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IDENTIFICATION AND IMPLEMENTATION OF FISHERIES COMPENSATION PROGRAMS AT THE KEMESS SOUTH MINE

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ABSTRACT

An extensive Fisheries Compensation Program has been undertaken at the Kemess Mine, located 10 kilometres east of Thutade Lake, in the northern Omineca Mountains of north central British Columbia. The minesite and study area are approximately 250 km north of Smithers, B.C. Annual fisheries monitoring programs were conducted during the predevelopment, construction and operation phases of the project and were critical in forming the basis of the compensation programs and later evaluation of program success. The fisheries compensation programs have achieved success in all aspects of the compensation. This paper will provide an overview of the efforts undertaken to accomplish the Compensation Programs, outline the challenges presented by the programs, and review their successes.

1.0 INTRODUCTION

The Kemess South open pit gold-copper mine is located in north-central British Columbia and was constructed in 1996/'98 and has been owned and operated by Northgate Exploration Ltd since February 2000. The Kemess South porphyry deposit contained a reserve of 163 million tonnes with an average grade of 0.67 grams/tonne gold and 0.23% copper, equating to 3.5 million ounces of gold and 830 million pounds of copper. Two of the major components of the Kemess Mine were the Tailings Storage Facility and the Waste Rock Dump. Construction of the Tailings Storage Facility was initiated in 1997 and the Waste Rock Dump in 1998.

The development of the Tailings Storage Facility and the Waste Rock Dump at the Kemess Mine impacted fish habitat utilized by bull trout and Dolly Varden. To offset these losses of fish habitat, an extensive Fisheries Compensation Agreement was developed and implemented. The Department of Fisheries & Oceans, Ministry of Environment and the Royal Oak Mines Inc. agreed upon the compensation programs.

The Compensation Programs were designed to mitigate the habitat loss associated with populations of bull trout and Dolly Varden. The bull trout population was based in Thutade Lake and moved into the Kemess Watershed to spawn and rear and can achieve a size of up to 90 centimetres. Approximately 50-85 pair spawn in the Kemess Watershed, comprising approximately 30% of the total Thutade population. The Dolly Varden are small stream resident fish and rarely exceed 15 centimetres in length. The programs included: (1) fish transplants to barren streams; (2) construction of an extensive water diversion system; (3) construction of three fish ladders (concrete weir design); (4) development of artificial spawning sites and (5) beaver dam removal to gain habitat access.

Initiation of the Compensation Programs began with a large-scale fish transplant program in 1996. The water diversion system was constructed in 1997 and operational in January 1998. The remainder of the compensation programs was initiated in 1999 and the monitoring will continue for the life of mine.

2.0 SITE LOCATION

The Kemess Mine is located 10 km east of Thutade Lake at the headwaters of the Finlay River, in the northern Omineca Mountains of north-central British Columbia and approximately 250 km north of Smithers, BC. The insert on Figure 1 shows the general location of the minesite.

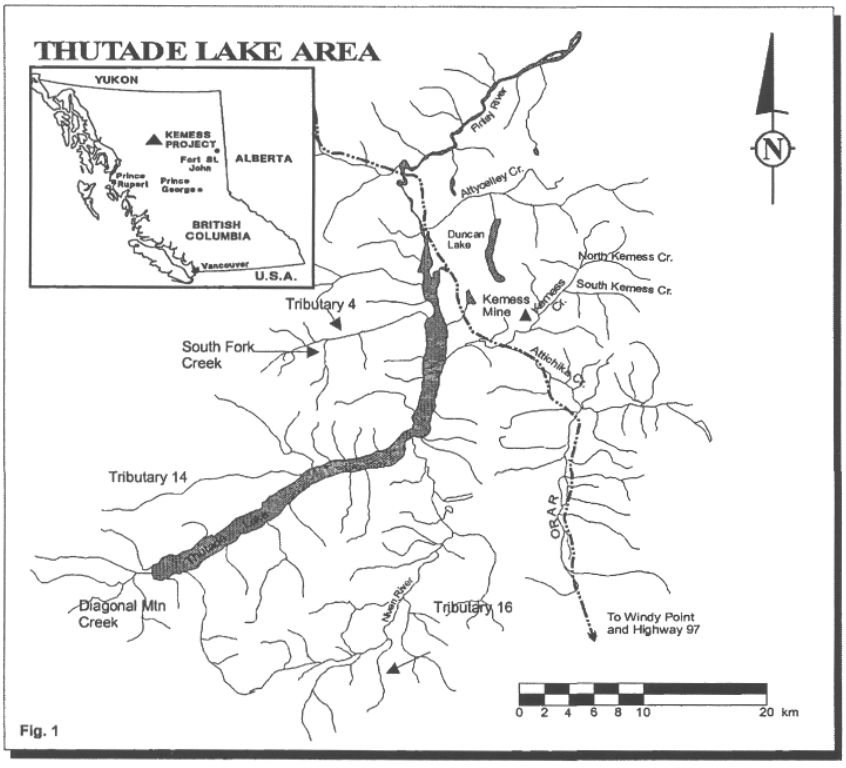


Fig. 1

3.0 HABITAT LOST DUE TO MINE DEVELOPMENT

The loss of fish habitat at the Kemess Mine occurred at two locations, (1) the Tailings Storage Facility and (2) the Waste Rock Dump. The development of the Tailings Storage Facility truncated the upper reaches of the South Kemess Creek and isolated its tributary South Arm Creek, resulting in the lost of 8 kilometres of stream channel and associated fish habitat. The lost the fish habitat occurred immediately upon the initiation of the dam construction in 1997. Prior to the construction of the Tailings Storage Facility, a fish salvage and transplant program was conducted in 1996 to prevent the isolation of fish within the new dam structure. The primary fish involved in the salvage and transplant were bull trout, Dolly Varden and mountain white fish.

The Waste Rock Dump development will result in the lost of 5 kilometres of a very small, low gradient resident Dolly Varden stream. However, the footprint of the Waste Rock Dump has not developed at the rate originally projected, as a large portion of the waste rock was used for buttress material in the Tailings Dam structure. Therefore, the lost of fish habitat did not occur until 2001. A salvage and transplant of Dolly Varden was conducted in 1996 and with further salvage conducted in 2000 just prior to encroachment on Waste Rock creek.

4.0 TRANSPLANT & RELOCATION OF FISH

Electro fishing and minnow trappings were used for the collection of fish in the impacted streams. Fish were transported in coolers, supplemented with oxygen and helicoptered to selected release sites.

Dolly Varden Transplant

A total of 2,460 Dolly Varden were salvaged for transplant; 610 Dolly Varden were salvaged from the Waste Rock area and 1,850 fish were salvaged from South Kemess and South Arm creeks. Waste Rock fish were released at locations in Diagonal Mountain Creek (Figure 1), while the South Kemess Dolly Varden were transplanted to small seepages in the upper reaches of Tributary 14.

The two streams were selected based upon the complex habitat components, including suitable over-winter and spawning habitat. Both locations are remote areas and a key to the selection was a lack of any other fish populations upstream from barrier falls located just upstream from Thutade Lake.

Program Success

Monitoring surveys conducted in 1997, 1998 and 2001 indicate that Dolly Varden have successfully spawned, produced fry and these fish are dispersing throughout both watersheds. Initial growth rates of transplanted fish were rapid but are declining as densities increase and food resources are exploited.

Bull Trout & Mountain White Fish Salvage

A total of 993 bull trout and 108 mountain whitefish were salvaged from the South Kemess drainage. The fish were released into Kemess Creek, at various locations immediately downstream of the South Kemess confluence.

5.0 MAINTAINING HABITAT IN SOUTH KEMESS CREEK

Water Diversion System & Low Flow Augmentation

A Water Diversion System (WDS) was constructed upstream of the Tailings Storage Facility (TSF). It consists of two earth fill dams, a run-of-the-river intake structure, two buried diversion conduits and a water release conduit. The functionality of the WDS diverts freshwater around the TSF into the South Dam reservoir for release into South Kemess Creek. The diversion system serves a two-fold purpose of controlling the TSF water balance and maintaining minimum flows in South Kemess Creek during the winter low flow period. The winter low-flow releases are designed to maintain base flows in South Kemess Creek and pre-development winter flows in lower Kemess Creek. Lower winter flows would result in dewatering of side channel areas that are very important for over wintering bull trout juveniles.

The South Diversion Dam is the primary WDS storage reservoir, with a capacity of 350,000 m^3 for low flow supplementation during winter months (mid-December to mid-April). The drainage catchment basin is 524 ha and represents 51% of the WDS catchment basin. These waters enter the South Dam via their natural drainage channel. The release of water is regulated via a sluice gate control assembly built into the dam structure. The released water enters a 3.7 km buried water conduit and discharges through an energy dissipation basin prior to entering South Kemess Creek.

The Eastern Diversion Intake is a run-of-the-river style intake that diverts water from South Kemess Creek, into the South Diversion Dam reservoir via a 4.8 km buried water conduit for storage and release. The drainage catchment basin is 330 hectares and represents 33% of the WDS catchment basin. The North Diversion Dam is a small earth fill dam that collects runoff from a 157 ha drainage catchment basin

and represents 16% of the WDS catchment basin. The diverted waters are transported via a 0.6 km buried water conduit to the South Darn reservoir.

The construction of the Water Diversion System was approximately $9 million. The additional cost to facilitate the storage of 350,000 cubic metres of water in the reservoir and the installation of a buried water conduit capable of delivering water during winter conditions was approximately $3.5 million.

Program Success

The WDS has been very successful and has operated as designed. The delivery of supplemental waters to South Kemess Creek during the low-flow period has prevented the loss of fisheries resources due to isolation and freezing during winter conditions. Specific release rates have also been incorporated into the annual operation to encourage bull trout spawner immigration into lower South Kemess Creek.

6.0 HABITAT ACCESS

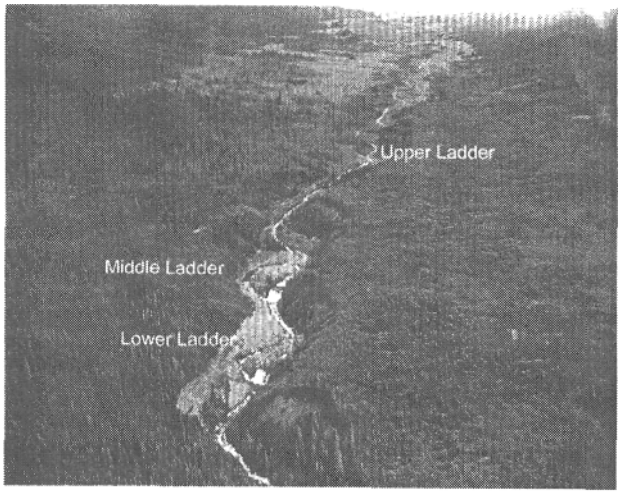
A number of other compensation options were agreed to by the federal and provincial government regulatory agencies and Royal Oak Mines Inc. to offset the loss of fish habitat due to mine development. The options consisted of construction of 3 fish ladders on South Fork Creek of Tributary 4 and selective removal of beaver dams on key Niven River tributaries. Both options provide new access to bull trout spawning and rearing habitat.

Fish Ladders

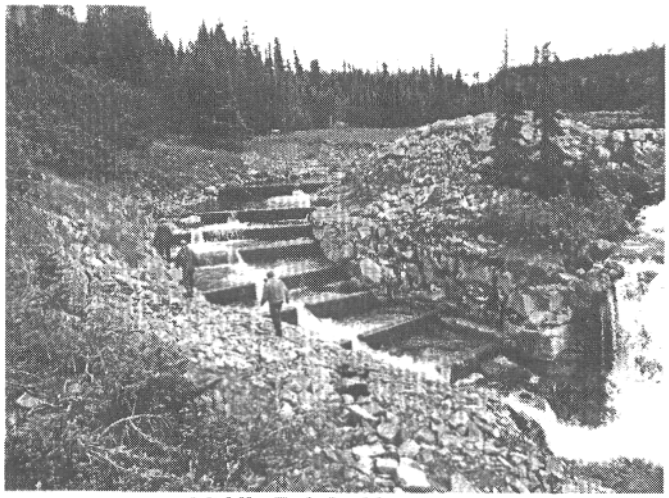
The south fork creek of Tributary 4 is located 8 km west of Thutade Lake and 20 km west-southwest of the minesite (Figure 1). Fisheries surveys had identified the south fork of Tributary 4 as a potential area to develop bull trout populations. During annual monitoring programs spawners were observed holding below the first impassable falls then drop down in the system to a few limited spawning sites.

The first barrier to fish migration on South Fork Creek was a 3 metre vertical impasse located approximately 0.6 km up the stream channel. In total there were 3 impasses in South Fork Creek that occurred within a distance of 0.4 km. The construction of 3 fish ladders allowed for access to the upper 2.5 kilometres of potential bull trout habitat. This was the main compensation project to offset the loss of bull trout habitat in South Kemess Creek.

In preparation for such a large construction project, independent engineering designs were developed for Concrete Weir Fish Ladders. The design incorporated the appropriate features of weir height and spacing, pool depths and vertical gain to facilitate the passage of bull trout. Some of the logistical challenges for the project included working in a remote area with no access and therefore the project was solely operated by helicopter support. The flying time to South Fork Creek from the Kemess Mine was 30 minutes per round trip.



South Fork Creek & the 3 Fish Ladders



Middle Fish Ladder

All construction materials for the project were staged at Kemess Mine and flown to South Fork Creek by a Sikorski 61 Helicopter. The materials consisted of: cement, sand, plywood forms & footings, rebar, small backhoe, mixer, generator, air track drill, compressor, welder, loader, 2 dumping trailers, *2* ATV's water pumps and other miscellaneous supplies. An independent satellite camp was established at the site for the duration of the construction project. Construction supervision and quality control was maintained through the entire construction program by an onsite representative of an independent engineering firm. The total cost for the three Fish Ladders was $933,300.

The construction project was initiated on July 9 and completed on September 16, 1999. Each fish ladder consists of a series of step weirs in an excavated channel that bypasses its associated vertical barrier. The individual weirs were rebar reinforced concrete walls, with a 0.5 metre by 0.5 metre deep notch for water passage and fish entry. The vertical drop between each successive weir is a maximum of 0.5 metres. To facilitate the manipulation of water flows into the new ladders, *2* control weirs were constructed at the upstream entrance to each ladder. A "Control Weir" was constructed at the entrance to the fish ladder and a "Main Channel Weir" was constructed in the original stream channel. The volume of water passing

through the new ladders and/or through the original stream channel is adjustable via the Stop Logs Blocks built into the 2 control weirs. This allows for the adjustment of water flow through the ladders to encourage usage by bull trout, to allow for redirecting the flows during ladder maintenance and to lessen the amount of water passing through the structures during high flow regimes (spring freshet).

Program Success

There has been limited success with the Fish Ladder program. The primary limitation is difficulty of fish passage into the Middle Ladder. To overcome this limitation a modification of the inlet pool will be constructed in 2002. Temporary test installations in 2001 determined a possible solution to be the construction of an inlet pool to the first weir on the ladder. However, there has been encouragement with ease of fish passage through the lower and upper ladders, as witnessed during the 1999 construction program and following the 1999 & 2000 transplant offish above the ladders.

Beaver Dam Removal

Additional bull trout access was gained through a beaver dam removal program on Tributary 16, a key tributary of the Niven River, (Figure 1). The tributary is located in a remote area and accessible only by helicopter, with a distance from the Kemess Mine of approximately 35 kilometres.

Previous fisheries surveys identified that approximately 5.5 kilometres of excellent bull trout habitat would be available for spawning and rearing with the removal of the beaver dams located near the bottom end of this tributary. The beaver dam removal program was conducted on July 22 to 28, 1999

A small satellite camp was established between the 2 beaver dam locations and all supplies were flown in by helicopter. At each location the dams were manually breached to slowly lower the water levels in the ponds over a 2-day period. Following the release of water, explosives were used to complete the removal of the dams. Four darns were removed in the lower site (400m upstream) and 2 dams were removed at the upper site (1200m upstream).

To prevent the re-establishment of the dams, non-climbing fencing was installed on both sides of the stream channel. The lower work site required approximately 215 metres of fencing along the stream banks and the upper work site required approximately 50 metres of fencing. To provide support and hold the fencing in place rebar rods were inserted on a 3 metre spacing interval. The total cost for the program was $32,500.

Tributary 16 - site of beaver dam removal and fencing

Program Success

The beaver dam removal program has been a successful, low cost and effective method of providing new habitat for bull trout. Bull trout immediately utilized the upper reaches of the creek following the 1999 dam removal program. To date, the annual surveys have recorded between 9 and 13 bull trout redds in the 5.5 kin of suitable habitat above the confluence with the Niven River, Due to the success of the program it has been expanded to include beaver dam removal on the nearby Tributary 12.

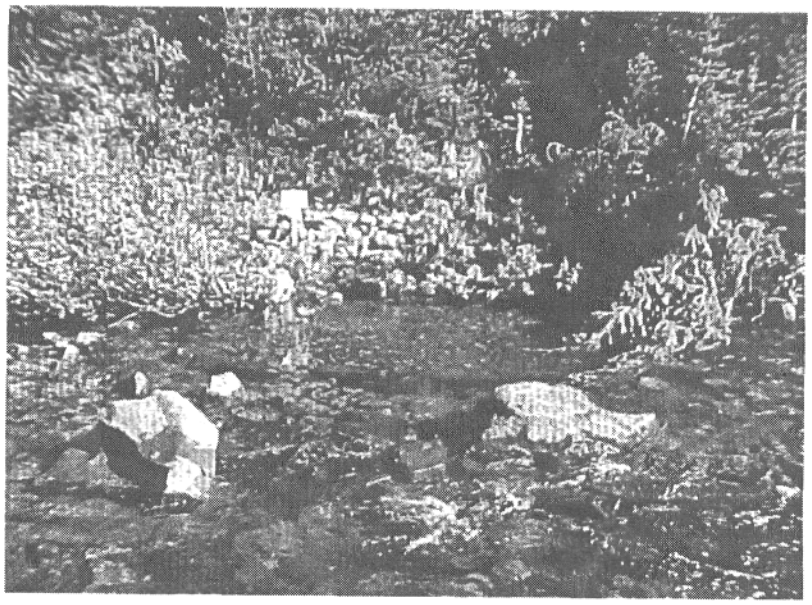
7.0 ARTIFICIAL SPAWNING HABITAT

South Fork Creek

Seven artificial spawning sites were developed in the 2,5 km reach above the upper fish ladder. The spawning bed work was completed during the period of August 4Ih to August 10*, 1999. Three spawning sites were constructed from existing insitu gravels and four spawning sites were constructed with screened gravels that were prepared at Kemess Mine and flown to the spawning bed location.

The artificial sites were pre-selected based upon suitable depth and velocity criteria for bull trout spawners, the presence of groundwater seepages and locations that would avoid excessive scour during high flow conditions. The sites were manually excavated to a depth of 40cm and over size material was selectively placed below the sites to prevent scour. The typical artificial spawning bed was 1.5 metres wide by 2 to 3 metres in length. The gravels were shoveled and raked into place for final preparation and

the beds were enhanced with manual placement of large organic debris cover. A total of 27 square metres of spawning habitat were created at a program cost of $38,500.



Tributary 4 artificial spawning bed

Program Success

The artificial spawning bed program has been partially successful in Tributary 4. Following successive freshets there has been significant scouring of some sites and the long-term survival of these sites is not certain. However a number of sites appear to have a greater likelihood of long-term survival. In 2000 four bull trout (3 males & 1 female) were transplanted above the fish ladders to encourage upward migration by other bull trout in the system by establishing a "scent". Three bull trout redds were established on the artificial beds. A similar bull trout transplant from below the fishway in 1999 resulted in development of 1 redd site. There were no redds recorded in 2001,

South Kemess Creek

Seven artificial spawning beds were constructed in the remaining 1.7 km section of South Kemess Creek. The work was completed from July 31 to August 3, 1999. All 7 spawning beds were constructed from prepared screened gravels at the Kemess Mine and transported to the creek. Historically bull trout had not utilized the lower section of South Kemess Creek for spawning due to lack of suitable bed material. The program would generate new spawning habitat in previously unused section of the stream channel.

Site selection was predetermined using similar criteria as stated above for South Fork Creek. At each site, existing cobbles and boulders were removed to a depth of 40 centimetres. The prepared screened gravels were transported to the creek in ore bags (~ $1m^3$ of gravel per spawning site). An excavator suspended the ore bags over the creek and the bag was cut open to release the gravels. The gravel was hand raked into place and oversize material was hand placed at the perimeter to minimize potential erosion. Large organic debris was added for cover at each location. The upper most spawning bed site did not have a proximal groundwater source. To provide groundwater to the area, a 175 metre long buried pipe was installed to deliver groundwater from an up gradient spring. Approximately 27 square metres of spawning habitat were created at a program cost of $52,200.

Program Success

The artificial spawning bed program has been very successful in South Kemess Creek. The annual surveys indicate that the beds are capable of surviving in the system through high flow conditions experienced during freshet. The 2001 annual surveys recorded 7 bull trout redds at the constructed sites in South Kemess Creek. This may be the first recorded success of bull trout using artificial beds in British Columbia.

8.0 CONCLUSIONS AND ACKNOWLEGEMENTS

The Kemess Mine fisheries compensation program was a large undertaking and presented a difficult challenge in achieving the No Net Loss policy of the Department of Fisheries & Oceans. In an effort to achieve this objective the proponent was required to examine potential options well beyond the drainage of the Kemess Watershed, in which the mine operated and the impact occurred. Ultimately, it required the construction of three fish ladders in a remote area that proved to be very costly and has not achieved the success of other simpler programs. However, there were also many positive fisheries accomplishments.

It must be acknowledge that David Bustard & Associates Ltd. was instrumental in the success of the Kemess fisheries compensation programs, and there were many successes. Their fieldwork provided the basis for all of the programs and gave Kemess Mine the best opportunity to achieve the objectives. In addition, the Annual Fisheries Monitoring programs conducted by Bustard et al were instrumental in recording the health of the fish populations during the entire construction to operation phase, which provided much comfort to the government agencies and Kemess alike. The authour will like to express appreciation for the invaluable efforts of Mr. David Bustard and Mr. Rob Dams.