# Waterfall Creek Enhancement Project 2000
# FsRBC Project #00-006-18



**Submitted to: the District of New Hazelton**

**Submitted by: Nortec Consulting**

**March 31, 2001**

# Abstract

The Waterfall/Station Creek system has historically been and continues to be impacted by transportation corridors, municipal and industrial developments and subject to various diversions of flow. The streams are of interest to local communities and Fisheries & Oceans Canada from a rehabilitation perspective.

Through local community initiatives towards stewardship, interest groups have been brought together to devise a restoration/rehabilitation plan to address present and future impacts to fish and the aquatic environment present in the system. The Fisheries Renewal Program of British Columbia (FsRBC) and the Bulkley/Morice Salmonid Preservation Group provided support by funding two projects carried out during late Fall 2000 and early Spring 2001.

A restoration/rehabilitation plan was developed that recommended and initiated measures to address community concerns by providing survey and design for rehabilitation work, while providing community involvement and focus through trail development and riparian restoration along the creek system.

The projects provided local employment in developing a consensus based stewardship program that incorporates stream monitoring, salmonid enhancement, instream restoration and riparian works, and an ongoing process for community groups to foster the goals of the Fisheries Renewal Program for the Waterfall/Station Creek system.

# Table of Contents

## 1.0 Introduction

Waterfall Creek system is located near New Hazelton, British Columbia and is a principal tributary of the Station/Waterfall/Mission Creek system, which flows into the Bulkley River approximately one kilometer above the Skeena/Bulkley river confluence.

Station Creek is used for domestic water supply for the communities of New Hazelton and Hagwilget, with the water being drawn from the mid-upper reaches. Waterfall Creek is impacted by urban and industrial development and transportation corridors prior to flowing into Station Creek, approximately four kilometers below the domestic water intake (Mitchell 1998)

A Fisheries Renewal Project was proposed and submitted for Waterfall Creek in June of 2000, on behalf of the District of New Hazelton(DNH). The project was approved for funding in late fall of 2000 as Project # 00-006-18 for a total of $34,000 with $24,000 allocated from FsRBC and the remainder as in-kind contributions from the District of New Hazelton. The project was initiated in late October of 2000 with field aspects completed by Early January 2001.

## 1.1 Objectives

The objectives of the project were to provide the following services:

- Develop a riparian and in-stream rehabilitation plan for Waterfall Creek including site prescriptions and a monitoring program.
- Develop a plan for educational trails along Waterfall Creek
- Using the plan to conduct riparian and terrestrial site improvements and establish monitoring sites.

Due to the proximity of this stream to a population center, community involvement and education were encouraged for this project.

Concurrently, a complimentary, FsRBC project was funded for Waterfall Creek by the Chicago Creek Community Environmental Enhancement Society (CCES), entitled "Waterfall Creek Stream Rehabilitation Survey. The purpose of this project was to conduct a legal survey and biological assessment of selected sites over approximately 1 kilometer of Waterfall Creek, develop plans to restore impacted habitat, improve available habitat and provide estimates of costs for proposed works. The project required Licenced Surveyor, Licenced Engineer and a Fisheries Biologist to complete the project. This project was approved and commenced in early November 2000.

While projects were operating concurrently and in the same area of Waterfall Creek, discussions amongst proponents and contractors attempted to avoid any duplication of effort. Subsequently The Chicago Creek project was to provide the survey, engineering and biological components as stipulated in their contract. The District of New Hazelton Project focused on completing riparian works, trail construction and establishment of monitoring sites.

The development of a stream rehabilitation plan, suitable for approval application was a mutual objective and surveys were carried out with contractors from both projects on site and working in conjunction to prepare a comprehensive rehabilitation plan.

This report therefore provides a summary of the works carried out in Fall 2000 and recommendations as well as the rationale for the engineered restoration plans developed by Kingston & Associates through the Chicago Creek contract.

## 2.0 Study Area

Waterfall Creek watershed falls primarily in the Interior-Cedar Hemlock Biogeoclimatic zone, best represented as the Hazelton Variant - ICHmc2 or moist cold sub-zone. Waterfall Creek arises in a series of swamps and drainage from a portion of the northeast face of the Roche de Boule Range of the Hazelton Mountains.

The creek is estimated to be 7km (Mitchell 1998) flowing from an area of approximately 9.5 square km. (See Figure#1) and joins Station/Mission Creek (WC46-0100) downstream of the District of New Hazelton, before flowing into the Bulkley River approximately 1 kilometer above the Bulkley/Skeena confluence at Hazelton BC.

## 2.1 Waterfall Creek Existing Conditions

A background of existing conditions on the Station/Waterfall Creek system was established in 1998 to evaluate current and potential impacts from proposed water withdrawal, for domestic purposes serving the District of New Hazelton and the Village of Hagwilget (Mitchell 1998). The following summary of the conditions and recent modifications to Station and Waterfall Creek is necessary to evaluate the proposed rehabilitation works from the Waterfall Creek Stream Rehabilitation Survey.

There is no historical data on stream flows from Waterfall Creek upstream from where it meets the District's impoundment overflow and diversion channel. The diversion channel combines with the impoundment overflow to join Waterfall Creek immediately above the waterfall for which the creek is named. The creek downstream of the waterfall is then a combination of Waterfall Creek proper and the diverted flows from Station Creek.

Below the waterfall the creek flows north through the community of New Hazelton then West/Southwest parallel to the CNR tracks, which cross the creek at two locations. Highway 16 in two locations also crosses the creek. In total there are 14 culverted stream crossings on Waterfall creek above the confluence with Station Creek.

Waterfall Creek downstream of the water supply facility and supplemented flow from Station Creek, is heavily impacted by urban and industrial development prior to flowing into Station Creek. These impacts include but are not limited to:

- Contaminated surface runoff from municipal streets, highway, CNR tracks, old bulk plant, gas stations, tire store, parking lots and a chipper mill.

- Town clearing and highway and CNR right of way throughout the developed areas of the community and transportation corridors have resulted in riparian vegetation being removed.
- Channelization for stream crossings and adjacent to CNR, highway and municipal roads has resulted in loss of pool and riffle habitat in favor of homogeneous channel characteristics with primarily mud and silt substrates.
- Fourteen culverts exist on Waterfall Creek further channelizing flows and resulting in potential barriers to fish migration at various flows.
- New Hazelton sewage treatment plant (STP) discharges effluent into Waterfall Creek after treatment in aerated lagoons, and filtration though a wetland complex.
- Municipal litter and refuse such as tires, garbage etc.

The cumulative effect of the existing and potential impacts to the creek have resulted in increased stream temperatures, decreased oxygen levels, degraded water quality through contaminants & effluent, lack of stream cover, habitat complexity and access for salmonids.

### 2.1.1 Waterfall Creek Aquatic Resources

Waterfall Creek contains populations of enhanced coho salmon (*Oncorhynchus kitsuch*) in the fry and juvenile stages, Cutthroat trout(*O. clarkii*) ranging from 33 – 90mm and Dolly Varden char (*Salvelinus malma*) ranging from 40 – 192mm (Mitchell 1998 & Bustard 1986). The creek also supports other aquatic life (i.e. aquatic invertebrates, amphibians).

The creek flows through and is adjacent to numerous wetland complexes that have a unique and valuable role in supporting diverse food chains, providing fish and wildlife resources and maintaining natural hydrologic systems. (See Wetlands Appendix 2)

### 2.1.2 Existing Conditions on Proposed Restoration Sites

Site #1: Date of survey Dec. 4/00

- Length 262m, average channel width 3.5m, average wetted width 3m
- Ave. max. riffle depth 18cm, ave. max. pool depth 45cm
- Gradient <1%
- 40% pool, 5 % riffle, 55% flat, 0% side channel, 10% debris unstable
- Cover total 40%, composition - 30% pool, 20% instream veg, 20% overstream veg, 30% cutbank
- Crown closure 20%, South/West aspect
- Substrate: 75% fines, 8% small gravel, 9% large gravel, 5% small cobble, 5% large cobble, with moderate compaction.
- Bank height .3m, 90% unstable, channel is unconfined, texture fines & gravels, 0% bar presence
- Flow stage low, water temperature 0-1 degree celcius

- Fish observed, lack of habitat diversity, siltation and organics throughout

Site #2: Date of survey Dec. 12/00

- Length 92m, ave. channel width 4m, ave. wetted width 2.5m
- Ave. max. riffle depth 20cm, ave. max. pool depth 40cm
- Gradient 1%
- 20% pool, 30% riffle, 20% run, 30% flat, 20% side channel presence, 20% debris unstable
- Total cover 40%: composition – 20% pool, 20% instream veg. 30% overstream veg., 30% cutbank
- Crown closure 20%, aspect South
- Substrate: 20% fines, 15% small gravel, 10% large, 20% small cobble, 20% large, 15% boulder, compaction moderate
- Bank height .3m, 50% unstable, texture fines & gravels, valley channel ratio 2 – 5 and frequently confined, 0% bar presence
- Flow stage low, water temperature <1 degree Celsius, flood signs .3m
- Comments: water flowing under culverts at lower end of site

Site #3: Date of survey Dec. 14/00

- Length 239m, ave. channel width 3.5m, ave. wetted width 2.5m
- Ave. max. riffle depth 30cm, ave.max. pool depth 50cm
- Gradient 1%
- 20% pool, 30% riffle, 30% run, 20% flat, side channel 15%, 10% debris unstable
- Total cover 50%: composition – 30% pool, 20% overstream veg., 30% cutbank, 20% cobble boulder
- Crown closure 30%, aspect West/Southwest
- Substrate: 20% fines, 10% small gravel, 20% large, 15% small cobble, 20 large cobble, 15% boulder, compaction moderate
- Bank height .5m, 50% stable, texture gravels & fines, Occasionally confined
- Flow stage low
- Deep pool above hwy 16 culverts, 75cm depth

Site #4: FOC fish sampling site, with berm construction fall 2000 and site investigation. Refer to FOC for site info.

Site #5: Between 9th Ave. and Hwy 16, Date of survey Nov. 24/00

- Length 85m, Ave. channel width 2.7m, ave. wetted width 2.5m
- Ave. max. riffle depth 20cm, ave. max pool depth 35cm
- Gradient 1 – 2%
- 30% pool, 40% riffle, 30% run, 0% side channels, 15% debris unstable

- Length 85m, Ave. channel width 2.7m, ave. wetted width 2.5m
- Ave. max. riffle depth 20cm, ave. max pool depth 35cm
- Gradient 1 – 2%
- 30% pool, 40% riffle, 30% run, 0% side channels, 15% debris unstable
- Total cover: 30%, comprised of 30% pool, 10% lwd, 20% overstream veg, 40% cutbank
- Crown closure 40%, aspect North
- Substrate 30% fines, 40% small gravel, 20% large, 5% small cobble, 5% large cobble, compaction high
- Bank height .3m, texture gravel & fines, occaisionaly confined, valley channel ratio 2-5, 15% bar presence
- Flow stage low, flood signs .25m
- This area would benefit from boulder placement and bank deflectors

Site #6: Highway 16 - upstream to 13th Ave. Date of survey Nov. 24/00

- Length 390m, ave. channel width 3.5m, ave. wetted width 3m
- Ave. max. riffle depth 18cm, ave. max. pool depth 45cm
- Gradient >2%
- 20% pool, 50% riffle, 30% run, 20% braided, 15% debris unstable
- Total cover 30%: composition - 35% pool, 15% lwd, 10% boulder, 10 % instream veg, 30% cutbank
- Crown closure 70%, Aspect – North
- Substrate: 25% fines, 25% small gravel, 10% large, 15% small cobble, 155 large cobble, 10% boulder, high compaction
- Bank height 30cm, 20% unstable, texture fines & gravels
- Valley channel ratio 2-5, frequently confined
- Flow stage low, flood signs .25m, 20% bar presence
- Numerous small debris jams,

## 2.2.0 Station Creek Conditions

Recent works on Station Creek were carried out by the District of New Hazelton in spring/summer 2000 to upgrade their water supply. These included construction of a flow control weir & water intake and a pipeline to a new water treatment plant. The existent diversion on Station Creek remains in place providing flow to the District's impoundment and overflow to Waterfall Creek. Future monitoring requirements are discussed further in the report.

Over time, in the development of a water supply for the local community there was diversions of smaller streams flowing off the hillside in attempts to maintain water quality for the community water supply. Two small streams historically flowing from swampy areas into Waterfall Creek were once diverted to Station Creek to minimize potential for contamination from beaver activity and turbidity. The diversions currently flow via culverts across the diversion channel and into Station Creek. The potential does exist to return these flows to Waterfall Creek should that option be desired and if the supplemented flows from the pipeline and existing diversion are deemed not be sufficient to provide flows conservation requirements.

Station Creek is impacted by reduction in flows from water withdrawal for the District of New Hazelton and Village of Hagwilget, channelization adjacent to the CNR tracks and from impacts flowing from Waterfall Creek discussed above.

The primary impact to Station Creek (and subsequently Waterfall Creek) for anadromus and resident fish species continues to be the Station Creek culvert under Highway 16, which is considered a barrier to upstream fish migration due to >1.2m drop at the culvert outflow. It is also considered a velocity barrier as it is aprox. 60m long with a 2% gradient (Bustard 1986). This culvert has prevented fish passage to upstream reaches for an estimated 20 years and while scheduled for replacement by the Ministry of Transportation & Highways in future, continues to require mitigative measures in conjunction with the Chicago Creek Enhancement Society to ensure coho production from the creek.

## 2.2.1 Station Creek Aquatic Resources

Station Creek contains pink salmon (*Onchohynchus gorbuscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), Cutthroat trout (*O. clarkii*) and Dolly Varden char (*Salvelinus malma).* The main fisheries values are located below the Highway 16 culvert impasse.

Station Creek flows through and adjacent to a large wetland/beaver complex. The complex was proposed for enhancement/development previously by Fisheries & Oceans Canada (FOC) upstream of the HWY 16 crossing and south of the CNR right of way. Wetlands are discussed further in this report in Appendix 2.

## 2.3 Users of the Station/Waterfall Creek System

The Waterfall/Station Creeks system has historically been, and continues to be, impacted by municipal and industrial concerns and subject to various diversions of flow. The streams are of interest to local community groups and Fisheries & Oceans Canada from a rehabilitation perspective. Thus there are numerous interests affected by changes in flows.

Station Creek is used for domestic water supply for the communities of New Hazelton and the Village of Hagwilget. Water supply investigations in recent years have determined that the most viable option for providing water to the communities is Station Creek, via a diversion in the upper reaches. Hence the application for water licence and improvements to the water supply system this past year.

The District of New Hazelton has developed a trail system in areas surrounding the community that take advantage of the recreational value and natural surroundings provided by Waterfall Creek in the area below the waterfall.

## 2.4 Enhancement Activities

Over the past 10 years, coho stocks to the Station/Waterfall Creek system have been enhanced through the efforts of the Salmonid Enhancement Program, in conjunction with a New Hazelton Elementary School Group and the Chicago Creek Enhancement Society. Initially the school group released small numbers of fry into the creek from classroom incubators/aquariums, and efforts were made annually to cleanup debris and garbage accumulating in the creek.

In recent years coho juveniles and smolts from lower Station Creek stocks have been incubated and reared at the Chicago Creek Hatchery and released into upstream Station/Waterfall locations, to seed available habitat in the areas inaccessible to anadromus species. While a formal enhancement plan has not been developed, the Chicago Creek Environmental Enhancement Society has been releasing between 12,000 – 17,000 coho yearlings for the past 5 years (B.Donas, FOC, personal communication).

The enhancement program has been supplemented with funds from Ministry of Transportation & Highways towards fence operations for adult capture on Lower Station Creek. Captured coho are then transported to above the Highway 16 culvert and released in Waterfall Creek. Broodstock for enhancement purposes are also collected at the fence. FsRBC has also contributed funds towards Chicago Creek hatchery operations in recent years, some of it towards completion of infrastructure.

The degree to which local residents and school groups have been committed to cleaning up the system, their continuing commitment, and the potential of this system as an educational/recreational environment has been considered in the development of these projects.

## 3.0 Hydrology

*A minimum flow requirement of 0.03 cubic meters per second was determined for Waterfall Creek below the District water impoundment and waterfall. This was to protect, ensure sufficient flow for fish passage through culverts, provide dilution for sewage discharge, and provide flows for rehabilitation purposes. This flow has not historically been available on a year round basis. Measures to mitigate increased water withdrawal in order to ensure cover, thermal protection, food sources, spawning requirements, clean water and access for fish are required for future planning for these systems (Mitchell 1998).*

## 3.1 Waterfall Creek Flows

The District of New Hazelton maintains records of discharge for Waterfall Creek during the mid-Spring to late Fall months, discharge readings during the winter months is not presently possible due to ice cover on the creek. The water level readings are taken from a site below Highway 16, above a set of culverts.

There is no historical data on stream flows from Waterfall Creek upstream from where it meets the District's impoundment overflow and diversion channel.

It appears from the flow records that during summer/fall 2000 Waterfall Creek flows were reduced as a result of weir construction on Station Creek, which affected flows from the original diversion site. Following weir construction in early spring 2000, it appeared flows were maintained through the original diversion channel, however movement of substrate into the culvert that provides flow to the impoundment, may be the cause of reduced flows during this period. Once this situation was identified the constraints to flows through the culvert were removed.

A consistent and improved flow-monitoring regime should be implemented to ensure flows are maintained to the creek.

The Station Creek Environmental Assessment by Mitchell/1998 determined that recommended minimum flow requirements would not always be met, and that over a 10 year period, from 1985 – 1995, there was up to 118 days where the flow at the diversion site on Station Creek would not have met both fish and municipal requirements. Therefore diversion of other water to the reaches of downstream of the waterfalls may be required to in future supplement flows in Waterfall Creek.

The construction of the new intake weir and pipeline from Station Creek in 2000 has improved the capability of the District to deliver water to the community water supply, and to the impoundment through overflow. Surplus water from the pipeline, over and above community needs, can be released through the impoundment to Waterfall Creek. Further, the existing diversion channel obviously requires modification and monitoring, at the culvert downstream of the intake weir, to ensure available flows are maintained through the diversion to meet conservation requirements in Waterfall Creek.

**WATERFALL CREEK STREAM REHABILITATION PROJECT (2000/2001)**

RECORDED FLOWS AND FLOW ESTIMATE SUMMARY

RECORDED MONTHLY AVERAGE FLOWS (CUBIC METRES PER DAY)

| YEAR | MONTH | | | | | | | | | | | | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | |
| | | | | | | | | | | | | | |
| 1994 | NR | NR | NR | NR | 21,306 | 27,484 | 16,185 | 9,046 | 9,621 | 10,904 | 7,018 | F | 14,509 |
| 1995 | F | F | F | 4,439 | 13,122 | 12,556 | 12,398 | 13,849 | 10,768 | 7,100 | 5,620 | F | 9,982 |
| 1996 | F | F | 5,072 | 10,135 | 10,383 | NR | NR | NR | 17,652 | 16,874 | 8,459 | NR | 11,429 |
| 1997 | F | F | 12,416 | 15,222 | 16,589 | 14,689 | 27,829 | 20,776 | 9,392 | 12,949 | 7,995 | 6,696 | 14,455 |
| 1998 | F | F | 5,045 | 8,292 | 25,384 | 18,545 | 15,163 | 9,207 | 9,865 | 9,235 | 5,231 | 3,612 | 10,958 |
| 1999 | F | F | 4,006 | 8,238 | 13,452 | 10,910 | 12,467 | 10,528 | 11,210 | 6,060 | 6,168 | 5,044 | 8,808 |
| 2000 | F | F | F | 5,673 | 6,938 | 7,858 | 6,413 | 3,339 | NR | NR | 3,676 | 5,002 | 5,557 |
| 2001 | F | F | F | | | | | | | | | | 0 |
| | | | | | | | | | | | | | |
| TOTALS | F | F | 6,635 | 8,667 | 15,311 | 15,340 | 15,076 | 11,124 | 11,418 | 10,520 | 6,310 | 5,089 | 10,881 |

NOTES: FLOWS RECORDED BY DISTRICT OF NEW HAZELTON AT TWO CULVERTS AT LOG SORT UPSTREAM OF CN CROSSING
JUNE AND JULY 1997 FLOWS ARE ESTIMATES ONLY
F = FROZEN CONDITIONS ON STREAM
NR = NO RECORD

FLOW ESTIMATE SUMMARY

| | | | | |
|---|---|---|---|---|
| RECORDED AVERAGE MONTHLY FLOW (1995, 1997 THROUGH 1999) | 11,107 | CUBIC METRES PER DAY | 129 | LITRES PER SEC. |
| ESTIMATED AVERAGE MONTHLY FLOW (1995, 1997 THROUGH 1999) | 9,522 | CUBIC METRES PER DAY | 110 | LITRES PER SEC. |
| RECORDED MAXIMUM MONTHLY FLOW | 27,829 | CUBIC METRES PER DAY | 322 | LITRES PER SEC. |
| ESTIMATED MINIMUM MONTHLY FLOW | 3,500 | CUBIC METRES PER DAY | 41 | LITRES PER SEC. |

## 3.2 Station Creek Flows

A proportion of upper Station Creek flows are diverted for water supply purposes and conservation requirements of Waterfall Creek at the primary diversion site and intake weir. There is no historical data on stream flows downstream of the diversion, where the flow is primarily from overland flow rather than from upper Station Creek. The historical Water Survey Canada (WSC) gauge was located above the diversion and diffuse surface flow areas, and only measured the upper 43% of the Station Creek length. The lower diffuse surface flows from swamps and overland surface flows add considerably to the drainage area. Flow analysis from 9 recorded years suggest that upper Station Creek, above the diversion, accounts for less than half of the volume of lower Station Creek. *(Mitchell 1998)*

Aquatic values of the reach below the diversion site, and above the beaver complex at the confluence with Waterfall Creek, were determined to be moderate due to access constraints, fish presence and gradient. The reaches of Waterfall Creek were considered to be of higher value fish habitat (*Mitchell 1998*) and through discussion with FOC it was determined that flows surplus to community requirements at the diversion site should be channeled to Waterfall Creek for conservation purposes. Therefore no minimum flows were recommended for the reaches of Station Creek from the primary diversion to its confluence with Waterfall Creek.

The majority of the water diverted for community purposes is returned to the Station Creek proper above of the confluence of Station/Waterfall creeks through the sewage treatment facility and wetland complex. Water supplied to the Village of Hagwilget is of course removed from the system. Conservation flows diverted to Waterfall Creek and surplus from the water supply facility remain in the Station/Waterfall system.

# 4.0 Results and Discussion

## 4.1 Stream Enhancement Works Fall/2000

- A total of 240m of walkway were constructed in the wetland complex between McLeod St. and Templeton St. Walkways were constructed using treated fence posts and treated 1 x 6. Note: Approximately 35m of railing for this walkway still needs to be constructed.
- One bridge and 179m of graveled walkway was also completed between McLeod St. and Templeton St. Approximately 20 conifer trees were planted along this trail. This trail and walkway have potential to be Class A trails with proper maintenance and more trail construction.
- Another bridge was constructed over Waterfall Creek south of the Yellowhead Hwy. East of Lots 23 & 24 on a riparian right of way. There is a footpath and crossing in this area that can in future be improved to connect the community trail

complex from the McLeod/Templeton section to the Waterfall and Water Tower sections of developed trails. This section of stream is relatively un-impacted in relation to downstream sections. The bridge needs to have a railing built on it, and the footpath could be upgraded to trail standards consistent with other community trails.

- Crews also brushed the section of community trail that runs from the Hagwilget ball field to New Hazelton and obstructions were removed.

## 4.2 Riparian Restoration Plan

*Throughout the developed areas of the community and particularly along the CNR right of way, the stream canopy in the riparian area has been significantly removed. This results in greater solar insolation and warmer water temperatures. Greater temperatures result in increased respiration by fish and aquatic organisms but warmer water contains less dissolved oxygen than colder water, so there is less available oxygen when organisms most need it (Mitchell 1998, Davis 1975).*

The existent riparian vegetation, in the areas of concern, is primarily deciduous at the shrub/herb stage and is functionally impaired. The overstory contains little if any coniferous species and is dominated by deciduous species. Where riparian structure is present it is comprised of approximately 100 stems per hectare of birch, aspen and cottonwood. These species are generally in layer with scattered mature trees.

The understory is basically made up of three layers. The first layer is predominately alder and willow with an average height of 5m with crown closure that varies between 1%-40%. The second layer is a mixture of several shrub species comprised of red osier dogwood, black twinberry, red elderberry and prickly rose. These shrubs average 2m in height with an average crown closure of 5%. The last layer is primarily grass species with some spirea. The grass is a potential regeneration problem due to % of ground cover.

### 4.2.1 Riparian Works/Fall 2000

Approximately 300 to 400 seedlings were planted with-in 5m of the creek. The seedlings were planted singularly or in clusters at staggered spacing. The immediate area around the seedlings was manually brushed within a 1m diameter of the seedling. Willow and alder were not brushed in riparian area as it provides bank stability, shade and a food source.

The species planted were Pl, Sx, Bl and Ba and stock was taken from a nursery site established by New Hazelton on the old ball field. Sites planted in fall 2000 were:

- Site 2 on the west side of the stream.
- Site 3 on both sides of the stream
- The downstream section of Site 4
- In the wetland complex adjacent to the walkway

The limiting factors that will prevent seedling survival are the water table, and the amount of competing vegetation. The water table constantly fluctuates depending on the amount of beaver activity and the season, this will contribute to seedling mortality.

Future planting of seedlings and larger stock should take place in elevated microsites. If the site is conducive to machine use, mounds can be established from materials excavated during restoration works and conifer seedlings planted on the mounds. The biggest stock available should be planted, for example conifers 50cm+ to be removed from the highway right of way and transplanted in selected sites. Cottonwood whips could also be planted in the wetter areas.

The competing brush could choke out the planted seedlings, and snow and vegetation press in the winter may also damage. Grass and herbs should be manually brushed at the time of planting and every year following until seedlings are established. Brush mats can also be utilized to limit amount of brush competition.

Small and large shrubs can be brushed at time of planting, but will coppice and cause more competition in the future, requiring constant monitoring and future brushing. Planting shade tolerant trees close to shrubs will prevent snow and vegetation press. At present there is no coniferous seed source for the riparian area around Waterfall Creek. Subsequently there is limited potential for LWD in the future. With large seedling stock, selected planting areas and a vigorous brushing program, conifers could be established to provide shade, food source, bank stability and a long term source of LWD.

It is recommended that sites where restoration works are carried out in future be planted as quickly as possible following works, with the largest stock available, and with natural seed source for herbs and grasses from the surrounding area if available.

## 4.3 Stream Restoration/Rehabilitation Rationale & Recommendations

### 4.3.1 Restoration rationale

*"Due to the present degraded nature of the stream, the introduction of point and non-point source contaminants, and it's potential value as a community stream, it is strongly recommended that any increase in water licence require a stream rehabilitation program to mitigate consequences of water withdrawal* (Mitchell 1998)."

As a result of application by the District of New Hazelton for increased water withdrawal from Station Creek to meet future demands, and flowing from recommendations from the Station Creek Environmental Assessment (*Mitchell 1998*), a Water Use Planning process was initiated to involve community groups and agencies to ensure common interests were addressed on the Station/Waterfall system.

The Mission Creek (Station/Waterfall) Steering Committee held meetings to discuss future plans for enhancement and restoration of impacted habitats within the system.

Results of the Waterfall Creek Enhancement Project (DNH) and the Waterfall Creek Stream Rehabilitation Survey (CCES) are to be presented to this group for support and/or approval. The Mission Creek Steering Committee is comprised of the following groups:

- District of New Hazelton
- Fisheries & Oceans Canada
- Ministry of Environment, Lands & Parks
- Chicago Creek Enhancement Society
- Gitksan Watershed Authority
- Canadian National Railways
- Ministry of Transportation & Highways

It is anticipated that through the continued involvement and efforts of the above groups that the restoration/rehabilitation of the watershed will be addressed. The following proposed habitat mitigation measures are for their review:

### 4.3.2 Habitat Restoration/Rehabilitation Measures

*Note: The following recommendations and rationale are to be viewed in conjunction with the Waterfall Creek Stream Restoration Report and Maps as produced by Kingston & Associates Ltd. for Chicago Creek Enhancement Society.*

In order to mitigate current and future impacts due to water use and community growth, and maintain aquatic habitat within Waterfall/Station Creek, the restoration measures must provide:

1. Cover for fish, thermal protection
2. Spawning habitat for fish
3. Water quality
4. Food source for rearing fish
5. Access for fish throughout the stream

1. Cover is important to fish to provide resting pools, rearing habitat and refuge from predators. It is presently conspicuous by its absence throughout Lower Waterfall Creek, particularly along the entire channelized section adjacent to the CNR tracks. Thermal protection is vital for a proper functioning ecosystem, as stream temperatures should remain <20 degrees Celsius throughout the summer for fish species present. Restoration measures proposed to improve cover include:

- Installation of instream structure such as large woody debris (lwd), root wads and boulders. (*See Site Maps 1 – 4 by Kingston & Assoc.*)
- Pool development by placement of instream structure such as weirs, lwd, boulder clusters etc. (*See Site Maps 1 – 4 by Kingston & Assoc.*)
- Riparian planting of coniferous and deciduous species to provide thermal cover, future shade, leaf litter and food source to the system, as well as a long term large woody debris source.

2. Spawning habitat requirements for coho, cutthroat and Dolly Varden char are similar in that their incubating eggs require clean, unsilted gravel 1 – 10 cm in diameter, with a flow of cool, clean oxygenated water. Restoration measures proposed include:

- Instream structures will be placed in series with washed gravels from 1 – 10 cm in diameter, placed at depths of 70 – 100cm., in water depths varying from 15- 50 cm. (*See Site Maps 1 – 4 by Kingston & Assoc.*)
- Weirs logs and boulders will provide localized areas of scour and gravel cleaning to increase available areas for spawning. (*See Site Maps 1 – 4 by Kingston & Assoc.*)
- These structures are also expected to provide macroinvertebrate habitat as the water depth and velocity requirements are very similar.
- *Criteria for gravels, flow depths are referenced from Fish Habitat Rehabilitation Procedures by Slaney & Zaldokas WRTC #9 Watershed Restoration Program BC and Estimates of Benefits for Salmonids from Stream Restoration Initiatives, Salney & Zaldokas 1996*

3. Water Quality: Clean water is essential to the stream ecosystem for spawning and rearing fish, macro invertebrates and amphibians.
   - Cleaning up of the terrestrial environment adjacent to the stream and minimizing the input of contaminants would assist in maintaining water quality.
   - Public awareness, community education and stewardship are to be fostered through signage and public participation, and use of trails in rehabilitated areas of stream throughout the community.

4. Food sources for rearing fish will be improved through boulder, cobble and gravel placement in rehabilitated areas and riparian restoration. The construction of repeating riffles, spawning areas and improved rearing habitats should provide improved macro invertebrate food production for resident fish.

- *Optimum macro invertebrate diversity and production is in waters 15-40cm deep, with a velocity of 0.15 – 0.8m/s, over a cobble-boulder substrate based on results of Gore 1978,* Orth & Maughan 1983.
- *Rearing macrohabitats for coho and cutthroat suggest velocities from 0 – 30 cm.s and water depth from 5 – 65 cm,* Keeley, Slaney & Zaldokas 1996

4. Access for fish throughout the stream is critical to fish migration and movement between feeding and resting areas and suitable over wintering habitats. While this project cannot address the primary constraint on fish movement (that being the Highway 16 culvert on Station creek), the recommendations flowing from *Station/Waterfall Creek Environmental Assessment (Mitchell 1998)* do try to address movement of fish through culverts, and access to available habitats currently utilized by fish. As a result of these recommendations, site inspections

and survey through the FsRBC projects, the following recommendations are being proposed to address access concerns:

- Site 1 will have boulder clusters and pool development downstream of twin culverts under the CNR tracks to provide resting area and over wintering pools. (*See Site Map 1 by Kingston & Assoc.*)
- Site 2 - Two culverts will be removed and replaced with new culverts with improved fish passage hydraulics and rock clusters, below the monitoring weir for water level control on culverts. (*See Site Map 2 by Kingston & Assoc.*)
- Site 3 (see Stream Details) two sets of twin culverts are proposed for removal to eliminate potential passage problems. (*See Site Map 3 by Kingston & Assoc.*)
- Site 4 - Rock clusters are proposed to be placed to ensure low flow water level control through CN culverts. (*See Site Map 4 by Kingston & Assoc.*)

### 4.3.3 Priorization of Proposed Sites

In order to priorize proposed rehabilitation measures it is imperative to consider the following criteria:

- long term water availability and sustainable flows
- concerns and comments from groups involved
- future salmonid enhancement plans
- cost benefit of proposed measures
- relative feasibility of, and long term effectiveness of proposed works
- stream habitat components provided and sustainability
- Land status within the proposed sites (Note: land status is provided in the Kingston & Assoc. Ltd. report)

With these criteria in mind, and on a preliminary basis the author offers the following comment on priorization of sites for consideration:

1. Site 2 should be the first priority to provide a long term flow monitoring site. Substrates in the area were more conducive to excavation and long term stability of proposed works.
2. Site 3B should be considered the second priority due to land status, elevation of stream banks, gradient available for restoration proposed and the subsequent removal of two sets of culverts.
3. Site 1 will provide improved rearing habitat at a relatively low cost, land status is also taken into consideration.
4. Site 3A is considered a third priority
5. Site 4 is the lower priority due to low bank elevation on the adjacent wetlands, soil conditions and long term viability concerns of proposed works. This site falls within CNR right-of-way.

The number of sites rehabilitated will of course be contingent on approvals by agency and funding available.

### 4.3.4 Monitoring Requirements

Flow monitoring on Waterfall Creek is carried out by the District of New Hazelton at a site approximately 90 m downstream of Highway 16 culverts (*See Site Maps 2 by Kingston & Assoc.*). Monitoring at this site is required to determine flows prior to the addition of flows from the District sewage out fall downstream. The intent is to determine dilution factors from the District waste treatment facility.

The District of New Hazelton proposes to monitor pipe flow and over flow to their impoundment, measure flow at the intake weir at the original site of the Water Survey Canada Station 0EE028, and measure flows of Waterfall Creek at the historical site downstream of HWY 16. Flows will be recorded on a weekly basis until ice conditions preclude accurate readings, as has been the case in past years. Water level gauges have been placed in the above locations and in Station Creek, approximately 1 km continuing South from Pugsley Street.

#### 4.3.4.1 Flow Monitoring Sites

1. Original site of Water Survey Canada Station 0EE028 above flow control weir on Station Creek.
2. District of New Hazelton historical flow monitoring site approximately 90m downstream of HWY 16. (*See Site Map 2 by Kingston & Assoc.*)
3. Station Creek water gauge approximately 1 km south of Pugsley Street.

#### 4.3.4.2 Monitoring of Effectiveness of Restoration/Rehabilitation Works

Monitoring of restoration activities in a stream is an important component of any rehabilitation project. To determine the benefit of works carried out in and about the stream, it is imperative to implement a monitoring program to track results of changes in habitat components, water quality and the relative benefits to aquatic organisms utilizing the habitat created or improved.

This will be facilitated by the fish information collected in Fall/winter 2000/01 by B. Donas, FOC and Bridie O'Brien, and a proposed FsRBC project to carryout downstream trapping in Spring 2001. Information collected will provide much needed baseline information on existing production and rearing densities, from natural and enhanced stocks currently using the system in the area of proposed works. A monitoring plan using the same methodology in future years would greatly assist in determining effectiveness of restoration works carried out.

The current fish information available should be presented to the groups involved and a plan established to coordinate the required components with the various groups.

## 5.0 Recommendations

- Implement rehabilitation strategies as soon as possible to mitigate for proposed increases in required water withdrawal volumes.
- Monitoring of rehabilitation works on an ongoing basis.
- In order to ensure minimum flows in Waterfall Creek, it was recommended that more water be diverted to the creek from the swamps located south of the District impoundment.
- Calibrate flows and continue to monitor Waterfall and Station Creek flows on a weekly basis.
- Roundtable meetings of the Mission Creek Steering Committee should continue to discuss future options and provide comment and concerns on an ongoing basis.
- Issues surrounding impacts projects proposed to the system should be resolved in this forum and the Water Use Panning process rather than through litigation.
- Completion of the Water Use Planning process to ensure concerns of participants are being met, and that a process exists for dispute resolution on an ongoing basis.
- Signage should be established that reflects the efforts of all groups involved and the stewardship objectives of the projects.
- Efforts must be continued towards having the culvert barrier issue on Highway 16 resolved. The expense and benefit of restoration works and continued enhancement remain questionable should this issue not be resolved in a timely fashion.

## 6.0 Literature Cited

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Keely, E.R., Zaladokas, D & Slaney, P.A. 1996. Estimates of production benefits for salmonid fishes from stream restoration initiatives. Watershed Restoration management Report #4 1996 WRP of BC, MELP

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Photos
1 & 2

Above: Site 1 Viewed from downstream, near foot of Thirteenth Avenue, looking upstream.

Below: Site 1 Viewed from culverts under CN tracks at Twelfth Avenue, looking downstream.

Photos
3 & 4

Above: Site 2 Viewed from culverts at Eleventh Avenue, looking upstream.

Below: Site 2 Viewed from Highway 16, looking downstream.

Photos
5 & 6

Above: Site 3 Viewed from Highway 16, looking upstream.

Below: Site 3 Viewed from culverts to be retained, looking downstream.

Photos
7 & 8

Above: Site 3 Showing culverts to be removed at bulk plant, looking downstream.

Below: Site 4 Showing site of proposed pool at former bulk plant, looking upstream.

Photos
9 & 10

Above: Site 4 View from culverts under CN tracks, looking upstream.

Below: Site 4 Showing a temporary weir at midpoint, looking downstream.

Photos
11 & 12

Above: Site 4 View from weirs at midpoint, looking upstream.

Below: Site 4 View from upper end, looking downstream.

# Appendix 2

## *Wetlands*

The Station/Waterfall system runs through and adjacent to numerous wetland complexes. Wetlands preform a unique and valuable role in supporting diverse food chains, complimenting fish and wildlife resources and maintaining natural hydrologic systems.

Wetland functions are the physical, chemical, and biological processes occurring in and making up an ecosystem. Processes include the movement of water through the wetland into streams; the decay of organic matter; the release of nitrogen, sulfur, and carbon into the atmosphere; the removal of nutrients, sediment and organic matter from water moving into the wetland; and the growth and development of all the organisms that require wetlands for life.

Wetlands help maintain and improve the water quality of our nation's streams, rivers, lakes, and estuaries. Since wetlands are located between uplands and water resources, many can intercept runoff from the land before it reaches open water. As runoff and surface water pass through, wetlands remove or transform pollutants through physical, chemical, and biological processes.

### *Removal of Biological Oxygen Demand from Surface Water*

Biological oxygen demand (BOD) is a measure of the oxygen required for the decomposition of organic matter and oxidation of inorganics such as sulfide. BOD is introduced into surface water through inputs of organic matter such as sewage effluent, surface runoff, and natural biotic processes. If BOD is high, low dissolved oxygen levels result. Low dissolved oxygen levels can lead to mortality of aquatic life. Wetlands remove BOD from surface water through decomposition of organic matter or oxidation of inorganics (*Hemond and Benoit 1988*). BOD removal by wetlands may approach 100% (*Hemond and Benoit 1988*).

### *Removal of Suspended Solids and Associated Pollutants from Surface Water*

Suspended solids (such as sediment and organic matter) may enter wetlands in runoff, as particulate litterfall, or with inflow from associated water bodies. Sediment deposition in wetlands depends upon water velocity, flooding regimes, vegetated area of the wetland, and water retention time (*Gilliam 1994; Johnston 1991*). Sediment deposition in wetlands prevents a source of turbidity from entering downstream ecosystems. Typically wetland vegetation traps 80-90% of sediment from runoff (*Gilliam 1994; J ohnston 1991*). Less than 65% of the sediment eroded from uplands exits watersheds that contain wetlands (*Johnston 1991*).

Other pollutants that impact water quality such as nutrients, organics, metals and radionuclides are often adsorbed onto suspended solids. Deposition of suspended solids, to which such substances are adsorbed, removes these pollutants from the water. Thus sediment deposition provides multiple benefits to downstream water quality (*Johnston 1991; Hemond and Benoit 1988; Hupp et al. 1993; Puckett et al. 1993*).

### *Removal of Metals*

Certain wetlands play an important role in removing metals from other water resources, runoff, and ground water (*Owen 1992; Gambrell 1994; Puckett et al. 1993*). Wetlands remove 20% - 100% of metals in the water, depending on the specific metal and the individual wetland (*Taylor et al. 1990*). Forested wetlands play a critical role in removing metals downstream of urbanized areas (*Hupp et al. 1993*).

Delfino and Odum (1993) found that lead leaking from a Florida hazardous waste site was retained at high levels by a wetland; less than 20 - 25% of the total lead in the soil and sediments was readily bioavailable. The majority of the lead was bound to soil and sediments through adsorption, chelation, and precipitation. Bioavailable lead was absorbed primarily by eel grass, which had bioaccumulated the majority of the lead. In another case, researchers found that wetland vegetation and organic (muck) substrate retained 98% of lead entering the wetland (Gambrell 1994 ).

### *Removal of Pathogens*

Fecal coliform bacteria and protozoans, which are indicators of threats to human health, enter wetlands through municipal sewage, urban stormwater, leaking septic tanks, and agricultural runoff. Bacteria attach to suspended solids that are then trapped by wetland vegetation (*Hemond and Benoit 1988*). These organisms die: after remaining outside their host organisms, through degradation by sunlight, from the low pH of wetlands, by protozoan consumption, and from toxins excreted from the roots of some wetland plants (*Hemond and Benoit 1988; Kennish 1992*). In this way wetlands have an important role in removing pathogens from surface water.

### *Water Supply*

Wetlands act as reservoirs for the watershed. Wetlands release the water they retain (from precipitation, surface water, and ground water) into associated surface water and ground water. In Wisconsin watersheds composed of 40% lakes and wetlands, spring stream outflows from the watersheds were 140% of those in watersheds without any wetlands or lakes (*Mitsch and Gosselink 1993*). Forested wetlands, kettle lakes and prairie potholes have significant water storage and ground water recharge (*Brown and Sullivan 1988; Weller 1981*). Forested wetlands overlying permeable soil may release up to 100,000 gallons/acre/day into the ground water (*Anderson and Rockel 1991*). Verry and Timmons (1982) studied a Minnesota bog which released 55% of the entering water to stream and ground water.

Ground water can be adversely affected by activities that alter wetland hydrology (*Winter 1988*). Drainage of wetlands lowers the water table and reduces the hydraulic head providing the force for ground water discharge (*O'Brien 1988; Winter 1988*). If a recharge wetland is drained, the water resources into which ground water discharges will receive less inflow, potentially changing the hydrology of a watershed (*Brinson 1993; Winter 1988*).

### ***Flood Protection***

Wetlands help protect adjacent and downstream properties from potential flood damage. The value of flood control by wetlands increases with: (1) wetland area, (2) proximity of the wetland to flood waters, (3) location of the wetland (along a river, lake , or stream), (4) amount of flooding that would occur without the presence of the wetlands, and, (5) lack of other upstream storage areas such as ponds, lakes, and reservoirs (*Mitsch and Gosselink 1993*).

Wetlands within and upstream of urban areas are particularly valuable for flood protection. The impervious surface in urban areas greatly increases the rate and volume of runoff, thereby increasing the risk of flood damage.

### ***Erosion Control***

By virtue of their place in the landscape, riparian wetlands, salt marshes, and marshes located at the margin of lakes protect shorelines and streambanks against erosion. Wetland plants hold the soil in place with their roots, absorb wave energy, and reduce the velocity of stream or river currents.

### ***Fish and Wildlife Habitat***

Diverse species of plants, insects, amphibians, reptiles, birds, fish, and mammals depend on wetlands for food, habitat, or temporary shelter. Many bird species utilize wetlands as sources of food, water, nesting material, or shelter. Migratory waterbirds rely on wetlands for staging areas, resting, feeding, breeding, or nesting grounds.

### ***Recreation, Aesthetics, Culture, and Science***

Wetlands have archeological, historical, cultural, recreational, and scientific values. Societies have traditionally formed along bodies of water and artifacts found in wetlands provide information about these societies.

Scientists value the processes of wetlands individually, particularly the role of wetlands in the global cycles of carbon, nitrogen, and water. Many scientists consider the removal of carbon dioxide from the atmosphere into plant matter and its burial as peat (sequestration) the most valuable function of wetlands (OTA 1993). Carbon sequestration is thought to be an important process in reducing the greenhouse effect and the threat of global warming.

### ***Water balance***

Wetlands play a critical role in regulating the movement of water within watersheds as well as in the global water cycle (*Richardson 1994; Mitsch and Gosselink 1993*).

Wetlands, by definition, are characterized by water saturation in the root zone, at, o r above the soil surface, for a certain amount of time during the year. This fluctuation of the water table (hydroperiod) above the soil surface is unique to each wetland type.

Wetlands store precipitation and surface water and then slowly release the water into associated surface water resources, ground water, and the atmosphere. Wetland types differ in this capacity based on a number of physical and biological charact eristics, including: landscape position, soil saturation, the fiber content/degree of decomposition of the organic soils, vegetation density and type of vegetation (*Taylor et al. 1990*):

### ***Community structure and wildlife support***

The inundated or saturated conditions occurring in wetlands limit plant species composition to those that can tolerate such conditions. Beaver, muskrat create or manipulate their own wetland habitat that other organisms, such as fish, amphibians, waterfowl, insects, and mammals can then use or inhabit (*Weller 1981; Mitsch and Gosselink 1993*).

Wetland shape and size affect the wildlife community and the wetland's function as suitable habitat (*Kent 1994b; Brinson 1993; Harris 1988*). The shape of the wetland varies the perimeter to area ratio. The amount of perimeter versus area has importance for the success of interior and edge species (*Kent 1994b*). Shape is also important for the possibility of movement of animals within the habitat and between habitats. Wetland size is particularly important for larger and wide ranging animals that utilize wetlands for food and refuge, such as black bear or moose, since in many locations wetlands may be the only undeveloped and undisturbed areas remaining.