# HENRETTA CREEK RECLAMATION PROJECT

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## ABSTRACT

In December 1990, Fording River Operations completed a detailed Environmental Impact Assessment and Stage I Mining Report for the Henretta Valley area. In December 1991, Fording River Operations was granted its mining and reclamation permit from the Ministry of Energy, Mines and Petroleum Resources. April 1997 marked the completion of mining activities in Henretta Valley. Mining activities required temporary relocation of 1,270 meters of Henretta Creek to enable mining of both sides and below the creek bed. Once mining of Henretta Valley bottom was complete, reclamation of Henretta was completed, the creek was reintroduced into the newly developed Henretta system. The first water flowed through the reclaimed Henretta Creek channel in late 1998 and the first high flow went through in the spring of 2000. Seven years of aquatic studies followed the completion of the project. Conclusions made in 2007 confirmed that the Henretta reclaim channel and Henretta Lake reclaimed systems have improved annually since its creation and in particular, Henretta Lake now supports a larger more productive population of fish than existed prior to mining.

**Keywords**  Spawning, benthic, westslope, density, mining, riparian

## BACKGROUND AND HISTORY

Brief History

Teck Coal Limited is a Canadian diversified resource company committed to responsible mining and mineral development. Through our interests in mining and processing operations in Canada, the United States and South America, our expertise expands the full range of mining activities. These include: exploration, development, smelting, refining, safety, environmental protection, product stewardship, recycling and research.

Our coal business includes six open-pit mines, five of which are located in the Elk Valley of southeastern BC. As the second largest supplier of steelmaking coal to the global steel industry and largest supplier in North America we sustain regions, communities and hundreds of suppliers through direct and indirect employment and community investment initiatives.

Mining operations at Fording River began in 1971, and the first coal shipment left the minesite in early 1972. The Fording River mine is the Company's largest operating metallurgical mine of the six encompassing approximately 4478 hectares, of which 800 hectares have been reclaimed. It is located within the Continental Temperature Climatic Zone and ranges in elevation from 1,650 metres to 2,285 metres above sea level. The main mining areas are Eagle Mountain to the east of the Fording River, Turnbull Mountain and Henretta Valley to the north of Eagle Mountain.

Metallurgical and thermal coal seams occur in the 500-metre thick Mist Mountain Formation on both sides of the Fording River Valley. The Mist Mountain Formation contains all the economic coal seams, and is the most widely occurring formation on Fording River's property. This economically important formation is an interbedded sequence of sandstones, siltstones, silty shales, mudstones, and low to high volatile bituminous coal seams.

<u>Henretta Creek Dragline Project – Valley Mining</u>

April 1997 marked the completion of mining activities in the Henretta Valley. Between 1991 and 1997, Fording River Operations used a Marion 8400 dragline with a bucket capacity of 46 cubic metres to mine approximately five million tonnes of clean coal from around and under Henretta Creek, in an area that was known as the Henretta Dragline Pit.

Mining of the Henretta Dragline Pit required moving a portion of Henretta Creek to enable mining of both sides and beneath the creek. Henretta Creek is a small stream with a mean annual flow of 8.3 cubic meters per second, and it contains a population of resident cutthroat trout (*Oncorhynchus clarki lewisi*). Gradient in the pre-mining stream averaged 1.67 percent with an average width of six to eight metres.

To get a sense of the magnitude of the work that was undertaken, one needs to look back over the history of the planning that went into mining the Henretta Valley area. Exploration activities began in the area in the early 1960s, but it wasn't until the 1990s that any mining occurred. A major element in the Henretta Creek reclamation involved the construction of a new channel with similar length and gradient to the original stream, in a location parallel to the installed diversion culverts. Aware of the need to minimize risk to both the environment and the mining sequence, a temporary diversion of Henretta Creek using two large corrugated steel pipe culverts measuring 1,800 millimetres and 2,200 millimetres in diameter was utilized. Fording River also installed an upstream cut-off dam to prevent water flow into the mining area. Over the course of the mining activities, the diversion culverts were realigned twice in order to accommodate the removal of all the valley bottom coal reserves.

In December 1990, Fording River Operations completed a detailed Environmental Impact Assessment and Stage I Mining Report for the Henretta Valley area. As a result of this work, the Company received an Approval-in-Principal, which allowed it to proceed with the pre-development work necessary for the proposed mining project. In December 1991, Fording River Operations was granted its *Mines Act* Permit from the then Ministry of Energy and Mines Minerals Division to begin the mining project in the lower segment of the Henretta Valley.

<u>Henretta Reclaim Channel Design and Development</u>

Over the past 40 years, Fording River Operations, through extensive research, have developed innovative reclamation techniques to address a variety of challenges they face such as high elevation, exposure to climatic conditions, and reclamation species selection. Fording River Operations put these techniques to work through successful rehabilitation of the mined portion of Henretta Creek. Riparian habitat research was added to the research efforts and program at Fording River from that time forward.

The reclamation of the lower Henretta Valley watershed was undertaken with the objective of returning the mined land to productive use, as prescribed in Fording River's environmental management program. The restoration began with the handling and rehandling of a total of 2.2 million bank cubic metres of material to rough in the new channel. Caterpillar D8, D10, and D11 crawler dozers and Caterpillar 375 and 330 hydraulic excavators were used to complete the detailed work within the channel and to reslope the surrounding area. The new channel was constructed with an average gradient of 1.65 percent, almost identical to that of the original channel. Since water was reintroduced flows through the channel have formed natural thalwegs and gravel bars.

The reclaimed channel was designed and constructed with stream features that are necessary to fish and aquatic species in the natural environment. These design features included sinuosity of the stream, drop structures, variable gradients, spawning gravels and sizes, large rock and log structures, deep pool winter habitat, and various types of lake side habitat. The restoration design also included a 3.5-hectare lake and a 0.5-hectare wetland area, which make up part of the project's 18-hectare riparian zone. Each design feature provides the range of requirements for those species which depend upon aquatic habitat. These include both aquatic species and terrestrial species.

Revegetation of the streamside area included the use of native species such as *carex spp*., bogbirch (*Betula pumlia*), willow (*Salix spp*.), black cottonwood (*Populus balsamifera ssp. Trichocarpa)*, and a variety of indigenous coniferous trees, including lodgepole pine (*Pinus contorta latifolia*) and Engelmann spruce (*Picea glauca ssp. engelmannii*) being the two dominant species.

Once the channel construction was completed, water was introduced through the reclaimed Henretta Creek channel in late 1998 and into 1999 with the first high flow through in the spring of 2000. As the water entered the newly created stream and lake, so did the resident cutthroat trout. Since 1998, monitoring of the reclaimed channel has been conducted by Interior Reforestation Co. Ltd. This monitoring has focused on successful establishment of riparian zone vegetation, fish species presence and channel utilization, benthic and invertebrate communities, and terrestrial species usage. A condition of the then Ministry of Energy and Mines Minerals Division *Mines Act* Permit was to complete this monitoring over a period of 7 years and report results annually with a final report issued. Fording River completed this successfully in 2006.

## HENRETTA RECLAIM CHANNEL MONITORING PROGRAM

### Goals and Objectives

Since 2000 Teck Coal, Fording River Operations (FRO) has completed an annual fish and fish habitat monitoring program within the Henretta Creek Valley, with studies focusing on the Henretta Creek Reclaimed Channel and Henretta Lake. The 7-year aquatic monitoring program began in 2000 and was completed during the 2006 survey. This document presents results from the final year, 2006, and a summary of the overall 7 years of monitoring of the aquatic monitoring program in Lower Henretta Creek.

The specific objectives for the monitoring program of Henretta Lake and the Henretta Creek Reclaimed Channel, as described in the terms of reference (Interior Reforestation, 2006), were to:

- ensure the Upper and Lower Reclaimed Channels are meeting stability objectives and are providing beneficial and improved use to fisheries and aquatic resources;

- add to the long-term water quality and temperature data sets at water monitoring sites;

- complete fish sampling efforts using the mark-recapture method and the closed, three-pass removal method and compare results between the two sampling methods;

- determine the status of benthic invertebrate colonization of the reclaimed channel and establish trends in population densities and biometrics at the control, upstream and downstream sites;

- determine Westslope cutthroat trout (WCT, *Oncorhynchus clarki lewisi*) use in Henretta Lake through angling and snorkelling data; and

- complete a photo point comparison of the Lower Henretta Creek reclamation improvements over the 7-year monitoring period to illustrate the progression of the reclaimed channel.

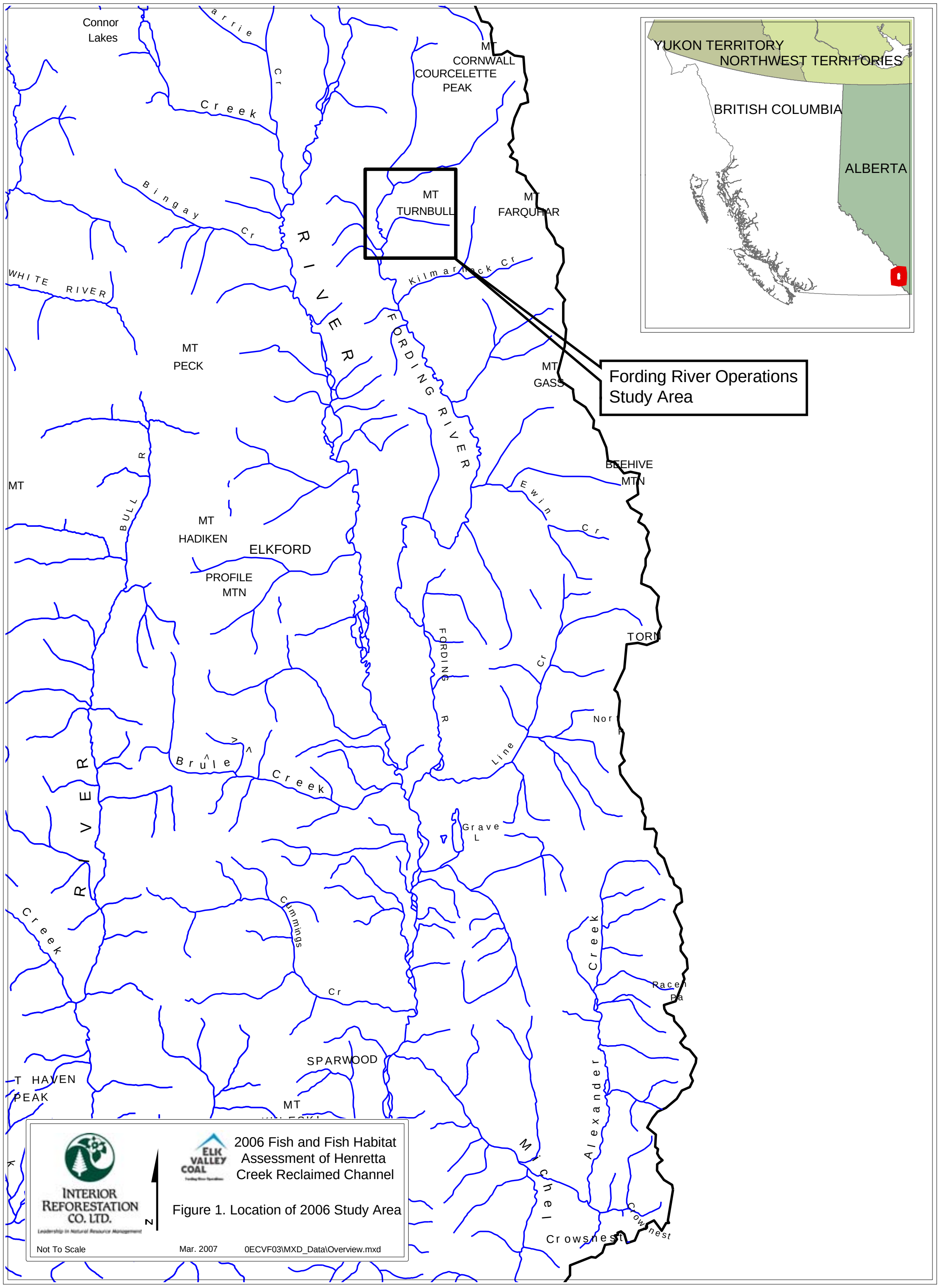


Figure 1. Overview map of Henretta Creek Reclaimed Channel study area (not to scale).

## STREAM WATER QUALITY MONITORING

### Stream Temperature Monitoring

Recorded stream water temperatures over the 7-year monitoring program for the Henretta Creek Reclaimed Channel has provided a simple and cost-effective means for conducting general comparisons of temporal and spatial data collected from this reclaimed channel and surrounding mines. Water temperature data provides a measure of long-term averages, seasonal trends and possible statistical deviations from calculated means. Future analyses of stream water temperature data should consider climatic variables such as air temperature and precipitation. Stream temperatures vary in relation to air temperatures, and most often a strong linear relationship exists. Departures from this linear relationship are common as melting snow in the spring can keep temperatures well below air temperatures for weeks or longer, and precipitation can result in inflows of surface or ground waters which can be quite different from air temperatures. The overall hydrology of any stream system is important, as it modifies the interacting factors of climate and insolation that determine the thermal regimes of running waters (Wetzel, 2001).

The same water temperature trends that were found previously in all other years' data from water monitoring stations were also observed in 2006. The downstream station's temperature regime was again found to be moderated by Henretta Lake. The temperature profiles for the upstream and downstream stations were quite different for 2006, as well as for the plotted 8-year mean. Therefore, the moderating affect of Henretta Lake on downstream reaches should be expected to continue in the future. Owing to the altered temperature regime, the water quality station downstream should be used to represent actual stream temperatures in Henretta Creek. Regardless, it should be noted that all temperatures recorded from the Henretta reclaim channel were below the ultimate upper incipient lethal temperature (19.7˚C; 95% CI 19.1 - 20.3) for Westslope cutthroat trout (Bear et al., 2005). Furthermore, Henretta Lake is continuing to provide suitable over-wintering habitat for WCT when stream water temperatures begin to rapidly drop, historically, sometime in November (O'Brien pers comm., 2007).

A study conducted by Bear et al. (2005) proved that the optimum growth temperature for Westslope cutthroat trout was 13.6˚C (95% CI 10.3-17.0). Historically, neither the upstream or downstream stations in the reclaimed channel reach mean daily maximum temperatures of 11˚C (Amos and Wright, 2000; Wright et al., 2001; Amos et al., 2002; Amos et al., 2003; Wright et al., 2004; Wright et al., 2005; Berdusco and Wright, 2006). The reclaimed channel only reaches high temperature values for approximately two and a half months out of an entire year and these values range from approximately 8˚ - 10˚C. The 2006 summer was warm and mild with very little precipitation; this was represented well in the 2006 temperature profiles, yet the maximum mean daily water temperatures were still below 11˚C. The lower temperature regimes found within the Henretta Reclaimed Channel may limit fish utilization and overall productivity, although it should be noted that these are most likely natural temperature variations which should not be attributed to mining activities. Despite these re-occurring observations, the reclaimed channel's temperature regimes are within WCT thermal tolerance levels.

General Water Quality Parameters

The 2006 analysis of monthly water quality data for stations in the Henretta Creek Reclaimed Channel and stations upstream and downstream in the Fording River revealed some minor exceedances for total suspended solids (TSS) and turbidity outside of the expected annual freshet (which occurred later in 2006, during June). For the remaining samples, results were within provincial water quality criteria for aquatic life. This information provides a defensible record of events and resulting effects; when used in conjunction with other environmental and biological data (e.g. Water Survey of Canada flows, Environment Canada precipitation records, and fish sampling results) it assists in identifying the biological significance of mine activities and natural events.

**BIOLOGICAL SAMPLING**

Spawning Asessment

The lack of spawning in 2006, and throughout the monitoring program coincides with the previous spawning assessment completed in the reclaimed channel prior to mining (Norecol, 1990) and the 7 spawning assessments completed post-reclamation (Oliver, 1999, 2000; Wright et. al., 2001, 2002, 2004, 2005; Amos et. al., 2003) despite naturally available and placed spawning substrate. Density of young WCT is positively correlated with the abundance of spawning gravel (Bozek and Rahel, 1991) and therefore with very little young age class representation during fish sampling, we can infer there is very low to no spawning occurring in the Henretta Creek Reclaimed Channel.

Fish Density Estimates

The densities of fish calculated from 2006 data for the three-pass removal method were comparable to historical results, with the exception of one sample location. The lack of WCT captured from this location was assumed to be partially in response to a relatively low flow year and at the time of sampling, fish were spread-out, holding in other areas of the reclaimed channel. Historically, fish have been captured in this location and the assumptions of the three-pass removal method were met, therefore the site is still considered to have potential for representing WCT populations. It is important to note that all WCT fish densities obtained by the three-pass removal method from the 7-year monitoring program have been consistently higher than or within the range of those observed during pre-mining studies completed by Norecol (1990) in Henretta Creek within the proposed mine area.

The mark-recapture population estimate method produced higher estimates of fish density for the Henretta Creek Reclaimed Channel than those calculated from the three-pass removal method in both 2006 and all previous years data. This is in agreement with results found during other studies which indicate that removal estimates – in this study, three-pass – are negatively biased, that is, they underestimate population size (Peterson et al., 2004; Rosenberger and Dunham, 2005).

The results from the mark-recapture survey reinforced the opinion that fish are continually using the reclaimed channel as rearing habitat. During recapture sampling in upstream reclaimed sections, the field crew captured a fish which had its right pelvic fin clipped, indicating it had been marked five days prior in downstream sampling areas. Furthermore, while angling Henretta Lake on August 15, 2006, field crews hooked, but did not capture a previously tagged fish with a yellow Floy® tag presumed to be from the marking procedure August 9-11, 2006. This observation suggested that within a 72-hour period a tagged fish had moved from upstream sections, as this was the only reach where fish were tagged, into Henretta Lake. The combined result of these two observations indicated that WCT were actively moving throughout, and utilizing the entire reclaimed channel.

Measured cross-sections within the reclaimed channel for 2006 represent the lowest water depth levels observed since the beginning of the 7-year monitoring program. We believe this had an impact on the observed 2006 population as other studies have shown that flow fluctuations directly affect the distribution and occurrence of fish within available habitat (Pert and Erman, 1994; Bain et al., 1988). Bain et al. (1988) state that lotic community structure is highly dependent on habitat stability and availability, and changes in these factors can affect an individual organism's ability to find and use its optimal habitat (Pert and Erman, 1994). Pert and Erman (1994) also concluded that overall, fish preferred the deepest water under both low and high flow conditions. Therefore, the missing length classes attributed to the 2006 results may be influenced by the low flows observed, and these fish were most likely holding in other habitats with deeper water which were limited in 2006 within the reclaimed channel.

It should also be noted that fish data from most years indicated that young-of-the-year cohorts (YOY) were not represented well within the Henretta Creek Reclaimed Channel. Since fry were represented in only two years of data and consisted of very low numbers, it was interpreted that YOY do not rear within the reclaimed channel. This was concluded from the seven years of observations which indicated that no active spawning occurs within the reclaimed channel. Therefore, fry would most likely be found up or downstream of the reclaimed channel where they emerged as fry. The uncharacteristic years when fry were captured probably occurred as a result of them being displaced downstream from their original rearing area. The lack of YOY was attributed to the absence of spawning, not to an absence of available habitat, as adequate rearing habitat for fry was noted throughout the entire reclaimed channel within the shallow shoreline zones amongst the rip-rap and boulders.

Discernable differences were noticed in WCT densities between stream sections sampled, which suggest that WCT were congregated within specific habitat unit types. Fish were frequently associated with deeper, more complex pool and glide areas containing secondary habitat created by the collection of small woody debris (SMD) and large woody debris (LWD). WCT were found within boulder habitat but to a lesser extent than the complex pool and glide areas. Fish were also found holding in locations with deeper shoreline areas associated with rip-rap, and captured within the flooded interstitial spaces between the shot-rock. Numerous WCT were captured from all the concrete invert control structures. When they were poured, and through head-cutting scour, overhanging ledges and holes within the cement developed, which ultimately provided excellent overhead cover for rearing fish. Most often, WCT were captured within areas that provided the best available overhead cover. Both in 2005 (Berdusco and Wright, 2006) and 2006, WCT > 300 mm were captured beneath the bridge in lower reclaim channel reaches. The bridge offers good overhead cover and the water depth is normally ~1.0 m deep. Notable areas within the reclaimed channel were comprised of uniform riffles with little to no habitat variability. No fish were captured from these areas, and thus made a seemingly clumped distribution of WCT throughout the reclaimed channel.

Examination of all capture data indicated that the population estimate sites seem to be representative of their corresponding reaches. However, length-frequency histograms indicated that the population estimate sites generally do not represent older age classes of fish, although age 3 and older fish have been captured in previous surveys (Wright et al., 2005; Wright et al., 2004; Wright et al., 2001). Fish from larger age classes were captured from population estimate sites only during three of the seven years density estimates were completed. This result appears to indicate that larger fish do not traditionally inhabit these habitats and were captured through chance. Therefore, it is difficult to state whether or not the sites are truly representative of their corresponding reaches or underestimating the proportion of these adult fish in the population. Overall, the mark-recapture method provided larger sample sizes which ultimately reveal more representative results when considering the composition of individuals making up the WCT population.

Overall, the Henretta Creek Reclaimed Channel is continuing to provide adequate rearing habitat for WCT. As channel morphology and riparian vegetation progresses in development the available habitat for WCT will increase and improve in the future. Current conditions within the reclaimed channel indicate that a healthy population of WCT resides within this system and is apparently self sustaining.

Benthic Invertebrate Assessment

Fluctuations of invertebrate densities and percent composition for various metrics among years, provides insight into the dynamics of the invertebrate populations in the Henretta Creek system. Tracking these fluctuations may provide understanding of changing invertebrate assemblages in response to climatic, stream flow, water temperature or mining activities. Use of multiple biometric indices can allow deficiencies in using only one indicator to be lessened by the incorporation of many measurements, thereby increasing their interpretative power. It is important to note that the metrics are used primarily for exploratory baseline data analysis, rather than a confirmation or contradiction of human (or industry) impacts on streams (Westcott, 1999). Despite this, comparison of benthic invertebrate data was meaningful as the primary intent of invertebrate monitoring in the Henretta Creek Reclaimed Channel was to ensure that invertebrate communities, which are a vital part of the aquatic ecosystem, are returning and can be utilized by fish. Concerns relating to discrepancies in sampling locations within the mine area before and after mining are not controllable, considering that the entire channel had been removed and reclaimed. Considering this, the 1990 results should be used primarily for general reference and as an indicator of pre-mining taxa presence from a single survey.

The percent composition of benthic assemblages found at each site within the Henretta Creek system were found to slightly differ among years of monitoring (Amos et al., 2002; Wright et al., 2004; Wright et al., 2005). The compositions shifted slightly when considering the taxonomic order of benthic aquatic insects found within each sample population. Most often the shifts in percent composition were based on the ratios of Ephemeroptera to Diptera and Plecoptera to Trichoptera. From the data collected one can only speculate as to why these differences exist, which may be attributed to a range of parameters such as climatic and water quality variations or mining influences. Although these variations in the benthic assemblages were observed, it is difficult to state why these observations have occurred without further, more robust analyses which were beyond the scope of this project.

Gatherers/collectors and scrapers were the two functional feeding groups (FFG's) which were most abundant within each site's sample population. Specialized feeders, such as scrapers, are considered one of the more sensitive organisms and are thought to be well represented in healthy streams (Barbour et al., 1999). Generalists, such as collectors, have a broader range of acceptable food materials than specialized feeders and thus are more tolerant to pollution which may alter availability of certain food (Barbour et al., 1999). In consideration of these two points and the corresponding tolerance values it should be noted that whether or not a site was dominated by scrapers or gatherers/collectors, all sites had > 50% intolerant organisms. The 2006 functional feeding groups and tolerance values indicated that Henretta Creek was well represented by benthic organisms which indicated an overall healthy stream system. When comparing all benthic invertebrate assessments during the 7-year monitoring program, similar observations were noted as in 2006; except for the control site in 2004 when the percent tolerant organisms was calculated as 59.7% (Wright et al., 2005). It is difficult to infer whether or not the 2004 value was an anomaly, as there were only two other years of data to directly compare the result to.

The mean densities for each site from 2003 – 2006 were not found to be significantly different from one another. An R-square value of 0.569 indicated that the year the sample population was collected and the site at which it was taken, explained 57% of the variance in mean densities, which is high for a biological population. It can be inferred that each year a sample was taken; the stream and climatic conditions of that year directly affected the benthic invertebrate assemblage. Furthermore, even though sites were selected for their similar conditions, the individual sites affect the benthic communities present and most likely differ. Norecol (1990) found that there was a high degree of similarity between replicates within any individual site in Henretta Creek; however, when comparing benthic communities among individual sites they were found to be different, suggesting benthic assemblages are controlled by geographical proximity.

The upstream site in 2006 appeared to have fewer organisms sensitive to pollution and an increase in the percent tolerant organisms; however, this interpretation of results was statistically proven wrong. Benthic invertebrates change in abundance and taxa composition over seasonal cycles (Barbour et al., 1999). It may be that these cycles are more pronounced at downstream sample locations, as it is located near the transition zone between natural and reclaimed channel habitat, and therefore may represent unique habitat characteristics found nowhere else in Henretta Creek.

From the comparisons of results from all the years' data, any fluctuations noticed among years were interpreted as being the result of natural variations. With collection of long-term data, using the same techniques exercised in 2003, 2004 and 2006 keeping sampling variables equal so direct comparisons of data is possible; developing trends may be seen within the benthic invertebrate assemblages. The small period of record (three years) that is directly comparable, limits the power of any statistical analyses applied. Long-term data sets would provide a means of detecting above or below average results within the metrics calculated. Since only three years of comparable data is available for analysis, it is difficult to conclude whether or not the benthic communities are stabilizing.

Physical Channel Attributes

Since construction, downstream reclaimed sections have progressed as placed structures and natural processes work together to increase habitat complexity and variability. Streambed materials have sorted out, and will continue to increase the amount of suitable spawning substrate and gravel bars. Select bars in the lower portion of the reclaim channel have begun to establish vegetation, and in time, will offer the overhead cover, shade and food source beneficial to WCT populations (Scott and Crossman, 1979). The creation of these bars also deepens the channel, and we expect more glide habitat will result, increasing habitat variability and complexity. High survival of original planted shrubs and steadily improving riparian vegetation as a result are positively contributing to the amount of overhead cover and terrestrial invertebrate food sources, and an overall, stable and self-sustaining riparian zone. The additional habitat enhancements constructed in 2002 have increased the amount of usable habitat within the creek which was observed during fish sampling in 2005 and 2006. Natural, rounded gravels are beginning to accumulate in sorting areas throughout this stream section. Sources of recruitment are likely from gravel placed by Fording River Operations staff or bank and streambed erosion/deposition. The incorporation of this material into the stream is an important indicator of processes such as scour/deposition and erosion contributing to the succession of this reclaimed channel.

Henretta Lake riparian areas continue to grow and expand. Initially, the measured growth in these zones was slow, but as root structures have developed, plants have expanded in both height and density through suckering. The hydro-seeded slopes to the south of the lake are both well established with a dense mat of vegetation and are stable considering the affecting root structures. Since reclamation was completed, there has not been an occurrence of significant erosion of this slope. This particular slope and the hydric meadow have been the most likely areas to observe various types of wildlife utilizing the reclaimed channel for both feeding and refuge. Each year, browse is evident on grass and sedges covering the exposed knolls and moist ground surrounding them. Henretta Lake and the hydric meadow complex remain functioning as intended, while flow through the inlet and outlet was unchanged through the monitoring period. Sufficient depth at both the inlet (0.40 m) and the outlet (0.45 m) was observed in 2006 supporting the assumption that their corresponding elevations are not changing, and fish access to Henretta Lake is being maintained.

Since construction, bedload movement, thalweg location changes, LWD re-distribution and bed scour have all contributed to the greatly changed morphology of upper reclaim channel reaches. This was expected to occur as part of the natural process required to establish and stabilize the channel. Less complexity of habitat types resulted as the stream processes dictated glide/riffle/pool configuration immediately following construction. Now that a more stable channel is currently in place, these same processes will help the stream evolve towards a more natural, productive stream; slowly increasing the amount of habitat offered to WCT and re-instating the required habitat type complexity present after construction. In specific portions of the stream where these processes were not as evident, the progression towards this favourable type of stream is well underway. Consistent thalweg position has allowed banks to stabilize and re-establish vegetation, distributed LWD has begun to develop habitat in new locations, and deeper channel beds are resulting in glide habitat forming where riffles dominated previously. At no point during the entire 7-year monitoring program were de-watered or dry sections of stream observed.

Adequate depth was been maintained over each of the constructed invert controls, with only minor head-cutting noted. This had resulted in creation of viable and well utilized fish habitat. Deposition and sorting of stream-bed materials is very apparent in the upper section of the reclaim channel. With natural, rounded gravels noted in deposition zones, it was apparent that gravels and natural material from the banks and streambeds further upstream was being distributed into the reclaimed channel. We anticipate this inclusion of autogenic substrate, and the resulting stream bed will blanket the entire reclaim channel in the future and is an indication the Henretta Creek Reclaimed Channel is progressing towards a more natural and properly functioning stream through this important process.

Throughout the entire reclaimed channel's riparian areas and approach slopes, planted and seeded vegetation has become well established, expanding year to year. Originally noted in 2005, an indication of the self-sustaining nature of the riparian areas was the expansion of these shrubs and grasses to other areas not treated post construction. This type of improvement is an important indicator to solidifying the success of this reclamation project. No recent erosion of significant magnitude was noted in the reclaim channel. Riparian vegetation appears to have grown solid root systems, binding banks and approach soils. As a benefit, solid root structure in the soil and banks that line the channel prevent increased precipitation and sudden moisture events from resulting in mass movement or transport of soil material into the reclaimed channel.

The most recent formal riparian vegetation plot survey was completed in 2004. Due to increased density through suckering and seeding propagation, it was difficult to count individual stems and a recommendation was made to use the Proper Functioning Condition Assessment Procedure (PFC) (Pritchard, 1998) to evaluate the riparian plant communities as they progress into later stages of establishment. The final riparian assessment is scheduled for Year 10 (2009), and it is recommended that incorporation of the PFC method is included at that time.

## CONCLUSION

From mining through to reclamation, the Henretta project demonstrates the commitment and success of mining and reclamation practices at Teck Coal. Riparian zone vegetation, fisheries re-establishment, aquatic communities, and habitat utilization by terrestrial and avian species are all indicators of the ongoing success and development of this project.

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**Personal Communication**

O'Brien, B. January 2007. Personal communication with Ms. Billie O'Brien, Senior Environmental Planner, Elk Valley Coal Corporation, Fording River Operations, Elkford, BC email of precipitation and air temperature data to Mr. Jeff Berdusco, Environmental Technologist, Interior Reforestation Co. Ltd., Cranbrook BC.