A Long Term Restoration and Public Awareness Strategic Plan for the Beach Creek Watershed

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We sincerely thank the volunteers of the Qualicum Beach Streamkeepers Society for their tireless dedication to the numerous streams of Qualicum Beach. These streams and their fish are in good hands because of the Streamkeepers' steadfast commitment to restoration, protection and public awareness.

As always, we thank Gloria Carswell for her enduring commitment to the fish and fish habitat of Vancouver Island and George Reid for his comments on the draft of this report.

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1.0 Introduction

The Qualicum Beach Streamkeepers were formed in June 1995, after a number of local citizens took a Streamkeepers course to learn more about stream function and fish habitat. In 1996, the group received a grant from the Urban Salmon Habitat Program (USHP), an initiative of the Province of BC which provides funding and technical support to stewardship groups so that they can undertake stream stewardship activities. The Streamkeepers wanted to use their grant for the restoration and public awareness of Beach and Grandon creeks. Before any restoration work could be implemented, however, habitat assessments had to be completed so that the factors limiting fish production could be identified.

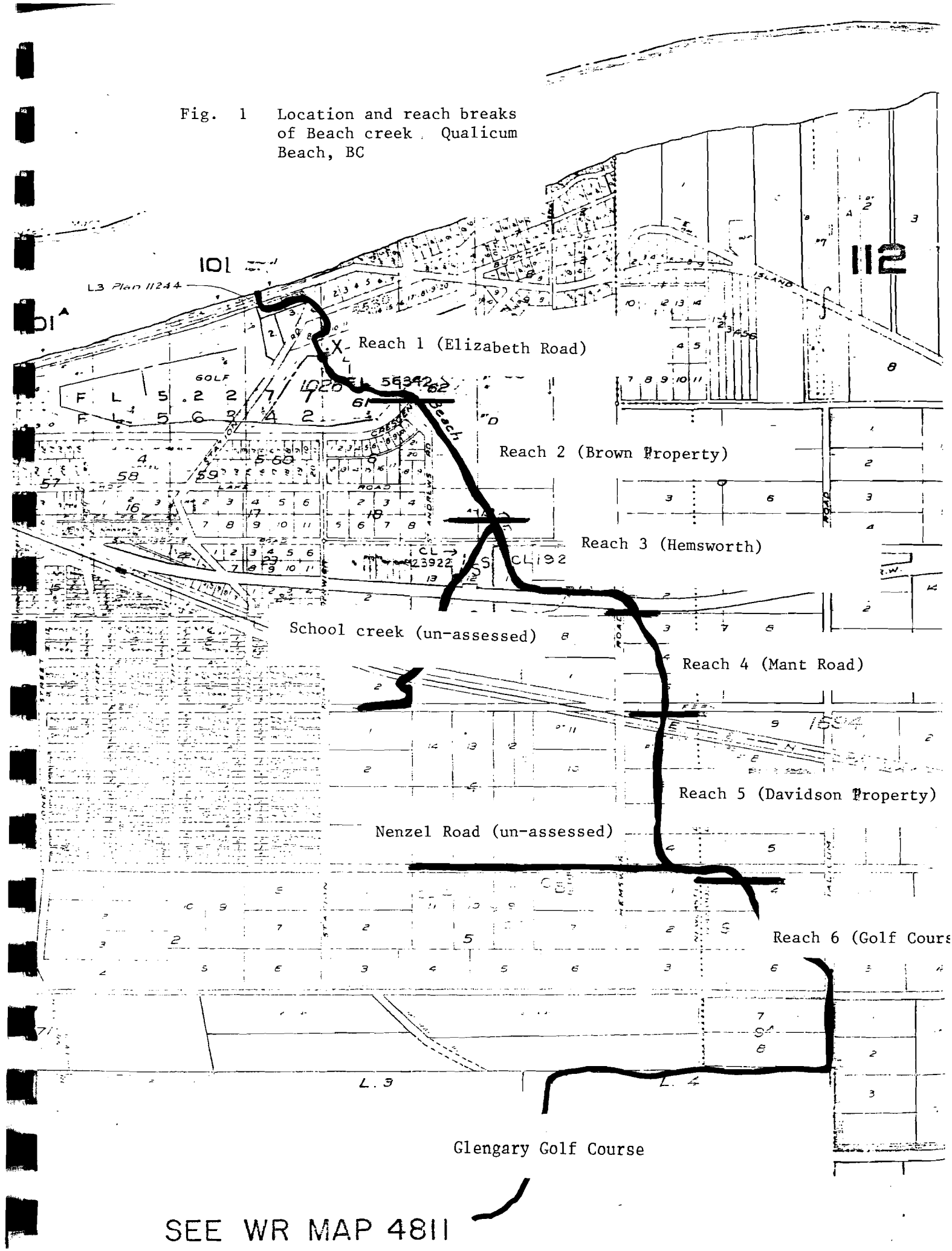
Beach creek was assessed by the Streamkeepers and students from the Kwalikum Secondary School between September 23 and October 18, 1996 (Fig. 1). The data gathered from the habitat assessment was analyzed and compiled into a final report entitled: Beach and Grandon Creeks Restoration Project (Qualicum Beach Streamkeepers, 1997). At a meeting with the Qualicum Beach Streamkeepers in 1998, we suggested that the Streamkeepers use their habitat assessment data to develop a strategic plan to guide long-term restoration and public awareness efforts of Beach creek. Staff from the USHP subsequently offered to review the habitat assessment data and help develop that plan. The objective of this document is to summarize the data from the 1996 habitat assessment and to outline a suggested strategic plan for the long-term protection and restoration of the Beach creek watershed.

2.0 Methods

We reviewed the data summaries and raw data from the Streamkeepers' final report to determine if a enough data existed to develop a strategic plan. We found that the final reach summaries for the habitat data were not prioritized according to reach or limiting factor in the Streamkeeper's report. We also found that the data had not been entered into the USHP Excel spreadsheet and that stream reach breaks had not been set based on the criteria outlined in the USHP Assessment and Mapping Procedures (Michalski, et. al., 1996). Therefore, we identified stream reach breaks; and entered the raw data into the USHP spreadsheet.

We used the data summaries produced from the USHP spreadsheet to identify the habitat factors limiting fish production in Beach creek. We then used this information to identify the priority stream reaches and habitat parameters which require restoration. We address each of these priorities in the strategic plan.

Fig. 1 Location and reach breaks of Beach creek, Qualicum Beach, BC



3.0 Results

3.1 Limiting Factors and Restoration Priorities

We assigned numerical ratings to each of the habitat parameters which could be limiting fish production in Beach creek by comparing the observed value for the habitat parameter with published biostandards for healthy streams (Johnson and Slaney, 1996) (Appendix 1). The higher the rating, the more critical the potential limiting factor. We determined the priority areas for restoration by identifying the highest ratings.

We present a comparison of the ratings for each of the instream habitat parameters measured in Beach creek in Table 2. We observed the highest ratings in reach 4 (Mant Road); reach 5 (Davidson Property) and reach 3 (Hemsworth). We found that altered stream sites were a specific concern in both reach 4 and reach 5. We also found a number of other habitat parameters which received high ratings including: the amount of fines; and, the amount of instream cover in the form of large woody debris and boulders. Both of these parameters were a concern in all of the reaches examined. Finally, we found that percent wetted area was a concern in all but one reach of Beach creek.

Table 2. Ratings of habitat parameters for data collected on Beach creek according to data presented in Streamkeepers final report and using USHP Excel spreadsheet.

HABITAT PARAMETER	Elizabeth Rd (R1)	Brown Property (R2)	Hemsworth (R3)	Mant Rd (R4)	Davidson Property (R5)	Golf Course (R6)	Total Ratings
Instream Habitat Parameters							
Percent Pool Area	1	3	3	5	1	1	**14**
Large Woody Debris (LWD/BF width)	5	5	5	5	5	5	**30**
Percent Cover in Pools	5	3	3	3	3	3	**20**
Average % Boulder Cover	5	5	5	5	5	5	**30**
% Crown Cover	1	1	1	1	3	1	**8**
Substrate (% Fines)	5	5	5	5	5	5	**30**
Erosion sites	1	1	2	0	4	0	**8**
Obstructions	0	0	0	0	0	0	**0**
Altered Stream Sites	1	1	1	34	9	1	**47**
Percent Wetted Area	5	5	5	5	3	5	**28**
Reach Totals	**29**	**29**	**30**	**63**	**38**	**26**	**215**
Riparian Parameters							
Land Use	332	141	2	34	5	70	**584**
Livestock Access	0	0	0	0	0	0	**0**
Slope	2	2	5		0	24	**33**
Stability	308	274	10	100	0	146	**838**
Totals	**642**	**417**	**17**	**134**	**5**	**240**	**1455**
Total for all Instream and Riparian Parameters							
	671	**446**	**47**	**197**	**43**	**266**	**1670**

We generated ratings for the riparian data by comparing the riparian data of Beach creek to standards for healthy streams (Johnson and Slaney, 1996) (Appendix 1). The higher the riparian rating, the higher the concern for that particular riparian parameter and, therefore, the more critical the need for addressing that parameter.

We found that the reaches of highest concern were Elizabeth Road (reach 1) and the Brown Property (Table 2). The Golf Course (reach 6) and Mant Road (reach 4) are also priority areas although less so that reaches 1 and 2.. We found that stability and land use were the riparian parameters of most concern, particularly in reach 1 (Elizabeth Road), reach 2 (Brown Property), Reach 6 (Golf Course) and reach 4 (Mant Road).

3.3 Restoration Priorities for Beach Creek Based on the USHP Excel Summary

We combined the ratings for instream and riparian parameters to determine the priority reaches and parameters for restoration in Beach creek (Table 2). The priority order for restoration by reach according to declining number of rating points is:

1. Elizabeth Road (reach 1; 671 points);
2. the Brown Property (reach 2; 446 points);
3. the Golf Course (reach 6; 266 points);
4. Mant Road (reach 4; 197 points);
5. Hemsworth (reach 3; 47 points); and,
6. Davidson Property (reach 5; 43 points).

The priority parameters to be addressed in these reaches are:

1. stability (838);
2. land use (584 points);
3. altered stream site (47 points);
4. slope (33 points);
5. large woody debris (30 points);
6. boulder cover (30 points);
7. percent wetted area (28 points); and,
8. percent cover in pools (20 points).

4.0 A Long-Term Protection, Restoration and Public Awareness Plan for the Beach Creek Watershed

We outline the limiting factors and stream reaches in order of priority for restoration and protection in the following strategic plan (Table 3). We have also identified specific objectives, activities, resources and a time frame for each project where possible.

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Stability	Elizabeth Road (Reach 1) Brown Property (Reach 2) Mant Road (Reach 4) Golf Course (Reach 6)	Restoration	To stabilize riparian areas in the Beach creek watershed	Conduct assessment to identify all areas of low stability along Beach creek; Hire botanist/bioengineer to develop action plan and identify species to be used. Hold public information session or conduct landowner contact to apprise community/neighbours of activities; Plant areas	Technical expertise (botanist/riparian technician) Volunteers Report production/distribution Public meeting/brochures/other public awareness tools for meetings and landowner contact Bioengineering supplies	Spring 1999	Winter 2000

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Land Use	Elizabeth Road (Reach 1) Brown Property (Reach 2) Mant Road (Reach 4) Golf Course (Reach 6)	Protection	To establish leave strips along riparian zones along Beach creek	1. Map riparian zones along undeveloped portions of Beach creek; 2. Work with Town to implement leave strips 3. Monitor development to ensure setbacks are observed	Mapping equipment (GPS; maps); Consultant to collate data; Volunteers	Spring, 1999	Spring 2000
		Protection	To monitor leave strip areas during development in the Beach Creek watershed.	Meet with Town to discuss development monitoring; Select Streamkeeper(s) to be involved; Develop plan to address how to handle any impacts during development (e.g.. call DFO, take pictures etc.); Meet with developer if necessary; Monitor development sites	Volunteers Technical advise for legal samples/monitoring strategy Action plan for emergency/infraction response	Spring 1999	Ongoing
		Protection	To fence leave strips along Beach creek.	1. Meet with developer and Town to determine if fencing is feasible; 2. Investigate best fencing types and prices 3. Write grant applications to secure funding for fencing; 4. Erect fencing	Volunteers Advise on fencing types Fencing supplies	Spring 1999	Ongoing
		Protection	To implement a Watershed Management Plan to develop goals and activities for the long term protection of Beach creek	1. Identify Streamkeeper to investigate Watershed Management Planning process; 2. Develop action plan for implementing program; 3. Set up steering committee with representatives from all levels of government; 4. Introduce concept to community through landowner contact and/or public reviews	Volunteers Facilitator Steering committee; working committee (stakeholders; local and senior governments) Meeting space Meeting supplies Report writing/distribution supplies Brochures/other public awareness tools including print media	Spring 1999	Ongoing
		Protection	To investigate an, if feasible, design a Community Greenways program for Qualicum Beach	1. Identify Streamkeeper to investigate Greenways programs from other jurisdictions (e.g. C. River) 2. Meet with Town and develop action plan using mapped riparian zone 3. Introduce concept to community through landowner contact and/or public reviews	Volunteers Project co-ordinator Funding for resource gathering/research Report production Public meetings/brochures and other public awareness tools	Fall 1999	2004

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Land Use (continued)	Elizabeth Road (Reach 1) Brown Property (Reach 2) Mant Road (Reach 4) Golf Course (Reach 6)	Protection	To include stewardship bylaws, policies and guidelines in the Qualicum Beach OCP	1. Investigate OCP's from other jurisdictions, particularly from District of North Vancouver; 2. Develop bylaw, policies and guideline specifics; 3. Hold public review	Volunteers Project co-ordinator Funding for resource gathering/research Report production Public meetings/brochures and other public awareness tools	Spring 2000	Ongoing
		Public Awareness	To host one or more watershed information events for the residents of the Beach creek watershed.	1. Investigate other similar public awareness projects (e.g.. Nanaimo, C. River0 2. Determine outline of information to be presented to community; 3. Print brochures 4. Conduct landowner contact to advise community of meeting 5. Advertise meeting in local newspaper 6. Hold meeting	Volunteers Funding for resource gathering/research Public meetings/brochures and other public awareness tools	Spring 1999	Ongoing - to coincide with watershed managemen t plan and protection; planning; restoration projects

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Altered Stream Sites	Brown Property (Reach 2) Mant Road (Reach 4)	Restoration	To identify sites and develop a bioengineering plan to address altered stream sites along Beach creek	Riparian planting; Individual landowner contact Monitoring riparian planting survival	1. Volunteers 2. Landowner Permission; 3. Planting strategy; 4. Plants and related supplies	Spring 1999	Winter 2000
	Elizabeth Road (Reach 1) (Golf Course Pond)	Restoration	1. To increase riparian and instream cover in Memorial Golf Course pond 2. To develop alternatives to golf course irrigation. 2. Potential Fish Barrier at dam downstream of Golf Course Pond	1. Investigate bioengineering techniques (false banks) to increase riparian cover around pond. 2. Introduce lwd cover within pond (using ballast to keep structure submerged. 3. Increase lwd cover around pond by securing structures to pond banks 4. Work with Golf Course to determine alternatives to pond dredging	1. Volunteers 2. Overview assessment to identify suitable locations for lwd; 3. Riparian assessment to determine suitable planting strategy; 4. Landowner permission; 5. lwd, plants and related supplies	Spring 1999	Winter 1999
		Public Awareness	To implement a landowner contact program in areas where altered stream sites are most severe in the Beach creek watershed	1. Investigate other public awareness/landowner contact projects (e.g.. Nanaimo, C. River0 2. Determine outline of information to be presented 3. Print brochures 4. Conduct landowner contact 6. Hold neighbourhood meeting where possible to facilitate discussions	1. Pamphlets (computer; design; printing) 2. Volunteers 3. Handouts on riparian planting and related supplies	Winter 1999	Winter 2000
		Protection	To install fencing along riparian zone leave strips following the restoration of altered stream sites along Beach creek	1. Obtain permission from landowners 2. Investigate best fencing types and prices 3. Write grant applications to secure funding for fencing; 4. Erect fencing	Volunteers Advise on fencing types Fencing supplies	Spring 1999	Winter 1999

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Substrate (sediment)	Elizabeth Road (Reach 1) Brown Property (Reach 2) Hemsworth (Reach 3) Mant Road (Reach 4) Davidson Property (Reach 5) Golf Course (Reach 6)	Restoration	To identify and limit sediment sources in the Beach creek watershed	1. Identify sediment sources 2. Develop a bioengineering plan to stop sediment inputs 3. Implement bioengineering plan	1. Volunteers; 2. Consultant to assist with overview assessment to identify areas for restoration and appropriate techniques;	Fall/Winter 1999	Ongoing
		Restoration	To investigate the feasibility of installing instream structures including large woody debris to facilitate flushing of Beach creek	1.Identify areas where instream structures can be installed to increase velocity in areas where sediment inputs have been limited; 2. Engineering/ feasibility study to design instream structures; 3. Obtain permits, permission and supplies; 4. Install structures; 5. Monitor structures to ensure they are working as anticipated.	1. Engineering plan for design of instream structures; 2. Materials and supplies	Spring 1999	Ongoing

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Percent Wetted Area		Restoration	To conduct a hydrology study to identify additional sources of water or water storage potential for the Beach creek watershed	1. Hire a hydrologist to determine how much additional water is required to maintain discharge above 10% of MAD; 2. Identify options for increasing water storage and release (including wells and water storage structures) throughout the length of the creek.	Hydrologist to determine options for improving flow Volunteers to collect data Report production Public/stakeholder meeting to discuss options	Summer 1999	Spring 2000
		Restoration	To conduct a study to investigate flow patterns, culvert blockages and water storage sites in the Beach creek watershed	1. Meet with Town and other stakeholders including golf course to develop project terms of reference; 2. Hire hydrologist and/or engineer to complete study 3. Identify priority projects	Hydrologist/engineer to conduct field investigation and determine options Volunteers to help collect data Report production Public/stakeholder meeting to discuss problems and options	Summer 2000	Spring 2001
		Restoration	To develop a stream flow restoration plan to address extreme flows, flow blockages and water storage for Beach creek.	1. Investigate restoration options for priority project identified above 2. Develop action plan; 3. Secure landowner permission and permits 4. Implement plan	Hydrologist/engineer to determine Action Plan Report production Public/stakeholder meeting to discuss problems and options	Summer 2001	Spring 2002
		Protection	To monitor flows before and after water introduction and storage projects are implemented to ensure that minimum flows for fish are available in Beach creek	1. Determine monitoring schedule 2. Schedule volunteers 3. Collate results 4. Determine additional needs/changes to be implemented	Volunteers Technical advise Report production Meetings with stakeholders to apprise them of situation	Fall 2002	Ongoing

Table 3. Long-term protection, restoration and public awareness plan for the Beach creek watershed.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Instream Cover (large woody debris)	Elizabeth Road (Reach 1) Brown Property (Reach 2) Hemsworth (Reach 3) Mant Road (Reach 4) Davidson Property (Reach 5) Golf Course (Reach 6)	Restoration	To increase cover for fish by placing large woody debris in Beach creek	1. Identify locations for placement of large woody debris; 2. Obtain landowner approval. 3. Continue to monitor changes in fish populations to determine success; 4. Monitor changes to stream channel to determine any changes due to lwd placement	Technical advise Volunteers Approval from local and senior governments Landowner permission Funding for materials and supplies Brochures/public awareness tools including public meetings/landowner contact Film/report production supplies Media (print/TV) to document project	Spring 2000	Ongoing
		Public Awareness	To host a watershed information event for local residents regarding restoration projects in the Beach creek watershed.	1. Investigate other similar public awareness projects (e.g.. Nanaimo, C. River0 2. Determine outline of information to be presented to community; 3. Print brochures 4. Conduct landowner contact to advise community of meeting 5. Advertise meeting in local newspaper 6. Hold meeting	Volunteers Funding for resource gathering/research Public meetings/brochures and other public awareness tools	Spring 1999	Ongoing - to coincide with watershed manageme nt plan and protection; planning projects
		Restoration	To identify water quality concerns in Beach creek	1. Discuss project with golf course 2. Determine sampling schedule and locations 3. Secure landowner permission where private land must be accessed	Water quality sampling equipment; Consultant to assist with project set-up; Laboratory costs	Summer, 1999	Ongoing
		Public Awareness	To implement a stream signage program on Beach creek	1. Investigate signage programs in other jurisdictions such as Nanaimo; 2. Obtain approval of Town and Regional 3. District to implement signage program; 4. Identify all stream crossings; 5. Hire sign company to produce signs; 6. Erect signs	Volunteers Local government/Highways/ landowner permission Sign design and production Media to introduce project Before and after landowner/resident questionnaires to determine signage success	Spring 2000	Spring 2001

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Start Date	End Date
Instream Cover (large woody debris) (continued)	Elizabeth Road (Reach 1) Brown Property (Reach 2) Hemsworth (Reach 3) Mant Road (Reach 4) Davidson Property (Reach 5) Golf Course (Reach 6)	Public Awareness	To increase awareness by golfers of fish and fish habitat	1. Obtain permission from golf course to erect signs highlighting fish habitat areas; 2. Determine suitable locations for signs; Erect signs Distribute Streamkeeper's and fish habitat awareness brochures in golf course clubhouses.	Graphic artist (at sign shop) to develop and produce signs; Materials and supplies; Volunteers; Paper and supplies for brochure production and distribution	Spring 2000	Fall 2000

4.1 Restoration of Unstable Areas in the Beach Creek Riparian Zone

We found the highest rating points of all instream or riparian parameters for stability. This parameter was a concern in all but reach 5 of Beach creek. We also found concerns with slope in the Golf Course Reach (reach 6) and altered stream sites in reach 5. Taken together, stability; slope and altered stream sites are all contributing to the amount of sediment in Beach creek. The Streamkeepers assessment showed that over 90% of the substrate of Beach creek is comprised of sediment.

The effects of suspended sediment on rearing salmonids are two fold, affecting both the water column and the streambed (Griffith, 1980). Light penetration to the streambed is diminished with increasing sedimentation which, in turn, limits the primary production and availability of food. Thompson (1972) reported decreasing potential productivity with decreasing substrate particle size, silt being the least productive. Sediment is also an efficient carrier of toxicants and trace metals. Once deposited, pollutants in these enriched sediments can be re-mobilized under suitable environmental conditions posing a risk to benthic life (Gavin and Moore, 1982). Furthermore, salmonids are sight feeders and Bachman (1958) observed the cessation of feeding by cutthroat at turbidity levels of 25 ppm. Herbert and Merkens (1961) report that sediment levels as low as 90 ppm can adversely affect the survival of trout. Perhaps the greatest impact of sediment is on eggs and emerging fry, however. Bjornn (1969) and McCudden (1977) showed that the percentage of fine sediment in the gravels prevented the emergence of chinook, and steelhead fry. When sediments reached between 20-25% fines, emergence dropped from about 80% to <10% .

We suggest that both restoration and protection measures be implemented to restore and protect the stability of the riparian zone and decrease the amount of sediment entering Beach creek. The first step in restoring the stream banks is to identify all the locations along the creek which are unstable or eroding. Thereafter, a plan to stabilize these areas through planting or bioengineering should be employed. According to Knighton (1997), sand banks can be problem to stabilize, however, workable strategies can include planting grasses, sedges, clover and even bracken fern from the lip of the bank to a depth of about 3 meters (Table 4). Although a sand face cannot be planted, areas above and below these areas can be planted with species that can sprout from roots. In the summer, shrubs and grasses capable of withstanding submersion may be planted at the edge of the water at the base of the sand face (Knighton, 1997).

Table 4. Suggested ground covers, shrubs and trees for planting sand bluffs (from Knighton, 1997).

Common Name	Scientific Name
Ground Covers	
Sedges	Carex spp.
Fescues	Festuca spp.
Kinnickinnick	Arctostaphylos uva-ursi
Tall Fringecup	Tellima grandiflora
Clovers	Trifolium spp.
Yerba Buena	Satureja douglasii
Dune Rye Grass	Elymus mollis
Shrubs and Trees	
Nootka Rose	Rosa nutkana
Oceanspray	Holodiscus discolor
Wolf Willow	Elaeagnus commutatus
Cherries	Prunus spp.
Currants	Ribes spp.
Balsam Poplar	Populus balsamifera
Black Cottonwood	Populus trichocarpa
Streamside	
Hardhack	Spiraea douglasii
Willows	Salix spp.
Sweet Gale	Myrica gale
Silverweed	Potentilla anserina

4.2 Land Use in the Beach Creek Watershed

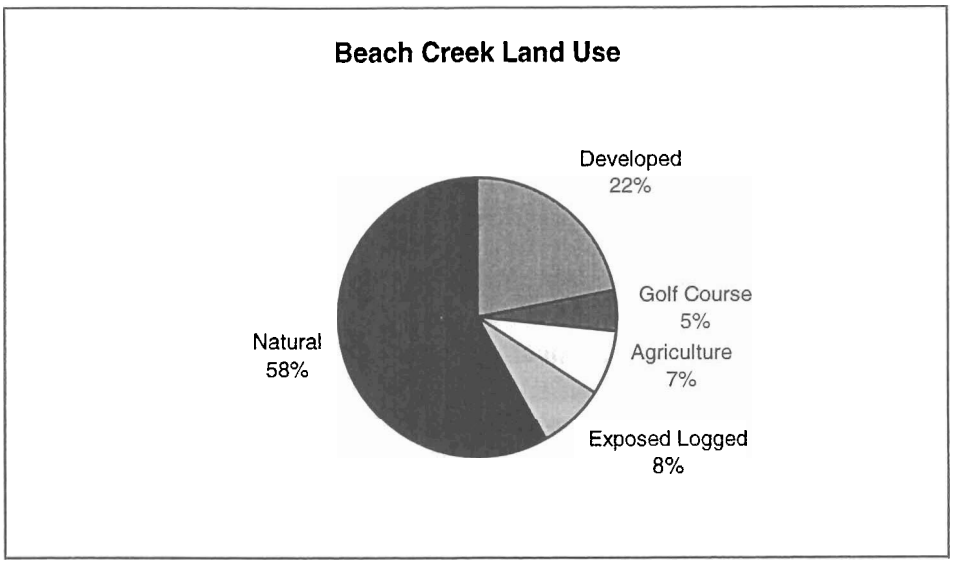
In their article, Learning to Live Within the Limits of the Land, Wood, Williams and Dombeck (1997) point out that for restoration to be effective, it must treat and correct the reason that ecosystem structure and function has been lost, rather than merely addressing the symptoms of these problems. Therefore, spending time and money on correcting individual stability problems will be ineffective if the fundamental problem which is the source of the problem, that is, the land use, remains untreated. As noted by Bisson et al.(1992) and Doppelt et al. (1993) stream conditions are largely a consequence of the overall health of the watershed and should not be managed as if they are separate from this context.

4.2.1 Protection of the Beach Creek Watershed

The present study identified land use as a concern in all but one reach of Beach creek. In fact, a recent study of land use and development in thirteen Vancouver Island watersheds by Reid et al (1999) found that only fifty-eight percent of the Beach creek watershed could be classified as natural or undeveloped. Much of this land exists in the Brown Property Reach (reach 2). We believe that the protection of this area as well as riparian strips within other natural areas is critical to the health

of the creek and will ultimately yield the greatest gain for the fish and fish habitat of the Beach creek watershed.

Figure 3. Land use in the Beach creek watershed, 1998 (from Reid et. al., 1999).



Mapping and Protecting the Riparian Zones

We suggest that the Streamkeepers compile a detailed map the riparian zones of Beach creek. Riparian zones are the area of streambank, including any side channels and associated banks, and the area of influence, which contains upland areas not normally inundated during high water conditions (Chilibeck, 1992). These zones exert a direct biological, physical and chemical influence on the stream and ultimately are responsible for the distribution, composition, and diversity of aquatic organisms available to the stream (Connin, 1991). Riparian zones support diverse assemblages of plants and animals; act as a physical buffer to protect the integrity of the stream bank and stream; provide a corridor and shelter for wildlife; and contribute large woody debris to the stream which provides cover for fish and insulates the stream from solar radiation (Nener et. Al., 1997). Furthermore, a well maintained riparian area will protect the stream from sediment inputs. According to Ruffin, (1998) although a riparian zone may fill with sediment, the sediment release is slow and gradual and the damage to the stream habitat is minimal. Protection and restoration of riparian zones must be a priority if we want to minimize sediment inputs from urban and agricultural development.

We suggest that the Town of Qualicum use the Streamkeeper's riparian zone map to identify riparian leave strips. These leave strips will include both the land and vegetation adjacent to watercourses which are to remain in an undisturbed state throughout and after the development process. Leave strips should be provided on all watercourses that flow into or contain fish or fish habitat. This includes wetlands, ponds, swampy areas or other intermittently wetted areas, small streams, side channels and ditches which may not flow throughout the entire year (Chilibeck, 1992).

Suggested leave strip widths for British Columbia are outlined in the Land Development Guidelines (Chilibeck, 1992), however, we suggest that the Town of Qualicum adopt the leave strip widths

proposed by the Washington Department of Fish and Wildlife. This agency recently reviewed nearly 1,500 pieces of literature on the importance of riparian areas to fish and wildlife and, based on that review, developed state-wide riparian management recommendations (WDFW, 1998). The newly revised standard Riparian Habitat Area (RHA) widths for Washington state streams vary from 46 meters for perennial or intermittent streams, to 76 meters for other streams and state shorelines.

The greatest sediment loads to streams are exported during the construction phase of development (Schueler, 1997). Therefore, we suggest that the Streamkeepers be involved in monitoring Beach creek leave strips to ensure that they are respected during development. We also suggest that permanent fencing be installed along riparian zones following development to ensure that leave strips remain in tact over the long-term.

Watershed and Greenways Planning for Beach Creek

In 1974, the Fort Collins Colorado City Council approved an Open Space Plan as part of their Comprehensive City Plan (Horak, 1989). This plan identified new stormwater drainage ordinances and master plans to improve drainage to natural drainage-ways, new grading and erosion guidelines to reduce sediment loading , wildlife, sensitive habitat and urban fishery plans and a 24 km greenway along the town's creeks and rivers.

The impetus for the Fort Collins Open Space Plan came from local citizens who encouraged city officials and the community to take a greater interest in open space, parks and trails (Horak, 1989). These individuals believed so deeply in their cause that some of the land used for the open space plan was donated by local developers, while other areas were acquired with funds raised through a community initiated 1% sales-tax increase (Horak, 1989). By broadening their approach to include the community in addressing ongoing land use and development practices, Fort Collins spearheaded one of the first watershed management processes. An increasing number of other communities are embarking on similar processes aimed at bringing about the recovery and preventing future damage to their urban watersheds.

We suggest that the Streamkeepers become involved in the long-term management of the Beach Creek watershed by initiating a Watershed Management Planning process. Protection and development goals for the watershed would be developed by community residents in co-operation with federal, provincial and local agencies. Ultimately the community's watershed protection strategies would be articulated in the Qualicum Beach Official Operating Plan (OCP).

On Vancouver Island, the Bilston Creek Watershed Habitat Protective Association was among the first stewardship groups to initiate a watershed planning process. The Millard-Piercy Watershed Stewards in Courtenay initiated their watershed planning process in early 1998 and since that time have defined long and short term community goals aimed at watershed protection. There are an increasing number of models upon which to base a watershed management planning process and we suggest that the Qualicum Beach Streamkeepers and the Town of Qualicum investigate the various ways these are being implemented in the Georgia-Basin, Puget Sound region.

We also suggest that in the course of their watershed plan, the Streamkeepers and the Town investigate implementing a Community Greenway program in Qualicum Beach. Community Greenways are linear green corridors that connect natural areas and create linkages between human

development and natural systems (Province of BC, 1996). Greenways are an ideal way of protecting stream corridors while also increasing public awareness of the importance of stream side habitat. The regional district of Comox Strathcona is involved in an intensive project to establish Greenways throughout their region and we suggest that a representative from the Qualicum Beach Streamkeepers be elected to investigate this, and other Greenways initiatives on Vancouver Island and the Lower Mainland. A Greenway action plan could then be developed for implementation in the Qualicum Beach area. Possible Greenways routes could also be identified in conjunction with the riparian mapping project suggested above.

Watershed and Greenways Planning for Beach Creek

We suggest that long-term watercourse protection be addressed in the Town of Qualicum Official Community Plan (OCP). This could be accomplished by introducing stewardship bylaws to protect the small parcels of land within the watershed and official policies and guidelines for watercourse and riparian protection.

Stewardship bylaws are environmentally focused yet simple, and administratively efficient directions for small parcels of land. (Province of BC, 1996). The Municipal Act contains provisions for environmental protection through these specific bylaws which can include:

1. Tree Protection/Soil Removal and Deposition/Watercourse Protection Bylaws
   These blanket bylaws are most effective in managing incremental changes which can lead to site or broader habitat degradation and are an important adjunct to setback requirements under zoning bylaws. They also enable enforcement through ticketing for minor offences and may provide a useful basis for litigation for major offences.
2. Zoning Bylaws
   These bylaws protect sensitive areas by not allowing specified land uses and/or buildings or structures within a defined area. Typically, this is achieved through setbacks or watercourse leave strips.
3. Development Variance Permits
   These permits are a form of zoning and subdivision regulation in that they enable councils and boards to vary applicable zoning or subdivision bylaw provisions in relation to a specific site - except those provisions dealing with use and density or a floodplain specification.
4. Development Permits
   These permits enable the greatest degree of site-specific attention to environmental stewardship for the purposes of ensuring conservation of lands in a natural state or re-vegetation of disturbed sites and dedication of watercourses.
5. Subdivision Bylaws
   These bylaws can set requirements for detailed design and construction of stormwater conveyance, detention and treatment facilities and provide standard specifications and details for erosion control and tree protection practices during construction of all parcels covered by the bylaw.
6. Subdivision Approvals
   The Land Title Act requires an approving officer to consider local government regulations to ensure that an application for subdivision meets the requirements of these bylaws. Hence, where stewardship regulations and requirements are in effect, these are directly applied to the design of the subdivision and related services.

We also suggest that the OCP include policies and guidelines regarding:

1. maintenance of natural stream flow rates;
2. stormwater maintenance;
3. infrastructure to keep roads and services away from streams;
4. limiting culverting or daylighting previously culverted streams;
5. stream leave strips;
6. water pollution and waste.

We suggest that the Town of Qualicum investigate bylaws and principles used in the District of North Vancouver's Environmental Protection Preservation Bylaw. This District has been singled out by both the Ministry of Environment and the Department of Fisheries and Oceans for their leadership in environmental stewardship through the adoption of stewardship bylaws (Province of BC, 1996).

4.2.3 Public Awareness within the Beach Creek Watershed

Many stewardship groups working on stream assessment and restoration activities have been confronted with a general lack of knowledge on the part of watershed residents about the importance and sensitivity of streams in their own back yards (Shepp and Cummins, 1997). Often the general public does not understand their connection to their streams and the associated ecosystems yet this understanding is critical to the success of long-term restoration and protection efforts.

We suggest that the Streamkeepers consider implementing watershed awareness programs to increase the level of knowledge about the Beach creek watershed. Information regarding the creek and the watershed could be presented and discussion about protection of the creek including private land stewardship could be facilitated. This type of forum could also be used to test the acceptance of a large scale watershed planning process or even smaller stream restoration projects. The city of Nanaimo has hosted a number of watershed information forums in co-operation with local stewardship groups including the Nanaimo Field Naturalists. We suggest that the Streamkeepers review this project to determine if a similar design could be employed.

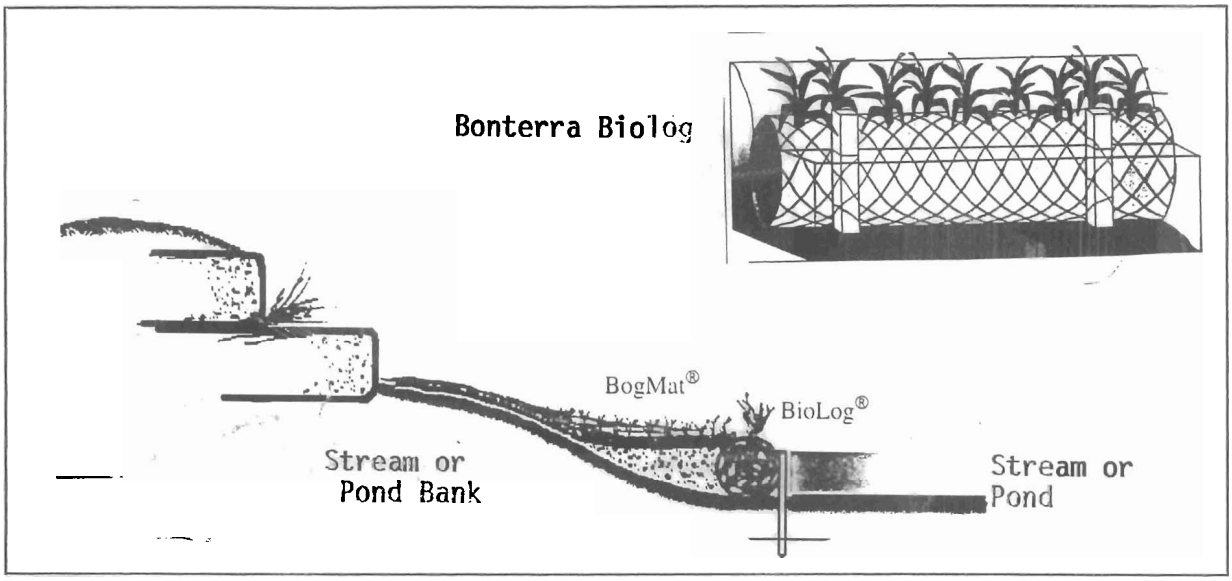
4.3 Altered Stream Sites in the Beach Creek Watershed

Altered stream sites are those areas along the stream bank which no longer maintain their natural character. These sites are usually the result of human intervention and include structures such as retaining walls. We found a total of 34 altered stream sites in reach 4 (Mant Road) and 9 in reach 5 (Davidson Property). Many of these altered sites are the result of the removal of riparian vegetation to the edge of the stream. There is also an altered site in the Memorial Golf Course in reach 1 (Elizabeth Road) where an irrigation pond is being maintained by a dam. At low water, this dam restricts fish migration and, throughout the year, the dam prevents sediment flushing. The sediment is building up in the golf course pond and must be dredged by maintenance staff. Any riparian cover around the pond prevents access to the pond and this situation may be resulting in elevated water temperatures within the pond.

4.3.1 Restoration of Altered Sites in the Beach Creek Watershed

We suggest that the Streamkeepers identify all of the altered sites along Beach creek and develop a plan to restore natural stream banks and riparian cover in these areas where possible. The suggestions for riparian planting outlined in Table 4 could be used as a guideline. We also suggest that the Streamkeepers investigate bioengineering techniques for some areas. For example, "biologs" could be used to increase riparian and instream cover at the Memorial Golf Course pond (Figure 4). These rolled fibre mats have been used along streams and lakes to successfully initiate plant growth and provide instream cover for fish. A number of other bioengineering techniques are available and we suggest that a plan be developed which outlines the areas which require remediation as well as the most appropriate technique. Thereafter, funds from programs such as the Urban Salmon Habitat Program and Fisheries Renewal BC should be approached for financial support.

Figure 4. Suggested revetment for Memorial Golf Course ponds using Bonterra Biologs



4.3.2 Protection and Public Awareness of the Beach Creek Riparian Zones

Information regarding the necessity and importance of the riparian zone must be disseminated to land owners to prevent or reverse alteration of stream side habitat on private property. Often the best way of discussing stream and riparian zone protection with private landowners is through landowner contact by local citizens and neighbours. Landowner contact programs can focus on a number of issues and concerns regarding private land stewardship and, when sensitive to the needs and specific concerns of the landowner can be extremely successful.

We suggest that the Streamkeepers consider implementing a landowner contact program in the areas along Beach creek where stream side alterations are most extreme. The program should concentrate on general information regarding the stream and the riparian zone but should also be designed with a view to helping the landowner where possible. For example, in agricultural areas, the Streamkeepers could offer to help the landowner by providing assistance and even financial support to build fences

outside of leave strips. Several programs including The Urban Salmon Habitat Program and Environment Canada have funded successful fencing programs on Vancouver Island.

We suggest that the Streamkeepers investigate existing landowner contact programs before designing their own approach. There have been several successful programs of this type implemented on Vancouver Island including projects by the Cowichan Community Land Trust Society, the Comox Valley Project Watershed Society and the Discovery Coast Greenways Society of Campbell River.

4.4 The Substrate of Beach Creek

4.4.1 Identification and Elimination of Sediment Sources

The stream banks in the Beach creek watershed are sand and, therefore, any development will cause a number of impacts including the introduction of sediment into the stream channel. Once sediment inputs are eliminated or minimized, there are a number of ways to dislodge the existing sediment. Scarification is one method which involves excavating the streambed and exposing the substrates to the flushing effect of the stream. Another technique is hydraulic flushing which uses high pressure jets of water and air to force the fines into the flow of the stream (Adams and Whyte, 1990). Constructing instream deflectors out of large woody debris will not only remove sediment by increasing the velocity and deepening the channel, but will also provide instream cover for fish (Koning and Keeley, 1997). We recommend that an assessment be undertaken to determine appropriate prescriptions where possible and locations in Beach creek.

4.5 Percent Wetted Area of Beach Creek

4.5.1 Restoration of Adequate and Consistent Flows to Beach Creek

Flow requirements for fish have been estimated using the Tennant (1976) or Montana method. This method is founded on the principle that stream width, mean depth and velocity vary as a function of mean annual discharge. The Tennant study demonstrated that a flow of 10% of the mean annual discharge results in a wetted width of 60% of the bankfull condition (Ministry of Environment, 1988). For this reason, a flow of 10% of the mean annual discharge is considered the minimum for short-term survival of rearing salmonids.

The estimated mean monthly flow in Beach creek is below 10% of the Mean Annual Discharge for the months of July, August, and September (Ministry of Environment, 1994). This supports our findings that the percent wetted area was less than 70% of the reach area in all but reach 5 during the assessment period (Table 2). We suggest that a hydrology study be conducted to determine how to augment low summer flows in Beach creek. The terms of reference of this study should include identifying additional water sources and/or storage opportunities and should result in an action plan and budget for the most feasible options. The Town of Qualicum and the two golf courses within the Beach creek watershed should be approached as possible funding partners since this study would also benefit these stakeholders.

4.5.2 Maintaining Natural Stream Flow in Beach Creek

Urbanization imposes a variety of watershed changes that profoundly affect stream processes. A study by Booth and Reinelt on the consequences of urbanization on aquatic systems in Washington state found that approximately 10% impervious area in a watershed typically yields demonstrable and probably irreversible loss of aquatic system function. This loss is reflected by measured changes in channel morphology, fish and amphibian populations, vegetation succession, and water chemistry (Booth and Reinelt, 1993).

According to Schueler (1987), the net effect of development in a typical, moderately developed watershed is a series of changes to stream hydrology including:

1. increased peak discharges to between 2-5 times higher than pre-development levels;
2. increased volume of storm runoff produced by each storm;
3. decreased time needed for runoff to reach the stream by as much as 50%; increased frequency and severity of flooding;
4. reduced stream flow during prolonged periods of dry weather due to a reduced level of infiltration in the watershed;
5. greater runoff velocity during storms due to the combined effect of higher peak discharges, rapid time of concentration, and smoother hydraulic surfaces that occur as a result of development.

Like most communities, the Town of Qualicum routinely cleans road-side ditches to facilitate drainage. In Qualicum Beach, however, several of these ditches are, in fact, tributaries to Beach creek and are coho and cutthroat trout habitat. Each time these water-courses are cleaned, the hydrology is destabilized and the habitat impacted. The Town of Qualicum must also routinely clean debris from culverts along Mant Road and below the Brown Property. Culvert sizes are usually based on the original stream flow and traditionally have been undersized (Baldwin, pers. com., 1998). Increased impervious area and stream straightening has resulted in higher stream flows which likely cannot be accommodated by the older culverts. If, in addition to this, the culverts are crushed or otherwise compromised, the stream flow pattern is interrupted and further exacerbates the likelihood of flooding and compromises natural stream flow.

We suggest that the Streamkeepers and the Town co-operate in a joint project to review the flow patterns and hydrology of the Beach creek watershed to determine where the stream flow is compromised. We also suggest that this study include an examination of appropriate instream and riparian restoration projects to limit fish access into the drainage ditches which have been created by the Town. In other areas, there may be instream and riparian restoration options which would allow the stream to function without ongoing stream cleaning. For example, in some channelled portions of the stream, the placement of Newbury weirs may be appropriate. These structures decrease the gradient by increasing the bed complexity in channelled reaches. This allows the stream to dissipate its energy rather than increasing its velocity as it flows downstream. There may be other areas where the stream could be relocated to adjacent private properties which have suitable riparian zones. We suggest that both the Streamkeepers and the Town be actively involved in developing the Terms of Reference for this study. Funding for this type of study may be available from programs including the Urban Salmon Habitat Program.

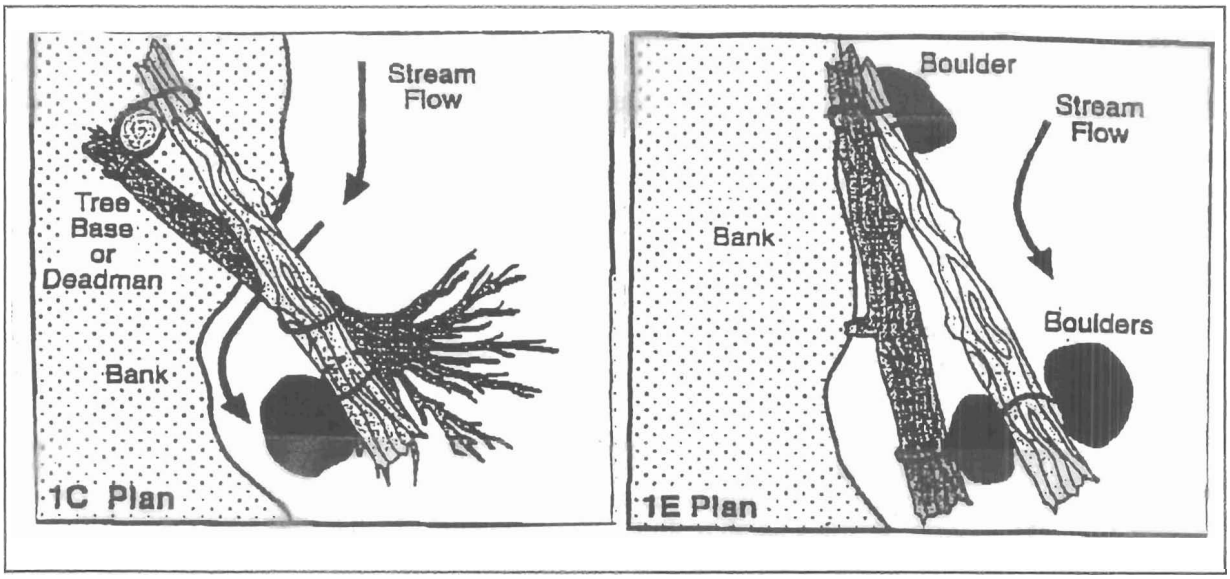
4.6 Instream Cover for Fish in Beach Creek

4.6.1 Restoration Projects to Increase Cover for Fish

Large woody debris (LWD) provides important physical and biological functions in the wide variety of habitats used by all species of Pacific salmon (Cederholm et. al. 1997). Research has shown that salmon fry stay in close association to log accumulations and rootwads (Lister and Genoe, 1970; Ward and Slaney, 1993). Bilby and Ward (1989) have found a positive correlation between the pool area of a stream and the volume of the large woody debris forming the pool and Megahan (1982) found that LWD promotes the storage of sediment in streams.

Our study found that the amount of large woody debris was limited in every reach of Beach creek. We suggest, therefore, that sites within stable, non-channelled areas of Beach creek be identified for the placement of aggregates of LWD and LWD/boulder complexes. Structures should be placed on the outside bends and log length should be between 1.5 and 2 times the bankful width to ensure stability (Fig. 5) (Hilderbrand et. al., 1998). Methods for installing large woody debris are outlined in several documents including: Stream Restoration Techniques (Technical Circular #9) published by the Ministry of Environment (Watershed Restoration Program, 1997).

Figure 5. Suggested large woody debris orientations and placements for Beach creek.



4.6.2 Public Awareness Projects Involving Local Citizens in Small Restoration Projects and Related Workshops

Stream restoration projects are an extremely valuable way to involve local residents and introduce people to the concept of stewardship. After becoming involved in a restoration project, a volunteer may gradually broaden his or her interest and eventually become involved in more holistic projects such as working to change detrimental land use activities and behaviour in the watershed. As Zuckerman (1997), points out, there is often an evolution from "thinking like a salmon" to "thinking

like a stream" to "thinking like a watershed" and eventually to "thinking like a watershed community."

We suggest that the Streamkeepers continue with individual habitat restoration projects such as placing large woody debris in Beach creek. We also suggest that the Streamkeepers hold short, informal meetings to explain these projects and the importance of Beach creek to local residents. The residents should be encouraged to discuss their concerns and ideas and should be invited to participate in the project. These meetings would provide an opportunity to disseminate information regarding fish and fish habitat to people whose actions most immediately impact the creek. Increasing the appreciation of the fragility of Beach creek by local residents may be the most important project the Streamkeepers can implement to ensure the long-term protection of this very valuable urban watershed.

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Appendix 1

Ratings Tables for Instream and Riparian Data

Appendix 1
Ratings Tables for Instream and Riparian Data

Ratings assigned to habitat parameters measured during the USHP assessment.

Habitat Parameter	Ratings (1 - 5) for the Comparison of Assessment Data to Habitat Diagnostics
Pools (%)	>55 % (Good) = 1 40 - 55% (Fair) = 3 < 40% (Poor) = 5
Large Woody Debris/Bankfull Channel Width	> 2 (Good) = 1 1 -2 (Fair) = 3 < 1(Poor) = 5
Percent Cover in Pools	> 20% (Good) = 1 6-20% (Fair) = 3 0-5% (Poor) = 5
Boulder Cover (%)	>30% (Good) = 1 10 - 30% (Fair) = 3 <10% (Poor) = 5
Crown Cover	>70 %(Good) = 1 40 - 70% (Fair) = 3 < 40% (Poor) = 5
% Fines	< 10% (Good) = 1 10-20% (Fair) = 3 >20% fines (Poor) = 5
Erosion Sites	<5% of reach length (Good) = 1 5-10% of reach length (Fair) = 3 >10% of reach length (Poor) = 5
Number of Obstructions	Assign 1 rating point for each obstruction
Number of Altered Sites/Reach Length	<5% of reach length (Good) = 1 5-10% of reach length (Fair) = 3 >10% of reach length (Poor) = 5
% Wetted Area (Wetted Area/Total Area)	>90% (Good) = 1 70%-90% (Fair) = 3 <70%(Poor) = 5
Off-Channel Habitat	>30% of stream length (Good) =1 15-30% of stream length (Fair) = 3 <15% of stream length (Poor) =5
Dissolved Oxygen	>7mg/l (Good) = 1 5 - 7 mg/l (Fair) = 3 < 5 mg/l (Poor) = 5
pH	6.5 - 8 (Good) = 1 5.5 - 6.5(Fair) = 3 <5.5 (Poor) = 5 >8 (Poor) = 5

Ratings used by the Excel© program for each riparian habitat parameter.

Riparian Parameter Ratings	Rating	Riparian Parameter	Rating
Land Use - Exposed; Industrial, Roads; Commercial; Farm(livestock); Golf Course	5	Livestock Access	<1% = 1 1-5% 3 >5% = 5
Land Use - Residential; Lawns; Farm (grass)	3	Slope	<40% = 1; 40% - 60% = 3; >60% = 5
Land Use - Natural	1	Stability	High = 1; Medium = 3; Low = 5