Lower Coquitlam River Fish Habitat and Flooding Assessment

Prepared for
Watershed Watch Salmon Society and
Kwikwetlem First Nation

Prepared by
Tanis Douglas, RPBio
Fernhill Consulting

Prepared with Financial Support of:

BC HYDRO FISH & WILDLIFE BRIDGE COASTAL RESTORATION PROGRAM

Project # 07 COQ.01

Acknowledgements

Many individuals participated in and guided this project. George Chaffee, Glen Joe and Nancy Joe from the Kwikwetlem First Nation provided a vision for a healthy lower river, and hosted two gatherings of all the interested groups and agencies. Craig Orr from Watershed Watch supported and guided the project. BC Hydro's Bridge Coastal Restoration Program provided the project funding and BC Hydro (Dave Hunter) also provided necessary reports and data. Further project funding was provided by the City of Coquitlam, as was GIS data. David Sellars from Water Management Consultants provided technical expertise relating to dikes and flooding and also participated in the assessment of conditions in the mainstem river. The discussions of dike conditions and of flood flows in this report come from David Sellars. Matt Foy from Fisheries and Ocean's Canada provided critical expertise and recommendations. Tony Matahlija from the North Fraser Salmon Assistance Society and Dave Bennie from Maple Creek Streamkeepers provided field accompaniment and local knowledge. The Greater Vancouver Regional District (Frieda Schade and Alison Evely) provided extensive information relating to Colony Farm, and also provided GIS services. Pat Slaney from PSlaney Aquatic Science Ltd. provided expertise on large woody debris installation, including design drawings.

25 individuals from 16 organizations participated in gatherings for this project and lists of these groups and individuals are provided in Appendices 1 and 2.

Executive Summary

A hydro dam, urban and agricultural development, and dikes have drastically altered the Coquitlam River. Adjacent gravel pits are also believed to be long-term negative influences. Off-channel habitat restoration projects have been undertaken in recent decades to improve conditions for fish. However, restoration work on the lower river (defined here as the 6.5 kilometres between the CP Rail Bridge and the river mouth) has been limited. For this project, the Kwikwetlem First Nation and Watershed Watch Salmon Society facilitated a restoration assessment of the lower river, with the following goals:

1. Develop working relationships. Working relationships between the interests and stakeholders in the Lower Coquitlam River are necessary to enable restoration work to proceed.

2. Develop restoration prescriptions. The main deliverable of this project was a set of restoration prescriptions to enable habitat restoration (mainly but not exclusively for fish) to be carried out in the short and longer-term.

A great deal of existing information was reviewed and summarized for this project, and a project initiation meeting was held that included 24 individuals from 16 different organizations. Subsequent field visits were made to assess the mainstem of the river, off-channel and riparian areas, and drainage on Colony Farm. Non-standard dikes along the river were another focus of this project, as they are seen to degrade fish and wildlife habitat. An experienced hydrologist was part of the project team to ensure any proposed changes to dikes would not increase flooding risks.

The mainstem river is highly altered and lacks large woody debris and other forms of complexity. With the exception of the upper one kilometre of the study area, gravel substrate is scarce to non-existent. Riparian habitat is poor in most of Colony Farm and riparian conifers are very scarce throughout the study area. River floodplain access is limited by dikes for most of the study area.

A total of 14 recommendations were developed as a result of this assessment. The recommendations are:

1. Complete tidal channels in the Sheep Paddocks

2. Construct tidal channels on upper Wilson Farm

3. Conduct wildlife and vegetation monitoring at the Sheep Paddocks Phase 1 project

4. Improve instream complexity

5. Monitor and assess the oxbow on IR#2, remove constriction

6. Consider the cost vs. benefit of non-standard dike maintenance

7. Investigate water quality

8. Reduce and control invasive exotic species

9. Take a watershed approach to stream health

10. Create outreach and educational opportunities

11. Work with Riverview property owner to conserve and improve habitat

12. Take a closer look at fish-bearing channels and ditches in southern Colony Farm

13. Review the fish habitat compensation project to determine whether access to and from the mainstem should be improved

14. Work with gravel pit operators to reduce sediment inputs

A project conclusion meeting was held to discuss these recommendations with the various groups and institutions. A budget was developed to address some of these recommendations in the near term. Planning is underway to determine whether further work on the Sheep Paddocks may proceed in 2008. Discussions will also occur in 2008 regarding the possibility of fish habitat work on Wilson Farm, as per recommendation #2.

All restoration work will need to be conducted in a manner that ensures Water Use Plan monitoring is not confounded. Under the Water Use Plan, BC Hydro is implementing a new flow regime for the benefit of fish, and monitoring is important to determine the benefits. It appears that the proposed work in the study area will not affect monitoring results.

Colony Farm is highly valued for its wildlife habitat, particularly for the birds of prey the old field habitat supports. Any changes to Colony Farm will need to be carefully considered and public consultation will be required, due to the high level of public use and interest.

A large number of organizations and individuals are involved in the stewardship of the Coquitlam River, and many more have an impact on the watershed by virtue of living and doing business in it. This project included a substantial group of people in developing and discussing restoration options. However, more could be done to manage the Coquitlam River at a watershed level, addressing the influences of various land uses on the river. A proposed process to hire a watershed coordinator could provide the means to work together under a common vision.

Table of Contents

Executive Summary ii
Table of Contents iv
Introduction 1
Goals and Objectives 2
Study Area 3
Lower River Dikes 4
Methods 11
Results 12
Proper Functioning Condition Assessment 12
Altered Flows and Channel Conditions 13
Sediment Inputs and Water Quality 14
BC Hydro Water Use Plan 16
Riparian Conditions 18
Oxbow habitat and Cemetery Flooding in IR#2 19
Existing Habitat Improvement Projects 22
Colony Farm Vegetation and Wildlife Management 22
Sheep Paddocks 27
Fish Habitat Compensation 29
Wilson Pond 30
Invasive exotic species 31
Discussion 34
Recommendations 36
Complete tidal channels in the Sheep Paddocks 36
Construct tidal channels on upper Wilson Farm 36
Conduct wildlife and vegetation monitoring at the Sheep Paddocks Phase 1 project 37
Improve instream complexity 37
Monitor and assess the oxbow on IR#2, remove constriction 41
Consider the cost vs. benefit of non-standard dike maintenance 42
Investigate water quality 42
Reduce and control invasive exotic species 43
Take a watershed approach to stream health 43
Create outreach and educational opportunities 44
Work with Riverview property owner to conserve and improve habitat 44
Take a closer look at fish-bearing channels and ditches in southern Colony Farm 44
Review the fish habitat compensation project to determine whether access to and from the mainstem should be improved 45
Monitor Wilson Pond and consider more native plantings 45
Work with gravel pit operators to reduce sediment inputs 45
Budget for 2008 Restoration (some items may extend into 2009) 46
References 47
Appendix 1: Organizations and Individuals at Project Initiation Meeting 50
Appendix 2: Organizations and Individuals at the Project Conclusion Meeting 51
Appendix 3: Relevant Supporting Documents 52
Appendix 4: Proper Functioning Condition Assessment 58
Appendix 5: Riparian Vegetation Mapping 76

Appendix 6: Water Quality Tests Appropriate for Detecting Landfill Leachate 79
Appendix 7: Financial Statement 80
Appendix 8: Performance Measures and Actual Outcomes 81
Appendix 9: Confirmation of BCRP Recognition 82

List of Figures

Figure 1: The mouth and lowest part of the Coquitlam River. Note the Wildlife Management Area at the mouth, IR#1 on the west bank, and the field habitat provided by Colony Farm and the Forensic Psychiatric Institute 7
Figure 2: Figure 2: Colony Farm and the lower portion of IR#2, including the oxbow. The sheep paddocks are the uppermost three fields on the west bank. The habitat enhancement (constructed channel) is visible in the lowermost sheep paddock. The Upper Wilson Farm (a wildlife management zone within Colony Farm park) is on the east side of the river. 8
Figure 3: The upper part of IR#2 is visible on the west bank below Pitt River Road. On the east bank a habitat compensation project is seen. Above the Pitt River Road a standard set-back dike is visible on the east (Port Coquitlam) side of the river and older dikes line the river. 9
Figure 4: Gates Park is seen on the west bank. Standard dykes constrain the river in a narrow channel. Gravel bars are seen above km 5.5. whereas the substrate downstream is mostly sand. 10
Figure 5: Indian Reserve #2 is on the east (right) of the main channel. The oxbow is shown here. The cemetery is adjacent to the top of the oxbow and is indicated by two arrows. Also shown is a constriction where an older dike crosses the oxbow. The bridge in this location has been removed. 20
Figure 6: Land use designations from the Colony Farm Land Use Plan (Colony Farm Land Use Study Steering Committee 1995) 23
Figure 7: Vegetation mapping in the Wildlife Management Areas and Integrated Wildlife Management Area at Colony Farm, based on 2004 orthophotos (Taitt 2006). The olive green is reed canary grass, light green is unknown grass, red is blackberry thickets and pink is mown blackberry. This mapping predates field 'renovation' done in a field in the upper Wilson Farm. 26
Figure 8: The sheep paddocks in 2006. The constructed channel is seen in the lower paddock, and feeds into the river via the slough (Munday Slough) seen running perpendicular to the Coquitlam River. 29
Figure 9: Fish habitat compensation project constructed in 1995 (see channel running parallel to the Pitt River Road). 30
Figure 10: Wilson Pond in July 2007. 31
Figure 11: Knotweed on Colony Farm, and a knotweed propagule found in the mainstem below the Pitt River Bridge. 32
Figure 12: Green frog (*Rana clamitans)* along the bank of the Coquitlam River (Reach E) 33
Figure 13: Flat triangle LWD structure with bank revetment and guard boulders. 38
Figure 14: Lateral log pair with intact downstream facing rootwads and alluvial boulder ballast 39
Figure 15: The J-Hook Vane developed by Dave Rosgen (diagram from Rosgen (N.D.)) 40
Figure 16: A modified J-hook vane that uses a ballasted log pair instead of boulders for part of the structure. View looking downstream 40

List of Tables

Table 1: Comparison of Treatment 1 and Treatment 2 releases (data from BC Hydro 2003, modified from Decker *et. al* 2006). 17

Introduction

The Coquitlam River has been altered from its natural state by a hydro dam that has drastically reduced flows and altered the sediment and large woody debris regime. Other factors that have major effects on the river's condition are the surrounding urban and agricultural development and associated dikes, and gravel pit operations believed to be contributing fine sand and silt to the river. The Coquitlam River historically supported all six Pacific salmon, as well as cutthroat trout and Dolly Varden char. Dam construction resulted in the extirpation of summer sockeye, but the stream still supports populations of the remaining species as well as longnose dace, cottids, lamprey and stickleback. Pink salmon were successfully reintroduced to Coquitlam River in 1995 following their extirpation in the 1960's (Decker *et. al* 2007). Discussion is ongoing regarding re-introducing a sockeye run to the river.

Recognizing the degraded state of the mainstem river, several off-channel fish habitat restoration projects have been created in recent decades at and upstream of river kilometre 9, and a lesser number in the study area. A great deal more restoration is possible in the lower river – defined here as the lower 6.5 kilometres below the CP Rail bridge. This project gathered the appropriate community groups and government agencies together to discuss and develop restoration prescriptions for the lower river (see Appendix 1 and 2 for lists of participants). The City of Coquitlam, Fisheries and Oceans Canada and the Greater Vancouver Regional District (GVRD) agreed to be core partners in this work together with the Kwikwetlem First Nation and Watershed Watch. The City of Port Coquitlam was brought into the project as it progressed.

This report condenses material from a large number of sources and groups, and provides a summary of conditions and restoration potential in the lower 6.5 kilometres of the Coquitlam River. While the assessment was mainly fish-focused, riparian conditions and wildlife habitat were considered and integrated into the assessment. Flood control is a concern for the neighbouring municipalities and landowners, and at the same time, dikes are seen as a degrading influence on the river. For this reason, an experienced hydrologist was part of the team in order to assess any proposed changes to dikes, to ensure that flooding risks are not increased.

Flooding has been an issue at the cemetery in IR#2 for some time. This project had the secondary aim of incorporating flood relief for this area into any river restoration prescriptions as possible.

Goals and Objectives

There were two main goals for this project:

1. Develop working relationships. Working relationships between the interests and stakeholders in the Lower Coquitlam River are necessary to enable restoration work to proceed.

2. Develop restoration prescriptions. The main deliverable of this project was a set of restoration prescriptions to enable habitat restoration (mainly but not exclusively for fish) to be carried out in the short and longer-term.

Related objectives to meet these goals were:

For Goal 1: Develop working relationships:

1. Gather the various interested parties to discuss restoration possibilities at the outset of the project. This process allows the parties to outline their interests and concerns.

2. Work with many of the interested parties to gather the necessary information and develop restoration options.

3. Gather the various interested parties to discuss proposed restoration options developed by the project team. This allows for the refinement of these options as well as a discussion of the logistics for their completion.

For Goal 2: Develop restoration prescriptions:

1. Review past restoration and assessment work relevant to the Lower River. Where appropriate review current functioning and make recommendations for improvement.

2. Assess restoration needs and possibilities.

3. Assess potential flooding issues and risks related to restoration activity, where potential restoration prescriptions include changes to dikes.

4. Develop restoration prescriptions and budgets for identified areas.

5. Develop a scope of work for any additional detailed analyses.

6. Develop a monitoring program as relevant.

Study Area

The project encompasses the lower Coquitlam River, from the river mouth at its confluence with the Fraser River, upstream to the CP Rail Bridge crossing, which is just above river kilometre 6.5. The CP Rail Bridge marks a significant boundary in the character of the floodplain along the lower Coquitlam River. Above the CP Rail Bridge the gradient is much steeper (approximately a 10 meter drop per 1,000 meters) and the channel bed is composed of cobbles and boulders. Below the bridge the channel gradient is slight (approximately 1.8 meter drop per 1,000 meters) and the channel bed is primarily silty sand and gravel (WIB 1978 in McLennan and Veenstra 2001). The CP Rail Bridge was therefore a natural boundary for the study area.

At the river mouth, the land is designated as a Wildlife Management Area (WMA) for its riparian values and for a heron rookery within the area. Just 200 meters upstream of the river mouth, the Maryhill By-pass crosses the river, and this is the upstream extent of the WMA and the lowest extent of the diking system on the west bank (on the east bank the dike extends to 500 meters above the river mouth). The municipalities of Port Coquitlam and Coquitlam own the area alongside the river within the dikes with the exception of the area within Kwikwetlem IR#2. On the upland side of the dikes, GVRD Parks (Colony Farms) is a large landowner within the study area. Their ownership extends from the Maryhill By-Pass on the east bank and Kwikwetlem IR #1 on the west bank (which extends between river kilometre 0.5 to 0.75), upstream to the lower boundary of IR#2 on the east bank at river kilometre 2.75. On the west bank, GVRD ownership extends further upstream, to approximately river kilometre 5.2, where the river runs directly alongside the Lougheed Highway. Kwikwetlem First Nation has significant property in IR#2 alongside the river, in addition to the smaller and more developed IR#1. A significant portion of IR#2 is within a setback dike along the east bank of the river between river kilometres 2.75 and 4.2 (just below the bridge crossing for the Pitt River Road), contains the best floodplain riparian habitat in the study area, and includes a cut-off oxbow.

The Forensic Psychiatric Institute also owns land alongside the west bank of the river, between the Maryhill By-pass to the south and GVRD Colony Farm to the north.

Above the Pitt River Road bridge crossing at river kilometre 4.2, the land on the east side of the river is owned by the municipality of Port Coquitlam. The riparian forest here is enclosed between a historic dike (now used as a trail) and a newer setback dike constructed to current flood protection standards. Gates Park, which consists of sports playing fields, is upstream of this riparian forest and runs alongside the river starting at river kilometre 5.5. Upstream of this Gates Park, land ownership outside the dike is in private hands. As previously mentioned, the GVRD Parks owns land along the west bank up to river kilometre 5.2, above which point the land outside the dikes is in private hands.

The study area is shown in detail in Figures 1 through 4. These orthophotos were provided by BC Hydro based on aerial photos taken by the City of Coquitlam in 2006.

Lower River Dikes

Dikes on the lower river were of interest in this project because they affect the value of the lower Coquitlam River floodplain as fish and wildlife habitat. Context for these dikes is provided here by David Sellars (Water Management Consultants, personal communication).

The Province does not consider the dikes in the Colony Farm Park area to be "Standard Dikes" (providing protection in a 1:200 year flood). The crest levels are generally below 200-year flood levels both for a 200-year Fraser River freshet and for the 200-year Coquitlam River flood event (Water Management Consultants, 2004). They are built to 100-year levels of protection suitable for agricultural land (Frieda Schade, GVRD, personal communication). The dikes provide some flood protection for three areas:

1. Home Farm Area comprising the Forensic Psychiatric Institute (FPI) and the Kwikwetlem First Nation Reserve #1.

2. Sheep Paddocks Area north of the CP Rail Slough and west of the Coquitlam River

3. Wilson Farm Area on the east side of the Coquitlam River

It is understood that the FPI and the Kwikwetlem First Nation Reserve #1 are generally above 200-year flood levels. However there are some structures at these locations below 200-year flood levels (including sewer, water and gas infrastructure) and access roads are well below flood levels. Therefore the dikes protecting this area are providing some flood protection even if it is not to the Provincial standard.

A fish habitat area has been constructed in the southern portion of the Sheep Paddocks Area by breaching the dike on the north side of the Munday Creek Slough. The potential flood issues caused by this breach were addressed in a report for the City of Coquitlam, (Water Management Consultants 2006). This report noted that the Coquitlam River dikes adjacent to the Sheep Paddocks north of the floodbox are non-standard. If they fail or overtop, floodwater could enter the Sheep Paddocks area from this reach of the Coquitlam River, flow back through the dike breach and raise water levels in Mundy Creek adjacent to the CP Rail line. The CP Rail Line would then effectively be providing flood protection for the Home Farm area, though this embankment was not designed as a dike and flood protection is not the responsibility of CP Rail. Therefore, future plans call for an exploration of the pros and cons of filling in the breach and installing a gated outlet.

The dikes along the Coquitlam River on the west side just north of the CP Railway Slough are in very poor condition. Sink holes and active bank erosion indicate that they are in a precarious state. These dikes would have been developed for farming in the past, but their main function now is to provide an elevated trail route. (However, as of mid-November 2007, the trail is washed out in places and is temporarily closed pending future

decisions on maintenance – Frieda Schade, GVRD, personal communication.) The BC Hydro towers in the area would have been designed to withstand floods because they could not depend on the Coquitlam River dikes in this area. The exception would be if there were cellular telephone facilities on the towers with kiosks at the base. Extending the southern Sheep Paddocks fish habitat area further north to the next "field" would not have a detrimental effect on flood protection for the Home Farm area, assuming the main outlet would be a gated structure through the reconstructed dike on the Munday Creek Slough.

The Wilson Farm area on the east side of the Coquitlam River is protected by non-standard dikes with crest levels below 200-year design levels (approximately 100-year flood design levels – Frieda Schade, GVRD, personal communication). The condition of the dikes generally appears better than on the west side adjacent to the Sheep Paddocks. The north side of Wilson Farm is adjacent to a Standard Dike that runs from high ground on the east to the Standard Dikes on the Coquitlam River. This dike does not provide flood protection to Wilson Farm.

The Wilson Farm area is drained by a pump station which maintains a relatively dryland environment. This is done to support the current management goal of maintaining and promoting old field habitat – the fields in Colony Farm are the only remaining extensive old field habitat in the north east part of the Lower Mainland, and they are managed for voles which sustain birds of prey. This is supported by a land use plan for Colony Farm developed in 1995 (Colony Farm Land Use Study Steering Committee 1995). It is hoped that drainage will also decrease the extent of moisture-loving reed canary grass (*Phalaris arundinacea)*, and increase mixed grasses, though it is not clear whether this is occurring. Apart from trails, there is no infrastructure that requires flood protection in the Wilson Farm area. The dikes and pump station are only in place to create the dryland environment. Depending on park objectives, part of this area could be used for fish habitat and floodplain enhancement while still providing habitat for the bird species of interest.

On the west side of the river, the dike comes to an end at the Maryhill By-Pass at the south end of Colony Farm. On the east side of the river, the dike comes to an end approximately 500 meters upstream of the river mouth, allowing for an area of floodplain forest above Maryhill By-Pass.

Further information on the Colony Farm dikes is provided by a Colony Farm Land Use Study Background Report (Quadra Planning Consultants Ltd. 1994). The Ministry of Environment has a floodplain management policy for the Coquitlam River, including Colony Farm. Upstream of the farm, the federal and provincial governments upgraded the dikes to a 1:200 year flood level (standard dikes), completing this work by 1994. Colony Farm has dikes to a 1:100 year flood level, and the farm is considered to be part of the Coquitlam River floodway. This means that the Ministry of Environment would oppose any development that involves raising ground levels at Colony Farm or raising existing dikes that would cause Coquitlam River water levels to rise upstream of Colony Farm, potentially impacting property (Quadra Planning Consultants Ltd. 1994). The newer

standard dikes can be seen on the east bank running below, through and above IR#2, and on the west bank above approximately river kilometre 5.25.

photo: BC Hydro/City of Coquitlam

Figure 1: The mouth and lowest part of the Coquitlam River. Note the Wildlife Management Area at the mouth, IR#1 on the west bank, and the field habitat provided by Colony Farm and the Forensic Psychiatric Institute

photo: BC Hydro/City of Coquitlam

Figure 2: Figure 2: Colony Farm and the lower portion of IR#2, including the oxbow. The sheep paddocks are the uppermost three fields on the west bank. The habitat enhancement (constructed channel) is visible in the lowermost sheep paddock. The Upper Wilson Farm (a wildlife management zone within Colony Farm park) is on the east side of the river.

photo: BC Hydro/City of Coquitlam

Figure 3: The upper part of IR#2 is visible on the west bank below Pitt River Road. On the east bank a habitat compensation project is seen. Above the Pitt River Road a standard set-back dike is visible on the east (Port Coquitlam) side of the river and older dikes line the river.

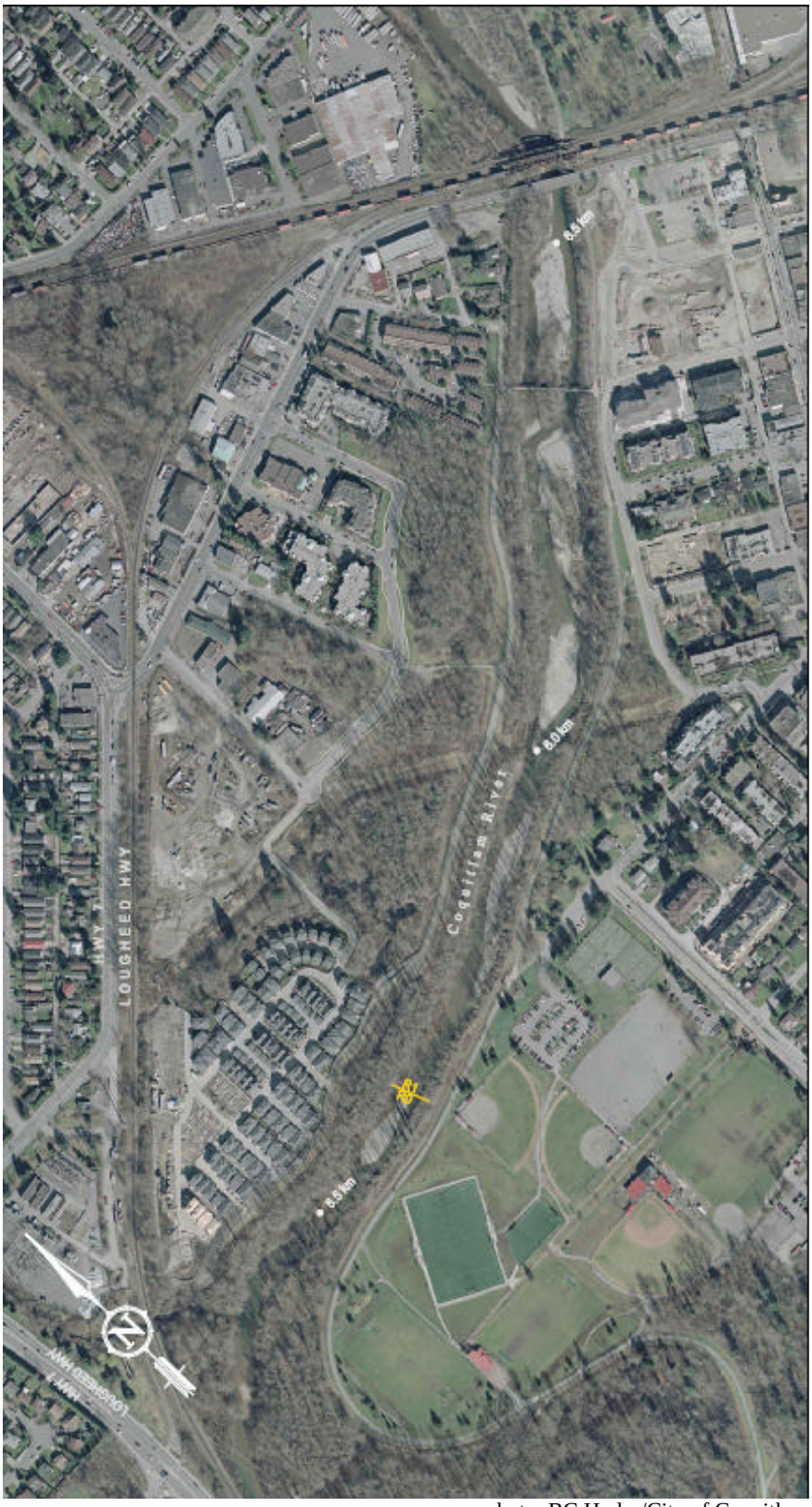


photo: BC Hydro/City of Coquitlam

Figure 4: Gates Park is seen on the west bank. Standard dykes constrain the river in a narrow channel. Gravel bars are seen above km 5.5. whereas the substrate downstream is mostly sand.

Methods

A great deal of existing information was reviewed for this project, and relevant reports are summarized in Appendix 3, with further reports mentioned in the References section of this document. After project initiation and information collection, a meeting of the various stakeholders and government bodies was held on July 16th, 2007 (see Appendix 1 for attendees). The intent of this meeting was to develop the working relationships required to complete this assessment and future restoration works. Other goals were to collect further existing information and inform project partners regarding the project and its goals. A tour for meeting attendees was given of the Sheep Paddocks restoration project, as well as of the cemetery on IR#2 and the adjacent dike and oxbow.

Subsequent field visits by the project biologist and local partners were made to inspect the project area, including the oxbow on IR#2, and the diking and drainage system on Colony Farm and upstream. A one-day inspection of the mainstem and riparian conditions was conducted by the project biologist and the project hydrologist, according to a Proper Functioning Condition methodology. More information on this methodology is found in Appendix 4. Essentially, this qualitative assessment is a useful tool that provides a quick and defensible method for assessing stream riparian and channel conditions. Using the methodology, reaches were rated as being in Proper Functioning Condition, Functional-at-Risk, or Non-functional. To come up with these ratings, a checklist is used to ask questions pertaining to hydrology, vegetation, and erosion/deposition. Riparian conditions were assessed using existing information (McLennan and Veenstra 2001) and current orthophotos (Figures 1 through 4). Existing fish habitat projects were examined and further in-channel and off-channel habitat fish habitat improvement opportunities were assessed

A meeting to discuss the draft recommendations was held on October 22nd, 2007 (see Appendix 2 for attendees). The intent of this meeting was to inform project partners and interested parties regarding the project outcomes, and solicit feedback on the recommendations and their implementation.

Results

Support for this project was evident in the turnout to the project initiation and conclusion meetings. 25 individuals from 16 organizations were present, and several made important contributions to the project as it developed. Goal 1: "Develop Working Relationships" was very successfully achieved.

Goal 2: "Develop Restoration Prescriptions" was also achieved. The recommendations for habitat improvements are discussed in the Recommendations section of this report. Results of the assessment process are described here. The information gathered from both existing sources and field assessments, including the Proper Functioning Condition Assessment, confirmed the problems with sediment inputs and altered flows, and also described riparian, channel and dike conditions, and the current management regime at Colony Farm.

Proper Functioning Condition Assessment

This qualitative assessment of the mainstem river provided a framework for describing conditions. Appendix 4 contains the full assessment as well as a description of how the assessment is done. The study area was divided into 5 reaches labelled A through E to distinguish them from numerical reaches developed in a salmonid stock and habitat assessment (Riley *et. al* 1998). The former assessment did not include the majority of the study area because of its very low values for fish. Only Reach E (km 5.65 to km 6.5, the uppermost reach in the study area) was included in the former study, as its gravel substrate does provide for some fish habitat.

Before human-caused changes, the study area would have contained multiple distributary and tidal channels in a wide floodplain containing typical riparian vegetation for this biogeoclimatic zone, e.g. cedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis),* skunk cabbage (*Lysichiton americanum*), and salmonberry (*Rubus spectabilis*) as well as cottonwoods (*Populus balsamifera ssp. trichocarpa),* alder (*Alnus rubra*), and willow (*Salix spp.*) on the medium and low bench floodplain sites.

The lower river would have contained some fine sediments due to its tidal nature (the normal tidal influence extends to kilometer 4.0), but would have exhibited significant complexity due to interactions between the stream channels and riparian vegetation. The study area would have offered extremely valuable fish habitat. Because the river will likely never re-attain these floodplain conditions due to management constraints, it was evaluated keeping in mind its capability, i.e. the highest ecological status it can attain given political, social and economic constraints. Capability only applies to constraints that a land manager cannot eliminate or change through a management action (Pritchard 1998). These constraints would include flood protection of infrastructure and the changed flow regime due to the Hydro dam.

This assessment described the lowermost reach (Reach A, which extends for only 150 meters), as being in Proper Functioning Condition given the current management

constraints of flow regulation and upstream channelization. This reach is not constrained by dykes and contains riparian trees. Reach B (km 0.15 to km 2.5) extends through the former agricultural fields of Colony Farm. Dikes constrain the river and riparian trees are almost entirely absent. Channel sediments consist of silt and sand. The channel lacks any form of complexity (large woody debris (LWD), pools/riffles or any form of cover). This reach was rated as non-functional, and the factors contributing to unacceptable conditions were listed as flow regulations, channelization, fine sediment input, urbanization, and lack of gravel recruitment due to the Hydro dam. Reach C (km 2.5 to 4.0) has these same factors listed, and has somewhat similar channel conditions – the reach is sand-dominated with localized gravel deposits. Instream complexity is absent. However, riparian conditions are very different – the riparian area is dominated by cottonwood with isolated sitka spruce, in contrast to the shrub-dominated communities in the reach below. The setback dyke on IR#2 on the east side of the river allows for a healthy floodplain and riparian community that includes an approximately 700 meter long oxbow channel now isolated from the mainstem. The river is constrained by a dyke on the west bank, but this dyke is not completely functional and does allow some floodplain access. This reach is rated 'Functional – at Risk' because even though stream channel conditions are poor, there is a relatively healthy riparian area and partially accessible floodplain due to setback/low elevation dykes. Increased flushing flows could potentially elevate the rating of this reach to Proper Functioning Condition within the current management constraints.

Reach D extends from kilometre 4.0 (just below the Pitt River Bridge) to kilometre 5.65. This reach is above the tidal influence of the Fraser River except during very large floods. The stream channel continues to lack complexity and LWD, and continues to be dominated by sand, with some deposits of gravel in the lower and upper ends of the reach. This reach has similarly poor channel conditions and a more limited and variable floodplain than Reach C, and has the same degrading factors listed as for Reaches B and C. It is rated Functional – at Risk. If flushing flows improve sediment conditions then this reach could be rated Proper Functioning Condition. Reach E (km 5.65 to km 6.5) has its lower end coincident with a reach break from a salmonid stock and habitat assessment (Riley *et. al* 1998), as this is the only part of the study area seen to provide any fish habitat value. This reach is highly channelized with a thin strip of riparian vegetation. The substrate is primarily composed of gravels, and the river contains prominent gravel bars with some pioneering vegetation. This reach is rated Functional – at Risk because it does contain gravel substrate and supports fish populations, unlike the reaches downstream. Flow regulations, channelization, fine sediment input and urbanization are listed as constraints contributing to unacceptable conditions.

Altered Flows and Channel Conditions

Large flood flows are extremely uncommon in the Coquitlam, with the last one occurring in 1961 with a peak flow of 527 m^3/s. Since that time the Coquitlam Reservoir has been operated at lower levels and there have not been significant flood events. The flood of October 2003 produced a downstream peak flow of 211 m^3/s and the flood of March 2007 had a peak flow of 215 m^3/s. Prior to the construction of the Coquitlam Dam the two-year (bankfull) flow would have been about 370 m^3/s (David Sellars, Water

Management Consultants, personal communication). Normal post-dam flows range from 2 – 10 m^3/s (Water Survey of Canada, Station 08MH141 in Decker *et. al* 2007). The river has likely adjusted to these reduced flows by narrowing its channel, in addition to the likely elimination (due to urbanization) of some channel capacity provided by secondary channels.

Reduced gravel recruitment is an issue due to gravels being trapped behind the Coquitlam dam, and the river is also affected by increased sedimentation due to reduced peak flows (Northwest Hydraulic Consultants Ltd. 2001). The dam also would reduce large woody debris (LWD) recruitment, a situation that is worsened by the very limited quantity of riparian conifers (and in some areas a complete lack of trees) in the study area.

As discussed in the Proper Functioning Condition Assessment, channel conditions in the study area of the Lower Coquitlam River are very poor. Gravel substrate is uncommon to non-existent in all but the top 1 kilometre of the study area. Sand is the dominant substrate, combined with finer silt in the lower 2.5 kilometres. Large woody debris is almost completely absent, as are channel complexity and cover. These conditions are attributed to the changed flow and sediment/LWD regime due to dam construction and operation, to the channelization of the river, and to the input of silt and fine sand from the gravel pit operations along Pipeline Road.

Stormwater run-off has predictable effects on water quantity in streams in urban areas: run-off increases flood levels because impervious areas (pavement, roofs) no longer allow infiltration into the ground. Rather, water is quickly piped into the receiving stream, allowing water levels to rise much more quickly than under natural forested conditions. It is not known how much stormwater has altered the hydrograph of the Coquitlam River; the altered flow regime will have a much larger effect on the river than will stormwater run-off. Changes to water quantity generally becomes an issue when impervious areas exceed 10% of the watershed area, and when impervious areas exceed 30%, stream habitat tends to become unusable for salmonids. Sudden high flows cause erosion that scours fish habitat, and the lack of water soaking into the ground can also affect base flows in the summertime. The Coquitlam River will always have the moderating influence of Or Creek and base flows from the dam, but the quality and quantity of stormwater runoff should not be discounted, particularly as the surrounding area continues to develop. Low impact development can reduce or eliminate the changes to water quantity caused by impervious area, by creating features that allow water to soak into the ground.

Sediment Inputs and Water Quality

In an assessment of conditions in the Coquitlam River (Higgins *et. al* 2001), experts agreed that the point source pollution associated with gravel mining operations was as important a factor affecting river conditions as were BC Hydro operations. Some data exist to substantiate this pollution source: in 2004 and 2005 the City of Coquitlam (City of Coquitlam 2005) did water quality monitoring upstream and downstream of the gravel pits. There was a clear difference between upstream and downstream measurements of

turbidity. At times turbidity can be related to rain events but there were also a number of spikes at the downstream location unrelated to rainfall and to upstream turbidity levels. The turbidity was measured as high as 2,000 NTU. In the 8 months on record, turbidity readings exceeded 400 NTU 17 times including a 5 day rainy period in January 2005, where downstream turbidity readings fluctuated greatly, ranging between 400 and 2,000+ NTUs. On this occasion, upstream turbidity was also elevated, though much less so and for a shorter duration.

The data collection also included temperature, dissolved oxygen, pH, and total dissolved solids. Currently, the City of Coquitlam is beginning to take more water quality data that will not be available until the instream sensors are removed (Melony Burton, City of Coquitlam, personal communication). Sediment pollution from this source has been an issue for a long time. In approximately 1980, the Province laid charges against Jack Cewe Ltd. for the operation of their gravel pit on Pipeline Road, for the damage the sediment pollution was causing to fish and fish habitat. The province won but the Cewe successfully appealed the decision (Pat Slaney, personal communication).

A recent report describing substrate monitoring under the BC Hydro Water Use Plan states that Or Creek is thought to be the largest source of sediment to the lower Coquitlam River, but also states that gravel mines contribute potentially significant quantities of fine sediment to the river (Northwest Hydraulic Consultants 2007). It is important to distinguish the type of sediment provided. In the watershed's current state, Or Creek is the major source of bedload (coarse sediment) to the lower river, due to 40 landslides, 60 gullies, and 22 kilometres of maintained and abandoned forestry roads (Water Management Consultants 2003). Between the confluence of Or Creek and the Coquitlam River and the first bridge crossing of Or Creek, the channel is bounded by steep and unstable slopes up to 100 metres in height. For most of this reach the exposed material is coarse-textured till and glacio-fluvial deposits. Sand and boulder sized material is delivered directly to Or Creek from numerous bank failures. This area is likely to be a significant source of sediment in the Coquitlam River. Restoration of the Or Creek watershed to eliminate the major sources of sediment would help address bed aggradation occurring upstream of the CP Rail Bridge (Water Management Consultants 2003). Suspended sediment from Or Creek has not been investigated, however the water quality data available indicates that suspended sediment in the lower river is coming from the gravel pits and not from further upstream (City of Coquitlam 2005). Ideally the gravel pits and settling ponds should be inspected and monitored directly.

Dissolved oxygen and temperature are likely water quality issues in the standing waters in Colony Farm. Standing water is found in ditches that line the dikes and in smaller ditches that separate the fields. These waters are likely unsuitable for salmonids. Water temperature was measured only at the oxbow in IR#2: on August 22nd, 2007, at 1:00 p.m., the temperature was 22°C in the middle of the channel, giving an indication that these waters do not provide salmonid habitat in summertime, even if access is possible.

An historic landfill is found near the river at approximately river kilometre 4.75, within the municipality of Port Coquitlam. An environmental assessment done for the entire

City of Port Coquitlam in 1992 (Gartner Lee 1992) states that reports of the contents of the dump vary. The authors noticed some visual evidence of leachate downstream of the dump and also stated that methane gas may be present at levels considered to be combustible. The report authors were unable to find any reports on this area during their study. During the current study, iron-rich water was seen downstream of the dump site, and this water was discharging gas. Iron is an indicator of leachate. However, it is not known whether this is a natural phenomenon or whether the presence of iron was caused in whole or part by leachate. Iron-rich groundwater was also seen occurring in natural seeps upstream of the dump. More investigation, including water sampling, is warranted to understand whether the dump is causing environmental harm.

Stormwater runoff is piped into the Coquitlam River from the surrounding neighbourhoods in the Cities of Coquitlam and Port Coquitlam. On the Port Coquitlam side, runoff from an 83 hectare catchment is pumped into the Coquitlam River just upstream of IR#2. Stormwater runoff is known to contain various pollutants that are washed off roads, parking lots, and lawns, such as hydrocarbons, metals, pesticides and fertilizers. Little information was uncovered regarding the quality and effects of stormwater runoff in the Coquitlam River, except for monitoring done to understand the quality of water flowing into Wilson Pond. Stormwater runoff was measured on one occasion in 1999, and met standards for aquatic life, though the pond itself (which is fed by stormwater runoff) did not meet the guidelines for dissolved oxygen, nitrite and temperature. (Quinlan and Raggett 1999).

BC Hydro Water Use Plan

In the past, the Coquitlam dam has contributed to large water fluctuations that have resulted in the scouring of spawning beds in the upper reaches. An agreement on the timing and rate of discharge was reached between BC Hydro, Ministry of Environment, and DFO in 1997 (Quadra Resource Planning Consultants Ltd. 1998) at the initiation of BC Hydro's Water Use Planning. Since 1997, base flows leaving the dam range from 0.8 to 1.9 m3/s depending on head. This level of base flow is described as "Treatment 1" (Decker *et. al* 2007). Treatment 1 is one of two regimes decided upon to compare changes in fish production under different flow regimes, and has been monitored between 2000 and 2007. This regime is an improvement from former conditions, and it is credited for improving chum (*Oncorhynchus keta)* and pink salmon (*O. gorbuscha)* returns in 2002 – 2006 compared to years prior to 1997 (Decker *et. al* 2007). Prior to June 1997, flow releases from the dam ranged from 0.06 to 0.5 m3/s not including occasional spill events.

Treatment 2 was scheduled to commence in 2007, but has been delayed by seismic upgrades to the dam. The necessary new gate will now likely be constructed in spring or fall 2008 (Dave Hunter, BC Hydro, personal communication). The flow releases under this regime range from 1.1 m3/s for base flows (steelhead (*Oncorhynchus mykiss)* rearing) to 5.9 m3/s for chinook (*O. tshawytscha)* spawning, and the volume changes depending on the month in question (see Table 1). Treatment 2 has these levels of flow as targets, and also has minimum flows that must be met when it is not possible to achieve

the target given low flows and other uses of water (i.e. GVRD drinking water). Treatment 2 will be implemented and evaluated for up to nine years (Decker *et. al* 2007). For a comparison of Treatment 1 and Treatment 2, refer to Table 1.

	Reservoir diversion schedule (m^3/s)			
	Coquitlam Dam releases			
		Treatment 2		
Period	Treatment 1	Target	Min	Target species and life stage
Jan 1-15	1.0	5.9	3.6	Chinook spawning
Jan 15-31	1.0	2.9	2.9	Chinook incubation
Feb	1.0	2.9	1.8	Chinook incubation
Mar	0.8	4.3	1.1	Steelhead spawning
Apr	0.8	3.5	1.1	Steelhead spawning
May	1.1	2.9	1.1	Steelhead spawning
Jun	1.4	1.1	1.1	Steelhead parr
Jul	1.4	1.2	1.1	Steelhead parr
Aug	1.1	2.7	1.1	Steelhead parr
Sep	0.8	2.2	1.1	Steelhead parr
Oct	0.8	6.1	3.6	Chinook spawning
Nov	1.1	4.0	1.5	Chinook spawning
Dec	1.1	5.0	2.5	Chinook spawning

Table 1: Comparison of Treatment 1 and Treatment 2 releases (data from BC Hydro 2003, modified from Decker *et. al* 2006).

Ramping rate (the rate of increase or decrease in flows) is also regulated by the Water Use Plan, to minimize stranding of fish.

The Coquitlam River fish monitoring program is focused on the effects of dam releases on fish productivity in mainstem habitat in reaches 2a, 2b, 3 and 4 of Coquitlam River, because this section contains the majority of productive spawning and rearing habitat in the Coquitlam River mainstem (Decker *et. al* 2007) (though the lower-most adult spawning index site does extend into the uppermost part of the study area). Therefore, the restoration recommendations proposed in this report are not expected to confound the results of WUP monitoring.

Flushing flows have been much discussed as a method to improve channel conditions in the river, by cleaning spawning gravels of fine sediments. It is possible that these flows would also improve gravel recruitment/distribution. Under the Water Use Plan, BC Hydro is carrying out substrate monitoring (Northwest Hydraulic Consultants 2007) to understand flow related changes to sediment. According to the first substrate quality assessment (Northwest Hydraulic Consultants 2007), flushing flows will be achieved opportunistically with annual releases of 30 to 50 m^3/s, for three to five days in duration, coinciding with high tributary inflows resulting in total flows of 70 to 100 m^3/s. Additionally, natural flows of 70 – 110 m3/s are expected one out of every four years. However it appears that no flushing flow releases are planned, as the Water Use Plan Fisheries Technical Committee has recommended that opportunistic flushing flows be

postponed until after the review period and flow trials have been conducted so as not to confound the monitoring results.

Riparian Conditions

The age and type of riparian vegetation is an extremely important determinant of stream health. Mature forest provides large woody debris (LWD) important for the structure of the stream channel and fish habitat, in addition to the other functions that riparian vegetation provides such as bank and channel stability, shade, organic inputs, wildlife habitat, and sediment filtering. Conifers are particularly important for LWD, as they attain a greater size and decay much more slowly than do deciduous trees.

Before being developed for agriculture, riparian vegetation would have surrounded multiple floodplain channels, and would have consisted of typical riparian vegetation in this biogeoclimatic zone, such as: cedar, sitka spruce, skunk cabbage, and salmonberry, as well as cottonwoods, alder, and willow on the medium and low bench floodplain sites.

The Proper Functioning Condition Assessment described riparian conditions in general terms for Reaches A through E. Detailed riparian floodplain mapping based on site series (Biogeoclimatic Ecosystem Classification) and structural stage was done in 2001 (McLennan and Veenstra 2001 – see Appendix 6) to provide a baseline floodplain condition for BC Hydro water use planning. It is important to note that the riparian mapping based on site series describes the vegetation potential based on floodplain elevation, and does not necessarily describe current, more disturbed conditions. Orthophotos from 2006 (see Figures 1 to 4) and site visits were used to confirm riparian conditions.

Riparian conditions are poor in Colony Farm between river kilometre 0.5 and 2.5. Through this section, dikes are maintained to be free of trees and the riparian vegetation consists of shrubs such as willow and hardhack (*Spirea douglasii)*. Below this section and the Fraser River, the Wildlife Management Area provides mature forested conditions dominated by cottonwood, as well as a lower bench area along the east bank dominated by shrubs, herbs, and wetland vegetation.

Riparian conditions improve above kilometre 2.5. A young cottonwood-dominated forest lines the east bank between kilometre 2.5 and 2.8. Above that point, the streamside forest is mainly mature and continues to be dominated by cottonwood. Conifers are very sparse and consist mainly of sitka spruce, occurring mainly between river kilometre 2.8 and 3.8. The lack of mature conifers in the study area is one reason why the Coquitlam River channel lacks complexity (LWD) and provides such poor fish habitat.

A significant portion of IR#2 contains very valuable mature and old forest. Some of this forest – particularly the older forest – is isolated from the floodplain by the standard dike that cuts through the reserve.

Oxbow habitat and Cemetery Flooding in IR#2

Flooding in the Kwikwetlem First Nation cemetery in Indian Reserve #2 has been an issue for some years. Historically, the active floodplain was much wider before it was constricted by dykes and bridges. Consequently, water levels are expected to rise higher in the main channel for events that would have previously activated the floodplain (Urban Systems Ltd. 2005). Flood conditions occur in the cemetery when mainstem flows exceed approximately 140 m^3/s (Bland 2001 in Urban Systems Ltd. 2005). When river levels in the Coquitlam River are high, the water backs up through a channel used to convey stormwater from Port Coquitlam, and overtops Old Pitt River Road into the cemetery, after which it drains into an adjacent cut-off oxbow (see Figure 5). The larger floods and their corresponding higher water levels in the main channel (i.e. associated with flow rates that overtop the non-standard dykes) remain the major threat to erosion and inundation of the area in and around the cemetery (Urban Systems Ltd. 2005). Additionally, there is a strong possibility that water levels in the oxbow are rising higher than they would have prior to floodbox removal in the non-standard dike that crosses the oxbow (Urban Systems Ltd. 2005). Since the cemetery is only about a metre above the average water level in the oxbow, it can also be expected that water will seep back through the loose silt layer into the cemetery (Piteau Associates Engineering Ltd. 2001 in Urban Systems Ltd. 2005).

In general, flooding may be worsened by aggradation in the mainstem, which has been occurring (Bland 2001 in Urban Systems Ltd. 2005) as the river has adjusted after being dredged for coal barge passage between 1913 and the 1950's, after subsequent gravel mining in the mainstem years, and with fewer high flow events in more recent decades.

The preferred option put forth by Urban Systems Ltd. (2005) to address the flooding issue in the cemetery was to raise the cemetery site, including an expanded area to the north, to the same height of the standard dyke, to address both surface water and groundwater concerns. This option would also allow a channel to be constructed that would connect the oxbow to the mainstem. More study of the implications of this option was recommended. Other options that could be combined with this solution to address flood levels include removing the right bank non-standard dike so that floodwaters can spread over this western floodplain (Urban Systems Ltd. 2005), though the investigation of the dikes in this current study indicated that the non-standard dike on the west bank was already somewhat ineffective in barring floodplain access.

Figure 5: Indian Reserve #2 is on the east (right) of the main channel. The oxbow is shown here. The cemetery is adjacent to the top of the oxbow and is indicated by two arrows. Also shown is a constriction where an older dike crosses the oxbow. The bridge in this location has been removed.

The cut-off oxbow (slough) on the reserve adjacent to the cemetery has been the subject of interest for potential improvements to fish habitat. A study was done in 2001 (Kerr, Wood, Leidal Associates Ltd. 2001) to look at the feasibility of side channel reactivation (i.e., creating better connections between the oxbow and the mainstem in order to provide better fish habitat). The oxbow was seen as having the potential for improved coho (*Oncorhynchus kisutch)* wintering habitat. A direct upstream connection to the river was not recommended, but a groundwater fed option from the Port Coquitlam pump house (located at the top of the oxbow and currently draining into the mainstem river) was seen as the preferred option. This option raises water quality concerns as the pump house is moving stormwater out of nearby subdivisions. As reported by Urban Systems Ltd. (2005) there was also interest in creating a channel or an intake that connected the oxbow to the mainstem river. Either option to create more flows might create more problems at the cemetery due to increased water levels and caution should be exercised (Urban Systems Ltd. 2005).

The oxbow was examined during this current study. Multiple depth measurements were taken along the length of the oxbow, and it was found that during summertime lower water levels, the oxbow averaged 1 meter in depth throughout. Temperature readings were taken and the last reading taken at 1:00 p.m. on August 22nd showed a temperature of 22°C. The outlet to the channel was located, and an approximately 2-meter elevation

difference was noted between the water surface at the oxbow outlet and the mainstem of the Coquitlam River. Tidal conditions and mainstem flow conditions at the time were relatively low. Multiple small channels including one main channel connect the oxbow and mainstem at high flows and high tides. These channels cut through a high silty bank and are well hidden by vegetation.

Any attempt to better connect the mainstem to the oxbow at its outlet will require addressing the elevation differences between the two. Simply digging an outlet channel will drain the oxbow. One (expensive) solution would be to excavate along the length of the oxbow to equalize the elevations. It is also possible that some kind of fishway could be constructed to connect the oxbow without draining it – this may require an extensive retaining wall. If summertime habitat were desired, increased flows would also be necessary to lower temperatures to within the range of comfort for fish. As discussed above, this could potentially be done via stormwater flows coming through the pump house from Port Coquitlam, or by an intake pipe coming from the mainstem river. Water quality concerns would need to be addressed in either case. Water coming from the mainstem river will contain sediment, and water coming from the Port Coquitlam pump house would need to be monitored to ensure it is high enough quality to achieve fish habitat objectives. Currently, it appears that improving the oxbow for fish is an expensive proposition with uncertain benefits. It would be interesting to know what if any fish use currently occurs in wintertime, and how often the two channels are connected.

Chronic flooding in the gravesites is related to groundwater levels, and the oxbow will have a strong influence on the water table. As mentioned, groundwater will seep from the oxbow into the cemetery site. Changing water levels in the oxbow could therefore lower the average water table in the cemetery. One way to address the groundwater table could be to remove the constriction across the oxbow caused by the old dike (see Figure 5). While the constriction does not currently impound water, at least during the summertime, if the beaver dam at that location is repaired the upstream water level will rise in winter. Removing the constriction so beavers can no longer dam it could lower the winter water table at the cemetery.

Currently, the oxbow is providing wetland habitat. In a brief visit it was seen to be well populated by introduced green frogs (*Rana clamitans*). It would be interesting to survey the area for other amphibian users and for other wetland-dependant wildlife, particularly if significant changes are proposed.

Potential actions to address the oxbow are found in the Recommendations section.

Existing Habitat Improvement Projects

Colony Farm Vegetation and Wildlife Management

Colony Farm Regional Park is managed by the Greater Vancouver Regional District (GVRD) based on a land use plan (Colony Farm Land Use Study Steering Committee 1995) with an overall goal: "to protect Colony Farm based on its importance for wildlife, agriculture, and passive recreation." After agriculture was discontinued on the farm in the 1980's, its importance for wildlife increased. According to the land use plan, Colony Farm is one of the most biodiverse areas in Coquitlam and Port Coquitlam, containing marsh, grassland, forests, hedgerows, ditches, and the Coquitlam River and its adjacent riparian vegetation. Colony Farm is the last remaining extensive field habitat in the northeast part of the Lower Mainland. The Burke Mountain Naturalists (as well as the Colony Farm Park Association and community gardens) have been very involved in the stewardship of Colony Farm Park. In 1996 the Burke Mountain Naturalists produced a bird species checklist that contained 156 species, or about one-third of all bird species occurring regularly in British Columbia (Quadra Planning Consultants Ltd.). Since the bird checklist was published in 1996, at least another three species have been sighted (Elaine Golds, Burke Mountain Naturalists, personal communication). A technical background report (Quadra Planning Consultants Ltd. 1994) to the land use study provides more information on these bird species, as well as listing mammal and herptile species that have been seen or may occur in the area. A plant species list compiled in 2006 is also available from the Burke Mountain Naturalists, and lists 159 species of plants seen at Colony Farm. Of these, a large proportion (approximately 36%) are non-native, and a sub-set of these are invasive.

The land use plan clearly designates zones for agricultural management, wildlife management, and integrated management (both wildlife and agriculture) – see Figure 6.

While not explicitly stated in the land use plan, currently one of the main management policies of the GVRD (who assumed ownership in 1996 when Colony Farm was designated as a Regional Park) is to place special focus on maintaining the Townsend's vole (*Microtus townsendii*) population for birds of prey at Colony Farm. This is done through vegetation management for old field habitat in the Wildlife Management Area (upper Wilson Farm and the Sheep Paddocks on Home Farm), and Integrated Management Area (lower Wilson Farm and one field in Home Farm south of the Sheep Paddocks). The lower Fraser Valley and Fraser River delta support the largest wintering population of birds of prey in Canada and a key prey species is Townsend's vole (*Microtus townsendii*). Old field habitat provides both food and cover for Townsend's voles (Taitt 2006). These and other small mammals contribute to a significant portion of the diet for the following raptors at Colony Farm:

- Red tailed hawk (*Buteo jamaicensis*),
- Northern Harrier (*Circus cyaneus*)
- Short-eared owl (*Asio flammeus*)
- Common Barn Owl (*Tyto alba*)
- Great Horned Owl (*Bubo virginianus*) (the preceding list from Erlich et al. 1998 in Quinlan and Raggett 1999)

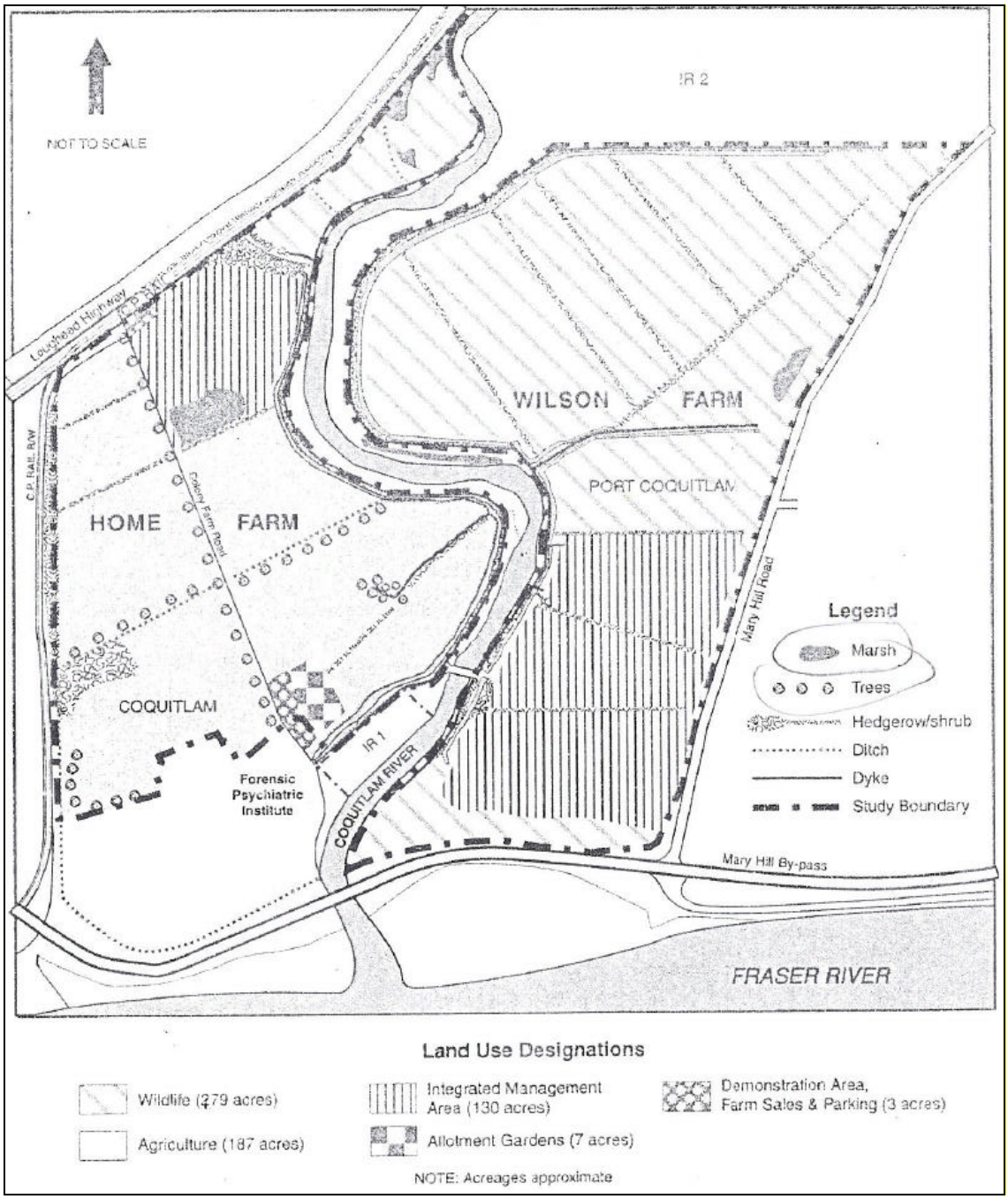


Figure 6: Land use designations from the Colony Farm Land Use Plan (Colony Farm Land Use Study Steering Committee 1995)

However the short-eared owl has not been seen at Colony Farm in recent years (Elaine Gold, Burke Mountain Naturalists, personal communication). Small mammals also contribute to the diets of the following bird species seen at the farm:

- Bald Eagle (*Haliaeetus leucocephalus*)

- Cooper's Hawk (*Accipiter cooperii*)
- Rough-legged Hawk (*Buteo lagopus*)
- Osprey (*Pandion haliaetus*)
- American Kestrel (*Falco sparverius*)
- Merlin (*Falco columbarius*)
- American bittern (*Botaurus lentiginosus*)
- Black-crowned Night-Heron (*Nycticorax nycticorax*)
- Great Blue Heron (*Ardea herodias*) (Erlich et al. 1998 in Quinlan and Raggett 1999)

Great importance is placed on maintaining habitat for these species in Colony Farm Park. Other bird species of management concern at Colony Farm that are not included in the lists above are Green Heron (*Butorides virescens)*, Hutton's Vireo (*Vireo huttoni)*, Peregrine Falcon (*Falco peregrinus)*, Sharp-shinned Hawk (*Accipiter striatus)*, Double-crested Cormorant (*Phalacrocorax auritus*) and Trumpeter Swan (*Cygnus buccinator*) (Beauchesne and Quinlan 1999), for a total of 19 bird species of management concern. Of these species, 10 are on the province's red or blue lists. (The American Peregrine Falcon is endangered/threatened – red listed – and 9 species are on the blue list because they are considered vulnerable/sensitive.) The remaining 9 bird species of management concern at Colony Farm are wintering raptors and owls because of the region's importance for these species.

The Greater Vancouver Regional District Parks department embarked on a wildlife enhancement program at Colony Farm Park starting in 1998. Funding came from the Vancouver Airport Third Runway Compensation Program and Tree Canada Foundation (Quinlan and Raggett 1999) as well as from Forest Renewal BC (a provincial funding source). Baseline biophysical inventory work was done in the summers of 1997 and 1998. In the fall of 1998, a field mowing program was initiated to maintain old field characteristics (mixed grasslands) by reducing the encroachment of blackberry and other shrubs. Two field areas (10m x 60 m) were mown in the lower Wilson Farm (Quinlan and Raggett 1999). In 1999, two of the fields on the lower Wilson Farm were mown, and a third was heavily infested with blackberries, therefore a brush cutter was used to remove vegetation (Quinlan and Beauchesne 1999). In addition to maintaining field habitat, mowing was done to reduce vegetation cover, providing better prey visibility and accessibility for raptors and Great Blue Herons (Ferrigan 1999 in Quinlan and Raggett 1999), though mowing was seen as effective for this purpose only in the short term, as over the course of one year the grass grows to previous, if not greater heights (Quinlan and Ragget 1999).

Over 4,500 trees and shrubs were planted by the GVRD in 1999 in strips in various locations in Colony Farm, with the goal of increasing habitat availability and structural diversity for target and non-target bird species (Ferrigan 1999 in Quinlan and Raggett 1999). Field management was done to complement these plantings (Frieda Schade, GVRD, personal communication). This included the mowing to remove blackberry, plus later tilling and planting to provide diversity in grass species.

Raptor perches and a Barn Owl nest box were also constructed to enhance wildlife habitat, though the follow-up evaluation (Quinlan and Raggett 1999) did not indicate that these were well used.

Reed canary grass dominates the fields in Colony Farm Park (see Figure 7). This grass prefers full sun in moist to wet habitats, but also tolerates extended periods of both wet and drought conditions (Graham 2003). It is likely native to British Columbia, but has hybridized with varieties from elsewhere, increasing its adaptability and making it a more aggressive invader. Reed canary grass is capable of near total dominance over native wetland plant communities (Graham 2003). At Colony Farm, attempts have been made to control this grass in two ways: i) maintaining drainage of the fields (ditch maintenance and continued use of the Wilson Farm pump station) to facilitate drier conditions that may allow other grasses to persist or establish, and ii) a field 'renovation' project that took place in 2006.

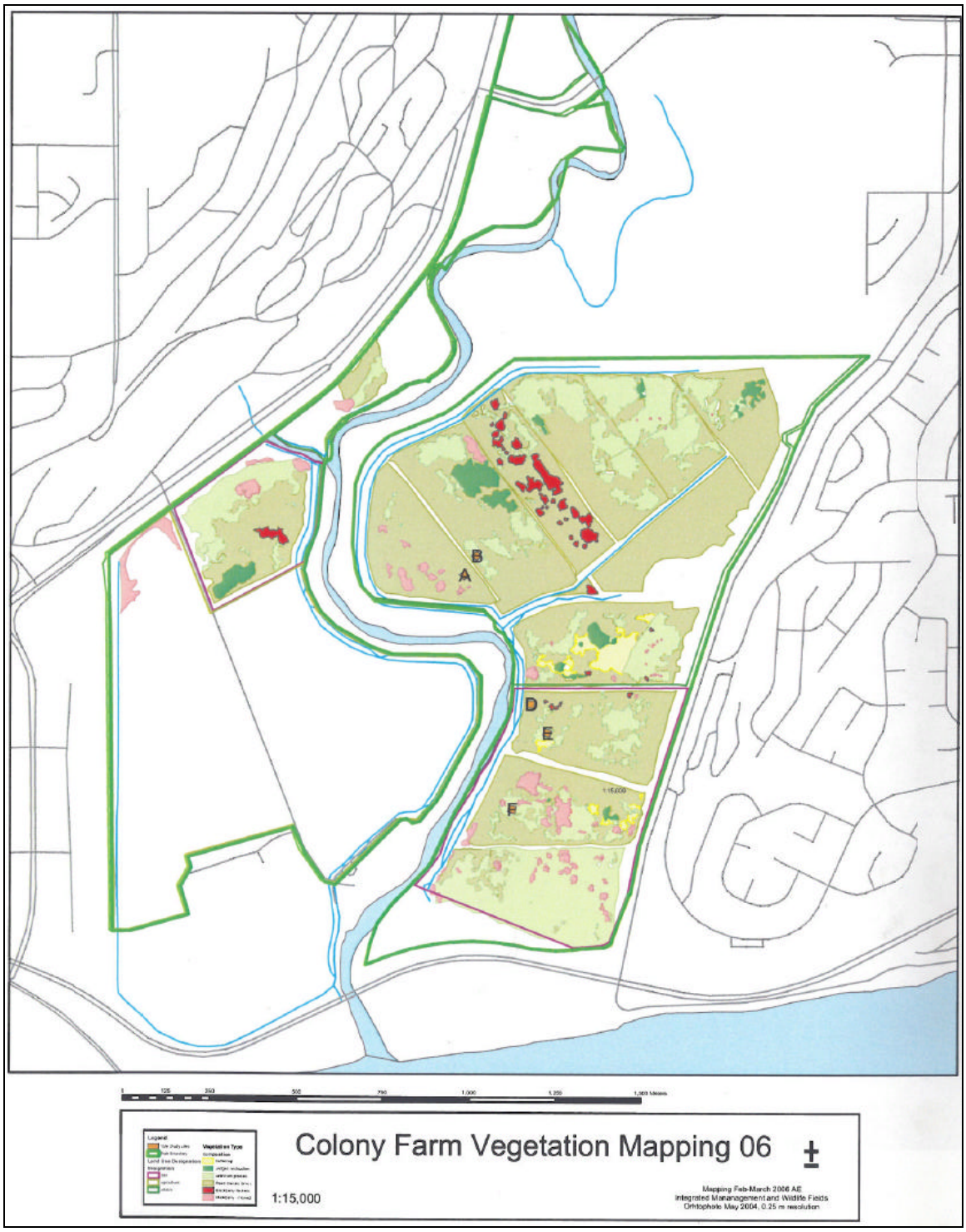


Figure 7: Vegetation mapping in the Wildlife Management Areas and Integrated Wildlife Management Area at Colony Farm, based on 2004 orthophotos (Taitt 2006). The olive green is reed canary grass, light green is unknown grass, red is blackberry thickets and pink is mown blackberry. This mapping predates field 'renovation' done in a field in the upper Wilson Farm.

The field renovation project took place in one of the fields in the upper Wilson Farm (Wildlife Management Area). Ploughing and tilling was done periodically throughout the summer to remove reed canary grass and prepare the field for seeding with other more desirable agricultural grass species. This work appears to have been successful (Alison Evely, GVRD Parks, personal communication).

The potential for purple loosestrife (*Lythrum salicaria)* invasion is an issue at Colony Farm and particularly at wetter sites such as the constructed wetland (see below) and any future fish habitat construction projects. Before and after wetland construction done in 1998, the presence of purple loosestrife was noted (Quinlan and Raggett 1999). A biological control program has been very successful in reducing the extent of this plant throughout Colony Farm Park (Alison Evely, GVRD Parks, personal communication) though total eradication is unlikely. During field visits in 2007, purple loosestrife was noted at the river mouth and along the margins of the oxbow in IR#2. Biological controls may need to be repeated in the future (Alison Evely, GVRD Parks, personal communication).

Sheep Paddocks

The sheep paddocks is an area in the upper Home Farm that has been reverting to wetland habitat in the absence of drainage. The following objectives were achieved in Phase 1 which involved construction of a tidally-flushed channel in the lower of the three paddocks (fields):

1. Increase off-channel inter-tidal slough habitat: 3,800 m2 of aquatic habitat was created, and had immediate use by coho smolts as well as emergent coho, chum salmon, chinook salmon, cutthroat trout (*Oncorhynchus clarki)* and steelhead. The channel had a stepped design (i.e. shallower benches lining the deeper channel, to promote wetland and waterfowl habitat) and was complexed with large woody debris.
2. Increase small mammal habitat, improve opportunities for raptor preying: 9,000 m2 of terrestrial habitat was modified by creating mounds from spoil and replanting these with shorter pasture grasses as an alternative to reed canary grass. These mounds were intended to provide vole habitat even when the rest of the field was flooded. Constructed log piles provided hiding cover on these mounds.
3. Increase amphibian and reptile habitat and riparian vegetation biodiversity by creating species-specific habitat and replanting with appropriate indigenous plants: rock dens were constructed for snakes, with sand placed adjacent. A sandy beach was constructed for turtles. One post was included for a raptor perch. The open field habitat was left intact over much of the area, while 950 shrubs and trees and aquatic plants were planted along the bank. A more diverse grass species mix was introduced into disturbed areas to provide alternatives to reed canary grass.
4. Increase the community stewardship ethic by providing limited access for observation of new habitat coupled with interpretive education and

descriptive signage: a viewpoint has an interpretive sign installed discussing the objectives and features of the project.

The newly constructed channel can be seen in see Figure 8, and as noted above has been very successful in providing off-channel habitat. To create fish access to the paddock, a non-standard, un-maintained dike was breached to connect the paddock to Munday slough. Concerns were later raised about potentially compromising flood protection. The pros and cons of repairing the breach and installing a floodbox will be explored in future as part of finalizing the restoration concept for Phase 2.

The planting of native vegetation was designed and completed by students and staff at Douglas College. The smaller shrubs have since been overwhelmed by grass. The project was designed to be completed in phases, with the work in the lower paddock being Phase 1. The complete restoration concept (Phase 2) also includes a channel in the paddock above, to be connected to the existing channel.

In addition to being well used by fish, Phase 1 of the Sheep Paddocks also supports water birds not previously seen in that part of the park (Frieda Schade, GVRD, personal communication). Maintaining the upland part of the Sheep Paddocks by controlling invasive species such as blackberry is an ongoing challenge and this long-term maintenance needs to be taken into account in restoration planning.

BC Hydro's Bridge Coastal Restoration Program provided funding for Phase 1, amounting to $78,375. The entire project (including in-kind contributions) was valued at $171,140.

Figure 8: The sheep paddocks in 2006. The constructed channel is seen in the lower paddock, and feeds into the river via the slough (Munday Slough) seen running perpendicular to the Coquitlam River.

Fish Habitat Compensation

In 1995 a fish habitat compensation project (compensation for fish habitat lost to development elsewhere) was constructed in the upper west part of Colony Farm Park – see Figure 9. This was to provide off-channel rearing and over-wintering habitat. However, the outlet to the channel was not designed taking into account likely beaver activity. As a result, the area has instead developed wetland habitat, with a channel that connects to the river only at high tide and high water levels. In addition, the channel outlet(s) under the river dyke appear to be designed in such a way that continued flows are not assured – in fact the outlets are highly constricted. These outlets should be assessed against their original design to determine whether corrective action should be taken to maintain a connection to the river. Overall, the project is not meeting its goal. However, the wetland habitat created is still valuable, and while not intended, is a

positive outcome of this project considering that wetland habitat is now very rare in the Coquitlam River watershed compared to historic conditions.

Figure 9: Fish habitat compensation project constructed in 1995 (see channel running parallel to the Pitt River Road).

Wilson Pond

Ducks Unlimited assisted the GVRD in the construction of a 1.5 hectare wetland (permanent pond) on Wilson Farm in 1998 (see Figure 10). The purpose of this project was to:

- Increase diversity of wildlife habitat
- Increase biological diversity of plant species, and
- Increase habitat diversity for bird species at Colony Farm (Quinlan and Ragget 1999)

In a follow-up survey done in 1999, the greatest avian abundance and diversity in Colony Farm was found in this area. 29 bird species were observed, and three species of waterfowl not previously documented as breeding were seen with juveniles (Pied-Billed Grebe, American Coot and Northern Shoveler) (Quinlan and Raggett 1999). Three species of amphibians were noted: roughskin newt (*Taricha granulosa*) and the introduced invasive bullfrog (*Rana catesbeiana*) and green frog (*Rana clamitans*). This wetland is fed by stormwater runoff, and the water quality in this runoff was found to meet standards for aquatic life, but the water quality in the pond itself did not meet standards for dissolved oxygen, nitrite and temperature. Vegetation changes were also considerable. Flooding led to a decrease in abundance and coverage of reed canary grass, allowing for the establishment of new aquatic species such as floating-leaved pondweed (*Potamogeton natans*), and the increase in extent for other species such as cattails (*Typha latifolia*) and common rush (*Juncus effusus)* (Quinlan and Raggett 1999). The follow-up

surveys for vegetation and wildlife were done only one year after the pond construction, so further changes have likely occurred. Further monitoring of birds, amphibians and vegetation changes would be of interest. Increasing native shrubs and trees on the pond margins would also be beneficial.

.

Figure 10: Wilson Pond in July 2007.

Invasive exotic species

Due to longstanding and significant human influences, the study area contains significant numbers and coverage of invasive exotic species. Reed canary grass is included in this category even though native varieties exist, because varieties from Eurasia have likely hybridized with native varieties and are the presumed cause of its aggressive habits (Graham 2003).

Reed canary grass is the most extensive of the invasive species found (see Figure 7). The only known ways to successfully control reed canary grass in native ecosystems are herbicides, and establishing competing native shrubs and trees to shade the grass out. Planting must be accompanied by maintenance to prevent the grass from competing with the trees and shrubs. Other methods such as burning, scraping, stomping, spraying and cutting have been used with limited success (Graham 2003). The GVRD is trying to control the extent of the grass by controlling moisture conditions. It is not known whether this approach has been successful. Field 'renovation' (tilling) to allow for other grass species was also successfully done.

Himalayan blackberry (*Rubus laciniatus*) and also evergreen blackberry (*Rubus discolour*) are found in the Colony Farm fields and along the banks of the Coquitlam River. In riparian areas, blackberry displaces native species that provide food, shade and

bank stability, and is difficult to remove. Mechanical or manual removal can be effective, if combined with follow-up visits to ensure complete eradication, and with planting of native species in any disturbed areas. Herbicides are also sometimes used, particularly in conjunction with cutting, though this treatment is generally inappropriate in riparian areas. In the study area, mowing has been done to suppress blackberry in some of the Colony Farm fields.

Japanese knotweed (*Polygonum cuspidatum*) is found in patches in Colony Farm and upstream. This bamboo-like plant prefers riparian areas, and is extremely difficult to eradicate. It will even grow through asphalt. It forms dense thickets that exclude other vegetation, and dies back in wintertime, leaving exposed soil. New plants can form from even small fragments of rhizomes left behind during control efforts, and even tiny fragments of the plant can form new rhizomes (Graham 2003). This is one way the plant distributes itself along riparian areas – by rhizomes and fragments moving downstream - see Figure 11. Because control is so difficult, the best method is to prevent establishment by monitoring areas and eradicating new infestations before they become established. A combination of cutting and glyphosate (Roundup) is likely the superior method of control (Graham 2003). Controlling the extent of Japanese knotweed is a high priority because of its persistent and aggressive nature and potential to colonize extensive areas.

Figure 11: Knotweed on Colony Farm, and a knotweed propagule found in the mainstem below the Pitt River Bridge.

Purple loosestrife is found in Colony Farm and other areas upstream – i.e. the oxbow in IR#2. As discussed in the section on Colony Farm Vegetation and Wildlife Management, this wetland invader has been successfully curtailed using biological controls, though more monitoring and future control measures may be required.

Policeman's helmet, also known as Himalayan Balsam (*Impatiens glandulifera*) is an annual that is swiftly spreading through the watercourses of the Lower Mainland (Graham 2003). It produces large numbers of seeds that are released from explosive seed pods. The seeds follow watercourses or are spread by human interactions (Graham 2003). The plant is easy to pull, and this should be done before the seeds are ripe.

Other invasive plant species are also found, particularly on Colony Farm, for example: Dame's rocket (*Hesperis matronalis*), oxeye daisies (*Chrysanthemum leucanthemum*), field bindweed (*Convolvulus arvensis)*, Tansy ragwort (*Senecio jacobaea)* Canada thistle (*Cirsium arvense*) and bull thistle (*Cirsium vulgare*). Most of these species are a particular nuisance for the agricultural sector.

Bullfrogs (*Rana catesbeiana*) are well-established in the study area, particularly in standing waters, including the Sheep Paddocks and Wilson Pond. Humans tend to create habitats very suitable for bullfrogs, and their effective control is unlikely. The best approach is to prevent their spread and to create varied habitats more suitable for native frogs, particularly seasonally wetted ponds. Green frogs (*Rana clamitans*) are also invasive and exotic, though it is not known how much an impact they are having on native populations. Green frogs are very abundant in the study area

Figure 12: Green frog (*Rana clamitans)* along the bank of the Coquitlam River (Reach E)

Discussion

New flow regimes negotiated as part of the BC Hydro Water Use Plan are a very important factor in improving fish habitat in the Coquitlam River. Improved base flows occurring since 1997 are already seen as improving fish returns, and increased flows (Treatment 2 – see Table 1) will occur as soon as the appropriate gate is constructed at the dam. Monitoring the results of increased flows is ongoing and will be used to determine long-term flow regimes. It will be important to ensure that restoration activities in the lower River do not confound the monitoring of new flow conditions. It appears that activities in the lower 5.5 kilometres will have no effect on WUP monitoring, and any activities in the upper (5.5 – 6.5 kilometre) part of the study area will likely also be able to proceed without confounding monitoring results.

Flushing flows have been much discussed as a remedy for sediment issues in the Coquitlam River. These flows will not occur during the WUP flow trials, which are expected to last until 2017. After that time we hope that flushing flows will be considered, and that ongoing sediment monitoring will have provided useful information on the relationship between flow and substrate embeddedness.

Historic land use at Colony Farm has been to the detriment of fish and floodplain habitat, as riparian forests were drained and cleared to make way for agriculture and the river was diked to control flooding. We propose to improve fish habitat while preserving the old field habitat for which Colony Farm is valued. We also hope that there will be an ongoing discussion regarding the trade-offs between floodplain/fish and old field values. Any changes to Colony Farm will need to be carefully considered and public consultation will be required, due to the high-value bird habitat provided, and the high level of public use and interest.

Water quality, including fine sediment pollution, is an unresolved issue in the Coquitlam River. Fisheries managers have long believed that turbid water released from upstream gravel operations are the cause of suspended and deposited fine sediments (silt, fine sand). Preliminary monitoring results (City of Coquitlam 2005) appear to support this belief. Other sources of pollution include stormwater runoff, and potential leachate from an historic landfill.

A large number of organizations and individuals are involved in the stewardship of the Coquitlam River, and many more have an impact on the watershed by virtue of living and doing business in it. This project included a substantial group of people in developing and discussing restoration options. However, more could be done to manage the Coquitlam River at a watershed level, addressing the influences of various land uses on the river. A proposed process to hire a watershed coordinator could provide the means to work together under a common vision. If key landowners and land managers in the watershed agree to participate in developing a watershed plan, and to support the plan's ongoing implementation by hiring a watershed coordinator, then substantial progress can be made to address the priority issues in the watershed. The level of success attained will always depend on how committed the key land managers are to the vision in the watershed plan.

Resources to support the watershed coordinator must be available on an ongoing basis to allow the plan to be implemented. The process of developing watershed plans implemented by a watershed coordinator has been successful in other areas.

Recommendations

Complete tidal channels in the Sheep Paddocks

The restoration project most ready to proceed is Phase 2 of the Sheep Paddocks. Partial funding is being applied for from the Pacific Salmon Commission and further funding may be solicited from the Bridge Coastal Restoration Program.

The specific objectives for this project are:

- Increase the amount of critical, tidal channel rearing and over-wintering habitat available to Coquitlam River coho and Harrison River chinook
- Provide 200 linear meters and 2,000 square meters of tidal channel habitat for these two species and all other native salmonids and fishes in the watershed
- Strengthen existing partnerships with the GVRD Parks, watershed stewardship groups, industry, Kwikwetlem First Nation, Fisheries and Oceans Canada, BC Ministry of Environment for the long term management, protection and restoration of the Colony Farm Park and adjacent public lands for the benefit of wild salmon and the other species that depend on their continued abundance.

If the partners and stakeholders agree and funding is confirmed, this work could proceed in 2008. Phase 1 is a proven success in providing off-channel fish habitat, and expanding this project is expected to provide more habitat to compensate for lost floodplain area in the lower Coquitlam River. The approach will be similar to that taken in Phase 1, where a fish channel is created, riparian vegetation is planted, and wildlife needs are taken into account. As part of Phase 2, the pros and cons of repairing the dike breach and installing a floodbox will be explored. Installing a floodbox would ensure that flood protection is maintained but would also create maintenance requirements. Purple loosestrife invasions will need to be monitored, and areas more suitable for native amphibians should be incorporated into the design, to compensate for the standing water habitat provided to bull frogs and green frogs. Native frogs benefit when shallow and ephemerally wetted habitat is provided. This habitat is less attractive to bull frogs, thus providing the native frogs with a habitat niche.

Construct tidal channels on upper Wilson Farm

The Wildlife Management Area in the Upper Wilson Farm is the next candidate for off-channel work once any restoration prescriptions for the Sheep Paddocks area are carried out. Assuming the Sheep Paddocks work continues to be successful and meets wildlife and flood protection needs at the same time as providing fish habitat, the work at the Sheep Paddocks can be a model for work at Wilson Farm. The management goals in the Wildlife Management Area do not specifically mention fish, but are compatible with this type of project. The potential scope of the project is much larger than the Sheep Paddocks and would be done in phases over a period of 10 years.

The intent is to create more off-channel habitat to compensate for that lost due to the channelization of the river. Prescription development and adaptive management and monitoring would be done to ensure that wildlife values are maintained at the same time that fish habitat is created. Assuming the necessary funding and consensus is in place, the first phase of work could proceed as early as 2009. The first phase would be relatively small in scope to allow for adaptive management in planning for the larger project. This area is highly valued for the bird habitat it provides. Any changes will require extensive consultation with the GVRD and with the public. Starting in late 2008, the GVRD, Kwikwetlem First Nation, Watershed Watch Salmon Society and Fisheries and Oceans Canada have agreed to work together to determine how or whether fish habitat can be incorporated into the management of the Wilson Farm area of Colony Farm Park. As this discussion unfolds the Burke Mountain Naturalists, Colony Farm Park Association and other partners would need to be involved. If changes are proposed some form of public consultation will be required.

Conduct wildlife and vegetation monitoring at the Sheep Paddocks Phase 1 project

Concerns about retaining existing wildlife values prompted the inclusion of wildlife features in the Sheep Paddocks project. Wildlife monitoring was also done (Keystone Wildlife Research 2005). Wildlife monitoring should be repeated to determine if there are any project impacts - either positive or negative. The previous study should be reviewed and its methodology repeated or modified as appropriate. This monitoring should hopefully provide a basis for adaptive management for future fish habitat projects, in order that wildlife needs can be successfully addressed and even enhanced.

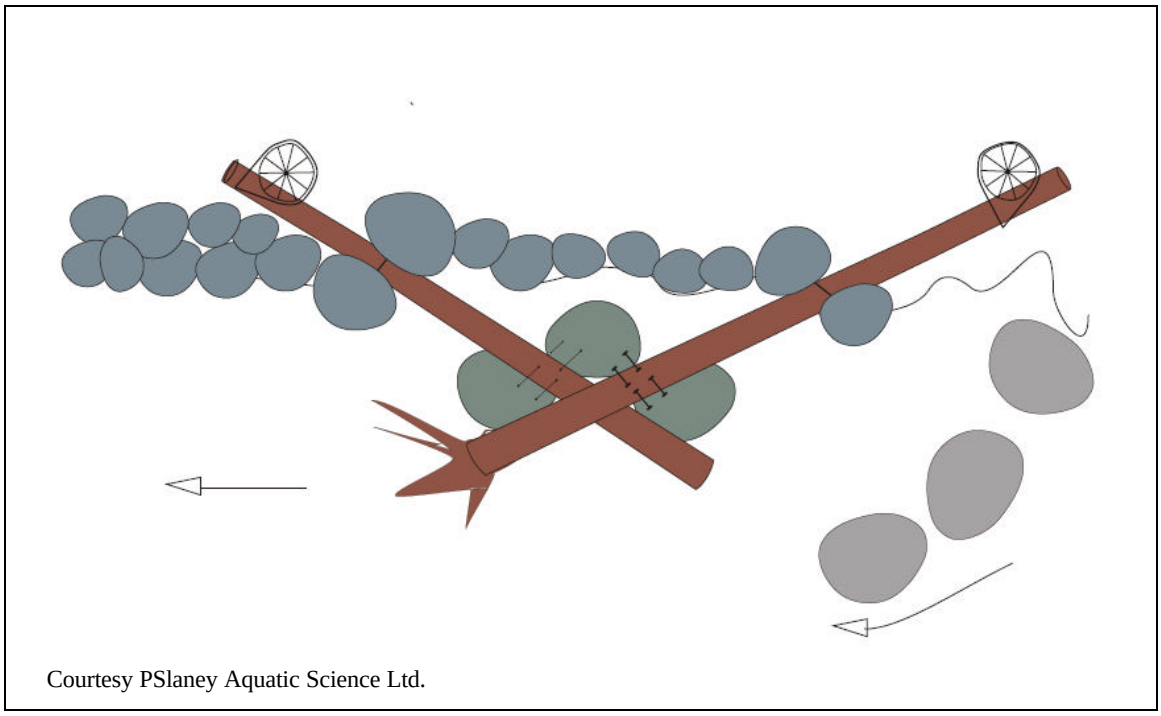
Some planted shrubs have been overwhelmed by grass. A survey should be conducted, ideally at the same time as the wildlife survey, to determine if fill planting or grass removal is required.

Improve instream complexity

The mainstem river in the study area is of low value to fish. Fish habitat and stock assessments have not included the lower 5.65 kilometres of the river, as this section was seen as being of low value. Even upstream of this point, the river lacks complexity and large woody debris cover. We propose improving instream habitat conditions with the addition of large woody debris (LWD). LWD structures provide hiding cover as well as creating scour pools, and thus greatly improve holding and rearing habitat for fish.

LWD structure design needs to be in compliance with Coast Guard regulations for navigable waters (e.g. navigable by canoe/kayak or inner tube). We propose three design templates that meet this requirement (Figures 13 – 16). These designs are sufficiently low profile to be appropriate within the channelized conditions of the Coquitlam River. Additionally, placement within sharp bends is avoided to reduce risks to any type of navigation by watercraft. Placement is done to approximate the location and spacing where a pool would typically occur in a more functional river channel.

Figure 13 is provided by Pat Slaney of PSlaney Aquatic Science Ltd., and depicts a flat triangle anchored by alluvial boulder ballasts and with alluvial boulder bank revetments to ensure that bank erosion does not occur. This bank protection is particularly applicable for banks dominated by erodible fine materials, such as those found in the study area, as the upstream log directs flow towards the bank. The alluvial boulders used are more natural in appearance than quarried rock. The triangulation of the structure offsets drag forces, so the rock ballast is required only to offset the buoyancy of the logs. The ends of the logs are anchored to the bank using either large trees or buried boulders. In compliance with navigable waters requirements, a cluster of 'guard' boulders is also included in the design. These boulders will deflect any watercraft (including inner tubes) away from the structure. The triangle will create a scour pool off its apex as well as providing overhead cover, thus providing rearing habitat for juveniles. The guard boulders and bank protection will also provide for juvenile habitat (Pat Slaney, personal communication).



Courtesy PSlaney Aquatic Science Ltd.

Figure 13: Flat triangle LWD structure with bank revetment and guard boulders

Figure 14 is also provided by PSlaney Aquatic Science Ltd. and is a variation on the design. It depicts a pair of lateral logs with intact rootwads, with some scattered bank boulders. The rootwad is facing downstream to minimize potential hazards to watercraft. Guard boulders are not necessary, and the logs are ballasted at the bank on the upstream end, and a few meters above the rootwad mass on the downstream end.

For both structures, ballasting requirements can be calculated using charts provided by Slaney *et. al* 1997.

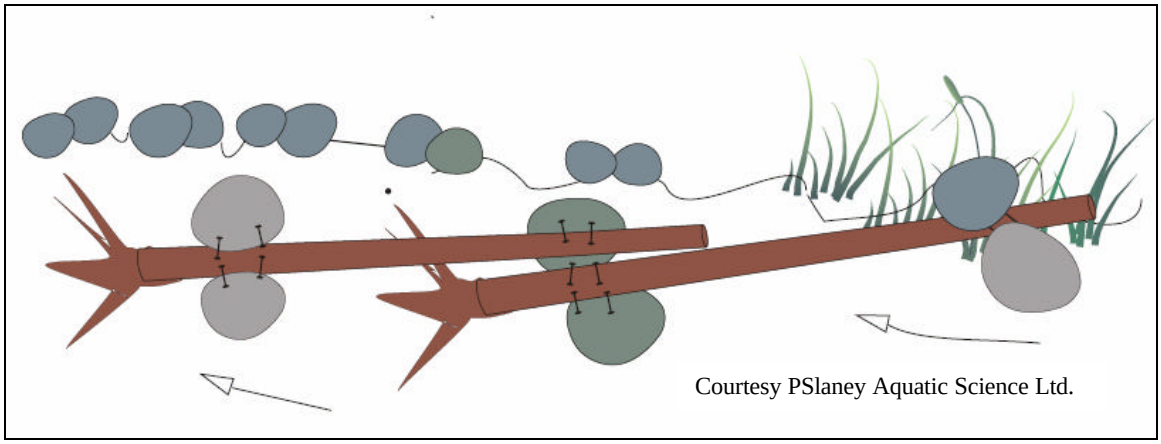


Figure 14: Lateral log pair with intact downstream facing rootwads and alluvial boulder ballast

Figure 15 shows a design developed in the United States (Rosgen N.D), called the J-hook vane. This has also been adapted in British Columbia to be used with a ballasted log pair with a boulder "J-hook" off the tip of the logs (Figure 16). The J-hook vane directs flow away from the bank and creates a scour pool that improves instream complexity. The boulders/logs also provide instream cover. This structure tends to provide more summer habitat, whereas the two log structures shown in Figures 13 and 14 provide winter refuges and summer rearing habitat, with coho fry and steelhead parr the targeted species/life stages (Pat Slaney, personal communication).

Costs for installation can be determined on a per structure basis, and can amount to $3,000 to $3,500 per structure (Pat Slaney, personal communication). A breakdown of potential costs for installing ten structures is given in Table 2. To place the logs and rocks, a spider hoe is preferred for its lower environmental impact: it runs with biodegradable oil, is very manoeuvrable (it walks on 'legs'), and most importantly creates much less disturbance in the riparian zone. A project biologist is required for the planning, regulatory approvals, supervision and report writing. A crew of two from the BC Conservation Foundation could be hired to do the LWD and boulder placement and securement work: the BCCF are very experienced and have a high success rate with LWD placement (Pat Slaney, personal communication). A First Nations trainee could round out this team.

LWD placement would be best done in the upper part of the study area, as this area already provides some habitat for fish. Assuming this placement is successful and fish habitat is improved, LWD prescriptions can be moved progressively downstream. Ten structures is a useful project size and is costed out in Table 2.

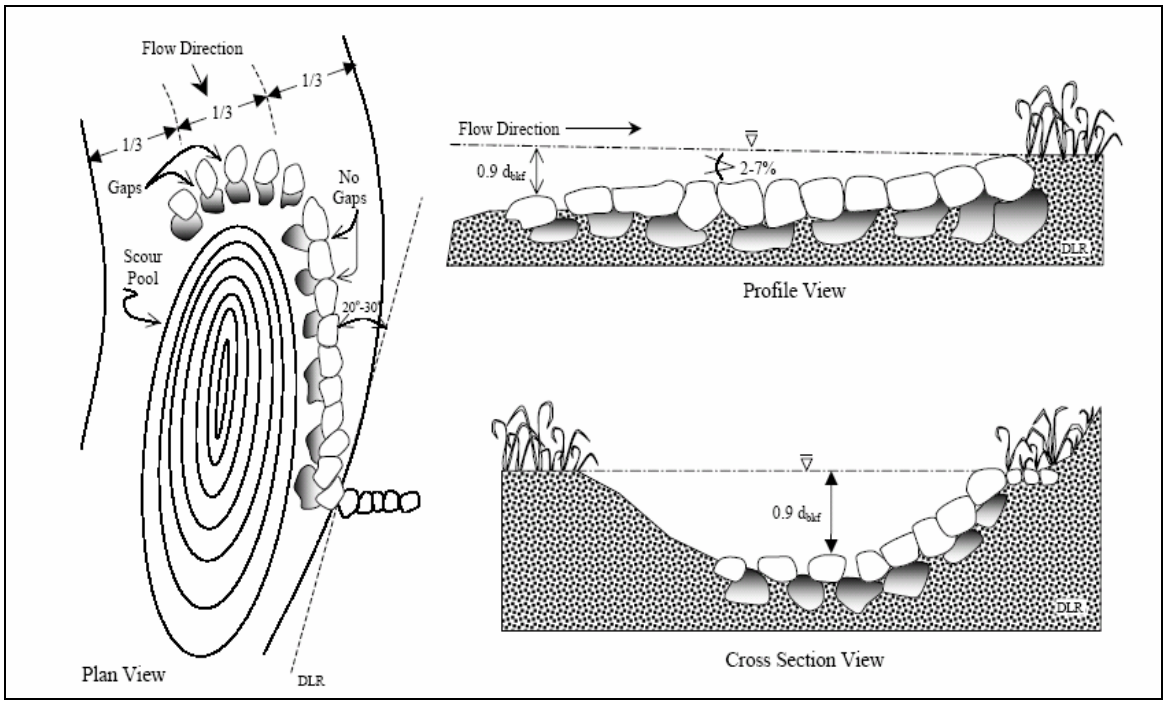


Figure 15: The J-Hook Vane developed by Dave Rosgen (diagram from Rosgen (N.D.))

P.Slaney photo

Figure 16: A modified J-hook vane that uses a ballasted log pair instead of boulders for part of the structure. View looking downstream

Item	Unit Cost	Days	Total Cost
Spyder excavator including travel/fuel	$2,000	4	$8,000
Project Biologist (including planning, supervision, write-up)	$600	10	$6,000
Two Cabling Technicians and First Nations trainee	$900	5	$4,500
Materials	$1,000	-	$10,000
Total potential costs for placing 10 LWD structures			**$28,500**

Table 2 Potential costs for LWD placement (Phase 1) assuming 10 structures placed.

Monitor and assess the oxbow on IR#2, remove constriction

Removing the constriction across the oxbow is a low cost intervention to potentially lower groundwater levels in the cemetery, and this removal can be done without further study. We recommend proceeding with this in 2008. Any further modification of the oxbow would need further discussion. While it may be appropriate to modify it further in future, the following questions need to be answered:

- How often is the oxbow connected to the main channel?
- What is the current fish usage?

It is simply not known whether the oxbow is already providing overwintering habitat, though it appears unlikely that it provides rearing habitat during summertime. The provision of overwintering habitat will depend on how often and how well it is connected to the mainstem. We recommend fish trapping over the winter, and periodic winter visits during high tide and high flow conditions to assess connectivity.

Options to connect the upstream end of the oxbow to the mainstem or to stormwater drainage should be evaluated in light of decisions to address flooding at the cemetery. An option to address flooding proposed by Urban Systems Ltd. (2005) also allowed for a channel to be constructed that connects the oxbow to the mainstem. If changes are not made to the cemetery, we advise against introducing more flow into the oxbow, as water levels in the oxbow will have a direct influence on the water table in the cemetery. Additionally, care must be exercised in introducing water from either the mainstem or from stormwater runoff: mainstem water has a sediment load that will cause problematic sediment deposition and likely require ongoing maintenance, and stormwater runoff may be of compromised quality.

Depending on the method chosen to provide flood protection to the cemetery, a large-scale modification of the oxbow may be appropriate. If the oxbow was excavated along its length, the water table at the cemetery would drop and connectivity between the outlet of the oxbow and the main channel would be easy to provide. This would be a major

endeavour with associated environmental impacts, and would not address the surface water flooding that occurs when mainstem flows exceed 140 m^3/s.

Consider the cost vs. benefit of non-standard dike maintenance

The flood protection benefit provided by the non-standard dikes in Colony Farm and upstream is limited, and is appropriate to the kinds of improvements that are present in Colony Farm. For the Wilson Farm area, the only infrastructure protected by the dikes is the trail system. However, the management of soil moisture conditions is seen to be another benefit of these dikes, particularly on Wilson Farm, for drainage efforts to control reed canary grass and preserve the old field type of vegetation.

We suggest that the function and purpose of the various dikes on Colony Farm be assessed over time to ascertain that the cost vs. benefit of dike maintenance (and pump station maintenance) is justified. It is possible that some areas do not need to be maintained (outside of the need to provide trail access), and this would open up possibilities to plant riparian trees to improve stream conditions, or even to breach dikes to improve floodplain conditions if appropriate.

A report on flood protection options (Northwest Hydraulic Consultants Ltd. 2002) indicates that upstream flood protection as well as flood protection for the Forensic Psychiatric Institute and IR#1 would be enhanced by allowing large floods to enter the Wilson Farm area. The report states that the GVRD would prefer to protect this infrastructure on the right (west) floodplain at the expense of inundating the left (east) floodplain. A potential option to protect the right floodplain is to reconstruct sections of the left dike so they breach during large floods. This option would also lower flood levels as far upstream as Scott Creek (Northwest Hydraulic Consultants Ltd. 2002). Thus, creating more floodplain area by modifying dikes can result in flood protection benefits as well as habitat benefits.

Changes to the dikes in Colony Farm would require further study. It is hoped that a cooperative way of proceeding can be identified that respects the established land use plan while also providing for fish habitat.

Investigate water quality

As far as we are aware, the quality of stormwater feeding into the river and its off-channel areas has had little analysis. We recommend a spot sampling program to understand whether the quality of this water might be detrimental to the Coquitlam River. We also recommend taking water samples downstream of the historic landfill, to understand whether harmful leachate might be making its way into the river. Appendix 6 contains a list of indicators useful for detecting leachate.

Reduce and control invasive exotic species

Invasive species are a serious issue in the Coquitlam River watershed. We particularly recommend a program to remove Japanese knotweed and discourage further invasions of this species before it becomes better established. Additionally, Himalayan balsam/Policeman's helmet appears to be relatively limited in extent and we recommend a two-year program to remove this species (the seeds may last for more than one year so a minimum two-year removal program is recommended).

The GVRD is already working to manage reed canary grass, blackberry, and purple loosestrife. We encourage the continuation of this work. We also recommend that new fish habitat projects take a proactive approach to managing purple loosestrife, and to providing amphibian habitat suitable to native species.

Coordination of invasive species management is already being done to some degree within municipalities and provincially. We recommend coordinating with municipal/provincial initiatives to ensure the most value for dollar, and developing a prioritized approach within the watershed. The City of Coquitlam is drafting an invasive plant strategy (Dave Palidwor, City of Coquitlam, personal communication), and this presents an opportunity to coordinate. This strategy is to be presented to the Committee in November 2007. The City uses their GIS to map invasives as well as track removal projects. They have good mapping of invasive species for part of the Coquitlam River, but nothing in the lower river. The City's proposed strategy includes seed money to support community partnerships, and could be applied to support the joint development of an invasives removal plan for the lower river, with the City and the Kwikwetlem First Nation/Watershed Watch Salmon Society. The strategy includes addressing knotweed on key streams like the Coquitlam River, particularly addressing the upstream mother plants causing downstream infestations. The City has done some experimentation on knotweed removal and intends to buy a herbicide injection gun (Dave Palidwor, City of Coquitlam, personal communication).

Take a watershed approach to stream health

There are numerous influences on the overall health of the Coquitlam River watershed. So many individuals and organizations have influence over the river that a bigger venue would be helpful in addressing the effects of all the various land uses. A coordinated effort to work with the two municipalities, the gravel pit operators, the government agencies, BC Hydro, community groups, major land owners (e.g. shopping malls, industrial parks, Riverview) and the general public is the best way to improve watershed health. In fact this is the only way to address non-point source pollution coming from stormwater runoff, and to address changes to stormwater quantity as a result of increasing urban developments.

A coordinated approach allows for more effective collaboration to address the priority issues. It also helps raise public awareness and stimulate action. There is a funding proposal developed by the City of Coquitlam and the Kwikwetlem First Nation, for a

watershed coordinator position whose job it would be to facilitate this type of approach. If this coordinator is in place and is supported by the various players, then degrading influences on the river could be more effectively addressed. The development of a Coquitlam River Watershed Management Plan, with sign-on by the various players, would be a very positive outcome of a watershed-level approach.

The initial approach proposed by the City of Coquitlam and the Kwikwetlem First Nation is to gather all the relevant information such as studies and reports, as well as information on the various individuals and groups working in the watershed. Then this information would be made public via a website. The third step would be to bring people together for a visioning exercise.

Create outreach and educational opportunities

Given the urban nature of the Coquitlam River and the fact that it still supports several salmon species, there is excellent potential to create outreach opportunities. Wildlife viewing sites can be created with interpretive signage, further to the work already done on Colony Farm – especially with information that relates to the river. In addition, there are opportunities to better connect the public with the salmon that use the river. A viewing station and signage could be created at the appropriate location upstream of the study area. If the appropriate location could be identified, it is possible that an underwater viewing area could be established alongside a spawning reach. This is something that has been successfully done elsewhere.

Greater public awareness generally translates into greater support for environmental initiatives, making outreach a useful tool.

Work with Riverview property owner to conserve and improve habitat

The large treed Riverview property is separated from Colony Farm by the Lougheed Highway and thus was not strictly part of the study area. However, the Riverview property is used by wildlife that also frequent the study area, particularly bird species. As this project unfolded new land uses were being proposed for the Riverview site. We recommend that the stakeholders involved in this study work with the landowner to ensure that important habitats on this property are retained during development.

Take a closer look at fish-bearing channels and ditches in southern Colony Farm

The lower treed part of the Wilson Farm area on Colony Farm contains a fish-bearing channel. Juveniles were spotted here in August 2007. The ditch that runs along Mary-Hill Bypass through this area is also fish bearing. These areas may be improved with minor modifications such as large woody debris addition.

Review the fish habitat compensation project to determine whether access to and from the mainstem should be improved

The fish habitat compensation project at the top end of Colony Farm Park near Lougheed Highway is not functioning as originally planned. We do not recommend major changes to this project as the wetland habitat it now provides has inherent value. However, if connectivity to the mainstem is still desired (at high tide/high water levels), the inlets/outlets through the non-standard dike need some maintenance and/or improvement. Currently, the two connections through the dike have a very low capacity due to siltation and /or collapse, and this capacity appears to be at further risk. It may be worthwhile to seek out the original design drawings and assess whether rehabilitation would make sense. It may make sense to remove the dike completely in that area as it is not providing much flood protection.

Monitor Wilson Pond and consider more native plantings

The pond constructed by Ducks Unlimited in Wilson Farm appears to be meeting its objectives. It would be interesting to do some formal monitoring to follow up on the monitoring done in 1999 shortly after the pond was constructed. This monitoring would be for bird use, amphibian use, and to assess vegetation changes. Increasing riparian shrubs and trees surrounding the pond would also be a beneficial action.

Work with gravel pit operators to reduce sediment inputs

The input of fine sediment from the three gravel pits has been an issue for fisheries biologists and conservationists for decades. Better on-site controls appear to be required, and it is likely that the three operators are in differing situations with respect to their on-site sediment control practices. Ideally the gravel pit operators would participate in watershed-level activities as described above. In any case, we recommend that the operators be approached to discuss changes to their operating practices. Data collected by the City of Coquitlam (in 2005 and in progress) may help convince the operators of the need to modify their practices.

Budget for 2008 Restoration (some items may extend into 2009)

Item	Activity	Cost	Total item cost
Sheep Paddocks Phase 2[1] & Remove Constrict-ion at Oxbow	Install new floodgate in phase 1 (restore dike across outlet)	$20,000	
	Excavate channel and provide habitat features	$60,000	
	Purchase and plant vegetation	$10,000	
	Project oversight	$10,000	
	Remove constriction (non-standard dike) at oxbow	$5,000	
	Total Cost Sheep Paddocks Phase 2 and Remove Constriction at Oxbow		$105,000
Develop Detailed Plans & Monitor	Coordinate, assess and budget for invasive species removal	$10,000	
	Work with partners to develop Wilson channels prescription[1]	$15,000	
	Work with partners on location/ extent of LWD placement and obtain regulatory approvals[3]	$15,000	
	Develop site plans for outreach/education together with partners	$20,000	
	Conduct wildlife monitoring at Sheep Paddocks Phase 1	$7,500	
	Carry out water quality monitoring (see Appendix 6 for leachate parameters(	$3,000	
	Total Cost Develop Detailed Plans		$70,500
Watershed Coordinator[2] (one year)	Watershed coordinator labour and overhead	$70,000	
	Kwikwetlem First Nation oversight and participation including technical advisor	$14,000	
	Coquitlam staff oversight and participation (9 staff and 2 council)	$14,000	
	Computer, mileage, meeting expenses[4]	$10,000	
	Total Cost Watershed Coordinator		$108,000
	Total Projected Costs 2008		$283,500

[1]does not include staff time from DFO
[2]exact 2008 costs to be determined by Coquitlam/Kwikwetlem after this position is established in late 2007
[3]an estimate of potential LWD placement costs is found on page 39
[4]does not include some materials and equipment provided by the City of Coquitlam

References

BC Hydro. 2003. Addendum to the Coquitlam Dam Water Use Plan Consultative Report. Prepared for the BC Hydro Coquitlam Dam Water Use Plan project, Burnaby, BC.

Beauchesne, S. and C. Quinlan. 1999. Colony Farm Regional Park Bird Summary. GVRD Parks Central Area.

Bland Engineering Ltd. 2001. Coquitlam River Downstream of Pitt River Road: Report on Navigation and Flood Protection Issues Relating to First Nations Lands. Report prepared for BC Hydro.

Colony Farm Land Use Study Steering Committee. 1995. Colony Farm Land Use Plan.

Decker, S., J. Macnair, G. Lewis and J. Korman. 2007. Coquitlam River Fish Monitoring Program: 2000 – 2006 Results. Prepared for BC Hydro.

Erlich, P.R., D.S. Dobkin and D. Wheye. 1998. The Birder's Handbook. New York: Simon and Shuster Inc.

Ferrigan, J. 1999. Old Field Management of Colony Farm. Draft Report.

Gartner Lee Limited. 1992. Environmental Assessment of Port Coquitlam. Prepared for the City of Port Coquitlam, June 1992.

Graham, P.A. 2003. Invasive Plants of Southwestern British Columbia. Website developed with the assistance of Langley Environmental Partners Society and BC Ministry of Agriculture and Food. Website viewed October 8, 2007. **http://www.shim.bc.ca/atlases/invasivespecies/Title.htm**

Greater Vancouver Regional District. 1998. Colony Farm Regional Park Land Use Plan Implementation Program. Bulletin #1, July 1998.

Higgins, P.S., D.R. Marmorek, D.P. Bernard, J. Korman, C.L. Murray and C.N. Peters. 2001. Workshop on Instream Flow Assessment in the Water Use Planning Process. Summary Report. Prepared for BC Hydro Water Use Planning Program Fisheries Advisory Team.

Keystone Wildlife Research. 2005. Wildlife Habitat Assessment, Enhancement Recommendations and Monitoring Schedule for the Colony Farm Restoration Project. Prepared for Fisheries and Oceans Canada.

Northwest Hydraulic Consultants Ltd. 2007. Coquitlam-Buntzen Water Use Plan monitoring program, Lower Coquitlam River substrate quality assessment, 2006 Annual Data Report. Submitted to BC Hydro and Power Authority, Burnaby, BC.

Northwest Hydraulic Consultants Ltd. 2002. Coquitlam River Dike Study: Hockaday Street to Fraser River. Final Report. Prepared for the Corporations of the Cities of Coquitlam and Port Coquitlam.

McLennan, D.S., V. Veenstra. 2001. Riparian Ecosystem mapping: lower Coquitlam River. Prepared by Oikos Ecological Services Ltd. For B.C. Hydro, Power Supply Environment, Burnaby, B.C.

Northwest Hydraulic Consultants Ltd. 2001. Coquitlam River channel morphology and substrate condition study. Prepared for BC Hydro and Power Authority, August 2001.

Northwest Hydraulic Consultants Ltd. 2007. Coquitlam-Buntzen Water Use Plan monitoring program, Lower Coquitlam River substrate quality assessment, 2006 Annual Data Report. Submitted to BC Hydro and Power Authority, Burnaby, BC.

Piteau Associates Engineering Ltd. 2001. Hydrogeological Assessment for Groundwater Control. Cemetery Site – Kwayhquitlum I.R. 2.

Pritchard, D. 1998. Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lotic areas. Technical Reference 1737-15. U.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO.

Quadra Planning Consultants Ltd. 1994. Colony Farm Land Use Study: Phase 1 Technical Background Report. Prepared for the Colony Farm Land Use Study Steering Committee.

Quinlan, C. and S. Beauchesne. 1999. Colony Farm Regional Bird Surveys Fall 1999. Greater Vancouver Regional District Parks Central Area.

Quinlan, C. and J. Raggett. 1999. Biophysical Inventory and Evaluation of Wildlife Habitat Enhancement. Colony Farm Regional Park Coquitlam/Port Coquitlam, BC, Summer 1999. Done by Capilano College for the Greater Vancouver Regional District.

Rosgen, D.L. No Date. The Cross-Vane, W-Wier and J-Hook Vane Structures…Their Description, Design and Application for Stream Stabilization and River Restoration. Wildland Hydrology Inc.

Riley, S.C., Korman, J and S. Decker. 1998. Coquitlam River Salmonid Stock Assessment. Prepared for BC Hydro, Burbaby, BC, by Ecometric Research Inc.

Slaney, P.A., R.J. Finnigan and R.G. Millar. 1997. Accelerating the Recovery of Log-jam habitats: Large Woody Debris-boulder Complexes. *In:* Slaney, P.A. and D. Zaldokas,

eds. Fish Habitat Rehabilitation Procedures (pp. 9-1 to 9-24). Watershed Restoration Technical Circular No. 9, British Columbia Watershed Restoration Program.

Taitt, M.J. 2006. Small mammal study in Colony Farm Regional Park habitats – January to March 2006. Prepared for GVRD Parks.

Urban Systems Ltd. 2005. Review of Flooding at Cemetery and Stormwater Flow Regimes. Prepared for the Kwikwetlem First Nation.

Water Management Consultants. 2003. Coquitlam River Hydrology Review. Prepared for the City of Port Coquitlam.

Water Management Consultants. 2004. Coquitlam River Flood Hazard Mitigation Options. Prepared for the City of Port Coquitlam.

Water Management Consultants. 2006. Mundy Creek Flood Protection Study. Prepared for the City of Coquitlam.

WIB. 1978. Coquitlam River Water Management Study. Water Investigation Branch, B.C. Ministry of the Environment, File No. 0273896-10. Victoria, B.C.

Appendix 1: Organizations and Individuals at Project Initiation Meeting

The following groups and individuals attended the project initiation meeting, and many were involved in further ways.

Group	Individual
BC Conservation Foundation	Rheal Finnigan
Burke Mountain Naturalists	Elaine Golds
City of Coquitlam Council	Maxine Wilson (Mayor)
City of Coquitlam Council/ Rivershed Society of BC	Finn Donnelly
City of Coquitlam	Melony Burton
	Mike Carver
	Dave Palidwor
Coquitlam River Watershed Society	Murray Clare
	Sherry Carroll
Fernhill Consulting	Tanis Douglas
Fisheries and Oceans Canada	Matt Foy
Greater Vancouver Regional District	Frieda Schade
	Will McKenna
Kwikwetlem First Nation	George Chaffee
	Glen Joe
	Nancy Joe
Maple Creek Streamkeepers	Dave Bennie
	Sandy Budd
Ministry of Environment	Erin Stoddard
North Fraser Salmon Assistance Society	Tony Matahlija
Pacific Salmon Foundation	Dianne Ramage
PSlaney Aquatic Science Ltd.	Pat Slaney
Water Management Consultants	David Sellars
Watershed Watch Salmon Society	Craig Orr

Appendix 2: Organizations and Individuals at the Project Conclusion Meeting

Group	Individual
Burke Mountain Naturalists	Elaine Golds
City of Coquitlam Council	Maxine Wilson (Mayor)
City of Coquitlam Council/ Rivershed Society of BC	Finn Donnelly
City of Coquitlam	Melony Burton
Coquitlam River Watershed Society	Murray Clare
Fernhill Consulting	Tanis Douglas
Fisheries and Oceans Canada	Matt Foy
	Tom Cadieux
Greater Vancouver Regional District	Frieda Schade
	Will McKenna
Kwikwetlem First Nation	George Chaffee
	Nancy Joe
Maple Creek Streamkeepers	Dave Bennie
North Fraser Salmon Assistance Society	Tony Matahlija
Watershed Watch Salmon Society	Craig Orr

Appendix 3: Relevant Supporting Documents

The following Coquitlam River-related reports were reviewed for this project. Reports pertaining to the Water Use Plan and to Colony Farm are grouped separately here.

City of Coquitlam. 2005. Coquitlam River Turbidity and Water Quality Data October 2004 – August 2005

> Sensors were placed in the river upstream (near Falacea Creek) and downstream (at Gallette Avenue) of the gravel pits. Turbidity, rainfall, pH, temperature and total dissolved solids were measured. There was a clear difference between upstream and downstream measurements of turbidity. At times turbidity can be related to rain events but there were also a number of spikes at the downstream location unrelated to rainfall and to upstream turbidity levels. The turbidity was measured as high as 2,000 NTU. In the 8 months on record, turbidity readings exceeded 400 NTU 17 times including a 5 day rainy period in January 2005, where downstream turbidity readings fluctuated greatly, ranging between 400 and 2,000 + NTUs. On this occasion, upstream turbidity was also elevated, though much less so and for a shorter duration. (For comparison purposes, drinking water must have turbidity below 1 NTU, and preferably below 0.1 NTU.) At their lowest, turbidity measurements for the Coquitlam River appear to be 10 NTUs or less (the scale of the graph does not allow for precise interpretations).

Kerr, Wood, Leidal Associates Ltd. 2001. Feasibility Study for a Side Channel Reactivation at Kwayhquitlum I.R. No. 2. Draft for Discussion.

> This report describes both the engineering feasibility studies of creating better connections to the oxbow in IR #2 and lowering groundwater in the cemetery. With respect to the oxbow, relative elevations and connectedness through the year requires more study. This oxbow is not suited to develop spawning habitat, but coho overwintering habitat may be improved. A direct connection to the river is not recommended but a groundwater fed option from the PoCo pumphouse is seen as the preferred option. This does raise water quality concerns due to nearby subdivisions.

Koop, Will. 2001. Red Fish Up the River. A report of the former Coquitlam salmon migrations and the hydro-electric developments at Coquitlam Lake, British Columbia, pre-1914. Presented for the Kwikwetlem First Nation through BC Hydro's Bridge Coastal Fish and Wildlife Rehabilitation Fund.

> This report describes historical research regarding the importance of the former sockeye run to the Kwikwetlem First Nation, and the circumstances and decisions surrounding the construction of the Coquitlam dam. The sockeye run was eliminated when the dam was rebuilt in 1914.

Kwikwetlem First Nation. 2003. Coquitlam River Watershed: Kwikwetlem Side-Channel Habitat Restoration, Public Awareness, and Report History - Final Report. Prepared for the Bridge Coastal Restoration Program.

This report describes both the engineering feasibility studies of creating better connections to the oxbow in IR #2 and lowering groundwater in the cemetery, and the work done by Will Koop in developing his report "Red Fish Up the River".

McLennan, D.S., V. Veenstra. 2001. Riparian Ecosystem mapping: lower Coquitlam River. Prepared by Oikos Ecological Services Ltd. For B.C. Hydro, Power Supply Environment, Burnaby, B.C.

Mapping was done along the lower 15 kilometres of the Coquitlam River, to provide BC Hydro with an ecological inventory to develop flow-related performance measures for floodplain habitats. Site series according to the biogeoclimatic ecosystem classification system were mapped within the active floodplain, and the mapping also noted vegetation structural (successional) stages.

North Fraser Salmon Assistance Society. 2005. Coquitlam River Habitat Rehabilitation Project. 2005. Prepared for the BC Hydro Bridge Coastal Fish and Wildlife Restoration Program.

Describes 2005 maintenance of formerly constructed off-channel habitat:

- Archery Pond (City of Coquitlam Park), 13 km upstream from river mouth, original construction early 1990's.
- River Springs oxbow lake and spawning channel (River Springs Strata Association property), 9 km upstream from river mouth, original construction 1994.
- Colony Farms Sheep Paddock Slough project (GVRD Park), 2.4 km from river mouth, original construction 2004.

The Colony Farms project is the only project within the current study area for the current "Lower Coquitlam River Fish Habitat and Flooding Assessment" project. The activities included anchoring instream LWD, replanting and seeding the riparian zone, and beaver fencing.

North Fraser Salmon Assistance Society. 2006. Coquitlam Off Channel Habitat Restoration Projects. Prepared for the BC Hydro Bridge Coastal Fish and Wildlife Restoration Program.

Describes 2005 maintenance of formerly constructed off-channel habitat, all of which is upstream of the study area for the current project:

- Or Creek Pond (GVRD watershed property), located just downstream of the Hydro dam, originally constructed early 1990s.
- Archery Pond (City of Coquitlam Park), 13 km upstream from river mouth, original construction early 1990s.
- Overlander Ponds (private property and Crown Forest), 100 m upstream of Pritchett Creek confluence, original construction 2002
- Grist Channel (City of Coquitlam Park), 9 km upstream from river mouth.
- Oxbow Channel (City of Coquitlam Park/Strata Association), 9 km upstream from river mouth, constructed 1994.

Urban Systems Ltd. 2005. Review of Flooding at Cemetery and Stormwater Flow Regimes. Prepared for the Kwikwetlem First Nation.

> This report reviews all hydrology work done to date pertaining to the flooding issue at the cemetery, and suggests a solution that involves raising ground levels at the cemetery site (especially an expanded area to the North) to the level of the standard dikes. This proposed solution requires more consideration but would also allow for an upstream connection of the oxbow to the mainstem river, to improve flows for fish.

Water Management Consultants. 2004. Coquitlam River Flood Hazard Mitigation Options. Prepared for the City of Port Coquitlam.

> This report developed options to mitigate flooding risk for urban development in the southern part of the watershed. The consultants looked at requirements to protect housing from flooding during a 200-year return interval flood. The dikes surveyed were deemed inadequate and the recommended solutions include raising the low-level outlet capacity of the Coquitlam Dam (to allow more controlled spillage that would reduce flood flows overtopping the dam), and raising existing dikes.

Water Management Consultants. 2006. Mundy Creek Flood Protection Study. Prepared for the City of Coquitlam.

> This report was commissioned after a dike was breached for the Sheep Paddocks project, to better understand any increases in flooding risk caused by this project. It was found that the risk of upstream flooding does not increase significantly. However the dike breach has removed a secondary barrier to flooding during freshet. The ability to improve flood protection in future could be negatively affected by the breaching of the slough dike.

Colony Farm Reports:

Beauchesne, S. and C. Quinlan. 1999. Colony Farm Regional Park Bird Summary. GVRD Parks Central Area.

> Data from eight studies conducted at Colony Farm were compiled, with species of concern distinguished from all other bird species. 19 species of management concern were listed, plus 91 further species. Of the species of management concern, 9 are on the provincial blue list (vulnerable or sensitive), one is on the red list (endangered/threatened – the peregrine falcon), and the remainder are on the yellow list (not at risk). All raptor and owl species at Colony Farm were included in the species of concern category due to the region's importance to wintering raptors and owls and because some of these species were being displaced by Vancouver International Airport improvements.

Colony Farm Land Use Study Steering Committee. 1995. Colony Farm Land Use Plan.

> This land use plan is a binding plan supported by a covenant. The Plan zones the park into areas for passive recreation, and fish and wildlife habitat. This document is the basis for land management and its objectives were to identify and engage key stakeholders, create an inventory of uses, and recommend a land use plan with the consent of key

stakeholders. The public was involved and informed in various ways throughout the process.

Greater Vancouver Regional District. 1998. Colony Farm Regional Park Land Use Plan Implementation Program. Bulletin #1, July 1998.

After the GVRD acquired responsibility for Colony Farm in 1996, this bulletin provided details about how the Land Use Plan was being implemented. The document covers new trails and trail maintenance, park staging areas, existing buildings and structures, dike maintenance and dog management and includes a multi-year capital program.

Greater Vancouver Regional District. 1999. Colony Farm Regional Park Amphibian Egg Mass Counts 1999. GVRD Regional Parks Department, April 1999.

1999 was the second year of volunteer amphibian egg mass counts and the counts were scheduled to target Northwestern salamander (*Ambystoma gracile)* breeding. Northwestern salamander and Pacific tree-frog (*Hyla regilla*) egg masses were identified along with one long-toed salamander (*Ambystoma macrodactylum*) egg mass, and this data could be used in future to detect population trends for Northwestern salamander. This salamander was a target of the survey as it is the only native species known to inhabit the ditches and may be vulnerable to ditch maintenance activity.

Quinlan, C. and S. Beauchesne. 1999. Colony Farm Regional Bird Surveys Fall 1999. Greater Vancouver Regional District Parks Central Area.

Colony Farm supports a diversity of bird species, including some blue-listed species and other species of concern. This study observed a total of 56 species. The variety of habitats at Colony Farm contributed to the diversity of species present.

Quinlan, C. and J. Raggett. 1999. Biophysical Inventory and Evaluation of Wildlife Habitat Enhancement. Colony Farm Regional Park Coquitlam/Port Coquitlam, BC, Summer 1999. Done by Capilano College for the Greater Vancouver Regional District.

This report describes survey work done to follow up on wildlife enhancements and to continue baseline biophysical inventory work done in 1997 and 1998. Evaluation was done for prior tree and hedgerow planting (plant survival and health), installed raptor poles (bird use), mowing of old field vegetation (vole use), and for a wetland constructed in 1998 (bird use, amphibian use, vegetation changes and water quality).

Quinlan, C. Colony Farm Regional Park Amphibian Study. GVRD Parks Central Area Office.

This report summarizes all available information so that the needs of amphibians can be considered in Park management decisions. A total of six species have been documented including two introduced species, the Bullfrog (*Rana catesbeiana*) and Green frog (*Rana clamitans*) and four native species, the Long-toed salamander (*Ambystoma macrodactylum*), Northwestern salamander (*Ambystoma gracile*), Pacific tree frog (*Hyla regilla*) and roughskin newt (*Taricha granulosa*).

Quadra Planning Consultants Ltd. 1994. Colony Farm Land Use Study: Phase 1 Technical Background Report. Prepared for the Colony Farm Land Use Study Steering Committee.

> This report discusses current and historic land use, and the resource values of the farm: agriculture, ecology and wildlife, and recreation. Public visions and issues are also described. A detailed description is given of wildlife species, vegetation, habitat-wildlife relationships and wildlife corridors. This was based on existing information, much of it based on plant and bird observations by the Burke Mountain Naturalists, as well as other bird accounts, general texts, and conversations with experts. Habitat types were categorized into six groups: marsh, grassland, forest, riparian-and-hedgerow, river, and disturbed. Bird use is extensively discussed and other wildlife use is inferred. Fish use is summarized.

Taitt, M.J. 2006. Small mammal study in Colony Farm Regional Park habitats – January to March 2006. Prepared for GVRD Parks.

> This work was done to measure the impacts of field management activities in the Integrated Management Fields (Lower Wilson Farm), and provide baseline data on small mammal populations, particularly Townsend's vole, before expanding the field management program to the Wildlife Fields (Upper Wilson Farm). Long-term management to enhance value for birds of prey could include reducing reed canary grass density in patches and encouraging a diversity of grasses in a spatial and temporal mosaic favoured by voles.

Water Use Plan-Related Documents Relevant to the Lower River:

BC Hydro. 2005. Coquitlam-Buntzen Project Water Use Plan. Revised for Acceptance by the Comptroller of Water Rights.

> The dam system and watershed hydrology are described. Operating conditions for the facility are detailed. The two flow trials are mentioned, as are ramping rates. A monitoring program is recommended. Water management implications for various interests are described. A review of the plan is recommended within 15 years of implementatoion. A review may be triggered sooner if fish passage over the dam is provided or if the river is identified as being able to handle flushing flows higher than 200 m^3/s.

Harris, N. (no date). Report of the Consultative Committee: Coquitlam-Buntzen Water Use Plan. Prepared by EcoPlan International, Inc.

> This report gives detail regarding the Water Use Planning process, objectives, operating alternatives, trade-offs, and recommendations coming from the Consultative Committee. The consensus recommendation identifies an operating plan that incorporates an adaptive management program. A monitoring program was identified.

Decker, S., J. Macnair, G. Lewis and J. Korman. 2007. Coquitlam River Fish Monitoring Program: 2000 – 2006 Results. Prepared for BC Hydro.

This document describes all the fish monitoring done since it began in 2000. It gives helpful background information about the WUP, and also suggests that fish returns have improved since flows were increased in 1997.

Higgins, P.S., D.R. Marmorek, D.P. Bernard, J. Korman, C.L. Murray and C.N. Peters. 2001. Workshop on Instream Flow Assessment in the Water Use Planning Process. Summary Report. Prepared for BC Hydro Water Use Planning Program Fisheries Advisory Team.

This document is of use mainly because the Coquitlam was chosen as a case study, and experts ranked the various negative influences on the river. The flow regime was a major issue, but sediment inputs from the gravel pits ranked just as high. Forestry effects were rated as a moderate influence but only for Or Creek. Non-point source pollutants were also ranked as a moderate influence. Fisheries issues of concern were identified. The group focused on instream flow release options to achieve appropriate minimum flows, appropriate ramping rate, and generate flows needed for gravel flushing and channel maintenance. Areas of uncertainty were identified, including what flushing flows would be needed.

Perrin, C.J. 2006. Periphyton and benthic invertebrate monitoring for water use planning in the Coquitlam River, 2006. Report prepared by Limnotek Research and Development Inc. for BC Hydro. 51 p.

Data was collected in 2006 and 2003, 2004, and will be used to determine if increased base flows and water releases to encourage spawning (extra flows to be released starting in 2007) will provide a benefit to ecosystem health.

Northwest Hydraulic Consultants Ltd. 2007. Coquitlam-Buntzen Water Use Plan monitoring program, Lower Coquitlam River substrate quality assessment, 2006 Annual Data Report. Submitted to BC Hydro and Power Authority, Burnaby, BC.

Flushing flows have been recommended under the WUP to reduce the quantity of fine sediment, thereby improving fish productivity. Substrate quality assessments are to provide a basis for evaluating the effectiveness of flushing flows at reducing fine sediment abundance and improving fish productivity. If the flushing flows are found to be effective, then a further goal will be to optimize the flushing flow criteria. This report describes the first year of substrate assessment.

Lower Coquitlam River 2003 Instream Flow Needs Assessment. Prepared for Coquitlam Water Use Plan Fisheries Technical Committee

Instream flow data (transects) were collected in this and a previous study, and the results are summarized. The analysis produced habitat-flow relationships for each species and life history stage. Target flows for spawning steelhead, coho and chinook, and for rearing steelhead parr, were given as a percent of mean annual discharge.

Appendix 4: Proper Functioning Condition Assessment

A Proper Functioning Condition Assessment (Prichard 1998) methodology was chosen to evaluate conditions in the mainstem river. This qualitative assessment is a useful tool that provides a quick and defensible method for assessing stream riparian and channel conditions. Proper Functioning Condition refers to how well the physical processes are functioning. The methodology was developed by the U.S. Bureau of Land Management and is based on extensive quantitative data collection, which was distilled into a checklist of seventeen hydrology, vegetation and soil/geology attributes that must be considered to determine the physical functioning of a stream and its riparian zone. This method is now widely used in North America and elsewhere, and relies on an interdisciplinary team with skills in hydrology, vegetation, soils/geology, and ecology. Where quantitative data are available these are reviewed, and in some cases additional quantitative data collection may be required to fully understand stream or channel conditions. The outcome of the Proper Functioning Condition assessment is a portrayal of physical conditions in the area under study, which can be used to develop management strategies and to monitor conditions over time. The assessment also highlights the limits of a watershed to produce certain values. In other words, it can be used to describe the potential condition of a system within land management constraints, to develop management strategies that are realistic and achievable.

In the case of the lower Coquitlam River, management constraints include the need for flood protection (i.e. dykes – though some dykes are no longer serving their original purpose), as well as a regulated flow regime and urban land uses that restrict the floodplain and the width of the riparian buffer. Land management objectives in Colony Farm Park also conflict with the establishment of healthy riparian and stream channel conditions. Gravel pit operations have a significant effect on the river, though for the purposes of this assessment it is assumed that fine sediment input from these operations can be significantly curtailed. Flushing flows under the BC Hydro Water Use Plan may also improve sediment conditions in the river, though these flows may not be any greater than flows that have regularly come down the river due to pre-spill releases at the dam.

In a Proper Functioning Condition Assessment, river reaches are rated as being in Proper Functioning Condition, Functional – at Risk, or Non-functional. A riparian-wetland area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and ground-water recharge;
- Develop root masses that stabilize streambanks against cutting action;

- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration and temperature necessary for fish production, waterfowl breeding, and other uses;
- Support greater biodiversity (Pritchard 1998).

Functional – at Risk is defined as: riparian-wetland areas are in functional condition, but an existing soil, water or vegetation attribute makes them susceptible to degradation. If possible, it is noting whether the system is trending upward (toward PFC) or downward.

Non-functional is defined as: riparian-wetland areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, etc.

A significant amount of assessment has already occurred on the Coquitlam River, much of it to support the Water Use Planning process led by BC Hydro. This data was reviewed, particularly two reports: Coquitlam River Salmonid Stock Assessment (Riley et. al 1998), which included a detailed fish habitat assessment, and Riparian Ecosystem Mapping Lower Coquitlam River (McLennan and Veenstra 2001). The fish habitat assessment done in 1998 divided the river into reaches, starting at approximately river km 5.65. Riley *et. al* did not include the lower 5.65 km in their assessment as they determined that this section was of extremely low value to fish – this determination was based on habitat quality and was substantiated by spot samples for fish presence. While we agree with their assessment with respect to fish habitat, our mandate was to examine the riparian and channel conditions in the lower 6.5 km of the mainstem, and we divided this study area into five reaches. These reaches are named Reach A, B, C, D and E so as not to be confused with the numeric reaches developed in the previous study.

Proper Functioning Condition checklist questions pertaining to vegetation and channel conditions able to resist erosion and dissipate energy need to be qualified: large flood flows are extremely uncommon in the Coquitlam, with the last one occurring in 1961 with a peak flow of 527 m^3/s. Since that time the Coquitlam Reservoir has been operated at lower levels and there have not been significant flood events. The flood of October 2003 produced a downstream peak flow of 211 m^3/s and the flood of March 2007 had a peak flow of 215 m^3/s. Prior to the construction of the Coquitlam Dam the two-year (bankfull) flow would have been about 370 m^3/s.

In the absence of meaningful flood flows, the PFC methodology is still applicable, but more focus was put on other factors important for the creation of fish habitat, particularly large woody debris (LWD) provision based on floodplain area and riparian conditions.

McLennan, D. and V. Veenstra. 2001. Riparian Ecosystem Mapping Lower Coquitlam River. Prepared for BC Hydro, Burnaby, BC, by Oikos Ecological Services Ltd.

Pritchard, D. 1998. Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lotic areas. Technical Reference 1737-15. U.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO.

Riley, S.C., Korman, J and S. Decker. 1998. Coquitlam River Salmonid Stock Assessment. Prepared for BC Hydro, Burbaby, BC, by Ecometric Research Inc.

Standard Lotic Checklist – Proper Functioning Condition (Bureau of Land Management, 1998)
Name of Riparian-Wetland Area: Lower Coquitlam River
Date: September 4th, 2007 Segment/Reach ID: Reach A: from km 0 to km 0.15
Team Observers: Tanis Douglas, David Sellars

Yes	No	N/A	HYDROLOGY
v			1) Floodplain above bankfull is inundated in "relatively frequent" events
		v	2) Where beaver dams are present they are active and stable
v			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
v			4) Riparian-wetland area is widening or has achieved potential extent
	v		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
v			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
v			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
v			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
v			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
v			10) Riparian-wetland plants exhibit high vigor
v			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
		v	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
v			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
		v	14) Point bars are revegetating with riparian-wetland vegetation
	v		15) Lateral stream movement is associated with natural sinuosity
v			16) System is vertically stable
v			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

This short reach extends from the mouth of the river (km 0) to approximately river km 0.15. On the east bank, the same riparian and floodplain conditions extend to river km 0.5. This reach is outside the dyke system and has an available floodplain. The reach is highly influenced by the Fraser River and its daily tidal fluctuations. Bottom sediments are very fine, the water is deep even at low tide, and the channel lacks complexity. Both sides of the river are included in a Wildlife Management Area established primarily to support a heron rookery. The riparian vegetation is dominated by cottonwoods (*Populus Balsamifera* ssp. *trichocarpa*), alder (*Alnus rubra*), and a diverse array of native vegetation. On the east bank, a tidal marsh includes the invasive species purple loosestrife (*Lythrum salicaria*). This reach is likely functioning close to its capability given the flow regulation and upstream channel conditions, but will likely never achieve its potential, which would include multiple tidal channels. Question #12 pertaining to LWD supply is marked "N/A" because this section of river will not naturally hold much LWD due to the tidal and flood influence of the Fraser River. This reach has been rated at a Proper Functioning Condition within the current management constraints of flow regulation and upstream channelization.

Summary Determination

Functional Rating:

Proper Functioning Condition ___v____
Functional—At Risk _____
Nonfunctional _____
Unknown _____

Trend for Functional—At Risk:

Upward _____
Downward _____
Not Apparent _v____

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _v_
No ___

If yes, what are those factors?

__v_ Flow regulations ___ Mining activities ___ Upstream channel conditions
__v_ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows ___ Other (specify)_____

Figure 1: A view of the river mouth (Reach A), including a tidal marsh and the Fraser River

Figure 2: Riparian vegetation in the Wildlife Management Area (reach A) at the mouth of the Coquitlam River, on the west bank.

Name of Riparian-Wetland Area: Lower Coquitlam River
Date: September 4th, 2007 Segment/Reach ID: Reach B: from km 0.15 to km 2.5
Team Observers: Tanis Douglas, David Sellars

Yes	No	N/A	HYDROLOGY
	v		1) Floodplain above bankfull is inundated in "relatively frequent" events
		v	2) Where beaver dams are present they are active and stable
	v		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	v		4) Riparian-wetland area is widening or has achieved potential extent
	v		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
		v	6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
	v		7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
v			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
v			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
v			10) Riparian-wetland plants exhibit high vigor
v			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
	v		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
	v		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
		v	14) Point bars are revegetating with riparian-wetland vegetation
	v		15) Lateral stream movement is associated with natural sinuosity
v			16) System is vertically stable
	v		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

This reach begins at the dyke at river kilometer 0.15 and extends through Colony Farm to river kilometer 2.5, approximately 250 downstream from Kwikwetlem Indian Reserve #2. It is characterized by streamside dykes and shrubby native riparian vegetation (e.g. willow (*Salix* spp.) and hardhack (*Spirea douglasii*)), as well as various exotic and often invasive species that line the dykes. The highly invasive Japanese knotweed (*Polygonum cuspidatum*) is becoming established in this reach. This reach is tidal and its profile is very flat, as is the case with the entire study area. The stream channel lacks any form of complexity (e.g. large woody debris, pools/riffles or any form of cover) and bottom sediments are fine silt and sand. This reach offers very poor fish habitat. The dykes and flow regulation generally prevent connection of the river to its floodplain, and dyke maintenance ensures that trees are generally absent. The altered sediment regime due to flow regulation and sediment input from the gravel pits has likely increased the proportion of fine sediment in this reach.

Before being developed for agriculture, the valley bottom in this area likely contained multiple channels in a floodplain containing typical riparian vegetation for a forested swamp in this biogeoclimatic zone (e.g. cedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis)* skunk cabbage (*Lysichiton americanum*), and salmonberry (*Rubus spectabilis*), as well as cottonwoods (*Populus balsamifera ssp. trichocarpa),* alder, and willow on the medium and low bench floodplain sites. It would naturally have contained some fine sediments due to its tidal nature but would have exhibited significant complexity due to interactions between the stream channels and riparian vegetation.

Summary Determination

Functional Rating:

Proper Functioning Condition _____
Functional—At Risk _____
Nonfunctional ___**v**___
Unknown _____

Trend for Functional—At Risk:

Upward _____
Downward _____
Not Apparent __**v**__

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _**v**_
No ___

If yes, what are those factors?

_**v**_ Flow regulations ___ Mining activities ___ Upstream channel conditions
_**v**_ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows _**v**_ Other (specify) fine sediment input, urbanization, lack of gravel recruitment due to the Hydro dam

Figure 3: Reach B at low tide, looking downstream towards the footbridge. Note sand bars.

Figure 4: Reach C looking upstream at river kilometre 1.5. Note the shrubby riparian vegetation.

Name of Riparian-Wetland Area: Lower Coquitlam River
Date: September 4th, 2007 Segment/Reach ID: Reach C: from km 2.5 to km 4.0
Team Observers: Tanis Douglas, David Sellars

Yes	No	N/A	HYDROLOGY
v			1) Floodplain above bankfull is inundated in "relatively frequent" events
		v	2) Where beaver dams are present they are active and stable
	v		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	v		4) Riparian-wetland area is widening or has achieved potential extent
	v		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
v			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
v			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
v			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
v			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
v			10) Riparian-wetland plants exhibit high vigor
v			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
	v		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
v			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
		v	14) Point bars are revegetating with riparian-wetland vegetation
	v		15) Lateral stream movement is associated with natural sinuosity
v			16) System is vertically stable
	v		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

This reach extends to the normal upstream limit of tidal influence. At its lower end, the riparian buffer widens and includes trees (dominated by cottonwood), in contrast to the shrub-dominated communities in the reach below. There is a diversity of riparian vegetation, but conifers (mostly sitka spruce*)* important for LWD contribution are sparse and found only on the east bank. Floodplain conditions differ on the east and west banks. On the east bank a setback dyke allows for a healthy floodplain and riparian community that includes the oxbow on IR#2, though at the upstream end of Reach C, an older dyke does come close to the river. On the west bank, a streamside dyke (the PoCo-Traboulay Trail) limits floodplain inundation, though this dyke is not completely effective and is at risk of erosion during high flows. Riparian vegetation exists in a narrow strip on the west bank between km 2.5 and 3.1 – this strip is adjacent to former fields (sheep paddocks) that are reverting to wetland vegetation in the absence of drainage maintenance. Upstream of this, drainage from areas of regenerating riparian vegetation on the west side of the river is allowed through the dyke in a few places and could allow fish access to these areas. Historic west bank protection measures (pilings and concrete rubble) have been ineffective. Channel sediments are composed mostly of sand, with some gravel bars, particularly in the lower 0.5 km of the reach. There is an almost complete absence of instream complexity (LWD, pools), and therefore of suitable fish habitat. The oxbow on IR #2 is the location of a former active channel of Coquitlam River – formerly the river flowed in two channels that joined at river kilometer 3.5 in this reach. The oxbow may offer fish habitat during winter (summer water temperatures are likely too high), though fish access and egress would be limited to times where the river level and tide level are both high, as there is an approximately 2 meter elevation difference between the water surface of the oxbow and the main channel at low flow/low tide. Note: this reach is rated 'functioning at risk' because even though stream channel conditions are poor, there is a relatively healthy riparian area and partially accessible floodplain due to setback/low elevation dykes. Flushing flows could elevate the rating of this reach to Proper Functioning Condition within the current management constraints.

Summary Determination

Functional Rating:

Proper Functioning Condition _____
Functional—At Risk ___**v**____
Nonfunctional _____
Unknown _____

Trend for Functional—At Risk:

Upward _____
Downward _____
Not Apparent __**v**__

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _**v**_
No ___

If yes, what are those factors?

_**v**_ Flow regulations ___ Mining activities ___ Upstream channel conditions
_**v**_ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows _**v**_ Other (specify) fine sediment input, urbanization, lack of gravel recruitment due to the Hydro dam

Figure 5: Reach C looking upstream from approximately river kilometre 2.8. Note riparian trees including a sitka spruce.

Figure 6: Reach C looking downstream towards historical bank protection works at km 3.75. The bank has eroded significantly from its original location.

Name of Riparian-Wetland Area: Lower Coquitlam River
Date: September 4th, 2007 Segment/Reach ID: Reach D: km 4.0 to km 5.65
Team Observers: Tanis Douglas, David Sellars

Yes	No	N/A	HYDROLOGY
	v		1) Floodplain above bankfull is inundated in "relatively frequent" events
		v	2) Where beaver dams are present they are active and stable
	v		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	v		4) Riparian-wetland area is widening or has achieved potential extent
	v		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
v			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
v			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
v			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
v			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
v			10) Riparian-wetland plants exhibit high vigor
v			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
	v		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
v			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
		v	14) Point bars are revegetating with riparian-wetland vegetation
	v		15) Lateral stream movement is associated with natural sinuosity
v			16) System is vertically stable
	v		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

This reach is above the normal tidal influence of the Fraser River, except during very large floods. The upstream reach break is coincident with a reach break determined by the authors of the *Coquitlam River Salmonid Stock Assessment* (Riley et. al), as they determined that the river below this point did not offer any fish habitat of note. Most of the reach is composed of run habitat, much of it deep. The stream channel continues to lack complexity and LWD, and continues to be dominated by sand, with some deposits of gravel in the lower and upper ends of the reach. Riparian vegetation is dominated by alder, cottonwoods, bigleaf maple, and there is an absence of conifers. On the east side of the channel, an older dyke forms the PoCo-Traboulay Trail and is set back from or runs near the channel. A more recent dyke (constructed between 1989 and 1994 when a formal dyking system was completed) is also present at a distance from the channel, coming alongside the channel at the very top of the reach. Along the west bank the CP Railway acts as a dyke, though in some locations there appears to be an older dyke between the river and railroad. The railway is set back from the channel at the lower end of the reach and runs close to the river between river kilometer 5.0 and 5.3, at which point the railway moves away from the channel and a recently built dyke takes its place. The west bank and a small section of the east bank also support a powerline ROW with its attendant vegetation management (tree removal). A sewage line ROW crosses the river at approximately river kilometer 4.3. This reach has similarly poor channel conditions and a more limited and variable floodplain than Reach C. It is also rated Functional-at-Risk. If flushing flows improve sediment conditions then this reach could be rated Proper Functioning Condition.

Summary Determination

Functional Rating:

Proper Functioning Condition _____
Functional—At Risk ___**v**____
Nonfunctional _____
Unknown _____

Trend for Functional—At Risk:

Upward _____
Downward _____
Not Apparent _**v**___

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _**v**_
No ___

If yes, what are those factors?

_**v**_ Flow regulations ___ Mining activities ___ Upstream channel conditions
_**v**_ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows _**v**_ Other (specify) fine sediment input, urbanization, lack of gravel recruitment due to the Hydro dam

Figure 7: Reach D gravel deposits at approximately river kilometre 4.3, upstream of the Pitt River Bridge.

Figure 8: The slow moving run habitat characteristic of much of Reach D.

Name of Riparian-Wetland Area: Lower Coquitlam River
Date: September 4th, 2007 Segment/Reach ID: Reach E: km 5.65 to km 6.5
Team Observers: Tanis Douglas, David Sellars

Yes	No	N/A	HYDROLOGY
	v		1) Floodplain above bankfull is inundated in "relatively frequent" events
		v	2) Where beaver dams are present they are active and stable
	v		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	v		4) Riparian-wetland area is widening or has achieved potential extent
	v		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
v			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
v			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
v			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
v			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
v			10) Riparian-wetland plants exhibit high vigor
v			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
	v		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
v			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
v			14) Point bars are revegetating with riparian-wetland vegetation
	v		15) Lateral stream movement is associated with natural sinuosity
v			16) System is vertically stable
	v		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

The downstream end of this reach is coincident with Reach 1 from Riley *et. al's* 1998 fish habitat assessment. The upstream end is at the CP Rail Bridge, which is the upstream limit of the study area (just upstream of river kilometer 6.5). Channel conditions are noticeably different from the downstream reaches, as the substrate is primarily composed of gravels, and the river contains prominent gravel bars with some pioneering vegetation. This is a straight reach narrowly bound by dykes, and riparian vegetation exists in a thin strip along both banks. A gas pipeline ROW crosses the channel at river kilometer 6.0. According to Riley *et. al*, this reach does support fish. *Riley et. al* also report that the reach is composed of runs with one section of pool habitat. Instream complexity is still very limited. Riparian vegetation is dominated by alder, cottonwoods and bigleaf maple (*Acer macrophylum*), and there is an absence of conifers. This area has been reported as supporting spawning for chum salmon (*Oncorhynchus keta*), and formerly supported pink salmon (*Oncorhynchus gorbuscha*) when they were still present in the river (Riley *et. al* 1998). This reach has a more restricted floodplain than reaches C and D downstream, but is rated functional at risk because it does contain gravel substrate and supports fish populations, unlike the reaches downstream.

Summary Determination

Functional Rating:

Proper Functioning Condition _____
Functional—At Risk ___**v**____
Nonfunctional _____
Unknown _____

Trend for Functional—At Risk:

Upward _____
Downward _____
Not Apparent __**v**__

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _**v**_
No ___

If yes, what are those factors?

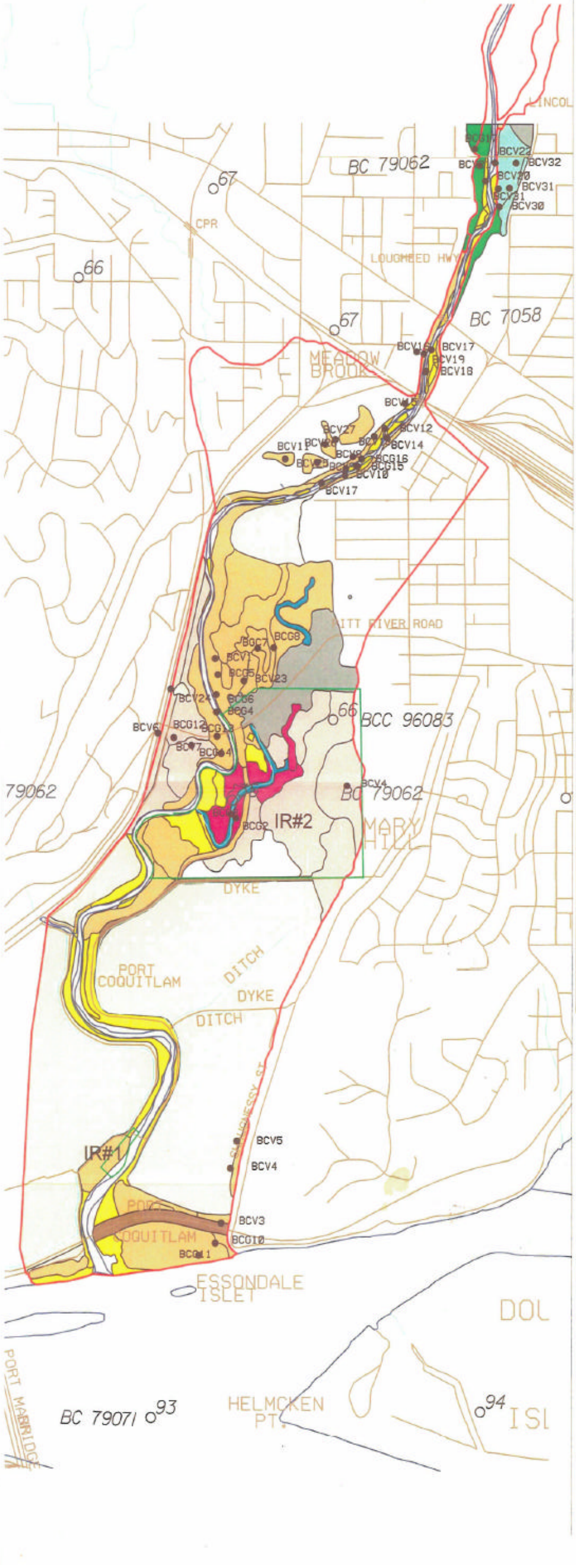
_**v**_ Flow regulations ___ Mining activities ___ Upstream channel conditions
_**v**_ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows _**v**_ Other (specify) fine sediment input, urbanization

Figure 9: gravel bar typical of Reach E: note the vegetation colonizing the bar and the continued lack of instream complexity.

Figure 10: Reach E at approximately river kilometre 6.3. Note the instream wood, the most seen at any location.

Appendix 5: Riparian Vegetation Mapping

The following maps are taken from McLennan and Veenstra (2001) and show the Biogeoclimatic Ecosystem Classification System site series and structural stages within the active floodplain.



SITE SERIES

RIPARIAN ECOSYSTEM MAPPING OF THE LOWER COQUITLAM RIVER

INTRODUCTION

This map displays riparian ecosystem polygons along the Lower Coquitlam River in Coquitlam and Port Coquitlam, British Columbia. Map polygons represent biogeoclimatic site series described in A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region (Green and Klinka 1994), and stand structural stages described in Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998). This map is accompanied by a report entitled Riparian Ecosystem Mapping of the Lower Coquitlam River. Fieldwork was completed in August 2000. This mapping of riparian ecosystems will provide the basis for assessing wildlife habitat values of riparian ecosystems along the Lower Coquitlam River.

Riparian site series describe the different kinds of ecological sites found in the mapped area, and can be placed into two categories: floodplain and non-floodplain sites. Floodplain sites include those ecosystems where flooding effects of the Coquitlam River directly affect the ecology of the site. Sites affected by flooding are located on the 'active floodplain' of the Coquitlam River, the boundary of which is indicated on the map. The ecology and habitat values of these ecosystems may be affected by any changes in the flooding regime of the Coquitlam River. Non-floodplain forest ecosystems occur outside of the active floodplain, mostly on elevated fluvial terraces that are no longer affected by water levels in the Coquitlam River. These ecosystems will not be impacted by changes in the flooding regime of the Coquitlam River.

LEGEND

Site Series

- 05 Cw-Swordfern / Fluvial Terrace Fresh Forest
- 07 Cw-Foamflower / Fluvial Terrace Moist Forest
- 08 Ss-Salmonberry / High Fluvial Bench Forest
- 09 Act-Red osier dogwood / Medium Fluvial Bench Forest
- 10 Act-Willow / Low Fluvial Bench Gravel Bar or Shrub Stand
- 12 CwSs-Skunk cabbage / Forested Swamp
- 31 Phalaris-Carex wetland / Sedge Grass Wetland
- CF cultivated field
- PD pond
- RP road
- UR urban-suburban
- Active Floodplain Boundary
- Reserve Boundary
- Ground Plot

N

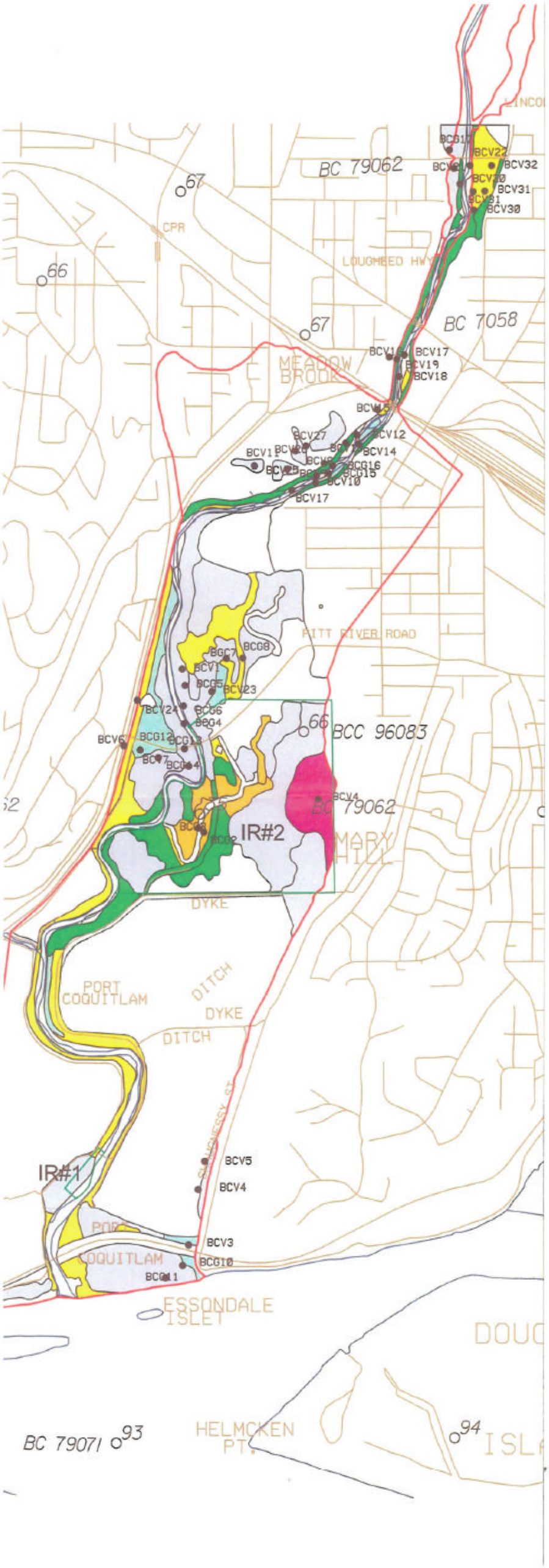
400 0 400 800 Meters

Riparian Ecosystem Mapping of the Lower Coquitlam River

Projection : UTM
Datum : NAD 83
Spheroid : GRS80
Zone : 10 N
Base : T.R.I.M. (BC Melp) 092G.026, 092G.027, 092G.036, 092G.037
TRIATHLON FORESTRY HEADQUARTER, VICTORIA, B.C.
Reserve Boundary Source: Resource Inventory; Ministry of Forests files

CREDITS
Ecosystem Mapping : Donald McLennan - Oikos Ecological Services Ltd., Smithers, B.C.
Field data collection : Donald McLennan and Valerie Veenstra - Oikos Ecological Services Ltd., Smithers
Digital Capture : Tony Lui (Triathlon)
GIS Technician : Cindy Chung
Project Supervisors : Donald McLennan (Oikos), Ken Blagborne (Triathlon)

THE POWER IS YOURS BC hydro OIKOS Ecological Services Ltd TRIATHLON



STRUCTURAL STAGE

RIPARIAN ECOSYSTEM MAPPING OF THE LOWER COQUITLAM RIVER

INTRODUCTION

This map displays riparian ecosystem polygons along the Lower Coquitlam River in Coquitlam and Port Coquitlam, British Columbia. Map polygons represent stand structural stages described in Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998). This map is accompanied by a report entitled Riparian Ecosystem Mapping of the Lower Coquitlam River. Fieldwork was completed in August 2000. This mapping of riparian ecosystems will provide the basis for assessing wildlife habitat values of riparian ecosystems along the Lower Coquitlam River.

Ecosystem Structural Stage describes the vegetation structural characteristics of the riparian ecosystem within a given map polygon. Seven stages are mapped and are described below.

Structural Stage	*Description*
Sparse/Bryoid	sparsely vegetated gravel bars and disturbed areas dominated by mosses, lichens and scattered grasses
Herb-Grass	well vegetated primarily wetlands and bars dominated by grasses and herbs
Shrub-Herb	Low Bench and disturbed areas dominated by shrubs and herbs
Pole Sapling	dense young stands (10-40 yrs) where inter-tree competition has not reduced stand density
Young Forest	older stands (25-80 yrs) where inter-tree competition has reduced stem density
Mature Forest	mature stands (40-250 yrs) where the original trees to regenerate are beginning to be replaced by understorey trees growing under the canopy - mostly mature black cottonwood stands with western redcedar regenerating beneath
Old Forest	old (>250 yrs), structurally-complex conifer dominated stands

LEGEND

Structural Stage

- 1 - Sparse / Bryoid (mosses and lichens)
- 2 - Herb / Grass Dominated
- 3 - Shrub / Herb
- 4 - Pole / Sapling
- 5 - Young Forest (generally 40 - 80 yrs)
- 6 - Mature Forest (140 - 250 yrs)
- 7 - Old Forest (>250yrs)
- Active Floodplain Boundary
- Reserve Boundary
- Ground Plot

N

200 0 200 400 600 800 Meters

Riparian Ecosystem Mapping of the Lower Coquitlam River

Projection : UTM
Datum : NAD 83
Spheroid : GRS80
Zone : 10 N
Base : T.R.I.M. (BC Melp) 092G.026, 092G.027, 092G.036, 092G.037
TRIATHLON FORESTRY HEADQUARTER, VICTORIA, B.C.
Reserve Boundary Source: Resource Inventory; Ministry of Forests files

CREDITS
Ecosystem Mapping : Donald McLennan - Oikos Ecological Services Ltd., Smithers, B.C.
Field data collection : Donald McLennan and Valerie Veenstra - Oikos Ecological Services Ltd., Smithers, B.C.
Digital Capture : Tony Lui (Triathlon)
GIS Technician : Cindy Chung
Project Supervisors : Donald McLennan (Oikos), Ken Blagborne (Triathlon)

THE POWER IS YOURS BCHydro OIKOS Ecological Services Ltd TRIATHLON

Appendix 6: Water Quality Tests Appropriate for Detecting Landfill Leachate

The following indicators, if tested in a laboratory using the appropriate procedures, will help determine if landfill leachate is present:

- Conductivity
- pH
- chloride
- sulphide
- ammonia
- Calcium
- Potassium
- Manganese
- Iron
- Sodium
- Tests for hydrocarbons, particularly those that are less volatile

Procedures and costs for testing the above parameters were investigated with Cantest Ltd. Included in this appendix is their quote for analysis including various testing options. Costs vary depending on the detection limits required for the metals, and depending on which test is chosen to detect hydrocarbons. The cheaper ICP total metals test (with higher detection limits) may be sufficient if budgets are tight. Also, it may be most appropriate to test for some substances using sediment samples as opposed to water samples, as sediment samples give a better indication of conditions over the longer term. Testing using a sediment sample to determine whether a mix of non-volatile hydrocarbons is present (EPH and LEPH/HEPH with PAH) may be most appropriate.

EPH = extractable petroleum hydrocarbons
LEPH = light extractable hydrocarbons
HEPH = heavy extractable hydrocarbons

LEPH and HEPH include most diesels, lubricating oils, greases, waxes, hydraulic oils.

PAH = polycyclic aromatic hydrocarbons, a group of heavy (non volatile) toxic compounds

Appendix 7: Financial Statement

Statement of income and expenditures

	BUDGET		ACTUAL	
INCOME	**BCRP**	**Other**	**BCRP**	**Other**
Fisheries and Oceans Canada	$ -	$ 1,800.00	**$ -**	$ 1,800.00
City of Coquitlam	$ -	$ 7,200.00	**$ -**	$ 7,200.00
Watershed Watch Salmon Society	$ -	$ 1,200.00	**$ -**	$ 1,200.00
Greater Vancouver Regional District	$ -	$ 1,800.00	**$ -**	$ 1,800.00
BCRP	$ 24,721.64	$ -	$ 24,524.77	$ -
Grand Total Income	**$ 24,721.64**	**$ 12,000.00**	**$ 24,524.77**	**$ 12,000.00**
EXPENSES				
Project Personnel				
Wages	$ 1,800.00	$ 1,200.00	$ 1,800.00	$ 2,400.00
Consultant Fees	$ 19,380.00	$ 10,800.00	$ 19,127.70	$ 6,350.00
MATERIALS AND EQUIPMENT				
Mileage (Travel)	$ 146.64	$ -	$ 276.36	$ 361.70
Meeting Expenses	$ 900.00	$ -	$ 975.71	$ -
Map purchase and printout	$ 250.00	$ -	$ -	$ -
ADMINISTRATION				
Overhead Costs	$ 1,745.00	$ -	$ 1,745.00	$ 600.00
Report Printing and Binding	$ 500.00	$ -	$ 600.00	$ -
Total Expenses	**$ 24,721.64**	**$ 12,000.00**	**$ 24,524.77**	**$ 9,711.70**
Grand Total Expenses	**$**	**36,721.64**	**$**	**34,236.47**
		36,721.64		34,236.47
BALANCE	**$**	**-**	**$**	**2,485.17**

Appendix 8: Performance Measures and Actual Outcomes

Our project did not have formal performance measures attached as no physical work was completed. Our stated objectives were achieved.

Appendix 9: Confirmation of BCRP Recognition

As our project contained no physical works, we did not create signage or other physical recognition opportunities for the BCRP. We did acknowledge the BCRP in our stakeholder meetings and on the front cover and the acknowledgements of this report. We will soon be sending a media release regarding the successful completion of this project, and a copy of this release will be provided to the BCRP project officer. If any newspaper coverage is obtained a copy will also be forwarded to the BCRP.