is currently at its potential channel type of B1. The stream's evolution toward its potential natural community will be accelerated by removing invasive species, and leaving downed trees in the channel where they fall. As the houses are quite distant from the bank, the addition of large woody material is not likely to cause any flood damage to property.

Reach 16 was determined to be in Proper Functioning Condition.

Reach 17 Colquitz River: 4521 Cheeseman Road to the waterfall upstream of the pond at 4525 Cheeseman Road

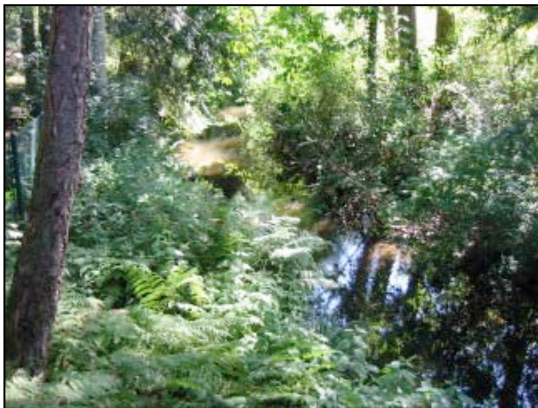
Reach 17 is approximately 93 m long and extends from 4521 Cheeseman Road, through a residential property (4525 Cheeseman Road) to a waterfall located upstream of a shallow pond. In this reach, the right bank, looking downstream, is armoured with a rock wall with 30 m of the upstream portion of the reach having no riparian vegetation. Instead, throughout this un-vegetated portion, lawns are found bordering the edge of the right bank. Evidence of erosion is apparent along these banks. Conversely, the left bank, looking downstream, is densely vegetated and is, therefore, not eroding. Upstream of the lawn area, there is an existing concrete dam with a spillway. A shallow pond filled with silt is directly upstream of the dam and is lined with rock on both banks. The water level in the pond is known to fluctuate within its banks and the only time flooding has occurred in the past 15 years in this reach was during the 2006/2007 winter storms (Scobie, Pers. Comm.). The channel is dominated by bedrock and contains relatively small cascades, waterfalls and pools. Downstream of the dam, the creek splits into several channels anastomosing around wads of vegetation and bedrock outcrops. The Rosgen channel type is an “A1” channel with high energy, and a steep slope.

Historically, the area would have been coniferous forest with patches of deciduous species and a riparian shrub understorey. The vegetation in this reach is now dominated by Pacific ninebark (*Physocarpus capitatus*), Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), and western redcedar (*Thuja plicata*), with various ornamental species also present. For a complete list of the species present see the reach checklist vegetation table in Appendix 2.

This reach has a “potential” and current Rosgen channel of “B1”. The stable nature of the bedrock substrate has prevented major degradation, however, there are areas of the reach that would benefit from restoration. The lawn that is subject to erosion would benefit from bioengineering with willow-wattles, and the addition of large wood to stabilize the bank from further erosion. Removing/controlling invasive species would also reduce the competition to the native plant species that are so important for sustaining the health of Colquitz River. Homeowner education is also recommended, as the properties along Reach 17 back onto the creek.

Reach 17 is in Proper Functioning Condition. However, for it to reach its desired potential, restoration of existing lawn areas and invasive species is necessary.

Reach 18 Colquitz River: The waterfall at 4525 Cheeseman Road to the first cascade at 4650 Pipeline Road



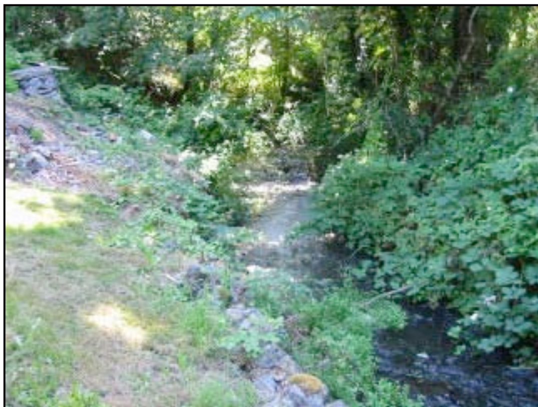
Reach 18 is approximately 100 m long and extends from the waterfall upstream of the pond at 4525 Cheeseman Road, through neighbouring residential properties and Saanich Park land to a cascade adjacent to an old cottage at 4650 Pipeline Road. Throughout this reach, the Colquitz River is entrenched with a vertical, heavily eroding and bare left bank. A mid channel bar is present downstream of the eroding bank, indicating sediment deposition either from the upper watershed or from the eroding bank. The channel material is dominated by clay banks with some bedrock outcrops. According to a property owner, Mr. Neil Gregory, the channel was full of silt prior to the winter storms of 2006/2007 which flushed the area out. Trout were observed in the creek at the time of the assessment, and Coho salmon used to be in abundance upstream of the aforementioned falls. Some new large wood, beneficial to the functioning of the system, appears to have fallen into the creek from the 2006/2007 winter storms. The current Rosgen channel type is a “Bc6”, an entrenched channel with moderate to low gradient.

Historically, the vegetation in the area would have consisted of coniferous forest with deciduous patches and shrubby understorey. Now, however, **this reach is overrun by invasive English ivy (*Hedera helix*), especially in the Saanich Parks property. Native vegetation is severely at risk of being overwhelmed by the English ivy (*Hedera helix*), to the extent that the ivy is encroaching upon neighbouring private properties, requiring major effort by residents to control it**, only for it to return from the park soon after. In addition to English ivy (*Hedera helix*), the vegetation is dominated by bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), and red alder (*Alnus rubra)* (for complete list see table in the Appendix 2 reach checklist).

The channel is classified as a Rosgen Bc6, however the condition of this channel is poor. The lack of native riparian vegetation due to the English ivy (*Hedera helix*) infestation has decreased the stability of the banks making them more susceptible to erosion that is already occurring throughout the reach. To improve this, removal of the ivy is required. However, because there is so much ivy present, removal and replanting must occur in stages to prevent the exposure of bare soil that can be easily eroded. Landowner education and outreach programs would be beneficial to aid in ivy control, stream stewardship, and preventing garden waste dumping near to, and in, the creek. Furthermore, there is concern that if a park trail were constructed in this area, it may lead to more damage to the creek as the section is narrow with little riparian cover.

Reach 18 is Functional-at-Risk with a downward trend due to the infestation of English ivy (*Hedera helix*), lack of proper vegetation for bank stabilization, and heavy erosion. A major wash-out in this reach may damage many downstream reaches, possibly contributing to further sediment deposition downstream.

Reach 19 Colquitz River: The cascade adjacent to 4650 Pipeline Road to the waterfall contiguous to the wire fence at 4656 Pipeline Road



Reach 19 is approximately 25 m long and extends from the riffle or cascade adjacent to the old cottage on 4650 Pipeline Road, to the upstream waterfall parallel with wire fencing at 4656 Pipeline Road. The right bank is densely covered with invasive species, particularly Himalayan blackberry (*Rubus armeniacus*). The left bank is composed of lawn that extends to the water's edge in locations where there are no existing bedrock outcrops. Garden waste was found piled at the wetted perimeter. There are two small waterfalls in this reach, one at the start and one at the end. The channel is dominated by bedrock and therefore erosion is only occurring in and around the areas of bedrock where the bank is sandy. The Rosgen channel type is an "A1" as it is confined in a bedrock gulley, entrenched, and has cascading portions.

Historically, the vegetation in this area would have been coniferous forest with deciduous patches and a shrubby understorey. Presently, it is dominated by Himalayan blackberry (*Rubus armeniacus*) and lawn with sparse willow (*Salix spp*.), bigleaf maple (*Acer macrophyllum*), and Garry oak (*Quercus garryana*). For a full list of species present refer to the table in the Reach 19 checklist found in Appendix 2.

Reach 19 was determined to be at its potential Rosgen channel type of "A1". Invasive species removal and successive replanting with the appropriate native riparian vegetation will aid in maintaining creek function and bank stability. Additionally, the lawn areas are prone to erosion that could be improved by planting a riparian buffer zone. Neighbourhood education programs are important for teaching and explaining the negative impacts of piling garden waste adjacent to the creek. As well, property owners need to understand that the lack of riparian vegetation could cause erosion of their property in times of peak flows such as in the winter of 2006/2007 when some of the lawn flooded.

Although the vegetation is in a poor state, Reach 19 was determined to be in Proper Functioning Condition, largely due to the bedrock that is preventing major erosion from occurring. However, improvements can be made by removing and controlling invasive species, and educating adjacent landowners about the importance of maintaining riparian vegetation.

Reach 20 Colquitz River: The waterfall contiguous with the wire fence at 4656 Pipeline Road to the riffle just upstream of 4674 Pipeline Road

Reach 20 is approximately 168 m long and extends from the waterfall with a wire fence at 4656 Pipeline Road under the Goyette Road bridge through a residential area to the riffle area just upstream of 4674 Pipeline Road. Downstream of the Goyette Road bridge, the left bank consists of manicured lawns to the water's edge, while the right bank (looking downstream) is dominated by Himalayan blackberry (*Rubus armeniacus*). Upstream of the bridge, the right bank (looking downstream) consists of manicured lawns right to the water's edge, while the left bank is bare except for a few trees and small garden shrubs. Undercutting and erosion is evident on both banks (even on inside edges) upstream of Goyette Road bridge, in particular, upstream of the white footbridge. On the right bank a large hose was found which may be in use for pumping water into or out of Colquitz River. Due to property access limitations, it was not possible to confirm that water was being withdrawn, however a search of water licenses did not show a license for this property. The channel is a silt/clay channel with a Rosgen channel type of "C6" although it is too wide and too shallow to represent a highly functional "C" channel. This is likely due to excessive stream energy and active erosion from bare stream banks, which flushes material downstream. Upstream of Goyette Road bridge, residential homeowners are mowing lawns right to the edge of the right bank. Trampling is also taking place on both sides of the creek, evident by the lack of vegetation on the banks. Point bars are forming as expected in a "C" channel, but the normal meander pattern is not present and the only observed point bar downstream of Goyette Road is not vegetated. Erosion on the left bank upstream of the white footbridge seems to be creating a depositional area just downstream. It is unknown whether other such depositional areas have occurred previously and whether or not they get scoured out during high velocity flows.

Historically, the vegetation in Reach 20 would have been representative of a coniferous forest with deciduous patches and a shrubby, riparian understorey. Banks throughout the reach are dominated by manicured lawns and Himalayan blackberry (*Rubus armeniacus*) with little riparian vegetation. **Bamboo (*Bambusa sp*.) was also observed and should be removed immediately** to prevent its spread to other areas as it is highly invasive and once established, difficult to eradicate. Bigleaf maple (*Acer macrophyllum*), English hawthorn (*Crataegus monogyna*), Red alder (*Alnus rubra*) and a few other species sparsely populate Reach 20 (see table in the Reach 20 checklist of Appendix 2 for complete list).

The potential Rosgen channel type is a Rosgen "C" channel, but one that is narrower and deeper than the existing channel. In order to improve this reach, homeowner education programs regarding the importance of riparian vegetation for maintaining creek function and bank stability would be beneficial. Furthermore, invasive species removal and control should be conducted in conjunction with planting of the appropriate native vegetation. Replanting the lawn areas that directly border the creek and elimination of mowing would also improve this reach. Other options for restoration and improvement include adding large woody debris and using a drop structure that creates a plunge pool, thus dissipating energy.

Reach 20 of the Colquitz River is Functional-at-Risk with no apparent trend and is relatively stable despite the lack of vegetation on the eroding banks. Furthermore, it is difficult to determine whether or not this reach is stabilizing, therefore, additional monitoring is recommended.

Reach 21 Colquitz River: The riffle upstream of 4674 Pipeline Road to the 2nd pedestrian bridge located within Beaver/Elk Lake Park

Reach 21 is approximately 136 m long and extends from the riffle just upstream of the property line for 4674 Pipeline Road, upstream along Pipeline trail within Elk/Beaver Lake Park to the second footbridge (which gas a concrete weir located directly beneath it). Natural lateral movement of the channel is constrained by the pipeline and adjacent trail on the right hand bank. On the left bank (looking downstream) are sections of bedrock outcrop as well as silt/clay banks. The Rosgen channel type is a “Bc3” with bedrock intrusions. Historically, the Rosgen channel type was likely a “C” channel. It may have been relocated to its current position when the pipeline was installed. It is also important to note that a weir located at the outlet of Beaver Lake controls the majority of flow downstream; therefore, the reach does not experience the fluctuations it would have historically, as extreme high/low flows are controlled.

Historically, the plant community in this reach was coniferous forest with deciduous patches and shrubby understorey. Currently, vegetation consists of species such as bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), Indian plum (*Oemleria ceraformis*), red alder (*Alnus rubra*), and red osier dogwood (*Cornus stolonifera*). Many of these species would have been present in the past as well, but probably in much higher densities, and in a later seral stage. For a complete list of vegetation refer to the vegetation table in the reach checklist within Appendix 2. Due to trampling along the pipeline and outer edges of the trail, the vegetation on the right bank is limited to a narrow strip that is decreasing in size. Horses are walking along the edges of the trail, avoiding the gravel surface and are thereby widening the trail and encroaching upon the vegetated areas. These vegetated areas are important for stabilizing the stream banks from erosion and continued trampling and vegetation loss will increase the risk of erosion.

The Rosgen channel type in Reach 21 is a “Bc3”, which is the same as its “potential”. However, improvements can be made in order to maintain and continue developing the health and function of the creek. Trampling by horses, and other trail users, is a significant problem in this reach and needs to be addressed as it is damaging the riparian vegetation. In order to mitigate the damage associated with trampling, exclusionary fencing in the area alongside the trail will protect the riparian area and allow the vegetation to grow back undisturbed. Additionally, the gravel may need to be replaced with another surface, to create a more horse-friendly path and halt trail widening caused by this activity. Any large wood that is in, or falls in, the creek should be allowed to remain there in order to provide habitat complexity and aid in the dissipation of energy from high flows as well as creating hydraulic complexity.

Reach 21 of Colquitz River is in Proper Functioning Condition.

Reach 22 Colquitz River: The 2nd pedestrian bridge located within in Beaver/Elk Lake to the outlet at Beaver Lake

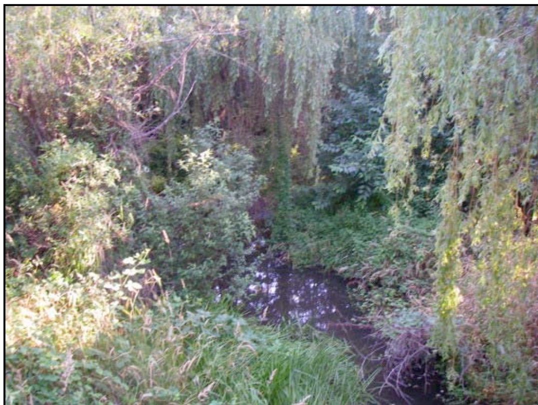
Reach 22 is approximately 403 m long and extends from the second footbridge along Pipeline Trail through a bedrock-lined channel to the outlet dam of Beaver Lake. This dam structure acts as a flow control point. An old steel riveted pipe, which was once used for supplying drinking water, runs the length of the channel with a park trail adjacent to the pipe. Walkers, joggers, equestrians, dogs, cyclists, and park maintenance crews use this popular trail. As in reach 21, the trail is currently widening due to trampling of vegetation. Near the upper end of this reach, horse trails continually cross the creek and have created large gaps of vegetation right to the wetted perimeter of the channel, causing erosion of the banks. The channel was likely realigned to its current location during to the installation of the pipeline and narrowed where a footbridge appears to have been located historically. The creek bottom is composed of fine silt and clay with cobble-sized angular rock. The Rosgen channel type is a "Bc2/3", with the bed material consisting of boulder-cobble with some bedrock intrusions. With previous winter high flows, the stream has accessed floodplain and has developed swampy areas. Just upstream the pedestrian footbridge at the downstream end of the reach, a small pool provides evidence of backwater created by the weir.

Historically, the vegetation community would have consisted of coniferous forest dominated by grand fir (*Abies grandis*), western redcedar (*Thuja plicata*), and Douglas fir (*Pseudotsuga menziesii*), with a diverse shrub and herbaceous community. Species presently observed include, bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii),* red alder (*Alnus rubra*), red osier dogwood (*Cornus stolonifera*), and western redcedar (*Thuja plicata*). For a complete list of plant species refer to the vegetation table located in the reach checklist within Appendix 2. This current vegetation likely differs from the historic (and potential) vegetation community inasmuch as it is a younger seral stage, and lacks riparian herbaceous species such as skunk cabbage, rushes and sedges.

Both the current and potential Rosgen channel type is a Rosgen "Bc2-3." This potential is not the desired future condition for the channel, but will remain as is as long as it is armored in place by bedrock and the adjacent trail/pipeline. Restoration would include fencing off the trampled areas and planting with coniferous trees and riparian vegetation. Over time, this vegetation will provide large woody debris to the river that should be allowed to remain for the purposes of dissipating flow energy and increasing habitat complexity. In the meantime, large woody debris could be added to increase habitat/hydraulic complexity and energy reduction. Furthermore, replacing the graveled paths with another surface type material (*i.e.* woodchips) may reduce trampling at the edges of the path since it is more horse-friendly.

Reach 22 of Colquitz River is in Proper Functioning Condition.

Reach 1 Swan Creek: Violet Avenue to the pipeline crossing adjacent to 763 Daisy Avenue



Reach 1 is approximately 61 m long and extends upstream of the Violet Avenue bridge crossing (where Swan Creek enters into Colquitz River), to a pipeline crossing adjacent to 763 Daisy Avenue where the channel becomes more gully-like. A public trail is located along the left bank while residential property is found on the right bank. The stream banks are composed of silt/clay substrate while the bottom of the channel contains a large amount of gravel. The presence of gravel may not be natural to the system, but it does affect the geomorphology of the creek and therefore the Rosgen channel type is a “C4.” The creek is classified this way due to its low gradient, moderately sinuous channel, and its continual access of floodplains. Vegetation is growing within the floodplains and stabilizing the substrate with roots. A small cement weir directs the water into the centre of the channel and reduces the amount of energy buffeting the banks. Just upstream of this concrete weir, a concrete pipe crosses the creek and channels water beneath it, while a temporary spill boom traps organic material further upstream. A small number of black/grey fish approximately 5 cm long were observed downstream of this pipe (likely stickleback). Also important to note is the presence of a large pile of garden waste on the right bank along 763 Daisy Avenue. Although this organic material has not yet fallen into the creek, if it does, it could create an anoxic environment by removing oxygen from the creek during decomposition. Secondly, it is preventing native riparian vegetation from growing in this area. There is little evidence of erosion and only a small section of trampling has occurred along the banks of this reach.

The vegetation in this reach consists largely of black cottonwood (*Populus balsamifera ssp. trichocarpa*), red alder (*Alnus rubra*), and red osier dogwood (*Cornus stolonifera*). Invasive species such as Himalayan blackberry (*Rubus armeniacus*) and reed canary grass (*Phalaris arundinacea*) are located in this reach alongside a number of other native and non-native plant species (refer to Appendix 2 for complete list). Historically, the vegetation in this area would have been a coniferous-dominated forest with patches of deciduous species. As it is, there are few conifers present and there is an absence of large woody debris in the channel that would aid in increasing sinuosity, while simultaneously diminishing the energy and erosion potential of the water.

The channel in reach 1 is at its potential Rosgen channel type of a “C4” even though it is shallower than one would expect for a “C” if it had a more natural hydrological regime. Some sinuosity, meander, and a few small rock riffles were noted. Restoration would include invasive species removal and control, combined with planting of appropriate native vegetation and regular weeding. Furthermore, placing large wood in the system to form more weirs would create step pools to slow the movement of water and generate a more complex habitat for organisms living in the stream environment. Additionally, if any large wood falls into this reach it should be allowed to remain, as it will not pose any flooding threats. Removing the utility pipe and the spill boom is also recommended if they are no longer in use.

Swan Creek reach 1 is in Proper Functioning Condition.

Reach 2 Swan Creek: The pipeline crossing at 763 Daisy Avenue to the upstream edge of the mountain bike area

Reach 2 is approximately 490 m long. It extends from 763 Daisy Road where the channel becomes gulley-like near 763 Daisy Road, through residential and park lands, to McKenzie Avenue, where the landscape opens up and the channel becomes more ditch-like downstream of the McKenzie Avenue overpass. This reach has steep, undercut, and eroding clay banks, consistent with a gulley. In general, the clay banks are undercut and eroding due to scouring from high peak flows. Upstream of Daisy Road, the right bank is armoured with rip-rap while on the opposite bank, a small section of floodplain is visible. A small amount of woody debris was also observed in this area. Further upstream, a wooden bridge crosses the creek and Himalayan blackberry (*Rubus armeniacus*) growth is dense. A smell of hydrocarbons was noted upstream of this bridge and was intermittent throughout the rest of the reach. Toward the upstream end of this reach, a large area has been excessively trampled and degraded due to mountain biking activity. Little vegetation is located in this area and mounds of soil for jumps may also supply an increased silt/sediment load to the creek. Furthermore, trampling may be jeopardizing the health of the surrounding conifers. The creek banks are already steep and sensitive to erosion and the lack of vegetation along the banks in this area may compound this problem by reducing the stabilizing function of surrounding root systems. Although the depth of the gully is variable, the channel is flat and at the time of the assessment there was no apparent flow (e.g. water was still). Due to the gully shape, flat gradient, and absence of floodplain, the Rosgen channel type was determined to be “Gc6”. This channel was likely created through excavation in the past to reduce the real or perceived risk of flooding. Today, it is maintained by high-energy flows from an urbanized watershed.

Historically, the vegetation in the area would have been mixed coniferous/deciduous forest dominated by Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western redcedar (*Thuja plicata*). Patches of bigleaf maple (*Acer macrophyllum*), Garry oak (*Quercus garryana*), red alder (*Alnus rubra*), and a vigorous shrub/herbaceous riparian community including Pacific ninebark (*Physocarpus capitatus*), red osier dogwood (*Cornus stolonifera*), salmonberry (*Rubus spectabilis*), sedges (*Carex spp*.), skunk cabbage (*Lysichiton americanum*), and willow (*Salix* spp.) would have been present as well. While Douglas fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) are present to some extent, the vegetation is dominated by red alder (*Alnus rubra*), shrubs including Pacific ninebark (*Physocarpus capitatus*), snowberry (*Symphoricarpos albus*), and invasive Himalayan blackberry (*Rubus armeniacus*).

For a complete list of vegetation consult the reach checklist in Appendix 2. Upland vegetation is more common along the sparsely vegetated banks than riparian species suggesting that the water table has dropped as a result of previous excavation and continual scouring from high-energy flows.

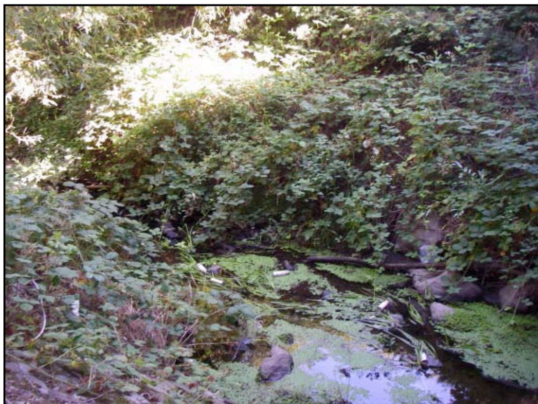
The historic channel type was likely a "C6" channel, following a similar course as today but with a higher stream bed elevation and water table (prior to excavation). Floodplains would have been well-developed, with abundant large wood, and the stream may have been interspersed with wetlands, as the gradient is so slight.

Without a major undertaking, including restoration of the upland watershed (to decrease flashiness of flows), this reach will not return to its historic channel type. Therefore, its "potential" channel type is a Rosgen "G6c", similar to its current state, but with restored floodplains, constructed floodplain terraces, and a healthy riparian vegetation community.

Restoration activities would consist of invasive species removal and control, creation of terraces using willow wattle bioengineering, and the development of floodplains in conjunction with planting appropriate native vegetation to stabilize the banks. To address the mountain biking and trampling concern, a fence should be installed in the sensitive area along with signage for educational purposes. Less ecologically sensitive areas away from the creek could be developed and designed as an alternative location for mountain bikers.

Reach 2 is Non-Functional as the banks are bare, severely scoured, eroded, and undercut. The creek is unable to successfully manage peak flows.

Reach 3 Swan Creek: Upstream of the mountain bike area to the McKenzie Avenue overpass



Reach 3 is approximately 54 m long and extends from the upstream end of the mountain biking area in Reach 2 to the willow across from the gravel path that intersects with the trail downstream of the McKenzie Avenue overpass (opposite 4008 Wiseton Street). The channel is composed of silt and clay and utilizes accessible floodplain. The narrow and deep characteristics of the channel are likely related to previous dredging that may have occurred during the overpass construction in the 1980's. As it is now, the Rosgen channel type is an "E6" with a low width/depth ratio. Spray paint cans were observed floating in the creek at the top end of this reach near the McKenzie Avenue overpass.

Currently, this reach is dominated by reed canary grass (*Phalaris arundinacea*) with a few other plant species intermixed (refer to Reach 3 checklist in Appendix 2 for complete list). Despite the lack of abundant native riparian species, no scour was visible in this reach. The historic vegetation community would have been similar to Reaches 1 and 2.

The historic and potential channel type for this reach is a Rosgen "C6." This potential has not been reached as the vegetation is not appropriate and the channel has been altered. Restoration efforts would include the removal of the reed canary grass (*Phalaris arundinacea*) by mulching or scraping, followed by a native riparian planting regime including willow (*Salix spp.*) cuttings to quickly form a canopy that will shade out the grass. After the willow (*Salix sp*.) cuttings have established themselves, a second phase of planting would include black hawthorn (*Crataegus douglasii*), red osier dogwood (*Cornus stolonifera*), and conifers. Furthermore, the surrounding area is flat and open presenting an opportunity for the creation of more meander or sinuosity- via realignment- similar to a "C" channel.

Despite the monoculture vegetation and past channel modifications, Reach 3 is in Proper Functioning Condition.

Reach 4 Swan Creek: McKenzie Avenue overpass to where the creek becomes lined with a rock wall downstream of Carey Road.

Reach 4 was previously excavated, is approximately 351 m long, and extends from the McKenzie Avenue overpass to downstream of Carey Road where the banks become armoured with rock. Within this reach, Saanich parkland lies on the left bank, and residential properties line the right bank. Underneath the McKenzie Avenue overpass, the banks are lined with rock walls preventing the growth of vegetation. Upstream of the McKenzie Avenue overpass, a small pipe crosses above the channel, whilst a nearby culvert discharges from the left bank. Further upstream, a large culvert with pipes projecting out of the bank (opposite 3972 Harlene Place), discharges a large volume of stormwater from the surrounding area. Garbage was observed throughout the reach, particularly downstream of the footbridge near Columbine Way where bicycles, shopping carts, children's toys, and other garbage have been tossed beneath a large weeping willow tree. A hydrocarbon smell, previously noted in Reach 2, was also present, as well as patches of oil sheen. The channel has a low gradient, is comprised of silt/clay substrate with areas of gravel, and has areas of accessible floodplain. Consequently, the present Rosgen channel type is a "C6".

The vegetation in this reach is composed of a mixture of black hawthorn (*Crataegus douglasii*), English hawthorn (*Crataegus monogyna*), Indian plum (*Oemleria cerasiformis*), red alder (*Alnus rubra*), willows (*Salix spp*.), and numerous other native and non-native species (refer to Appendix 2, Reach 4 checklist for the full list). There are pockets of wetland species such as cattails (*Typha latifolia*), and small flowered bulrush (*Scirpus microcarpus*) suggesting that historically, this section of Swan Creek may have been more of a wetland area than a true channel. In general, the potential vegetation of the area should consist of a conifer-dominated forest with patches of deciduous trees and shrubs.

Historically, the vegetation in the area would have been mixed coniferous/deciduous forest dominated by Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western redcedar (*Thuja plicata*). Patches of bigleaf maple (*Acer macrophyllum*), Garry oak (*Quercus garryana*), red alder (*Alnus rubra*), and a vigorous shrub/herbaceous riparian community including Pacific ninebark (*Physocarpus capitatus*), red osier dogwood (*Cornus stolonifera*), salmonberry (*Rubus spectabilis*), sedges (*Carex spp*.), skunk cabbage (*Lysichiton americanum*), and willow (*Salix* spp.) would have been present as well. Judging by the topography and geology, the historic channel type was a Rosgen "C6"; similar to the current channel type, but smaller and less entrenched, with more accessible floodplains, and possibly wetland areas.

The potential Rosgen channel type of a"C6"has been reached although there are key aspects that are missing. Fortunately, due to its easy access, the reach could be restored to include more natural features such as increased sinuosity, large wood, and more accessible floodplain. Adding large wood/rock, installing log weirs, and planting the channel with riparian shrubs will increase habitat complexity and protect banks from erosion and trampling. The garbage in the creek needs to be removed and invasive species management should be more rigorous. For areas of poor water quality, especially from inflow pipes, some form of interception and cleansing would be beneficial to maintain and even improve habitat.

Reach 4 is in Proper Functioning Condition with numerous restoration opportunities, as it has not reached its desired future condition.

Reach 5 Swan Creek: Downstream of Carey Road where rock wall starts to Glanford Road

Reach 5 is approximately 361 m long and extends from just downstream of Carey Road alongside McKenzie Avenue, under McKenzie Avenue to the Glanford Road crossing. The channel has steep banks created from the fill for McKenzie Avenue and is constrained between McKenzie Avenue and Glanford Road. Upstream of Carey Road, residential lawns go right to the edge of the bank in some locations and ornamental plants are present. The present Rosgen channel type is a "B6" due to its sinuosity, width/depth ratio, and entrenchment conditions. The stream banks are vegetated but a floodplain is essentially non-existent, due, in part, to the rock walls.

The dominant vegetation along this creek is Himalayan blackberry (*Rubus armeniacus*) and reed canary grass (*Phalaris arundinacea*); also present is Douglas fir (*Pseudotsuga menziesii*), non-native poplar (*Populus* sp.), Nootka rose (*Rosa nutkana*), red alder (*Alnus rubra*), and willow (*Salix* spp.). Duckweed (*Lemna* spp.) was observed in the stream, indicative of abundant light and nutrients and low flow. Historically, the vegetation in this area would have been coniferous forest with patches of deciduous trees. While some of the species that would make up that community are present, they are less prominent than the invasive species.

Similar to Reach 4, the historic channel type in Reach 5 was a "C6" channel, or perhaps an "E" channel within a wetland area. Given the constraints of current municipal infrastructure (McKenzie Avenue and Glanford Road), the channel type is not likely to be restored to its historic state. Therefore, the potential channel type is similar to its current condition. However, as a result of gradient and potential for floodplain creation and accessibility, the potential Rosgen channel type is a "Bc6". Nevertheless, invasive species removal and replanting with dense native riparian vegetation will improve the function and health of this reach.

Reach 5 is Functional-at-Risk with no apparent trend because the channel is stable and will remain the same unless planting occurs. While the channel is not actively eroding/aggrading and it is functioning to move water/sediment in balance with the landscape setting, it is at risk due to dominant invasive species, steep banks, and flashy flows (clay banks are preventing erosion).

Reach 6 Swan Creek: Glanford Road to McKenzie Avenue crossing near Willowbrook subdivision (650 McKenzie Ave)

Reach 6 is approximately 292 m long, extending upstream from Glanford Road through a park area into a culvert underneath McKenzie Avenue. The section upstream of the first footbridge in the park was restored between 2000 and 2003. Restoration included development of the adjacent Willowbrook subdivision and stormwater ponds with a connecting outlet channel, as well as realignment of the creek and planting of native vegetation (Malmkvist, 2002). The channel was designed and constructed as a Rosgen "C6" channel type with a low gradient, moderate meanders, and accessible floodplains. The banks within the reach are densely vegetated with some isolated trampling evident off the gravel path bordering Willowbrook subdivision. On the left bank, yard waste is being dumped in the riparian zone, which may lead to the introduction of invasive species and if placed in the creek, could create anoxic conditions due to decomposition processes. Upstream of the stormwater pond outlet channel, an oily sheen was noted in the creek. The stormwater pond outlet near Willowbrook subdivision is in need of repair as the weir is failing causing the pond to drain. This must be repaired to sustain the function of the stormwater pond and to prevent erosion of the Swan Creek outlet channel by increased flows. A ten-year overflow dam was also installed during restoration downstream of McKenzie Avenue directing overflow to the stormwater ponds when necessary.

Red alder (*Alnus rubra*) is the dominant vegetation of this reach. Other vegetation within this reach includes: black cottonwood (*Populus balsamifera ssp. trichocarpa*), hardhack (*Spirea douglasii*), Indian plum (*Oemleria cerasiformis*), willow (*Salix spp*.), and a variety of other species (for a full list of vegetation see the Reach 6 checklist in Appendix 2).

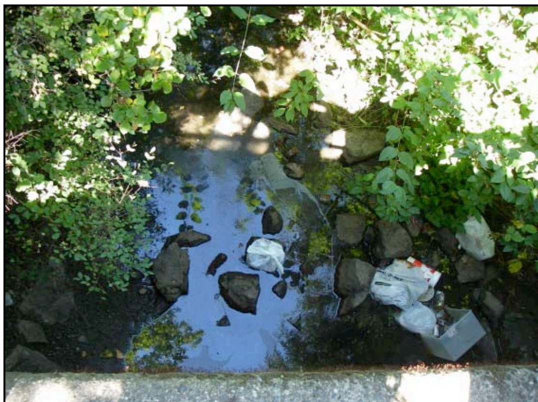
Historically, this area may have consisted of a "C6" channel type given the low gradient and substrate; alternatively, it may have been a continuation of a large wetland extending from Swan Lake (see Reach 7 summary). Supporting this, is a plan outlining the first subdivision of the Lake Hill property (no date), describing lots 73, 72 and 71 on the upstream and downstream sides of McKenzie Avenue as "partly swamp; outlet of lake running through" (BC Provincial Archives, Kenneth McKenzie Collection; map from Saanich Archives). Assuming the wetland was present, flows in this reach would have been attenuated, and the lower portions of the reach may not have seen summer flows.

In the past, the surrounding vegetation was probably a predominantly coniferous forest with a large deciduous tree and shrub component. Dominant species would have included black cottonwood (*Populus balsamifera* spp. *trichocarpa*), hardhack (*Spirea douglasii*), Pacific crabapple (*Malus fusca*), red alder (*Alnus rubra*), red osier dogwood (*Cornus stolonifera*), sedges (*Carex* spp.), skunk cabbage (*Lysichiton americanum*), and willow (*Salix* spp.).

Restoration of this reach would include repairing the failing weir in order to enhance the function of the stormwater pond behind it. The repair would entail using filter fabric and rock to fill in and block the eroded area beneath the log weir that has been breached. This can be done quickly by hand and is a high priority. Invasive species removal, with sequential planting of native riparian vegetation, is required to prevent erosion, and shade out invasive species. To ensure the success of the invasive species removal program, residential education on the prevention of invasive species would be beneficial.

Reach 6 is in Proper Functioning Condition.

Reach 7 Swan Creek: McKenzie Avenue to the pedestrian bridge at Kent Road



Reach 7 is approximately 367 m long, extending from the McKenzie Avenue culvert (perpendicular to the Willowbrook subdivision), upstream through park and residential areas to the pedestrian bridge crossing at Kent Road. To prevent flooding of neighbouring properties, frequent dredging has occurred throughout this reach, leaving this reach a ditch-like gully. The stream banks are overly steepened, and the reach lacks proper floodplain accessibility. Consequently, the Rosgen channel type is a ditched "Gc6". The flow in the channel is nearly non-existent due to the low gradient of the channel, attenuation of upstream flows by Swan Lake, and low summer flows. Little scour is apparent, although it is suspected that erosion is taking place underneath the vegetation along the banks (due to dense blackberry thickets, it was very difficult to access and observe the channel). A large amount of garbage and an oily sheen on the water was observed in the creek below the Ralph Street Bridge suggesting this area is a common dumpsite. The right bank of this reach has been bermed, suggesting that dredging spoils were placed on this bank. Upstream of Ralph Street, an unused grassy field is located on the left side of the creek that could be utilized for restoration purposes (see below). Downstream of the Kent Road Bridge, a 12-inch diameter steel pipe crosses the creek channel. The water quality in this reach is also of concern due to the surrounding urbanization and the excess garbage littered within the creek.

The vegetation in this area consists of a mix of native and non-native/invasive species such as agricultural grasses, black hawthorn (*Crataegus douglasii*), English hawthorn (*Crataegus monogyna*), Himalayan blackberry (*Rubus armeniacus*), Pacific willow (*Salix lassiandra*), reed canary grass (*Phalaris arundinacea*), and in the channel, duckweed (*Lemna sp*.) and **purple loosestrife** (*Lythrum salicornia*). (For a complete list of vegetation refer the table in the Reach 7 checklist in Appendix 2). Throughout the reach, the banks are overgrown with Himalayan blackberry (*Rubus armeniacus*) whose roots are not strong enough to fully stabilize the banks. Consequently, erosion is suspected, but unconfirmed. The purple loosestrife should be removed immediately. The species currently present indicate that the water table has dropped, despite the presence of some facultative species (*e.g.* hawthorn and willow). Due to the flat terrain throughout the reach and a low slope in the downstream reaches, renewed dredging will not likely effect any more drainage (flooding occurs regularly in Reach 8), and it should be noted such practices have a negative ecological impact.

Historically, per the 1858 Victoria District Official Map, the reach consisted of a 100-200 metre wide wetland that extended from Swan Lake to upstream of McKenzie Avenue (see diagram overlaid with the current road layout in Swan Lake section). On some maps, this area is labeled as “swamp.” There is no information in these documents describing the type of vegetation, but shrub wetlands are still commonly found in this region. Additionally, the area was frequently inundated from lake outflows (thus precluding bogs/fens which rely mostly on precipitation and groundwater inputs). Such shrub-dominated swamps had vegetation consisting of red osier dogwood (*Cornus stolonifera*) and willow (*Salix* spp.), with a sedge understorey consisting of Pacific water parsley (*Cicuta douglasii*), sedge (*Carex* spp.), and skunk cabbage (*Lysichiton americanum*). There may have been one or many channels that resembled a Rosgen “E” channel, *i.e.* highly sinuous, with a low width to depth ratio and very wide floodplains; or, in places, there may have been no defined channel in this wetland area.

Depending on how it is managed, this reach may have several possible ‘potential’ states or successional trajectories. A realignment of the reach to produce a more sinuous channel with floodplain terraces, would create a Rosgen “C6” channel, thus allowing for more water storage, better energy dissipation, and a healthier vegetation community. The creation of a wetland community would also be an appropriate option for this reach as it was once predominantly a lentic system; however, more land would be required. A combination of a meandering channel and floodplain wetlands is a third possibility for restoration. Furthermore, the grassy lot between Ralph Street and Kent Road could be used to construct a large meander bend (a common characteristic of “C” channels), thus allowing for some energy dissipation for the lower portion of the reach. The addition of large woody debris would also aid in creating meanders and add to channel and habitat complexity. If and when the sewer pipe is replaced, it should be installed under the stream channel, so as not to interfere with the natural hydrological patterns.

Reach 7 is Nonfunctional as the channel has been ditched to drain the surrounding area. Floodplains are not accessible, stream banks are vertical and bare in many locations, and the riparian vegetation zone is too narrow and overgrown with invasive species. This reach would be in much worse condition if not for the low gradient and the presence of Swan Lake upstream attenuating peak flows. This reach is an excellent opportunity for restoration as there is land available, and the ditched creek is attempting to “behave” like a wetland, rather than as a stormwater conduit.

Reach 8 Swan Creek: The pedestrian bridge at Kent Road to the Patricia Bay Highway

Reach 8 is approximately 353 m long and extends from the pedestrian bridge at Kent Road, through the Saanich Allotment Gardens to a culvert under the Patricia Bay Highway. This section of Swan Lake Creek has also been ditched, similar to Reach 7. At the downstream end between Kent Road and the allotment gardens, the banks are steep, bare in places and the floodplain cannot be accessed. In the upper portion of this reach, however, where it flows through the allotment gardens, flooding occurs every year. (This is perceived as socially undesirable, however, to the gardeners and a few neighbouring residents). Moving upstream through this reach, the floodplain is wider and the channel shallower. The channel type is a ditch.

Figure 7. Portion of Reach 8 of Swan Creek when flooded, looking NW from near upstream end, January 6, 2007.

Photo courtesy of: Lise Townsend

Although the floodplain is "accessible" during the wettest months, there is no floodplain available at any other time of year in the dug-out ditch. Native riparian vegetation is regularly cut back to allow gardening in the allotted plots, many of which are within 10 m from the top of the bank of the ditch. Garden waste and compost bins are located immediately adjacent to the channel, and some of these items were retrieved from floating down the channel during several weeks of very high water in January 2007. Introduction of invasive species from this refuse is another concern and has already occurred in the case of purple loosestrife (*Lythrum salicornia*) which was noted in the channel just upstream of the bridge at Kent Road and also in a plot in the gardens. Although the floods bring nutrients, the gardeners would justifiably be concerned about the water quality that inundates their food plots annually, due to urban runoff from the highway and upstream of Swan Lake. The presence of Swan Lake upstream reduces the peak flows experienced by this reach as a result of the lake's very large storage capacity.

The vegetation in the area is composed of primarily Himalayan blackberry (*Rubus armeniacus*), Pacific willow (*Salix lasiandra*), reed canary grass (*Phalaris arundinacea*), and weeping willow (*Salix babylonica*). A variety of other vegetation is also present such as black hawthorn (*Crateagus douglasii*), English hawthorn (*Crateagus monogyna*), Nootka rose (*Rosa nutkana*), and red osier dogwood (*Cornus stolonifera*). At the upstream end, a monoculture of invasive reed canary grass (*Phalaris arundinacea*) exists within and around the channel. For a complete list of plant species present refer to the Reach 8 checklist in Appendix 2. The potential vegetation community would be similar to the historic species described above, although possibly with more allowance for deciduous and coniferous trees.

Restoration options and "potential" for this reach can be framed in three different scenarios. Option 1: land use and management could continue essentially as they are today. In this scenario, major restoration options are limited, as there is little area to work with to improve stream function, and gardeners will likely be opposed to planting tall trees or widening the riparian zone, because of the negative effect that shade would have on the productivity of their gardens. Some minor improvements in water quality and invasive species could result with better management of garden activities, such as placing refuse/compost facilities back from the stream, and education about invasive species. Some willow plantings in the upstream section could shade out the reed canary grass, but may not be welcomed by the gardeners. Option 2: land use continues as a community garden, but some plots are re-located (within this general area or elsewhere) and some remaining plots re-configured. In this case, a setback from the stream (for gardens and clearing activities) of about 15 m is recommended; this would be approximately the width required under the Riparian Area Regulation. Additionally, the stream channel should be meandered to the degree possible, widened, terraced, and planted with native riparian species. Education of, and collaboration with, the gardeners (*e.g.* for growing riparian plantings) is highly recommended. Option 3: land use change from a community garden to a public park, with relocation of garden plots to another area that is not prone to flooding and the other concerns discussed above. This would allow more flexibility in restoration design, and a large wetland, consisting of diverse habitats such as islands, channels, open water and shrub swamp, could be created. Such an area could include public trails, boardwalks, interpretive signs and education programs. Some elements of food production could be incorporated in appropriate areas, possibly including native plants and traditional indigenous foods and materials. Properly

designed, this area could also act as a refuge/spawning area for salmonids and provide abundant bird habitat.
Reach 8 is Nonfunctional as it is a ditched channel with a highly constrained riparian zone.

Reach 9 Swan Creek: Swan Lake

Reach 9 includes the outlet channel from Swan Lake to the Patricia Bay Highway as well as the lake itself. Swan Lake is 9.79 hectares in area and is located within the Swan Lake Christmas Hill Nature Sanctuary, which was formed in 1975. Land use around the lake prior to this (since the early 1900s) was primarily agricultural and residential. The wetlands surrounding the lake were cleared of native vegetation, probably in the 1910s, and were cultivated into the 1990s, mostly for hay. The outflow channel appears to have been dredged at least as recently as the late 1970s. The Patricia Bay Highway, which crosses the outflow stream near the lake, was constructed in the 1960s along a pre-existing roadbed, and upgraded in the early 1990s. The culvert conveying Swan Creek under the highway has reportedly collapsed partially and is believed to act as a weir in detaining flows (Lloyd, pers. comm.).

At the time of assessment, the surface of the lake hosted locally dense mats of algae and duckweed (*Lemna* spp.), indicating poor water quality. Phytoplankton was also visible, specifically *Aphanizomenon*, and probably others. Swan Lake is a eutrophic lake, a condition caused by excessive nutrient inputs and subsequent microbial decomposition and consumption of dissolved oxygen. Eutrophic lakes are characterised by excessive phytoplankton, turbid water and low dissolved oxygen (Sheffer, 2004). Nutrient sources today are mostly non-point source or internal recycling from the sediments and include runoff from agricultural and urban areas. In the past, significant point-source nutrient loading also occurred, principally due to wineries and sewage inputs. Two wineries operated upstream of Swan Lake between the late 1920s/early 1930s and the early 1970s, and discharged their waste products to Blenkinsop Creek, the inflow stream to Swan Lake (Kersey, 1976). These activities have resulted in accumulation of nutrients in the sediments of Swan Lake that are likely still being recycled into the water column by biogeochemical processes to this day. As a result, the diversity of invertebrates and fish that can tolerate the low-oxygen conditions of the water is much reduced. Salmonids, for example, cannot presently survive in the narrow zone between excessive temperature near the surface and low oxygen in the lower layers of the lake.

Another factor contributing to a change from historic conditions is the connection between Blenkinsop Lake and Swan Lake, which was probably established at some time during the late 1800s and early 1900s in order to drain the large wetland that previously existed at the south end of Blenkinsop Lake. According to maps from the 1850s, the headwaters of Swan Lake were previously located around a small wetland located at the present site of the Saanich Public Works

Yard. Thus the watershed was substantially smaller and nutrient inputs from the upland areas would have been limited to surface runoff from forested lands.

Today, Blenkinsop Creek is the only substantially open channel flowing into Swan Lake, however numerous storm drains discharge to the transition areas adjacent to the wetlands surrounding the lake. There is one outflow stream, Swan Creek. Several restoration and habitat enhancement projects have been undertaken in areas around the lake. In the 1980s, Tuesday Pond was constructed for bird habitat, although it has partially filled in with reed canary grass (*Phalaris arundinacea*) and mannagrass (*Glyceria* sp.). The outflow stream channel was re-constructed around this time, with gradually sloping banks replacing the vertical-sided ditch previously maintained, and replanted with native species. Also around this time, a stream channel was created at the southwest side of the lake where a stormwater drain discharges, behind the municipal hall parking lot, and this channel was also planted with native trees and shrubs (MacGillvray, pers. comm.). A beaver lodge is present in the outlet channel of the lake and is still active.

Vegetation surrounding the lake today consists of several communities including:

- An aquatic vegetation community in the form of a floating mat, consisting of yellow pond lily (*Nuphar polysepalum*), cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus lacustris*), mannagrass (*Glyceria* sp.) and reed canary grass (*Phalaris arundinacea*).
- A fringe of tall shrubs along the lake shoreline, primarily willow (*Salix sitchensis, S. hookeriana, S. lasiandra, S. scouleriana, S. geyeriana.*) and red osier dogwood (*Cornus stolonifera*), with little understorey vegetation, which are also present along the outflow stream, and an inflow channel at the southwest end.
- A reed canary grass (*Phalaris arundinacea*) near-monoculture, which dominates extensive areas of the wetlands beyond the shrub fringe, particularly on the northeast and southwest sides, a total area of approximately 11 hectares.
- Some “islands” of hardhack (*Spirea douglasii* spp. *douglasii*) among the reed canary grass, particularly on the northwest and northeast sides of the lake.
- Occasional small pockets of cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus lacustris*), silverweed (*Potentilla anserina*), small-flowered bulrush (*Scirpus microcarpus*), spikerush (*Eleocharis* spp.), sedge (*Carex* spp.) and smartweed (*Polyganum* spp.).
- A treed swamp area at the southwest side of the lake, shoreward of the grass-dominated wetlands, consisting mostly of black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), red alder (*Alnus rubra*) and western redcedar (*Thuja plicata*).
- Various shrub/treed transition areas surrounding the lake, consisting of species such as English hawthorn (*Crataegus monogyna*), black hawthorn (*Crateagus douglasii*), grand fir (*Abies grandis*), red alder (*Alnus rubra*), Pacific crabapple (*Pyrus fusca*), and English ivy (*Hedera helix*). For a complete list of vegetation observed during the field assessment, see the Reach 9 checklist in Appendix 2.

Historically, it is thought that Swan Lake was characterised by much lower levels of nutrients, as the high levels observed today are mostly due to human causes. This would have resulted in a different flora and fauna community within and immediately adjacent to the lake. The vegetation was most likely characterised by tall shrubs, deciduous trees and conifers closer to the upland areas. The understorey may have included skunk cabbage (*Lysichiton americanum*) and sedges (*Carex* spp.), while the shoreline community might have consisted of various rushes, sedges, cattail and possibly bog species in elevated zones such as around floating logs. See Townsend (in progress) for more information about historical vegetation.

It should be noted that the PFC method assesses mainly the *physical* ability of wetlands to withstand disturbances such as wind/wave energies and overland flows, and to maintain saturated soils within normal ranges. These are valid pre-requisites for wetland function. However, the system is not designed to assess more subtle processes such as shifts in nutrient regime and biological characteristics, which are factors of concern in this system. Thus, Swan Lake was determined to be in Proper Functioning Condition. However, it is far from its desired potential due to the high level of eutrophication and prevalent invasive species. Furthermore, water quality is affected by the dumping practices that occurred historically and the dense urbanization presently surrounding the lake. Spills of toxic substances into Blenkinsop Creek have occurred periodically throughout the years, with two major spills in 2007 alone. The invasive species and urban pollutants from untreated stormwater are likely getting worse. Swan Lake is a highly disturbed system and the watershed itself has been altered hydrologically by agricultural activity, the historical winery and sewage discharges, urbanization, and the construction of the channel connecting Swan Lake and Blenkinsop Lake.

In order to improve the function of Swan Lake, planting with native riparian vegetation, especially in the areas dominated by reed canary grass (*Phalaris arundinacea*), will aid in shading out invasive species and creating a more natural vegetation community. It is critical to improve the water quality at the watershed level. This can be done by improved stormwater management, such as BMPs, to ensure the water is treated to some extent prior to being conveyed into Swan Lake. Water quality testing would provide a better understanding of what is coming into the lake and allow for monitoring over the long term to note trends. Dredging the lake to remove some of the accumulated sediment is a possibility but there is the potential for this material to be toxic (and require safe disposal elsewhere) and it may be more prudent to leave it as is and attempt to prevent further accumulation and pollution. Aeration or biomanipulation could aid in breaking down the excess organic material causing the eutrophication of Swan Lake. Absorbent booms or other mitigation at locations of stormwater entry may reduce the load of hydrocarbons, and other surface pollutants, entering the lake. These and other options require further investigation.

Reach 1 Blenkinsop Creek: The willow line at the inlet of Swan Lake to the upstream end of the Swan Lake (Lochside) Trestle

Reach 1 is approximately 296 m long and extends from the willow line at the inlet to Swan Lake, under Saanich Road, to a gully near the north end of the Lochside Trail trestle. The area downstream of the pedestrian bridge to the willow line was not examined in detail due to dense brush but is considered a continuation of the rest of the reach.

Just upstream of the pedestrian bridge, the left bank is steep and bare while the right bank is heavily trampled under a weeping willow (*Salix babylonica*) tree. The channel is incised, has vertical clay banks, and has a slope of approximately 2%. The Rosgen channel type is a ditch with some isolated sections of floodplain on the east side of the trestle. The creek is attempting to evolve into a Rosgen "C" channel. In this area, the inside bend gets flooded and gravel is present in the channel. It was probably washed into the stream from nearby roads. A large amount of garbage was also noted east of the trestle where the creek flows through the open, grassy area off of Leeds Place. Flashy flows occur in this reach due to the highly impervious areas that Blenkinsop Creek drains. These flashy flows are causing erosion within the channel. Due to the clay banks, however, this scouring and erosion is mitigated to an extent.

The vegetation along the top of the banks is dense and consists of black cottonwood (*Populus balsamifera ssp. trichocarpa*), black hawthorn (*Crataegus douglasii*), bigleaf maple (*Acer macrophyllum*), English hawthorn (*Crataegus monogyna*), Himalayan blackberry (*Rubus armeniacus*), red osier dogwood (*Cornus stolonifera*), reed canary grass (*Phalaris arundinacea*), and willow (*Salix spp*.). For a complete list of plants see the reach checklist in Appendix 2. It is important to note that vegetation is lacking on the vertical banks, leaving them exposed to erosion.

Historically, Blenkinsop Creek carried lower flows since Blenkinsop Lake was not connected to this system until a drainage ditch was installed to allow cultivation of the large bog south of Blenkinsop Lake, probably in the late 1800s or early 1900s (as per historical maps and documents). However, the stream in Reach 1 is noted more or less in the same location on old maps. The 'dog-leg' in the channel east of the trestle suggests parts of the channel were re-located when that area was cultivated. Previously, it probably followed a more natural, sinuous course. The low gradient of the land and geomorphology (primarily clay substrate) suggest the historic channel type was a Rosgen "C6". With a smaller catchment, the stream may have dried up in the summer, and peak flows would certainly have been much less. Large wood in the channel would have created new floodplains and added to channel complexity and energy dissipation.

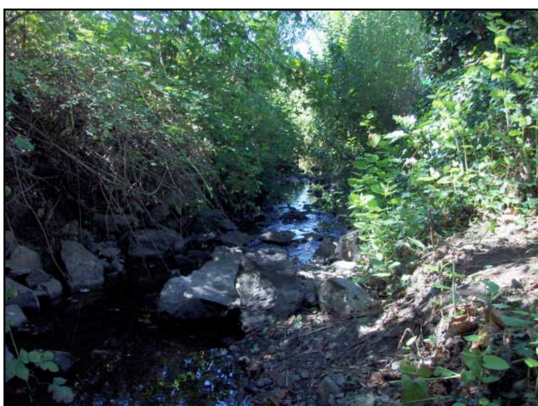
Near the confluence with Leeds Creek was a small wetland, probably dominated by a mix of shrubs and cedar. Surrounding vegetation consisted of conifer-dominated forest to the south and a more open Garry oak (*Quercus garryana*) woodland/savanna to the north and east (Victoria Official Map, 1858).

The potential channel type was projected to be a Rosgen "C6"; *i.e.*, it could be restored, in similar form, to its historic condition with some differences due to alterations of watershed. Currently, it is a ditch-like and has little access to any floodplain, especially downstream of the Lochside Trail Trestle.

Restoration opportunities include the re-creation of a wetland east of the trestle with a reconstructed, more sinuous channel running alongside it. This would create more floodplain accessibility, help mitigate flashy and peak flows and improve water quality. Furthermore, a weir could be built to direct low flows through the wetland while peak flows would still be able to access the channel, so as to not overwhelm the wetland. Two phases of planting are also suggested. The first phase would include planting (*Salix spp*.), black cottonwood (*Populus balsamifera ssp. trichocarpa*), and red alder (*Alnus rubra*) to shade out the abundant reed canary grass (*Phalaris arundinacea*). Phase two would involve filling in the understorey with plants such as conifers, ferns, sedges (*Carex spp*.), and skunk cabbage (*Lysichiton americanum*).

Reach 1 is Non-functional as a result of its ditch-like character, downcut channel, and erosion/scouring activity.

Reach 2 Blenkinsop Creek: Upstream end of Lochside Trail Trestle to the box culvert downstream of Quadra Street



Reach 2 is approximately 249 m long and extends from the upstream end of Lochside Trail trestle alongside the trail to the box culvert downstream of Quadra Street. The channel in this reach consists of a bedrock gully, a width/depth ratio greater than 12% and a slope of roughly 2.5%. The Rosgen channel type is a "B2". Very little floodplain is accessible as the channel is constrained by the old railway bed; however, what is present is sufficient for the channel type. Just upstream of the north end of the Lochside Trail trestle, both banks are armoured with rock and residential property is encroaching upon the right bank. In this location, a small island splits the creek into two channels that merge again at the downstream end of the island. Concrete sandbags and a rock wall held in place by wire fencing were also noted armouring the creek upstream of the small island bordering residential property. Upstream of the culvert under the trail, overhanging banks were observed on the left side. Erosion is occurring in places, as is trampling, especially at the upper end of the reach. A large amount of angular rock is artificially found in Reach 2 that has altered the geomorphology of the reach. This rock has been beneficial as it functions to dissipate the energy of peak flow events.

The vegetation in this reach consists primarily of bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), common snowberry (*Symphoricarpos albus*), and English ivy (*Hedera helix*). Red osier dogwood (*Cornus stolonifera*) and Western redcedar (*Thuja plicata*) dominate the island. For a full list of vegetation refer the reach checklist in Appendix 2. **Japanese knotweed (*Fallopia japonica*) is present just downstream of the island close to the north end of the Lochside trestle. This is a highly invasive species that has not yet taken hold in the Greater Victoria area and should be removed as soon as possible.** The District of Saanich and the Swan Lake Nature Sanctuary were notified of its presence.

The Victoria District Official Map of 1858 shows a linear riparian corridor in a gully in the location of Reach 2. Although a channel is not drawn on the map, it may reasonably be assumed that the given slope and topography would have allowed for surface flow. However, as discussed in the Reach 1 summary, flows would have been much less than today without the connection from Blenkinsop Lake, and with a forested watershed to intercept, infiltrate and store rainwater. Therefore, the Rosgen channel type was probably a “B1”, although smaller than could be expected with today’s hydrology. The substrate was probably bedrock but with fewer boulders than now, as these are likely products of blasting and fill for the rail line. Given lower peak flows, sediment and vegetation, probably including thick moss beds, would have accumulated in the shaded gulley.

Lochside Trail is a CRD pedestrian/bicycle trail that was built on the old Canadian Northern Pacific Rail line. This railway was completed in 1917 and transported passengers and freight to Patricia Bay until 1919 (Turner, 1997) with limited freight continuing into the 1970s. The rail line in this area was constructed in a pre-existing gully, where a large amount of fill was placed. This resulted in a much narrower stream corridor and less opportunity for lateral migration of the channel, and floodplain formation; however, given the bedrock substrate these processes were not likely critical to the function of this channel.

The presence of boulders has altered the potential of this channel to a Rosgen “B2”. The stream could be more highly functional by increasing floodplain access and energy dissipation with rock weirs and large wood, which would also create more sinuosity and increase habitat complexity. Bioengineering on the eroding banks near the downstream end would increase stability, while signage could decrease trampling and vegetation loss. A viewing platform at the upper end of the creek near the sanitary sewer cap could provide a vantage point for observing the creek while preventing trampling along the bank itself. Signs could provide information about the creek on the viewing platform, to educate trail users about the importance of creeks within the urban setting. Invasive species removal will allow for improved vigour of native riparian species; **English ivy and Japanese knotweed are priorities for control**. For the areas downstream where residential property lines the creek, homeowner education or even covenants (to be implemented if the property is sold) could reduce the amount of degradation occurring in that area. Furthermore, if wood does fall into the creek it should be left in place because its presence does not pose a flood threat.

Reach 2 is Functional-At-Risk with a downward trend due to the bank armouring at the downstream end (indicating excessive erosion) as well as the undercut and almost vertical eroded banks in other areas.

Reach 3 Blenkinsop Creek: Between the box culvert and Quadra Street

This reach was designated as a separate reach in order to discuss possible restoration opportunities that would arise if it were to be daylighted. The present owner has expressed interest in daylighting and has discussed this with Saanich, Ministry of Environment and the CRD. Reach 3 is culverted for 140 m from the outlet of the box culvert under the parking lot at 3950 Quadra Street to where it opens up briefly, immediately downstream of Quadra Street.

A number of restoration possibilities were discussed for the daylighting of this stretch of Blenkinsop Creek. By examining the small portion of creek that is outside of the culvert downstream of Quadra Street, it was determined that the channel is approximately 9m wide and therefore, the daylighted channel could fit within the right of way. However, for it to be an ecologically functioning channel, more lateral space (about 4-5 m) would be necessary. This daylighting would connect with Reach 2, indicating that the new channel should be gulley-like with a possible "B" channel in the bottom. Stabilizing the toe of the slope and fencing for safety would be necessary due to the fact that the slopes will be steep to fit within the constrained land area. Lock-block or rock stack walls could be used to create and stabilize the new slope with terraces that could be planted with native riparian and upland plant species. Advanced bioengineering techniques may also be possible in place of, or in addition to, hard structures. A step could be created at bankfull in order to create a floodplain within the channel. The channel could be filled with rock lines to form step pools that will lead to aeration in the channel and energy dissipation. Energy dissipation techniques or structures will need to be in place where the water flows out of the Quadra Street culvert to ensure peak flows do not rip apart or degrade the new channel.

Reach 4 Blenkinsop Creek: Quadra Street to the Cumberland Dam.

Reach four is approximately 1073 m long and extends from Quadra Street, through a primarily commercial area, followed by agricultural lands to the Cumberland Dam off Lochside Drive. Two sections of the stream in this reach are contained in underground culverts: under Quadra Street, and between McKenzie Avenue and the Lochside BC Hydro substation. Between Quadra Street and McKenzie Avenue, the right bank is constrained by a vertical concrete wall that forms the parkade and part of the London Drugs store in Saanich Centre. The channel here is straight and contained in a deep gully. Opposite the Lochside substation on Lochside Drive, rock stack walls and bedrock form the banks. Upstream of this, a small dam (Cumberland Dam) is located immediately downstream of a pedestrian bridge. This dam is managed by the Municipality of Saanich for stormwater storage for flood protection, usually leading to the seasonal flooding of the agricultural land upstream of this dam.

The present channel consists largely of a man-made ditch (as well as culverts) that was apparently blasted through rock in some locations in order to connect Blenkinsop Lake to Swan Lake and drain the upstream, low-lying, arable land. The channel type is a ditch with gully characteristics due to the overly steepened banks. Vegetation along the channel is dominated by Himalayan blackberry (*Rubus armeniacus*), reed canary grass (*Phalaris arundinacea*) and willow (*Salix spp*.), with big leaf maple (*Acer macrophyllum*) and red osier dogwood (*Cornus stolonifera*) also present (see Appendix 2 for a full list of species).

Historically, a large bog wetland was present on the south side of Blenkinsop Lake, with a rim of volcanic rock that prevented overland flows (Hardy, 1956; Victoria Official Map, 1858). This wetland was drained in the late 1800s (1894 according to a reference cited in Rigg, 1922) with a ditch that connected it to the Swan Lake inflow stream, which previously originated from a small wetland at the present site of the Saanich Works Yard (4026 Borden Street). This ditch was later progressively deepened to further improve drainage for agriculture and flood protection. In the area where Reach 4 of Blenkinsop Creek is now located, the landscape appears to have previously consisted primarily of an open Garry oak (*Quercus garryana*) savanna or woodland, with some conifers (Victoria Official Map, 1858).

The “potential” channel type, given the constraints of maintaining the current regime of flood mitigation and drainage, is thought to be a Rosgen “G” channel. This would include a gully shape (due to limited adjacent area in which to meander the channel or re-slope banks), but with some areas of constructed floodplain terraces to allow more riparian plant growth and attenuation of high flow energies. Improvements can be made to this reach by improving the vegetation surrounding the creek especially in the area behind the Saanich Center that is covered in Himalayan blackberry (*Rubus armeniacus*). Step logs and/or weirs can be used to dissipate the high energy of the peak flows by creating pools, while floodplain terracing can be constructed to increase floodplain availability and aid in dissipation of energy. Bioengineering such as willow wattles will stabilize and protect the steep banks. Clearing the creek of garbage and implementing educational signage will help improve the health of the creek and create awareness of its presence and importance.

Reach 4 is Non-functional as it is an artificially created channel with no channel characteristics present to create meander or dissipate the energy of peak flows. Furthermore, the vegetation present is not suitable to perform functions such as stabilization that are expected of riparian vegetation. The channel itself is highly constrained within steep banks, rock, and culvert walls. Accordingly, the stream is unable to re-create a natural channel form.

Reach 5 Blenkinsop Creek: The Cumberland Dam to Blenkinsop Lake

Reach 5 is approximately 517 m long and extends from the Cumberland Dam pedestrian bridge just downstream of Don Mann Excavating Ltd. to the outlet of Blenkinsop Lake. The Don Mann Excavating Ltd. site (4088 Lochside Drive) may be a source of sediment to the creek in this area as a large amount of sediment was observed on their site. However, mitigation techniques may be in place, as a wash area is in use.

For many decades, this reach of Blenkinsop Creek was channelized in a ditch through the center of the Galey Farm property. In 2000, a restoration project was initiated to realign the channel along the Lochside Trail edge of the property (Malmkvist, 2002). The channel was then reconstructed from a nonfunctional ditch into a functional creek. The Rosgen channel type is a “C6” and has a meandering form and floodplain terraces. Although floodplain is present, it is constrained as a result of the agricultural fields on the left bank and the Lochside Trail on the right bank. Due to the dense vegetation growth, especially in the lower to midsection of the creek, it almost resembles a long pond system. Upstream, Blenkinsop Lake attenuates water flows, while downstream, a dam restricts/ stops the flow of water leaving the reach and causes flooding during winter months. Some areas of trampling were noted next to Lochside Trail.

The vegetation in this restored reach is composed of black cottonwood (*Populus balsamifera ssp. trichocarpa*), red alder (*Alnus rubra*), red osier dogwood (*Cornus stolonifera*), and willow (*Salix ssp*.). Invasive species, such as Himalayan blackberry (*Rubus armeniacus*), are present in this reach. However, they are concentrated on the Lochside Trail side of the creek indicating the need for invasive species management within the Saanich Park system.

As previously described (see Reach 4 Summary), a large wetland was historically present on the south side of Blenkinsop Lake. Vegetation in the wetland and around the lake margins included bog species such as bog birch (*Betula glandulosa*), Labrador tea (*Ledum groenlandicum*), lodgepole pine (*Pinus contorta*), sphagnum moss (*Sphagnum* spp.), and round-leaved sundew

(*Drosera roduntifolia*), as well as wetland "generalists" such as cattail (*Typha latifolia*), hardhack (*Spirea douglasii*), hard-stemmed bulrush (*Schoenoplectus lacustris*), and sedges (*Carex* ssp.) (Hardy, 1956). The adjacent conifer forest included Sitka spruce (*Picea sitchensis*)- a rare occurrence in this region- Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*) with an understorey dominated by salal (*Gaultheria shallon*) (Rigg, 1922).

Unless the current land use (agriculture) is changed, the potential of this reach is to remain a channel, rather than to return to a wetland ecosystem. Thus, the potential channel type is a Rosgen channel "C6," the same as its present form. It is therefore showing continued success as a restored creek system. In order to maintain and improve this reach, second phase of planting should be conducted at the north end of the reach with black cottonwood (*Populus balsamifera ssp. trichocarpa*) and red alder (*Alnus rubra*) to increase the variety of plant species in that area. Furthermore, invasive species removal and control on the Lochside Trail side needs to be undertaken.

Reach 5 of Blenkinsop Creek is in Proper Functioning Condition as restoration has created a functional creek channel from a previously nonfunctioning ditch.

Reach 6 Blenkinsop Creek: Blenkinsop Lake

Reach 6 consists of Blenkinsop Lake, which covers approximately 7.24 hectares located within Blenkinsop Lake Park. A weir located at the outlet of the lake controls the amount of flow leaving the lake. The surrounding watershed is urbanized to an extent but also includes working agricultural lands. At the time of the assessment, the lake was covered almost entirely with duckweed (*Lemna spp*.) indicating high nutrient content and eutrophic conditions. Young bullfrogs (invasive species) were noticed in abundance along the edges of the lake.

The vegetation near the Lochside Trail trestle consists of abundant evergreen blackberry (*Rubus laciniatus*), European bittersweet (*Solanum dulcamara*), hardhack (*Spirea douglasii ssp. douglasii*), Himalayan blackberry (*Rubus armeniacus*), red alder (*Alnus. rubra*), salal (*Gaultheria shallon*), and willow (*Salix spp*.). Along the shoreline, duckweed (*Lemna spp*.), hard-stemmed bulrush (*Scirpus lacustris*), and yellow pond lily (*Nuphar polysepalum*) were noted. A complete list of vegetation can be found in the reach checklist (see Appendix 2). The eutrophic conditions of the lake today have altered the vegetation community existing along the edge of the lake compared to the historical condition.

Historically, the lake was probably much lower in nutrient content and was popular for swimming and fishing (as seen in Saanich Archives, images and oral histories), indicating the water was clear, low in phytoplankton and higher in oxygen and submersed aquatic vegetation.

The presence of *Sphagnum* moss in the peat next to the lake (Rigg, 1922) also points to a bog ecosystem that was characterised by low nutrients and acidic soils. Due to the development of agriculture, and more recently urbanization, nutrient retention has decreased, subsequently increasing runoff. This created a shift in the water conditions from a historically clear water system, to one of turbid water, dominated by phytoplankton and decreased dissolved oxygen levels due to microbial decomposition. This phenomenon of alternate stable states is common in lakes affected by agriculture and urban development (Sheffer, 2004).

The surrounding vegetation was historically composed of conifer forest (including: coastal hemlock, *Tsuga heterophylla*; Douglas fir, *Pseudotsuga menziesii*; grand fir, *Abies grandis;* Sitka spruce, *Picea sitchensis*; and western redcedar, *Thuja plicata*), deciduous trees and shrubs, Garry oak (*Quercus garryana*) and associated species (Hardy, 1956). The wetland vegetation included bog and marsh species, as described in the Reach 5 summary. The “potential” vegetation includes many of these species. However, with a changing climate orientated to increasing temperatures, Sitka spruce and western redcedar may be less successful at this site. Furthermore, bog species are not likely to survive with the high nutrient loading currently experienced. The extensive bullfrog (*Rana catesbeiana*) population is a concern throughout the region as well as in Blenkinsop Lake, and it is unknown what effects it will have on other species and ecosystem processes. The transitional (wetland/upland) ecosystem near the trestle is worthy of further study, as it has relatively few invasive species and a sedge/salal understorey that is relatively uncommon in the urban area.

Blenkinsop Lake is in Proper Functioning Condition despite its highly eutrophic condition, as the physical characteristics of the shoreline are sufficient to buffer wind and wave energies, and it is not in danger of conversion to a terrestrial environment. Improvements can be made by removing and controlling the invasive species present and by planting more coniferous trees. Options for harvesting and using duckweed as a fertilizer or compost could be investigated as a means to reduce the amount of nutrients and subsequent oxygen depletion when the dense duckweed cover degrades. However, any long-term improvement in water quality would require addressing the nutrient loading through changes in agricultural practices and surrounding land management. **Bullfrogs should also be controlled to reduce their numbers and prevent their migration to other areas**.

Reach 1 Durrell Creek: The confluence with Colquitz River downstream of Loenholm Road to Wilkinson Road

Reach 1 is approximately 138 m long extends from the confluence of the Colquitz River and Durrell Creek, to Wilkinson Road. The stream passes by a residential property on the right and Loenholm Road on the left. The channel is ditch-like with steep, actively eroding, bare banks. Accessible floodplain is non-existent and it is unlikely that the water escapes the channel unless under extremely high flows. At the time of assessment, there was very little water in the channel. The clay-based substrate is easily erodable and as a result has been channelized. Therefore, the channel was classified as a ditch.

Historically, the vegetation in this area would have consisted of a conifer-dominated forest with a small riparian zone due to low flows. The potential vegetation for this reach is constrained in comparison to the historic condition due to the height restriction imposed by the overhead power lines. Consequently, more riparian shrubs would be a more realistic restoration potential than tall trees. Red osier dogwood (*Cornus stolonifera*) is the dominant vegetation within this reach. Other less abundant species include: bigleaf maple (*Acer macrophyllum*), black hawthorn (*Crataegus douglasii*), red alder (*Alnus rubra*), and willows (*Salix spp*.). For a complete list of vegetation see Appendix 2.

The potential Rosgen type for this reach is a small “C6” channel. In order to achieve this potential, narrowing, re-grading and terracing the slopes with bioengineering would be needed to create accessible floodplain and allow for sediment deposition. Addition of wood and rock in the channel would allow for energy dissipation and improve hydraulic and habitat complexity. Planting the banks with native riparian vegetation would assist in stabilizing the clay banks with their root systems. Plant species would have to be selected carefully due to the height constraints dictated by the overhead power lines. An invasive species management and removal plan should be implemented at the start of restoration to ensure the success of the new plantings.

As a result of the steep, bare, and actively eroding banks, Reach 1 is classified as Non-functional.

Durrell Creek Reach 2: Wilkinson Road to Charlton Road

Reach 2 is approximately 436 m long and extends from Wilkinson Road, through the Wilkinson Correctional Centre property, to Charlton Road. Just upstream of Wilkinson Road, the banks of Durrell Creek have been graded back thus widening the channel and disrupting the width/depth ratio. The channel changes slightly upstream of the BC Hydro tower on the Correctional Centre property into one that has been dug-out, ditched, and significantly altered. The excavation of the channel was conducted by the Municipality of Saanich in 2002, along with plantings, to improve drainage in the Durrell Watershed (Pollard, Pers. Comm.). The banks are extremely steep as a result of the excavation and the clay soils are of a highly erodable nature. Additionally, vegetation is unable to grow on these banks, further impacting stability. However, due to the low flows experienced in this section of channel, and the tight clay soils, evidence of excessive erosion is not present. The method of the excavation has created vertical and bare banks making it difficult for new vegetation to grow. A series of three pond structures with over-steepened banks are also found spaced out in the channel. Due to the vertical banks, deep channel, and low flows, the stream is not able to access its floodplain. The ponds seem to have been an attempt to compensate for this, but their design impedes their functionality and they should be reconfigured. The channel type classification for this reach is a ditch.

The historical vegetation of Reach 2 was either composed of coniferous forest and shrubs or a wet meadow community suggested by the flatness of the land. Due to the constraints of the correctional centre property and overhead power lines, the potential vegetation for this reach is a small tree and shrub community. Presently, the vegetation is dominated by young willows (*Salix spp*.) that were planted within the channel during the 2002 municipal work. Duckweed (*Lemna sp*.) and water plantain (*Alisma plantago-aquatica*) are common within the ponded sections. Black hawthorn (*Crateagus douglasii*), English hawthorn (*Crateagus monogyna*), Nootka rose (*Rosa nutkana*), and snowberry (*Symphoricarpos albus*) are also present throughout the reach. The vegetation is concentrated within the channel itself except for a small section just upstream of Wilkinson Road where vegetation is growing on the banks. Mowing practices along with the steep banks hinder the growth of riparian and upland vegetation outside of the channel.

The potential Rosgen classification for this reach is a “C6” channel. In order to achieve this potential, the banks and ponds should be terraced and planted with fast growing riparian species such as red alder (*Alnus rubra*) and more willows (*Salix spp*.) of the type that are already present. This effort will reduce bank steepness, create floodplain areas and improve hydraulic conditions and habitat complexity. For this planting to occur in the ponds, as well as along the entire reach, the soil may have to be amended due to the abundance of clay. Vegetation species selection will have to take into account the height requirements of the overhead power lines and the security needs of the Wilkinson Correctional Centre.

As a result of the ditched nature, this reach is Functional-at-Risk with no apparent trend. The trend is not apparent because the channel is stable and the low flows experienced in this reach do not cause excessive erosion. However, the reach does not have the ecological function that would be expected for a "C" channel.

Durrell Creek Reach 3: Charlton Road to Interurban Road

Reach 3 is approximately 128 m long. It extends from the upstream edge of the Wilkinson Correctional Centre at Charlton Road, to Interurban Road. The stream passes through the middle of one residential property (4231 Interurban Road) before going into a culvert underneath Interurban Road. The channel banks are armoured for the entire length of the reach with a rock-lined vertical wall. The banks are bare and oversteepened with a shed abutting the left bank, as well as a paddock area. A small bridge crosses the channel from the left bank to a field on the right bank. The channel conveys water from one point to another but has no other functional ability and is, therefore, classified as a ditch.

The only vegetation growing within this reach is some water-plantain (*Alisma plantago-aquatica*), some apple trees and within the channel, duckweed (*Lemna sp*.). Historically, the surrounding area would have consisted of a coniferous dominated forest with intrusions of Garry Oak (*Quercus garryana*) meadow. With an appropriate planting regime, the historical vegetation condition and habitat could be restored.

The potential Rosgen classification for this reach is a "Bc6" channel. In order to achieve this potential, short-term restoration efforts should include the regrading of the stream banks and a comprehensive native riparian planting plan to create an ecologically functioning riparian zone. In the long term, the stream should be moved adjacent to Charlton Road, the present channel back-filled, and a covenant instated.

Due to the bareness of the banks, and the rock-lined stabilizing wall, Reach 3 is Non-functional.

Durrell Creek Reach 4: Interurban Road to Granville Avenue

Reach 4 is approximately 1123 m long, extending from Interurban Road through primarily agricultural land, to Granville Avenue. For the majority of the reach, the ditched and straightened channel runs between agricultural fields and seasonally accesses the fields as floodplain. A small, vegetated terrace is present on the left bank just upstream of the culvert under Granville Avenue. Upstream of the terrace, the channel narrows and flows between horse paddocks on the right bank, and cow pastures on the left. As a result of the straightening and ditching, Reach 4 does not have a true Rosgen channel type and is characterized as a ditch.

Vegetation is abundant in the areas directly encompassing the ditch due to planting by the District of Saanich in 2001 (Pollard, Pers. Comm.). This vegetation has maintained the banks in good condition creating some ecological function within the ditch. Current vegetation within this reach includes: black cottonwood (*Populus balsamifera ssp. trichocarpa*), Hooker's willow (*Salix hookeriana*) Pacific willow (*Salix lassiandra*), red alder (*Alnus rubra*), and Sitka willow (*Salix sitchensis*). Duckweed (*Lemna sp.*) and water-plantain (*Alisma plantago-aquatica*) inhabit the channel itself. Invasive species such as Himalayan blackberry (*Rubus armeniacus*), **Purple loosestrife** (*Lythrum sp*.), and reed canary grass (*Phalaris arundinacea*) were also noted. Historically, the bulk of this reach would have been unhindered wetland and the vegetation would have reflected this type of habitat. **The purple loosestrife is highly invasive and should be controlled immediately.**

The potential Rosgen channel type of this reach would be a lentic community with a Rosgen "E6" or "C6" channel running through it (the channel type would be dependent upon the amount of water flowing through this reach). In order to improve this reach, a series of wetland ponds connected with Rosgen "E" or "C" type channels could be constructed within the right of way. Clumps of willows and other riparian vegetation could be planted within this wetland pond similar to what is currently present in Quick's Bottom. Ultimately, if the District of Saanich acquired this land it could be restored into a large wetland habitat creating a bird sanctuary and nature park comparable to that at Viaduct Flats.

Despite its ditched shape, the vegetation that has been planted within and along its banks has transformed it into a functioning channel. As a result, Reach 4 is at Proper Functioning Condition on a low scale despite it lacking a Rosgen channel characterization.

Reach 1 Viaduct Creek: Quick's Bottom to Markham Road

Reach 1 is approximately 386 m long. It extends from its entrance point into Quick's Bottom, upstream through park and residential property to Markham Road. Due to prior ditching and excavation, this section of Viaduct Creek is a straight narrow channel with a flat bottom. Floodplains accessible within this reach are being utilized. The Rosgen classification for this reach is an artificially straightened "C6," as the dominant substrate is silt/clay and the channel retains some "C" characteristics such as gradient and floodplain access. Although the banks are undercut in some areas, the overall stream bank conditions within this reach are acceptable due to vegetative cover.

The banks of this channel are primarily densely vegetated with black hawthorn (*Crataegus douglasii*) and English hawthorn (*Crataegus monogyna*). A variety of other plant species are present as well (refer to reach checklist in Appendix 2). Historically, this area would have been a shrubby, deciduous-dominated forest with an abundance of conifers near the top of the reach. In order to attain the potential vegetation community, additional black cottonwood (*Populus balsamifera ssp. trichocarpa*), red alder (*Alnus rubra*), willow (*Salix sp*.), and other shrubs are necessary. There are very few invasive species present within this reach.

The potential Rosgen channel type for this reach is a more sinuous, meandering "C6" channel. In order to reach full potential, improvements, such as the addition of large wood to create more complex habitat and channel characteristics, are necessary. Alternatively, meander and sinuosity can be created by using an excavator to realign the creek. Preventative invasive species management should be initiated.

Reach 1 of Viaduct Creek is at Proper Functioning Condition; however, more sinuosity and deciduous trees are needed in order for it to reach desired future condition.

Reach 2a Viaduct Creek: Markham Road to where the tributary enters upstream of 4484 Markham Road

Reach 2a is approximately 287 m long and extends from the Markham Road bridge to the property boundary of 4484 Markham Road (where the tributary from Layritz Park enters). This section of Viaduct Creek travels through two residential properties and a small portion of the Vancouver Island Technology Park property. The banks are clay, but within the channel cobble dominates and bedrock outcrops appear in places. The Rosgen channel type is a “G3” due to the cobble substrate, gully shape and moderate gradient. In this reach, the banks are overly steepened and erosion is occurring on outside bends.

An old wooden bridge once crossed Viaduct Creek but has since fallen apart creating a large pile of wood downstream of its historic location. Upstream of the barn on 4484 Markham Road, the creek widens in a small section with pond-like characteristics. Within this pond-like structure, sediment continues to be deposited, thus filling up the channel and forcing the water to move towards the left bank.

The likely cause of this excessive amount of deposition can be found upstream of the 4484 Markham Road property line. At this location, a tributary entering Viaduct creek is experiencing a **head cut** and is transporting large amounts of sediment and runoff from Layritz Park and nearby parking lots. An entire section of the bank, including a coniferous tree, has slid into the tributary channel sending continual loads of clay sediment downstream. Upon reaching the wide gully-like area at 4484 Markham Road, the flow is slowed and the sediment then settles out creating a large island. **This head cut needs to be addressed and mitigated as it is currently moving up the tributary channel**. If the degradation of the tributary is allowed to persist, bank slumping and severe erosion will continue to occur upstream, thereby creating large sediment deposits that will severely damage the function of Viaduct Creek downstream.

In the past, water has always flowed through this reach year round. However, at the time of assessment almost no flow was visible. Upstream, two weirs at the mouth of Viaduct Flats may be the cause of this reduced flow as little water is able to get through these barriers and supply the downstream areas.

The lower section of this creek is overgrown with Himalayan blackberries (*Rubus armeniacus*) while upstream, the sediment deposition area is covered in European bittersweet (*Solanum dulcamara*). The remainder of the reach consists of Douglas fir (*Pseudotsuga menziesii*), English hawthorn (*Crateagus monogyna*), Indian plum (*Oemleria cerasiformis*), sword fern (*Polystichum munitum*), red alder (Alnus rubra), and willow (*Salix spp*.). For a complete list of vegetation, refer to the reach checklist in Appendix 2. Historically, the vegetation of the area would have had a similar composition to the current state (*i.e.* a mixed coniferous-deciduous forest); however, the native vegetation would have been in greater abundance. As it is now, there is not enough vegetation present to fully stabilize and protect the banks from erosion.

Reach 2a of Viaduct Creek has the same Rosgen channel type classification as its potential (“G3”); however, it is not at its desired future condition. This system is lacking large woody debris that would increase hydraulic and channel complexity, and stabilize the eroding banks. Invasive species removal and control would benefit the reach by allowing for the succession of appropriate native riparian species. Planting the reach with native riparian species will further stabilize the eroding banks. Furthermore, for this reach to maintain its function, the head cut on the tributary upstream must be dealt with immediately (for possible mitigation methods see the summary for Reach 2b). The hydrology of the two weirs should be examined to determine the amount of water attenuation that ensues in the winter and the amount of base flow released during the summer months.

Reach 2a of Viaduct Creek was determined to have a rating of Functional-At-Risk (with no apparent trend) due to the sediment deposition activity occurring within the Layritz Park tributary, the occurrence of bank erosion, and a lack of large wood within the system.

Reach 2b Viaduct Creek: The upstream property line of 4484 Markham Road to the weirs at the outlet of Viaduct Flats

Reach 2b is approximately 439 m long. The reach extends from the property boundary of 4484 Markham Road downstream of the confluence with an unnamed tributary draining Layritz Park, through a section of park and trail, to the weirs downstream of Viaduct Flats. The channel is a ditch with flat and steep sides.

In the lower section of this reach, downstream of the stormwater ponds, bank erosion is severe. The majority of floodplain occurring within this reach is in the upper portion of the channel near Viaduct Flats. Consequently, the Rosgen channel type is a “Gc6” with areas that have been ditched and straightened.

The aforementioned unnamed tributary channel exhibits a significant head cut that supplies excessive sediment downstream to the main stem Viaduct Creek channel. This tributary is fed by storm water from Layritz Park and Markham Road. A remnant wetland remains in the field upstream of Markham Road and could be seen on airphotos, prior to redevelopment. Heavy trampling has occurred in the areas downstream of the stormwater ponds, destroying current stream bank vegetation and preventing riparian vegetation reestablishment. The bank stabilizing function of the roots has thus been severely reduced amplifying the eroding power of peak flows.

Upon exiting the forested area, the creek passes alongside constructed stormwater ponds into an open grassy area bifurcating into two channels downstream of the weirs at Viaduct Flats. This grassy area is inundated with invasive species such as reed canary grass (*Phalaris arundinacea*) and thistle (*Cirsium arvense*). During the assessment, little flow was noted due either to natural low summer flows or perhaps due to the weirs preventing water flow. During site visits at the time of assessment and at other times in 2007, it was observed that the area surrounding the weirs has been inundated with the **invasive bullfrog species**. Above Viaduct Flats, the watershed drains a large rural area.

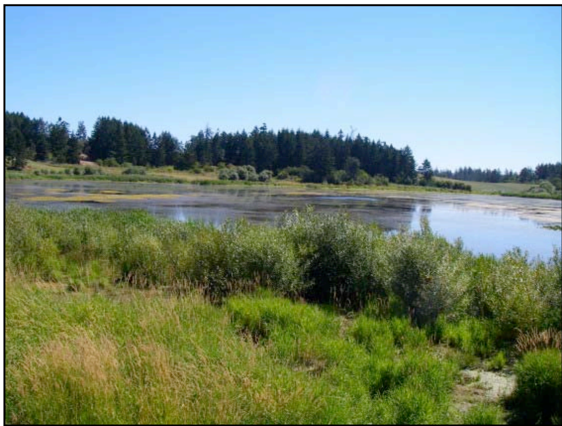
The lower half of the reach is dominated by conifers while the vegetation community in the upper half is primarily composed of shrubs and grasses. Along the greenline, however, there is less than 50% cover. Planting near the weirs in the upper portion of the creek has been successful and it is recommended that the planting continue. In general, the primary trees include bigleaf maple (*Acer macrophyllum*), grand fir (*Abies grandis*), red alder (*Alnus rubra*), and Western redcedar (*Thuja plicata*). Additionally, the dominant shrub species within the reach are Indian plum (*Oemeleria cerasiformis*), oceanspray (*Holodiscus discolor*), salmon berry (*Rubus spectabilis*), and snowberry (*Symphoricarpos albus*). For a full list of vegetation refer to the reach checklist in Appendix 2.

The potential for this reach is a Rosgen channel type of “C6”. As the current channel is too straight, lacks available floodplain and appropriate vegetation, restoration is necessary to reach this potential. In order to improve this reach, invasive species removal should be conducted along the length of the reach in a similar fashion to that occurring at the weirs. Planting should also be expanded throughout the reach as it will aid in removal of invasive species by shading, and enhance bank stability. In heavily eroded areas, V-shaped weirs should be installed in order to direct water flow to the center of the channel thereby reducing some of the stress on the banks that is causing erosion. Furthermore, these small weirs are capable of trapping sediment which could raise the channel up so that it may access additional floodplain. Fencing and signage in the lower section would decrease the amount of trampling and educate those using the trail.

The head cut should be arrested as soon as possible to prevent further significant sediment inputs downstream into Viaduct Creek. It is recommended that a flexible gabion mattress (filled with cobbles) be installed within the channel at the head cut location. The mattress should be affixed to the bed using bent rebar staples hammered into the clay soil. The mattress should be keyed into the bed at the upstream end to prevent underflow. It is recommended that a Professional Engineer qualified in river engineering review the design and inspect the constructed works. Exclusionary fencing should be installed for safety reasons and to allow vegetation to return around the head cut itself. Community education through signage is also recommended.

Reach 2b of Viaduct Creek is Functional-At-Risk with a downward trend due to the lack of floodplain accessibility, eroding banks, reduced vegetative cover, and the head cut occurring in the Layritz Park tributary.

Reach 3 Viaduct Flats: The weirs upstream of Viaduct Creek to the upstream end of Viaduct Flats



Reach 3 extends from the weirs at the upstream end of Viaduct Creek and includes Viaduct Flats. Before it was converted back into a wetland and park attraction, Viaduct flats was a potato field that seasonally flooded during the winter months. This wetland is sheltered by surrounding hills with nearby forest, and is therefore exposed to only a small wind fetch. Well-known bird habitat, Viaduct flats is home to an abundance of waterfowl and other bird species including Canada geese, Great Blue Herons, Mallard ducks, and red-winged blackbirds. Viaduct Flats receives water from Viaduct Creek, Conway Creek, and Goward Springs Creeks. Viaduct Flats is bordered by VITP (Vancouver Island Technology Park), Camosun College, and Glendale Gardens and Woodland (formerly the Horticultural Centre of the Pacific).

Historically, the surrounding area would have been mature coniferous forest morphing to shrubby riparian species as it approached the wetland, and then aquatic plant species near the open water. Presently, Douglas fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) form the outer edge of the wetland. Closer to the open water, black cottonwood (*Populus balsamifera ssp. trichocarpa*), English hawthorn (*Crateagus monogyna*), hardhack (*Spiraea douglasii*), and willows (*Salix spp*.) become more dominant. Vegetation adjacent to, and within the open water area, largely consists of Pacific water-parsley (*Oenanthe sarmentosa*), smartweed (*Polygonum amphibium*), and yellow pond lily (*Nuphar polysepalum*). For a complete plant list refer to Appendix 2 for the reach checklist.

Reach 3 is in Proper Functioning Condition and is in good shape resulting from continued supportive management after restoration initiatives. Invasive species have been well-managed to date and it is recommended that this management continue especially as Himalayan blackberry (*Rubus armeniacus*), reed canary grass (*Phalaris arundinacea*), and Scotch broom (*Cytisus scoparius*) have been seen growing in the area. Other improvements would include the addition of large woody debris into the open water area itself, thereby providing additional cover and perches for birds and habitat complexity for fish and other aquatic life.

Reach 4 Viaduct Creek: The inlet at Viaduct Flats to Interurban Road

Reach 4 is approximately 60 m long and extends from the inlet of Viaduct Flats, upstream through wetland areas, and into a ditch (alongside a trail) where the creek crosses Interurban Road. Alongside the trail, the creek is ditch-like and straight, with a few large rocks upstream of the bridge. The flow of water at the time of assessment was almost non-existent and too low to support fish. In the high flow winter months, the water extends over the channel banks (downstream of the parking lot bridge) into a grassy field and eventually discharges into Viaduct Flats. The ditch-like channel is vegetated with sections of trees and reed canary grass (*Phalaris arundinacea*). This section of creek has been realigned, straightened, and ditched. The silt/clay channel has access to little floodplain above the bridge, but in contrast, downstream the channel has the capacity to utilize floodplain near the mouth of the flats. The Rosgen channel type in this reach is a narrow ditch.

The vegetation in this reach consists of black cottonwood (*Populus balsamifera ssp. trichocarpa*), horsetail (*Equisetum sp*.), Nootka rose (*Rosa nutkana*), red alder (*Alnus rubra*), reed canary grass (*Phalaris arundinacea*), and willow (*Salix spp*.). For a complete list of vegetation for this reach refer to the reach checklist in Appendix 2. Vegetation has been planted along the left bank upstream of the parking lot bridge. This planting, along with existing trees, benefits the areas because it is shading out the Himalayan blackberry (*Rubus armeniacus*) and other invasive species.

Reach 4 of Viaduct Creek has not reached its potential Rosgen “C” channel type, because it is constrained in a ditch-like channel. To improve this reach, planting of native species should continue in order to shade out invasive species. There are opportunities within this reach to create floodplain terraces that would aid in increasing sinuosity and creating a “C” type channel.

Reach 4 is Non-functional as it is a ditch and portrays none of the stream characteristics expected for a functioning “C” channel. This channel is simply conveying water downstream.

Reach 5 Viaduct Creek: Interurban Road to the wooden plank bridge at 478 Viaduct Avenue West

Reach 5 is approximately 104 m long and extends from Interurban Road upstream through residential property to the footbridge at 478 Viaduct Avenue West (downstream of the Goward Springs A-Viaduct Creek confluence). On the property of 490 Viaduct Avenue West, the right (and a portion of the left) bank is armored with rock in an attempt to control erosion that is undercutting the driveway. On the left bank, lawn is maintained to the edge of the creek bank with few shrubs present. A large compost pile was also noted along the lawn area. There is evidence of flow control measures or restoration-perhaps a fisheries project- about halfway through this reach in the form of a log weir and a concrete weir. The dominant gravel substrate of this reach was likely added during the restoration work, thereby covering the previously silt/clay-dominated channel. The log weir is failing as water flow is skirting the edge of the weir on the right bank causing obvious erosion. Conversely, the concrete weir has allowed for the build up of sediment, and has subsequently raised the channel creating access to the surrounding floodplain area. Downstream of the concrete weir, the stream bank conditions vary from sparsely vegetated to actively eroding and downcutting. The driveway, buildings, and woodpile at 478 Viaduct Avenue West are located close to the edge of the bank. Furthermore, drainage pipes from the driveway discharge into Viaduct Creek causing localized erosion of the bank adding to the already heavily eroded channel. Although constrained on the right bank by residential properties, the channel has meander and was thus classified as a Rosgen "C4" channel type.

Historically, the area would have been coniferous forest dominated by Douglas fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*) with riparian shrubs. Presently, red alder (*Alnus rubra*) is the most common vegetation in this reach with English ivy (*Hedera helix*) abundant in the understorey. Other species such as bigleaf maple (*Acer macrophyllum*), common horsetail (*Equisetum arvense*), and western redcedar (*Thuja plicata*) can be seen along with those plants listed in the reach checklist (Appendix 2). Within this reach, vegetation is limited due to manicured lawns encroaching the edge-of-bank and the eroded, oversteepened banks. Upstream of the concrete weir more vegetation is present although the riparian species are sparse.

Although in poor condition, Reach 5 has reached its potential Rosgen channel type of a "C4". Restoration efforts should include the implementation of bed stabilization bars (similar to those in the upstream section) to raise the level of the channel, and bioengineering of the lower sections to replace the rock lining and improve bank stabilization. Once the bed has been naturally built up with sediment and the bioengineering has taken hold, the banks should be planted with conifers and shrubby species. Invasive species management will ensure the success of the new riparian plantings. Homeowner education on invasive species and yard waste management would also aid in improving this reach.

Reach 5 of Viaduct Creek is Functional-at-Risk with no apparent trend as the upper portion is stable while the lower portion is actively eroding.

Reach 6 Viaduct Creek: The footbridge at 478 Viaduct Avenue West to the fence at 458 Viaduct Avenue West

Reach 6 is approximately 157 m long and extends from the discharge point of Goward Springs A Creek into Viaduct Creek, upstream of the 478 Viaduct Avenue West footbridge, to the property boundary of 458 Viaduct Avenue West. The channel in this reach is eroded and under cut. The floodplain is small and is not being accessed due to the downcutting of the channel. The Rosgen channel type is a "C6" as it does have some meander, but is in poor condition due to the erosion occurring. The evidence of heavy erosion may have resulted from the draining of a wetland upstream (see Reach 8 Viaduct Creek). Goward Springs A Creek discharges into Viaduct Creek at the lower section of this reach, but impacts Reach 5 more than Reach 6.

The vegetation in this reach consists of mostly upland species and the riparian zone is almost nonexistent. **English ivy (*Hedera helix*) is dominant throughout this reach**. Vegetation being threatened by the ivy in this reach includes grand fir (*Abies grandis*), red alder (*Alnus rubra*), sword fern (*Polystichum munitum*), and western redcedar (*Thuja plicata*). For a complete list of vegetation refer to the reach checklist (Appendix 2).

Reach 6 has reached its potential Rosgen channel type of a "C6"; however, it is in poor shape. In order to improve this reach, **an invasive species removal and management program needs to be implemented quickly** before the English ivy (*Hedera helix*) out-competes the remaining native vegetation. A series of log weirs should be installed in order to prevent further downcutting of the channel and allow for sediment deposition and reformation of the channel. To create floodplain and reduce erosion from high flows, banks should be terraced with bioengineering.

Reach 6 is Non-functional due to the current erosion, downcutting, and inability of the channel to dissipate the flows it receives.

Reach 7 Viaduct Creek: The fence at 458 Viaduct Avenue West to where creek enters the wetland area at 458 Viaduct Avenue West

Reach 7 is approximately 28 m long. It extends from the property boundary of 458 Viaduct Avenue West, through two residential properties (one on each side of the creek) to where the creek enters the wetland area upstream of the pedestrian footbridge. Created by ditching, this reach is narrow and incised with steep banks, thus resembling a Rosgen "G6" channel. The channel and bank substrate consist of silt/clay with some peat. The banks are heavily vegetated with reed canary grass (*Phalaris arundinacea*), with no signs of erosion. This is likely due to the wetland upstream attenuating the water. Furthermore, the floodplain area is not accessible due to incision of the creek. The channel has been dug in the past 15-20 years to drain the wetland in order to use the land for farming purposes. Both the left and right banks have lawns encroaching up to the edges.

The vegetation in this reach is dominated by reed canary grass (*Phalaris arundinacea*) and has some common horsetail (*Equisetum arvense*), creeping buttercup (*Ranunculus repens*), Himalayan blackberry (*Rubus armeniacus*), morning glory (*Ipomoea indica*), red alder (*Alnus rubra*), and thistle (*Cirsium arvense*). Historically, this section was more of a wetland than a channel and would have had a cattail, sedge and shrub community surrounded by coniferous forest. A complete list of vegetation can be viewed in the reach checklist (Appendix 2).

Reach 7 has not reached its potential Rosgen "E" channel type, due to its ditch-like characteristics. In the short term, the potential is for the channel to form a sinuous "E" channel with large areas of floodplain, with the long-term potential of morphing into a large wetland. Restoration efforts to improve function would include bioengineering with willows to replace existing reed canary grass (*Phalaris arundinacea*), followed by a second phase of planting with sedges and cattails once the invasive species have been shaded out.

Reach 7 is in Proper Functioning Condition as there are no major issues of concern in this reach likely due to the wetland upstream attenuating flows. It is, however, far from desired future condition.

Reach 8 Viaduct Creek: Where the creek enters wetland area at 458 Viaduct Avenue West to the confluence of Viaduct Creek and Excelsior Creek at 414 Viaduct Avenue West

Reach 8 is a 0.9 ha wetland extending from the footbridge on 458 Viaduct Avenue West through a large hay field, a cow paddock, and a horse pasture, to the confluence of Excelsior Creek and Viaduct Creek. This reach is lentic in nature with a large wetland area located on the property of 455 Green Mountain Road. A ditch has been dug through this wetland, likely for drainage purposes and access to arable land within the last 15-20 years (Askew, *pers. comm*.). However, this is the only section where a channel is present. In this location, haying or mowing occurs along the wetland area, nearly to the edge of the channel. Upstream of the ditched channel, a cow paddock followed by a horse pasture line the low-lying wetland depression. Extreme trampling has occurred in these locations especially by the horses that are not restricted by fencing as the cows are. Manure is also present within the wetland depression potentially affecting water quality downstream when flooding occurs during the winter months.

Although the riparian-wetland vegetation consists of more than two species and is, therefore, classified as diverse, it is likely much smaller and limited in its recruitment of riparian-wetland vegetation than it was historically because of the current draining, grazing, and trampling. Additionally, there are few shrubs in the lower section of the reach due to mowing practices in the hay field. Along the ditched area, in the lower portion of the reach, reed canary grass (*Phalaris arundinacea*) is the dominant vegetation with some small flowering bulrush (*Scirpus microcarpus*), cattail (*Typha latifolia*), water-plantain (*Alisma plantago-aquatica*), and willow (*Salix spp*.). The upper section of the reach consists of hardhack (*Spirea douglasii ssp. douglasii*), willow (*Salix spp*.), and few other species since vegetation growth is hindered by the grazing and trampling activities. Upstream of 414 Viaduct Avenue West where Excelsior Creek flows, the vegetation has not been disturbed and is representative of what the trampled wetland area should look like. For a full list of vegetation see the reach checklist in Appendix 2.

Reach 8 is Functional-at-Risk with no apparent trend due to the excessive trampling and grazing in the upper section and the past ditching in the lower section. Improvements can be made by planting native vegetation, such as red osier dogwood (*Cornus stolonifera*), and willows (*Salix spp*.) to shade out the reed canary grass (*Phalaris arundinacea*). A second phase of planting with trees and riparian shrubs will restore some of the wetlands natural vegetation. Placing a weir in the ditch-like channel will allow for continued downstream flow as well as re-establishing the hydrology of the landscape. A grazing management plan coupled with exclusionary fencing should be implemented to allow for wetland and vegetation recruitment and succession in the paddock areas.

Reach 9 Viaduct Creek: The confluence of Viaduct Creek and Excelsior Creek to Viaduct Avenue West road crossing

Reach 9 is approximately 132 m long and extends from the confluence of Viaduct Creek and Excelsior Creek (at 414 Viaduct Avenue West), along the property line between 414 and 402 Viaduct Avenue West, to the Viaduct Avenue West crossing. This channel is bare, undercut, heavily eroded, and ditch-like. Additionally, the incised characteristics of the channel prevent the creek from accessing its floodplain. The Rosgen channel type is a “G6” with a slope between 2-4%.

The vegetation within this reach is sparse consisting of English hawthorn (*Crateagus monogyna*), Himalayan blackberry (*Rubus armeniacus*), Indian plum (*Oemleria ceraformis*), red alder (*Alnus rubra*), reed canary grass (*Phalaris arundinacea*), Scouler’s willow (*Salix scouleriana*), snowberry (*Symphoricarpos albus*), and western redcedar (*Thuja plicata*). This scarcity may be the result of previous trenching/ditching of the channel that has subsequently lowered the water table making it difficult for vegetation to access the water supply. A complete list of vegetation can be reviewed in the reach checklist (see Appendix 2).

Reach 9 has not reached its potential Rosgen channel type of “C6”. In order to improve the health and function of this reach, the channel should be terraced with bioengineering, followed by planting of native, shade-tolerant riparian species to further stabilize the banks. Furthermore, the addition of log or concrete weirs and large woody debris will shield the banks and dissipate the energy of peak flows reducing erosion. A combination of terraces and weirs throughout the reach will create accessible floodplain and thereby capture sediment allowing the channel to rebuild itself.

Reach 9 is Non-functional due to its heavily eroding and undercutting banks indicative of a system unable to manage and attenuate peak flows. Vegetation has also become scarce along the banks due to a drop in the water table caused by the dredging of the channel.

Reach 10 Viaduct Creek: Viaduct Avenue West crossing to the headcut upstream of 389 Viaduct Avenue West

Reach 10 is approximately 17m long. It extends from Viaduct Avenue West road crossing, through residential property to a headcut upstream of 389 Viaduct Avenue West. The stream bank conditions of this reach are densely vegetated with some erosion occurring on the outside bends. It contains highly variable substrate beginning with bedrock in the first portion of the reach, through sections of cobble and boulder, then to a silt substrate closer to the upstream end of the reach. There are sections of accessible and utilized floodplain throughout that are sufficient for the channel type. The slope is steep and in a small section downstream of 389 Viaduct Avenue West there is evidence of slight downcutting. Deer tracks were noted adjacent, and within, the channel along with the presence of large wood. At the end of the reach, **a headcut was observed** of approximately 60 cm depth. Reach 10 is a Rosgen "B1-6" type channel.

The vegetation in this reach is composed of almost entirely native species. Bigleaf maple (*Acer macrophyllum*), common horsetail (*Equisetum arvense*), Douglas fir (*Pseudotsuga menziesii*), and salal (*Gaultheria shallon*) are the dominant species. The vegetation densely covers the banks and grows in the channel providing excellent root stability. Invasive species present are creeping buttercup (*Ranunculus repens*) and reed canary grass (*Phalaris arundinacea*). The vegetation in this reach is representative of the historical vegetation, a mixed coniferous-deciduous forest. For a complete list of the species present see the reach checklist in Appendix 2.

Reach 10 has reached its potential channel type of a Rosgen "B" with varying substrates. Improvements can be made by the addition of more large wood at the downstream section near the culvert to stabilize areas along the banks that are experiencing erosion and reduce the velocity of flows moving through the culvert to Reach 9. Placement of large wood will dissipate the energy of peak flows, slow the volume of water passing through the reach, and thus have a positive impact on all reaches downstream. Although there are currently few invasive species present, the implementation of an invasive species removal plan would prevent future problems. For recommendations on mitigating the headcut see Reach 11.

Reach 10 is functioning well and is in Proper Functioning Condition.

Reach 11 Viaduct Creek: The headcut upstream of 389 Viaduct Avenue West to the bedrock outcrop downstream of 365 Viaduct Avenue West

Reach 11 is approximately 68 m long. It extends from the headcut upstream of 389 Viaduct Avenue West through a forested area to where the tree canopy opens up at the bedrock outcrop downstream of 365 Viaduct Avenue West. The channel continues upstream above the headcut with a gentler slope than Reach 10 downstream. A large, moist, seepage area is located on the right bank indicating good floodplain availability and utilization for this reach. The stream banks are thickly vegetated and no erosion was noted except for the headcut area. The Rosgen channel type is a "Bc6" as it shows some "C" characteristics such as the floodplain area.

The vegetation in this area is dominated by the following species: bigleaf maple (*Acer macrophyllum*), common horsetail (*Equisetum arvense*), Douglas fir (*Pseudotsuga menziesii*), skunk cabbage (*Lysichiton americanum*), salal (*Gaultheria shallon*), and western redcedar (*Thuja plicata*). As with Reach 10, the vegetation in Reach 11 is representative of the historical vegetative community. For the complete list of vegetation see the reach checklist in Appendix 2.

Reach 11 has reached its potential channel type of a Rosgen "Bc6"; however, there are improvements that can be made within this reach. **The headcut must be attended to in order to prevent it from traveling up the valley any further**. Boulder sized rocks can be installed in front of the headcut to provide a buffer between the water flow and the eroding channel. An invasive species monitoring and removal plan will also be important for maintaining the health of the native vegetation present.

Reach 11 is in Proper Functioning Condition due to its accessible floodplain, generally stable channel, and vigorous native vegetation.

Reach 12 Viaduct Creek: The bedrock outcrop downstream of 365 Viaduct Avenue West to the driveway of 353 Viaduct Avenue West

Reach 12 is approximately 105m long. It extends from the bedrock outcrop where the tree canopy opens up downstream of 365 Viaduct Avenue West, to the driveway of 353 Viaduct Avenue West. This reach runs through the front yard of 365 Viaduct Avenue West alongside a horse paddock (on the right bank) and underneath the driveway via a culvert (approximately 600 mm diameter). At the time of assessment, no water was present in the channel and chickens were roaming the dry creek bed. The chickens and a nearby horse enclosure are close enough to the channel for excrement to enter the water during high flow potentially affecting water quality downstream.

The banks throughout this property lack vegetation, and erosion is evident in this trampled area. On the edge of the property, discarded equipment remains that may be a source of unknown contaminants *(e.g.* oil) into the creek system. Upstream of the fence marking the property line between 365 and 353 Viaduct Avenue West, stream banks appear to have been eroded and a pump, pumping water out of the creek, was noted and is still functioning. Upstream of 353 Viaduct Avenue West, the banks are much more densely vegetated and continue to be so until the end of the reach. Overall, the channel within the reach is wide, flat and has access to floodplain. During heavy rains, it is possible that this area flash floods. The Rosgen channel type is a “C6”. Important to note is that a large disturbance has recently occurred upstream in the form of an abandoned (?) attempt at driveway installation. A 7-10 m wide ditch has been dug and backfilled with junk fill. The excavated area extends from the Viaduct Avenue West Road, down the slope, across the channel (and what appears to be a wetland) eventually connecting to the 353 Viaduct Avenue West driveway. The excavated area has filled with water and a large amount of silt was noted in the bottom of Reach 12, which may be attributed to this disturbance. However, long-term effects are unknown.

In the lower section of the reach, the vegetation is extremely sparse except for a large patch of Himalayan blackberries (*Rubus armeniacus*) and some bamboo (*Bambusa sp*.). Once into the 353 Viaduct Avenue West property boundary, the vegetation becomes denser and includes Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), ocean spray (*Holodiscus discolor*), red alder (*Alnus rubra*), western redcedar (*Thuja plicata*), and willow (*Salix spp*.). Other species are also present and are listed in the reach checklist (see Appendix 2).

Reach 12 has reached its potential of a Rosgen channel type “C6”; however, it is in poor condition. Improvements to the reach should include re-planting the bare banks at 365 Viaduct Avenue West with native riparian vegetation. This will stabilize and protect the banks from erosion. Homeowner education on animal disturbance and trampling must parallel the planting efforts to allow for vigorous growth. Invasive species removal, especially the Himalayan blackberry (*Rubus armeniacus*), and **bamboo** (*Bambusa sp.*) followed by replanting with fast-growing red alder (*Alnus rubra*) and willow (*Salix spp.*) is essential and will further aid in shading any invasives out and maintaining bank stability. The bamboo should be removed immediately. A smaller channel terraced with bioengineering would restore the width/depth ratio and increase floodplain within the channel.

Reach 12 is Functional-at-Risk with a downward trend due to the degradation occurring as a result the lack of vegetation and the fact that the channel has been straightened and over-widened. If this reach is not improved, continued bank erosion will supply downstream reaches with excessive sediment and amplify existing problems.

Reach 13 Viaduct Creek: The driveway of 353 Viaduct Avenue West to the property boundary between 335 Viaduct Avenue West and Logan Park

Reach 13 is a wetland approximately 0.23 hectares in size. It extends from the upstream end of the 353 Viaduct Avenue West driveway through 335 Viaduct Avenue West to the property break at Logan Park. This reach has lentic characteristics and is found in a large open area fringed by conifers**. In the spring of 2007, an attempt was made to cross the creek in order to build a driveway. As a result, a large section has been dug-out and concrete and other debris has been piled up against the edge of Viaduct Avenue West protruding into the wetland area.** The riparian-wetland area has been narrowed up as a result of this degradation and berms have been created along the sides of the excavated area. These berms may be impeding flow downstream or changing the surface drainage pattern. Furthermore, there is uncertainty surrounding changes to the route of passage of overland flows because of this recent degradation. Any work in and around the creek should have proceeded only with a Section 9 of the Water Act permit which requires that proper plans be submitted to the Ministry of Environment for approval.

The vegetation in the area consists of bigleaf maple (*Acer macrophyllum*), common horsetail (*Equisetum arvense*), Indian plum (*Oemleria cerasiformis*), lady fern (*Athyrium filix-femina*), red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), skunk cabbage (*Lysichiton americanum*), and sword fern (*Polystichum munitum*). Invasive species present include creeping buttercup (*Ranunculus repens*) and Himalayan blackberry (*Rubus armeniacus*). In general, the riparian-wetland plants are vigorous except for where the excavation has occurred. A complete list of species is found in the reach checklist (see Appendix 2).

Reach 13 is Functional-at-Risk with a downward trend due to the extensive degradation that has occurred from the attempted driveway construction. As the destruction is so recent, it is difficult to determine what the long-term effects will be on this system in terms of remaining in balance with water and sediment supplies. In the meantime, there are improvements that can be made. In the short term, immediate mitigation for erosion and sediment control should be implemented in order to prevent excess sediment from being transported downstream to the lower reaches. *The junk fill must be removed.* Over the long term, the area can be restored by replanting native riparian vegetation along the cut. Backfilling the excavated area with the currently bermed-up soil and replanting with riparian species would also aid in restoring the area to a more stable condition.

Reach 14 Viaduct Creek: The edge of the wetland to upstream of the pond near 235 Hector Road where the channel disappears at the headwaters

Reach 14 is approximately 172 m long and extends from the end of the wetland furthest from Viaduct Avenue West, through Logan Park, to the headwaters upstream of the pond near 235 Hector Road. There are multiple small, narrow channels that seem to have been initially formed by an old road whose ruts collected surface flow. The channels themselves are Rosgen type “E6” although they lack sinuosity due to their origins as wheel ruts. Floodplain is available, although it may not be accessed due to the low flows expected in a headwater. The reach is well vegetated on the banks although the channels are bare and incised in places. Near the end of this reach, a small pond with **bullfrogs** and a grounded old rowboat were noted.

The dominant vegetation in this reach includes bigleaf maple (*Acer macrophyllum*), creeping buttercup (*Ranunculus repens*), marsh skullcap (*Scutellaria galericulata*), red alder (*Alnus rubra*), salal (*Gaultheria shallon*), sedges (*Carex sp*.), trailing blackberry (*Rubus ursinus*), and willow (*Salix spp*.). For a complete list of vegetation see the reach checklist in Appendix 2.

Reach 14 has not reached its potential of a wetland system with no existing channel that accommodates overland and subsurface flow. However, the vegetation is filling in and the reach will likely evolve out of its channelized state over time. This reach is Functional-at-Risk with an upward trend as it is in the process of restoring itself. In order to increase the recovery time of this system, large wood could be added to the area forcing the flows in the channel to dissipate over the entire area.

Reach 15 Viaduct Creek: The upstream boundary of 335 Viaduct Avenue West to the culvert under the trail at Logan Park

Reach 15 is approximately 135m long and extends from the upstream edge of the wetland alongside Viaduct Avenue West, to the culvert in Logan Park that passes underneath the park trail. The channel is narrow and the banks of this reach are steep. On the left bank, Viaduct Avenue West constrains the channel and the construction of this road may have played a part in creating the Rosgen channel type “G3”. The right bank is also constrained by bedrock outcrops and the channel is incised. Despite this, the upper section consists of available floodplain, although its presence decreases proportionately downstream as the channel opens up into a wetland. Upstream, the culvert beneath the trail acts as a dam attenuating flows and is beneficial for the functioning of Reach 15.

The banks are vegetated along this reach with bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), Indian plum (*Oemleria cerasiformis*), red alder (*Alnus rubra*), salal (*Gaultheria shallon*), and snowberry (*Symphoricarpos albus*). For a complete list of vegetation refer to the reach checklist in Appendix 2. The abundant vegetation is acting to stabilize and buffer the steep banks from eroding during peak flows.

Reach 15 has attained its potential Rosgen channel type of “G3” for it is a functioning system, and except for monitoring the small amount of invasive species present, requires little improvement.

Reach 15 is in Proper Functioning Condition as the reach represents a stable functioning system with appropriate vegetation and no notable degradation.

Reach 16 Viaduct Creek: The culvert under the trail in Logan Park upstream to the end of Logan Park

Reach 16 is a wetland approximately 0.44 ha in size. It extends from the culvert beneath the pedestrian trail in Logan Park, upstream to where the wetland area ends in the headwaters. Directly upstream of the trail exists an open and moist, wetland area. This wetland area is in very good shape and is protected within the boundaries of Logan Park.

The area is dominated by big leaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*). Vegetation surrounding (and slowly filling in) the wetland consists of sedges (*Carex spp*.), skunk cabbage (*Lysichiton americanum*), and sword fern (*Polystichum munitum*). For a complete list of the vegetation refer to Appendix 2 for the reach checklist.

Reach 16 is in Proper Functioning Condition, as the vegetation is diverse and vigorous. The wetland is functioning as it should, and there are no restoration requirements within this reach.

Conclusions

Twenty-two reaches of Colquitz River, nine reaches of Swan Lake Creek, six reaches of Blenkinsop Creek, sixteen reaches of Viaduct Creek, and four reaches of Durrell Creek were assessed according to Proper Functioning Condition techniques. Overall, the assessment covered 18.4 km of stream channel within the Colquitz River Watershed with the following results: 8,954 m of creek are in Proper Functioning Condition; 172 m of creek are Functional at Risk with an upward trend; 2029 m of creek are Functional-at-Risk with no apparent trend; and 6517 m of these channels are Non-functional. For further explanation of these findings see Tables 6-11 PFC Summary Determinations for results. Though approximately half the length of these channels is in PFC, that does not mean that these areas are good habitat nor that they are in desired future condition. PFC simply indicates that the channels are physically stable and have the vegetation needed for maintenance and recovery. Even within the reaches classified as PFC, improvements are needed.

Physical conditions

The physical and hydrological function of the Colquitz River Watershed has been limited in numerous locations due to increasing urban land use and ditching and dredging for agriculture and other drainage purposes. However, there are pockets throughout the Colquitz River Watershed which are representative of historical ecological condition and which can be used as reference reaches for restoration.

Water Storage and Flows

Narrow riparian zones, as observed in numerous locations throughout this watershed, reduce the capacity for water storage. As a result, stream channels experience flows that peak more quickly during rain events. These peak flows are high energy and the altered stream channels lack dissipation features to prevent erosion. Hydrological storage in the watershed could be increased with the reconstruction of floodplains and/or wetlands. The municipal government of Saanich has already been active in the purchasing of land adjacent to the creeks (especially Colquitz River) in order to ensure their protection and management. Floodplains and wetlands could be created within this corridor. Run-off from impervious surfaces can also be reduced by better on-site management, by residential, government and commercial property owners, which will improve water quality and decrease the volume of water flowing into the creeks of the Colquitz River Watershed.

Water Temperature and River Bank Conditions

Water temperatures in the Colquitz River Watershed range from <5ºC in the winter to >20ºC in the summer (Grant *et al*., 1993). The higher temperatures observed in the summer months are due a combination of reduced riparian vegetation, low summer flows (caused in part by lack of groundwater recharge) and high temperature runoff from impervious surfaces during the summer and fall. The higher temperatures may be affecting the population and species type of fish living within this system as the salmonid threshold is 15ºC. The bank conditions range from stable and well-vegetated to actively eroding bare banks. In areas, banks have been artificially stabilized with rocks and walls in attempts to protect upslope land and structures. Ditching, straightening and armouring of banks is the norm in this watershed. Some recent restoration efforts have attempted to reverse this trend.

Riparian Plant Communities

Native riparian plant communities have been reduced in numerous reaches throughout the watershed as a result of encroaching urbanization, agriculture, and other human activities. Trampling (by people and dogs) is of particular concern in parks. Invasive species have become ubiquitous, further stressing the native vegetation. Invasive species are not as capable of stabilizing stream banks as native vegetation; nor are they as suitable as a food source for wildlife.

Native Fish Habitat

Historically, the Colquitz River Watershed was a source of numerous and abundant fish species, including salmonids. Over the years, human-induced alterations have reduced the ability of the streams in the watershed to support these fish and numbers have decreased significantly from an escapement of 300-500 in 1945 to 15 in 1991 (Krocker, 1993).

Future Studies, Information Needs, and Management Opportunities

Data Needs

- More data for stream flow is needed in order to create a comprehensive hydrograph for Colquitz River and its tributaries within the Colquitz River Watershed. The improved understanding of the movement of water within the watershed will enable planning for better restoration, enhanced maintenance, and flood events. Additionally, more detailed information could further explain the impact of impervious surfaces on stream conditions to interested parties. With this information, the municipality can track changes in water flow overtime as climate and other environmental conditions are altered.
- Mapping of actual floodplains, both present and historical, is required to assess the degree to which restoration can compensate for altered water flows. Photographs, particularly aerial photos with ground-truthing, following large rain events should be taken regularly, even if mapping of this information is not feasible in the immediate future. As climate change brings more frequent, intense rainstorms, Saanich will need to review the watershed’s capacity to absorb and control flows. Areas where flooding can occur, without damaging property, should be identified and the requisite actions taken to reinstate the natural floodplains in these areas. Wherever possible, hardened structures should be avoided in favour of good design and natural plantings, large wood and judicious and sparing placement of rock where necessary.

Education Needs

- The members of the general public, business, and government agencies (including Saanich staff) working and living within the watershed should continue to be educated on the impact of run-off from impervious surfaces. Mitigation efforts should then be encouraged throughout the watershed including reduction of impervious surfaces, and use of on-site storage and infiltration measures such as rain barrels and vegetated swales.

- There are several interested community groups who are very active within the watershed, including the Gorge-Tillicum Community Association. Such groups could (and we believe would) act as ambassadors to promote rainwater management if they were provided with the educational materials to do so.
- School stewardship programs such as those that have occurred through Spectrum Community School and Strawberry Vale School (under the Urban Salmon Habitat Protection Project) could be reinstated and expanded to involve students in stewardship activities.
- Community outreach events could be organized to bring awareness to the presence of the streams within communities. Additionally, these events could explain the importance of maintaining riparian zones and reducing invasive species thus promoting public action on these two fronts.
- An understanding of the historical condition of the watershed is needed. The role of wetlands and floodplains in providing the ecological services needed to maintain summer flows, create habitat and control flooding should be highlighted and taught together with the message of rainwater management.

Restoration Needs

Recommendations for restoration are discussed in the following sections and in the individual reach summaries. In short, they concentrate on:

- The planting of native riparian vegetation to combat erosion via bank stabilization and improve habitat requirements for wildlife.
- Continued invasive species removal to ensure the full succession of riparian species.
- The implementation of bioengineering techniques, such as willow wattles, to further moderate the effects of erosion.
- The construction of floodplains, terraces, and wetland areas to increase the hydrological storage within the watershed.

Recommendations

The following recommendations represent opportunities to ensure the creeks of the Colquitz River Watershed do not degrade, maintain their current function and advance toward their potential and desired future conditions.

Critical Actions

There are several issues that should be addressed immediately, in order to prevent degradation and significant damage to property and/or significant future expense:

Headcuts

1. The headcut at 4484 Markham Road (downstream of Markham Road at the entrance to VITP) is significant and in need of immediate attention. Additional flows from recent work at Layritz Park have exacerbated the poor condition of the channel and accelerated the headcut. This headcut has the potential to increase, in the near future, to the point where it will undercut Markham Road.

2. There is (presently) a very small headcut upstream of 389 Viaduct Avenue West on Viaduct Creek in a reach that is otherwise in very good condition. This headcut should be addressed to prevent downcutting and loss of a significant area of functional, healthy stream habitat. What is presently less than a 60 cm drop, could easily become a significant gully, similar the one seen at VITP.

Invasive Plant Species

1. In addition to the ubiquitous invasive species such as Himalayan blackberry, there are several emerging invasive species that are present in small numbers and can still be eradicated before they become a significant problem. They include Japanese knotweed, purple loosestrife and bamboo. All three plants have been found in the Colquitz watershed and should be immediately eradicated from these locations:

Japanese Knotweed	Reach 2, Blenkinsop Creek, near the north end of the Swan Lake (Lochside) trestle.
Purple Loosestrife	Reach 4, Durrell Creek between Interurban Road and Granville Avenue Reach 7, Swan Creek, just upstream (south) of McKenzie Avenue
Bamboo	Reach 12, Viaduct Creek near 365 Viaduct Avenue West Reach 10 a, Colquitz River near 4252 Moor Park Place Reach 20, Colquitz River just upstream of 4674 Pipeline Road

The Loosestrife and knotweed near Swan Lake (Swan Creek reach 7 and Blenkinsop Creek reach 2) are of particular concern, because they could easily invade the Nature Sanctuary or the restored wetland area immediately north of McKenzie Avenue.

General Recommendations

Planning and management at the watershed scale is necessary to address many of the concerns highlighted in this assessment. Integrated watershed management (IWM) is a concept variously defined but generally acknowledged to include ideas such as (Townsend, 2006):

- utilising the watershed as an effective management unit for planning and development;
- addressing multiple and interrelated land use values, as opposed to managing for narrow values such as drinking water or flood control;
- involving various stakeholders and levels of government in planning and implementation;
- maintenance and restoration of watershed ecosystems;
- an attempt to preserve or restore natural hydrological cycles and habitat; and
- integration across multiple disciplines and knowledge.

IWM would therefore enable a holistic and long-term approach to restoration and conservation. There is currently a high level of interest in IWM among local public and government agencies. This type of management could address multiple resource objectives beyond riparian restoration, such as improved water quality, climate change adaptation, urban forest stewardship, West Nile virus management and enhancement of quality of life in the municipality. Implementation of IWM could also allow for more funding opportunities, for example through Ministry of Community and Rural Development grants and LiveSmart BC initiatives. Watershed management, land use planning, and stream restoration, although not without costs, can also offer significant economic benefits to communities and land owners/ managers (Barraclough and Hegg, 2008; Center for Watershed Protection, 1997).

The second general recommendation is the need to implement best management practices (BMPs) for stormwater, particularly at the small site level across the watershed. This would substantially reduce the volume of runoff and increase the lag time (time between maximum rainfall and maximum river stage), and move toward a more natural flow regime. High-energy, erosive flows are responsible for a large percentage of degraded conditions observed in the field. Water quality, although not directly assessed in this report, would also be significantly improved. Locally relevant BMP resources are listed in Malmkvist and Townsend (2008).

More focused recommendations, as highlighted from field observations, include the following:

1. Control invasive plant species, plant native riparian species on and near the banks, and use bioengineering such as willow wattles to moderate erosion activity in degraded areas. To be most effective, this would be best implemented as a municipal or watershed-scale effort (*i.e.* part of an IWM plan as described above), entailing prioritization and planning, research and trial of various methods, as well as long-term follow up, maintenance and monitoring.
2. Fence riparian corridors in park areas with high visitation to keep dogs and people out of the creeks and off the banks and permit vegetation to re-grow.
3. Create specific viewing areas to permit people to view and access the creeks without trampling vegetation.

4. Increase educational signage in parks and green spaces to inform, educate and promote stewardship. Engage local schools to assist in developing the text wherever possible. Create signs that target different age groups and interests.
5. When woody debris enters a creek system it should be allowed to remain (where flooding is not a risk to private property or infrastructure) to mitigate peak flows, and aid in the creation of meander and floodplain.
6. Continue acquiring property adjacent to the Colquitz River for management and protection purposes and extend this to the other creeks in the watershed wherever possible.
7. Ensure that large tracts of floodplain, including Viaduct Flats, Quick's Bottom, Panama Flats, and key areas around Blenkinsop Lake and Swan Lake remain accessible to flood waters in perpetuity. This may require property acquisition, leasing arrangements or other legal instruments. While this may appear cost-prohibitive, without these key areas, the potential costs of flood damage to downstream property and infrastructure could be very significant.
8. Develop an "adopt-a-stream" program, similar to the "adopt-a-highway" programs where community groups and companies sponsor litter control, to care for specific reaches of creeks within the watershed.

Recommendations by Reach

Colquitz Reach 1 (From the Admirals Road bridge crossing to upstream of the 2nd footbridge in Cuthbert Holmes Park)

Invasive species removal and control should be implemented and soil and vegetation rehabilitation conducted in the locations of heavy trampling in the upland area. The management plan for Cuthbert Holmes Park should be reevaluated or updated to address forest health issues, trampling and invasive species management. At a minimum, it is critical to remove ivy from trees in this area, before it causes more mortality that could open up gaps and facilitate further invasions. Trampling in the forested area between the two foot-bridges is quite severe, and is self-reinforcing due to heavy dog traffic. Soil amendments, replanting with shrubs and trees, and fencing around replanted areas will be required; small areas could be restored first and expanded as the vegetation becomes established.

A stewardship program (*e.g.* Green Shores), including the residents lining the left bank and the park managers, would benefit the reach by creating awareness about the importance of native riparian vegetation and hydrologic processes within this system.

Colquitz Reach 2 (From upstream of the 2nd footbridge in Cuthbert Holmes Park to the Trans Canada Highway bridge)

Invasive species removal and control is required in this reach to allow for the full succession of native riparian and upland species. Planting more native riparian and upland species will stabilize the banks. The plant community is currently dominated by shrubs, and could benefit by tree planting, particularly fast-growing deciduous trees (with a conifer understorey). Adding large wood rock, and gravel will improve the general habitat complexity for fish and other organisms. This reach is not constrained by land use and therefore there is the opportunity for reconfiguration of the creek channel.

Colquitz Reach 3 (From the Trans Canada Highway bridge to the north end of the southernmost boardwalk bridge alongside Interurban Road)

The channel in this reach is constrained by bedrock and, consequently, the only restoration possibility is the removal and control of invasive species.

Colquitz Reach 4 (From the north end of the southernmost boardwalk bridge along Interurban Road to the north end of the northernmost boardwalk bridge)

The control of invasive species will allow for the succession of native riparian and upland vegetation. This can be accomplished by mowing the invasives, mulching and planting black cottonwood and willows to shade out the invasives in the long term. This is preferred to removing them outright, as their roots are stabilizing the banks. Removing the invasive species may be an option provided it is combined with stabilizing activities such as bioengineering. The human activity occurring around the cement blocks should be monitored to determine if they have an impact on stream health and if they are a liability.

Colquitz Reach 5 (From the end of the northernmost boardwalk bridge to upstream of large cement platforms below the overhead footbridge)

Landowner education regarding the functions of riparian vegetation is important to maintain the stability of the right bank of this reach, which is already showing evidence of heavy erosion. Park mowing practices should be altered to reduce the access of trail users to the edge of the banks in order to avoid excessive trampling that prevents vegetation from growing. Planting along the streambanks is recommended if vegetation recovery does not occur following elimination of trampling.

The addition of large woody debris will add habitat complexity while creating sinuosity that will help reduce the velocity of peak flows.

Colquitz Reach 6 (From upstream of cement stepping stones below overhead footbridge to the Interurban Road crossing)

Restoration in this reach is limited due to inaccessibility. However, invasive species control can be conducted along with some improved habitat complexity by the addition of large wood and/or rock. This reach is well protected from human access by its physical character.

Colquitz Reach 7 (From Interurban Road crossing to the playground in Hyacinth Park)

Upstream of Marigold Avenue the open section with the weeping willows presents a good area for creek reconfiguration. Sinuosity and meandering can be increased and the addition of wood and rock would further improve habitat complexity. This area is currently dominated by weeping willow and grass, providing minimal habitat. The grass is periodically mowed, preventing other species from establishing. Also, weeping willows create deep shade and prevent the growth of other plants. Therefore to establish a diverse riparian community, every second weeping willow should be removed. The removed trees can be replaced by native riparian vegetation such as deciduous trees and shrubs (*e.g.* alder, native willows, cottonwood, salmonberry, red osier dogwood, Pacific ninebark). Once the root systems of the newly planted vegetation are strong enough, the remaining weeping willow can be removed. The existing aquatic vegetation (small-flowered bulrush) could be supplemented by additional plantings of this species and others such as sedges and rushes.

Mowing adjacent to the creek banks and in other areas that are not playing fields should be reduced or stopped so as to reduce the ease of accessing creek banks resulting in trampling issues. The open grassy areas adjacent to the playground provide good candidates for native tree planting for urban forest management objectives, and to create more shade for park users. The area with large oak trees could be restored with Garry Oak ecosystem species, as part of Saanich's Garry Oak Restoration Project.

Colquitz Reach 8 (Panama Flats from the playground in Hyacinth Park to Roy Road)

This section of the creek is currently a dug-out ditch. To restore this reach, meander, sinuosity, floodplain and other C channel characteristics must be recreated. If Panama Flats could eventually be acquired by the municipality, it represents an ideal opportunity for wetland restoration, which would ensure it continues to provide stormwater management in a much more functional way than annually cultivated fields. Where channel restoration is limited by the public trail and private property, there may still be an opportunity to create floodplain terraces with minimal sinuosity, which would allow more riparian plantings and reduce erosion. Farther upstream (between the stormwater pond and Roy Rd.), there is ample room for channel restoration with increased sinuosity and possibly adjacent ponds and/or wetlands. Additionally, invasive species removal followed by a native riparian and upland vegetation planting will further enhance the health and function of the creek in this area. Connecting the stormwater pond to the creek will further aid in reducing the energy of peak flows resulting in less erosion (it currently appears to be connected only by subsurface seepage).

Colquitz Reach 9 (From Roy Road to upstream of Gabo Creek confluence in Rosee Grove)

In the lower portion of the creek, land is available on the left bank that could be utilized for the creation of floodplain and wetlands while at the same time increasing the sinuosity of the channel. Invasive species removal with subsequent revegetation using shade tolerant plants will improve bank stability and reduce competition between native and non-native species. Bioengineering and the addition of large woody debris will increase habitat complexity and aid reducing the impact of peak flow energy.

Colquitz Reach 10a (From upstream of Gabo Creek confluence in Rosee Grove to the staked trail off Lindsay Road)

The overgrowth of Himalayan blackberry in Copley Park should be removed and replaced with native riparian vegetation. The trail throughout this reach should be moved back from the creek where possible with the vacated area being replanted with native species, preferably thorny shrubs such as rose and black hawthorn, to prevent the excessive trampling seen currently. The area just upstream of the playground in Rosee Grove, where banks and upland areas are bare, needs to be planted and fenced until suitable vegetation has become dense enough to stabilize the banks. The addition of large wood will improve habitat complexity and aid in absorbing the energy of peak flows.

Colquitz Reach 10b (The wetland at Vanalman Avenue and Northridge Crescent)

Invasive species removal and control followed by replanting with the appropriate native vegetation will further increase the function of this lentic reach.

Colquitz Reach 11 (From the small trail off Lindsay Road to the bridge at 4444 Wilkinson Road)

This reach is at a high level of Proper Functioning Condition and should be protected. Invasive species are not overly abundant and should be controlled before they proliferate.

Colquitz Reach 12 (From the bridge at 4444 Wilkinson Road to the pedestrian bridge at entrance to Quick's Bottom)

Invasive species removal and the continued planting of native riparian vegetation should ensue. Additionally, the wood piling wall is deteriorating and at risk of collapsing, which could cause flooding. It should be removed and the fill pulled back. The re-sloped bank should then be stabilized, preferably with bioengineering, or a combination of bioengineering and hard structures.

Colquitz Reach 13 (Quick's Bottom)

In order to maintain the integrity of the wetland a reduction in the reed canary grass monoculture is needed. Planting of willows and other shade forming shrubs and trees would aid in this endeavour by shading out the reed canary grass. Successional planting of native riparian vegetation over a number of years would create age class diversity as well as increase habitat complexity

Colquitz Reach 14 (From the pedestrian bridge at the entrance to Quick's Bottom to the footbridge at 4654 West Saanich Road)

In order to remove the reed canary grass impeding the channel, the grass must be scraped off or aggressively mulched (cut back, layered with biodegradable cloth or cardboard and organic material). Immediately following this treatment, the area should be replanted with fast growing native riparian vegetation such as willow species. Planting around the existing restored areas with taller trees could also aid in reed canary grass control by shading.

Colquitz Reach 15 (From the footbridge at 4654 West Saanich Road to the West Saanich Road crossing)

This reach would benefit from planting additional coniferous trees, along with removing and controlling invasive species. Additionally, habitat complexity should be increased by placing large woody debris and/or rock into the channel.

Colquitz Reach 16 (From West Saanich Road crossing to 4521 Cheeseman Road)

Invasive species removal and control will allow for more vigorous native riparian species. The large woody debris in the channel should be left in place as it increases channel complexity, which is beneficial for fish and stream function. Homeowner education would help in reducing the garbage observed.

Colquitz Reach 17 (From 4521 Cheeseman Road to the waterfall upstream of the pond at 4525 Cheeseman Road)

Bioengineering techniques would stabilize the right bank, which is currently eroding. The addition of wood to line these banks will also improve stability and reduce scouring.

Colquitz Reach 18 (From the waterfall at 4525 Cheeseman Road to the first cascade at 4650 Pipeline Road)

This area is currently over-grown with English ivy. The ivy in this reach must be removed in stages in order to prevent soil erosion from vacated areas and to ensure the survival of those native species at the site. Landowner outreach will be necessary to improve the condition with ivy removal, as well as increasing awareness as to what impacts human activity can have upon creek systems.

The riparian area is very narrow in this section and if a park trail were to be installed it may damage the area extensively.

Colquitz Reach 19 (From the cascade at 4650 Pipeline Road to the waterfall contiguous to the wire fence at 4656 Pipeline Road)

This section is entirely private property with lawns and invasive species to the creek's edge. A program of invasive species removal with replanting and neighborhood education would be highly beneficial along this stretch of creek.

Colquitz Reach 20 (From the waterfall contiguous to the wire fence at 4656 Pipeline Road to the riffle upstream of 4674 Pipeline Road)

The banks of reach 20 must be revegetated with native riparian vegetation to replace the mowed grass that is present there now. Homeowner education regarding the importance of the function of riparian vegetation and the benefits of a healthy creek would improve the creek adjacent to residential properties.

Colquitz Reach 21 (From the riffle upstream of 4674 Pipeline Road to the 2nd footbridge in Beaver/Elk Lake Park)

Large wood should be left within the creek channel to provide habitat complexity and create sinuosity. Invasive species removal and control will allow for healthier, more vigorous, native vegetation to stabilize the banks. Trampling is an issue that may be solved by fencing along the side of the path adjacent to the creek. Furthermore, horses are widening the trail by walking on the furthest edges of the path. This may be a result of the trail surface (gravel) being inappropriate for horse riding; other options such as wood chips (although not cedar) should be investigated, and resurfacing may help prevent further trampling.

Colquitz Reach 22 (From the 2nd footbridge in Elk/Beaver Lake Park to the outlet at Beaver lake)

The trail edges should be planted to reduce trampling. Conifers are present in small numbers and should be augmented so as to be available to act as large woody debris in the future. The addition of large woody debris, rock, and gravel will increase habitat complexity making this reach more habitable to fish and other aquatic organisms.. Small weirs that direct flows toward the middle of the channel would help in narrowing the channel to create a form more in line with its potential.

Swan Creek Reach 1 (From Violet Avenue to the pipe crossing at 763 Daisy Avenue)

Invasive species removal and control with subsequent planting of appropriate native vegetation would be beneficial. Placing large wood into the system to form more weirs will also create step pools to slow the movement of water and generate a more complex habitat for organisms living in the stream environment. Additionally, if any large wood falls into this reach it should be allowed to remain as it will not pose any flooding threats in this area. Removing the utility pipe and the spill boom is also recommended if they are no longer needed.

Swan Creek Reach 2 (From the pipe crossing at 763 Daisy Avenue to the upstream end of the mountain biking area)

Bank stability can be improved by invasive species removal and control followed by the planting of appropriate native vegetation. Bioengineering with willow wattles and the creation of terraces and floodplain will also improve the ability of the creek to absorb high flows with less erosion. To discourage mountain biking, which is currently contributing to trampling, signage indicating an environmentally sensitive zone and possibly a fence could prevent the use of the land immediately adjacent to Swan Creek.

Swan Creek Reach 3 (From upstream end of the mountain biking area to the McKenzie Road overpass)

Removal of the extensive reed canary grass can be conducted by scraping or mulching followed by a phase 1 planting with willows to shade out the area. Once the willows are established and the grass is reduced significantly, a phase 2 planting with more diverse species will restore a more natural vegetation community. Bioengineering techniques and the addition of wood to the system will increase complexity and create meander.

Swan Creek Reach 4 (From McKenzie overpass to where the creek becomes lined with a rock wall downstream of Carey Road)

Meanders could be constructed and the channel could be widened to increase the complexity of the system. The addition of large wood, along with log and rock weirs, would redirect the water flow toward the middle of the channel, reducing localized erosion along the banks. Invasive species removal, followed by native riparian plantings, would improve reach function. Signage and garbage removal in the trampled areas would educate trail users of the importance of riparian areas and creek systems.

Swan Creek Reach 5 (From downstream of Carey Road where rock wall starts to Glanford Road)

Invasive species removal with the subsequent planting of dense native riparian vegetation is the only feasible improvement to this reach due to the constricting roadways.

Swan Creek Reach 6 (From Glanford Road to McKenzie Avenue crossing near Willowbrook subdivision)

The stormwater pond outlet near Willowbrook subdivision is in need of repair as the weir is failing causing the pond to drain. This can be fixed by adding rocks on the upstream side of the weir. The addition of wood in the lower section of this reach as well as more planting along the grassy area upstream of Glanford Avenue will increase complexity and stability. Throughout the reach, invasive species removal and control would be beneficial.

Swan Creek Reach 7 (From McKenzie Avenue to the pedestrian bridge at Kent Road)

Meander bends could be constructed using the grassy property between Ralph and Kent streets. Additional floodplain, rock/wood for channel complexity, and diverse riparian plantings should also be implemented. This will reconfigure the creek from a ditch-like channel to more of a C channel. In the short term, invasive species removal and native riparian plantings would also improve the function of this reach.

Swan Creek Reach 8 (From the pedestrian bridge at Kent Road to the Patricia Bay Highway)

There are three scenarios for restoration along this reach. First, land use and management continue as is. Major restoration options are limited, as there is little area to work with to improve stream function. Some willow plantings in the upstream section could shade out the reed canary grass. Secondly, land use continues as a community garden, but some plots are re-located (within this general area or elsewhere) and some remaining plots re-configured. For this scenario, a setback from the stream of about 15 m is recommended (approximate width for Riparian Areas Regulation). Additionally, the stream channel could be meandered, widened, terraced, and planted with native riparian species. Thirdly, land use could change from a community garden to a public park, with relocation of garden plots to another area that is not prone to flooding. Restoration design would be more flexible, and a large wetland, consisting of diverse habitats such as islands, channels, open water and shrub swamp, could be created. Public trails, boardwalks, interpretive signs and education programs could be included. Some elements of food production could be incorporated in appropriate areas, possibly including native plants and traditional indigenous foods and materials.

Swan Creek Reach 9 (Swan Lake)

Numerous opportunities for restoration exist for this eutrophic lake, however there are no simple fixes. Watershed improvements related to stormwater best management practices could greatly improve the quality of the water entering the lake, and is recommended as a critical step. Dredging would remove some of the excess sediment; however, there is a chance that this material may be toxic. Although sediment dredging has been proposed in the past as an option to remove the thick layer of organic material from the lake, in many other cases it has been shown to be ineffective in the long term for controlling eutrophication (Sheffer, 2004). This option would need to be carefully considered, including testing the composition of the sediments for contamination concerns. Biomanipulation (adding or removing certain species of aquatic organisms) could be investigated, and in some cases has been shown to be effective in shifting lakes from a eutrophic to a clear water condition. Additionally, invasive species removal and control will allow for the improved health and abundance of native vegetation. Due to the extensive areas dominated by invasive species (particularly reed canary grass), a long-term and/or large scale effort will be required. Swan Lake is prone to contamination from chemical spills in the upstream watershed due to extensive storm drains and impervious surfaces. A better response and spill prevention program could help protect the lake. See also Townsend (in progress) for further discussion about restoration opportunities at Swan Lake.

Blenkinsop Creek Reach 1 (From the willow line at the inlet of Swan Lake - the upstream end of the Lochside Trail Trestle)

The removal of invasive species and a subsequent two phase native vegetation planting scheme will restore the banks of the creek and maintain bank stability. In the area upstream of the Swan Lake Trestle, in the area of the open field, the construction of a wetland would be beneficial. A wetland in this location would allow for mitigation of peak flows by providing another area in which the water could flow and lose energy, thereby protecting the banks of the channel. Additionally, it could act to filter the water improving the quality of the water flowing into Swan Lake.

Blenkinsop Creek Reach 2 (From the upstream end of Lochside Trail Trestle to the box culvert downstream of Quadra St.)

Installing rock weirs and large wood would create more sinuosity, increase habitat complexity, and aid in mitigating the energy of peak flows. Bioengineering techniques can be used to stabilize eroding banks, especially in the lower portion of the reach where rip-rap has already been installed. Signage should be placed in easy view of the trail to designate environmentally sensitive areas and educate trail users. Just downstream of the box culvert, a viewing platform could be constructed in the heavily trampled area to provide a lookout point and to prevent trampling of the banks. Educational information stands could be set-up on this viewing platform. Invasive species control should also remain a priority.

Blenkinsop Creek Reach 3 (The section between the box culvert and Quadra Street that may be daylighted upon land development)

In the event that this location does become redeveloped, there is the opportunity of daylighting this section of the creek. The creek section that is daylighted now is approximately 9 meters wide. Using this distance as an outline, the new creek channel could fit within the boundaries of the right of way. However, for this to be an ecologically functioning creek, an additional 4-5m would be necessary. *A new* channel could be constructed with lock-block structures for the walls. These structures could then be planted with native vegetation. A terrace could be constructed at bankfull to create a floodplain within the channel boundaries. Additionally, rock steps or weirs could be placed within the channel to form step pools and allow for aeration. The slope of the banks will be steep but stabilization structures at the toe of the slope can be installed as well as a fence for public safety.

Blenkinsop Creek Reach 4 (From where the creek daylights downstream of Quadra Street to Cumberland Dam)

Invasive species removal with replanting with native riparian and upland species would benefit this reach immensely especially in the area behind the Saanich Centre. The implementation of stop logs, rock weirs, and floodplain terracing would restore some characteristics a more natural channel would portray. Bioengineering techniques would further improve this reach by providing protection against peak flows and stabilizing the steep banks. Signage about garbage littering in the creek, as well as other creek processes could improve awareness and educate trail users.

Blenkinsop Creek Reach 5 (From Cumberland Dam to Blenkinsop Lake)

Some restoration has already been carried out along this reach with a realigned channel. To ensure continued succession and prevent invasive species encroachment, a second phase of planting is recommended, especially at the northern end to increase the variety of species. The landowner has controlled invasive species on the left bank, however the right bank (along

Lochside trail) is extensively populated with invasive species. Removal and control should be carried out to prevent spread to the privately-owned lands.

Blenkinsop Creek Reach 6 (Blenkinsop Lake)

Invasive species removal and control, with subsequent native riparian and upland species planting, especially trees, will positively enhance the vegetation community of the lakeshore. Blenkinsop Lake is highly eutrophic due to fertilizer runoff from agricultural fields. The source of nutrient loading should be controlled before any site-specific remediation is attempted. This could be carried out with landowner education, incentives and partnerships, in order to decrease fertilizer use and plant more riparian species as buffers. Large numbers of bullfrogs are present within the lake, as they are in Swan Lake and most other fresh water bodies in the region. The municipality should keep informed of advances in knowledge regarding bullfrog control, and if possible work with other agencies to limit their numbers.

Viaduct Creek Reach 1 (From Quick's Bottom to Markham Road)

There is room along this reach to increase meander and sinuosity via excavation to create a more natural channel form. The addition of large woody material would also improve the reach by increasing habitat complexity.

Viaduct Creek Reach 2a (From Markham Road to the upstream property boundary of 4484 Markham Road)

There are many areas along this reach that are dominated by Himalayan blackberry. It should be removed to allow succession of native riparian vegetation. Once removed, the areas should be replanted with appropriate vegetation. Adding woody material will improve bank stability by deflecting some of the energy of peak flows. The headcut in the tributary upstream must be mitigated to prevent further downstream sedimentation and lowering of the water table upstream. A combination of rock and bioengineering would likely be required.

Viaduct Creek Reach 2b (From the upstream boundary of 4484 Markham Road to the weirs at the outlet of Viaduct Flats)

In the lower section of the reach, small weirs can be installed to trap sediment and build up the channel so that it can access its floodplains.
Additional native riparian and upland species should be planted. This planting will aid in shading out reed canary grass and keeping the channel open. The headcut resulting from flows from Layritz Park must be mitigated to prevent downstream sedimentation. More detailed suggestions for mitigation of the headcut are included in the reach summary for Reach 2b.

Viaduct Creek Reach 3 (Viaduct Flats)

This system is a functional wetland, however, it could be enhanced with the addition of large wood in to the open water area, to create cover for fish and perches for birds. Invasive species management should continue especially for Himalayan blackberry, Scotch broom, and reed canary grass.

Viaduct Creek Reach 4 (From the inlet at Viaduct Flats to Interurban Road)

Planting with native riparian and upland species should continue to shade out the invasive species present.

Viaduct Creek Reach 5 (From Interurban Road to the footbridge at 478 Viaduct Avenue West)

Bioengineering techniques, bed-stabilization bars, and large woody debris can be used to raise the creek bed and stabilize the eroding banks in the lower section of the reach. Once the bed has become more stable, native conifers and shrubs can be planted to further stabilize the banks with their root systems.

Viaduct Creek Reach 6 (From the footbridge at 478 Viaduct Avenue West to the fence at 458 Viaduct Avenue West)

The extensive ground cover of English ivy must be controlled in order to ensure the survival of the few native riparian species found in this reach. Replanting with more native species will improve the stability of the banks. In addition, log weirs can be implemented in series to build the bed up by allowing sediment deposition. Terraces and floodplains should be created to mitigate the energy of peak flows.

Viaduct Creek Reach 7 (From the fence at 458 Viaduct Avenue West to where creek enters wetland area upstream of 458 Viaduct Avenue West)

The reed canary grass should be cut back and mulched followed by a phase one planting of willows utilizing bioengineering techniques. Once the grass has been shaded out a second phase of planting can be initiated using sedges and cattails.

Viaduct Creek Reach 8 (From where creek enters wetland area upstream 458 Viaduct Avenue West to the confluence of Viaduct Creek and Excelsior Creek at 414 Viaduct Avenue West)

Not much restoration is possible in this location if land uses (agriculture and pasture) are maintained. In the short term, fencing to restrict access of the horses and cows in the riparian zone is critical to prevent soil disturbance from trampling, and nutrient loading from manure. A seasonal grazing program may also be useful to allow the vegetation to establish itself. Planting more trees and shrubs in the lower section of the reach will create microsites important to wetland function. Additionally, in the event that the private property is redeveloped, there could be an opportunity to restore the wetland function by installing a weir that will retain water.

Viaduct Creek Reach 9 (From the confluence of Viaduct Creek and Excelsior Creek at 414 Viaduct Avenue West to Viaduct Avenue West crossing)

Log or rock weirs could be added to build up the channel bottom through sediment deposition, so that it may access floodplain. Meanders and terracing could also be created to restore some more natural characteristics to this channel. Wood should be added to prevent the bank erosion. Furthermore, an intensive planting regime should be implemented along the bare banks.

Viaduct Creek Reach 10 (From Viaduct Avenue West crossing to the headcut upstream of 389 Viaduct Avenue West)

Large wood can be added in the lower portion of this reach to create a few weirs that will aid in stabilizing the channel. Furthermore, these weirs will absorb some of the energy of peak flows thereby reducing degradation in Reach 9.

Viaduct Creek Reach 11 (From the headcut upstream of 389 Viaduct Avenue West to the bedrock outcrop downstream of 365 Viaduct Avenue West)

The headcut at the downstream end of this reach should be managed so that it does not erode upstream. Rock can be placed at the downstream end of the headcut, along with bioengineering, to prevent further erosion. Invasive species should also be removed.

Viaduct Creek Reach 12 (From the bedrock outcrop downstream of 365 Viaduct Avenue West to the driveway of 353 Viaduct Avenue West)

Replanting along the bare banks of the creek through 365 Viaduct Avenue W is necessary to improve the function of this section of creek. Strategically placing wood/rock to redirect flow toward the centre of the channel could help in reestablishing the correct width/depth ration expected for a C channel. Terracing along the edges of the channel will allow access to floodplain. The Himalayan blackberries overgrowing the lower section of Reach 12 should be removed and the area replanted with fast growing riparian species such as alder and willow to prevent other invasive species from encroaching. Homeowner education will benefit this reach as well, to discourage manicured lawns and ornamental plantings along the stream.

Viaduct Creek Reach 13 (From the driveway of 353 Viaduct Avenue West to the property boundary between 335 Viaduct Avenue West and Logan Park)

This area has been degraded by illegal filling and road construction. Over the short term, immediate mitigation for erosion and sediment control is required to prevent excess sediment exposed by the excavation from traveling downstream.

In the longer term, intensive planting of native riparian and upland species should occur. Soil can be removed off the newly created berms and be placed in the driveway to fill in the excavated area. Additionally, compost or mulch should be added along with riparian plantings.

Viaduct Creek Reach 14 (From the edge of the wetland to upstream of the pond near 235 Hector Road)

Large wood can be used to break up the channels and redistribute water over a larger area to recreate wetland character. The pond should be allowed to fill in.

Viaduct Creek Reach 15 (From the upstream boundary of 335 Viaduct Avenue West to the culvert under the trail in Logan Park)

Monitoring for invasives would be beneficial for this reach in order to impede the distribution of non-native species.

Viaduct Creek Reach 16 (From the culvert under the trail in Logan Park to the upstream boundary of Logan Park)

As of now, no restoration is necessary. The reach is protected within Logan Park.

Durrell Creek Reach 1 (From the confluence with Colquitz River at Loenholm Road to Wilkinson Road)

Terracing, narrowing, and regrading the channel will create more accessible floodplain that will aid the erosion problem as well as promoting a more suitable width/depth ratio. Removal of invasive species followed by the planting of native riparian vegetation will stabilize the banks and improve ecological functioning. The addition of rock and large wood will increase channel complexity.

Durrell Creek Reach 2 (From Wilkinson Road to Charlton Road)

The steep banks should be terraced and planted with native riparian vegetation. The species selected must be in compliance with the security requirements of Wilkinson Road Correctional Centre. Invasive species that are present currently can be shaded out by fast growing native plant species.

Durrell Creek Reach 3 (From Charlton Road to Interurban Road)

The bare banks should be planted with native riparian vegetation to create a small riparian zone. Upon purchase or redevelopment of this land, the channel could be regraded to reduce bank steepness, and planted to increase bank stability. A covenant could then be established for the maintenance of the stream channel. Alternatively, the channel could be moved alongside Charlton Road (and restored), to connect the two pieces of land currently bisected by the stream channel.

Durrell Creek Reach 4 (From Interurban Road to Granville Avenue)

A series of wetland ponds could be constructed within the right of way and connected by Rosgen “E” or “C” channels. Ultimately, the agricultural land could be bought and the area restored into a large wetland and nature sanctuary similar to what is present at Viaduct Flats.

References

Askew. 2007. Personal communications regarding property owned along Viaduct Creek to Aqua-Tex staff. Victoria, B.C.

Barraclough, C.L. and D.A. Hegg. 2008. Nature's Revenue Streams: Five Ecological Value Case Studies. Published by the Canada Mortgage and Housing Corporation. 89 pp.

Butterfield, P. 1997. Colquitz River: Water quality analysis. The Corporation of the District of Saanich. 24pp.

Center for Watershed Protection. 1997. The economics of watershed protection. Watershed Protection Techniques 2(4): 469-481.

Dawson, J. 1986. A water quality investigation of Swan Lake. 29pp.

Fuchs, Marilyn A. 2001. Towards a Recovery Strategy for Garry Oak and Associated Ecosystems in Canada: Ecological Assessment and Literature Review. Technical Report GBEI/EC-00-030. Environment Canada, Canadian Wildlife Service, Pacific and Yukon Region.

Grant, D.R., C.L., Barraclough, Wm. P. Lucey, and A.P. Austin. 1994. Quick's Bottom, Colquitz River, and Blenkinsop Creek: Water Quality and Habitat Assessment Summer 1993 (Final Report). Department of Biology, University of Victoria, Victoria, B.C. 129 pp.

Green, R.N. and K. Klinka. 1994. A Field Guide to Site Interpretation for the Vancouver Forest Region. B.C. Ministry of Forests Research Program.

Gregory, N. 2007. Personal communications regarding property owned along the Colquitz River to Aqua-Tex staff. Victoria, B.C.

Hall, F.C., 2001. Ground-based photographic monitoring. Gen. Tech. Rep. PNW-GTR-503. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 340 p. http://www.fs.fed.us/pnw/pubs/gtr503/

Hardy, G.A. 1956. Notes on the flora and fauna of the Blenkinsop Lake area on southern Vancouver Island, British Columbia. Report of the Provincial Museum. pp. 25-67.

Hardy, G.A. 1956. Notes on the flora and fauna of the Blenkinsop lake area on Southern Vancouver Island, British Columbia. 67pp.

HAT. 2005. Good Neighbours: Colquitz River Habitat Enhancement Project. 11pp.

Kersey, B. 1976. Lamont's home-made wine started Island wine industry. The Daily Colonist. Sunday, June 6, 1976. 1pp.

Krocker, G. 1993. An examination of the water quality of Colquitz River and the water flow characteristics of Quick's Bottom. Report for Biology 408, UVIC. Victoria, B.C. 19pp.

Langford, R.W. 1975. The aquatic environment: A review for the Municipality of Saanich. Prepared for the Corporation of the District of Saanich. 113pp.

Langford, R.W., and T. Burns. 1977. Lake and stream inventory of the Capital Regional District. BC Ministry of Environment, Lands, and Parks. Victoria, BC. 67pp.

Lewis, L., L. Clark, R. Krapf, M. Manning, J. Staats, T. Subirge, L. Townsend and B. Ypsilantis. 2003. Riparian area management: riparian-wetland soils. TR 1737-19. US Department of the Interior. Bureau of Land Management, BLM/ST/ST-03/001+1737, National Science and Technology Center, Denver, CO. 124 pp.

Lloyd, R. (previous Saanich municipal engineer). 2007. Personal communications regarding Patricia Bay Highway culvert at Swan Creek to Aqua-Tex staff. Victoria, B.C.

Lucey, Wm. P. 1982. A Limnological Investigation of the Colquitz Drainage Basin. University of Victoria. 58pp.

MacGillvray, W. (Swan Lake Nature Sanctuary site maintenance supervisor). 2007. Personal communication regarding stream restoration at southeast side of Swan Lake to L. Townsend. Victoria, B.C.

Malmkvist, L. 2002. Smart municipal development: A process for planning and implementing urban stream restoration and stormwater management in residential and agricultural areas. Case studies of residential and agricultural development in Saanich, B.C. Master of Science Thesis, University of Victoria. 264pp.

Malmkvist, L. and L. Townsend. 2008 draft. Watercourse Management Classification Protocol (Draft). Prepared for the District of Saanich, Environmental Services Department. Swell Environmental Consulting.

Maser, C., R.F. Tarrant, J.M. Trappe, and J.F. Franklin (Technical Editors). 1988. From the forest to the sea: a story of fallen trees. USDA Forest Service General Technical Report PNW 229. 200 pp.

Morrison, Jo-Anne. 1983. Transcriptions from an interview with Bob Mercer, #309 1745 Leighton Avenue, Feb. 3. Filed in Saanich Archives. Retrieved March 2007.

Neate, F.E. 1967. Colquitz River: An Appraisal and Plan. Corporation of the District of Saanich.

Neate, F.E. 1967. Colquitz River: An Appraisal and Plan. Corporation of the District of Saanich. 41pp.

Nuszdorfer, N.C., K. Klinka, and D.A. Demarchi. 1991. Chapter 5: Coastal Douglas fir zone. In: Ecosystems of British Columbia special report series. Ed: D. Meidinger and J. Pojar. B.C. Ministry of Forests Research Branch. pp 81-93.

Pojar, J. and A. MacKinnon. 1994. Plants of Coastal British Columbia, including Washington, Oregon and Alaska. BC Ministry of Forests and Lone Pine Publishing. Vancouver BC. 527 pp.

Pollard, A. 2007. Personal communications regarding Durrell Creek watershed to Aqua-Tex staff. Victoria, B.C.

Pottinger Gaherty Environmental Consultants Ltd. and Northwest Hydraulic Consultants Ltd. 2000. Durrell Creek integrated watershed management plan. Prepared for the Corporation of the District of Saanich. 129pp.

Prichard, D., F. Berg, W. Hagenbuck, R. Krapf, R. Leinard, S. Leonard, M. Manning, C. Noble, and J. Staats. 1999. Riparian area management: a users guide to assessing Proper Functioning Condition and the supporting science for lentic areas. TR 1737-16. Bureau of Land Management, BLM/RS/ST-99/001+1737, National Applied Resource Sciences Center, Denver, CO. 109 pp.

Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: a users guide to assessing Proper Functioning Condition and the supporting science for lotic areas. TR 1737-15. Bureau of Land Management, BLM/RS/ST-98/001+1737, National Applied Resource Sciences Center, Denver, CO. 126 pp.

Rigg, G.B. 1922. A bog forest. Ecology 3(3): 207-213.

Riparian Coordination Network. 2002. Creeks and communities: A continuing strategy for accelerating cooperative riparian restoration and management. Bureau of Land Management, Denver, Colorado. BLM/WO/GI-02/014+6740. 16 pp.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO. 352 pp.

Rosgen, D. and L. Silvey. 1998. Field guide for stream classification. Wildland Hydrology, Pagosa Springs, CO. 193 pp.

Scobie. 2007. Personal communications regarding property owned along Colquitz River to Aqua-Tex staff. Victoria, B.C.

Sheffer, M. 2004. Ecology of Shallow Lakes. Kluwer Academic Publishers. Dordrecht.

Swan Lake Nature Centre Archives. 1994. Compiled historical notes.

Townsend, L. In progress, Master’s thesis related to the ecology of Swan Lake. University of Victoria, School of Environmental Studies. Victoria, B.C.

Townsend, L. 2006. Integrated Watershed Management, a Review of Selected Practices. Completed for the Capital Regional District, Victoria B.C. Greenway Consulting.

Turner, R.D. 1997. Vancouver Island Railroads. Sono Nis Press, Victoria B.C.

Victoria Fish and Game Protective Association. 2002. Colquitz Creek Salmonid Enumeration Program, 2001-2002.

Victoria Official Map. 1858. Stored in BC Land Titles Office.

Walsh, D., B. Blecic, and W. VanBruggen. 1994. Saanich-Victoria water allocation plan. B.C. Ministry of Environment, Lands, and Parks Vancouver Island Region. pp. 1-12, 16-18, 23-37, 40-42.

Yorath, C.J. and H.W. Nasmith. 1995. The geology of Southern Vancouver Island: A field guide. Orca Book Publishers, Victoria, BC.172 pp.

Zaccarelli, W. 1975. An Inventory of the biota of Swan Lake with some basic limnological aspects and recommendations. Prepared for the Swan Lake – Christmas Hill Nature Centre Society.