Clayburn Creek Watercourse Assessment: Development and Stream Management in an Urban Residential Area.

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Abstract:
The Clayburn Creek watershed, Abbotsford, British Columbia has undergone numerous changes in the recent past. These changes have dramatically increased the number of high water flow events. High flow events on this fish bearing stream are causing increased erosion along the stream channel increasing the sediment load of the stream. These events can be correlated to increasing development and population growth upstream from Clayburn Village within the Clayburn Creek watershed. Mapping of the stream course with a Trimble GPS along with the plotting of numerous cross sections across the stream channel will allow the researchers to determine if any changes are occurring within the stream channel in the future. Measurement of precipitation and stream turbidity values will allow the monitoring of rainfall events and their impact on the watershed. With developments being expanded and new developments being planned for upstream locations it is necessary to document the present state of the watershed and to collect baseline data. This knowledge if used to assist in the implementation of effective mitigation practices may alleviate future flood events from impacting historic Clayburn Village.

Keywords: Stream mapping, Flood event, Turbidity, Development, Stream Management.

1.0 Introduction

Development surrounding the Clayburn Creek watershed has quickened the response rate of the creek from precipitation events, increased the sediment loading in the stream and increased the discharge rates within the watercourse. There is evidence of flooding, erosion and deposition within the channel likely related to increasing development pressures within the watershed. Residential, commercial and heritage properties within the village have been affected by these changes to the stream. The research that has been gathered at Clayburn Creek prior to six new development sites should influence the social policy relating to the human need of responsible development. Residential developments within a watershed need to be examined in the context of flood mitigation, this data will help influence the variance / set back distances required for future development within an urban setting adjacent to a watercourse. This will

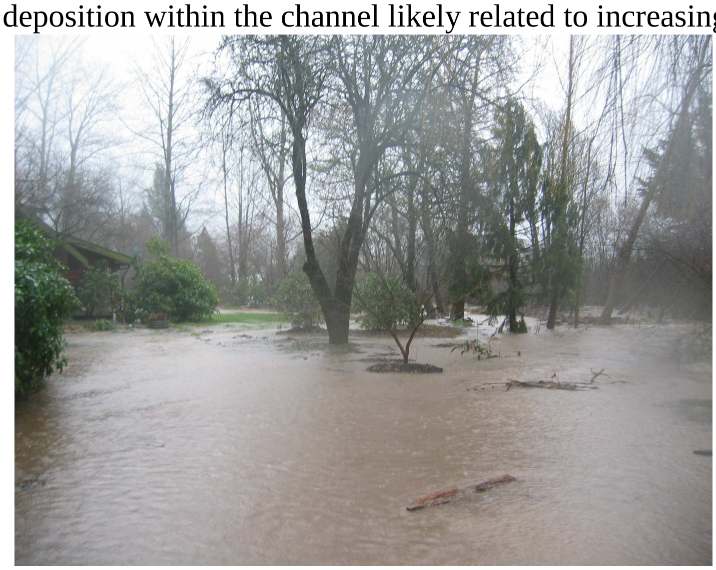


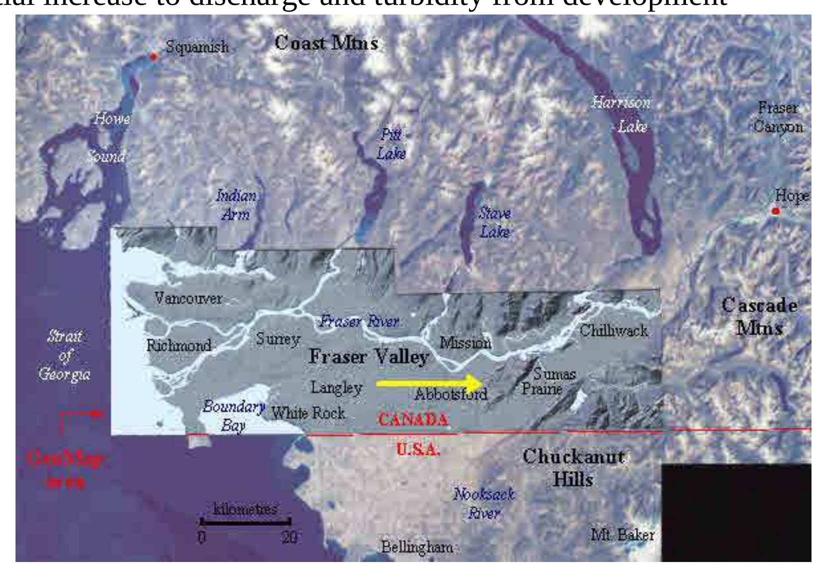
Figure 1. Clayburn Creek flooding residential area of Clayburn Village on January 10, 2007.

help to develop methods of residential development that are more sustainable to the ecosytem which in turn will help reduce the risk to human welfare by mitigating flood events within a residential area. This report has been prepared for the University College of the Fraser Valley, specifically with regard to social policy proposal for the Ministry of Environment - Intergrated Flood Hazard Management. This report discusses the reconnaissance of the surrounding riparian zone and watercourse of Clayburn Creek beginning in the summer of 2007. This fish bearing creek runs adjacent to agricultural lands, residential areas, institutional facilities and other common areas such as roads, bridges, and constructed roadside watercourses. The historic use in the surrounding lands is varied, however; notable is the significant past environmental damage done by the historic Clayburn Brick Company. Fenced off areas within the village are visible where the burners once were and presently contain contaminated soil. Fortunately, the area has also maintained some natural beauty in stretches upstream from Clayburn Village. Downstream there is evidence of urbanization and its associated negative effects. What happens within the section of Clayburn Creek surrounded by Clayburn Village will be better understood by mapping and analyzing field data. This will be accomplished from examining the creek from the schoolhouse location and upstream to the areas that are not yet as heavily impacted. Research is needed prior to more changes taking place. The developments that are taking place should utilize stream setbacks that are able to mitigate the flood events experienced by residential developments.

2.0 Background

Clayburn Creek located in southwest British Columbia flows through the village of Clayburn. The headwaters of Clayburn Creek are located above the village near the Auguston development which is currently undergoing phase 8. Clayburn village is in a low lying floodplain near the Fraser River. According to residents, during the great flood event in mid 1948, Clayburn Village, the first company town in British Columbia, was fortunate enough to be missed by the rising waters of the Fraser. The present has not seen high water levels from the Fraser River but has seen a substantial increase to discharge and turbidity from development upstream. Madeline Hardin, President of the Clayburn Village Society, in August of 2007 expressed her concerns to Steven Marsh of the University College of the Fraser Valley Geography Department of the increased flood events during the fall and winter of 2006/2007.

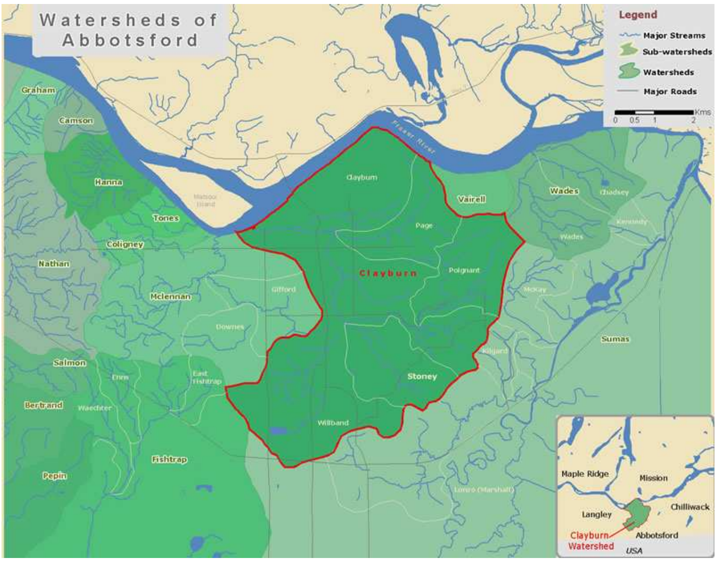
The City of Abbotsford surrounds Clayburn Creek which is nestled between the Cascade mountain range in the east, the Coast Mountains in the north and Mount Baker to the south. The Headwaters of the creek are located on the western slope of



Source: http://gsc.nrcan.gc.ca/urbgeo/geomapvan/images/space_600e.gif

Figure 2. Clayburn Creek is surrounded by mountains within the Fraser Valley

Sumas Mountain. Eventually draining into the Fraser River, Clayburn creek has many tributaries and flows through natural landscapes, urbanized areas and agricultural areas. The lower reaches are being altered by erosion and deposition in many areas due to increased flows. The response rate of rain events entering the creek is quickening and there is an increase to the sediment loading of the creek waters. This quicker response rate is likely due to development and also possibly climate change or variability of climate. Residential flooding has happened on 5 occasions in the previous 3 years within Clayburn Village.



Source: www.fraservalleyconservancy.ca/watershed.html

Figure 3. The Clayburn Watershed, part of the larger Georgia Basin, drains the western slope of Sumas Mountain.

Within the village is an assortment of small home based businesses and cottage industries. The heritage schoolhouse was flooded recently and experienced extensive damage. A loss of revenue from rentals of the schoolhouse and the basement suite in the building is one of the negative impacts that the increased flooding have caused. There have been two restoration projects of the schoolhouse partially funded by the provincial and municipal governments that have taken place in the last decade.

3.0 Methodology

A stream habitat walk is a simple and useful approach in observing, identifying and analyzing the surrounding areas of a stream's habitat; which allows for proper assessment of the environment and collection of associated data. This method, otherwise known as StreamWalk; is utilized within the EPA protocol as a screening tool to observe 'first hand' issues regarding the stream's health. This method is less costly than other procedures as it is routinely performed mainly through volunteer efforts and requires minimal training and basic equipment. While the Stream Habitat Walk is primarily used to promote public awareness and encourage local volunteers to get involved rather than for scientific importance; the method is valuable for programs and environmental stewardship groups interested not only in water quality, but also in stream habitat and surrounding eco-systems. Additionally, accessibility and low cost allows for continued monitoring and observation of changes in stream habitat and physical characteristics; therefore providing comparable data that could benefit various user groups; such as environmental, government officials, and developers.

Preparation was mainly completed within the classroom environment, over the previous four years, including lectures and notes on the basic instruments and procedures to follow while collecting field data. On site education was also a priority. The EPA website was referenced with regard to river and stream monitoring, bio-assessment protocols, habitat assessment and physical characteristics pertaining to water quality. Turbidity was discussed in previous education including previous field experience.

Site monitoring is important to any study of water quality to develop a baseline data schematic. A baseline is important to document changes that may be occurring over time that would not normally be discovered without formal data collection. Decisions concerning the watershed management should not be made without baseline data to provide evidence to support any decisions made. Evidence of impacts and changes documented within the studies allow for better judgment and evaluation by community officials to better manage the watershed. Many levels of government, fish, stream and park protection groups, stewardship groups and others with specific interest to the site use data from the monitoring of streams. Different requirements and interest groups require different fields of data with different levels of quality assurance to feasibly use the data collected. Users of the data collected can be for a number of potential purposes. These needs must be accessed prior to collection to ensure the validity of the data to the multi purpose groups. Various purposes of data collection include: stream protection, screening and zoning of the lands surrounding the watershed. Parameters, or objectives of the study must be properly determined prior to the start of the study to ensure quality and consistency problems will be alleviated. A specific goal based approach is necessary for the data to be valuable and useful. Data quality needs to be examined during the discussion of parameters to determine the level of quality needed. This is examined in five different ways including: accuracy, precision, completeness, representativeness and comparability (EPA, accessed Oct., 2007).

Sampling considerations involved methods that should include: how the samples are collected, which sampling equipment will be used, any preparation that would be needed, protocols to be followed and whether samples will be analyzed in the field or transported to a lab. Reasons for specific monitoring sites chosen must be included within the study parameters. Criteria for site assessment includes representativeness, ease of identification on a map, water flow conditions throughout the year, convenience and permission for access and inflows of tributaries and runoff from structures. A sampling program should be similar in time of day and season for best results. Coordination of the data management and presentation should be developed with a plan to interpret, adapt, store and manipulate within a data base. Quality assurance must be addressed to insure to credibility of the data collected. By adhering to the program and ensuring the training is consistent, credibility of the data collection is maintained. "Only if the same location is consistently sampled can temporal changes in the water quality be interpreted with confidence. Therefore, accurately written station location descriptions (that identify key landmarks and give the site a simple and unambiguous name) must be prepared on the first visit to every sampling site. All field measurements should be entered directly into the field logbook while in the field" (EPA website, Field Sampling Manual, pg. 4).

The study of Clayburn Creek began with concern of flood events within the historic village. The objective was to map the longitude of the stream and document the creek and surrounding riparian zone characteristics. Numerous cross sections were completed after the initial stream data. After hiking the creek a number of times taking pictures assessing the stream for signs of erosion and deposition and attending a training session on the Trimble GPS Unit, the collection of the data, water samples and other information on this partially developed area surrounding the creek was begun. Water sampling for Turbidity was done with a handheld LaMotte 2020 meter. Calibration of the unit was done prior to the start of each collection date with a 1.0 NTU standard. Recalibration in the field was done if necessary. Samples were taken in flowing water from the stream bank with the LaMotte supplied glass containers fully submerged and emptied prior to each sample. A stream bank sample was used as the most important issue regarding sampling is the samplers' safety (EPA website, Field Sampling Manual, pg. 19). The water samples were obtained by filling a container held just beneath the surface of the water, "commonly referred to as a dip or grab sample" (EPA website, Field Sampling Manual, pg. 12). Immediate analysis with the Lamotte avoided settlement concern. The majority of samples collected from streams and rivers in British Columbia are grab samples taken near the surface at one point in the cross section of the flow (EPA website, Field Sampling Manual, pg. 18). The researchers while taking samples and collecting data were given the opportunity to discuss stream issues with some residents of Clayburn Village. On many occasions first hand accounts from the residents that had been affected by, or had witnessed the changes in the creek flows in the recent past were noted.

. Throughout the fall 2007 and winter of 2008 measurements of the stream and weather data was collected. Detailed cross sections were compiled of the mapped area as were water samples for Turbidity at six sites. Sites were selected on the basis of being representative of the reach in question and for allowing ease of access. Below is a map indicating all sites sampled from Clayburn Creek.

Site one is behind the historic schoolhouse on Wright Street. The basement of the building has flooded on three occasions in the past year. Oral reports from numerous residents have indicated that this is a new event in the history of the schoolhouse. The basement was previously rented out to offset the maintenance and operation of the heritage site.

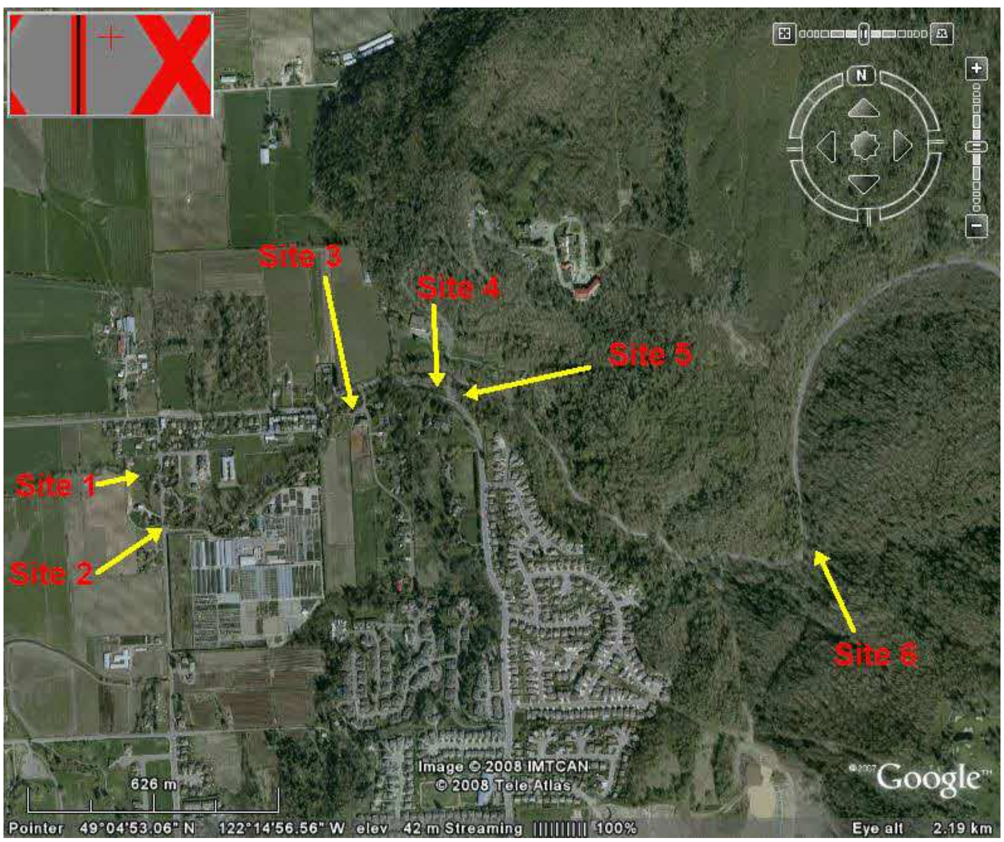


Figure 3. Sampling locations surrounding Clayburn Village.

Site two is upstream from the schoolhouse, still on Wright St., with easy access at a small bridge, with minimal trespassing on privately owned lands. The water samples were taken between the bridge and tree on the right bank of the creek Site three is further east on Clayburn Rd. where the creek crosses under and the road splits into an upper and lower direction. Near the downstream culvert opening where the City of Abbotsford has installed a water flow meter and depth measurement equipment samples were obtained.

Site four and five are further along on either side of the bridge crossing over the creek at the development site adjacent to Summit Bible College on the lower road. Site four is downstream of the bridge on the left bank between the bridge and the protective metal gas pipeline enclosure. Site five is upstream of the bridge on the left bank on the rocks near the sidewall of the culvert structure.

Site six is ~ 5 km further along the lower road increasing in elevation and decreasing population density. An information sign states Poignant Creek. At the foot of the pedestrian bridge, before it crosses over Poignant Creek, the sample was taken from the banks edge following the path on the downstream right bank straight to the waters edge.

Samples were taken from site one and two because of the dynamic changes happening in flood events within the village core. The flood events described by Madeline Hardin indicated that they had been localized to the schoolhouse, the church across from the schoolhouse and residential homes within the village core adjacent to the creek. Site three is outside the core village area and is occupied by various users, including commercial, low density residential, recreational and small home based businesses. This low density developed area is downstream from a parcel that has been rezoned and is currently slated for mid density strata development. Information before the development project starts is important to understand and document the changes that may come about because of the development.

Sites four and five are at the foothills of the proposed development therefore requiring documentation during the process to note any increases that may arise due to increased runoff and disturbed substrate materials from construction in the surrounding floodplain. Documented land instability of the slopes on the right bank was discussed prior to sampling site selection. Site six is a tributary of Clayburn Creek and flows higher in elevation and in more natural landscapes that are lightly tread upon but are currently used for recreational purposes. Users of the area are resident, visitor and animals pets such as canines. This area has been less affected by human activity than most inhabited areas within the Fraser Valley. A standard stadia rod was used to collect depth data within the creek itself. Measurements were taken to 2 significant figures in meters. A Clinometer was used to calculate the bank slope and the gradient of the creek. Temperature was taken in °Celsius of the water and air with a standard thermometer read at a minimum of 3 minutes. A standardized tape measure was read in meters to measure the width of the creek at various points, including wetted bank and bank full. Wetted bank is calculated at the extent the water flow reaches or laps the bank. Bank full measurements were taken where the water has reached and the vegetation is just beginning to take root.

A Hobo Weather Station was set up in a resident's backyard as it was an ideal location in the heart of Clayburn Village. Theft and vandalism were minimized by location but yet it was accessible and indicative of the microclimatic conditions found within the village. The main weather station is located at the Abbotsford Airport which may not be close enough to extrapolate for use within Clayburn Village with much accuracy. Sensors in the weather station measured: Relative Humidity (%), Temperature (°C), Precipitation (mm), Air Pressure (K Pascal's), and Dew Point (°C). These values were measured during October 2007 up to and including January 2008.

4.0 Data Presentation

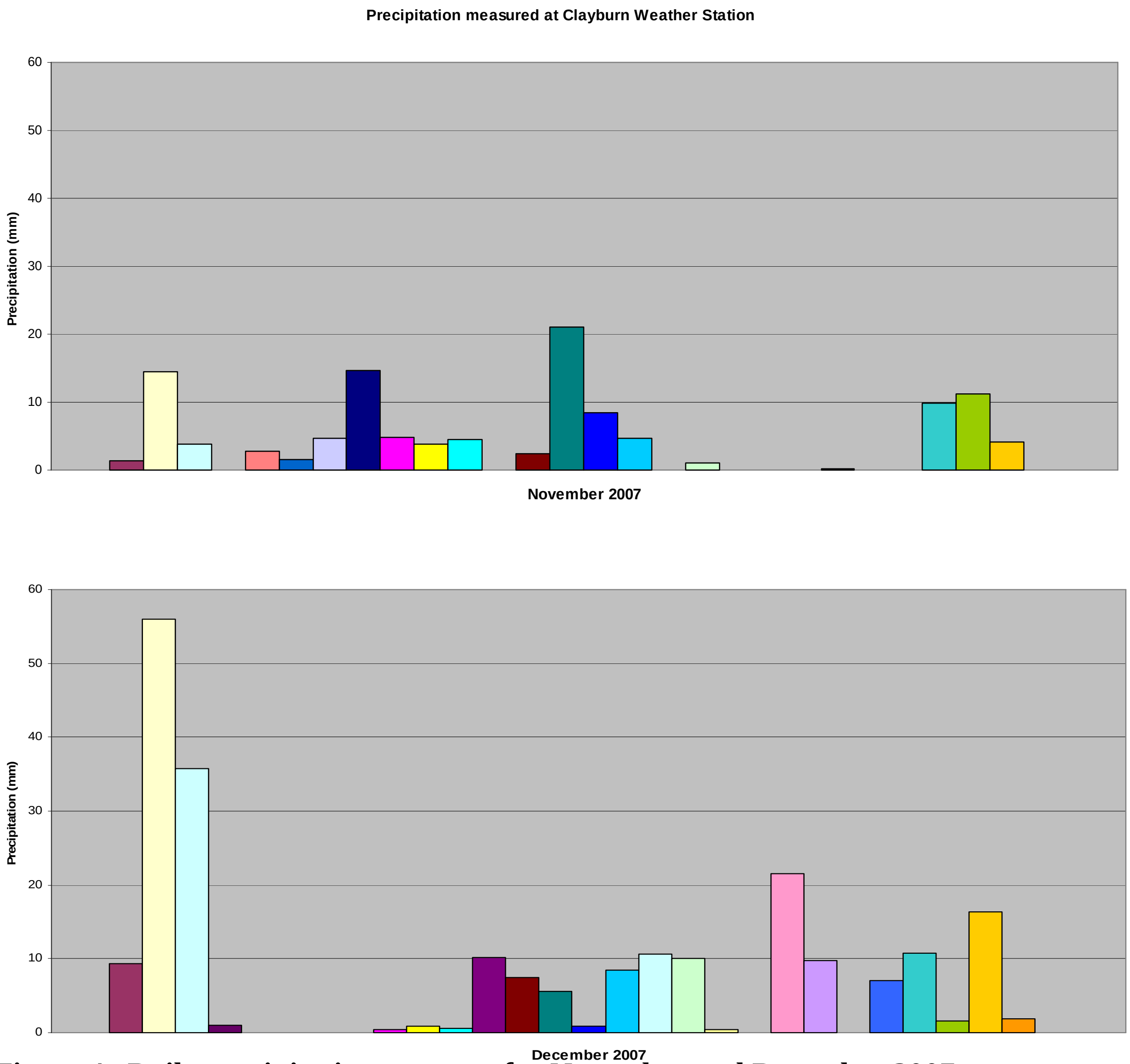


Figure 4. Daily precipitation amounts for November and December 2007.

Table 1. Turbidity (NTU's)

Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Oct.15, 2007	2.4	1.3	1.5	1.2	0.95	1
Oct.19, 2007	17	17	18	17	18	8.2
Oct.22, 2007	40	45	34	32	31	16
Nov.14, 2007	2	1.8	2.1	2.2	1.8	1.4
Nov.16, 2007	9.2	7.7	6.7	6.8	6.7	3.4
Nov.19, 2007	1.5	1.3	1.1	1	1.1	0.85
Dec.03, 2007	1000	190	150	-	-	-
Dec.04, 2007	22	21	21	21	21	13
Dec.05, 2007	-	30	21	-	-	-
Jan.11, 2008	27	26	22	23	22	19
Jan.14, 2008	55	60	65	60	60	39
Jan. 24, 2008	2.6	2.4	-	-	-	-

5.0 Discussion

The discussion that follows includes: physical characteristics of the stream and stream bank, biological properties and habitat assessments for both high and low gradient streams. Further to this are the examination of SHIM data collected of the watercourse and riparian zone.

The stream channel was found to have little substrate compaction and was comprised of sand and other fine sediment deposition. This was frequent in the village core. Fine sands and other particles made up a great percentage of the channel bed, decreasing the stability. Gravels and cobbles show evidence of being carried downstream and deposited. Rip Rap lined various points along the banks with a few boulders scattered within the stream. Obstructions have been documented and have also been documented to have been transferred downstream by high water flows. This area of the stream course is not in equilibrium as shown by the erosion and depositional changes that are occurring. Bank stability is a key issue due to increased erosion from increased runoff and intensity of water flows. Sloughing of bank materials is evident within much of the stream channel. The vegetation along the banks are not conducive to increased bank stability as they are predominantly shallow root systems including invasive plants such as blackberry, ivy and other non native plants. Slide scars are present in areas upstream from Clayburn Village. Numerous slides have allowed eroded materials to enter the stream including mature trees, boulders and fine grained material such as sand and clay.

Figure 5. Usual flow conditions illustrating erosion and mitigation along the channel.

Prior to the city dredging in September 2007 the channel had a substantial amount of cobble sized material that had been deposited from previous high flows. This material raised the channel bed by more than a meter in some areas. Coupled with an increase in water discharge this enabled the creek to flood its banks more frequently. After dredging was completed the channel is deeper and wider allowing for the increased flows to travel through the channel without spilling over its banks onto residential property. Although this is the hope it is still weather dependant as heavy rainfall increases the sediment deposition within the channel. Aiding in the efforts of restoration, the City of Abbotsford is protecting the banks of the creek with burlap, rip rap, sandbags and other modifications. Some areas have been dredged in an attempt to control the flooding experienced within the village core. Unfortunately much of the burlap is already being torn away from the banks by high flows. Turbidity is a key issue as

Figure 6. In channel deposition of cobble material within the Village reach of Clayburn

Clayburn Creek is a fish bearing stream. It is a spawning habitat for salmon and is inhabited by resident fish species such as trout. Many other aquatic animals require this habitat in equilibrium to flourish.

Increases in Turbidity will decrease dissolved oxygen, increase temperature and damage breeding grounds by depositing a layer of silt cutting off oxygen. After short intense rainfalls the water quickly turns brown and increases in depth. After repeated days of heavy precipitation the creek is over its wetted bank depth and has measured values of turbidity upwards of 200 NTU's. Normal turbidity values within Clayburn Creek have been measured to be in the range of 1 – 2 NTU's. After intense rainfall and flooding the creek leaves behind sediment on the flood plain in the residential areas as it retreats. Clean up of this is costly, and is the resident's responsibility. Clean up of the sediment can be a repeated occurrence during the wet season. Some home owners have spent a great deal of money trying to mitigate the flood events at their property using boulders, raising elevation levels of their property and increasing vegetation cover. During normal flow conditions it is evident how much erosion occurs within this creek. Attempts at restoration are clear with the modifications visible to the naked eye. Mitigation has been attempted in many areas of the channel. Some have remained helpful while others have been destroyed by high flows. Several areas of the creek are crossed by gas piping contained within protective metal casings. Many of the metal casings are dented and damaged from debris that is carried by high flows. Material such as mature trees are easily picked up and carried downstream damaging banks, the channel bed and gas lines adjacent to vehicle bridges crossing the creek. Some residents have water lines and personal bridges that cross the creek that may be in danger of damage from high water flows.

Figure 7. Same portion of channel as in Figure 6, illustrating the dredging done by the City of Abbotsford in fall 2007.

Figure 8. Debris damaged gas line that crosses the channel at the Wright Street bridge in Clayburn Village.

Rainfall was collected within the village commencing October 2007. In November Clayburn Village experienced 19 out of 30 days with precipitation. There were 3 days where values over 10mm per day were measured. During the month of December precipitation was measured on 22 days. Values over 10 mm were measured on 8 of the days with the 3rd measuring 56 mm and the 4th measuring almost 36 mm. Both months experienced many days of precipitation only exaggerating the effects of increased impervious surfaces and increased flows of Clayburn Creek. Concerns regarding future development and its impact on this heritage area and creek are numerous at present. Future development is being planned for the Auguston and the Sandyhill areas. Both of these are located within higher elevations of the tributaries to Clayburn Creek and will likely impact the area greatly by removing natural cover, and increasing the amount of impermeable surfaces in the watershed. This leads to higher floods and more frequent floods with a greater potential for higher turbidity in the stream, higher temperature of the water within the creek and greater concentration of other pollutants entering channel.

Flooding is becoming more frequent and has not been a common occurrence prior to the past few years. Flooding is also happening in locations that have not seen flooding previously. The response rate to precipitation events may be lessening. Within an hour of a short intense rainfall event the creek is rising and turbidity is increasing dramatically. Damage has been noted on several occasions in residential and heritage sites that have not fallen victim to floods in the past. Obstructions have been found to be frequent within the channel as the high flows carry debris downstream and lodge it into other riparian vegetation or man made obstructions such as a collapsed bridge located upstream from the Village. This is a potential concern for the residents downstream. There is a possibility that the obstruction will dislodge and cause a large debris flow. This particular footbridge fell due to erosion and undercutting of its' left bank. If this stream was in equilibrium a collapse of the bank and bridge would not have happened by these forces. Future development is extensive and widespread throughout the higher elevations of Clayburn Creek watershed. There are 6 areas of mid to high density residential areas that will directly impact the lower reaches. Increased runoff, pollution and erosion from construction are imminent. Mitigation attempts include detention ponds and sediment berms to decrease response rate and sediment entering the creek. Currently, the City is in negotiations with developers with regard to further protection from increased runoff from impervious surfaces, construction and removal of vegetative cover.

Clayburn Creek contributes significantly to the discharge of Willband Creek downstream from Clayburn Village (Dayton & Knight Ltd., Clayburn Creek Drainage Study (July 1991) pg. 1-1). These low lying agricultural lands have a regular occurrence of flood events that overflow Clayburn Road. Prior to increased development Dayton & Knight state that "in a 100 year flood event a very significant portion of Matsqui Prairie will face flooding and will stay flooded for a long time under current (1991) upland drainage policies" (Dayton & Knight, Clayburn Creek Drainage Study (July 1991) pg. 1-1). Development has increased significantly since this report was written with two major residential areas, Auguston and Sandyhill, having been created or expanded. Some of Clayburn Village is also seeing new development spring up. Unfortunately, developers were, as of 1991, only required to provide stormwater detention to a 10 year frequency. The Clayburn Creek Watershed drains ~ 5680 acres of land on Sumas Mountain western slope. It then continues to drain to the Matsqui Slough and eventually into the Fraser River (Dayton & Knight, Clayburn Creek Drainage Study (July 1991) pg. 2-1). Increased runoff from higher ground development projects must be managed for the village and other low lying areas to avoid flooding.

Clayburn Creek contains both riffle areas and pools. It is not channelized to any degree and is natural in appearance but remains in close contact to urbanization and future development. Pool depth varied, particularly after dredging was completed. The depth of most pools varied from .5 m to 1.5 m. Materials deposited in the stream bed include silts, muds and an abundance of sands. Various locations have major deposits of sand within the stream course. A mix of sands and gravels were present at a majority of the stream bed examined. Cobbles varying in diameter from 2 – 10 inches were found sporadically after dredging had been completed. Upon collecting data at the lower reaches of the study parameters, the stream bed consisted of higher values of sands, silts, mud and gravels with a small percentage of cobbles being found in this region. Further upstream the stream bed included much more cobbles and gravels with a lower percentage being made up of sands, silts and mud. Included in this segment are boulders, rip rap, bank stabilization and armouring. Within the village core area there were boulders over 10 inches in diameter, but this was limited with relatively few areas and concentrated in areas that have had previous stabilization procedures. Further upstream just before site 3 larger particles were found in much higher percentages. Boulders and large cobbles are the abundant stream bed composition with fines, gravel and sands still evident but to a much less degree. The stream bed itself was not stable and was not embedded in a majority of the stretches traversed. In places the abundance of sand made the trek much more difficult while safety was jeopardized by the collapsing or shifting stream bed under minimal weight bearing. Compaction of the stream bed is quite low in a majority of places within the village core area, while there are a few locations that medium compaction is apparent.

Within the stream naturally occurring debris was found to be plentiful with twigs, leaves and small branch limbs floating in the stream course and deposited on the waters edges. Crown closure of the area is between 41 – 70 %, with mixed forest cover. The banks of the creek also contained shrubs at around 34 – 66 % with both low and high being documented with the average height less than 3 meters. Few obstructions were noted and will be discussed further into the investigation. Vegetation within the stream was minimal with episodes of iron coloured algae growth found in the initial hike up the creek in August, 2007. The stream bank was covered in many spots with invasive blackberry bushes, non native grasses, ferns and ivy's. Stream banks were being degraded in many places, with evidence of erosion and bank collapse. Many stream banks were actively adding eroded material to the stream. Garbage and other waste such as leaves, clippings, discarded bricks and many other items were noted in the channel. Large items such as part of a concrete foundation slab were occasionally noted. Some active uptake of the stream water was present as were direct flow discharge pipes from the adjacent private properties. Water sampling site three downstream from the bridge has an inflow from a culvert that is grated to stop debris from entering.

Generally the water appeared near to clear. Exceptions to this were post rainfall events. The creek measured between ~ 5 meters and ~ 6 meters wide with a meandering planform. The stream banks consisted of a majority of fine material, armoured in places with rip rap and burlap. Undercutting was evident at a majority of outer bends and in straight sections as well. Bank slopes alternated from having a slight slope of ~ 10° to a steeper bank of 40°. Artificial bank modifications were evident as discussed within the report. The channel shape was found to be shallow narrow in moderate flows and deep and wide through after rain events.

The local watershed can potentially be affected by surrounding and upstream land use. Residential single family dwellings are becoming denser and expanding within the watershed area. More roads are being built reducing the pervious ground space available to reduce infiltration of precipitation. New developments within the watershed are expanding while there remains a large amount of agricultural land use in downstream areas. Most of the adjacent farms are growing crops such as blueberries. Upstream there are hiking paths and recreational activities that are becoming more utilized with the increase in population in the area. Previous land use in Clayburn Village included a brick plant in the early 20th Century. Against many odds this creek is still home to much wildlife and fish. Ducks, raccoons, rats, birds and fish, including salmon, have been documented throughout this study. Unfortunately there are some fish barriers that do impact the spawning rates.

All four velocity – depth regimes are apparent within the watercourse including, slow – deep, slow – shallow, fast – deep and fast – shallow. Generally the water reaches both banks and little exposed substrate is exposed but there are some areas that water does not reach both banks. Channel alteration is present with dredging, bank armouring and shoring structures present in at ~ 30% of the stream. Burlap, riprap, tires and sandbags have been used to reinforce stream banks. Only one weir was documented and it was relatively low. Riffles and bends are relatively frequent thus enhancing the stream habitat. Both banks of the stream bear the scars of erosion with sloughing obvious, undercutting extensive and are moderately unstable. The potential increases during high flow events. Protection from native plants is lacking while invasive plants are taking over. Invasive blackberries often line both banks. Human activities have had significant impact on this stream. The stream habitat is well suited in its natural form to be colonized and sustain an adequate habitat for many creatures and fish. Mixtures of substrate materials are present and there are pool areas available for fish resting during migration.

During the initial evaluation of August 16, 2007 the water flows were moderate and fairly clear. A build up of slime on the bed with an iron colored algae was noted in places. Accumulations of cobbles were noted in various locations spanning up to ~ 2 meters wide and many more long. Undercutting was present with a majority of tree roots exposed along the stream banks within the village reach. Evidence of high flow damage were apparent on pipes that crossed the stream just below bridges. Creosote soaked wood structures were immersed in water and garbage was present. Major obstructions within the stream were few apart from the deposits of cobble. Water extraction and human alteration of some banks and surrounding zones were noted. Dredging of the stream bed was almost completed by September 24, 2007 leading to an increased ability of the creek to flow in some critical areas. These critical areas of the reach have overflowed its banks previously on numerous occasions hence mitigation of the deposition of cobbles was necessary. Prevention of flooding in residential areas is of importance.

The unfortunate drawback of dredging was apparent as more fine particles were exposed to erosional processes by the flowing water. Some areas were also artificially enhanced to protect from fast rising water. Burlap was spiked into many banks that were previously showing signs of erosion and others that had been torn apart during the dredging procedure from heavy machinery. Track marks were still visible in many of the top of bank areas along the creek Vegetation was destroyed along both banks where the gravel, cobble and boulders were removed from. The soft and fine bank material was readily being wash away by the higher flows that run through the creek after precipitation events. Increased runoff adds to the extent of erosion and sloughing present. In addition to burlap that was placed after this date, black plastic sediment fences were placed on the left bank, just prior to site 3, adjacent to blueberry fields. This armour helps with erosion of the bank but does not hinder the invasive blackberries that have overtaken the banks in many areas of the stream.

September 30th, 2007 the creek was experiencing high flows as the previous day included over 20 hours of rain. The rains had begun on September 29th at ~ 4:00 pm and lasted near to noon the next day. The typical water flow through the creek is shown below (Figure 9), in stark contrast, under the same bridge, to the high flows seen in the previously in Figure 8. The water is clearly brown from suspended sediments. This increased turbidity of Clayburn Creek is due to a combination of erosion of the upstream banks and from runoff. October 1st, 2007 a small overcast break in conditions that had allowed the stream to narrow back to its typical flow volume. Sand deposition was documented within the channel. The water was nearly clear except for near large amounts of fine sand deposition. The stream bed is visible with substrate recognizable to the discerning eye.


Figure 9. Site 1 evaluation and mapping.

October 15th, 2007 mapping of the longitude of the creek was initiated. It was overcast with an air temperature of 10.8° C and with the water temperature slightly lower at 10.2° C. It was a moderate flow near the schoolhouse just below site one. The channel was near to natural with an open park area adjacent to the right bank and agricultural lands on the left. The channel was a riffle pool over a 1° gradient. Crown closure was 41 – 70 % in the resident spawning habitat. No bars were present. The substrate consisted of 50 % fines, 45 % gravels and 5 % cobble. The substrate was compacted very low and moved easily under every step. Rip rap was present and being used to protect personal property. The wetted width was 4.95 meters wide. Bank full was measured at 5.68 meters. Wetted depth was 0.1 meter and bank full depth was 0.2 meters. In stream cover was ~ 40 %, consisting of mixed forest in a primarily urban residential area. The left bank was between 34 and 66 % shrubs between 2 – 10 meters tall on a 20° slope. The bank was fine materials that were not stable and will be cut away from higher than normal velocity flows. The right bank was mainly grasses. Low shrubs covering ~ 5 – 33 % were noted on a sloped bank of 14°. Again low stability of the bank consisting of a majority of fines was documented. Invasive blackberries do not help the bank stability of the area as the shallow root system of the bush does nothing to stabilize the bank.

Further excursions at Clayburn Creek show consistency of weather and stream conditions including bank instability with a majority of fine materials visible. Low compaction of the stream bed was noted and a vast area of undercutting present in a majority of areas along the channel. Increases in rainfall show increases to Turbidity readings throughout the study. Normal ranges of Turbidity reading were ~1.0 NTU's while the maximum reading was ~200 NTU's. After a substantial rainfall a reading of 1000 NTU's was documented after an error code. The equipment was recalibrated prior to the second value recorded. Elevated readings were found to be normal after precipitation events. Increased water flows from precipitation were documented in addition to elevated Turbidity readings. Evidence of higher flows such as debris dropped at the edge of the bank, bark mulch and leaf removal as well as burlap covered with sediment deposits. Much organic debris littered the edge of the water and more was jammed in amongst tree trunks in and near the water. Vegetation such as rushes was broken off from the high velocity flows. Old sand bags littered both banks and upstream branches were trapped partway under burlap covered repair sites. Approximately halfway between site one and three, water was lapping at a private deck that is normally dry. Other residential areas also had evidence of flooding. Scouring and log jams are present along the reach studied. On occasion the City of Abbotsford flow meter had debris on it, possibly obscuring readings. The banks of this creek are being eroded by the high, fast flowing water events. Further to this study cross-section data was collected in various locations along the segment longitude that had been previously mapped. This information will be accessible within a map that is currently under construction and will include obstructions, overhead structures such as private property bridges, modifications, documentation of fish; sand bagging and deposition attributes will be accessible

6.0 Conclusions

Clayburn Creek has experienced a number of bank full events as well as over the bank events onto surrounding floodplain. Evidence of these high water flows include debris, erosion and deposition within the channel, obstructions carried by the flow and severe damage to pipelines crossing the creek. Undercutting of the banks is present along much of the segment mapped in the village core area. Sites of deposition of large cobbles, boulders, fine sediments, and an increase in turbidity of the creek's flow were found. Land use surrounding this area is varied but pollution from agriculture, animal feces (possibly from both a kennel and a veterinary office), and increased dumping in urbanized areas contributes to the degradation of the stream. It is unfortunate that with development come so many challenges to attempt to maintain a balance between artificial and natural landscapes. Increasing development always corresponds with decreased permeable surfaces to filter and trickle the water before being released into the creek and water courses draining the land the development sits upon. It is imperative to slow the peak flows as they only gain speed with more impervious land in the basin. It is already known from previous reports that the 11 – 100 year range storm is similar to the increased peak flow from urbanized areas (Dayton & Knight, Clayburn Creek Drainage Study (July 1991)). Associating this with the increased land development in the area additional armouring and structural stabilization of the creek are necessary to mitigate the increased frequency of flood events. This is also necessary to provide a means to diminish erosion and its related negative effects.

Responsible development is an approach to helping mitigate some of the negative effects of urbanization. Reduction of the development is not realistic at this point in time. Increasing the detention pond size and creating a slow release rate of captured waters would reduce the high flow events found in Clayburn Creek. Prior to the increased water reaching the creek a diversion could remove some of the storm waters and increased runoff from developed impervious areas away from the city storm system into areas that would absorb and release at a slower rate. This would help to reduce the velocity and quantity of water eroding at the banks of the channel. The channel can also be armoured and stabilized by native plantings with good root structures alongside the removal of invasive species from the immediate stream side. This could strengthen the slope stability and decrease erosion without harming the rich habitat it supports. Important to new development are the needs to assess the variance set back that are currently in use. A wider set back would enable the riparian zone to withstand some issues facing the stream. A healthy riparian zone with plantings of deep rooted vegetation reduces the sediment loading and erosion found on watercourses. If a wider setback is mandated it is possible it will help to create a better balance between development and watercourse health. A wider set back could also be beneficial to new development structures, such as residential homes, with a decreased risk to flood events.

A healthy stream in balance does not flood its banks as often as one that is not in equilibrium. It is imperative to continue to study this creek and future research could be gathered by means of the Stream Habitat Walk method with village, student and other volunteers. Changes are happening fast and the more data compiled with help strengthen the solutions found. Mitigation of the urban development surrounding watercourses and its associated effects are in need of implementation.

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File name for paper: Erickson-Shawna-wdcag2008paper.doc