YUKON PLACER SECRETARIAT

# Water Quality Monitoring Annual Report 2017

## Klondike River Watershed

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# Water Quality Objective Monitoring, Klondike River Basin, 2016

## Hydrologic and Geomorphic Characteristics of the Klondike River Drainage Basin

The Klondike River, a major tributary to the Yukon River, drains an area of approximately 7800 square kilometers and has an overall channel length, including the North Klondike River, of approximately 160 Km.

The North Klondike River, a tributary of the Klondike River, drains an area of approximately 1100 square kilometers. From its headwaters in the Ogilvie Mountains, the North Klondike flows in a southerly direction for approximately 75 kilometers until its confluence with the Klondike. It then flows west, down the valley as the Klondike for approximately 42 kilometers until it joins the Yukon River near Dawson. The North Klondike, for its first 58 kilometers, flows through a narrow valley entrenched between high mountains, the remaining length of the Klondike River flows south through relatively flat topography. The banks of the river are stable with relatively little erosion except during flood periods.

Water Survey of Canada's gauging stations are located near the mouth of the north Klondike (09EA004, Km 9.5 Dempster Highway), and at the mouth of the Klondike River (09EA003) near Dawson.

**North Klondike**

| | |
|---|---|
| Topographical drainage Basin | 1100 Sq. Kilometers |
| Area of Lakes | <2% |
| Area of Forest | <44% |
| Channel Length | 76.5 Kilometers |
| Terrain | glaciated |

**Klondike**

| | |
|---|---|
| Topographical drainage Basin | 7800 Sq. Kilometers |
| Area of Lakes | <1% |
| Area of Forest | <30% |
| Channel Length | 160 Kilometers |
| Terrain | Left Limit: non-glaciated<br>Right Limit: glaciated |

In 2017, water samples were collected at 31 sites in the Klondike River basin. Sampling commenced on May 24, 2017 and 690 samples were collected up until the end of the season on September 28, 2017. A combination of automatic composite sampling and grab sampling methods were used in the basin. In addition to automated sampling equipment, level monitoring instrumentation was installed at three sites, on Bonanza Creek, just upstream of the confluence with the Klondike River and on Hunker Creek , upstream of the highway crossing which is below all mining (BAM), and at the Klondike confluence. This monitoring equipment has provided us with additional data that correlates with the precipitation data collected via our portable weather stations and has allowed us to derive changes in stream flow and water velocity at these sites.
An additional 101 samples were collected by CMI staff during routine mine inspections.

Atmospheric data was collected using three portable weather stations located at Hunker Creek, North Klondike River and the Klondike River. Additional information was provided through the Yukon Government Community Services weather station at the Klondike Fire Center, located at the Dawson City Airport.

Basin total flow data was provided to us by the Water Survey of Canada station located near the mouth of the Klondike River. Flow data for the individual tributaries to the Klondike River was collected at the time of sampling by the staff of E.M.R CMI using the methodology outlined in the Yukon Placer Secretariat's, Water Quality Monitoring Protocol.

## Site Codes and Global Position of Water Quality Sampling Locations in the Klondike River Watershed

| SITE_DESCRIPTION | SITE_CODE | LATITUDE_DD | LONGITUDE_DD |
|---|---|---|---|
| Klondike River mouth | KL01 | 64.05348 | -139.43961 |
| Klondike River upstream of Bonanza Creek | KL02 | 64.04311 | -139.40936 |
| Klondike River upstream of Hunker Creek | KL03 | 64.03619 | -139.20204 |
| Klondike River downstream of Goring Creek and upstream of Hunker Creek | KL04 | 64.05810 | -139.03092 |
| Klondike River at Dempster Highway | KL05 | 63.99030 | -138.74612 |
| Klondike River downstream of Too Much Gold Creek and upstream of Dempster highway | KL06 | 63.95778 | -138.69030 |
| Klondike River upstream of Too Much Gold Creek | KL07 | 63.95131 | -138.66690 |
| Klondike River at highway washout downstream of Flat Creek | KL08 | 63.95782 | -138.69005 |
| North Klondike River upstream of confluence with Klondike River | KL_NK01 | 64.00195 | -138.59622 |
| Adams Creek mouth | KL_BO_AD01 | 63.93412 | -139.33099 |
| All Gold Creek below all mining | KL_AL01 | 63.94263 | -138.61734 |
| Eldorado Creek mouth | KL_BO_EL01 | 63.91943 | -139.31390 |
| Elodorado Creek Left Fork | KL_BO_EL06 | 63.86261 | -139.24573 |
| Eldorado Creek Right Fork | KL_BO_EL05 | 63.86261 | -139.24573 |
| Eldorado Creek downstream of French Gulch | KL_BO_EL02 | 63.91267 | -139.31483 |
| Eldorado Creek upstream of French Creek | KL_BO_EL03 | 63.90855 | -139.31382 |
| Upper Eldorado Creek background | KL_BO_EL04 | 63.86187 | -139.24578 |
| Flat Creek below all mining | KL_FL01 | 63.94308 | -138.60225 |
| French Gulch mouth | KL_BO_EL_FR01 | 63.90865 | -139.31442 |
| Goldbottom Creek mouth | KL_HU_GO01 | 63.96433 | -138.96706 |
| Last Chance Creek mouth | KL_HU_LA01 | 64.01050 | -139.09091 |
| Too Much Gold Creek mouth | KL_TO01 | 63.95132 | -138.66708 |
| Victoria Gulch mouth | KL_BO_VI01 | 63.91261 | -139.20930 |
| Bonanza Creek below all mining | KL_BO01 | 64.04054 | -139.40814 |
| Lower Bonanza Creek | KL_BO02 | 64.01295 | -139.37022 |
| Lower Bonanza Creek downstream of bridge | KL_BO03 | 63.97027 | -139.35472 |
| Bonanza Creek downstream of Adams Gulch | KL_BO04 | 63.93550 | -139.32798 |
| Bonanza Creek upstream of Adams Gulch | KL_BO05 | 63.93415 | -139.32977 |
| Bonanza Creek downstream of Eldorado Creek | KL_BO06 | 63.92047 | -139.31600 |
| Upper Bonanza Creek upstream of Eldorado Creek | KL_BO07 | 63.91943 | -139.31390 |
| Upper Bonanza Creek upstream of Victoria Gulch | KL_BO08 | 63.91261 | -139.20930 |
| Hunker Creek below all mining | KL_HU01 | 64.02943 | -139.17867 |
| Hunker Creek mouth - most upstream fork | KL_HU01C | 64.03619 | -139.20204 |
| Hunker Creek mouth fork with multiple channels - larger creek bed | KL_HU01B | 64.03592 | -139.20201 |
| Hunker Creek mouth behind Fischer's gas station | KL_HU01A | 64.03382 | -139.20634 |
| Hunker Creek downstream of Henrry Gulch | KL_HU02 | 64.02838 | -139.17522 |
| Hunker Creek downstream of Last Chance Creek | KL_HU03 | 64.01345 | -139.09187 |
| Hunker Creek upstream of Last Chance Creek | KL_HU04 | 64.01050 | -139.09091 |
| Hunker Creek downstream of Goldbottom Creek | KL_HU05 | 63.96918 | -138.98291 |
| Hunker Creek upstream of Goldbottom Creek | KL_HU06 | 64.96433 | -138.96706 |
| Hunker Creek above all mining left fork | KL_HU07 | 63.91105 | -138.88522 |
| Hunker Creek right fork | KL_HU08 | 63.89025 | -138.92522 |
| Hunker Creek above all mining and downstream of right and left fork | KL_HU09 | 63.91503 | -138.88501 |

**Water Quality Objective monitoring, Klondike River Watershed – Summary**

The Klondike River Watershed was once again designated a 'watershed of interest' for monitoring in 2017 as it likely will remain for many more years to come.

Five automatic water-sampling stations, three portable weather-monitoring stations and three level logger sites were set up and maintained from May 24, 2017 until shutdown on September 28, 2017. Water sampling sites in the Klondike received multiple visits during the monitoring season owing to their close proximity to Dawson.

The objective of the monitoring is to answer two key questions:
(1) Are the WQO established in the new regime being achieved?
(2) If not, is this due to placer mining activity or to other causes?

From the data obtained by these instruments and through on site visits and sampling conducted by CMI staff, the following observations regarding the water quality in the basin can be made:

Question #1 - Are the WQO established in the new regime being achieved?

On average, over this monitoring period, the water quality objectives (WQO) were met at all but 2 sites in the watershed: Hunker Creek below all mining and Bonanza Creek below all mining. On several days of monitoring, the WQO were not met at some of the other sites as well.

Out of the 690 water samples collected on the Klondike River, Hunker and Bonanza Creek and several other tributaries, the water quality met the minimum objectives set under the Fish Habitat Management System daily **57.1** percent of the time.

On those occasions when the WQO were not met and the Total Suspended Solids levels were greater than the objectives, a direct correlation between environmental conditions and the volume of solids in the water was observed. In most cases, rainfall, as either localized events or basin wide occurrences, increased the amount of surface run off and subsequent soil erosion from the land, increasing the input of sediment into the receiving waters.

These increases occurred simultaneously at the time of the rain event or in a period of one or two days after the rain event, as surface water continued draining from the land and ground water infiltrated the watercourse.

Increases in sediment-laden ground and surface water entering the system add to the amount of sediment in the water. The ability of the receiving water to dilute these inputs of sediment is negated by the re-suspension of streambed material and by the further erosion of the streams banks that occurs along with the increased flows that are generated by the aftermath of these rain events.

Question #2 - If not, is this due to placer mining activity or to other causes?

In order to fully understand the root cause of the WQO not being achieved, the following information and data will be required:

a. Extent of placer mining upstream from monitoring sites.

b. The distance between monitoring sites and placer activity

c. The timing, flow volume and duration of effluent discharge from upstream sites.

d. History of forest fire upstream of the monitoring site.

e. Recent flood events / high water at the time of sampling.

f. Natural water quality or background.

Heightened sediment inputs and diminished water quality is thought to be due to rain events in the monitored areas. Surface water runoff and ground water infiltration into a body of water will intensify the sediment-loading while at the same time increase the rate of flow. The increased flow can scour bank and bed material, compounding the loading. These increases are generally well correlated in the frequency and duration to recorded rain events however, not every time. Spikes in solids concentrations have been observed during periods of no precipitation. Why this occurs is yet to be determined. The additional information requirements listed above would assist in answering this and other related questions.

Knowing exactly from where and when these non-point sources of this additional sediment originate or why they occur is a critical question. Are previously or current mined areas more susceptible to ground and surface erosion than primary old growth and regenerated areas? Are there non-mitigated sources of input and could there be better control of these areas? If results indicate that point source effluent discharge appears to have little to no effect when discharge standards are maintained, and generally, compliance has been the norm, then what is the effect of multiple non-point sources and effluent exceedances on water quality?

Without the monitoring and evaluation of water quality upstream and downstream of stripped, mined and reclaimed sites and without the collection of additional water quality and flow data of mine effluent discharge in a watershed, most of these questions detailed above will remain unanswered. Any causal direct relationship to mining activity versus other natural environmental occurrence cannot be categorically determined if the additional information and data listed above is not collected, a task which is beyond the scope of this protocol and will have to be addressed through another regime component within the Fish Habitat Management System.

## The Fish Habitat Management System - Klondike River Watershed (Category A)
## Sample Results that Exceed Water Quality Objectives for 2017

| Sampling Station | KL01 | KL_BO01 | KL02 | KL_HU01 AT HWY XING | KL_HU01C, KLONDIKE CONFL. | KL03 | KL05 | KL06 | KL_NK01 | KL_FL01 |
|---|---|---|---|---|---|---|---|---|---|---|
| Location Description | Mouth | BAM | u/s KL_BO01 | BAM | Mouth | u/s KL_HU01 | at demptser hwy | u/s dempster hwy | u/s of Klondike R | Mouth |
| Sample Type | *Grab* | Auto/*Grab* | Auto/*Grab* | Auto/*Grab* | Auto/*Grab* | *Grab* | *Grab* | *Grab* | Auto/*Grab* | *Grab* |
| Lat Y | 64.05348 | 64.04054 | 64.04237 | 64.02943 | 64.03619 | 64.03529 | 63.99030 | 63.95778 | 64.00195 | 63.94316 |
| Long X | -139.43961 | -139.40814 | -139.40956 | -139.17867 | -139.20204 | -139.20909 | -138.74612 | -138.69030 | -138.59622 | -138.60188 |
| Habitat Classification | Area of special consideration | Moderate-L | Area of special consideration | Moderate-L | Moderate-L | High | High | High | High | Moderate-L |
| Water Quality Objective (mg/L) | 25 | 80 | 25 | 80 | 80 | 25 | 25 | 25 | 25 | 80 |
| Date of Sampling | | | | | | | | | | |
| | | | | | | | | | | |
| 24-May-17 | | 110.4 | | *183.6* | 56.4 | *42.4* | | | 16.0 | |
| 25-May-17 | *26.0* | 132.0 | *27.2* | 158.0 | 35.6 | | | | 12.4 | |
| 26-May-17 | *24.0* | 88.8 | *24.8* | 1406.4 | 26.8 | | | | 8.4 | |
| 27-May-17 | | 33.2 | | 103.2 | 65.2 | | | | 12.8 | |
| 28-May-17 | | 17.2 | 14.8 | 117.2 | | | | | 7.6 | |
| 29-May-17 | | 16.0 | 3.6 | 146.4 | | | | | 10.0 | |
| 31-May-17 | | 15.2 | 26.0 | 286.4 | | | | | 13.2 | |
| 1-Jun-17 | | 12.8 | 0.8 | 433.2 | | | | | 6.4 | |
| 2-Jun-17 | | 25.2 | 1.6 | 566.0 | | | | | 1.2 | |
| 3-Jun-17 | | 36.8 | 8.0 | 674.0 | | | | | 4.4 | |
| 4-Jun-17 | | 14.8 | 4.4 | 689.3 | | | | | 4.4 | |
| 5-Jun-17 | | 10.0 | 1.6 | 684.7 | | | | | 0.8 | |
| 6-Jun-17 | | 31.2 | 9.2 | 857.3 | | | | | 4.8 | |
| 7-Jun-17 | | 25.6 | 1.2 | 179.2 | | | | | 0.8 | |
| 8-Jun-17 | | 6.4 | 1.6 | 549.2 | | | | | 1.2 | |
| 9-Jun-17 | | 19.6 | 5.6 | 202.4 | | | | | 5.6 | |
| 10-Jun-17 | | 12.4 | 1.2 | 234.8 | | | | | 2.0 | |
| 11-Jun-17 | | 6.8 | 1.6 | 127.6 | | | | | 2.8 | |
| 21-Jun-17 | | 8.0 | 39.6 | 5.6 | | | | | 1.6 | |
| 25-Jun-17 | | 234.0 | 4.8 | 44.4 | | | | | 4.8 | |
| 11-Jul-17 | *8.8* | 213.6 | 11.6 | 314.0 | *118.0* | | | | 1.6 | |
| 12-Jul-17 | | 1259.2 | 31.6 | 1012.0 | 194.0 | | | | 0.8 | |
| 13-Jul-17 | *36.0* | 141.2 | 72.4 | 177.0 | 80.7 | | | | 1.2 | |
| 15-Jul-17 | | 43.2 | 15.6 | 104.0 | 52.5 | | | | 2.0 | |
| 16-Jul-17 | | 46.0 | 14.4 | 88.0 | 68.4 | | | | 1.6 | |
| 17-Jul-17 | | 12.0 | 8.4 | 37.6 | 56.5 | | | | 2.8 | |
| 18-Jul-17 | | 340.4 | 8.0 | 256.5 | 45.5 | | | | 0.8 | |
| 19-Jul-17 | | 269.2 | 24.4 | 2682.5 | 622.0 | | | | 4.0 | |
| 20-Jul-17 | | 252.8 | 8.4 | 119.5 | 66.4 | | | | 2.8 | |
| 21-Jul-17 | | 3300.0 | 28.4 | 2417.5 | 582.0 | | | | 2.8 | |
| 22-Jul-17 | | 538.4 | 10.8 | 468.0 | 218.0 | | | | 1.6 | |
| 23-Jul-17 | | 225.2 | 12.8 | 97.5 | 54.0 | | | | 1.2 | |
| 24-Jul-17 | | 223.2 | 5.6 | 59.0 | 51.2 | | | | 1.6 | |
| 25-Jul-17 | *2.4* | 337.2 | 8.4 | 44.0 | 46.4 | *4.0* | | | 2.8 | |
| 26-Jul-17 | | 303.2 | 2.0 | 58.0 | 68.0 | | | | 2.0 | |
| 27-Jul-17 | | 714.4 | 3.6 | 185.2 | 64.4 | | | | 3.2 | |
| 28-Jul-17 | | 319.6 | 1.2 | 81.2 | 62.4 | | | | 1.2 | |
| 29-Jul-17 | | 170.8 | 1.2 | 49.2 | 44.0 | | | | 0.8 | |
| 30-Jul-17 | | 24.8 | 1.2 | 46.4 | 26.8 | | | | 1.6 | |
| 31-Jul-17 | | 67.2 | 1.2 | 26.4 | 34.4 | | | | 2.4 | |
| 1-Aug-17 | | 250.0 | 1.2 | 120.4 | 31.6 | | | | 2.0 | |
| 2-Aug-17 | | 145.2 | 1.2 | 27.6 | 14.4 | | | | 1.6 | |
| 3-Aug-17 | | 174.8 | 0.8 | 19.6 | 14.8 | | | | 0.8 | |
| 4-Aug-17 | | 82.4 | 3.6 | 24.0 | 26.0 | | | | 2.4 | |
| 5-Aug-17 | | 179.2 | 0.8 | 15.2 | 11.6 | | | | 1.6 | |
| 6-Aug-17 | | 116.4 | | 14.4 | 15.6 | | | | 2.0 | |
| 15-Aug-17 | | 30.8 | | 127.2 | 35.2 | | | | 2.4 | |
| 16-Aug-17 | *4.0* | 40.4 | 8.0 | 327.2 | 313.2 | *7.2* | | | 4.0 | |
| 17-Aug-17 | | 32.4 | 0.8 | 159.2 | | | | | 2.0 | |
| 18-Aug-17 | | 24.8 | 0.8 | 110.8 | | | | | 0.4 | |
| 22-Aug-17 | | 8.4 | 2.4 | 196.0 | | | | | 3.2 | |
| 23-Aug-17 | | 37.2 | 3.2 | 213.2 | | | | | 6.4 | |
| 24-Aug-17 | | 16.4 | 2.8 | 135.6 | | | | | 2.0 | |
| 25-Aug-17 | | 102.4 | 4.0 | 23.6 | | | | | 6.4 | |
| 26-Aug-17 | | 118.4 | 1.2 | 37.2 | | | | | 3.2 | |
| 28-Aug-17 | | 129.6 | 2.8 | 20.8 | | | | | 6.0 | |
| 30-Aug-17 | | 84.0 | 3.6 | 16.4 | | | | | 4.0 | |
| 31-Aug-17 | | 1394.4 | 7.6 | 267.6 | | | | | 6.8 | |
| 1-Sep-17 | | 104.0 | 4.8 | 170.8 | | | | | 3.6 | |
| 2-Sep-17 | | 94.0 | 4.0 | 73.6 | | | | | 7.2 | |
| 3-Sep-17 | | 32.0 | 5.6 | 123.2 | | | | | 2.8 | |
| 6-Sep-17 | *2.8* | 66.4 | 3.2 | 96.8 | 24.4 | *2.8* | *2.4* | | 8.0 | *1.6* |
| 8-Sep-17 | *5.2* | 32.8 | 5.6 | 48.8 | 36.8 | | | | 1.2 | |
| 11-Sep-17 | | 36.8 | 28.0 | 124.4 | 58.0 | | | | 0.8 | |
| 12-Sep-17 | | 34.8 | 74.8 | 57.2 | 42.0 | | | | 0.4 | |
| 13-Sep-17 | | 36.0 | 32.0 | | 39.2 | | | | 2.0 | |
| 14-Sep-17 | | 45.6 | 14.8 | 93.6 | 34.0 | | | | 1.6 | |
| 15-Sep-17 | | 16.4 | 14.0 | 136.8 | 40.8 | | | | 3.2 | |
| 16-Sep-17 | | 18.8 | 7.2 | 105.6 | 61.6 | | | | 0.8 | |
| 19-Sep-17 | | 24.8 | 10.0 | 80.0 | 42.4 | | | | 2.8 | |
| 20-Sep-17 | | 38.8 | 6.0 | 104.8 | 84.4 | | | | 0.4 | |
| 21-Sep-17 | | 28.4 | 7.2 | 58.0 | 110.0 | | | | 2.0 | |
| 26-Sep-17 | *5.6* | 12.4 | 4.8 | 87.0 | 102.8 | | | | 1.6 | |
| 28-Sep-17 | | | | | 105.6 | *4.8* | | | | |
| Total Seasonal Average TSS (mg/L) by site | 10.1 | 114.5 | 8.8 | 167.5 | 58.9 | 9.2 | 2.4 | | 3.2 | 1.6 |
| Number of days sampled | 12 | 126 | 114 | 124 | 71 | 8 | 1 | | 125 | 1 |

| Legend | |
|---|---|
| | Not continuously monitored |

Water Samples that are: Above / Below the Water Quality Objective