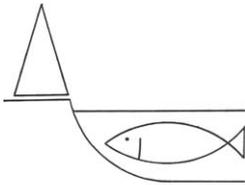


A COMPREHENSIVE FISHERIES STUDY OF THE  
LOWER REACH OF BIGHILL CREEK AND  
TRIBUTARIES: 2008 - 2009  
TOWN OF COCHRANE, ALBERTA

---

The Alberta Conservation Association -020-00-90-153



---

---

Bow Valley Habitat Development

A COMPREHENSIVE FISHERIES STUDY OF THE  
LOWER REACH OF BIGHILL CREEK AND  
TRIBUTARIES: 2008 - 2009  
TOWN OF COCHRANE, ALBERTA

---

The Alberta Conservation Association -020-00-90-153

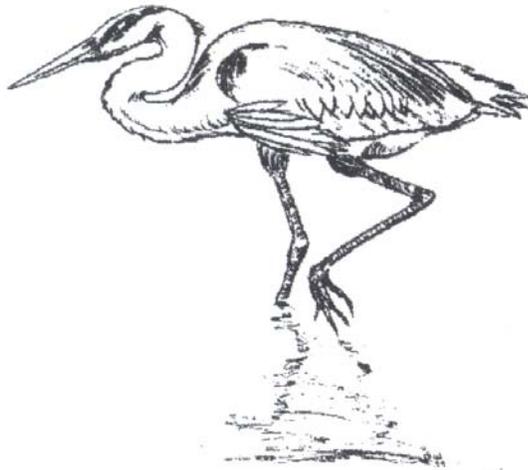
Report prepared by:  
Guy Woods

Bow Valley Habitat Development  
#5 Glenport Road  
Cochrane, Alberta T4C 1G8  
November 16, 2009

Phone: 403-932-4467 Cell: 852-7102  
Email: [guywoods@telusplanet.net](mailto:guywoods@telusplanet.net)

## Acknowledgements

A number of individuals contributed to the successful completion of this study. Special thanks are extended to Mr. Andy Degraw, Town of Cochrane, Parks and Facilities, Operational Services Division, for his collection of water samples and lab costs for analyses. The Alberta Conservation Association for funding support for the completion of this study. Thanks are also given to the volunteers that helped out in the angling survey work and beaver dam removal, to allow migration of trout further up the stream system this spring. We acknowledge the contribution of time and effort by members of the Cochrane Branches and Banks organization for their help in re-vegetation of a beaver dam site this spring. Thanks are extended to the volunteers that participated in the redd count survey and trout trapping part of the program. Although not entirely part of this study program, volunteers contributed a total of 93 volunteer hours. Including the Cochrane Scout Troop, which completed a stream clean up at Millennium Creek. See appendix 5., at the end of this study report, for the total time contributions made.



## Table of Contents

Table of Contents.....	i
1.0 Introduction.....	1
1.1 Study Area.....	4
1.2 Study Objectives.....	4
2.0 Methods.....	5
2.1 Stream Sections.....	6
2.2 Angling Survey.....	7
2.3 Fall Spawning Survey (2008).....	8
2.4 Trout Trapping Program.....	8
2.5 Water Quality and Turbidity Testing.....	10
2.5.1 Water Quality Testing.....	10
2.5.2 Secchi Water Clarity and Turbidity Recording.....	10
2.6 Riparian and In-stream Fish Habitat Assessment.....	11
2.7 Data Analyses.....	11
3.0 Results and Discussion.....	12
3.1 Angling Survey for 2008 – 2009.....	12
3.2 Fall Spawning Survey 2008.....	15
3.3 Trout Trapping Program 2009.....	18
3.3.1 Trout Fry Emergence on Bighill Creek.....	18
3.3.2 Trapping Program on BHC (main-stem).....	20
3.3.3 Trapping of Feeder Tributaries.....	21
3.3.4 Distribution of Juvenile YOY Trout.....	22
3.3.5 Growth Frequency of Juvenile Trout in BHC.....	23
3.3.6 Presence of Non-Sport Fish Species in Bighill Creek.....	24
3.3.7 Non-Resident Sport Fish Species not Trapped in BHC.....	26
3.4 Water Quality and Clarity Sampling Results.....	26
3.4.1 Water Quality Sampling and Analyses.....	26
3.4.2 Seasonal Water Clarity and Turbidity Levels.....	27
3.4.3 Storm Drain Impacts.....	29
3.5 Riparian and Fish Habitat Assessment.....	29
3.5.1 Lower Reach (8 km).....	29
3.5.2 Middle and Upper Reach.....	31
3.5.3 Feeder Tributaries.....	32
4.0 Conclusion and Recommendations.....	34
5.0 References Cited.....	36
6.1 List of Appendices.....	37

### List of Figures

Figure 1. Map of Bighill Creek watershed.	2
Figure 2. Map of spawning redds on BHC.	16
Figure 3. Comparison of species trapped chart.	22
Figure 4. Profile of growth frequency for juvenile trout chart.	24
Figure 5. Sechi water clarity/turbidity chart.	28

### List of Tables

Table 1. Summary of BHC Angling Survey. 2008	13
Table 2. Summary of BHC Angling Survey. 2009	14
Table 3. Summary of combined angling survey results.	14
Table 4. Summary of the quality of angling experience.	15
Table 5. Total number of trout redds identified and mapped on BHC and tributaries.	17
Table 6. Trapping results for 2009 trapping program.	21
Table 7. BHC Sechi Data for 2009.	28
Table 8. Channel bankful widths for Section 3 site – 4 <sup>th</sup> Ave. Bridge.	30
Table 9. Channel bankful widths for Section 2 site – Glenbow Drive.	31
Table 10. Channel bankful widths for the middle reach of BHC.	32

### List of Plates

Plate 1. A photo of the glass viewer and camera assembly.	9
Plate 2. Photo of a 28 mm trout captured on May 14 <sup>th</sup> .	19
Plate 3. A 22 mm trout fry captured on May 23 <sup>rd</sup> .	20
Plate 4. A 110 mm brook trout captured on September 29 <sup>th</sup> .	23
Plates 5-10. Photos of non-sport fish species captured in BHC.	25-26

## 1.0 Introduction

Bighill Creek is the second largest tributary to the Bow River between Ghost and Bearspaw dams. The headwaters of Bighill Creek consist of two primary east and west tributaries that join together approximately 100 m, North of Highway 567. The west tributary flows approximately 10 km from feeder springs located at the upper end of "Hutchison's coulee", near the Westbrook area. The east branch has its start approximately 8 km upstream in the "Lochend Lakes" (wetlands) area, adjacent to Lochend Road. From the confluence of the two primary feeder creeks, the main stem flows approximately 2.7 km downstream to where the feeder spring from the Bighill Springs Provincial Park enters the Bighill Creek. The main stem flows approximately 14 km downstream of where the park spring enters the Bighill Creek, to the mouth on the Bow River (See Figure 1.0).

Historically, the Bighill Creek was reputed to be a healthy trout fishery providing good recreational angling. To augment existing wild trout populations reduced by harvest, the creek was stocked with a variety of trout species between 1929 and 1969. This included the introduction of cutthroat trout, brook trout, brown trout and rainbow trout (Rawson 1939 and Rees 1987). An experimental fish rearing facility was constructed on the feeder spring, at the Provincial Park in 1950, but the attempts were unsuccessful, possibly due to the low water temperatures in the spring creek (MacDonald 1950).

Since the provincial stocking of Alberta Streams was cutback in the 1960's, the Bighill Creek has been dependant on natural reproduction for recruitment of trout into the system and migration of sport fish upstream of the Bow River. However, very little spawning activity of wild trout in the Bighill Creek has been reported in recent years. The only documented spawning activity recorded on the Bighill Creek was that which was observed on the Provincial Park feeder spring in the later 1980's (Sosiak 1986, Rees 1987). The lack of suitable spawning habitat and conditions in the main stem of the stream has limited natural reproduction along the entire reach of Bighill Creek in past years. The most limiting factor has been the excessive siltation in the middle reach

of the creek (Rees 1987).

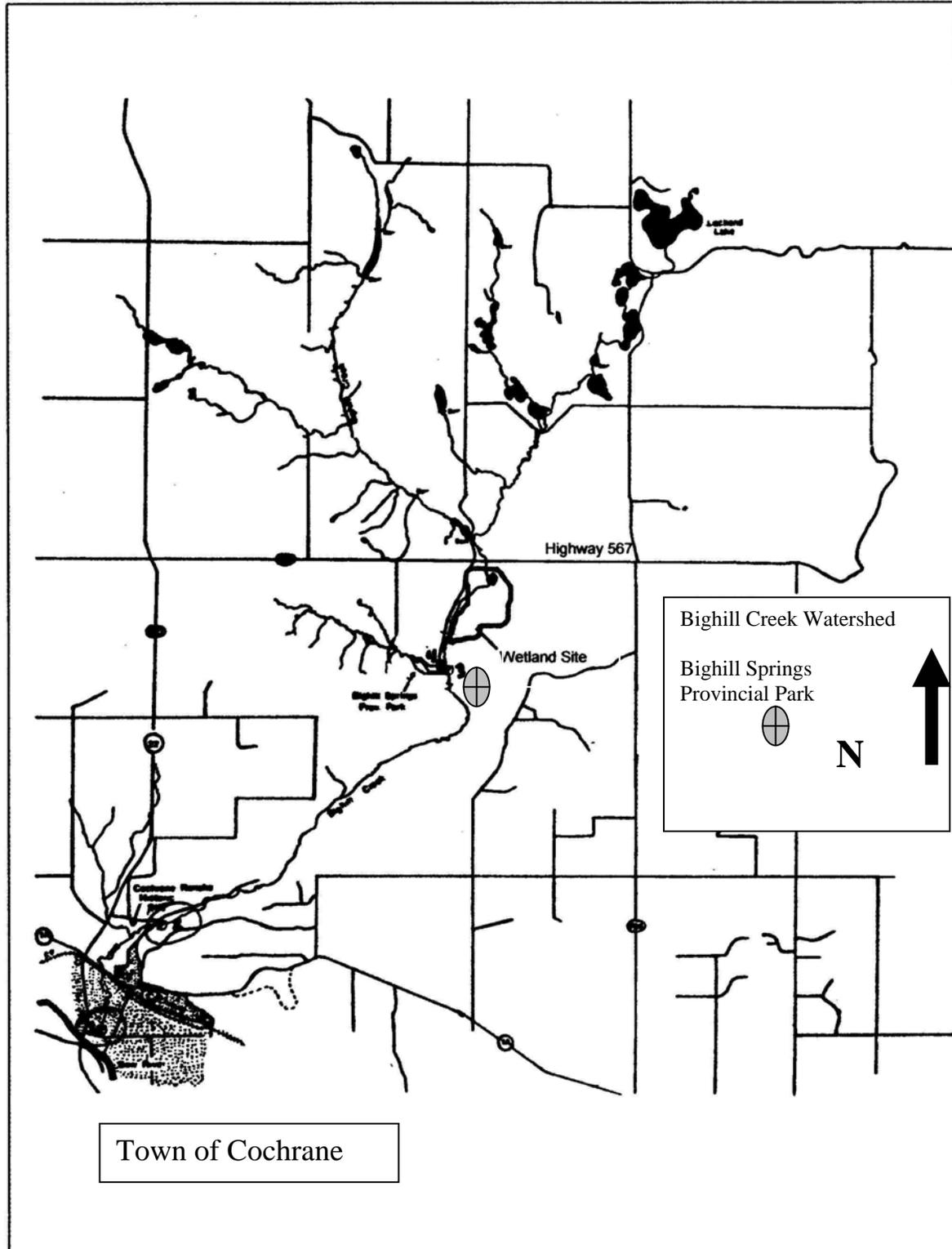


Figure 1. Map of the Bighill Creek Watershed.

However, in recent years there has been a marked increase in the volume of flow in the Bighill Creek. The reason for this improved quantity of water flowing in the creek channel is highly speculative, but with the increase there have already been signs of recovery in the trout populations inhabiting the Bighill Creek. In 2005, under estimated 1:20 year flood conditions on Bighill Creek, a large portion of the lower end of the stream was scoured down to clean gravel and considerable bed movement resulted in a definite improvement in streambed conditions for both spawning and invertebrate populations. The Bighill Creek has an estimated 1:100 year flow record of 22 cms (Winhold 1990), so historically, the creek is known to high flow events when there is adequate precipitation during the spring run-off period.

Every spring, for the past five years or so, Vancouver Island University has conducted an electro-fish training course on the lower end of Bighill Creek. For those consecutive years they have captured numerous trout in their program, indicating that a marked increase in trout populations is evident in the lower reach of Bighill Creek. With this in mind, Bow Valley Habitat Development decided that further investigation was required to determine whether these signs of recovery in the Bighill Creek trout fishery were the result of natural reproduction or migration from the Bow River. A comprehensive fisheries study was planned for a two year period, starting in 2008 and being completed in 2009. With growing concerns regarding water quality from both ground water and stream sources in the minds of the general public and of major importance from a fisheries perspective, it was decided that some water quality study, including testing for organic compounds, heavy metals and seasonal turbidity monitoring be included in this proposed fisheries study as well.

To complete the proposed fisheries study, BVHD formed a partnership program with the Alberta Conservation Association, the Town of Cochrane, Operational Services Div., Parks and Facilities Department, to carry out the proposed task. With limited funding available, it was decided that the main focus of the two year study would be directed at the lower reach of the Bighill Creek. However, some information on the upper reach is included in this study report.

### 1.1 Study Area

The primary study covers approximately 9.6 km of the lower Bighill Creek and the area is defined by stream channel kilometres. The area studied encompasses the property of three different land owners; The Town of Cochrane, the Franciscan Friars and the M.D. of Rockyview 44.

- The Town of Cochrane study sites are located over a distance of 5.5 km of creek, from the mouth at the Bow River, to the Fourth Ave. Bridge; GPS (51-12-12.89 N 114-28-00.82 W) UTM–Zone 11- NAD83 - Northing 5675513 Easting 676955.
- The Franciscan Friars and M.D. study sites are located over a distance of 4.1 km of stream channel. This land is located on the creek from the Fourth Ave. Bridge, upstream to the east boundary of the M.D. land; GPS (51-12-43.47 N 114-25-49.00 W); UTM-Zone 11-NAD83 – Northing 5676547 Easting 679480.

Some field data regarding the middle reach of the Bighill Creek was collected during the 2008 study year and it will also be included in this report.

### 1.2 Study Objectives

Study objectives include the following:

- To monitor the number, distribution and population characteristics of rainbow trout, brown trout and brook trout, caught and released by volunteer survey anglers in the Bighill Creek during the 2008 – 09 angling season.
- To determine the timing of the upstream spawning migration and post-spawning emigration of brown trout and brook trout in Bighill Creek.
- To document and map (GPS) the number and location of brown trout and brook trout spawning redds on the lower reach of Bighill Creek.
- To identify and map key spawning habitat utilized during the 2008 fall spawning season for brown trout and brook trout.
- To complete a juvenile trout trapping program to evaluate the success and survival of incubation and hatch of trout eggs laid down in the 2008 fall spawn.

- To identify the habitats that are utilized by juvenile trout after their emergence from the spawning beds, such as small feeder spring tributaries and backwater habitats. This will be accomplished using trout trapping methodology.
- To identify non-sport fish species that live and reproduce in Bighill Creek.
- To conduct baseline water quality testing for organic compounds and heavy metals on all small ground water feeder spring tributaries and compile data previously collected for the main stem of Bighill Creek. The testing results will be reviewed by an AEP water quality specialist to assess the results and any possible impacts on salmonid species.
- To complete seasonal Sechi water clarity or turbidity baseline data collection and records.
- To assess fish habitat deficiencies along the entire reach of Bighill Creek, with special emphasis on the lower reach area.
- To draft some recommendations for some possible measures to improve the riparian Zone, water quality and fish habitat on the Bighill Creek.
- To utilize volunteer support where possible in the study program.

## 2.0 Methods

The comprehensive fisheries study methods of Bighill Creek consisted of five primary parts: a volunteer angling survey, a spawning survey, a trout trapping program, water quality and turbidity testing and a riparian and fish habitat assessment. The volunteer angling survey was completed over a two year period (2008 – 2009) to determine species of sport fish present in the creek and to assess the quality of the present day sport fishery in Bighill Creek. The fall spawning survey was completed in 2008, to identify species of spawning trout that utilize Bighill Creek and to map their redds, along with their preferred spawning habitats on the lower reach of the creek. The spawning survey would also establish the time window for fall spawning activity in the creek.

The trout trapping program was carried out to determine the success of the trout egg incubation from the fall 2008 spawn and to establish and document juvenile trout

distribution and post emergence movements in the creek and its tributaries. The trapping program would also identify and document resident non-sport fish species that live and reproduce in the creek. The water quality testing for organic compounds and trace heavy metals would be completed to determine any possible impacts on the fishery, as well as documenting baseline data for future reference. The Secchi clarity and turbidity readings would also be documented for future reference. The riparian and in-stream habitat assessment work would be completed along the entire reach of Bighill Creek to identify existing deficiencies and make some possible recommendations to improve some of these present day conditions.

### 2.1 Stream Sections

In order to facilitate the identification of the areas of some of the activities in the angling survey, spawning survey and trout trapping program, the lower reach of the Bighill Creek was divided up into four sections for the study. The following is a description of the boundaries of the four sections of study on the lower reach of Bighill Creek:

Section # 1: From the mouth of the creek on the Bow River, upstream .44 km to Griffin Road; GPS 51-10-58.85 N ;114-28-50.66 W : UTM-Zone 11, NAD 83, Northing 5673193; Easting 676067.

Section # 2: From Griffin Road, upstream 2.03 km to Glenbow Drive: GPS 51-11-36.24 N ;114-28-54.62 W : UTM-Zone11, NAD83, Northing 5674348: Easting 676027.

Section # 3: From Glenbow Drive, upstream 3.03 km to the 4<sup>th</sup> Ave. Bridge: GPS 51-12-12.89 N;114-28-00.82 W: UTM-Zone11,NAD83, Northing 5675513: Easting 676955.

Section # 4: From the 4<sup>th</sup> Ave. Bridge, upstream 4.12 km to the east boundary of M.D. of Rockyview 44 property : GPS 51-12-43.47 N; 114-25-49.00 W: UTM-Zone11,NAD83, Northing 5676547: Easting 679480.

The remaining areas of Bighill Creek are described as the middle and upper reach.

## 2.2 Angling Survey

BVHD recruited a team of experienced fly fisherman for this task. The survey fly fisherman would use single barbless, artificial fly hooks to insure a better chance of survival for all of the trout that were captured and live released in the survey. No bait was used in this survey. All of the 6 members of the team were Town of Cochrane residents. The angling survey for the first season was completed over a time window of September 20<sup>th</sup>, 2008 to October 05<sup>th</sup>, 2008. The second season was completed from May 01<sup>st</sup>, 2009 to August 16<sup>th</sup>, 2009. The total hours contributed for both seasons and the results will be combined for analysis of the results. This survey covers the full extent of an angling season on the Bighill Creek, except for the month of April and the majority of October.

All of the volunteer anglers were required to fill out the following survey card in their reports:

Date of Angling	Anglers Name	Time In	Time Out	Species Captured	Length-cm approximate	Section Fished	Total Days Catch	Total Time Angling - Hours	Quality of Angling Experience
-----------------	--------------	---------	----------	------------------	-----------------------	----------------	------------------	----------------------------	-------------------------------

Only trout that were landed would be defined in the catch section. If trout were hooked, but not landed, the angler could still rate their angling experience as good, if they felt that it was still an enjoyable outing. All anglers were required to report to me as soon as they could, so that I could record their angling result on a computer file. Where possible, a photo was taken of their catch, before it was live released.

After completion of the two year angling survey, a catch per angling effort, species and size, species distribution and quality of angling experience assessment could be determined. Prior to the 2008 fall spawning season for both brown trout and brook trout, all of the angling volunteer team was instructed to watch for the first signs of spawning activity on the Bighill Creek and to report this to BVHD as soon as it occurred.

### 2.3 Fall Spawning Survey (2008)

Starting in the last days of September, a redd survey was conducted over a 9 km reach on the lower end of Bighill Creek. Permission to access all three properties was obtained. The survey was carried out by an experienced professional, accompanied by volunteer help on some outings. All redds were confirmed by BVHD. The location of each redd was recorded on a Garmin 12XL – GPS Unit and later mapped on a Garmin software mapping program. All of the data was also saved in a GPS Exchange (loc; gpx;zip) file for generic use. To differentiate between brown trout and brook trout redds, the size range for both would be based on those excavated by observed trout actively spawning. This range in redd size would then be used as a guide in identifying other redds located in the survey. The size range would be mentioned in the results section of this report.

### 2.4 Trout Trapping Program

To determine trout fry emergence and distribution, a 2 litre soft plastic bottle trapping method will be used (Woods, G. R., 1999). Approximately 12 – 14 bottle traps will be set on and below primary spawning areas on the Bighill Creek in the month of May 2009, to determine the success of incubation and emergence of spawned brown trout and brook trout eggs. The traps were spread out over an area usually covering 3 – 4 key spawning locations, with between 3 and 4 traps being set at each key spawning location area. The traps were set over a 2 to 3 day period and checked twice daily. If trout were captured the first or second day, the traps were moved to a new location in the same area.

After the emergence period, traps were set at different locations on the creek, including small feeder spring tributaries to determine these feeder habitats use by juvenile trout in their earlier stages of life. Traps were also moved further down the system from the spawning areas, during the trapping program, to determine the distribution of trout after emergence and as they grow to a larger size. The trapping program would also confirm the underutilization of certain areas of the stream, due to lack of suitable habitat.

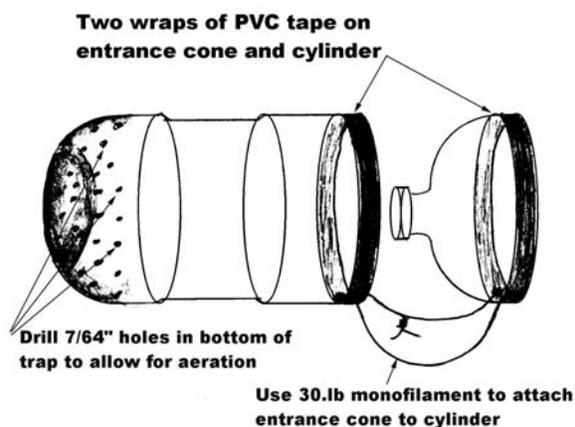
The preferred habitat in which the traps were placed in the main-stem of the Bighill Creek consisted of moderate flow velocity in shallow water, with a depth of approximately 14 cm – 40 cm. Bank undercuts, lateral margin backwaters and woody debris, including overhanging willow branches, were the preferred trapping sites on the creek. On the small feeder tributaries that were trapped, the traps were placed in mid channel in both low and moderate velocities. The traps were anchored using available flat rocks and gravel inside of the traps. In some locations where there was submerged woody debris and willow branches, the traps could be wedged underneath in a secure manner.

All of the trout captured in the trapping program were placed live, in a glass viewer with a camera bracket attached, for taking macro photographs of each sampled trout. On the back of the viewer glass is a ruler marked in millimetres and centimetres for accurate measurement of each sampled trout. The photos could then be downloaded into a computer photo software program, to be cropped and enlarged to confirm accurate measurement. A number of sampled non-sport fish were also photographed and included in this report.



**Plate 1.** A photo of the glass viewer and camera

Below: A diagram of a 2 litre plastic soft bottle trout trap, used in the Bighill Creek, 2009 trout trapping program. A total of 21 traps were constructed for the program.



A record of all species and numbers of non-sport fish that reside and reproduce in the Bighill Creek was also documented. A photo collection of these other species is included in this report.

### 2.5 Water Quality and Turbidity Testing

An important part of the fisheries study is to test the water quality of the small groundwater feeder tributaries to the Bighill Creek for organic compounds and trace heavy metals and compile data of previous testing for the main-stem of the Bighill Creek. Also, relevant baseline data of the water clarity and turbidity of the main-stem of the Bighill Creek is required for future reference.

#### 2.5.1 Water Quality Testing

Town of Cochrane staff and BVHD completed a sampling of ground spring water from two different feeder spring creeks that enter the Bighill Creek, within the boundaries of the Town of Cochrane. A bottled organics and heavy metal sample were collected from each of the two feeder springs, on two different dates. The samples were prepared and shipped off to Bodycote Testing Lab in the City of Calgary. Testing data from two previous samplings for Millennium Creek and the main-stem of the Bighill Creek were also compiled for this study. Results from the two new samplings were forwarded to AEP Water Resources for evaluation and comments regarding the potential impacts on salmonid populations. Results from the previous testing of Millennium Creek had already been assessed by AEP Water Resources (In-stream Enhancement of Millennium Creek, Phase One, 2005). The findings are documented in this report and copies of the results of testing are included in the Appendices.

#### 2.5.2 Sechi Water Clarity and Turbidity Recording

A weekly record of water clarity throughout the open water season on Bighill Creek was documented. The readings were made using an 8 inch Sechi Disk at a beaverdam site

located approximately 200 m downstream of the 4<sup>th</sup>. Ave. Bridge. The readings taken were made when conditions in the creek were not influenced by precipitation events and all readings were made mid day at approximately 1:00 PM. Records of clarity were made from April 10<sup>th</sup>, through to October 27<sup>th</sup>, 2009. There were still turbidity influences from the spring run-off evident when the recordings were started. One Sechi reading was made on October 14<sup>th</sup>, 2008, which was pertinent to this study report and it will be mentioned in the spawning study results section.

### 2.6 Riparian and In-stream Fish Habitat Assessment

Measurements on stream channel geometry were made on a section of the middle and lower reach of Bighill Creek for comparison purposes. On the middle reach, two 100 m sections were measured for bankfull width. One of the sections was representative of a wider reach of the channel and the second unit was a section of a more narrow reach of the channel. Observations and field notes were made regarding riparian habitat, channel substrate and in-stream fish habitat all along the middle to lower reach of the creek.

### 2.7 Data Analyses

The angling survey results were related to time, in a catch per effort mean average, where number of trout per hours angled was determined. The size and species of trout captured would also be averaged for both years that the survey was conducted. All of the spawning redds identified and recorded by GPS in the 2008 season were logged on a computer file and mapped with GPS software. A CD disk of the data will be submitted to ASRD Fish & Wildlife regional fisheries biologists, with the research license completion report. The trout trapping results would determine emergence time, post emergence distribution of juvenile trout, approximate growth rates and identification of non-sport fish species present in the creek.

Water quality sampling will be completed by Town of Cochrane staff and sent to

Bodycote Labs for analyses. Water testing results for two feeder springs would be sent to AEP Water Resources, Limnologist, Al Sosiak, for comments on water quality for salmonids. Riparian and in-stream habitat disturbances, the result of land use practices and natural processes were discussed in relationship to stream resident populations of trout and areas selected by brook trout and brown trout for spawning.

### 3.0 Results and Discussion

#### 3.1 Angling Survey for 2008 – 2009

In 2008, from September 20th – October 05th, 5 different anglers made a total of 15 outings to fish the Bighill Creek, on the lower reach area. The angling survey was conducted on the lower 8.5 km of creek, from the mouth on the Bow River, upstream. A total of 51 angling hours were contributed by the volunteers, with a total catch of 45 trout. Of those 45 trout; 30 were brook trout, 12 were brown trout and 3 were rainbow trout. The mean average size of the seasons catch is 22.7 cm. The mean average catch per hour's effort is .8 trout per hour of angling. Of the 15 outings, the quality of the experience was rated as: Excellent; on 5 outings, Good; on 4 outings, Fair; on 5 outings and Poor; on 1 outing.

In 2009, from May 01 – August 16, 4 different anglers made a total of 21 outings to fish the lower reach of Bighill Creek. The angling survey was conducted on the lower 7 km of creek, from the mouth on the Bow River, upstream. A total of 37 angling hours were contributed by the volunteers, with a total catch of 28 trout. Of those 28 trout; 14 were brown trout, 12 were brook trout and 2 were rainbow trout. The mean average size of the seasons catch is 29.8 cm. The mean average catch per hour's effort is .7 trout per hour of angling. Of the 21 outings, the quality of the angling experience was rated as: Excellent; on 4 outings, Good; on 9 outings, Fair; on 3 outings and Poor; on 5 outings. The majority of poor angling experiences were in early spring from May 01<sup>st</sup> to May 10th.

A total of 37 angling hours were contributed by these volunteers, with a total catch of 28 trout. Of those 28 trout; 14 were brown trout, 12 were brook trout and 2 were rainbow trout.

**Table 1. Summary of Bighill Creek Angling Survey 2008**

This survey was completed by fly fisher's using artificial flies with barb-less single hooks. All trout captured are released with minimal injury. The quality of the angling experience is expressed by each angler.

Date	Angler	Time in	Time out	Species captured	Length - cm approximate	Section	Total days catch	Total time angling	Quality of angling
Sept.20/08	Phil S.	11.30 AM	3:30 PM	BRKT	21	2			
				BRKT	30	2			
				BRNT	19	2	3	4	Good
				BRKT	20	2			
				BRKT	21	2			
Sept.22/08	Guy W.	3:30 PM	5:30 PM	BRKT	16	2			
				BRKT	17	2			
				RBT	21	2	5	4	Excellent
				BRKT	18	3			
				BRKT	21	3			
Sept.23/08	Guy W.	3:30 PM	5:30 PM	BRKT	23	3			
				BRNT	33	3	4	2	Excellent
				BRKT	18	3			
				BRKT	20	3			
				BRKT	21	3			
				BRKT	21	3			
				RBT	19	3			
Sept.23/08	Jake G.	11:00 AM	1:00 PM	BRKT	32	3	6	2	Excellent
				BRKT	20	2			
Sept.24/08	Eric S.	6:30 PM	7:30 PM	BRKT	19	2	2	2	Good
				BRKT	21	2	1	1	Fair
Sept.30/08	Guy W.	10:30 AM	2:00 PM	BRKT	30	1	1	3.5	Fair
				BRKT	16	1			
				BRKT	22	1			
				BRKT	23	1			
				BRKT	20	1			
Oct.02/08	Guy W.	10:30 AM	2:30 PM	BRNT	31	1			
				BRNT	36	1	6	3.5	Excellent
				BRKT	21	3			
				BRKT	20	3	2	4	Fair
				RBT	20	3			
				BRKT	19	3			
				BRKT	20	3			
Oct.04/08	Phil S.	10:00 AM	3:00 PM	BRKT	18	3			
				BRKT	22	3			
				BRNT	25	3			
				BRNT	23	3	7	4	Excellent
				BRNT	40	2			
Oct.04/08	Guy W.	10:00 AM	3:00 PM	BRNT	27	2	2	5	Good
				BRNT	31	2			
				BRNT	29	2			
Oct.04/08	Guy W.	10:00 AM	3:00 PM	BRNT	21	2	3	5	Good
Oct.05/08	Jake G.	4:00 PM	6:00 PM	BRNT	24	4	0	2	Poor
	Guy W.			BRKT	17	4	2	2	Fair
	Mark B.			BRKT	19	4	1	2	Fair

**Table 2. Summary of Bighill Creek Angling Survey 2009**

This survey was completed by fly fisher's using artificial flies with barb-less single hooks. All trout captured are released with minimal injury. The quality of the angling experience is expressed by each angler.

Date	Angler	Time in	Time out	Species captured	Length - cm approximate	Section	Total days catch	Total time angling	Quality of angling
May 01/09	Eric S.	2:30 PM	3:30 PM			2	0	1	Poor
	Guy W.					2	0	1	Poor
May 02/09	Jake G.	2:00 PM	4:00 PM			1	0	2	Poor
May 04/09	Phil S.	4:00 PM	5:00 PM	BRKT	30	2	1	1	Poor
May 09/09	Guy W.	12:30 PM	2:00 PM	BRKT	28	1			
				RBT	18	1	2	1.5	Good
May 10/09	Eric S.	11:30	12:30					1	Poor
	Guy W.			BRNT	46	3	1	1	Good
May 11/09	Guy W.	11:30 AM	1:00 PM	BRKT	23	1			
				BRNT	36	1			
				BRKT	19	1			
				BRNT	40	1	4	1.5	Excellent
May 11/09	Phil S.	3:30 PM	6:00 PM			3	0	2.5	Good
May 11/09	Eric S.	6:00 PM	7:30 PM			3	0	1.5	Fair
May 15/09	Guy W.	5:30 PM	7:00 PM	BRKT	21	2			
				BRKT	29	2			
				BRNT	48	2	3	1.5	Excellent
May 16/09	Guy W.	12:00	1:30 PM	BRNT	40	1			
				BRNT	30	1			
				BRNT	21	1			
				BRNT	16	1	4	1.5	Excellent
May 22,09	Guy W.	10:30 AM	12:00 n	BRNT	43	1			
				BRNT	40	1			
				BRKT	25	1			
				RBT	25	1			
				BRKT	20	1			
				BRNT	28	1	6	1.5	Excellent
May 22/09	Phil S.	3:30 PM	6:00 PM	BRNT	38	3	1	2.5	Fair
June 13/09	Phil S.	8:00 AM	11:30 AM	BRNT	30	3	1	3.5	Fair
June 14/09	Guy W.	11:30 AM	12:30 PM	BRKT	24	3	1	1	Good
June 20	Phil S.	6:30 PM	8:30 PM	BRKT	25	2	1	2	Good
July 25	Eric S.	7:00 AM	9:30 AM			2	0	2.5	Good
July 26	Eric S.	7:00 AM	9:30 AM	BRKT	26	3			
				BRNT	27	3	2	2.5	Good
Aug. 13	Eric S.	7:00 AM	9:30 AM	BRKT	39	3	1	2.5	Good
Aug. 16	Eric S.	4:00 PM	6:00 PM			2	0	2	Good

( Note: For the angling survey, the boundary for section # 1 was moved upstream to Glenpatrick Drive crossing. This measure balanced the distance of fishable creek channel between Section # 1 and Section # 2.)

**Table 3. Summary of combined angling survey results for Bighill Creek 2008 – 2009.**

Combined Angling Season	Total Number of Outings	Total Combined Catch	Percentage of Catch Relative to Species			Calculated Average Size Of Trout Caught (cm)	Effort (Angler-hours)	CPUE Catch-per-unit-effort, Fish caught per/angler hrs.
			RBT	BRKT	BRNT			
2008 + 2009	15 + 21	45 +28	RBT	BRKT	BRNT	22.7 + 29.8	51 + 37	0.88 + 0.75
Sept. – Oct 08 May – Aug 09	36	73	6.8%	57.5%	35.6%	25.4	88	0.82

**Table 4.** Summary of how the quality of the angling experience was rated by volunteers.

Total number of outings	Percentage of outings rated as <b>Excellent</b>	Percentage of outings rated as <b>Good</b>	Percentage of outings rated as <b>Fair</b>	Percentage of outings rated as <b>Poor</b>
36	25%	36.1%	22.2%	16.6%

In summary, the lower 7 km of Bighill Creek provided a “Moderately Good” angling experience, over the two year survey period, for those volunteers involved. The largest brown trout captured during the survey was 48 cm in length. The largest brook trout captured was 39 cm and the largest rainbow trout was 32 cm. These are good size trout for a relatively small Alberta stream.

### 3.2 Fall Spawning Survey 2008

In 1986, during a tour of the Provincial Park spring creek with ASRD Fisheries biologist, Al Sosiak, BVHD (Guy Woods) showed Mr. Sosiak some brook trout redds in the feeder tributary, from the 1985 spawning season. Further investigation of the tributary and Bighill Creek by ASRD Fisheries Technologists Kerry Rees and Dave Eaton, revealed a small population of brook trout in the creek. The spawning activity was first reported on the feeder tributary over the next few years (Sosiak 1986, Rees 1987). Up until 2008, there was no documentation confirming trout spawning activity on the lower reach of Bighill Creek. During the 2008 and 2009, fall spawning period, the small Provincial Park feeder tributary was visited to check for any spawning activity. There were no trout or trout redds identified in the spring creek during those two seasons.

On September 28<sup>th</sup>, 2008, Phil Sheepy spotted the first spawning pair of brook trout in Section # 3, while out for a walk along the Bighill Creek. He called me to let me know this activity and the exact location. On September 29<sup>th</sup>, 2008, I marked the brook trout redd with a Garmin GPS instrument. The spawning redd survey started on that date in 2008. I secured permission to access property further upstream and continued to visit the creek every few days after that initial visit, mapping the location and species of trout redds along the lower reach of the creek (see Figure 2.).

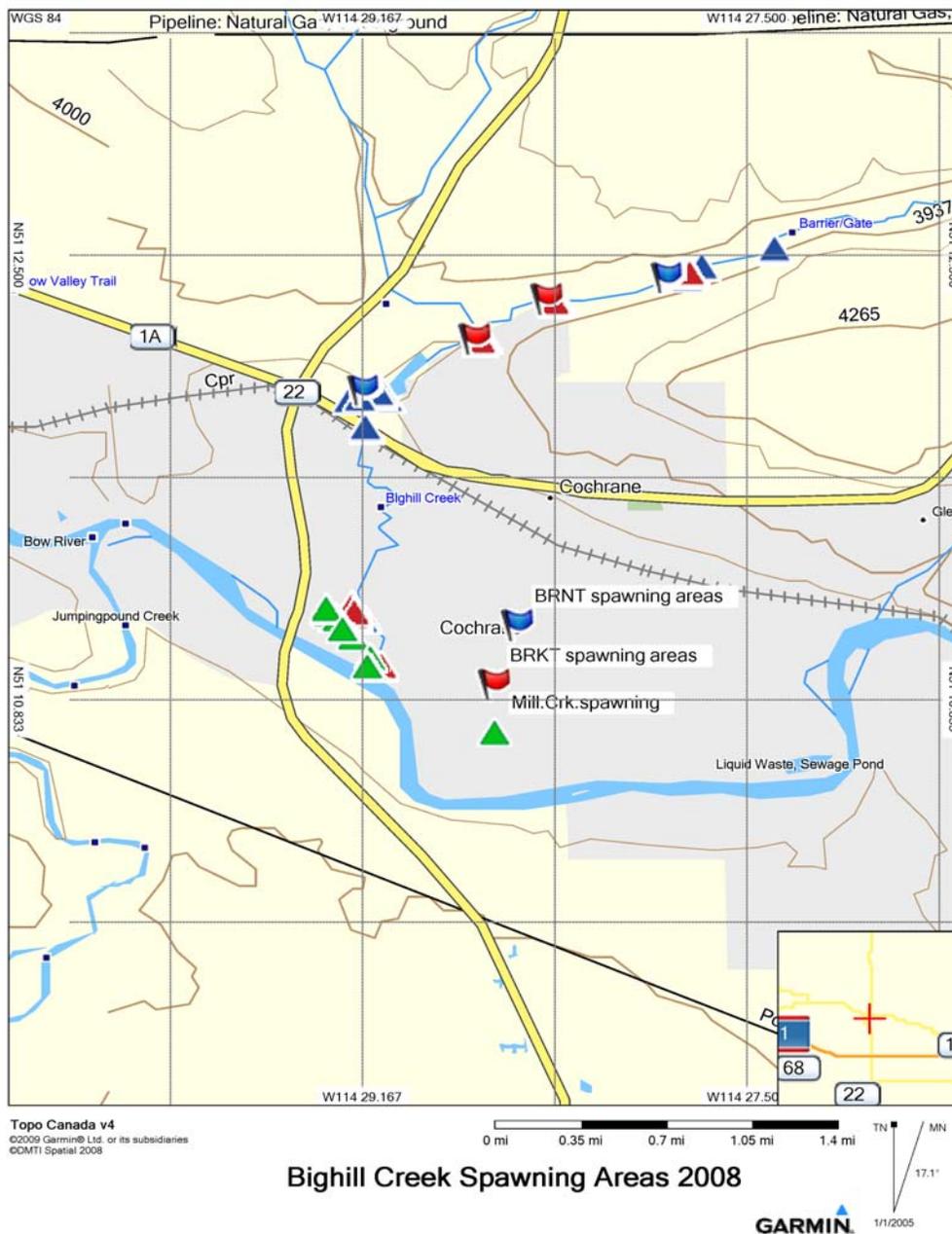


Figure 2. Map of the location of key spawning areas on the lower reach of Bighill Creek. Blue flags represent brown trout, red flags represent brook trout and green triangles represent brook trout on Millennium Creek. (See Appendix 2).

The survey of both Bighill Creek and Millennium Creek (a tributary on the lower end of the creek, near the mouth of the Bow River) continued over a time frame of 38 days on Bighill Creek, until November 04<sup>th</sup>, 2008. With a total of 12 visits to the creek to record

redd locations. On Millennium Creek a total of 5 visits were made, covering the days of Oct. 22<sup>nd</sup> to November 09<sup>th</sup>, of 2008. (See Field Notes; Appendix 1.)

The brown trout redds were identified by observation of spawning trout over the redds or by the size of the redd, usually approximately 28 cm to 40 cm wide by approximately 45 cm to 60 cm in length. The brook trout redds were identified by observing trout over them or by an approximate size range of 20 cm to 30 cm wide by 25 cm to 40 cm in length. These redd size estimations were confirmed by observation of the two different species of trout actually spawning. The brown trout were also observed to be utilizing larger spawning gravel than the brook trout observed. The first brown trout spawning on the creek was observed and documented on October 03, 2008.

**Table 5.** Total number of trout redds identified and mapped on Bighill Creek and Millennium Creek, during the fall spawning season of 2008.

Stream or Tributary	Estimated Spawning Period	Brown trout redds	Brook trout redds
Bighill Creek	BRNT. - First three weeks in October. BRKT. - Last days of Sept. until mid-October.	23	38
Millennium Creek	BRKT. Second week of Oct. until the last week.	0	24

(See Appendix 2.)

During the fall spawning period of 2008, on October 14<sup>th</sup>, BVHD observed that the creek was flowing turbid. A Sechi reading of 7 inches was made and documented, at a site just below the 4<sup>th</sup> Avenue Bridge on that date. Concerns that this event would impact the success of the spawned eggs that were then incubating in the gravel; BVHD investigated the situation and discovered that Ducks Unlimited Canada was completing a maintenance project at one of their wetland sites on the Hutchinson property, next to Lochend Road. In a meeting with Jim Stelfox in the spring of 2009, Jim showed me a map of the restricted activities area of Bighill Creek and I observed that the Northeast feeder tributary is not entirely covered in the restricted activities boundaries. The result of this event, though not intentional, may have impacted the survival rate of incubating trout eggs over the winter of 2008 and 2009.

Although there was no comprehensive spawning survey work completed this fall of 2009 on Bighill Creek, the stream was checked for spawning activity over the month of 2009, BVHD made a total of 8 visits to the creek and observed extensive spawning activity along the entire lower reach. The spawning activity observed this fall was concentrated in the same areas as 2008, with some new activity in other near areas of the creek. Millennium Creek was surveyed and a total of 19 redds were identified, but not mapped.

### 3.3 Trout Trapping Program 2009

In order to confirm a successful incubation of trout eggs in Bighill Creek it was important to trap trout fry immediately after they emerge from the redd gravel in the early spring. With all of the middle and upper spawning areas of the creek isolated by beaver dams downstream of them, we can determine that any captured juvenile fry would not be migrants from the Bow River. I have observed that trout fry are very poor swimmers during the first few weeks after their emergence and they are mobile in a downstream direction, with the stream flow. Based on this knowledge, it was decided that placing traps immediately downstream of known spawning areas would provide the best result.

#### 3.3.1 Trout Fry Emergence on Bighill Creek

During the 2009 trout trapping program, it was determined that trout fry emerge from the spawning redds on BHC over the first three weeks of May. The timing of the hatch or the amount of time that trout larva spend in the gravel was not explored during this study. However, it can be estimated that the eggs from the 2008 spawning season hatch sometime in March or April, each year.

The first traps were placed in the Bighill Creek on May 13<sup>th</sup>, after the water clarity had improved and the stream levels were lower than in the previous weeks. In the morning of that day, traps were set at three different 2008 spawning sites in Section 3 and Section 4. They were tended in the evening and a few 5 spine stickleback and 2 Lake

Chub were captured and released. The following morning the first few trout were captured directly below a brown trout spawning area, at the mouth of the Man of Vision feeder spring. One was measured at 26 mm and the second 28 mm. There was trace coloration of orange yolk still present, below their lateral line, over the stomach area.



**Plate 2.** This 28 mm trout fry was captured on May 14<sup>th</sup>, 2009, on Bighill Creek.

Brown trout fry are approximately 23 mm – 24 mm in length, when they emerge from the spawning gravel in the spring, brook trout are approximately 17 mm when they emerge (John Enns, Livingston Hatchery, pers. Comm. 2009). With trace yolk coloration in both of these juvenile trout and their capture in relationship to the brown trout spawning areas, I speculate that both of these trout were brown trout. In any case, this capture event confirmed that there is natural reproduction occurring in the lower reach of Bighill Creek.

The smallest trout fry captured on May 23<sup>rd</sup>, in Section 3, was 22 mm in length and this trout was suspected of being a brook trout. The fish had very little trace of yolk visible and a dark spot directly between the bases of the pectoral fins indicated natural feeding. Another small trout fry was lost on May 24<sup>th</sup>, from escaping thru the 2 mm mesh of the dip net. The day after this event, the dip net was replaced by a 1 mm, mesh size. No further fry of such a small size were captured after that date.



**Plate 3.** This 22 mm trout fry was captured on BHC on May 23<sup>rd</sup>, in Section 3.

### 3.3.2 Trapping Program on BHC (main-stem)

From May 13<sup>th</sup>, trapping was completed over the summer months and early autumn until September 30<sup>th</sup>, when the program was finished. A total of 51 trout fry and YOY were captured, processed and released back into the creek (see Appendix 3.). During the month of September, the majority of the trout were positively identified as brook trout. The lack of confirmed brown trout in the later part of the trapping program could be related to the dominance and competitiveness of brook trout in habitats that were trapped. Deeper areas of the creek, which are less suitable habitats for juvenile trout, were not trapped in the program.

Consideration must be given to the impact of the turbid water event that occurred and was documented in mid October, during the 2008 fall spawning period. It is possible that this event may have impacted the survival of brown trout eggs over that incubation period. Excessive caudal peduncle tail damage was observed on a number of juvenile trout fry that were captured. This may have been the result of their struggle to free themselves from the spawning gravel, which was observed to contain considerable silt on some redds.

Other resident fish species that occupy the Bighill Creek and that were trapped during the 2009, trapping season were: 5 Spin Stickleback, Lake Chub, Pearl Dace, Longnose Dace and White Sucker. The following table and chart represents the sampling results:

**Table 6.** Trapping results for 2009 trapping on Bighill Creek and tributaries.

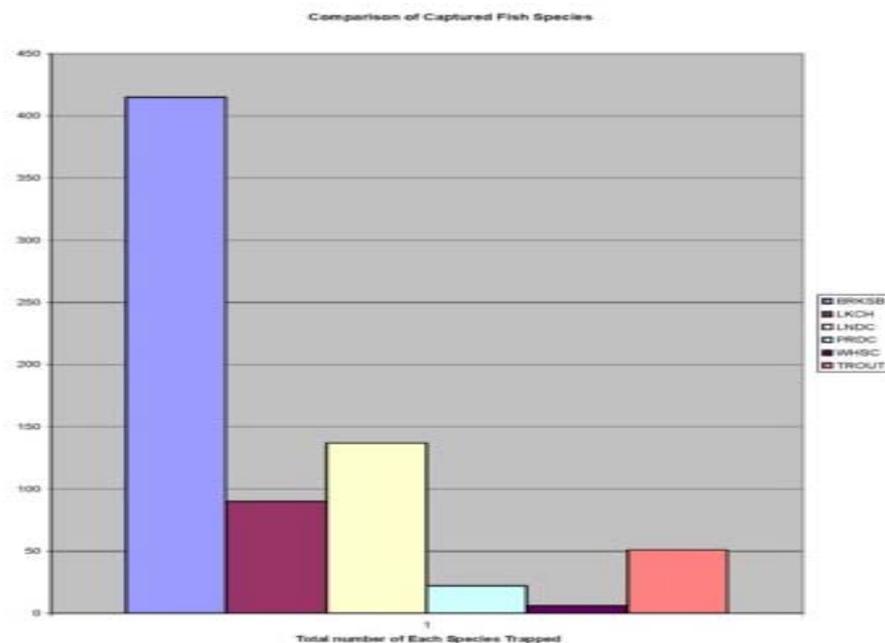
Species of Fish trapped	Total number of fish trapped in each Section of Bighill Creek							Total trapped
	Mill. Crk.	Section #1	Section #2	Section #3	Section #4	MV spring	RH spring	
Stickleback	99	6	7	247	56	0	0	415
Lake Chub	0	2	2	53	33	0	0	90
Longnose Dace	0	27	7	79	24	0	0	137
Pearl Dace	0	0	0	20	2	0	0	22
White Sucker	0	1	2	3	0	0	0	6
Trout - Fry/YOY	0	0	0	34	0	1	16	51
<b>Totals</b>	<b>99</b>	<b>36</b>	<b>18</b>	<b>436</b>	<b>115</b>	<b>1</b>	<b>16</b>	<b>721</b>

**Mill. Crk.** = Millennium Creek spring pond    **MV spring** = Man of Vision Feeder Spring    **RH spring** = Ranch House Feeder Spring

### 3.3.3 Trapping of Feeder Tributaries

Besides Millennium Creek, a primary feeder tributary that enters the Bighill near the mouth of the Bow River, four other small feeder tributaries on the lower reach of BHC were trapped to determine their usefulness to juvenile trout as habitats. Only two of these other feeder tributaries produced evidence that they were used as nursery habitats for young trout. On June 30<sup>th</sup>, traps were set in the Man of Vision (MOV) and Ranch House (RH) feeder springs. On July 01<sup>st</sup>, the first trout (50 mm) was captured in the RH feeder spring. On July 03<sup>rd</sup>, the first and only juvenile trout (55 mm) was captured in a trout trap, approximately 50 metres upstream of the mouth on BHC.

The Man of Vision feeder spring was a very shallow spring creek to trap. There were few places where the depth exceeded 10 mm. The bottom substrate was silt with organics, so when the traps were placed in the channel, a small depression was excavated to create an area deep enough to submerge the entrance cone of the bottle traps.



**Figure 3.** Comparison of species captured during the 2009 trapping program on BHC.

In total, 16 juvenile trout were captured in the Ranch House Feeder Spring, over the 2009 trapping season program. There was a small 27 cm waterfall on the RH feeder spring, located approximately 120 metres upstream of the mouth on BHC. No trout were captured above this natural barrier on the RH feeder spring. Only the one trout was captured on the MOV feeder spring. It is believed that YOY trout enter these small feeder springs when they have developed enough swimming ability to navigate some of the steeper gradients in the feeder springs. The first juvenile trout captured in a trap that had been placed at the mouth of the RH feeder spring, was captured on June 01<sup>st</sup> and it was measured at 30 mm, in length.

#### 3.3.4 Distribution of Juvenile YOY Trout

No trout fry or YOY were captured on Millennium Creek, during the 2009 trapping program. There may have been some hatch from the 2008, fall spawning of brook trout, but BVHD was unable to confirm this. However, there was a hatch of 5 Spine

Stickleback in the spring pond, which indicates that water quality is suitable for some species reproduction. There was also no juvenile trout captured in Section 4, downstream of the trout redds mapped during the fall 2008 spawning season. These upper redds were determined to be more susceptible to siltation from upstream on the creek and it is possible that the trout eggs were smothered in silt from the spring run-off and the turbidity event recorded on October 14<sup>th</sup>, 2008.

Trapping did not produce any capture of juvenile trout in the lower Section 1 and Section 2 of the BHC. The hypothesis for the lack of juvenile trout presence in these sections is based on in-stream habitat deficiencies and this will be covered in the Fish Habitat Assessment part of this report.

A number of large brown trout were also captured in these sections during the angling survey. Because of the mature brown trout's territorial nature, the juvenile trout may have avoided these sections of the creek after migrations from their emergence areas further upstream.

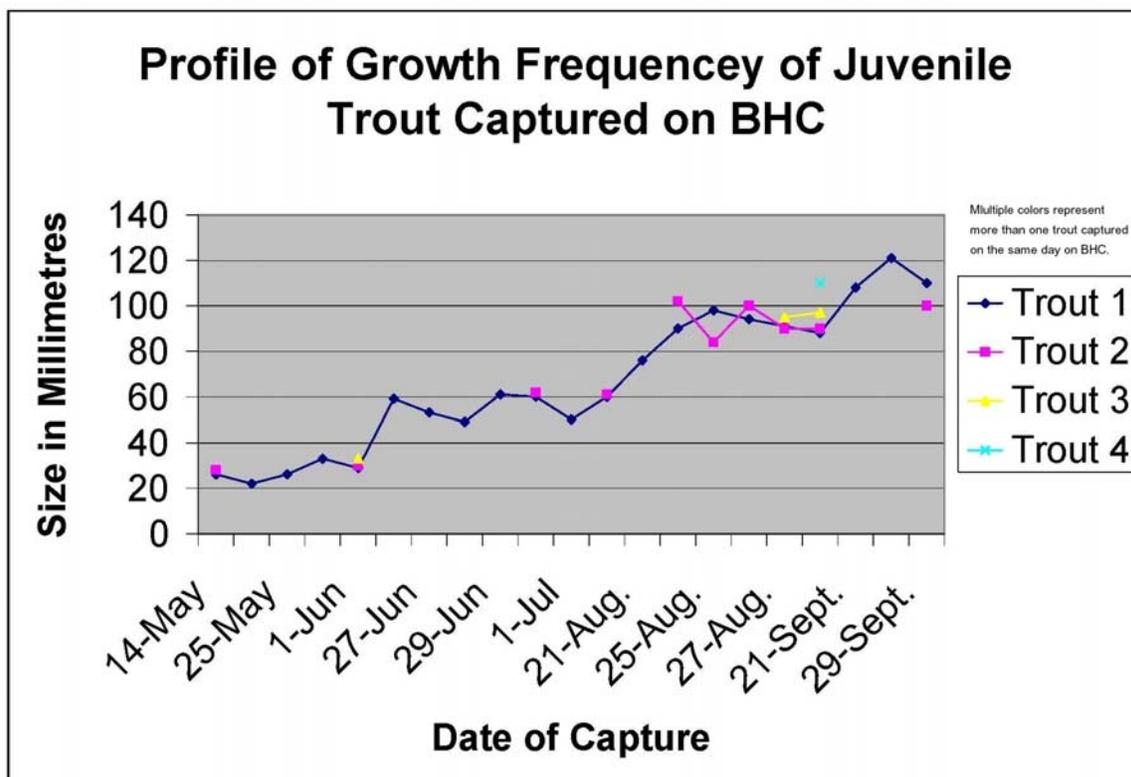
#### 3.3.5 Growth Frequency of Juvenile Trout in BHC

Trout captured over the 2009 seasons exhibited rapid growth. Trout captured in mid May, measured between 22 mm and 28 mm in length. By September, all trout that were believed to be brook trout, measured between 88 mm and 120 mm in length.



**Plate 4.** This brook trout, captured on September 29<sup>th</sup>, was 110 mm.

The following chart profiles the growth rate of YOY trout that were sampled during the trapping program on Bighill Creek's main-stem:



**Figure 4.** The above chart illustrates the growth rate of juvenile trout captured during the trapping season in the Bighill Creek. None of the trout captured in the feeder springs are included.

### 3.3.6 Presence of Non-Sport Fish Species in Bighill Creek

The Bighill Creek is home to a variety of sport fish and non-sport fish species on the lower reach of the creek. BVHD participated in an electro fish training program, conducted by Ray Sloan, of Mount Royal College in 1995. During that shocking program, burbot and a number of other non-sport fish species were captured. The burbot are migrants that entered the creek from the nearby Bow River. It can be determined that these and some other non-sport species of fish utilize the lower reach of Bighill Creek as a nursery habitat during their early life stages.

In the 2009 trout trapping program on BHC, 5 Spine Stickleback, Lake Chub, Pearl Dace, Longnose Dace and white sucker were captured in the traps along the lower reach of the creek. It is believed that all of the above are reproducing on the creek and many of these fish were captured in the shallow riffle areas of the creek while spawning in the spring of 2009. BVHD, sampled small eggs in the gravel on June 28<sup>th</sup>, at one old trout redd on the lower reach in Section 2, while conducting a kick sample with a seine net, for invertebrates and dead trout eggs.

The healthy populations of these non-sport fish species in the Bighill Creek are of major importance as a forage base for both sport fish species of trout and other fish predators, such as diving birds, herons, mink, etc... The results from the 2008 and 2009 angling survey indicate that there are plenty of larger brook trout and brown trout to prey on this forage base, throughout the year.

There may be other species of non-sport fish present in Bighill Creek, other than those captured during the trapping program. Deeper water habitats were not sampled using this trapping method. Juvenile trout habitats were the focus during the entire program.

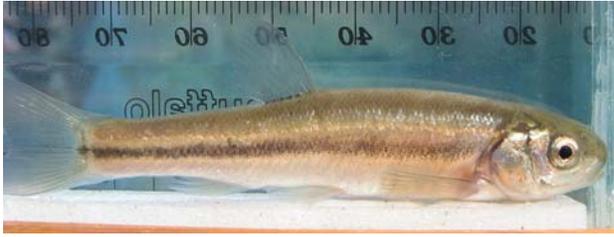
A number of the resident non-sport fish species that were captured during the 2009 trapping program in the BHC, were photographed to create a reference for fish identification. From that library of photos, a number of pictures were chosen for inclusion in this report document. The following is a sample of those photos:



Above: 5 Spine Stickleback



Above: Longnose Dace



Above: Pearl Dace



Above: White Sucker



Above: Lake Chub



Above: Adult Pearl Dace

**Plates 5-11.** Photos of reproducing resident non-sport fish species of Bighill Creek.

### 3.3.7 Non-Resident Sport Fish Species not Trapped in BHC

In the 2008 and 2009, angling survey conducted on the lower reach of the creek, rainbow trout were captured and documented, as far up the stream as 6 km. These trout are also believed to be migrants from the Bow River. During past electro-fish programs on the lower reach of Bighill Creek, mountain whitefish, cutthroat trout and rainbow trout have been captured on the lower reach of Bighill Creek (Braumandl, E. 2007, Earl, J. 2007). None of the above mentioned species of sport fish were trapped during the 2009 trapping program. This confirms that there is no natural reproduction of these species in the Bighill Creek. I conclude that all of these other sport fish species are migrants from the Bow River.

## 3.4 Water Quality and Clarity Sampling Results

### 3.4.1 Water Quality Sampling and Analyses

Water quality sampling and analyses has been completed on the main-stem of Bighill Creek in the past. AEP Water Resources conducted a monitoring program that covered

a time window from 1989 until 1997. Alberta Forestry, Lands and Wildlife (1990) reported the presence of creosote-related compounds in the creek from a wood treatment plant; however, contaminant levels in fish and water samples were very low. The water sampling study in 1996 reported that nutrients, coli forms and sediment were noted to be higher in Bighill Creek than in Jumpingpound Creek (a nearby tributary to the Bow River), likely as a result of agricultural impacts and/or urban runoff (Sosiak 1996). The results of the monitoring program are provided on a CD, included with this report.

Sample analyses from the two new ground water feeder spring tributaries (Man of Vision and Ranch House Spring) were sent into AEP Water Resources for review by water quality specialist Al Sosiak. Al pointed out that the sampling on the Man of Vision spring revealed higher than normal levels of ortho phosphate, similar to Millennium Creek results which were considered a higher in this organic compound than most Alberta Streams ( Sosiak 2004, pers. comm.). However, he did point out that there were no concerns from a fisheries perspective. The results of the testing of both of these springs, as well as the testing results from 2004 for Millennium Creek, are attached as an appendix to this report. This important baseline information can be used for future reference.

#### 3.4.2 Seasonal Water Clarity and Turbidity Levels

Bighill Creek is susceptible to high quantities of silt movement in the stream channel every spring, during freshets. Grazing and beaver activity just upstream of Cochrane have contributed to siltation, as have road crossings and storm culverts draining into the creek within the town site (Alberta Energy and Natural Resources 1986, Rees 1987). Large quantities of silt have accumulated in the middle and upper reaches of Bighill Creek, due to the lower gradients and flow velocities in that section of the creek.

During the 2009 study program on the Bighill Creek, Secchi water clarity and turbidity readings were collected on a weekly basis. One reading that was recorded on October 15<sup>th</sup>, 2008 was also included in the records:

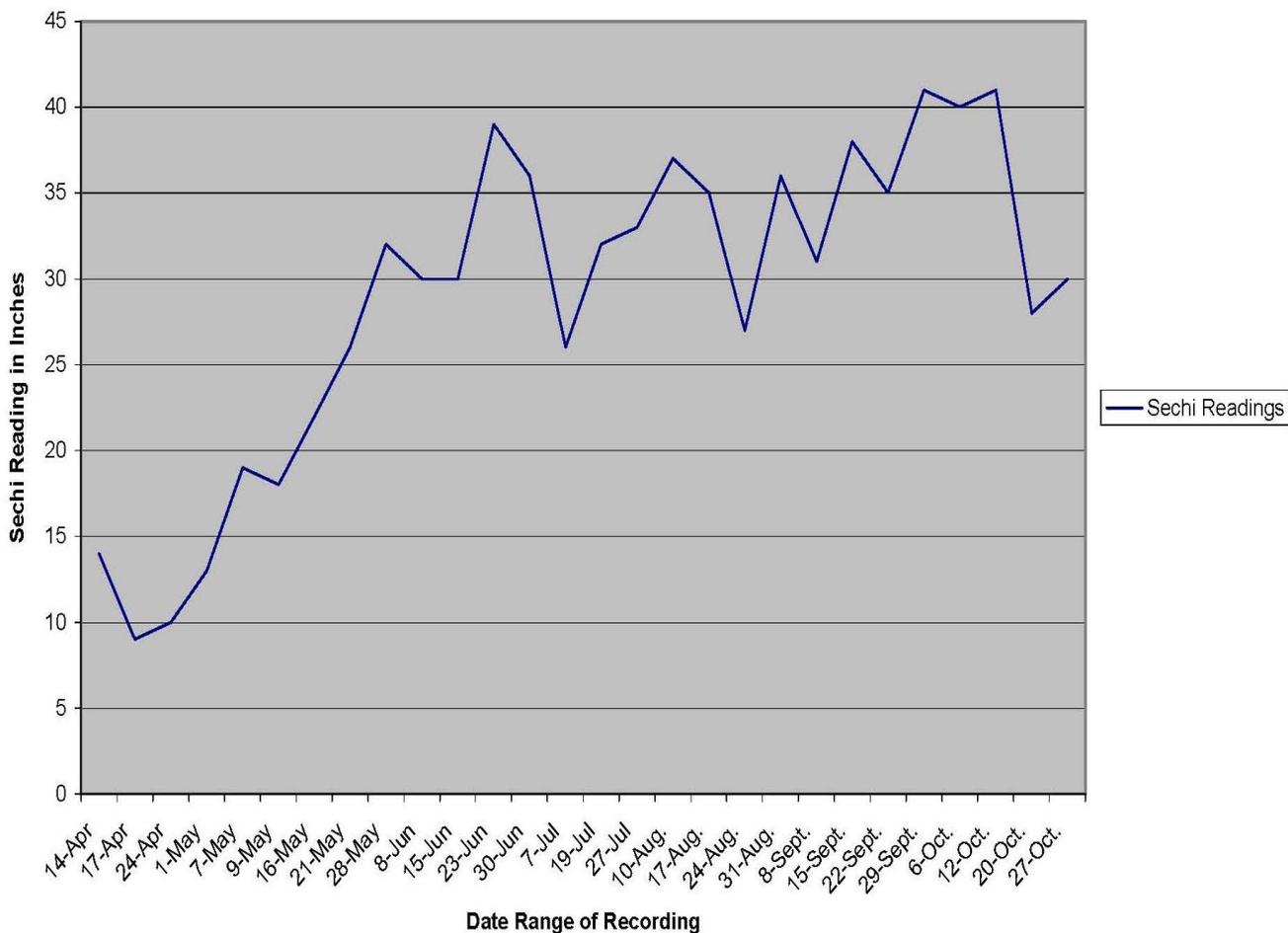
**Table 7. Bighill Creek Sechi Data**

October 15<sup>th</sup>, 2008 Sechi reading 7 inches

Date: Sechi reading (inches)

April 10/09	14	June 15/09	30	Sept.08/09	31
April 17/09	9	June 23/09	39	Sept.15/09	38
April 24/09	10	June 30/09	36	Sept.22/09	35
May 01/09	13	July 07/09	26	Sept.29/09	41
May 07/09	19	July 19/09	32	Oct. 06/09	40
May 09/09	18	July 27/09	33	Oct.12/09	41
May 16/09	22	August 10/09	37	Oct. 20/09	28
May 21/09	26	Aug.17/09	35	Oct. 27/09	30
May 28/09	32	Aug.24/09	27		
June 08/09	30	Aug.31/09	36		

**Sechi Water Clarity/Turbidity**



**Figure 5. Spring, summer and early fall profile of water clarity and turbidity on Bighill Creek.**

### 3.4.3 Storm Drain Impacts

Currently, there are 7 storm drains entering the lower reach of Bighill Creek. These surface water discharges contribute to further siltation in the lower creek (Alberta Energy and Natural Resources 1986, Rees 1987). This drainage also makes the lower reach vulnerable to potential spills that could have a negative impact on the fishery. One storm drain in particular, is located just below the culverts on the parking lot of the Town Office buildings, on the Ranch House feeder spring. Due to the low volumes of flow in this spring tributary to the BHC, any storm drain run-off has a considerable influence on the water quality in the spring creek. This spring creek was found to be an important habitat for juvenile trout, during the trapping program of 2009. Any chemical spill entering the spring creek could be detrimental to the health of the trout in the spring creek, due primarily to the lack of dilution of any chemicals in the discharge.

### 3.5 Riparian and Fish Habitat Assessment

#### 3.5.1 Lower Reach (8 km)

Until as recently as the 1960's and 1970's, the lower reach of Bighill Creek was vulnerable to livestock activities along its banks. Presently, the properties covering the lower 8 km of the stream are not being utilized for livestock and since this change in land use, the stream's riparian zone has had a chance of recovery. With this riparian recovery, so too has the fishery started to improve along the lower creek. The lower reach, which once lacked spawning gravel (Rees 1987), now has sufficient spawning gravel and habitat to sustain a wild trout population. In 2005, a 1:20 year flood event on the BHC scoured pool habitats and rejuvenated spawning gravel in some key areas on the lower reach of the creek.

The riparian cover on most of the lower reach has contributed to good in-stream fish habitat along most of its course (ISC,OHC,UCB,OHV). The woody debris from riparian growth provides good holding cover habitat all along the lower creek where the trees and shrubs border the stream channel. Sweepers from downed willow limbs or willow

trees that have collapsed along the stream banks were prime trout trapping sites, during the 2009 trapping program. It was in this type of habitat that most of the juvenile trout were captured.

Where the habitat for trout was in good condition and there was available spawning habitat, a cross section measurement of bankful widths was recorded. The site chosen for these measurements was located directly below the path bridge, immediately downstream of the 4<sup>th</sup> Avenue Bridge – GPS; 51-12-12.73 N; 114-28-02.16 W: UTM; Zone 11, NAD83, Northing 5675507; Easting 676929:

**Table 8.** Channel bankful width on a 100 m section directly below 4<sup>th</sup> Avenue Bridge.

Location	Cross section measurement of bankful width in metres					Mean average bankful width
	Metre 0	Metre 25	Metre 50	Metre 75	Metre 100	
100 metre	3.0 m	2.8 m	2.4 m	2.3 m	2.2 m	2.5 metres

There are deficiencies in the riparian habitat along the creek from a location just downstream of the pedestrian path in the Ranch Park from a GPS location 51-11-52.72 N ; 114-28-55.23 W; downstream for a distance of 1.45 km to a location just upstream of Glenpatrick drive; GPS location 51-11-26.73 N; 114-28-51.15 W. This reach has very few trees and shrubs to shelter the stream channel; however, the channel is narrow and stable from riparian grasses, sedge, etc. The stream bed, due in a large part to the lower gradient on the channel, contains large amounts of silt. Where there are deficiencies in riparian growth the stream channel has a number of unstable bank erosion sites on the outside of oxbows and bends.

With the lower gradient and silt, combined with high exposure to sun light, there is an abundance of large-sheathed pond weed (*Potamogeton vaginatus* Turcz.) in this reach of the BHC where riparian growth is absent. This plant becomes very thick in the stream channel, especially in the later part of summer. The creek channel becomes choked with it and this thick mat, in slower areas of the channel, further reduces velocity of flow and inhibits much of the fish habitat. However, western water sedge, canary grass and

other riparian grasses do provide some good bank cover and later in the season, as the mature grasses drape over the stream channel, the habitat for trout is enhanced. No juvenile trout were captured in this lower reach of BHC, during the trapping program.

Measurements for the average bankful width were made in 2009, on this reach. A 100 m section starting directly below the culvert on Glenbow Drive starting at GPS – 51-11-35.76 N; 114-28-54.14 W: UTM-Zone 11, NAD83; Northing 5674331 Easting 675960:

**Table 9.** Channel bankful width directly below Glenbow Drive.

Location	Cross section measurement of bankful width in metres					Mean average bankful width
	Metre 0	Metre 25	Metre 50	Metre 75	Metre 100	
100 metre	1.8 m	1.7 m	2.6 m	2.0 m	2.7 m	2.1 metres

### 3.5.2 Middle and Upper Reach

The middle and upper reach of the Bighill Creek have suffered from agricultural practices over the years. Cattle grazing and trampling has caused unstable banks, stream widening and excessive siltation (Cunningham 1963, Thompson 1977a, Borutski 1987, Alberta Energy and Natural Resources 1987, Rees 1987). Riparian vegetation in this middle reach consists of grasses and shrubs, providing little or no instream cover and shade (Alberta Energy and Natural Resources 1987, Rees 1987). The channel through the middle reach is very low in gradient, from the mouth of the Provincial Park feeder spring, for a distance of 2 km downstream, the gradient is estimated to be < .5%. the channel is trapezoidal in cross section, with deeper areas on the outside of bends and oxbows, the result of helical flow. The channel substrate is made up of silt and while measuring channel bankful widths in 2008, I found this silt to be knee deep in all of the areas where measurements were taken.

Two 100 m lengths of stream channel were measured for bankful width by BVHD. Both sites were located approximately 2 km down the stream channel. One was a wider representation of the channel and the other was a more narrow section. Section #1(wider representation): GPS; 51-14-52.82 N; 114-22-54.81 W.

Section # 2(narrower representation): GPS; 51-14-38.66 N; 114-22-36.50 W.

The following table is a record of those measurements:

**Table 10.** Channel bankful width on two 100 metre sections on the middle reach.

Location	Cross section measurement of bankful width in metres					Mean average bankful width
	Metre 0	Metre 25	Metre 50	Metre 75	Metre 100	
Middle crk.						
Section #1	5.11 m	4.73 m	4.22 m	3.59 m	5.84 m	4.69 metres
Section #2	3.70 m	3.85 m	3.50 m	3.53 m	3.56 m	3.62 metres

Based on these measurements, the mean average bankfull width on this middle reach is 4.15 metres. Comparing this average with the mean average of the two sections measured on the lower reach of the creek, which averaged 2.3 metres for bankful width, the middle reach averages 1.8 metres wider in bankful width. This wider channel profile, combined with the low gradient is further impacted by dense Large-Sheath Pondweed during the summer months. These conditions result in higher water temperatures, at times reaching the upper tolerance level for salmonids (Cunningham 1963, Alberta Energy and Natural Resources 1987).

### 3.5.3 Feeder Tributaries

The largest feeder spring tributary to Bighill Creek on the lower reach is Millennium Creek, a small spring creek that enters the BHC near the mouth of the Bow River. A restoration program was completed on this tributary in 2008 and the stream is still in a riparian recovery along its new stream banks that were created in 2005. Millennium Creek continues to be monitored on a yearly basis and presently there are efforts to improve spawning habitat on the stream, after 24 brook trout redds were mapped on the creek in the fall of 2008. The present day goal is to insure a successful incubation of eggs over the winter months, resulting in a spring emergence of trout fry. I am confident that this can be accomplished by 2010.

There are a number of other small feeder springs that enter the BHC on the lower reach study area of 2008-2009. Two of these spring creeks hold promise as important nursery

habitats for juvenile trout. Trout were captured in these two feeder springs during the 2009 trapping program; however, there are some habitat deficiencies that will be mentioned in this report.

#### *3.5.3.1 Man of Vision Feeder Spring*

The Man of Vision feeder spring enters the BHC, just south of the Man of Vision statue in Cochrane Ranch Park. Its source is a ground water spring located at the base of the hill just east of the statue. The spring creek is approximately 300 metres in length and it flows throughout the year. The volume of flow is very low and an estimated .3 gal. per second is evident during lower flow periods. However, one juvenile trout was captured in a trap approximately 50 metres upstream of the mouth on BHC. The entire length of this feeder spring is inundated with vegetation, primarily western water sedge. The bankfull width is very wide for the volume of flow and this channel maintains a wetted perimeter of approximately 1 metre.

It is evident that the spring creek channel was trampled by livestock over the years and there is no defined channel with bank differential, except for a two metre length near the mouth. The fact that one trout was captured on its lower end indicates that there is some potential for improvement on this small feeder tributary.

#### *3.5.3.2 Ranch House Feeder Spring*

The Ranch House feeder spring enters the BHC, directly south of the Town of Cochrane Office building parking lot. When the parking lot was built, two small culverts were placed on this feeder spring creek to pave a section of the parking lot over top of the feeder spring. Below these culverts, the fish habitat in the feeder spring can be considered moderate to good (OHC,ISC,UCB,OHV). The channel is deep and has high banks on most of its reach, with considerable siltation. There is a storm drain that enters the small feeder tributary, just east of the downstream end of the two culverts. It is believed that the majority of silt present in the feeder spring comes from this source.

A total of 16 juvenile trout were captured in this feeder tributary, downstream of a small waterfall that prevents upstream migration on the spring creek. From the two culverts at the parking lot, downstream to the small waterfall, there is approximately 100 metres of good habitat that is not utilized by juvenile trout. No trout were captured above the small waterfall during the 2009 trapping program. Almost the entire length of this small feeder spring, from the culverts downstream to the mouth, there is limited pool habitat.

#### 4.0 Conclusion and Recommendations

Conflicting reports on the presence and use of spawning habitats on the lower reach of Bighill Creek exist (Rees 1987). However, the spawning survey confirms that a recent increase in the volume of flow in BHC and the cleansing of spawning gravels by the 2005 flood event, have resulted in reproductive activity by both brown trout and brook trout on the lower reach of the creek. Furthermore, the trout trapping program established that there is a quantitative success in the incubation of trout eggs over the winter months on BHC. The angling survey also establishes that the BHC has potential to develop into a good recreation angling stream, once again. Baseline data on the water quality on two new feeder springs has been documented and data for Millennium Creek and the main-stem of Bighill Creek has been compiled and all of the above has been added to this report.

Permission to access the middle reach of the BHC for study purposes was not obtained for the 2009 study program. However, it is important that the lower reach, where permission has been granted, be the initial focus of any improvements that will enhance the present day fishery, in-stream fish habitat and riparian habitat along the stream's banks. A range of deficiencies in both riparian and in-stream fish habitat have been identified in this study, but in a general scope. Measures can be taken to further enhance this fishery. The following recommendations are put forward as a consequence of the 2008 – 2009 study on the lower reach of Bighill Creek:

1. Current fish management regulations, along with the restricted activities boundaries on the creek may not protect the brown trout and brook trout spawning populations in BHC. Both brown trout and brook trout start their spawning in the first weeks of October on the creek. At this time, these fish are vulnerable to being captured by angling, adding additional stress to the trout and possibly being harvested. With the streams location, within the limits of the Town of Cochrane, this stream requires additional protection in order to maintain the fishery.
2. Future efforts to protect key spawning areas along the lower creek should be incorporated into the Town of Cochrane's, policy for Engineering and Operational Services activities along the lower creek.
3. Consideration for storm drain placement on BHC and its tributaries should be based on a "No Net Loss" fisheries and habitat policy. Some compensation for fish habitat and riparian enhancement for such impacts should be considered.
4. Measures to enhance and create riparian and fish habitat along the lower reach of the BHC may be undertaken, where deficiencies exist.
5. Efforts to further educate and inform the public of the importance of the habitat and fishery on Bighill Creek should continue into the future.
6. Millennium Creek should continue to be monitored for a successful incubation of trout eggs, as future measures are taken to enhance the spawning habitat to insure survival of incubating trout eggs and hatching fry.

## 5.0 References Cited

- Alberta Energy and Natural Resources, 1987. Buck for Wildlife Bighill Creek Streambank Evaluation Report. Prepared by Alberta Energy and Natural Resources, Fish and Wildlife Division, Calgary, Alberta.
- Borutski, D. 1980. Bighill Creek Stabilization Evaluation. Prepared by Alberta Fish and Wildlife Division, Red Deer, Alberta.
- Braumandl, B.2007, Earl, J. 2007. Electro Fish results for Bighill Creek. Malaspina University – College, Alberta Sustainable Resources, Fish and Wildlife, Cochrane, Alberta.
- Cunningham, E.B. 1963. The Proposed Stream Improvement Project on Bighill Creek. Prepared by Alberta Fish and Wildlife Division, Calgary, Alberta.
- MacDonald, W.H. 1950. Report on Bighill Springs Experiment 1950. Prepared by Alberta Fish and Wildlife Division, Calgary, Alberta.
- Rees, K. 1987. A fisheries phase II survey of Bighill Creek (14-34-25-4-W5). Prepared by Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, Calgary, Alberta.
- Sosiak, A. 1986. Effects of the Lochend Project on Bighill Creek. Internal Memorandum, prepared by Alberta Forestry, Lands and Wildlife, Calgary, Alberta.
- Sosiak, A. 1996. Agricultural Impacts on Jumpingpound and Bighill Creek. Internal Memorandum, prepared by Alberta Environmental Protection, Natural Resources Service, Water Management Division, Calgary, Alberta.
- Thompson, G.E. 1977a. Bighill Springs Creek. Internal Memorandums (April 5 and 27, 1977). Prepared by Alberta Energy and Natural Resources, Fish and Wildlife Division, Calgary, Alberta.
- Winhold, T.H. 1990. Cochrane Flood Plain Study. Alberta Flood Damage Reduction Program. Alberta Environmental Protection, River Engineering Branch, Technical Services and Monitoring Division, Edmonton, Alberta.
- Woods, G.R. 2004. Long Term Master Plan for the Protection and Enhancement of Cochrane Streams. Prepared by Guy Woods (Bow Valley Habitat Development) Cochrane. AB.
- Woods, G.R. 1999. Ecology and Management of Northwest Salmonids, Bull Trout II, Conference Proceedings. Prepared by Bow Valley Habitat Development, Cochrane, Alberta. P 187.

## 6.1 List of Appendices

Appendix 1. Bighill Creek Spawning Survey, 2008 Field Notes.

Appendix 2. Spawning Survey GPS data records.

Appendix 3. Trout Trapping Data, 2009 Field Notes.

Appendix 4. Water Quality Sampling Results.

Appendix 5. Total volunteer contributions in time.

## APPENDIX ONE

### Bighill Creek Spawning Survey, 2008 Field Notes

- Sept. 29 – Phil Sheepy spotted the first spawning brook trout, near the oldest tree in Cochrane. I went down to map the redd the next day, it was located on the south bank of the channel just downstream of the path bridge, directly south of the Cochrane Ranch House buildings. This site was identified as Site # 1.
- Sept. 30 – The day that I confirmed the spawning redd at Site # 1, I found 2 more brook trout Redds with trout over them, just downstream of the path bridge below the fourth ave. road bridge. This site was identified as Site # 2.
- Oct. 01 – I spotted one more brook trout redd, with trout over it, at Site # 2.
- Oct. 02 – I spotted the fourth brook trout redd at Site # 2, with trout over it.
- Oct. 03 – I counted another 3 brook trout redds, with trout over them, at Site # 1. I discovered spawning Brown trout, just upstream of the path bridge near the corrals in the park, west of 1A hwy. I identified this site as Site # 3. I wasn't expecting the brown trout to be spawning so early in the fall.
- Oct. 04 – Spotted 3 large redds, probably brown trout, approximately 200 m upstream of the 1A bridge. Found another redd approximately 800 m east of the fourth ave. bridge.
- Oct. 05 – Located 3 more brown trout redds, just upstream of the first brnt. Redds located. Found another 2 brown trout redds just above the first path bridge north of the 1A. Counted 3 more brook trout redds at the bridge directly south of the Ranch buildings. Found another 3 brook trout redds below the foot bridge just downstream of 4<sup>th</sup> ave. bridge. Located 3 brook trout redds and 1 brown trout redd, just downstream of the next bridge, east of the 4<sup>th</sup> ave. bridge.
- Oct.17 – Found 2 more redds on the lower end of the creek and a number of new redds in the park area of Cochrane Ranch. In the days preceding Oct.15, the water in the creek was high and turbid. I discovered that DU had completed a maintenance program on one of there sites on Bighill Creek, on Hutchison land.
- Oct.19 – Walked the creek with Jake Gotta today. Identified 4 more brown trout redds and 5 more brook trout redds. We spotted some active brown trout spawning on the Franciscan land. The brook trout probably finished spawning around the end of the second week of Oct.
- Oct.21 Spotted two more brown trout redds on the lower reach of Bighill Creek. I counted 11 brook trout redds on Millennium Creek. The spawning of brook trout on Mill. Crk. happens later in the season than on Bighill. Probably around the third week of Oct.
- Oct.23 Walked the section just upstream of 4<sup>th</sup> ave. bridge today and just below the bridge. Spotted two new brown trout redds directly below the foot bridge just downstream of 4<sup>th</sup> ave. I believe that the brown trout are finished spawning.
- Nov.04 Mapped two more brown trout redds at the first path bridge up from 1A highway. I suspect that brown trout spawning on the creek finishes off in about the third week of Oct.

APPENDIX TWO - SPAWNING SURVEY GPS DATA  
RECORDS 2008

Label Bearing	Type	Symbol	Description	Waypoint	Comment	Latitude	Longitude	Elevation	Distance to Active Point
BH8-BK N/A	Other	Dot		BH8-BK	05-OCT-08 17:3N51.20121	W114.47313			N/A
BH7-BK N/A	Other	Dot		BH7-BK	05-OCT-08 17:3N51.20121	W114.47313			N/A
BH6-BK N/A	Other	Dot		BH6-BK	05-OCT-08 17:2N51.20128	W114.47282			N/A
BH5-BK N/A	Other	Dot		BH5-BK	05-OCT-08 17:2N51.20130	W114.47287			N/A
BH4-BK N/A	Other	Dot		BH4-BK	05-OCT-08 17:2N51.20128	W114.47296			N/A
BH38BK N/A	Other	Dot		BH38BK	31-OCT-08 18:1N51.18424	W114.48227			N/A
BH37BK N/A	Other	Dot		BH37BK	31-OCT-08 18:0N51.18393	W114.48219			N/A
BH36BK N/A	Other	Dot		BH36BK	31-OCT-08 17:5N51.18088	W114.48038			N/A
BH35BK N/A	Other	Dot		BH35BK	31-OCT-08 17:4N51.18087	W114.48040			N/A
BH34BK N/A	Other	Dot		BH34BK	31-OCT-08 17:4N51.18086	W114.48044			N/A
BH33BK N/A	Other	Dot		BH33BK	31-OCT-08 17:4N51.18083	W114.48046			N/A
BH32BK N/A	Other	Dot		BH32BK	31-OCT-08 17:4N51.18082	W114.48049			N/A
BH31BK N/A	Other	Dot		BH31BK	19-OCT-08 20:2N51.20540	W114.45788			N/A
BH30BK N/A	Other	Dot		BH30BK	19-OCT-08 20:2N51.20539	W114.45787			N/A
BH3-BK N/A	Other	Dot		BH3-BK	05-OCT-08 17:2N51.20129	W114.47295			N/A
BH29BK N/A	Other	Dot		BH29BK	19-OCT-08 20:0N51.20542	W114.45851			N/A
BH28BK N/A	Other	Dot		BH28BK	19-OCT-08 20:0N51.20540	W114.45851			N/A
BH27BK N/A	Other	Dot		BH27BK	19-OCT-08 18:4N51.20365	W114.46764			N/A
BH26BK N/A	Other	Dot		BH26BK	17-OCT-08 17:2N51.19782	W114.48043			N/A
BH25BK N/A	Other	Dot		BH25BK	17-OCT-08 17:2N51.19782	W114.48041			N/A
BH24BK N/A	Other	Dot		BH24BK	17-OCT-08 17:1N51.19570	W114.48135			N/A
BH23BK N/A	Other	Dot		BH23BK	17-OCT-08 16:5N51.18459	W114.48231			N/A
BH22BK N/A	Other	Dot		BH22BK	17-OCT-08 16:5N51.18459	W114.48230			N/A
BH21BK N/A	Other	Dot		BH21BK	06-OCT-08 17:0N51.19772	W114.48085			N/A
BH20BK N/A	Other	Dot		BH20BK	06-OCT-08 14:5N51.18464	W114.48231			N/A
BH2-BK N/A	Other	Dot		BH2-BK	05-OCT-08 17:2N51.20124	W114.47301			N/A
BH19BK N/A	Other	Dot		BH19BK	05-OCT-08 20:0N51.20684	W114.45192			N/A
BH18BK N/A	Other	Dot		BH18BK	05-OCT-08 20:0N51.20682	W114.45196			N/A
BH17BK N/A	Other	Dot		BH17BK	05-OCT-08 19:0N51.19783	W114.48059			N/A
BH16BK N/A	Other	Dot		BH16BK	05-OCT-08 18:0N51.20363	W114.46751			N/A
BH15BK N/A	Other	Dot		BH15BK	05-OCT-08 18:0N51.20363	W114.46749			N/A
BH14BK N/A	Other	Dot		BH14BK	05-OCT-08 18:0N51.20360	W114.46753			N/A
BH13BK N/A	Other	Dot		BH13BK	05-OCT-08 18:0N51.20362	W114.46753			N/A
BH12BK N/A	Other	Dot		BH12BK	05-OCT-08 17:5N51.20363	W114.46774			N/A
BH11BK N/A	Other	Dot		BH11BK	05-OCT-08 17:5N51.20360	W114.46775			N/A
BH10BK N/A	Other	Dot		BH10BK	05-OCT-08 17:5N51.20362	W114.46777			N/A

Label Bearing	Type	Symbol	Description	Waypoint	Comment	Latitude	Longitude	Elevation	Distance to Active Point
<b>Bighill Creek Brook Trout Spawning 2008</b>									
BH1-BK N/A	Other	Dot		BH1-BK	05-OCT-08 17:1N51.20118	W114.47317			N/A
BH-9BK N/A	Other	Dot		BH-9BK	05-OCT-08 17:5N51.20364	W114.46778			N/A

Label Bearing	Type	Symbol	Description	Waypoint	Comment	Latitude	Longitude	Elevation	Distance to Active Point
<b>Bighill Creek Brown Trout Spawning 2008</b>									
BH9-BN N/A	Other	Dot		BH9-BN	17-OCT-08	17:2N51.19759	W114.48190		N/A
BH8-BN N/A	Other	Dot		BH8-BN	17-OCT-08	17:2N51.19759	W114.48189		N/A
BH7-BN N/A	Other	Dot		BH7-BN	17-OCT-08	17:1N51.19578	W114.48136		N/A
BH6-BN N/A	Other	Dot		BH6-BN	17-OCT-08	17:1N51.19566	W114.48143		N/A
BH5-BN N/A	Other	Dot		BH5-BN	05-OCT-08	20:0N51.20695	W114.45187		N/A
BH4-BN N/A	Other	Dot		BH4-BN	05-OCT-08	19:0N51.19793	W114.48040		N/A
BH3-BN N/A	Other	Dot		BH3-BN	05-OCT-08	19:0N51.19802	W114.48034		N/A
BH23BN N/A	Other	Dot		BH23BN	04-NOV-08	16:4N51.19779	W114.48067		N/A
BH22BN N/A	Other	Dot		BH22BN	04-NOV-08	16:4N51.19771	W114.48072		N/A
BH21BN N/A	Other	Dot		BH21BN	23-OCT-08	18:1N51.20360	W114.46739		N/A
BH20BN N/A	Other	Dot		BH20BN	23-OCT-08	18:1N51.20361	W114.46738		N/A
BH2-BN N/A	Other	Dot		BH2-BN	04-OCT-08	17:2N51.19747	W114.48254		N/A
BH19BN N/A	Other	Dot		BH19BN	21-OCT-08	19:4N51.18373	W114.48160		N/A
BH18BN N/A	Other	Dot		BH18BN	21-OCT-08	19:4N51.18374	W114.48157		N/A
BH17BN N/A	Other	Dot		BH17BN	19-OCT-08	20:3N51.20584	W114.45705		N/A
BH16BN N/A	Other	Dot		BH16BN	19-OCT-08	20:1N51.20510	W114.45813		N/A
BH15BN N/A	Other	Dot		BH15BN	19-OCT-08	20:1N51.20511	W114.45817		N/A
BH14BN N/A	Other	Dot		BH14BN	19-OCT-08	19:2N51.19787	W114.48069		N/A
BH13BN N/A	Other	Dot		BH13BN	17-OCT-08	17:4N51.19755	W114.47986		N/A
BH12BN N/A	Other	Dot		BH12BN	17-OCT-08	17:4N51.19754	W114.47987		N/A
BH11BN N/A	Other	Dot		BH11BN	17-OCT-08	17:3N51.19790	W114.48059		N/A
BH10BN N/A	Other	Dot		BH10BN	17-OCT-08	17:3N51.19787	W114.48056		N/A
BH1-BN N/A	Other	Dot		BH1-BN	04-OCT-08	18:2N51.19754	W114.47983		N/A

Label Bearing	Type	Symbol	Description	Waypoint	Comment	Latitude	Longitude	Elevation	Distance to Active Point
MC9BK N/A	Other	Dot	Millennium Creek	MC9BK	22-OCT-08	17:0N51.18317	W114.48302		N/A
MC8BK N/A	Other	Dot	Brook Trout Spawning	MC8BK	22-OCT-08	16:5N51.18447	W114.48427		N/A
MC7BK N/A	Other	Dot		MC7BK	22-OCT-08	16:5N51.18446	W114.48427		N/A
MC6BK N/A	Other	Dot		MC6BK	22-OCT-08	16:5N51.18443	W114.48427		N/A
MC5BK N/A	Other	Dot		MC5BK	22-OCT-08	16:5N51.18443	W114.48426		N/A
MC4BK N/A	Other	Dot		MC4BK	22-OCT-08	16:5N51.18443	W114.48424		N/A
MC3BK N/A	Other	Dot		MC3BK	22-OCT-08	16:5N51.18439	W114.48422		N/A
MC2BK N/A	Other	Dot		MC2BK	22-OCT-08	16:5N51.18437	W114.48421		N/A
MC24BK N/A	Other	Dot		MC24BK	09-NOV-08	16:5N51.18448	W114.48425		N/A
MC23BK N/A	Other	Dot		MC23BK	09-NOV-08	16:5N51.18444	W114.48425		N/A
MC22BK N/A	Other	Dot		MC22BK	09-NOV-08	16:5N51.18381	W114.48359		N/A
MC21BK N/A	Other	Dot		MC21BK	31-OCT-08	18:4N51.18446	W114.48423		N/A
MC20BK N/A	Other	Dot		MC20BK	31-OCT-08	18:3N51.18412	W114.48412		N/A
MC1BK N/A	Other	Dot		MC1BK	22-OCT-08	16:5N51.18440	W114.48420		N/A
MC19BK N/A	Other	Dot		MC19BK	31-OCT-08	18:3N51.18410	W114.48407		N/A
MC18BK N/A	Other	Dot		MC18BK	28-OCT-08	15:5N51.18387	W114.48367		N/A
MC17BK N/A	Other	Dot		MC17BK	28-OCT-08	15:4N51.18314	W114.48299		N/A
MC16BK N/A	Other	Dot		MC16BK	28-OCT-08	15:4N51.18314	W114.48298		N/A
MC15BK N/A	Other	Dot		MC15BK	25-OCT-08	16:0N51.18085	W114.48126		N/A
MC14BK N/A	Other	Dot		MC14BK	22-OCT-08	17:2N51.18072	W114.48101		N/A
MC13BK N/A	Other	Dot		MC13BK	22-OCT-08	17:2N51.18136	W114.48100		N/A
MC12BK N/A	Other	Dot		MC12BK	22-OCT-08	17:2N51.18136	W114.48102		N/A
MC11BK N/A	Other	Dot		MC11BK	22-OCT-08	17:1N51.18266	W114.48235		N/A
MC10BK N/A	Other	Dot		MC10BK	22-OCT-08	17:0N51.18318	W114.48303		N/A

## APPENDIX THREE

### Trout trapping data – Trapping started on May 13/09

May 01/09 – Set traps in Mill.crk.

May 02/09 – Captured 10 stickleback in Millennium Creek.

May 03/09 – Captured 6 stickleback in Mill. Creek. Pulled traps.

May 13/09 – Set traps in the morning at 4 different sites; three traps on Mill. Crk. pond and 2 traps per three sites on Bighill creek. Set traps at all locations on areas just downstream of known spawning beds. Checked traps in the evening and caught 2 lake chub and 4 stickle back minnows in 3 of the traps set on Bighill Creek.

May 14/09 – Captured 3 lake chub and 8 stickle back minnows on the traps in BGH and two brown trout juvenile trout at the mouth of the feeder spring below Man of Vision. One was **26 mm** and the other was **28 mm**. Pulled the traps at that site.

May 15/09 – Set traps in three new locations, all feeder springs down from spawning areas. Caught 6 stickle backs and 2 Lake Chub and 1 pearl dace today. No trout!

May 15/09 – Set traps in Mill.crk.

May 16/09 – Captured 22 stickleback in Mill. Crk.

May 16/09 – Caught 16 sticklebacks, 9 lake chub and 2 white suckers today.

May 17/09 – Captured 14 sticklebacks, 11 lake chub, 1 pearl dace and 1 white sucker.

May 17/09 – Captured 18 stickleback in Mill. Crk.

May 18/09 – Captured 18 stickleback, 7 lake chub and 3 longnose dace.

May 19/09 – Captured 8 stickleback, 5 lake chub. Moved some traps in a little closer to the known spawning areas of brook trout, from the previous fall.

May 20/09 – Captured 4 stickleback and 2 lake chub.

May 21/09 – Captured 3 stickleback and 1 lake chub

May 21/09 – Set traps in Mill crk.

May 22/09 – Captured 9 stickleback and 5 lake chub.

May 22/09 – Captured 28 stickleback in Mill. Crk.

May 23/09 – Captured 15 stickleback in Mill. Crk. Pulled traps.

May 23/09 – Captured 14 stickleback and 4 lake chub. Caught 1 trout **22 mm**, below the key brook trout spawning area, just downstream of 4<sup>th</sup> Ave. bridge.

May 24/09 – Captured 7 lake chub, 6 stickleback, 4 longnose dace, **1 pearl dace, lost one trout thru the mesh of the dip net**. Captured and lost this trout 40 m downstream of the path bridge brook trout spawning area.

May 25/09 – Captured 6 stickleback, 5 lake chub. 1 juvenile trout **26 mm long** approximately 25 metres downstream of the path bridge spawning area which was a primary brook trout spawning area during the 2008 fall spawning season.

May 26/09 – Captured 5 sticklebacks, 2 longnose dace and 4 lake chub.

May 27/09 – Captured 5 stickleback and **1 trout – 33 mm long**. This trout was captured in the mouth of the Ranch spring, upstream of the path bridge and second primary brook trout spawning area.

May 28/09 – Captured 4 sticklebacks and 1 pearl dace.

May 29/09 – Captured 5 stickleback.

May 30/09 – Captured 7 stickleback, 3 lake chub and 1 dace.  
May 31/09 – Captured 6 sticklebacks and 3 longnose dace.  
June 01/09 – Captured 4 stickleback, 2 lake chub. One trout **30mm** at the mouth of the Ranch spring. Two trout – **29 mm** and **33mm**, just downstream of the fourth Ave. spawning area.  
June 25/09 – Captured 25 stickleback, 2 dace.  
June 26/09 – Captured **one trout, 59mm**. 16 stickle back, 6 LN dace, 1 LK chub.  
June 27/09 – Captured one trout **53 mm**. 8 LN dace, 9 stickleback, 2 LK chub.  
June 28/09 – Captured one trout **49 mm**, 5 LN dace, 9 stickleback.  
June 29/09 – Captured one trout **61mm**, 14 stickleback, 8 LN dace, 1 pearl dace, 1 LK chub.  
June 30/09 – Captured two trout **60 mm + 62mm**. 16 stickleback, 12 LN dace. Set traps in the Man of Vision spring creek and the Ranch House Spring creek.  
July 01/09 – Captured one trout **50 mm**, about 60 m up the Ranch House Spring. There is a small waterfall just upstream of the capture site, which trout may not be able to pass. Caught 8 LN dace, 16 stickleback.  
July 02/09 – Captured 7 LN dace, 13 stickleback.  
July 03/09 – Captured 6 LN dace, 8 stickleback, the following trout; MoV spring **55mm**, Ranch House Spring – **70mm, 51mm, 53mm, 54mm, 55mm**. In Bighill Creek **60mm, 61mm**. Set 4 traps on the lower end of Mill. Crk.  
July 04/09 – Captured 6 LN dace 1 LK chub and 14 stickleback.  
July 05/09 – Captured 2 LN dace. Pulled traps from both BH and Mill. Crk. Cleaned traps.  
July 31/09 – Set traps on Bighill just below 4<sup>th</sup> ave., on the Ranch H. Spring and the boundary of MD and Boothby.  
Aug.01/09 – Caught 27 stickleback and 4 trout in the Ranch H. Spring;**67MM,73MM,72MM, 84MM**.  
Aug.02/09 – Caught 16 stickleback. 2 Longnose dace and 1 lake chub at the boundary of MD and Boothby. Pulled my traps.  
Aug.19/09 – Set 19 traps in BHC and in the Ranch House Spring Creek.  
Aug.20/09 – Trapped **1 trout 85mm** in the Ranch Spring, Plus 18 stickleback, 6 LN Dace, 7 Pearl Dace, 2 LK Chub.  
Aug.21/09 – Trapped 4 pearl dace, 6 Longnose dace, 17 stickleback and **5 brook trout (positive I.D.); 4 in the Ranch spring – 106mm,84mm,95mm,100mm; one in the BHC 76mm**.  
Aug.22/09 – Trapped 9 stickleback, 3 LN dace, 1 pearl dace and 2 Lake chub. **Caught one trout in Ranch spring 84mm, two in BHC; 90mm, 102mm. All 3 are brook trout (positive ID)**. Pulled traps out of ranch spring and brook trout spawning area.  
Aug.24/09 – Washed and set traps in the area below the primary brown trout spawning site.  
Aug.25/09 – Caught 2 longnose dace and two brook trout. **98mm and 84mm**.  
Aug.26/09 – Caught 1 longnose dace and two trout, **94mm and 100mm**.  
Aug.27/09 – Caught 1 longnose dace and three trout, **91mm,90mm and 95mm**. Pulled traps.  
Aug.31/09 – Set traps in Section 2.  
Sept.01/09 – 8 long nose dace, 2 white sucker, 1 stickleback.  
Sept.02/09 – 17 long nose dace, 1 white sucker, 2 lake chub and 2 stickleback. Pulled traps and set them in Section 1.  
Sept.03/09 – Caught 7 LN dace, 2 lake chub and 1 stickle back. Pulled traps.  
Sept.08/09 – Set traps in section 3, below brown trout spawning areas.  
Sept.09/09 – No fish!  
Sept.10/09 – 4 trout and 1 Longnose dace, **88mm, 90mm, 97mm and 110mm**.

Sept.11/09 – No fish! Pulled traps.  
Sept.18/09 – Set traps in brown trout spawning site.  
Sept.19/09 – 5 Longnose dace, 1 lake chub.  
Sept.20/09 – 2 Longnose dace, 1 Pearl Dace.  
Sept.21/09 – 1 trout, **108 mm.**  
Sept.22/09 – 1 trout, **121 mm.**  
Sept.23/09 – 1 Lake Chub.  
Sept.24/09 – 2 Lake Chub.  
Sept.25/09 – 1 Lake Chub. Pulled traps.  
Sept.27/09 – Set traps in Section 3.  
Sept.28/09 – 1 Longnose dace, 1 Lake Chub.  
Sept.29/09 – 1 Pearl Dace, 2 trout, **110 mm, 100 mm.**  
Sept.30/09 – 2 Pearl Dace, 1 long nose dace. Pulled Traps, end of trapping program.

APPENDIX FOUR –

WATER QUALITY SAMPLING RESULTS

For the following:

MILLENNIUM CREEK

FEEDER SPRING CREEKS 1 AND 2  
Man of Vision and Ranch House springs

MAIN STEM OF BIGHILL CREEK



Norwest Labs  
 7217 Roper Road  
 Edmonton, AB. T6B 3J4  
 Phone: (780) 438-5522  
 Fax: (780) 438-0396

### Analytical Report

**Bill to:** Town of Cochrane  
**Report to:** Town of Cochrane  
 Box 10  
 Cochrane, AB, Canada  
 T4C 1A4  
 Attn: Andy Degraw  
 Sampled By:  
 Company:

**Project ID:**  
**Name:** Big Hill Spring  
**Location:**  
**LSD:**  
**P.O.:**  
**Acct. Code:**

**NWL Lot ID:** 326732  
 Control Number: E 163935  
 Date Received: Aug 17, 2004  
 Date Reported: Aug 20, 2004  
 Report Number: 584879

NWL Number 326732-1  
 Sample Description Water Sample  
 Matrix Water - General

Analyte	Units	Results	Results	Results	Detection Limit
<b>Inorganic Nonmetallic Parameters</b>					
Orthophosphate-P	Dissolved	mg/L	0.11		0.05
<b>Metals Extractable</b>					
Silicon	Extractable	mg/L	4.16		0.05
Sulphur	Extractable	mg/L	9.64		0.05
Mercury	Extractable	mg/L	<0.0001		0.0001
Aluminum	Extractable	mg/L	<0.005		0.005
Antimony	Extractable	mg/L	<0.0002		0.0002
Arsenic	Extractable	mg/L	0.0004		0.0002
Barium	Extractable	mg/L	0.214		0.001
Beryllium	Extractable	mg/L	<0.0001		0.0001
Bismuth	Extractable	mg/L	<0.0005		0.0005
Boron	Extractable	mg/L	0.027		0.002
Cadmium	Extractable	mg/L	<0.00001		0.00001
Chromium	Extractable	mg/L	0.0023		0.0005
Cobalt	Extractable	mg/L	<0.0001		0.0001
Copper	Extractable	mg/L	<0.001		0.001
Lead	Extractable	mg/L	<0.0001		0.0001
Lithium	Extractable	mg/L	0.018		0.001
Molybdenum	Extractable	mg/L	0.002		0.001
Nickel	Extractable	mg/L	<0.0005		0.0005
Selenium	Extractable	mg/L	0.0016		0.0002
Silver	Extractable	mg/L	<0.0001		0.0001
Strontium	Extractable	mg/L	0.536		0.001
Thallium	Extractable	mg/L	<0.00005		0.00005
Tin	Extractable	mg/L	<0.001		0.001
Titanium	Extractable	mg/L	<0.0005		0.0005
Uranium	Extractable	mg/L	0.0024		0.0005
Vanadium	Extractable	mg/L	0.0001		0.0001
Zinc	Extractable	mg/L	<0.001		0.001
Zirconium	Extractable	mg/L	<0.001		0.001
<b>Physical and Aggregate Properties</b>					
Temp. of observed pH and EC		°C	19.4		
Solids	Total Suspended	mg/L	<2		1
<b>Routine Water</b>					
pH			8.10		
Calcium	Extractable	mg/L	67.1		0.2
Magnesium	Extractable	mg/L	38.7		0.1



**NORWEST  
LABS**

**Analytical Report**

Norwest Labs  
7217 Roper Road  
Edmonton, AB. T6B 3J4  
Phone: (780) 438-5522  
Fax: (780) 438-0396

**Bill to:** Town of Cochrane  
**Report to:** Town of Cochrane  
Box 10  
Cochrane, AB, Canada  
T4C 1A4  
Attn: Andy Degraw  
Sampled By:  
Company:

**Project ID:**  
**Name:** Big Hill Spring  
**Location:**  
**LSD:**  
**P.O.:**  
**Acct. Code:**

**NWL Lot ID:** 326732  
Control Number: E 163935  
Date Received: Aug 17, 2004  
Date Reported: Aug 20, 2004  
Report Number: 584879

NWL Number 326732-1  
Sample Description Water Sample  
Matrix Water - General

Analyte	Units	Results	Results	Results	Detection Limit
<b>Routine Water - Continued</b>					
Sodium	Extractable mg/L	24.6			0.4
Potassium	Extractable mg/L	4.0			0.4
Iron	Extractable mg/L	<0.01			0.01
Chloride	Dissolved mg/L	25.2			0.5
Fluoride	mg/L	0.18			0.05
Nitrate - N	mg/L	2.3			0.1
Nitrite - N	mg/L	<0.05			0.05
T-Alkalinity	as CaCO3 mg/L	320			5
Hardness	as CaCO3 mg/L	327			

Approved by:

Anthony Neumann, MSc  
Laboratory Operations Manager

**Methodology and Notes**

**Bill to:** Town of Cochrane  
**Report to:** Town of Cochrane  
Box 10  
Cochrane, AB, Canada  
T4C 1A4  
Attn: Andy Degraw  
Sampled By:  
Company:

**Project ID:**  
**Name:** Big Hill Spring  
**Location:**  
**LSD:**  
**P.O.:**  
**Acct. Code:**

**NWL Lot ID:** 326732  
**Control Number:** E 163935  
**Date Received:** Aug 17, 2004  
**Date Reported:** Aug 20, 2004  
**Report Number:** 584879

Page: 3 of 3

**Method of Analysis:**

MethodName	Reference	Method	Date Analysis Started	Location
Alkalinity, pH, and EC in water	APHA	* Electrometric Method, 4500-H+ B	18-Aug-04	Norwest Labs Edmonton
Alkalinity, pH, and EC in water	APHA	* Titration Method, 2320 B	18-Aug-04	Norwest Labs Edmonton
Anions (Routine) by Ion Chromatography	APHA	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	19-Aug-04	Norwest Labs Edmonton
Chloride in Water	APHA	* Automated Ferricyanide Method, 4500-Cl- E	19-Aug-04	Norwest Labs Edmonton
Mercury (Extractable) in water	APHA	* Cold Vapour Atomic Absorption Spectrometric Method, 3112 B	19-Aug-04	Norwest Labs Edmonton
Metals ICP-MS (Extractable) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	19-Aug-04	Norwest Labs Edmonton
Metals Trace (Extractable) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	19-Aug-04	Norwest Labs Edmonton
Orthophosphate-P in Water	APHA	* Automated Ascorbic Acid Reduction Method, 4500-P F	19-Aug-04	Norwest Labs Edmonton
Solids Suspended (Total, Fixed and Volatile)	APHA	* Total Suspended Solids Dried at 103-105°C, 2540 D	19-Aug-04	Norwest Labs Edmonton

\* Norwest method(s) is based on reference method

**References:**US EPA  
APHAUS Environmental Protection Agency Test Methods  
Standard Methods for the Examination of Water and Wastewater**Comments:**

Please direct any inquiries regarding this report to our Client Services group.  
Results relate only to samples as submitted

The test report shall not be reproduced except in full, without the written approval of the laboratory



Analytical Report

Bill To: Town of Cochrane  
 Report To: Town of Cochrane  
 101 Ranch House Road  
 Cochrane, AB, Canada  
 T4C 2K8  
 Attn: Andy Degraw  
 Sampled By:  
 Company: T.C.

Project:  
 ID:  
 Name:  
 Location: BHL Ranch  
 LSD:  
 P.O.:  
 Acct code:

Lot ID: **651631**  
 Control Number: L 000812  
 Date Received: Oct 28, 2008  
 Date Reported: Nov 3, 2008  
 Report Number: 1168707

Analyte	Units	Results	Results	Results	Nominal Detection Limit
<b>Reference Number</b> 651631-1					
<b>Sample Date</b>					
<b>Sample Time</b>					
<b>Sample Location</b>					
<b>Sample Description</b> Water Sample					
<b>Matrix</b> Wastewater					
<b>Inorganic Nonmetallic Parameters</b>					
Orthophosphate-P	Dissolved	mg/L	0.13		0.01
<b>Metals Extractable</b>					
Silicon	Extractable	mg/L	4.63		0.05
Sulfur	Extractable	mg/L	79.2		0.3
Mercury	Extractable	mg/L	<0.0001		0.0001
Aluminum	Extractable	mg/L	0.028		0.005
Antimony	Extractable	mg/L	<0.0002		0.0002
Arsenic	Extractable	mg/L	0.0007		0.0002
Barium	Extractable	mg/L	0.048		0.001
Beryllium	Extractable	mg/L	<0.0001		0.0001
Bismuth	Extractable	mg/L	<0.0005		0.0005
Boron	Extractable	mg/L	0.056		0.002
Cadmium	Extractable	mg/L	<0.00001		0.00001
Chromium	Extractable	mg/L	0.0025		0.0005
Cobalt	Extractable	mg/L	0.0002		0.0001
Copper	Extractable	mg/L	0.002		0.001
Lead	Extractable	mg/L	0.0002		0.0001
Lithium	Extractable	mg/L	0.024		0.001
Molybdenum	Extractable	mg/L	0.002		0.001
Nickel	Extractable	mg/L	0.0021		0.0005
Selenium	Extractable	mg/L	0.0096		0.0002
Silver	Extractable	mg/L	<0.00001		0.00001
Strontium	Extractable	mg/L	1.16		0.001
Thallium	Extractable	mg/L	<0.00005		0.00005
Tin	Extractable	mg/L	<0.001		0.001
Titanium	Extractable	mg/L	0.0062		0.0005
Uranium	Extractable	mg/L	0.0030		0.0005
Vanadium	Extractable	mg/L	0.0051		0.0001
Zinc	Extractable	mg/L	0.003		0.001
Zirconium	Extractable	mg/L	<0.001		0.001
<b>Physical and Aggregate Properties</b>					
Solids	Total Suspended	mg/L	18		1
<b>Routine Water</b>					
pH			8.42		
Temperature of observed		°C	22.4		
pH					
Calcium	Extractable	mg/L	95.0		0.2



Analytical Report

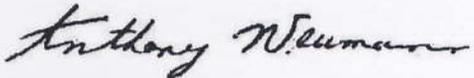
Bill To: Town of Cochrane  
 Report To: Town of Cochrane  
 101 Ranch House Road  
 Cochrane, AB, Canada  
 T4C 2K8  
 Attn: Andy Degraw  
 Sampled By:  
 Company: T.C.

Project:  
 ID:  
 Name:  
 Location: BHL Ranch  
 LSD:  
 P.O.:  
 Acct code:

Lot ID: **651631**  
 Control Number: L 000812  
 Date Received: Oct 28, 2008  
 Date Reported: Nov 3, 2008  
 Report Number: 1168707

Reference Number 651631-1  
 Sample Date  
 Sample Time  
 Sample Location  
 Sample Description Water Sample  
 Matrix Wastewater

Analyte	Units	Results	Results	Results	Nominal Detection Limit
<b>Routine Water - Continued</b>					
Magnesium	Extractable	mg/L	62.5		0.2
Sodium	Extractable	mg/L	95.8		0.4
Potassium	Extractable	mg/L	4.7		0.4
Iron	Extractable	mg/L	0.28		0.03
Chloride	Dissolved	mg/L	42.8		0.4
Fluoride		mg/L	0.12		0.05
Nitrate - N		mg/L	0.87		0.01
Nitrite - N		mg/L	<0.005		0.005
T-Alkalinity	as CaCO3	mg/L	402		5
Hardness	as CaCO3	mg/L	494		
Sulfur	Extractable	mg/L	79.2		0.3

Approved by:   
 Anthony Neumann, MSc  
 Laboratory Operations Manager



**Methodology and Notes**

Bill To: Town of Cochrane	Project:	Lot ID: <b>651631</b>
Report To: Town of Cochrane	ID:	Control Number: L 000812
101 Ranch House Road	Name:	Date Received: Oct 28, 2008
Cochrane, AB, Canada	Location: BHL Ranch	Date Reported: Nov 3, 2008
T4C 2K8	LSD:	Report Number: 1168707
Attn: Andy Degraw	P.O.:	
Sampled By:	Acct code:	
Company: T.C.		

**Method of Analysis**

Method Name	Reference	Method	Date Analysis Started	Location
Alkalinity, pH, and EC in water	APHA	* Electrometric Method, 4500-H+ B	29-Oct-08	BTG Edmonton
Alkalinity, pH, and EC in water	APHA	* Titration Method, 2320 B	29-Oct-08	BTG Edmonton
Anions (Routine) by Ion Chromatography	APHA	* Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	29-Oct-08	BTG Edmonton
Chloride in Water	APHA	* Automated Ferricyanide Method, 4500-Cl- E	30-Oct-08	BTG Edmonton
Mercury (Extractable) in water	APHA	* Cold Vapour Atomic Absorption Spectrometric Method, 3112 B	03-Nov-08	BTG Edmonton
Metals ICP-MS (Extractable) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	30-Oct-08	BTG Edmonton
Metals Trace (Extractable) in water	APHA	Hardness by Calculation, 2340 B	29-Oct-08	BTG Edmonton
Metals Trace (Extractable) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	29-Oct-08	BTG Edmonton
Orthophosphate-P in Water	APHA	* Automated Ascorbic Acid Reduction Method, 4500-P F	30-Oct-08	BTG Edmonton
Solids Suspended (Total, Fixed and Volatile)	APHA	* Total Suspended Solids Dried at 103-105°C, 2540 D	29-Oct-08	BTG Edmonton

\* Bodycote method(s) based on reference method

**References**

APHA Standard Methods for the Examination of Water and Wastewater  
 US EPA US Environmental Protection Agency Test Methods

**Comments:**

Please direct any inquiries regarding this report to our Client Services group.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.

## Analytical Report

Bill To: Town of Cochrane  
 Report To: Town of Cochrane  
 101 Ranch House Road  
 Cochrane, AB, Canada  
 T4C 2K8  
 Attn: Andy Degraw  
 Sampled By:  
 Company: T.C.

Project:  
 ID:  
 Name: Big Hill Creek Town Office  
 Location:  
 LSD:  
 P.O.:  
 Acct code:

Lot ID: **691069**  
 Control Number:  
 Date Received: Jul 7, 2009  
 Date Reported: Jul 13, 2009  
 Report Number: 1233663

Analyte	Matrix	Units	Reference Number	Results	Nominal Detection Limit
			691069-1	Results	
<b>Inorganic Nonmetallic Parameters</b>					
Orthophosphate-P	Dissolved	mg/L		0.02	0.01
<b>Metals Extractable</b>					
Silicon	Extractable	mg/L		3.22	0.05
Sulfur	Extractable	mg/L		152	0.3
Mercury	Extractable	mg/L		<0.0001	0.0001
Aluminum	Extractable	mg/L		0.155	0.002
Antimony	Extractable	mg/L		<0.0002	0.0002
Arsenic	Extractable	mg/L		0.0013	0.0002
Barium	Extractable	mg/L		0.054	0.001
Beryllium	Extractable	mg/L		<0.0001	0.0001
Bismuth	Extractable	mg/L		<0.0005	0.0005
Boron	Extractable	mg/L		0.060	0.002
Cadmium	Extractable	mg/L		0.00002	0.00001
Chromium	Extractable	mg/L		0.0005	0.0005
Cobalt	Extractable	mg/L		0.0003	0.0001
Copper	Extractable	mg/L		0.002	0.001
Lead	Extractable	mg/L		0.0004	0.0001
Lithium	Extractable	mg/L		0.036	0.001
Molybdenum	Extractable	mg/L		0.001	0.001
Nickel	Extractable	mg/L		<0.0005	0.0005
Selenium	Extractable	mg/L		0.0093	0.0002
Silver	Extractable	mg/L		<0.00001	0.00001
Strontium	Extractable	mg/L		1.20	0.001
Thallium	Extractable	mg/L		<0.00005	0.00005
Tin	Extractable	mg/L		<0.001	0.001
Titanium	Extractable	mg/L		0.0107	0.0005
Uranium	Extractable	mg/L		0.0035	0.0005
Vanadium	Extractable	mg/L		0.0026	0.0001
Zinc	Extractable	mg/L		0.010	0.001
Zirconium	Extractable	mg/L		<0.001	0.001
<b>Physical and Aggregate Properties</b>					
Solids	Total Suspended	mg/L		27	1
<b>Routine Water</b>					
pH				8.32	
Temperature of observed		°C		21.1	
pH					
Calcium	Extractable	mg/L		91.4	0.2



Analytical Report

Bill To: Town of Cochrane  
 Report To: Town of Cochrane  
 101 Ranch House Road  
 Cochrane, AB, Canada  
 T4C 2K8  
 Attn: Andy Degraw  
 Sampled By:  
 Company: T.C.

Project:  
 ID:  
 Name: Big Hill Creek Town Office  
 Location:  
 LSD:  
 P.O.:  
 Acct code:

Lot ID: **691069**  
 Control Number:  
 Date Received: Jul 7, 2009  
 Date Reported: Jul 13, 2009  
 Report Number: 1233863

Reference Number		691069-1		
Sample Date				
Sample Time				
Sample Location				
Sample Description	Matrix	Water Sample	Water	
Analyte	Units	Results	Results	Nominal Detection Limit
<b>Routine Water - Continued</b>				
Magnesium	Extractable	mg/L	100	0.2
Sodium	Extractable	mg/L	105	0.4
Potassium	Extractable	mg/L	5.4	0.4
Iron	Extractable	mg/L	0.28	0.01
Chloride	Dissolved	mg/L	48.8	0.4
Fluoride		mg/L	0.11	0.05
Nitrate - N		mg/L	0.18	0.01
Nitrite - N		mg/L	<0.005	0.005
T-Alkalinity	as CaCO3	mg/L	321	5
Hardness	as CaCO3	mg/L	640	

Approved by:

Laurie Brown, MSc  
 Client Services Manager

**Methodology and Notes**

Bill To: Town of Cochrane  
 Report To: Town of Cochrane  
 101 Ranch House Road  
 Cochrane, AB, Canada  
 T4C 2K8  
 Attn: Andy Degraw  
 Sampled By:  
 Company: T.C.

Project:  
 ID:  
 Name: Big Hill Creek Town Office  
 Location:  
 LSD:  
 P.O.:  
 Acct code:

Lot ID: **691069**  
 Control Number:  
 Date Received: Jul 7, 2009  
 Date Reported: Jul 13, 2009  
 Report Number: 1233663

**Method of Analysis**

Method Name	Reference	Method	Date Analysis Started	Location
Alkalinity, pH, and EC in water	APHA	* Electrometric Method, 4500-H+ B	10-Jul-09	BTG Edmonton
Alkalinity, pH, and EC in water	APHA	* Titration Method, 2320 B	10-Jul-09	BTG Edmonton
Anions (Routine) by Ion Chromatography	APHA	* Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	10-Jul-09	BTG Edmonton
Chloride in Water	APHA	* Automated Ferricyanide Method, 4500-Cl- E	10-Jul-09	BTG Edmonton
Mercury (Extractable) in water	APHA	* Cold Vapour Atomic Absorption Spectrometric Method, 3112 B	10-Jul-09	BTG Edmonton
Metals ICP-MS (Extractable) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	10-Jul-09	BTG Edmonton
Metals Trace (Extractable) in water	APHA	Hardness by Calculation, 2340 B	10-Jul-09	BTG Edmonton
Metals Trace (Extractable) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	10-Jul-09	BTG Edmonton
Orthophosphate-P in Water	APHA	* Automated Ascorbic Acid Reduction Method, 4500-P F	09-Jul-09	BTG Edmonton
Solids Suspended (Total, Fixed and Volatile)	APHA	* Total Suspended Solids Dried at 103-105°C, 2540 D	10-Jul-09	BTG Edmonton

\* Bodycote method(s) based on reference method

**References**

APHA Standard Methods for the Examination of Water and Wastewater  
 US EPA US Environmental Protection Agency Test Methods

**Comments:**

Please direct any inquiries regarding this report to our Client Services group.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.

APPENDIX FIVE

TOTAL VOLUNTEER CONTRIBUTIONS IN TIME



# Millennium Creek Reclamation and Fisheries Habitat Enhancement Project



Phone: 403-932-4467

Fax: 403-932-4467

Email: goww@cochrane.net

## VOLUNTEER CONTRIBUTION

DATE	NAME	PROJECT	TIME IN	TIME OUT	TOTAL TIME
APRIL 10/09	Guy Woods	BH BEAVER DAM REPAIR		PERMITTING	4
APRIL 25/09	"	BH " " "	9:00 AM	2:30 PM	5
"	Jake Gotta	"	"	2:00 PM	4.5
"	Eric Schumann	"	"	2:00 PM	4.5
"	Mark Bartlett	"	"	11:30 AM	2.5
"	PHIL SHEEY	"	"	2:00 PM	4.5
"	Len Ayotte	"	"	10:30 AM	1.5
April 26	Guy Woods	"	10:30	11:30	1
"	M Bartlett	"	10:30	11:30	1
APRIL 29	G. Woods	"	10:00	11:00	1
May 10	G. WOODS	Willow weeding	10:00	11:30	1.5
"	Eric Schumann	"	11:00	11:30	.5
May 17	G. WOODS	WILLOW	1:00 PM	3:00 PM	2
"	Eric Schumann	"	"	"	2
"	Fannie Desrosiers	"	1:00	"	2
"	Dan Grombosi	"	1:00	"	2
"	TIM GIESSE	"	1:00	1:40	2.5
"	Anne Luceorsha	"	"	3:00 PM	2
"	Cam Baird	"	"	"	2
"	Clint Munkidun	"	"	"	2
"	Samus Munkidun	"	"	"	2
"	Carlson Munkidun	"	"	"	2
"	AND SPARROW	"	"	"	2
June 18	Peter HUGHES	Mill Crk. Cleanup	6:00	8:00 PM	2
"	Billy HUGHES	"	"	"	2
"	Cole HUGHES	"	"	"	2
"	Jason Grombosi	"	6:15	"	2
"	Kyle Edwards	"	6:30	"	1.5
"	Liam DEGINA	"	"	"	1.5
"	ALEX BILLOUT	"	"	"	1.5
"	Ryan	"	"	"	1.5
"	Zech	"	"	"	1.5
"	Russell	"	"	"	1.5
"	Julien C.	"	"	"	1.5
"	Thomas Bernier	"	"	"	1.5
"	ALAN EDGECOMBE	"	"	"	1.5
"	Noel Betts	"	"	"	1.5
"	William Betts	"	"	"	1.5
"	Guy WOODS	"	5:45	8:15	2.5
"	AND SPARROW	"	6:30	8:00	1.5

54

89.5

